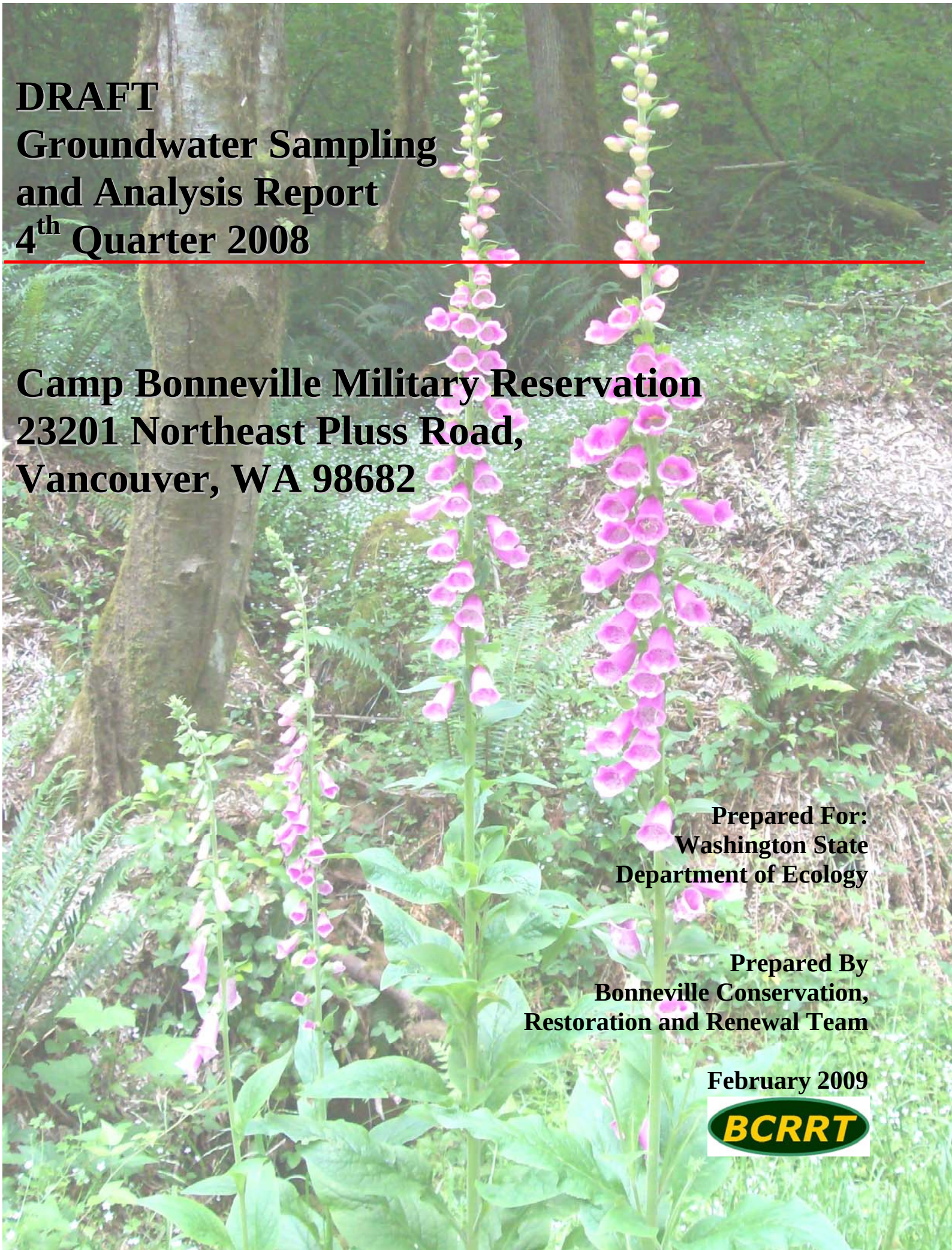


DRAFT
Groundwater Sampling and Analysis Report 4th Quarter 2008

Camp Bonneville Military Reservation
23201 Northeast Pluss Road, Vancouver, WA 98682

Prepared For:
Washington State Department of Ecology

Prepared By
Bonneville Conservation, Restoration and Renewal Team

February 2009

BCRRT

Michael Baker Jr., Inc.
A Unit of Michael Baker Corporation

5261 Fountain Drive
Suite A
Crown Point, IN 46307

219-736-0263
FAX 219-755-0233

Engineering & Energy

February 11, 2009

Mr. Mike Gage
Bonneville Conservation Restoration and Renewal Team, LLC (BCRRT)
Camp Bonneville
23201 NE Pluss Road
Vancouver, WA 98682

SUBJECT: Draft Groundwater Sampling and Analysis Report – 4th Quarter, 2008 for the former Camp Bonneville Military Reserve located in Vancouver Washington

Dear Mr. Gage:

This letter and its attachments constitute the Draft Groundwater Sampling and Analysis Report – 4th Quarter, 2008 for submittal to the Washington Department of Ecology (WDOE). The Electronic Data Deliverable (EDD) was uploaded to the Camp Bonneville website for access by WDOE on February 4, 2009. Attached to this letter are:

1) Figures 1, 2, 6 and 7
2) Groundwater Data Graphics,
3) Draft Groundwater Sampling and Analysis Report – 4th Quarter, 2008 by PBS Engineering and Environmental (PBS), and
4) Electronic copies of the submittal on CD.

Following your review, please forward two copies of the entire submittal to:

Mr. Ben Amoah-Forson, Ph.D., P.E.
Washington State Department of Ecology
Toxics Cleanup Program
PO Box 47600
300 Desmond Drive
Olympia, Washington 98504

4th Quarter 2008 Sampling Event Delay

The 4th quarter 2008 monitoring event was delayed due to a series of strong winter storms which impeded travel to/from the site, laboratory supply/sample shipment, and could have altered routine sample procedures. WDOE agreed that PBS, BCRRT's subcontractor, could delay the sampling until the weather moderated. The gsampling was performed in the first full week in January 2009 (but is still referred to as the 4th qtr 2008 event).

There was significant precipitation just prior to/during the sampling event with water in the North Fork of Lacamas Creek cresting high enough to threaten the road/culverts south of LF4/DA1, flood the LFMW17 location, and cause higher than usual purge water turbidity readings at LFMW17 and 18.

The data from the 4th quarter sampling is expected to have some deviations from previous results/patterns/trends due to the sampling event delay/offset and significant precipitation prior/during sampling.

Recent Groundwater Sampling Results at Boundary Area/Sentinel Wells

- With the use of dedicated pumps and low flow purging/sampling techniques (which obtain water samples with lower turbidity), the total and dissolved metals concentrations have decreased significantly. All of the total and dissolved metals detections in groundwater from these wells were below MTCA Method A and B regulatory screening levels.

- Petroleum hydrocarbons have not been detected in any of the Boundary Area/Sentinel Wells throughout the monitoring, except for an isolated detection of diesel range petroleum hydrocarbons in LCMW02DW at 0.15 mg/L in January 2006.

- Perchlorate or Explosive constituents have not been detected at any of the Boundary/Sentinel Wells.

- No deviations with the Boundary/Sentinel well results were attributed to the 4th quarter sampling delay/offset or significant precipitation prior/during to sampling.

Recent Groundwater Sampling Results at Landfill 4/Demolition Area 1 Wells

The 4th quarter 2008 monitoring event was delayed due to a series of strong winter storms which impeded travel to/from the site, laboratory supply/sample shipment, and could have altered routine sample procedures. WDOE agreed to that PBS, BCRRT's subcontractor, was to conduct the event once the weather moderated and the sampling was performed the in the first full week in January (but still referred to as the 4th qtr 2008 event). Upon review of historic groundwater data at Landfill 4/Demolition Area 1, the following appears to be occurring at the site:

- HMX and RDX concentrations in groundwater have been relatively stabile in both concentration and distribution throughout all of the 23 LF4/DA1 groundwater sampling events (2001 to 2009).

- Well LF4-MW-1A – perchlorate concentrations of 36 parts per billion (ug/L) were elevated compared with the prior 17 sampling events with previous levels ranging from 1.6 to 17 ug/L; this well is located upgradient of the LF4/DA1. This increase may be attributed significant precipitation prior/during to sampling which could "push" contamination upgradient during an unusual spike in groundwater level and/or additional flushing of residual impacted soils.

- Well LF4-MW-1B – although an estimated (above the MDL but below the MRL) perchlorate detection (0.59, 0.32, and 0.73J ug/L) were reported in the last three sampling events, this result may not be representative of onsite conditions but rather reflect the replacement of the previous analytical laboratory. While the effects of the heavy precipitation (just prior and during the sampling event) have not been realized yet, LFMW1B, since this well is located upgradient of the LF4/DA1 and the shallow well LF-MW-1A has an established history of low perchlorate concentrations, neither the detection nor absence of perchlorate at this well effects the monitoring program.

- Well LF4-MW-2A – perchlorate concentrations appear to have reached a degree of equilibrium during the last ten quarterly sampling events (2006 to 2009) with perchlorate concentration/groundwater level patterns that are almost identical. The seasonal variation appears to be inversely correlated with increased precipitation/groundwater elevations:

    - The lowest perchlorate concentrations/highest groundwater level occur in the 1st quarter events (~140 to 150 ug/L, ~ 495 mean sea level [MSL]), < 5 inches of precipitation, versus,
    - The highest perchlorate concentrations/lowest groundwater level occur in the 3rd quarter events (~240 to 280 ug/L, ~ 490 MSL, and > 20 inches of precipitation).

    The perchlorate concentration has begun its seasonal decrease during this sampling event and the overall 2007/2008 trend is slightly decreasing.

- L4MW2B perchlorate levels follow a quasi-seasonal pattern with a very slight decreasing trend from a peak concentration (530 ug/L, 3rd quarter 2006) when the longer lag time for seasonal effects are taken into consideration. While the last four quarters have seen an increased in perchlorate concentration:

    - The rate of increase decreased between the 3rd and 4th quarter versus the previous quarters (i.e. leveling off), and,
    - The 520 ug/L 4th quarter result is less than the previous peaks (up to 530 ug/L in 3rd qtr 2008).
    - The effects of the heavy precipitation just prior and during sampling have not been realized yet.
    - It is anticipated that the LF4MW2B perchlorate levels will decrease again, based on the cyclical pattern observed since 2007."

    The perchlorate concentration patterns observed in LF-MW-2A are not repeated in the LF-MW-2B data. There has been little historical connection between perchlorate concentrations and precipitation/groundwater elevations at this well,

    LF4-MW-2B concentrations of 1,1-Dichloroethene and 1,1- Dichloroethane have been relatively stable, Tetrachloroethene results are just above the detection level, and the concentrations of Dichlorodifluoromethane and 1,1,1-Trichloroethane have been steadily decreasing. Measured concentrations of all of these detections in 4th Quarter 2008 samples were below MTCA Method A or B regulatory screening levels. Low levels of 1,2-Dichloroethane (1.58 ug/L) were also detected at below MTCA Screening levels.

- Well LF4-MW-3A - perchlorate concentrations have remained relatively stable with a low in 1st quarter 2008 and a raised peak concentration of 120 ug/L during the 4th quarter 2006 sampling event.

- Well LF4-MW-3B - perchlorate concentrations have remained below the peak concentration (55 ug/L) observed in the 4th quarter 2006 and sampling event.

- Well LF4-MW-4A - perchlorate concentrations increased to a peak concentration (40 ug/L) observed in the 4th quarter 2006 and 2nd quarter 2007 sampling events but has reduced to between 29 to 34 ug/L for the last six quarters.

- Well LF4-MW-5A - perchlorate concentrations have been generally stable after decreasing from a peak of 64 ug/L in the initial sampling event in the 4th quarter 2001to less than 42 ug/L during the last 8 quarters. The trace detections of Tetrachloroethene have been generally stable at <1 ug/L; below MTCA Method A or B regulatory screening levels.

- Well LF4-MW-7B - perchlorate concentrations have been generally stable at 2 to 4 ug/L for the last 21 quarterly sampling events (with the exception of an apparent field cross contamination issue during the 1st quarter 2006 event/field staff were retrained to address this issue).

- Well LF4-MW-17 – the 2nd Quarter 2008 estimated (above the MDL but below the MRL) concentrations of 1,2,4-Trimethylbenzene and Naphthalene (0.12 and 0.35 ug/L, respectively) were non-detectable in the 3rd and 4th Quarter 2008 samples.

The LF4/DA1 and Boundary Area/Sentinel Wells analytical detections continue to follow the patterns and concentrations that have been observed throughout the sampling events conducted for BCRRT. BCRRT submitted a request for modifications to the analytical parameters for the 2009 monitoring events in the January 2009 Draft Perchlorate Evaluation Landfill 4/Demolition Area 1 (RAU 2C).

If you have any questions, please contact me at (219) 736-0263.

Very truly yours,

MICHAEL BAKER JR., INC.

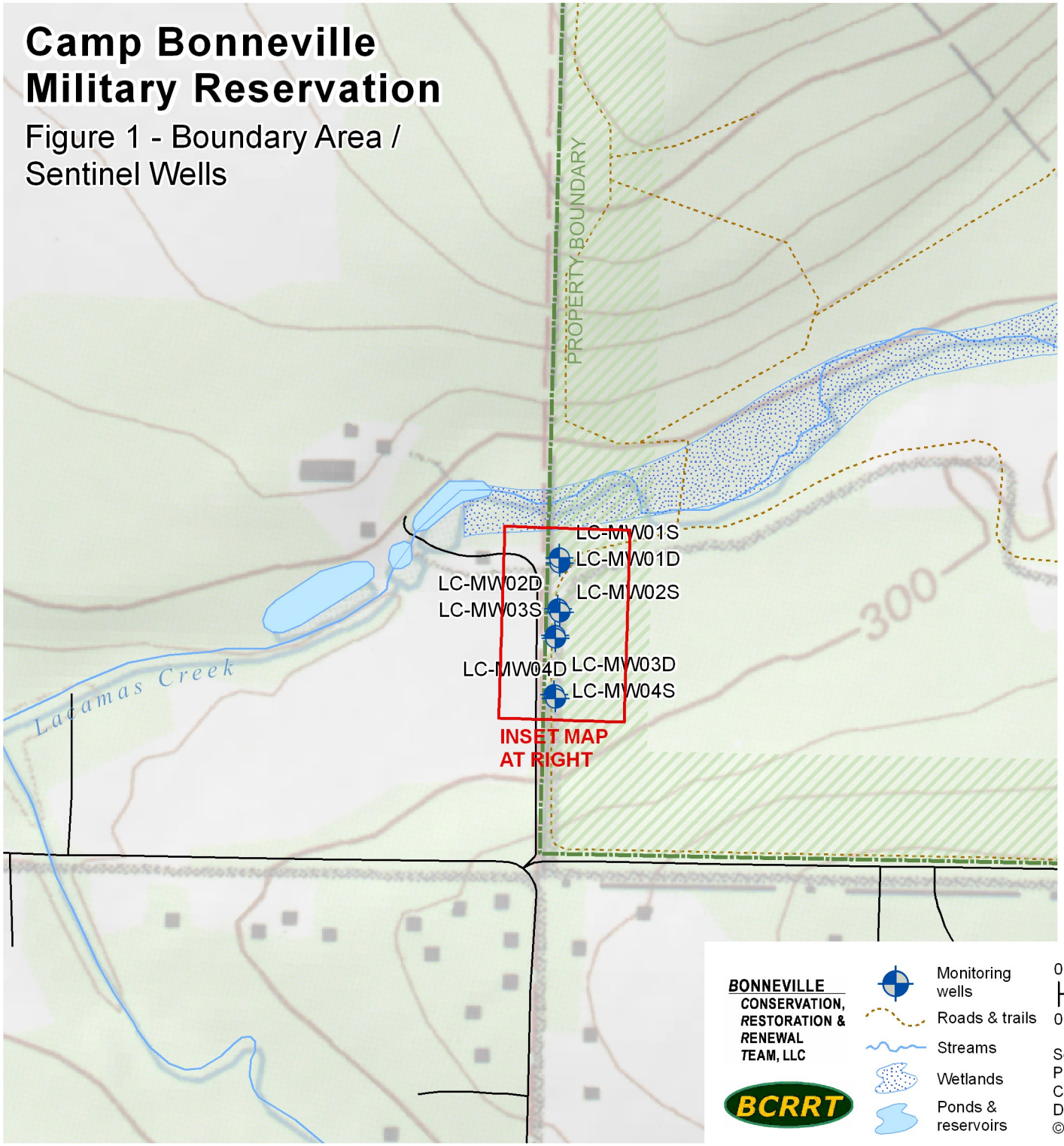
James D. Peyton
Senior Geologist

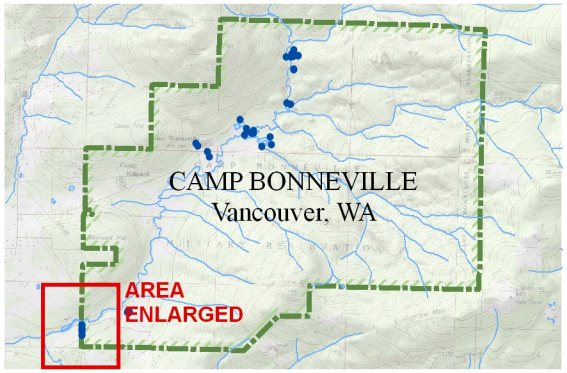
Mark J. Knight, CHMM
Project Manager

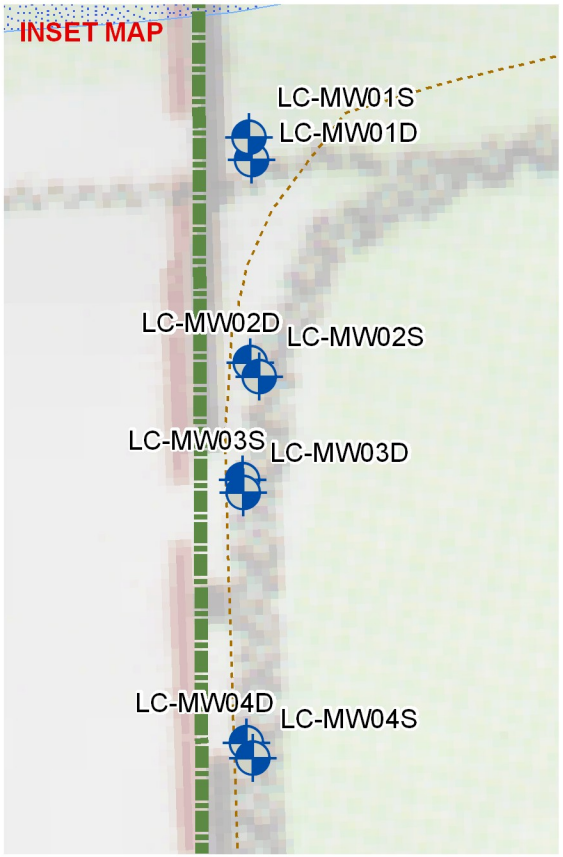
MJK/JDP/amt
Attachments

Camp Bonneville Military Reservation

Figure 1 - Boundary Area / Sentinel Wells







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BCRRT

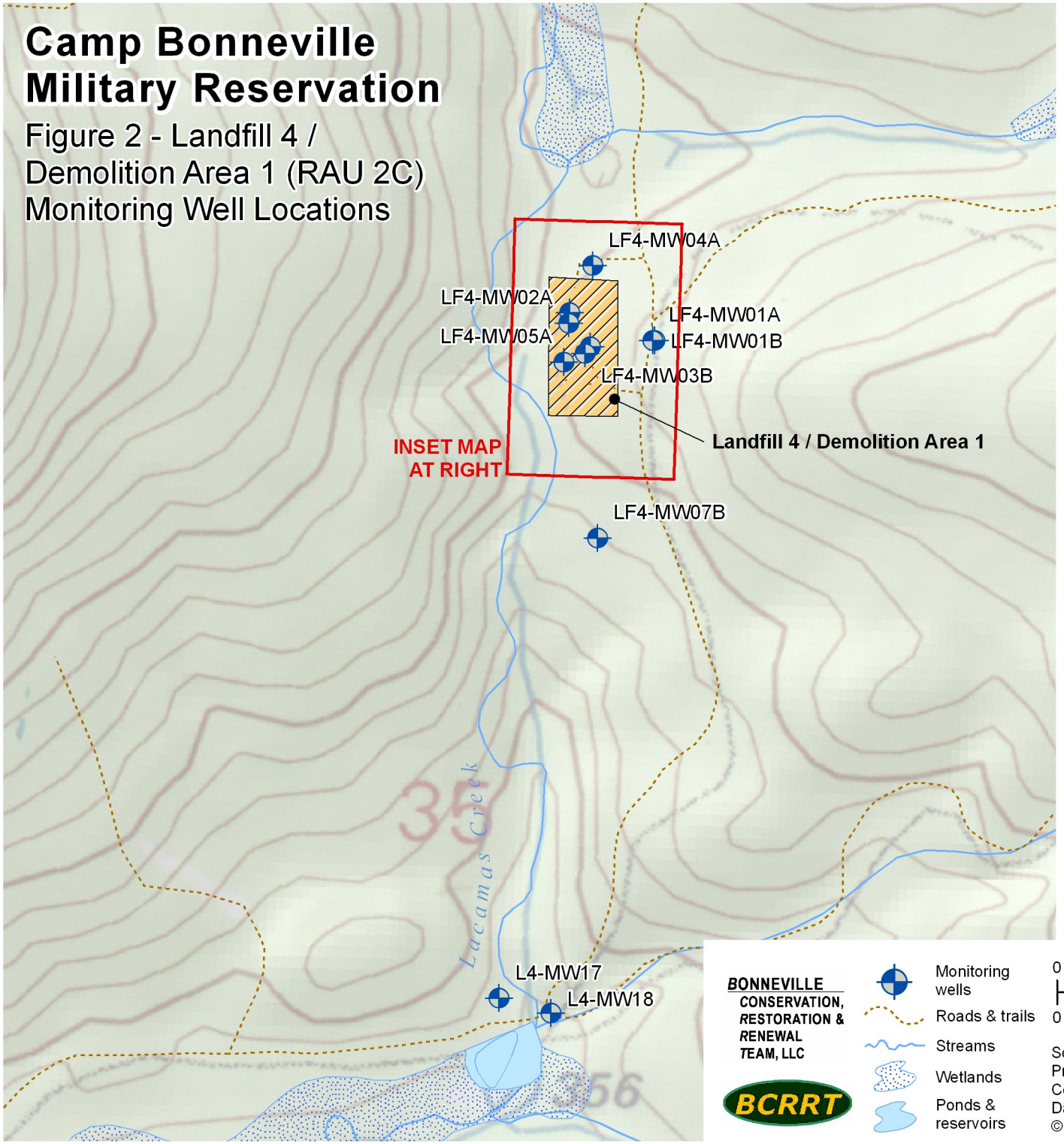
Monitoring wells
Roads & trails
Streams
Wetlands
Ponds & reservoirs

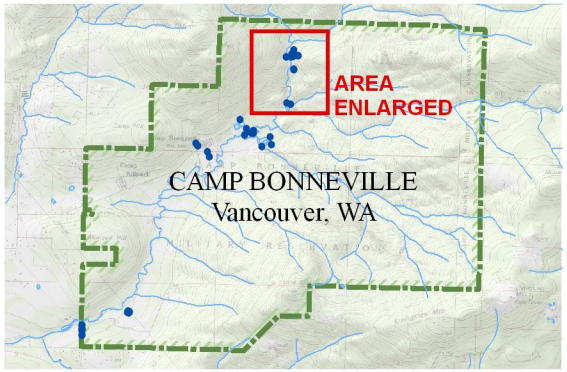
0 200 400 600 800 1,000 ft
0 100 200 m

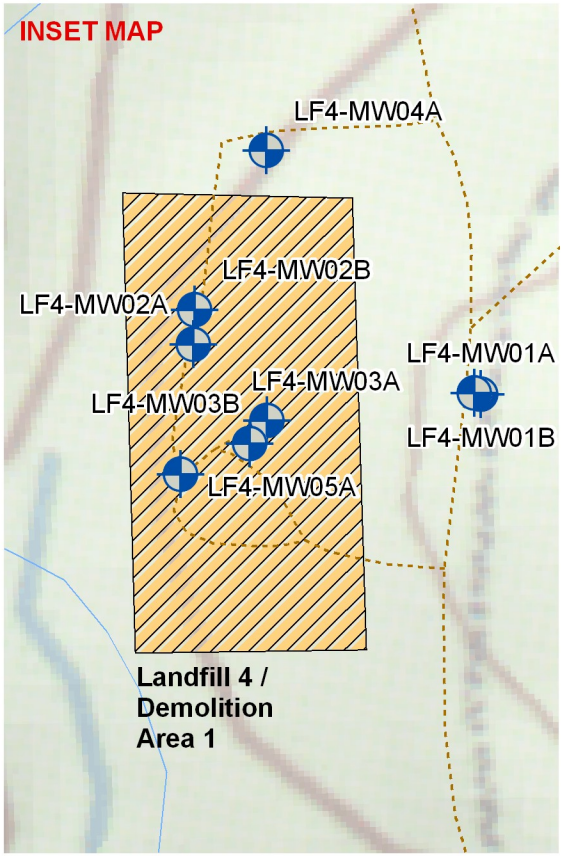
Scale - 1:5,000
Projection - Lambert Conformal Conic
Coordinate System - State Plane Washington South FIPS 4602
Data - Parsons & U.S. Army Corps of Engineers

Camp Bonneville Military Reservation

Figure 2 - Landfill 4 / Demolition Area 1 (RAU 2C) Monitoring Well Locations







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BCRRT

Monitoring wells
Roads & trails
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Wetlands
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0 200 400 600 800 1,000 ft
0 100 200 m

Scale - 1:5,000
Projection - Lambert Conformal Conic
Coordinate System - State Plane Washington South FIPS 4602
Data - Parsons & U.S. Army Corps of Engineers


Camp Bonneville
Military Reservation
Figure 6
Landfill 4/Demolition Area 1
Shallow Groundwater Contours
MW-4A
483.91
MW-5A
492.71
MW-3A
485.20
MW-5A
486.69
MW-1A
514.76
490
490
490
490
490
500
510
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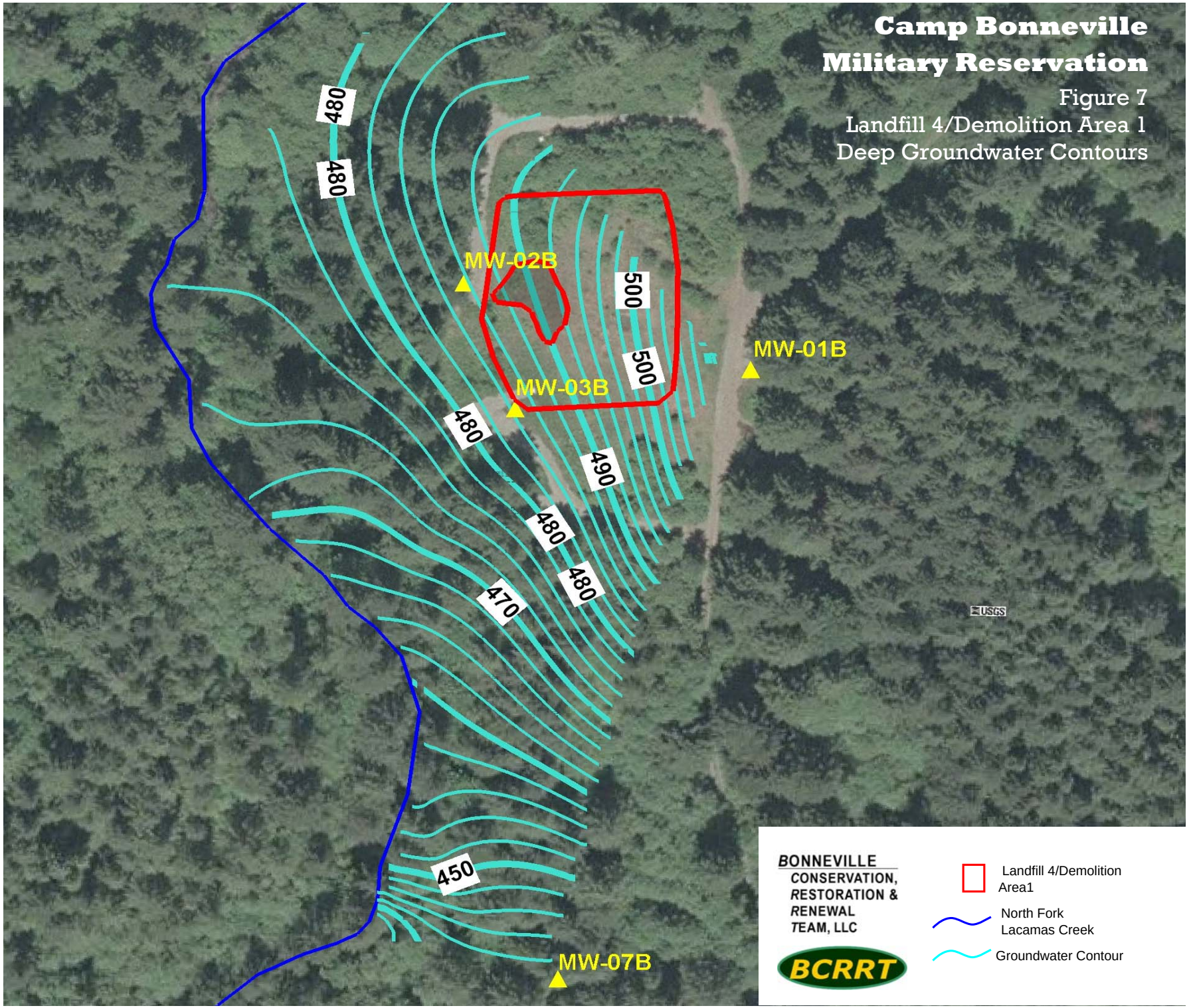
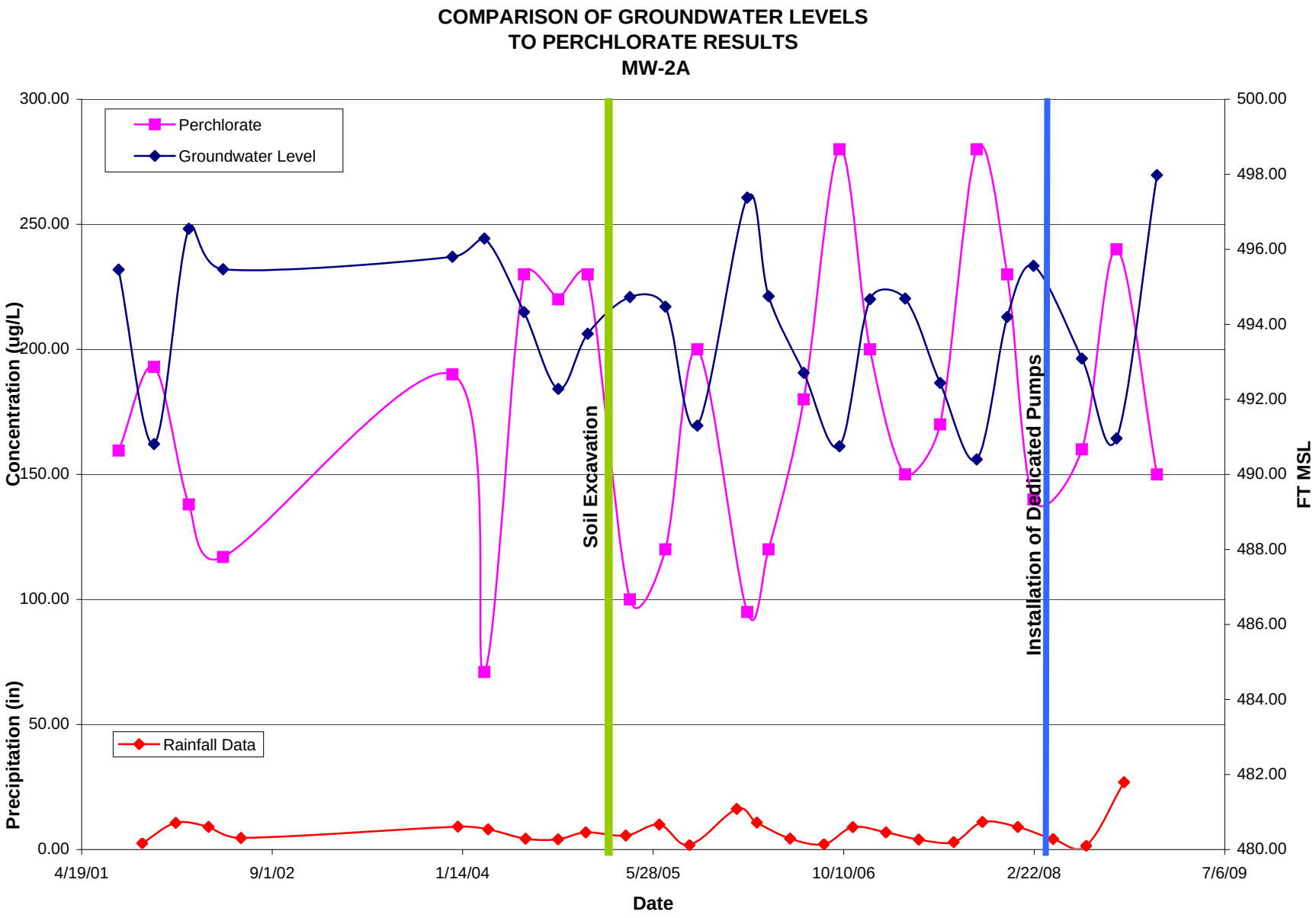
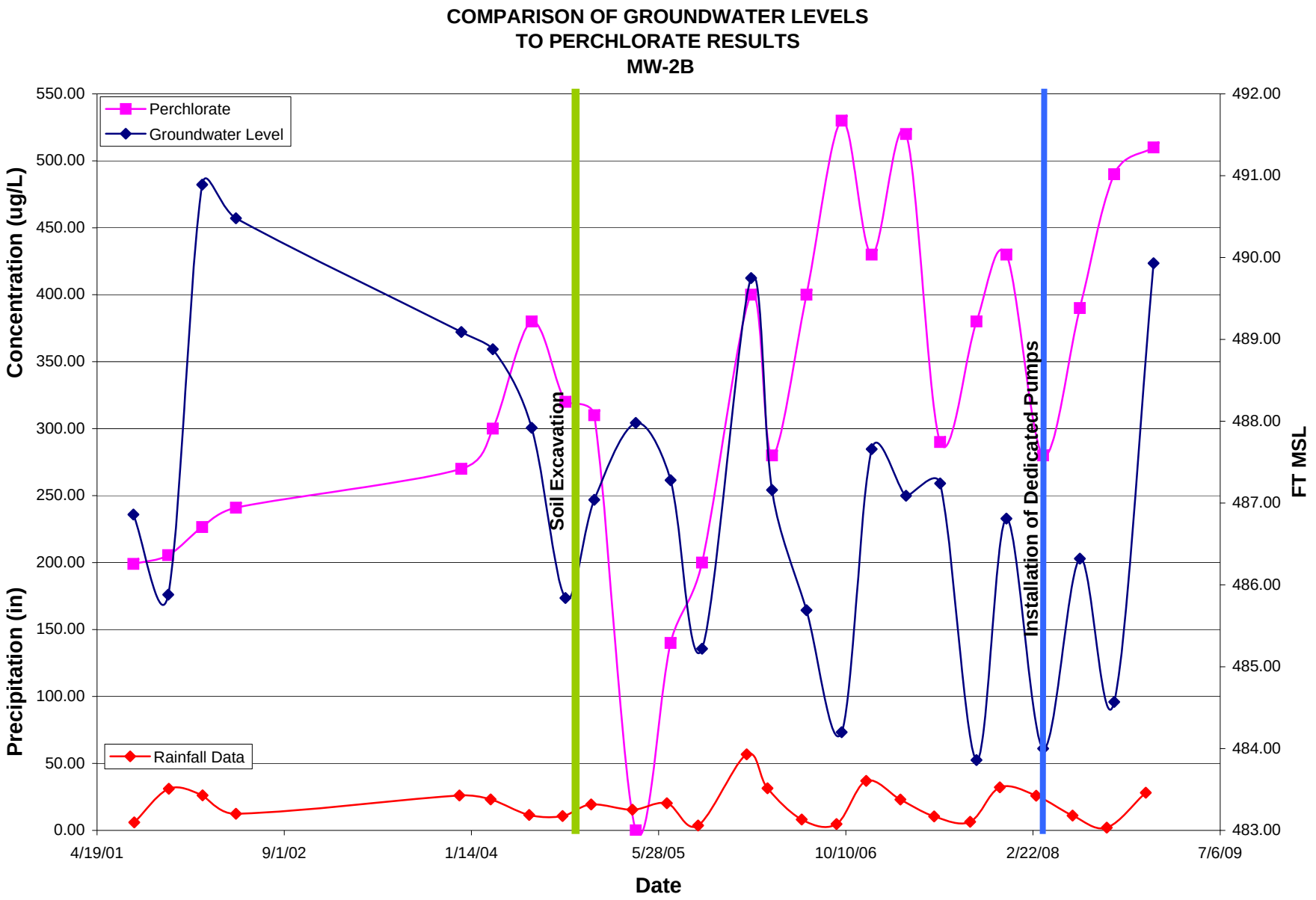
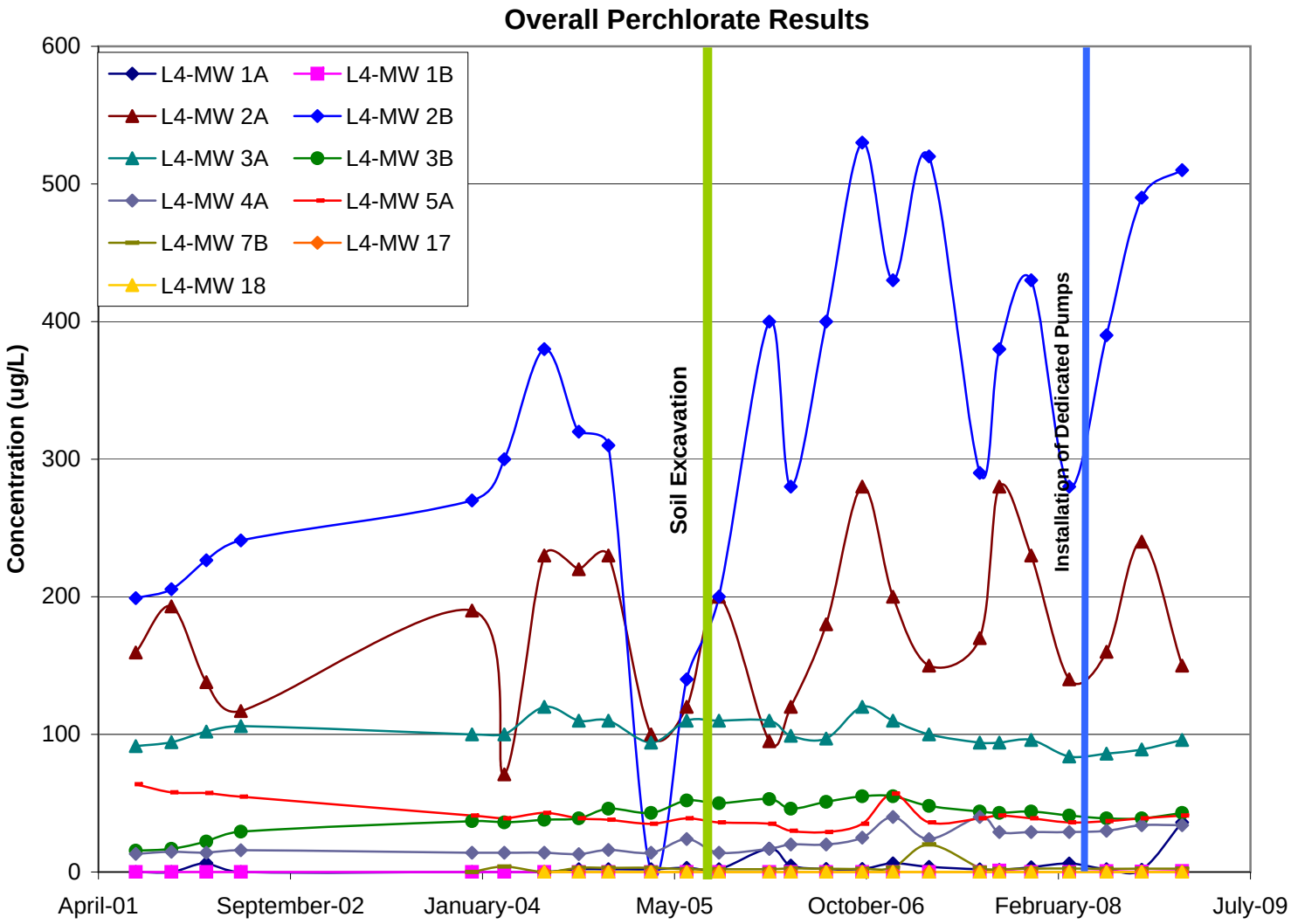
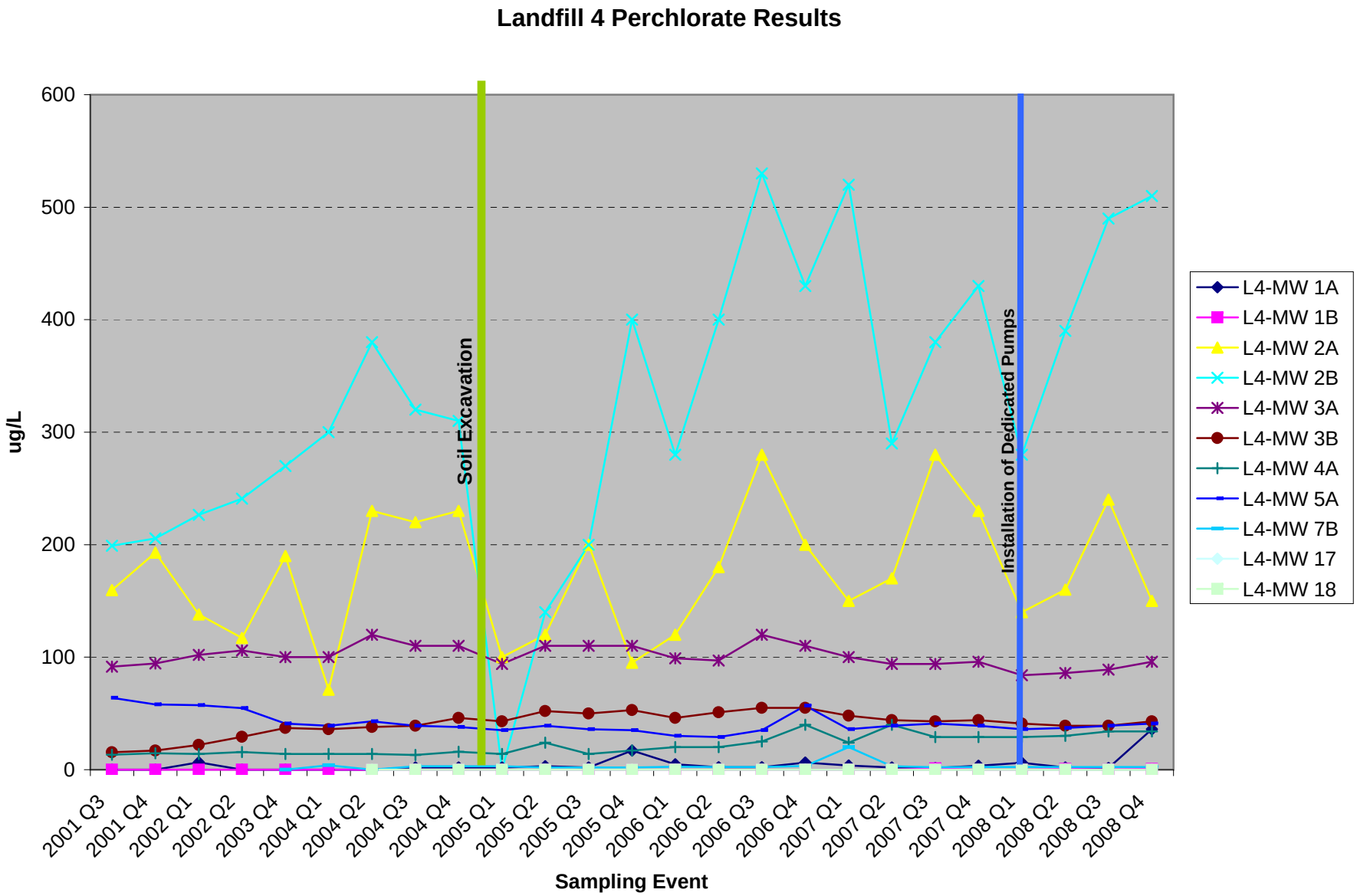
RESTORATION &
RENEWAL
TEAM, LLC
BCRRT
Landfill 4/Demolition Area1
North Fork Lacamas Creek
Groundwater Contour

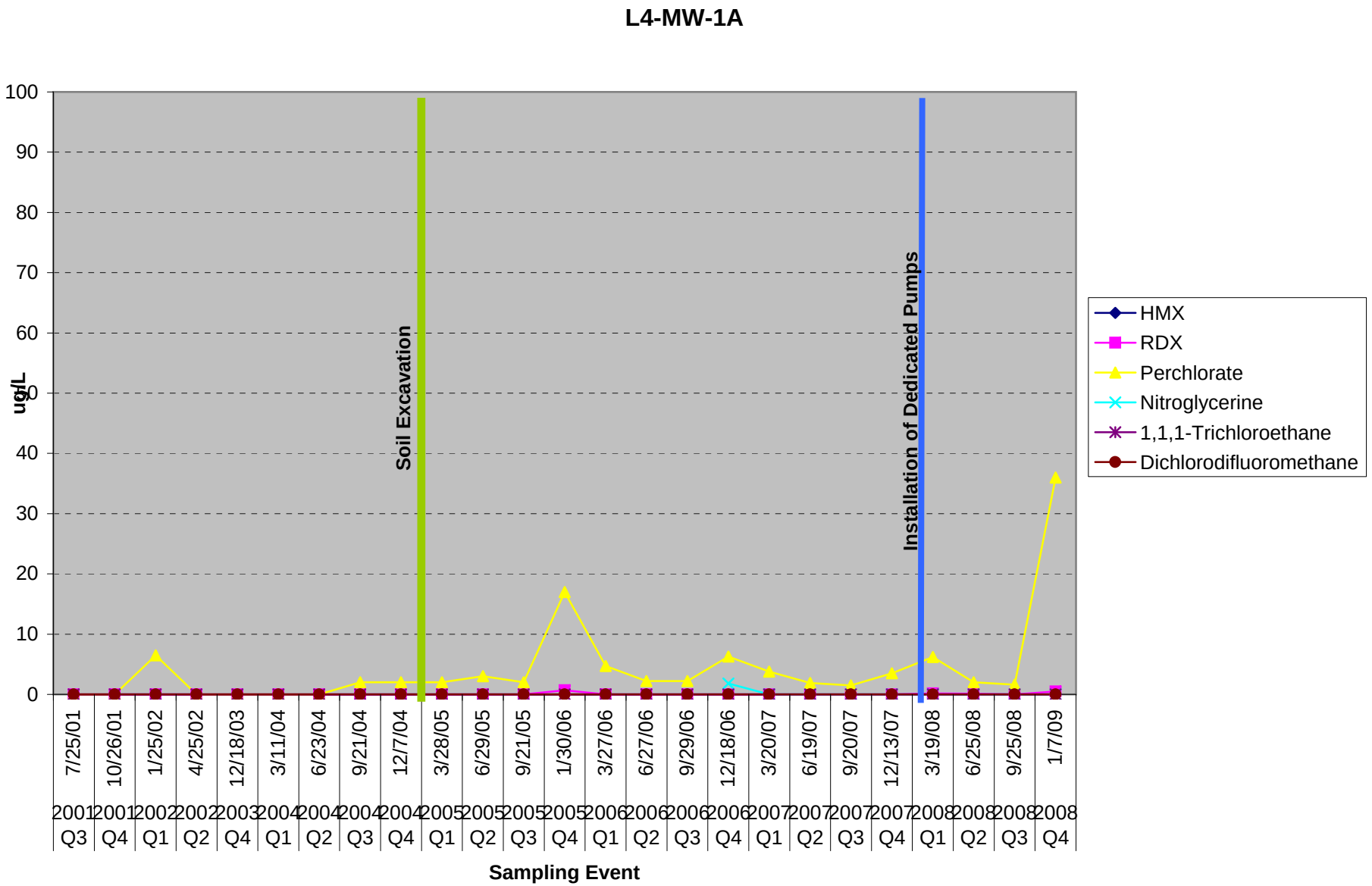

Camp Bonneville
Military Reservation
Figure 7
Landfill 4/Demolition Area 1
Deep Groundwater Contours
480
480
MW-02B
500
500
MW-01B
MW-03B
480
490
480
480
470
450
MW-07B
USGS
BONNEVILLE
CONSERVATION,
RESTORATION &
RENEWAL
TEAM, LLC
BCRRT
Landfill 4/Demolition Area1
North Fork Lacamas Creek
Groundwater Contour

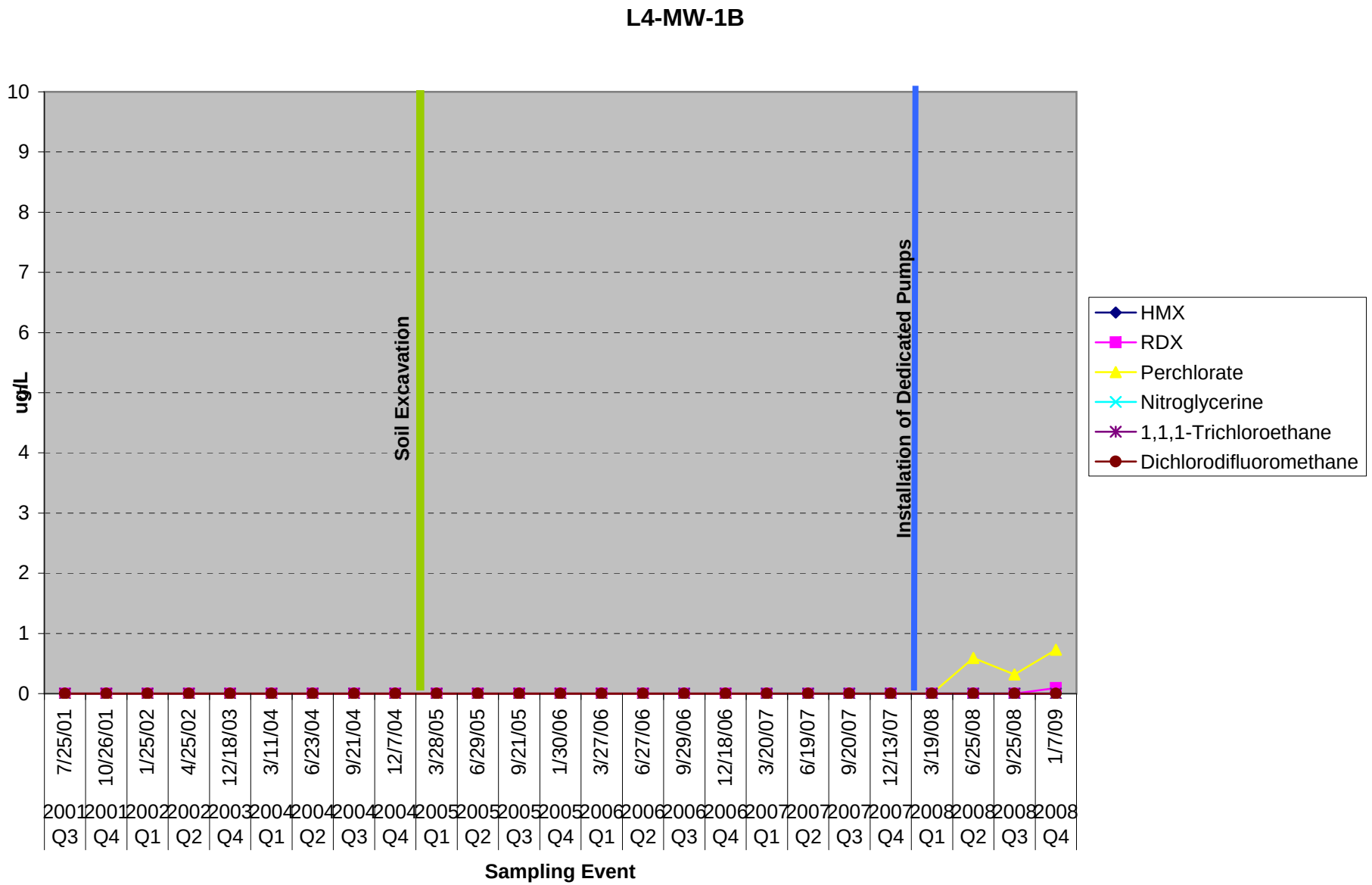

COMPARISON OF GROUNDWATER LEVELS
TO PERCHLORATE RESULTS
MW-2A
Perchlorate
Groundwater Level
Rainfall Data
Soil Excavation
Installation of Dedicated Pumps
Concentration (ug/L)
Precipitation (in)
FT MSL
Date
300.00
250.00
200.00
150.00
100.00
50.00
0.00
500.00
498.00
496.00
494.00
492.00
490.00
488.00
486.00
484.00
482.00
480.00
4/19/01
9/1/02
1/14/04
5/28/05
10/10/06
2/22/08
7/6/09

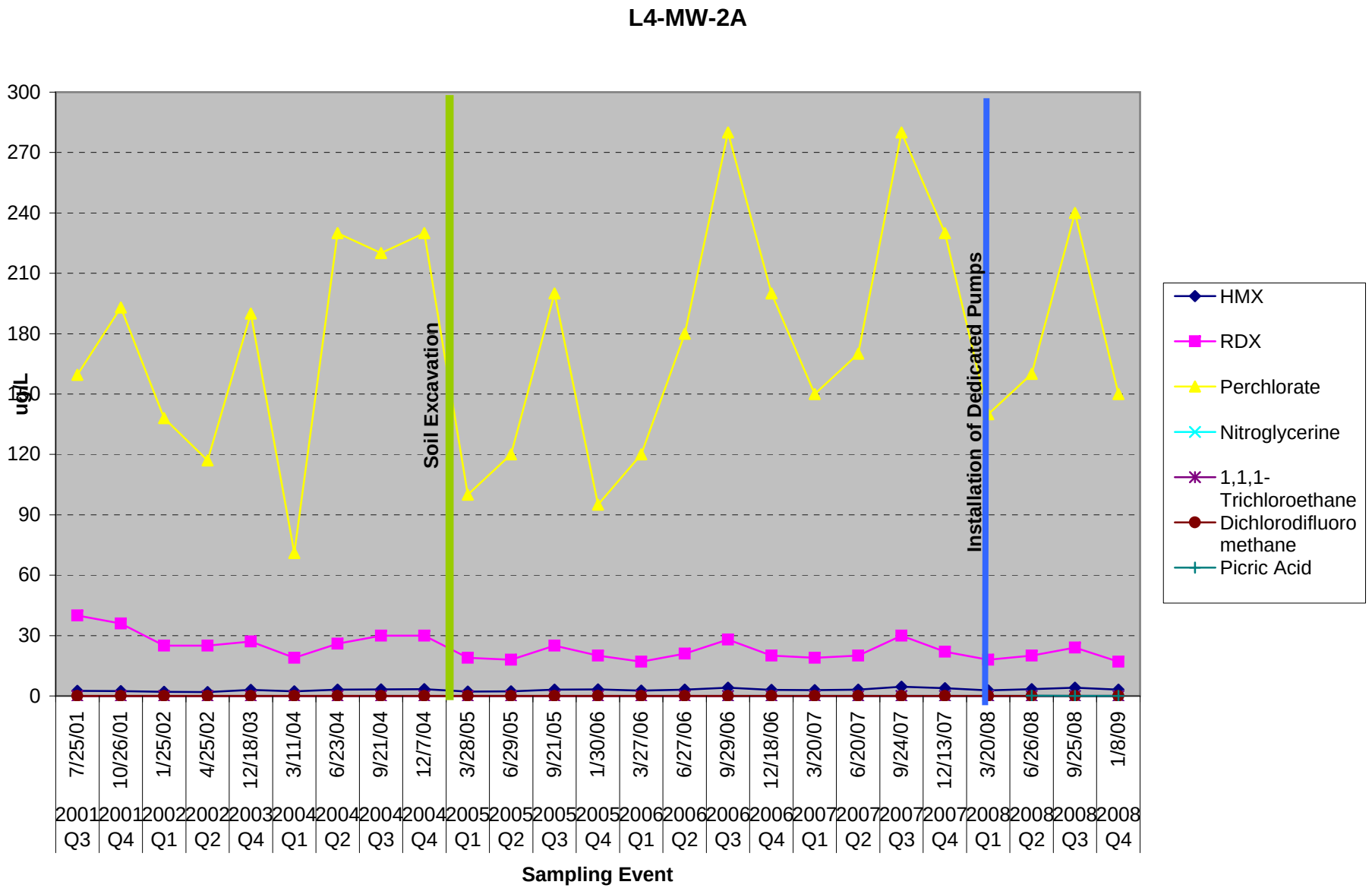

COMPARISON OF GROUNDWATER LEVELS
TO PERCHLORATE RESULTS
MW-2B
Perchlorate
Groundwater Level
Rainfall Data
Soil Excavation
Installation of Dedicated Pumps
Concentration (ug/L)
Precipitation (in)
FT MSL
Date
550.00
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
492.00
491.00
490.00
489.00
488.00
487.00
486.00
485.00
484.00
483.00
4/19/01
9/1/02
1/14/04
5/28/05
10/10/06
2/22/08
7/6/09


Overall Perchlorate Results
Concentration (ug/L)
600
500
400
300
200
100
0
April-01
September-02
January-04
May-05
October-06
February-08
July-09
L4-MW 1A
L4-MW 1B
L4-MW 2A
L4-MW 2B
L4-MW 3A
L4-MW 3B
L4-MW 4A
L4-MW 5A
L4-MW 7B
L4-MW 17
L4-MW 18
Soil Excavation
Installation of Dedicated Pumps

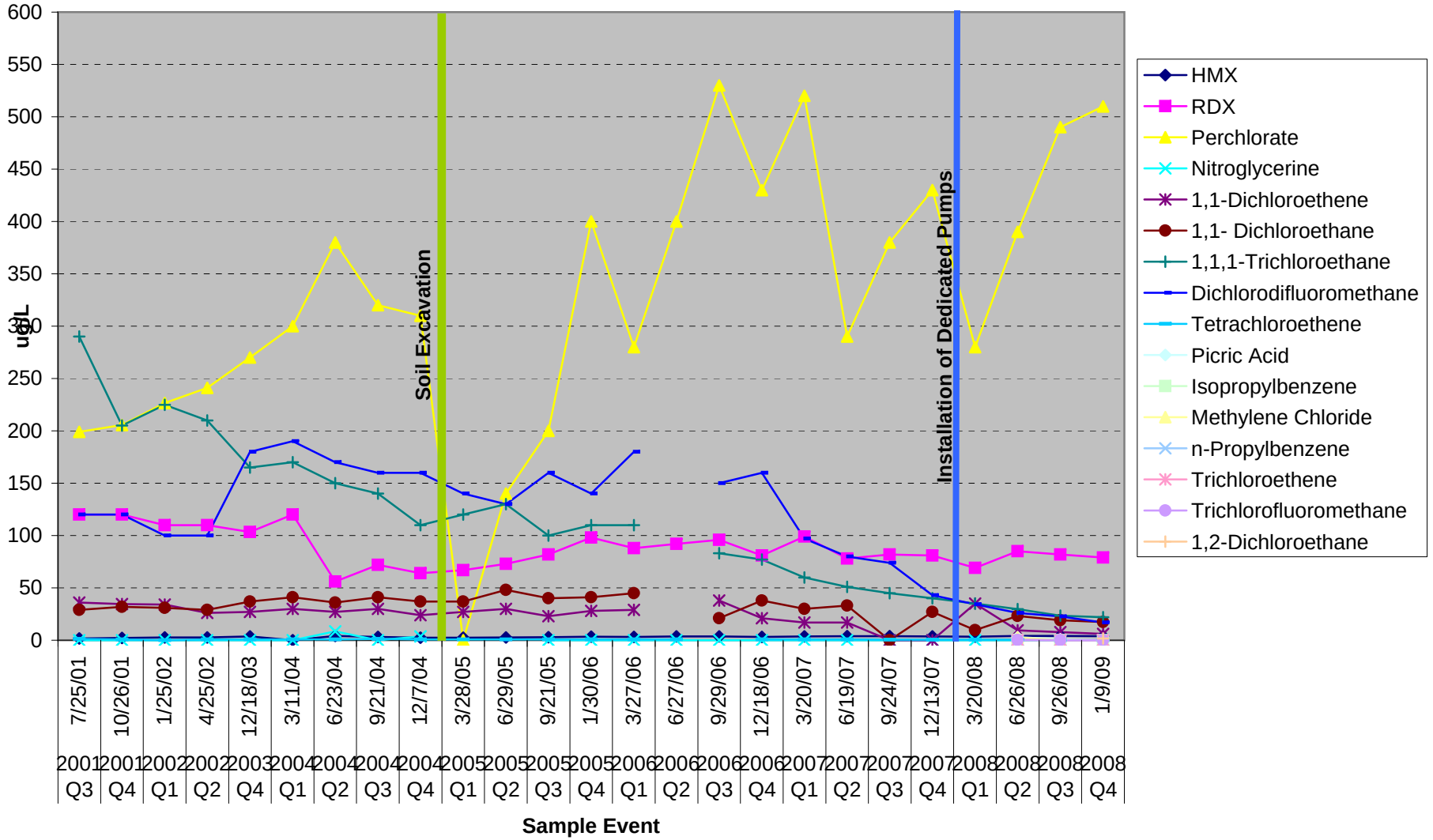

Landfill 4 Perchlorate Results
ug/L
600
500
400
300
200
100
0
Soil Excavation
Installation of Dedicated Pumps
2001 Q3
2001 Q4
2002 Q1
2002 Q2
2003 Q4
2004 Q1
2004 Q2
2004 Q3
2004 Q4
2005 Q1
2005 Q2
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
Sampling Event
L4-MW 1A
L4-MW 1B
L4-MW 2A
L4-MW 2B
L4-MW 3A
L4-MW 3B
L4-MW 4A
L4-MW 5A
L4-MW 7B
L4-MW 17
L4-MW 18


L4-MW-1A
100
90
80
70
60
50
40
30
20
10
0
ug/L
Soil Excavation
Installation of Dedicated Pumps
HMX
RDX
Perchlorate
Nitroglycerine
1,1,1-Trichloroethane
Dichlorodifluoromethane
7/25/01
10/26/01
1/25/02
4/25/02
12/18/03
3/11/04
6/23/04
9/21/04
12/7/04
3/28/05
6/29/05
9/21/05
1/30/06
3/27/06
6/27/06
9/29/06
12/18/06
3/20/07
6/19/07
9/20/07
12/13/07
3/19/08
6/25/08
9/25/08
1/7/09
2001 Q3
2001 Q4
2002 Q1
2002 Q2
2003 Q4
2004 Q1
2004 Q2
2004 Q3
2004 Q4
2005 Q1
2005 Q2
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
Sampling Event

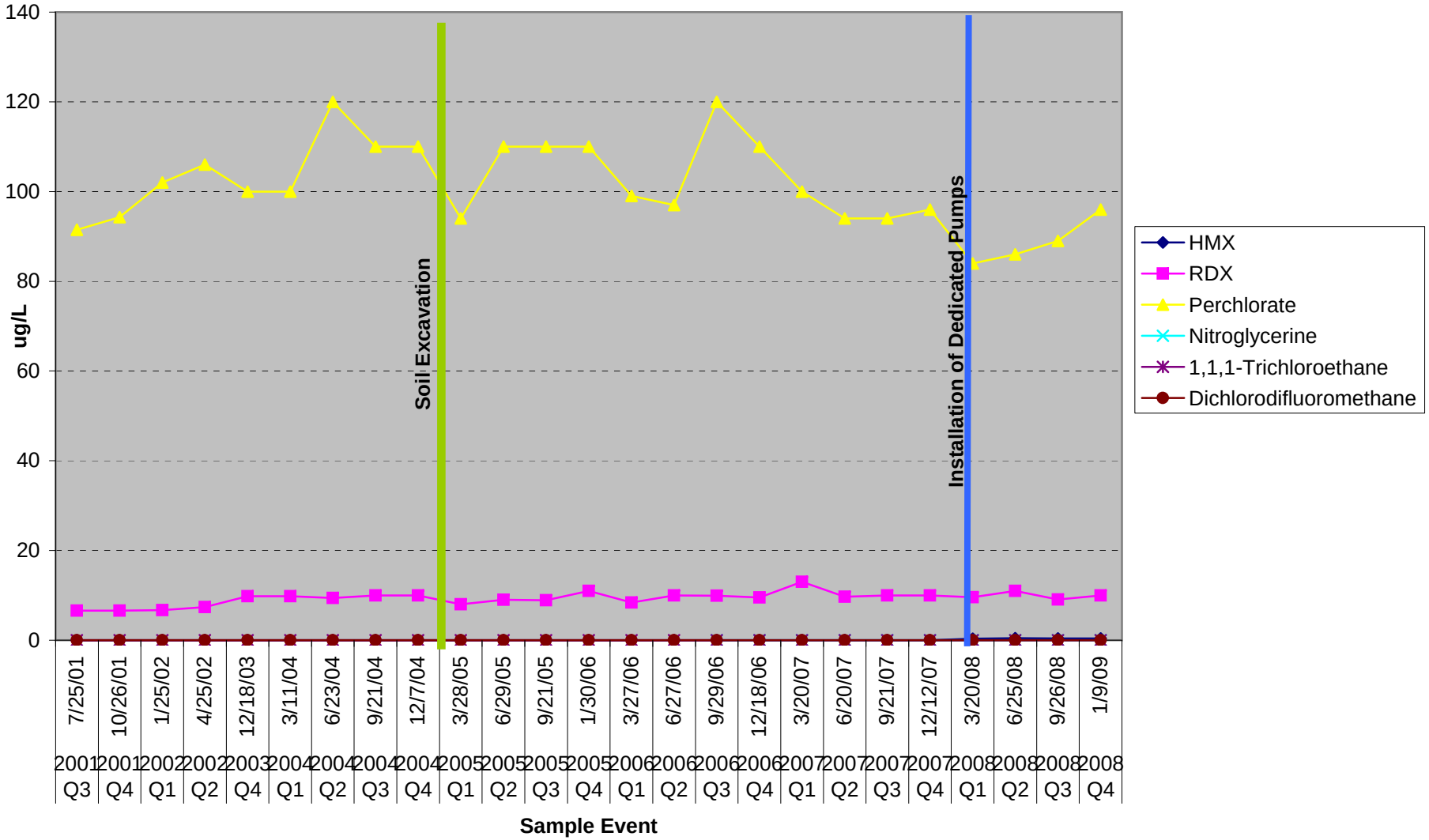

L4-MW-1B
ug/L
10
9
8
7
6
5
4
3
2
1
0
Soil Excavation
Installation of Dedicated Pumps
HMX
RDX
Perchlorate
Nitroglycerine
1,1,1-Trichloroethane
Dichlorodifluoromethane
7/25/01
10/26/01
1/25/02
4/25/02
12/18/03
3/11/04
6/23/04
9/21/04
12/7/04
3/28/05
6/29/05
9/21/05
1/30/06
3/27/06
6/27/06
9/29/06
12/18/06
3/20/07
6/19/07
9/20/07
12/13/07
3/19/08
6/25/08
9/25/08
1/7/09
2001 Q3
2001 Q4
2002 Q1
2002 Q2
2003 Q4
2004 Q1
2004 Q2
2004 Q3
2004 Q4
2005 Q1
2005 Q2
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
Sampling Event

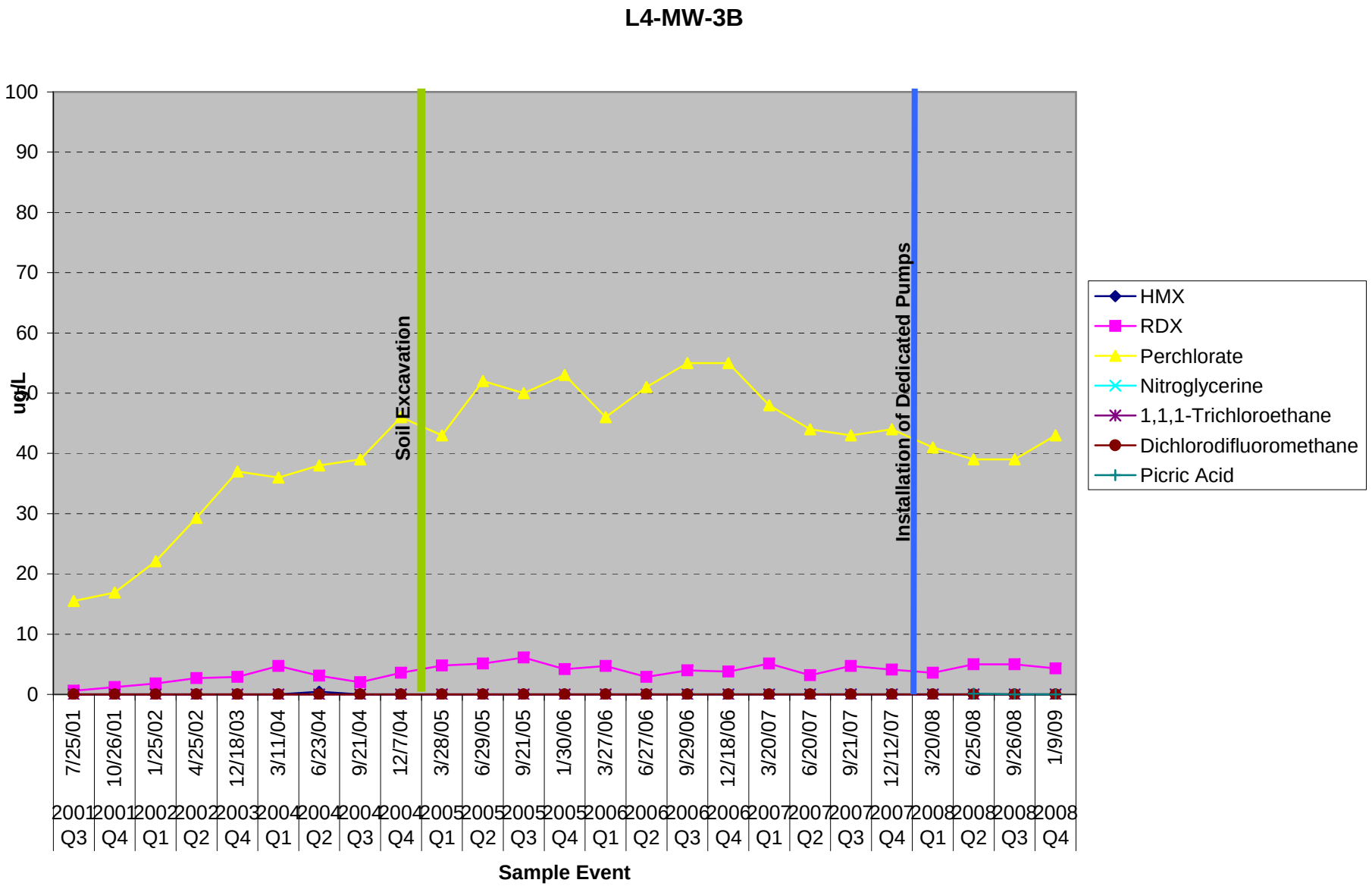

L4-MW-2A
ug/L
300
270
240
210
180
150
120
90
60
30
0
Soil Excavation
Installation of Dedicated Pumps
HMX
RDX
Perchlorate
Nitroglycerine
1,1,1-Trichloroethane
Dichlorodifluoromethane
Picric Acid
7/25/01 2001 Q3
10/26/01 2001 Q4
1/25/02 2002 Q1
4/25/02 2002 Q2
12/18/03 2003 Q4
3/11/04 2004 Q1
6/23/04 2004 Q2
9/21/04 2004 Q3
12/7/04 2004 Q4
3/28/05 2005 Q1
6/29/05 2005 Q2
9/21/05 2005 Q3
1/30/06 2005 Q4
3/27/06 2006 Q1
6/27/06 2006 Q2
9/29/06 2006 Q3
12/18/06 2006 Q4
3/20/07 2007 Q1
6/20/07 2007 Q2
9/24/07 2007 Q3
12/13/07 2007 Q4
3/20/08 2008 Q1
6/26/08 2008 Q2
9/25/08 2008 Q3
1/8/09 2008 Q4
Sampling Event

L4-MW-2B

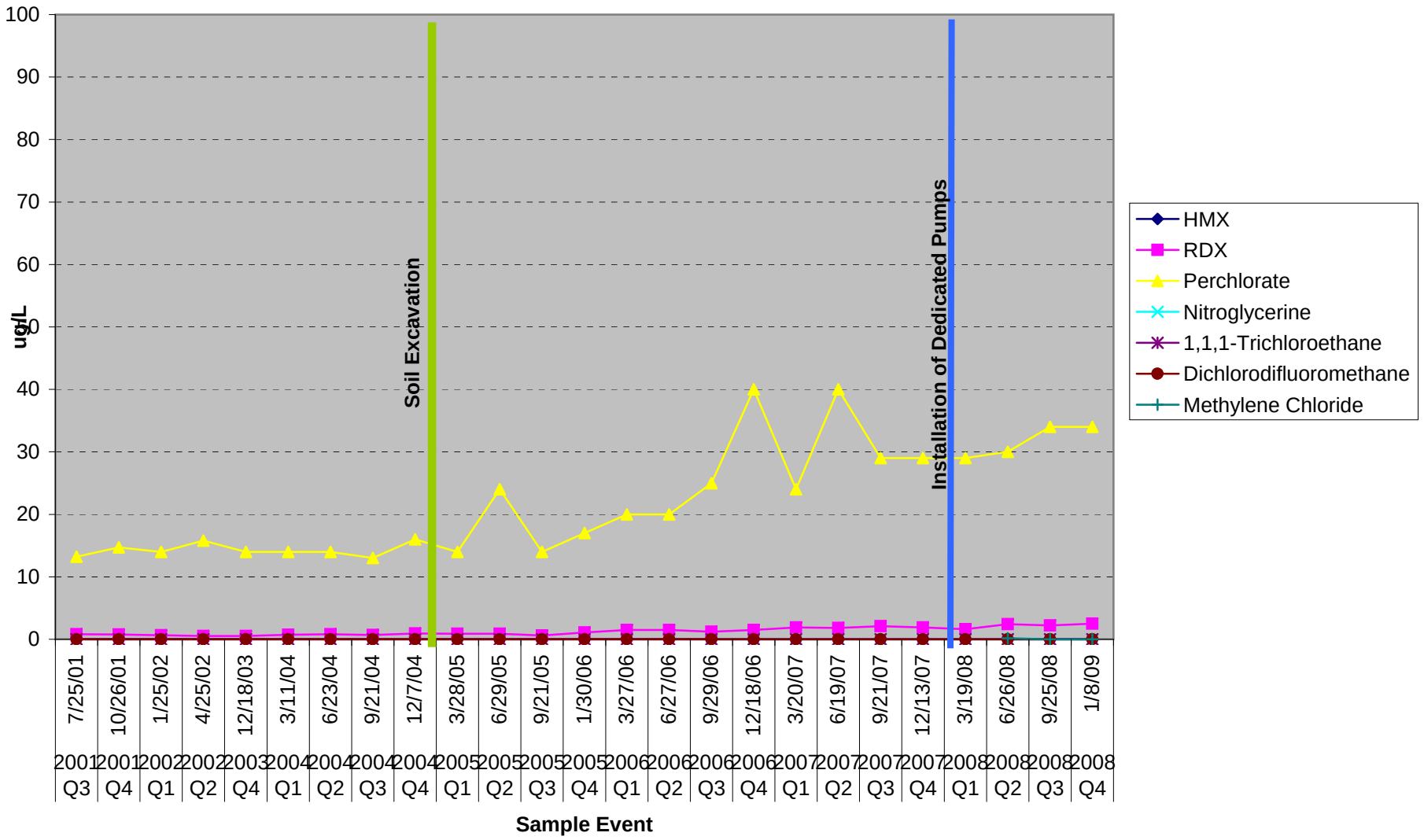

600
550
500
450
400
350
300
250
200
150
100
50
0
ug/L
Soil Excavation
Installation of Dedicated Pumps
7/25/01 2001 Q3
10/26/01 2001 Q4
1/25/02 2002 Q1
4/25/02 2002 Q2
12/18/03 2003 Q4
3/11/04 2004 Q1
6/23/04 2004 Q2
9/21/04 2004 Q3
12/7/04 2004 Q4
3/28/05 2005 Q1
6/29/05 2005 Q2
9/21/05 2005 Q3
1/30/06 2005 Q4
3/27/06 2006 Q1
6/27/06 2006 Q2
9/29/06 2006 Q3
12/18/06 2006 Q4
3/20/07 2007 Q1
6/19/07 2007 Q2
9/24/07 2007 Q3
12/13/07 2007 Q4
3/20/08 2008 Q1
6/26/08 2008 Q2
9/26/08 2008 Q3
1/9/09 2008 Q4
Sample Event
HMX
RDX
Perchlorate
Nitroglycerine
1,1-Dichloroethene
1,1- Dichloroethane
1,1,1-Trichloroethane
Dichlorodifluoromethane
Tetrachloroethene
Picric Acid
Isopropylbenzene
Methylene Chloride
n-Propylbenzene
Trichloroethene
Trichlorofluoromethane
1,2-Dichloroethane

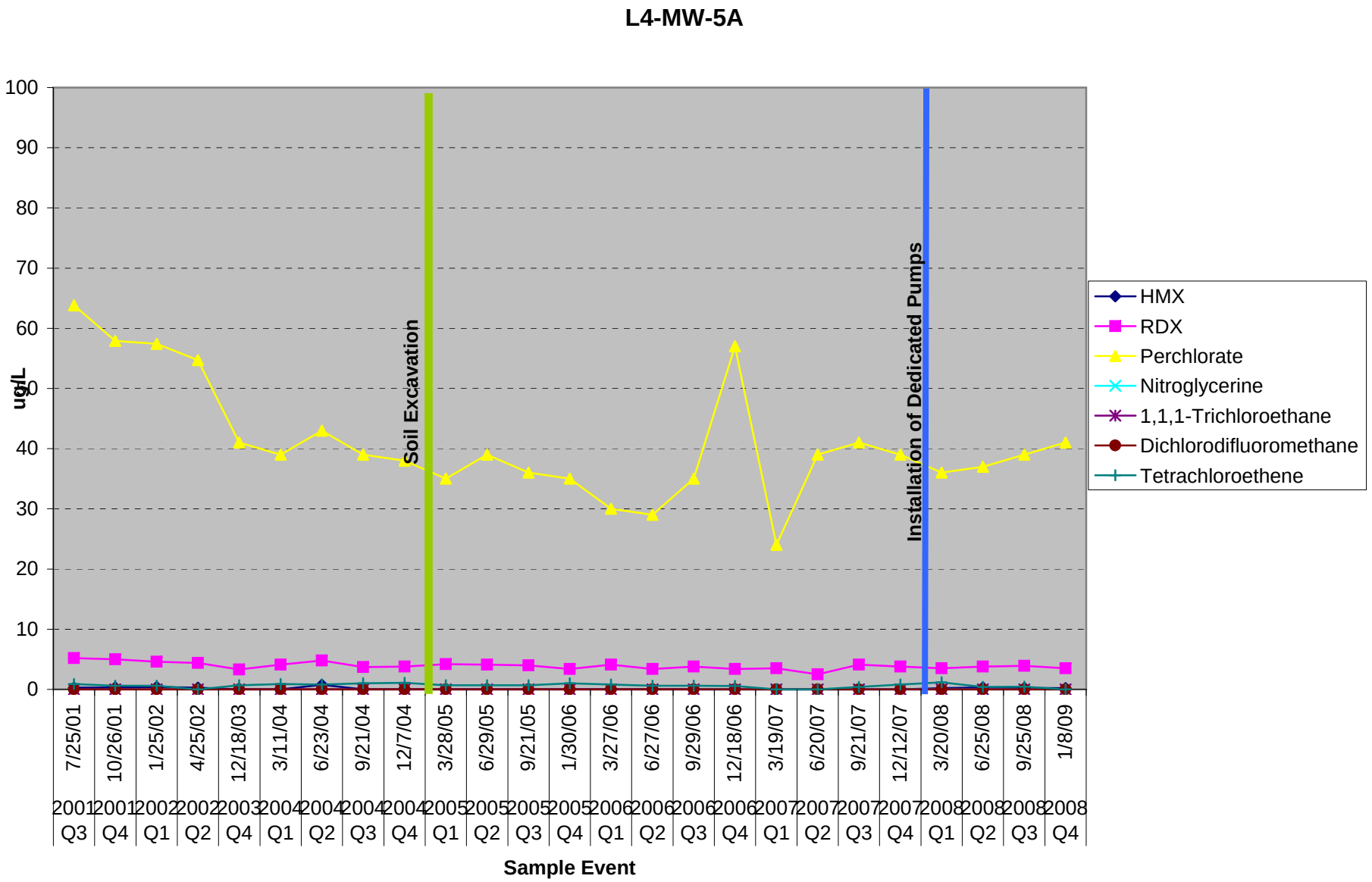
L4-MW-3A


140
120
100
80
60
40
20
0
ug/L
Soil Excavation
Installation of Dedicated Pumps
HMX
RDX
Perchlorate
Nitroglycerine
1,1,1-Trichloroethane
Dichlorodifluoromethane
7/25/01
10/26/01
1/25/02
4/25/02
12/18/03
3/11/04
6/23/04
9/21/04
12/7/04
3/28/05
6/29/05
9/21/05
1/30/06
3/27/06
6/27/06
9/29/06
12/18/06
3/20/07
6/20/07
9/21/07
12/12/07
3/20/08
6/25/08
9/26/08
1/9/09
2001 Q3
2001 Q4
2002 Q1
2002 Q2
2003 Q4
2004 Q1
2004 Q2
2004 Q3
2004 Q4
2005 Q1
2005 Q2
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
Sample Event

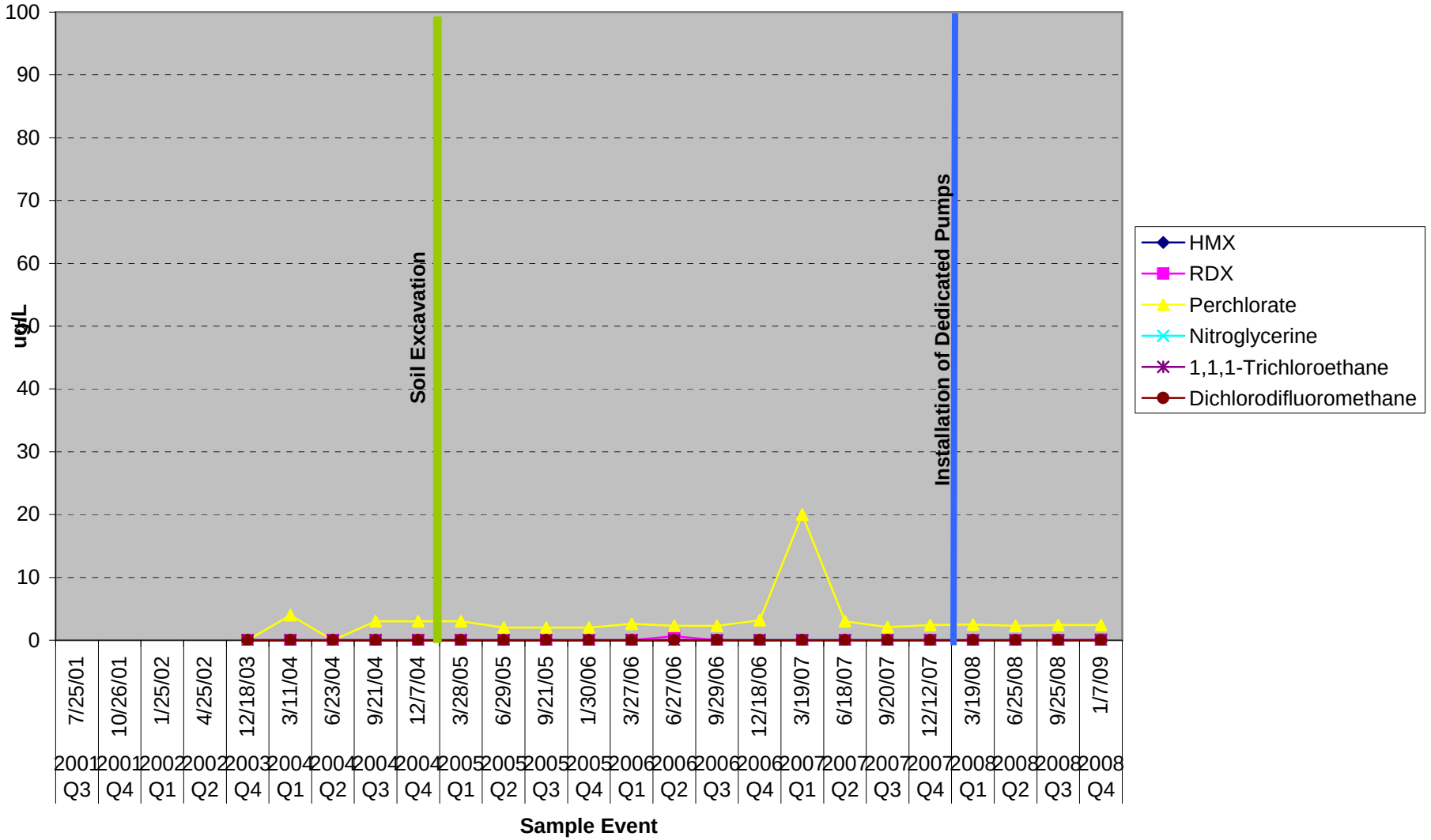

L4-MW-3B
ug/L
100
90
80
70
60
50
40
30
20
10
0
Soil Excavation
Installation of Dedicated Pumps
HMX
RDX
Perchlorate
Nitroglycerine
1,1,1-Trichloroethane
Dichlorodifluoromethane
Picric Acid
7/25/01
10/26/01
1/25/02
4/25/02
12/18/03
3/11/04
6/23/04
9/21/04
12/7/04
3/28/05
6/29/05
9/21/05
1/30/06
3/27/06
6/27/06
9/29/06
12/18/06
3/20/07
6/20/07
9/21/07
12/12/07
3/20/08
6/25/08
9/26/08
1/9/09
2001 Q3
2001 Q4
2002 Q1
2002 Q2
2003 Q4
2004 Q1
2004 Q2
2004 Q3
2004 Q4
2005 Q1
2005 Q2
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
Sample Event

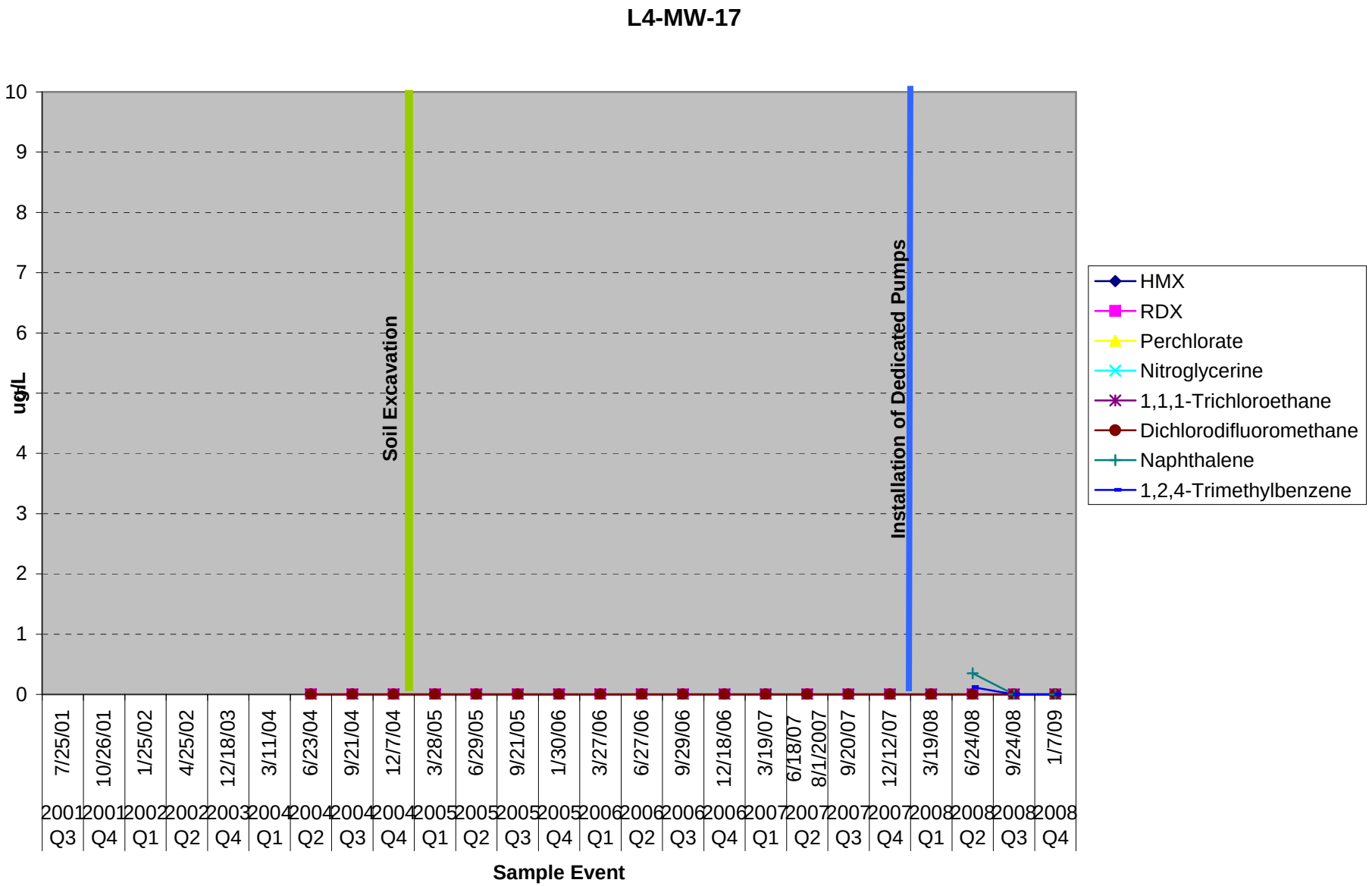
L4-MW-4A


100
90
80
70
60
50
40
30
20
10
0
ug/L
Soil Excavation
Installation of Dedicated Pumps
HMX
RDX
Perchlorate
Nitroglycerine
1,1,1-Trichloroethane
Dichlorodifluoromethane
Methylene Chloride
7/25/01
10/26/01
1/25/02
4/25/02
12/18/03
3/11/04
6/23/04
9/21/04
12/7/04
3/28/05
6/29/05
9/21/05
1/30/06
3/27/06
6/27/06
9/29/06
12/18/06
3/20/07
6/19/07
9/21/07
12/13/07
3/19/08
6/26/08
9/25/08
1/8/09
2001 Q3
2001 Q4
2002 Q1
2002 Q2
2003 Q4
2004 Q1
2004 Q2
2004 Q3
2004 Q4
2005 Q1
2005 Q2
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
Sample Event

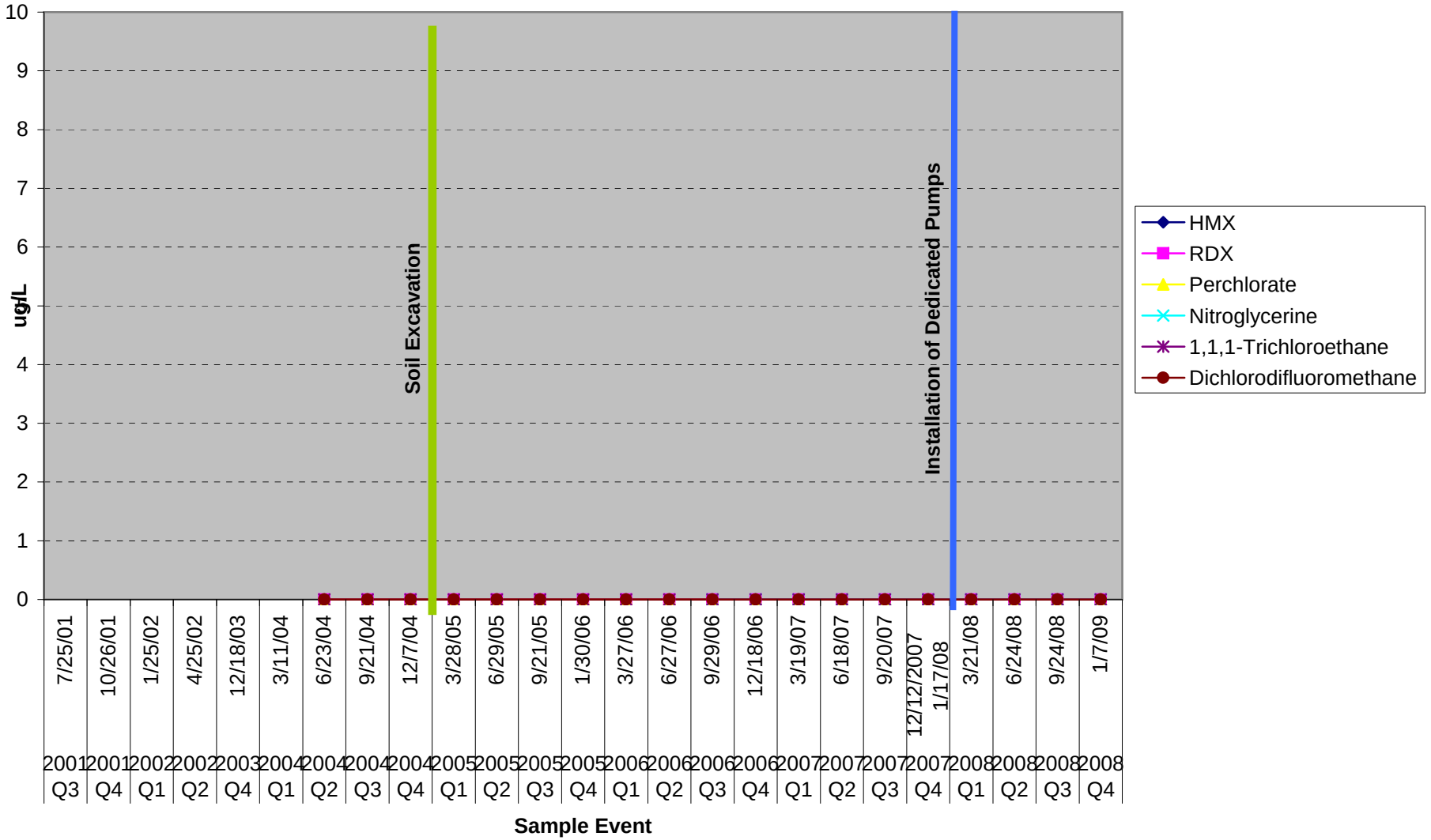

L4-MW-5A
100
90
80
70
60
50
40
30
20
10
0
ug/L
Soil Excavation
Installation of Dedicated Pumps
HMX
RDX
Perchlorate
Nitroglycerine
1,1,1-Trichloroethane
Dichlorodifluoromethane
Tetrachloroethene
7/25/01
10/26/01
1/25/02
4/25/02
12/18/03
3/11/04
6/23/04
9/21/04
12/7/04
3/28/05
6/29/05
9/21/05
1/30/06
3/27/06
6/27/06
9/29/06
12/18/06
3/19/07
6/20/07
9/21/07
12/12/07
3/20/08
6/25/08
9/25/08
1/8/09
2001 Q3
2001 Q4
2002 Q1
2002 Q2
2003 Q4
2004 Q1
2004 Q2
2004 Q3
2004 Q4
2005 Q1
2005 Q2
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
Sample Event

L4-MW-7B

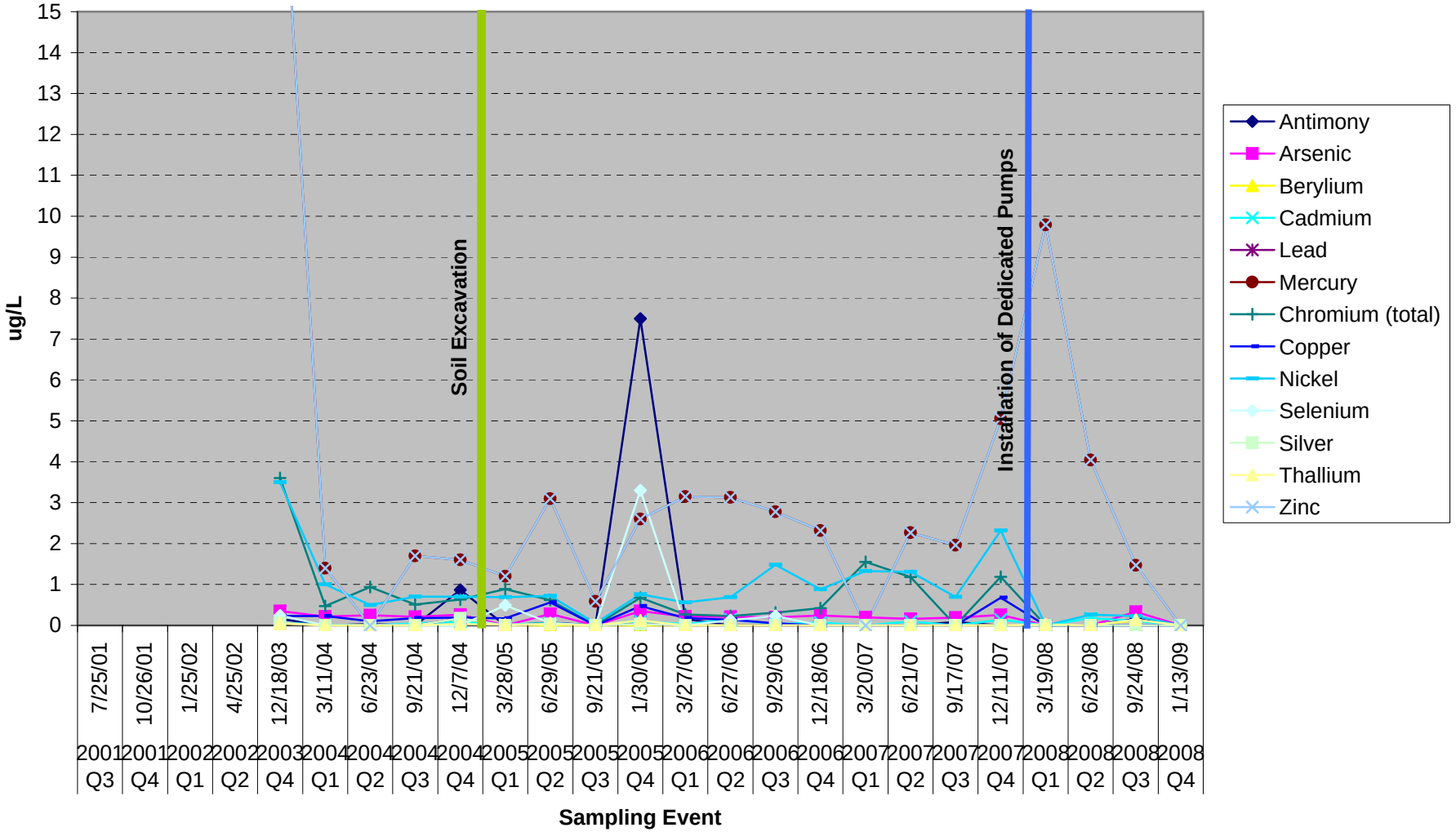

100
90
80
70
60
50
40
30
20
10
0
ug/L
Soil Excavation
Installation of Dedicated Pumps
HMX
RDX
Perchlorate
Nitroglycerine
1,1,1-Trichloroethane
Dichlorodifluoromethane
7/25/01
10/26/01
1/25/02
4/25/02
12/18/03
3/11/04
6/23/04
9/21/04
12/7/04
3/28/05
6/29/05
9/21/05
1/30/06
3/27/06
6/27/06
9/29/06
12/18/06
3/19/07
6/18/07
9/20/07
12/12/07
3/19/08
6/25/08
9/25/08
1/7/09
2001 Q3
2001 Q4
2002 Q1
2002 Q2
2003 Q4
2004 Q1
2004 Q2
2004 Q3
2004 Q4
2005 Q1
2005 Q2
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
Sample Event


L4-MW-17
ug/L
10
9
8
7
6
5
4
3
2
1
0
Soil Excavation
Installation of Dedicated Pumps
HMX
RDX
Perchlorate
Nitroglycerine
1,1,1-Trichloroethane
Dichlorodifluoromethane
Naphthalene
1,2,4-Trimethylbenzene
7/25/01 2001 Q3
10/26/01 2001 Q4
1/25/02 2002 Q1
4/25/02 2002 Q2
12/18/03 2003 Q4
3/11/04 2004 Q1
6/23/04 2004 Q2
9/21/04 2004 Q3
12/7/04 2004 Q4
3/28/05 2005 Q1
6/29/05 2005 Q2
9/21/05 2005 Q3
1/30/06 2005 Q4
3/27/06 2006 Q1
6/27/06 2006 Q2
9/29/06 2006 Q3
12/18/06 2006 Q4
3/19/07 2007 Q1
6/18/07 8/1/2007 2007 Q2
9/20/07 2007 Q3
12/12/07 2007 Q4
3/19/08 2008 Q1
6/24/08 2008 Q2
9/24/08 2008 Q3
1/7/09 2008 Q4
Sample Event

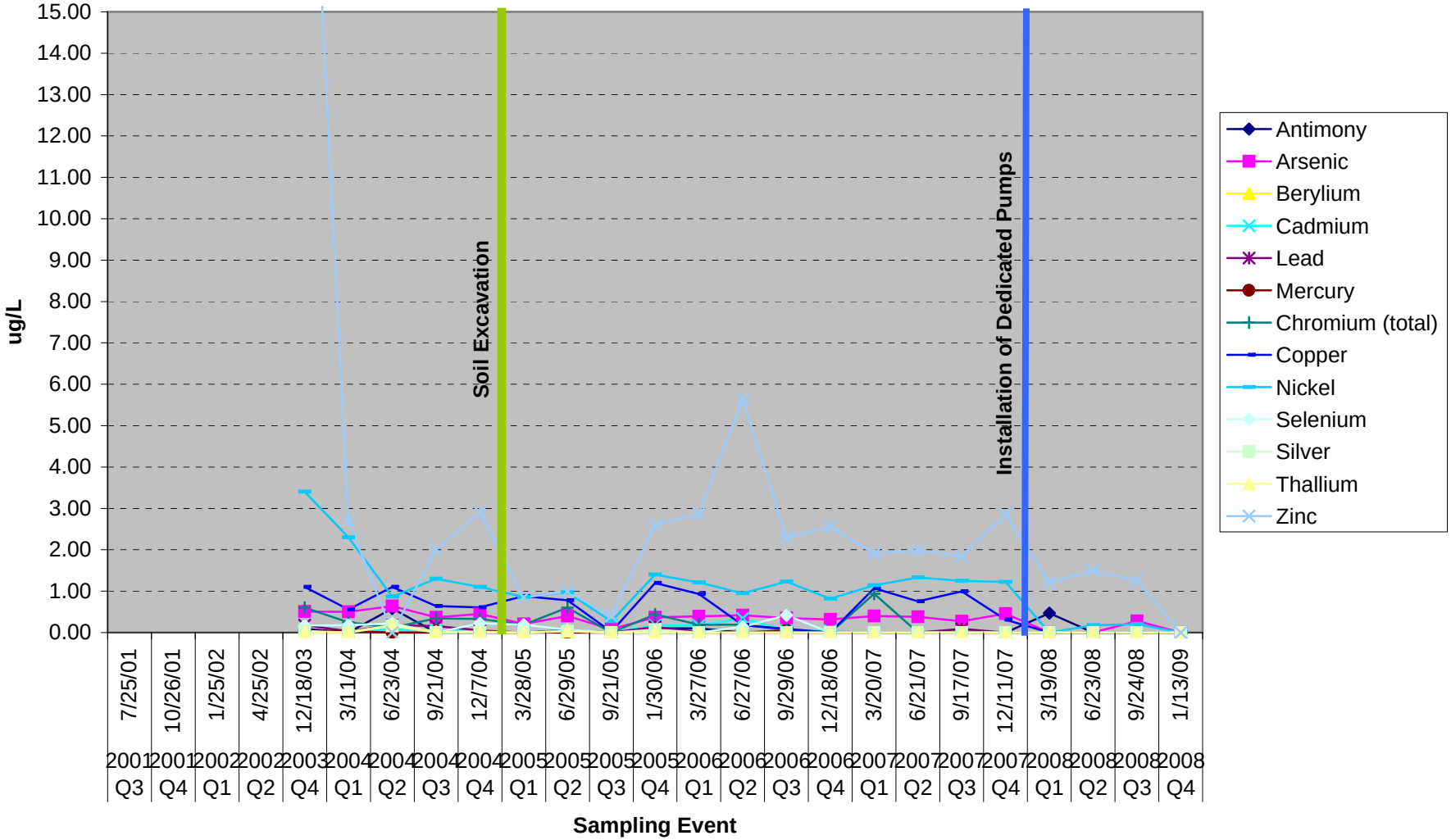
L4-MW-18


10
9
8
7
6
5
4
3
2
1
0
ug/L
Soil Excavation
Installation of Dedicated Pumps
HMX
RDX
Perchlorate
Nitroglycerine
1,1,1-Trichloroethane
Dichlorodifluoromethane
7/25/01
10/26/01
1/25/02
4/25/02
12/18/03
3/11/04
6/23/04
9/21/04
12/7/04
3/28/05
6/29/05
9/21/05
1/30/06
3/27/06
6/27/06
9/29/06
12/18/06
3/19/07
6/18/07
9/20/07
12/12/2007
1/17/08
3/21/08
6/24/08
9/24/08
1/7/09
2001 Q3
2001 Q4
2002 Q1
2002 Q2
2003 Q4
2004 Q1
2004 Q2
2004 Q3
2004 Q4
2005 Q1
2005 Q2
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
Sample Event

LC-MW-01SW


ug/L
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Soil Excavation
Installation of Dedicated Pumps
7/25/01 2001 Q3
10/26/01 2001 Q4
1/25/02 2002 Q1
4/25/02 2002 Q2
12/18/03 2003 Q4
3/11/04 2004 Q1
6/23/04 2004 Q2
9/21/04 2004 Q3
12/7/04 2004 Q4
3/28/05 2005 Q1
6/29/05 2005 Q2
9/21/05 2005 Q3
1/30/06 2005 Q4
3/27/06 2006 Q1
6/27/06 2006 Q2
9/29/06 2006 Q3
12/18/06 2006 Q4
3/20/07 2007 Q1
6/21/07 2007 Q2
9/17/07 2007 Q3
12/11/07 2007 Q4
3/19/08 2008 Q1
6/23/08 2008 Q2
9/24/08 2008 Q3
1/13/09 2008 Q4
Sampling Event
Antimony
Arsenic
Berylium
Cadmium
Lead
Mercury
Chromium (total)
Copper
Nickel
Selenium
Silver
Thallium
Zinc

LC-MW-01DW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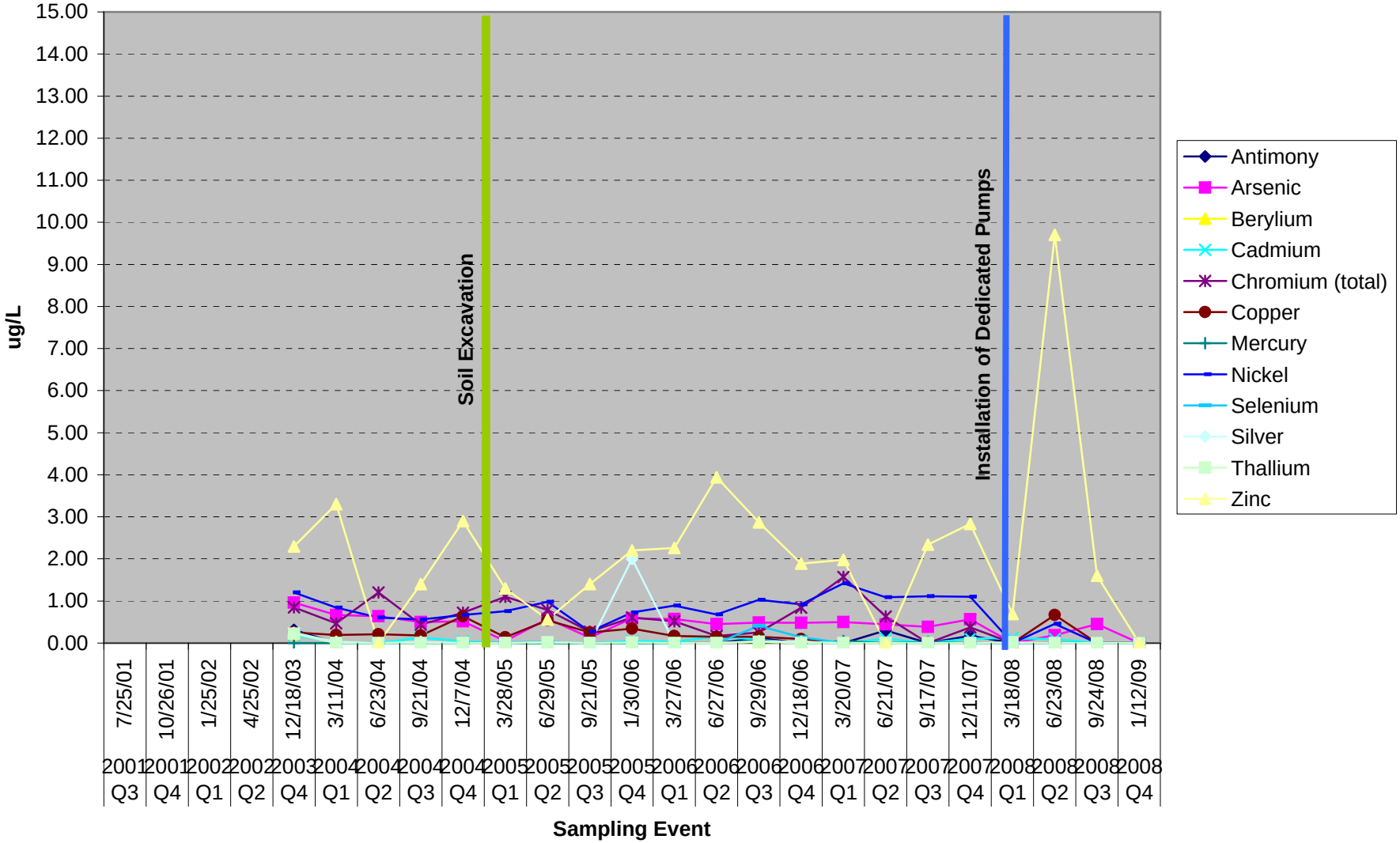
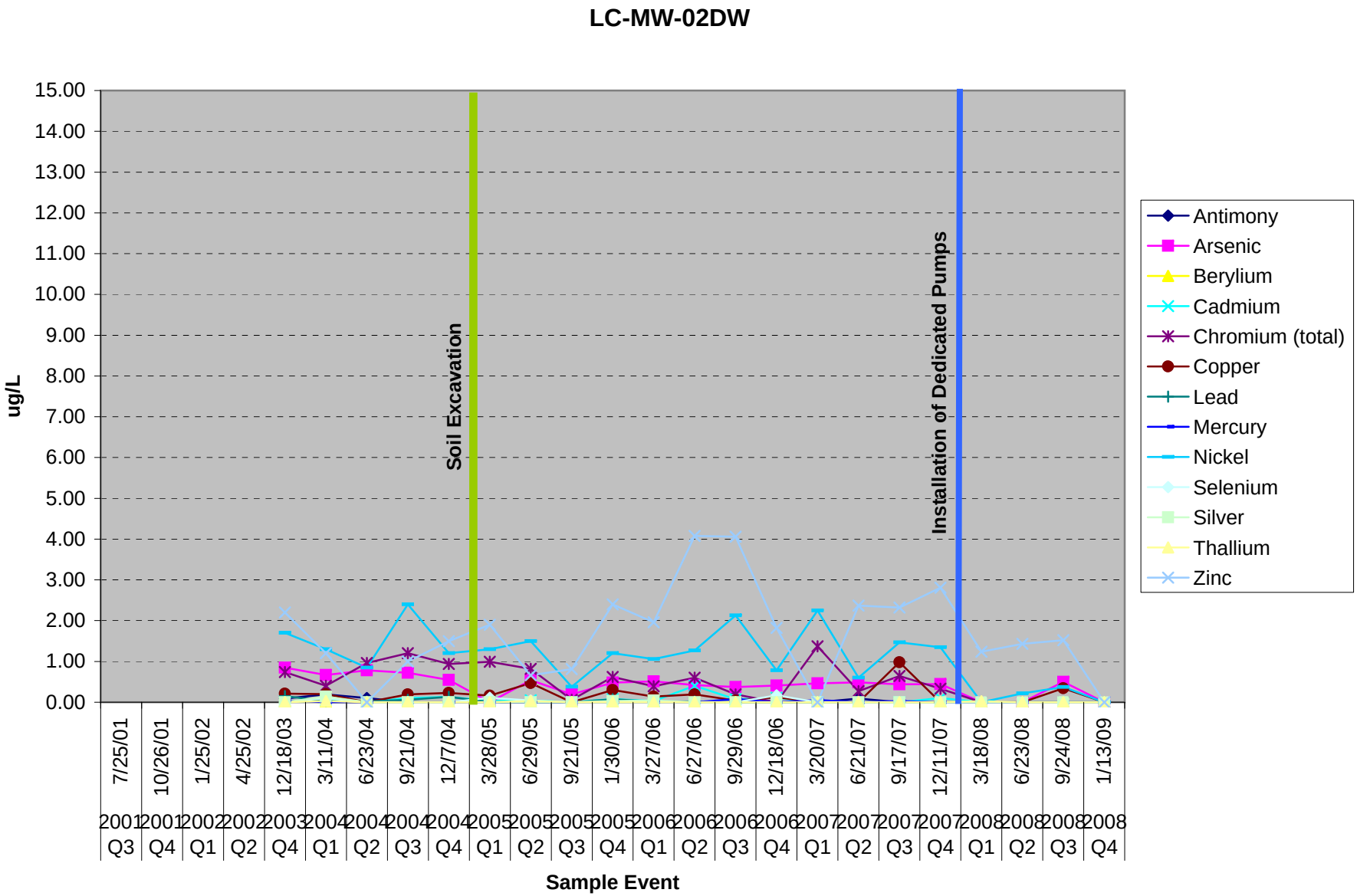
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
ug/L
Soil Excavation
Installation of Dedicated Pumps
Antimony
Arsenic
Berylium
Cadmium
Lead
Mercury
Chromium (total)
Copper
Nickel
Selenium
Silver
Thallium
Zinc
7/25/01
10/26/01
1/25/02
4/25/02
12/18/03
3/11/04
6/23/04
9/21/04
12/7/04
3/28/05
6/29/05
9/21/05
1/30/06
3/27/06
6/27/06
9/29/06
12/18/06
3/20/07
6/21/07
9/17/07
12/11/07
3/19/08
6/23/08
9/24/08
1/13/09
2001 Q3
2001 Q4
2002 Q1
2002 Q2
2003 Q4
2004 Q1
2004 Q2
2004 Q3
2004 Q4
2005 Q1
2005 Q2
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
Sampling Event

LC-MW-02SW


15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
ug/L
Soil Excavation
Installation of Dedicated Pumps
Antimony
Arsenic
Berylium
Cadmium
Chromium (total)
Copper
Mercury
Nickel
Selenium
Silver
Thallium
Zinc
7/25/01
10/26/01
1/25/02
4/25/02
12/18/03
3/11/04
6/23/04
9/21/04
12/7/04
3/28/05
6/29/05
9/21/05
1/30/06
3/27/06
6/27/06
9/29/06
12/18/06
3/20/07
6/21/07
9/17/07
12/11/07
3/18/08
6/23/08
9/24/08
1/12/09
2001 Q3
2001 Q4
2002 Q1
2002 Q2
2003 Q4
2004 Q1
2004 Q2
2004 Q3
2004 Q4
2005 Q1
2005 Q2
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
Sampling Event


LC-MW-02DW
ug/L
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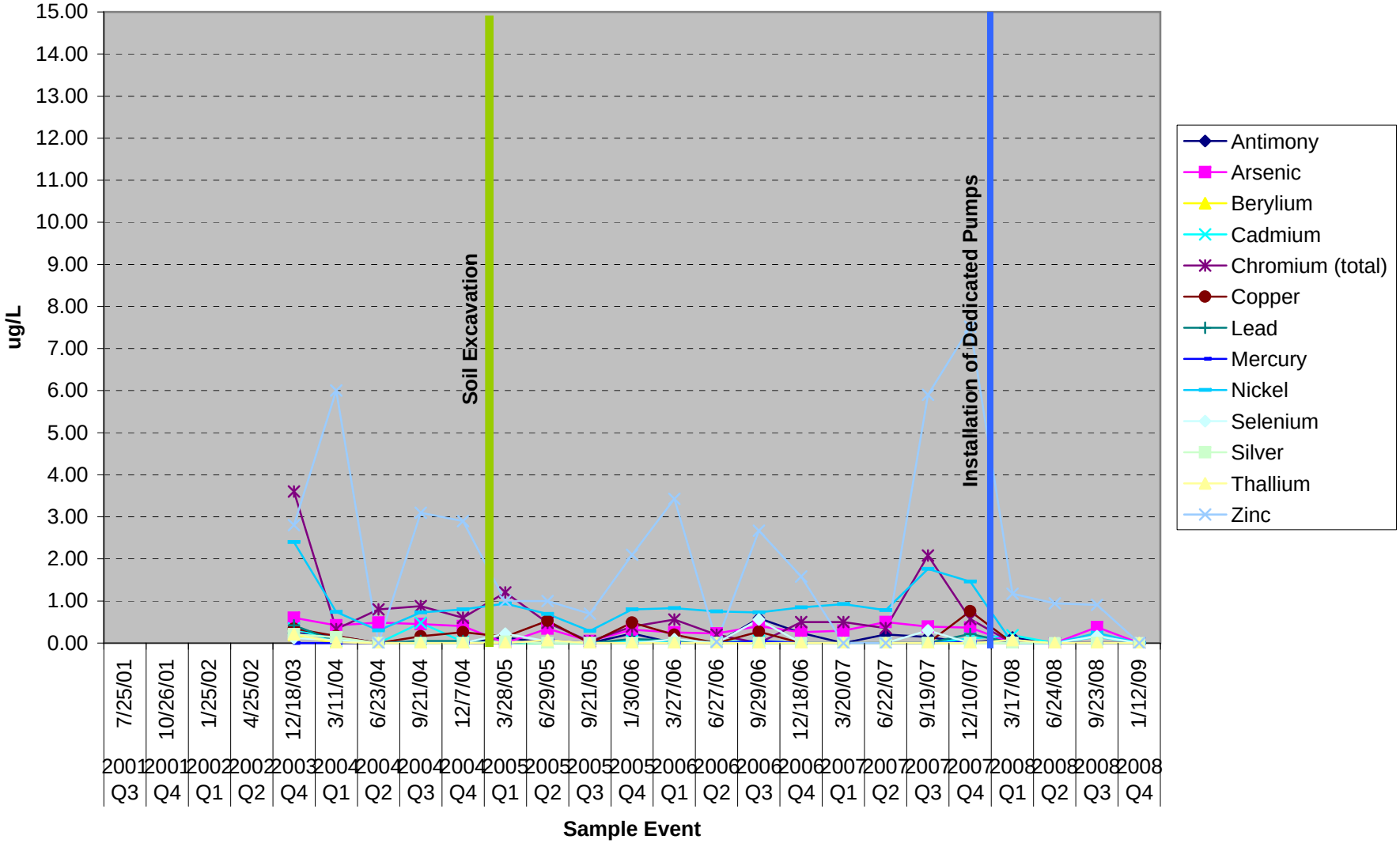
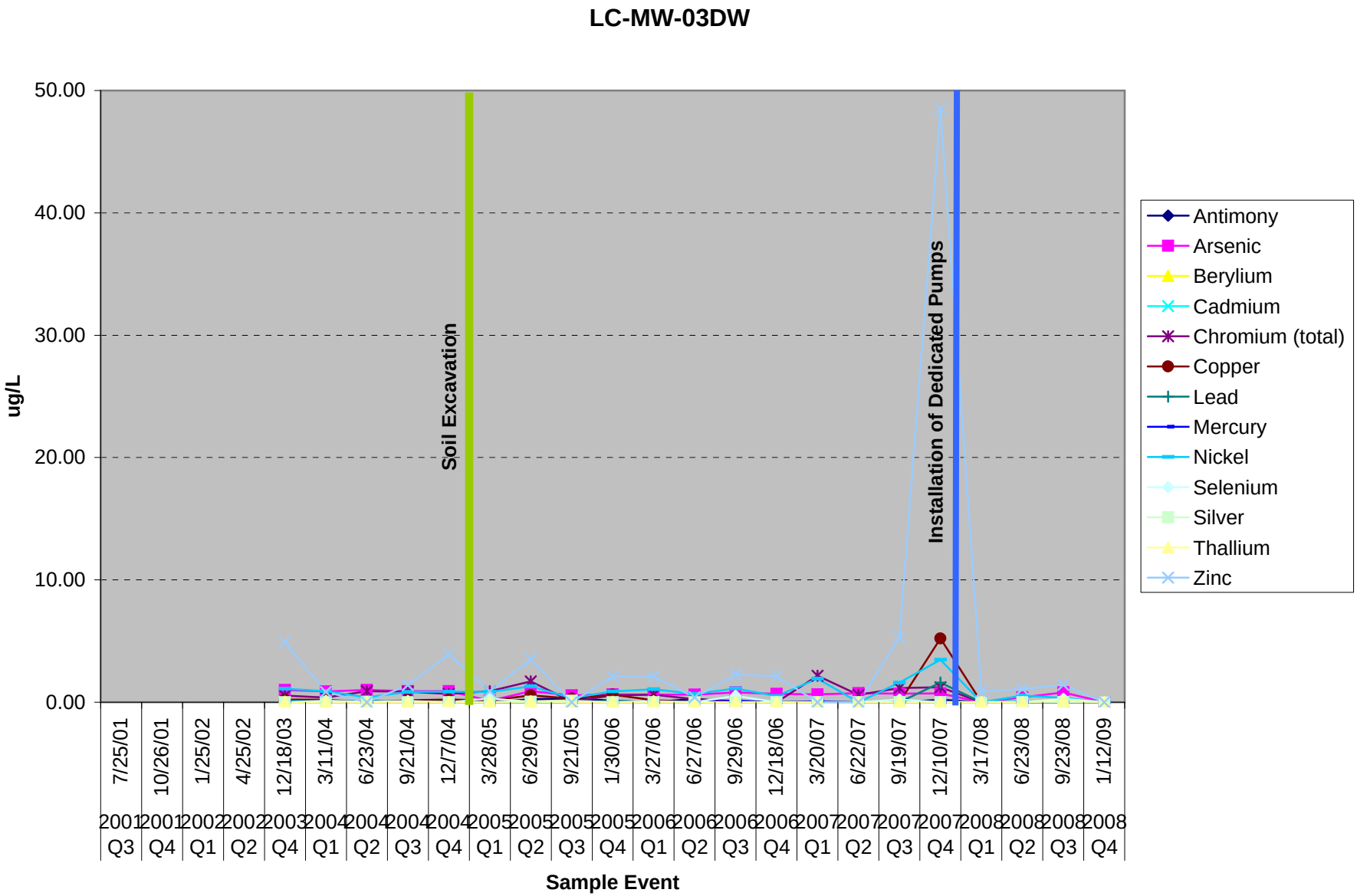
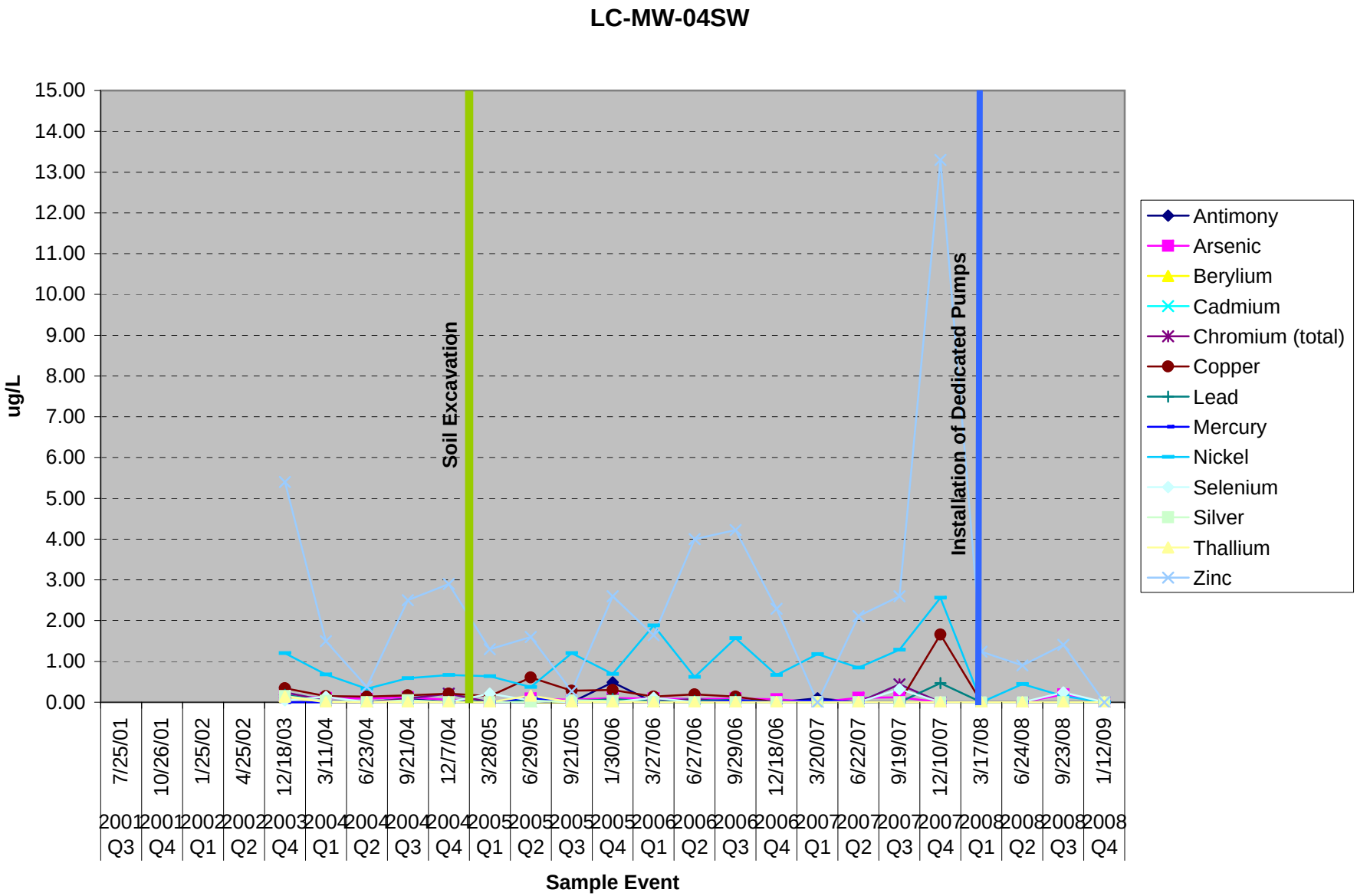
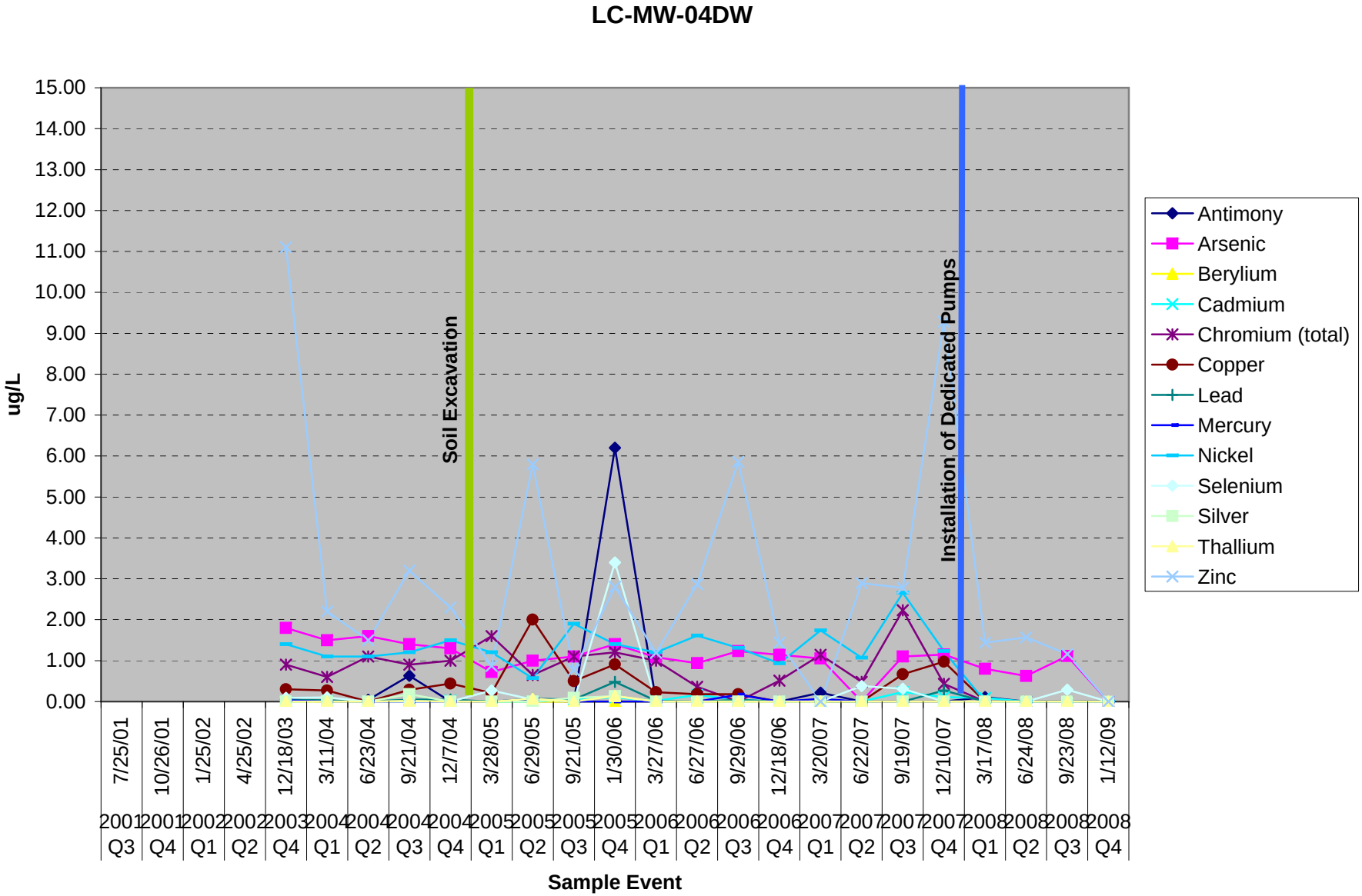
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Soil Excavation
Installation of Dedicated Pumps
7/25/01 2001 Q3
10/26/01 2001 Q4
1/25/02 2002 Q1
4/25/02 2002 Q2
12/18/03 2003 Q4
3/11/04 2004 Q1
6/23/04 2004 Q2
9/21/04 2004 Q3
12/7/04 2004 Q4
3/28/05 2005 Q1
6/29/05 2005 Q2
9/21/05 2005 Q3
1/30/06 2005 Q4
3/27/06 2006 Q1
6/27/06 2006 Q2
9/29/06 2006 Q3
12/18/06 2006 Q4
3/20/07 2007 Q1
6/21/07 2007 Q2
9/17/07 2007 Q3
12/11/07 2007 Q4
3/18/08 2008 Q1
6/23/08 2008 Q2
9/24/08 2008 Q3
1/13/09 2008 Q4
Sample Event
Antimony
Arsenic
Berylium
Cadmium
Chromium (total)
Copper
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc

LC-MW-03SW

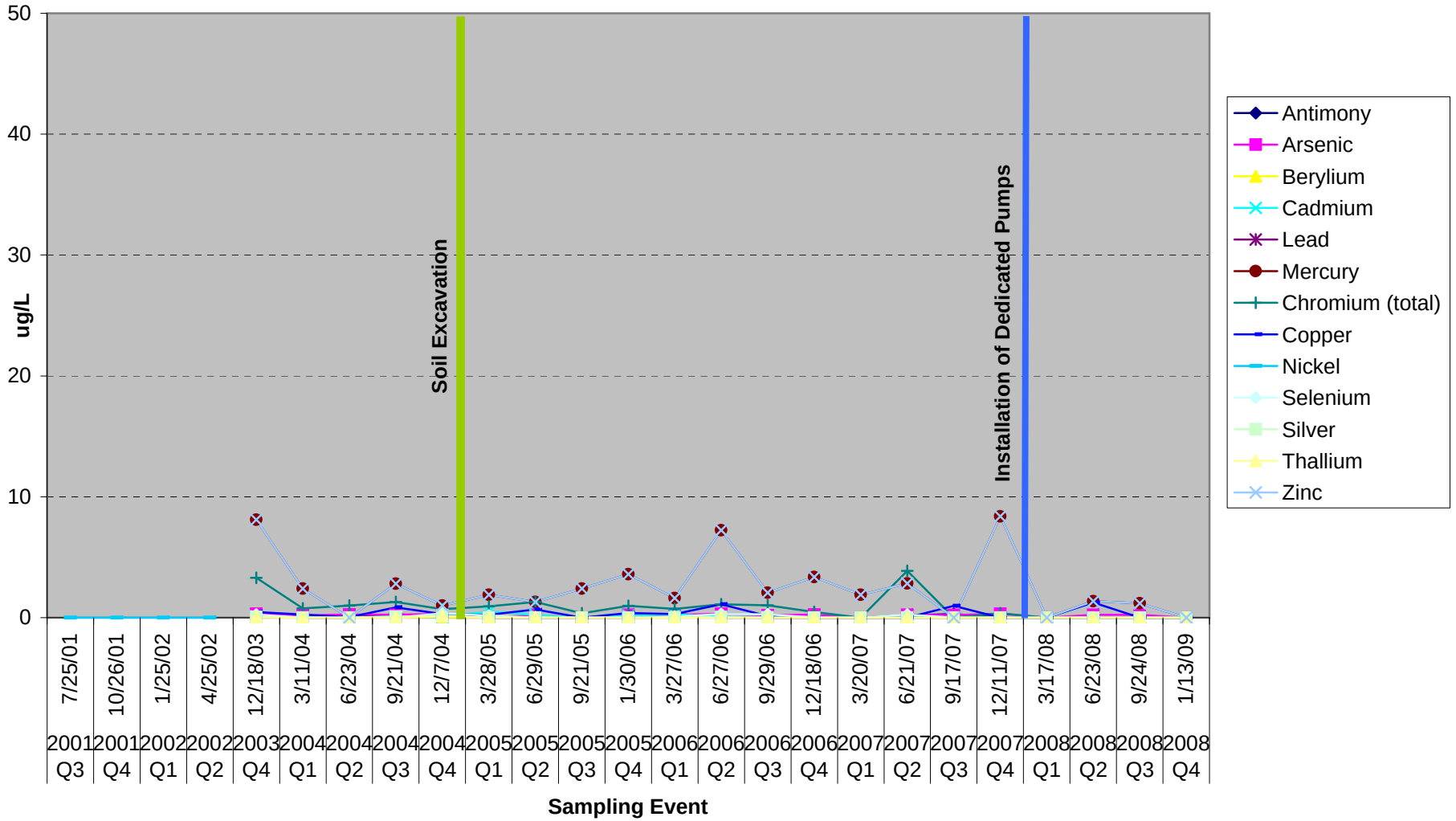

15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
ug/L
Soil Excavation
Installation of Dedicated Pumps
Antimony
Arsenic
Berylium
Cadmium
Chromium (total)
Copper
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc
7/25/01
10/26/01
1/25/02
4/25/02
12/18/03
3/11/04
6/23/04
9/21/04
12/7/04
3/28/05
6/29/05
9/21/05
1/30/06
3/27/06
6/27/06
9/29/06
12/18/06
3/20/07
6/22/07
9/19/07
12/10/07
3/17/08
6/24/08
9/23/08
1/12/09
2001 Q3
2001 Q4
2002 Q1
2002 Q2
2003 Q4
2004 Q1
2004 Q2
2004 Q3
2004 Q4
2005 Q1
2005 Q2
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
Sample Event


LC-MW-03DW
50.00
40.00
30.00
20.00
10.00
0.00
ug/L
Soil Excavation
Installation of Dedicated Pumps
Antimony
Arsenic
Berylium
Cadmium
Chromium (total)
Copper
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc
7/25/01
10/26/01
1/25/02
4/25/02
12/18/03
3/11/04
6/23/04
9/21/04
12/7/04
3/28/05
6/29/05
9/21/05
1/30/06
3/27/06
6/27/06
9/29/06
12/18/06
3/20/07
6/22/07
9/19/07
12/10/07
3/17/08
6/23/08
9/23/08
1/12/09
2001 Q3
2001 Q4
2002 Q1
2002 Q2
2003 Q4
2004 Q1
2004 Q2
2004 Q3
2004 Q4
2005 Q1
2005 Q2
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
Sample Event


LC-MW-04SW
ug/L
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Soil Excavation
Installation of Dedicated Pumps
7/25/01 2001 Q3
10/26/01 2001 Q4
1/25/02 2002 Q1
4/25/02 2002 Q2
12/18/03 2003 Q4
3/11/04 2004 Q1
6/23/04 2004 Q2
9/21/04 2004 Q3
12/7/04 2004 Q4
3/28/05 2005 Q1
6/29/05 2005 Q2
9/21/05 2005 Q3
1/30/06 2005 Q4
3/27/06 2006 Q1
6/27/06 2006 Q2
9/29/06 2006 Q3
12/18/06 2006 Q4
3/20/07 2007 Q1
6/22/07 2007 Q2
9/19/07 2007 Q3
12/10/07 2007 Q4
3/17/08 2008 Q1
6/24/08 2008 Q2
9/23/08 2008 Q3
1/12/09 2008 Q4
Sample Event
Antimony
Arsenic
Berylium
Cadmium
Chromium (total)
Copper
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc


LC-MW-04DW
ug/L
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Soil Excavation
Installation of Dedicated Pumps
7/25/01 2001 Q3
10/26/01 2001 Q4
1/25/02 2002 Q1
4/25/02 2002 Q2
12/18/03 2003 Q4
3/11/04 2004 Q1
6/23/04 2004 Q2
9/21/04 2004 Q3
12/7/04 2004 Q4
3/28/05 2005 Q1
6/29/05 2005 Q2
9/21/05 2005 Q3
1/30/06 2005 Q4
3/27/06 2006 Q1
6/27/06 2006 Q2
9/29/06 2006 Q3
12/18/06 2006 Q4
3/20/07 2007 Q1
6/22/07 2007 Q2
9/19/07 2007 Q3
12/10/07 2007 Q4
3/17/08 2008 Q1
6/24/08 2008 Q2
9/23/08 2008 Q3
1/12/09 2008 Q4
Sample Event
Antimony
Arsenic
Berylium
Cadmium
Chromium (total)
Copper
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc

LC-MW-01SW


50
40
30
20
10
0
ug/L
Soil Excavation
Installation of Dedicated Pumps
Antimony
Arsenic
Berylium
Cadmium
Lead
Mercury
Chromium (total)
Copper
Nickel
Selenium
Silver
Thallium
Zinc
7/25/01 2001 Q3
10/26/01 2001 Q4
1/25/02 2002 Q1
4/25/02 2002 Q2
12/18/03 2003 Q4
3/11/04 2004 Q1
6/23/04 2004 Q2
9/21/04 2004 Q3
12/7/04 2004 Q4
3/28/05 2005 Q1
6/29/05 2005 Q2
9/21/05 2005 Q3
1/30/06 2005 Q4
3/27/06 2006 Q1
6/27/06 2006 Q2
9/29/06 2006 Q3
12/18/06 2006 Q4
3/20/07 2007 Q1
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9/17/07 2007 Q3
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1/13/09 2008 Q4
Sampling Event

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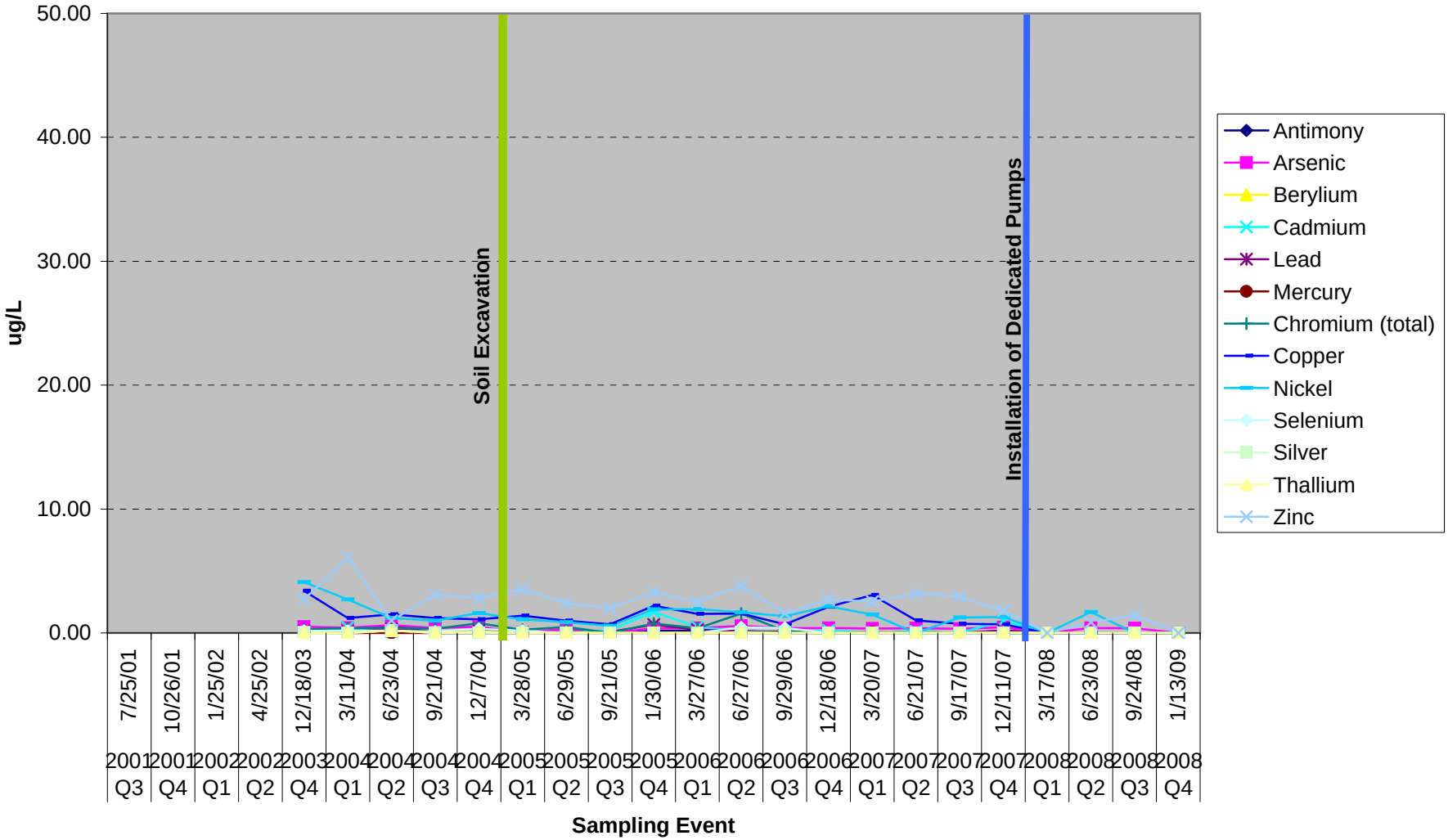
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Cadmium
Lead
Mercury
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Zinc
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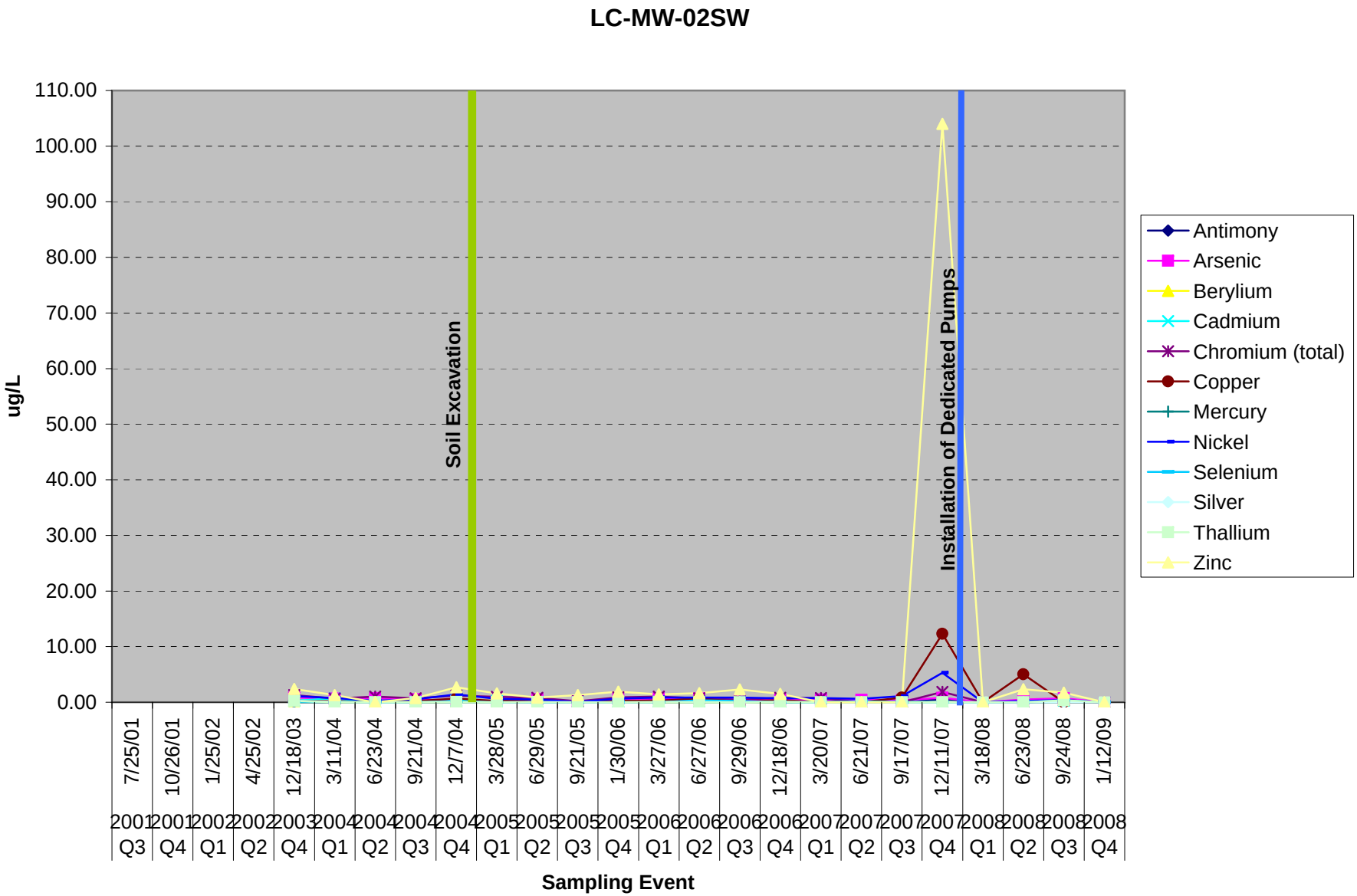
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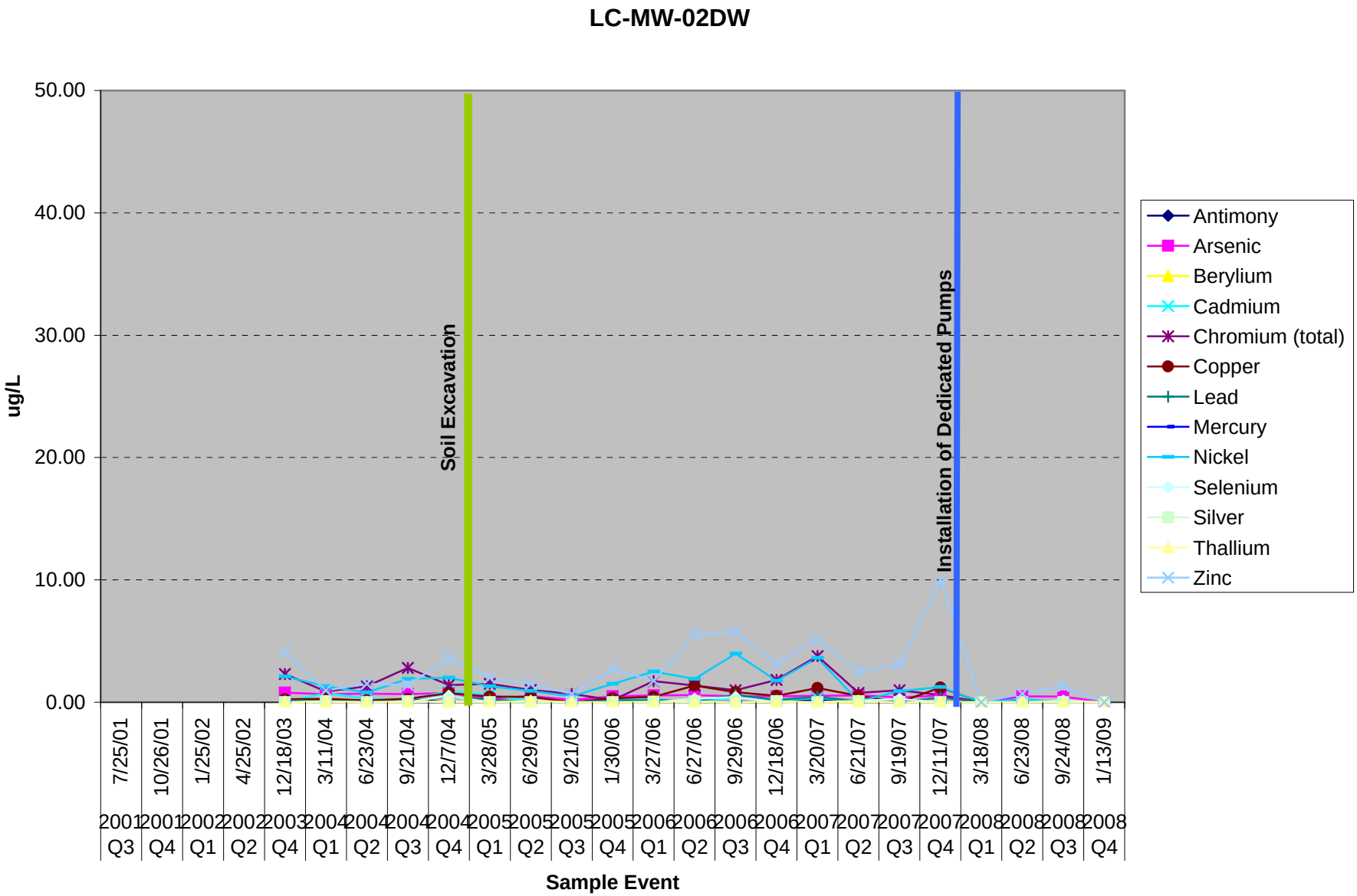
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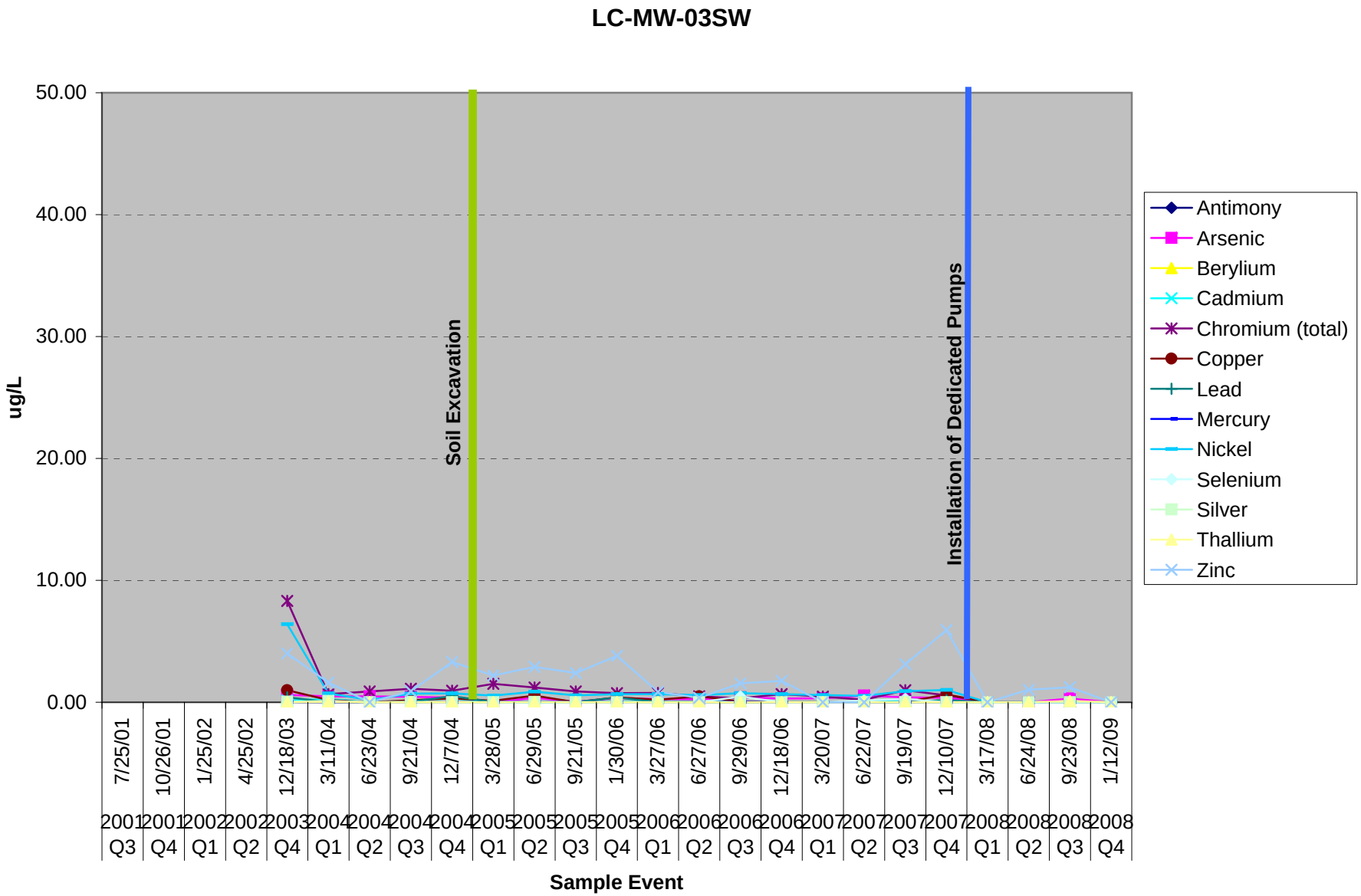
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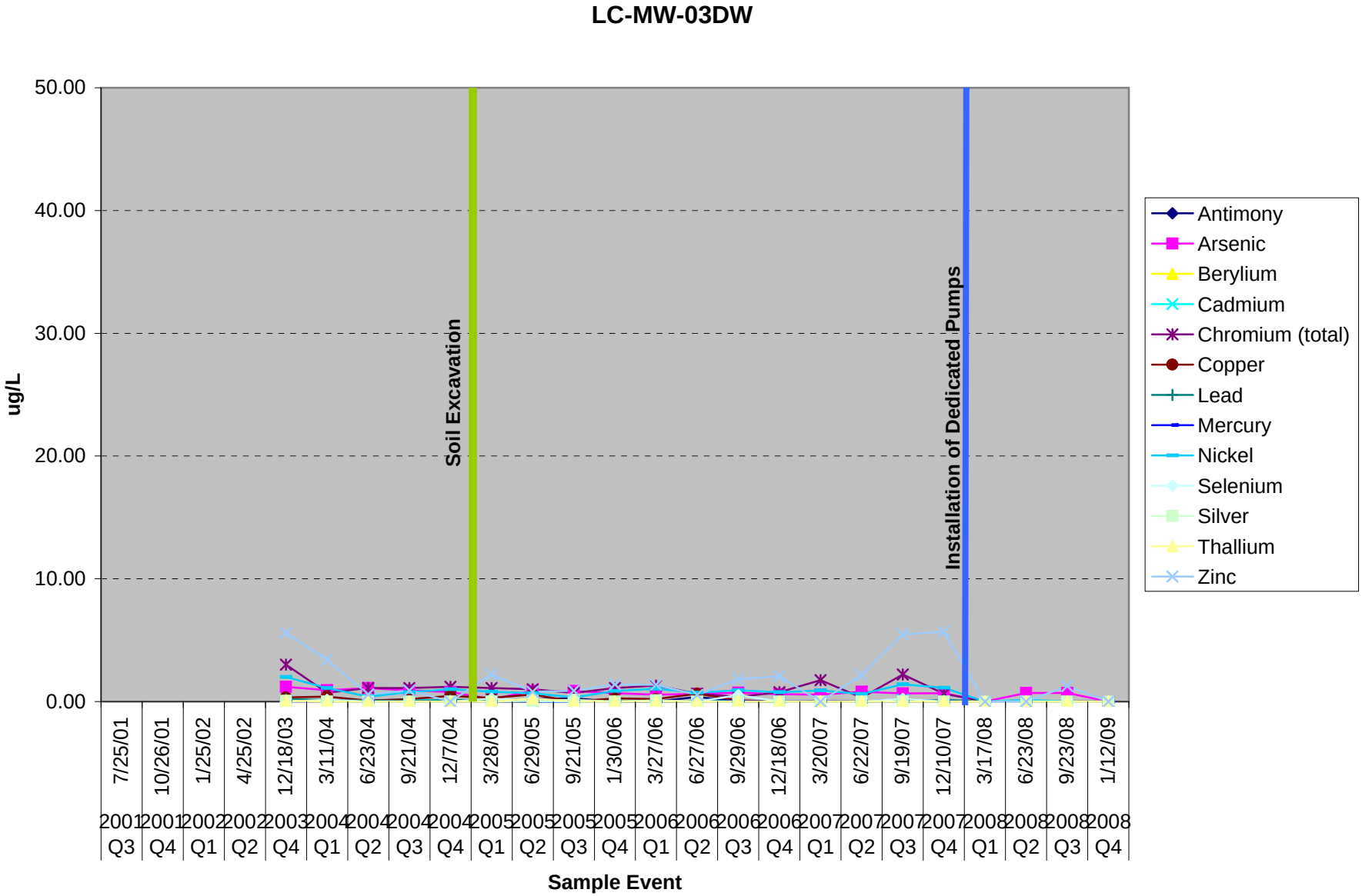
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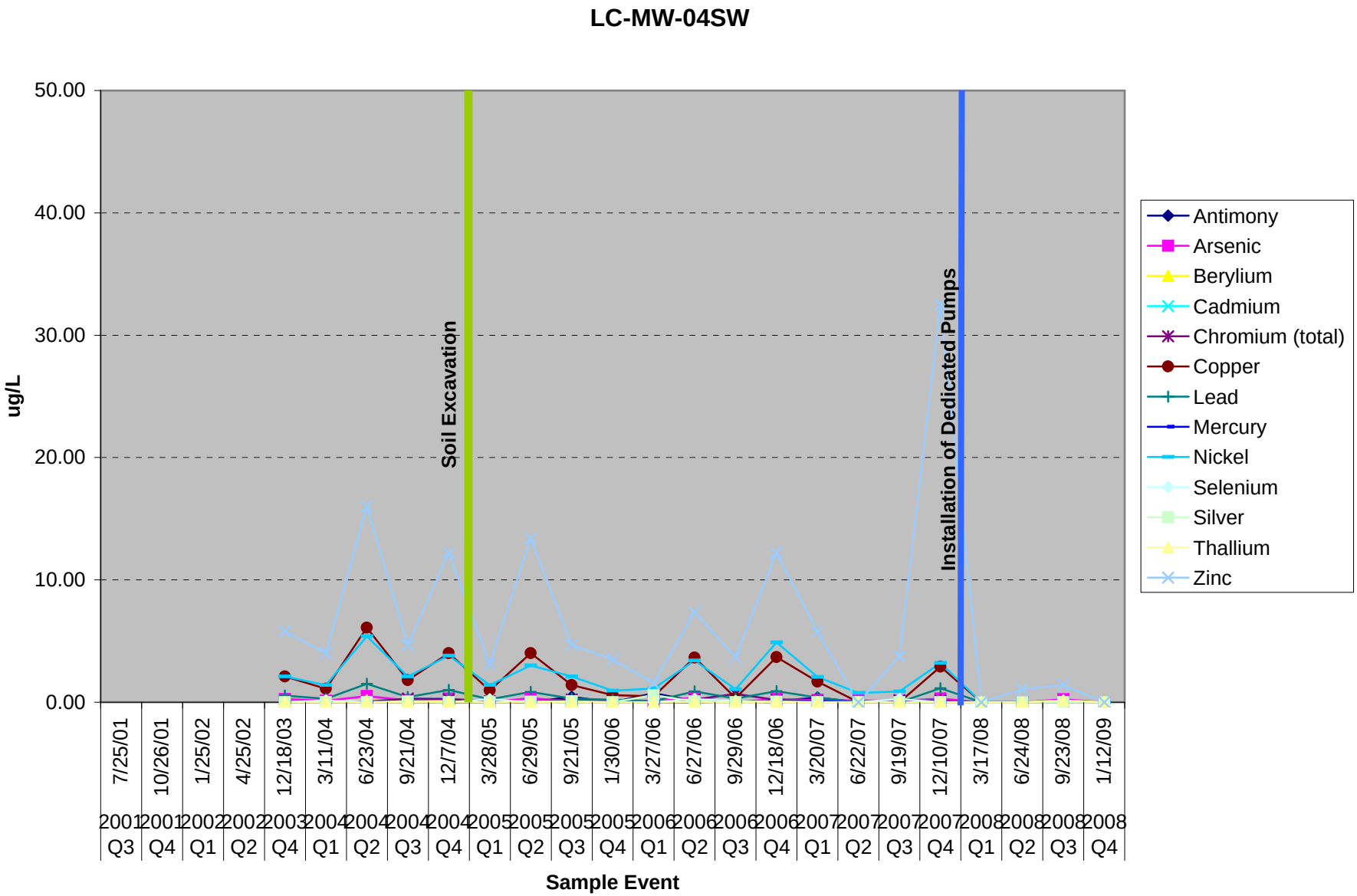
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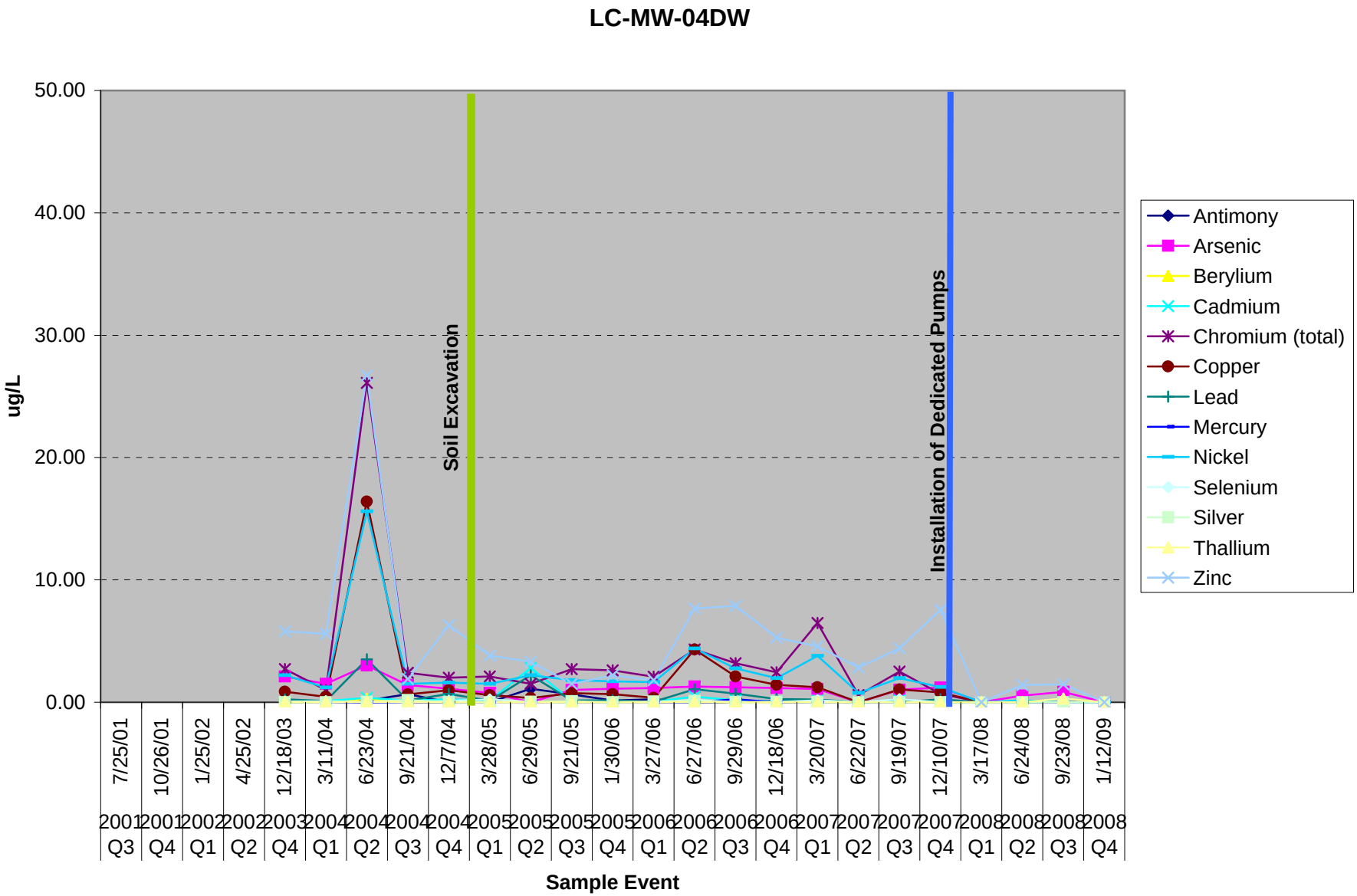
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2008 Q1
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2008 Q3
2008 Q4
Sample Event

PBS | Engineering + Environmental

Groundwater Sampling and Analysis Report

4th Quarter 2008

Camp Bonneville
Vancouver, Washington

Prepared for:
Washington State Department of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600

January 30, 2009
PBS Project No. 70489.000, Task 6215

4412 SW Corbett Avenue, Portland, OR 97239
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1.0 INTRODUCTION

This report documents the results of groundwater sampling and analysis at two monitoring well installation locations at Camp Bonneville. The sampling and analysis was conducted for the 4th Quarter 2008. This work was performed by PBS Engineering + Environmental (PBS), Portland, Oregon, under contract to Michael Baker, Jr., Inc. (Baker). The work was performed at the Camp Bonneville Military Reservation (Camp Bonneville) northeast of Vancouver, Washington (Figure 1). Camp Bonneville is a former United States government military facility that was selected for closure under the Base Realignment and Closure (BRAC) authorization.

As part of the early transfer process for Camp Bonneville Military Reservation (CBMR), the U.S. Department of the Army (Army) and Clark County, Washington (Clark County, "County"), along with the Bonneville Conservation, Restoration, and Renewal Trust, LLC (BCRRT), negotiated an Environmental Services Cooperative Agreement (ESCA). The groundwater monitoring program is a component of the remedial-action services performed in support of the Conservation, Restoration, and Renewal Program (CRRP) associated with the facility. The CRRP includes those activities necessary to obtain Notice(s) of Completion, Site Closeout(s), and CERCLA Warranty(ies) for reconveyance of the CBMR from the BCRRT to Clark County. These additional remedial actions address requirements contained in agreements between the BCRRT and the Washington State Department of Ecology (WDOE).

The groundwater monitoring work was performed in general accordance with the Sampling and Analysis Plan (SAP) revised on September 25, 2007, the Health and Safety Plan (HASP) revised on August 24, 2007, and the Quality Assurance Project Plan (QAPP) dated November 3, 2006. Laboratory analytical services were provided by TestAmerica located in Portland, Oregon, Seattle, Washington, and Denver, Colorado, under contract to Baker.

1.1 Project Objectives

The overall objectives of site investigations at Camp Bonneville, which have been previously conducted as part of the U.S. Army BRAC process, have been to identify contaminated areas and determine the next appropriate steps toward restoration of those sites. This quarterly monitoring report describes the results of ongoing environmental monitoring of groundwater parameters at two areas in Camp Bonneville. Monitoring wells have been installed in these areas to monitor shallow and deeper groundwater to maximum depths of approximately 75 feet below the ground surface (bgs).

The sites that are currently monitored include one old landfill/demolition area (Landfill 4/Demo Area 1) and the Camp Bonneville base boundary at Lacamas Creek. Two other demolition areas (Demolition Areas 2 and 3) were previously monitored, but were removed from the monitoring program per agreement with WDOE in 2006. The attached Figure 2 shows locations of these monitoring sites.

Investigation activities included groundwater sampling at the old landfill/demolition area and the area where Lacamas Creek exits the southwest side of the base. These investigations were conducted in general accordance with the project SAP, with adjustments made in the field to accommodate site conditions. The analytical results obtained from groundwater samples collected at the various monitoring well locations were compared with screening levels established for the site to determine if the groundwater potentially poses an unacceptable environmental risk. Cleanup levels

established by WDOE under the Model Toxics Control Act (MTCA) have been used as screening criteria to evaluate the levels of contaminants detected at Camp Bonneville.

1.2 Scope of Work

PBS conducted a round of groundwater sampling at 19 existing monitoring wells for the 4th Quarter 2008 sampling event. Sampling for this quarter was performed from January 7 through 13, 2009. The sampling event was postponed from December 2008 due to hazardous weather conditions. Department of Ecology was contacted and approved the delay in groundwater sampling. The wells were purged and sampled utilizing low-flow, minimal-drawdown procedures, as described in detail in the Groundwater Sampling and Analysis Plan (SAP, PBS, 2007f). On March 11 through 12, 2008, dedicated bladder pumps were installed into each of the wells. The bladder pumps are activated using air regulated through a control box with a small air compressor as the air source.

2.0 SITE BACKGROUND

2.1 Site History

Camp Bonneville comprises approximately 3,820 acres and is located in southwestern Washington, approximately 10 miles northeast of Vancouver, Washington (Figure 1). The Department of the Army used Camp Bonneville for live fire of small arms, assault weapons, artillery, and field and air defense artillery between 1910 and 1995. Since 1947, Camp Bonneville has also provided training for a variety of military and non-military units, including National Guard, Army Reserves, and U.S. Air Force and federal, state, and local law enforcement agencies. The Federal Bureau of Investigation (FBI) used one firing range on the site for training through 2008. Camp Bonneville includes approximately 820 acres of land leased from the State of Washington Department of Natural Resources (DNR).

In July of 1995, Camp Bonneville was selected for closure under the 1995 Base Realignment and Closure process. The Camp Bonneville Reuse Plan (Otak, September 1998; updated 2003) called for the majority of Camp Bonneville to be transferred to Clark County for the public benefit – education, law enforcement, and parks, with no financial gain to Clark County. The 820 acres currently leased from the Washington DNR would either be returned to the State, the lease renewed, or the property purchased and transferred to Clark County. Transfer of the site to The Trust for Public Lands and subsequently to Clark County, began in 2006. The facility was transferred from the Army to Clark County and from the County to the Bonneville Conservation Restoration and Renewal Team (BCRRT) on October 3, 2006. BCRRT and Clark County entered into a Prospective Purchaser Consent Decree with the Washington Department of Ecology (WDOE) that requires investigating and remediating the site. Clark County intends to use the site as a Regional Park and Wildlife Refuge.

Through the years, several ordnance and explosive (OE) items have been found within Camp Bonneville's boundaries. Recent OE characterization, sampling, and removal efforts performed at Camp Bonneville confirmed the presence of OE at the site. Some of these OE items were determined to be unexploded ordnance (UXO).

2.2 Previous Investigations

During previous investigations, shallow monitoring wells were installed at Camp Bonneville at four sites: Landfill 2, Landfill 3, the Pesticide Mixing/Storage Building, and the Former Sewage Pond (Figure 2, Shannon & Wilson, 1999). Additional shallow and

deep wells were installed at Landfill 4, Demolition Area 2, Demolition Area 3, and the Base Boundary at Lacamas Creek. The groundwater monitoring wells are located in areas of documented disposal of UXO. However, the areas of the wells were cleared of UXO prior to well installation. Groundwater sampling activities were conducted only in the immediate area of the wells and did not occur in areas that have not been previously checked and cleared of UXO.

In May 2004, PBS supervised installation of two additional groundwater monitoring wells along North Fork Lacamas Creek below Landfill 4 (PBS, 2004b). The monitoring well completed in bedrock (Monitoring Well L4-MW17) was located at the west side of North Fork Lacamas Creek, at a point where the creek exits the ravine below Landfill 4. The monitoring well completed in alluvium (Monitoring Well L4-MW18) was located at the east side of North Fork Lacamas Creek near the bottom of the ravine and above the junction of an east-trending tributary stream to Lacamas Creek.

2.3 Monitoring Well Numbering

Different numbers have been assigned, over time, to monitoring wells at the Base Boundary at Lacamas Creek, Demolition Area 2, and Demolition Area 3. Well numbers used by PBS in monitoring reports for the 4th Quarter 2003, 1st Quarter 2004, and 2nd Quarter 2004 were based on proposed well locations and well identifiers, as presented in the PBS-Army BRAC Contract documents. The actual well numbers were assigned by the U.S. Army Center for Health Promotion and Preventative Medicine (CHPPM) when the wells were installed. The CHPPM well identifiers are the numbers on the well caps. Remedial Investigation (RI) reports previous to PBS' reports have used the well numbers assigned by CHPPM. Washington State Department of Ecology well tag numbers are consistent across both numbering systems.

Table 6 shows the monitoring well numbers used by PBS (per the PBS-Army BRAC Contract document), Washington State Department of Ecology well tag numbers, well locations, total depth, screened interval and CHPPM well identification numbers used in former RI reports for Camp Bonneville. The well numbers used in the PBS quarterly reports are cross-referenced to the CHPPM numbers and the WDOE well tag numbers in Table 6.

2.4 Groundwater Monitoring Locations

For the 4th Quarter 2008, PBS conducted groundwater sampling and analysis for monitoring wells at the Landfill 4 area and the Base Boundary at Lacamas Creek. The locations of monitoring wells are shown on Figure 3 (Base Boundary at Lacamas Creek) and Figure 4 (Landfill 4/Demo Area 1). The monitoring wells at the sites are listed below (S = shallow well; D = deep well) according to the CHPPM numbers:

- Base Boundary at Lacamas Creek
  - Paired Monitoring Wells: LC-MW01S and LC-MW01D
  - Paired Monitoring Wells: LC-MW02S and LC-MW02D
  - Paired Monitoring Wells: LC-MW03S and LC-MW03D
  - Paired Monitoring Wells: LC-MW04S and LC-MW04D

- Landfill 4/Demo Area 1
  - Paired Monitoring Wells: L4-MW01A (shallow) and L4-MW01B (deep)
  - Paired Monitoring Wells: L4-MW02A (shallow) and L4-MW02B (deep)

- Paired Monitoring Wells: L4-MW03A (shallow) and L4-MW03B (deep)
- Monitoring Well L4-MW04A (shallow)
- Monitoring Well L4-MW05A (shallow)
- Monitoring Well L4-MW07B (deep)
- Monitoring Well L4-MW17 (in bedrock)
- Monitoring Well L4-MW18 (in alluvium)

2.5 Chemicals of Potential Concern

A summary of chemicals of potential concern (COPC) is presented in Table 1. Specific analytes and laboratory analysis methods, sample container types, preservation techniques, and holding times for the chemical analyses are presented in Tables 2-2 and 2-3 in the GW SAP (PBS, 2006).

Table 1. Chemicals of Potential Concern

Sampling Areas	Munitions Compound Classes	High Explosives and Organic Compounds	Artillery Propellants	Other
Landfill 4 Demolition Areas Base Boundary	Artillery Propellants HE Missile/ Rocket Propellants	TNT RDX PETN PA HMX NG	Black Powder (nitrate) Plasticizers Stabilizers AP	Priority Pollutant Metals TPH SVOCs VOCs

Notes:
AP = ammonium perchlorate
Black powder is a mixture of potassium or sodium nitrate, charcoal, and sulfur
Plasticizers = dibutylphthalate; diethylphthalate
Stabilizers = diphenylamine; N-nitrosodiphenylamine
HE = high explosives; 2,4 DNT, 2,6 DNT
HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine (Cyclonite)
NG = nitroglycerine
PA = picric acid
PETN = pentaerythritol tetranitrate
TNT = 2,4,6-trinitrotoluene
TPH = total petroleum hydrocarbons
VOCs = volatile organic compounds
SVOCs = semivolatile organic compounds

3.0 GROUNDWATER SAMPLING

PBS conducted groundwater sampling for the 4th Quarter 2008 event at 19 existing monitoring wells at two locations within Camp Bonneville (Figures 3 and 4). Monitoring wells were sampled during the period of January 7 through 13, 2009. The monitoring wells were sampled in accordance with the procedures established in the groundwater SAP, dated December 14, 2006, and revised September 25, 2007. The procedures detailed in the SAP include sample collection, sample labeling, chain of custody, field documentation, decontamination, and investigative-derived waste handling. The groundwater SAP was prepared by PBS and Michael Baker, Jr., and submitted to WDOE. Health and safety procedures followed during site activities were in compliance with the procedures established in the Site Health and Safety Plan (HASP), dated October 30, 2006, and revised August 14, 2007. The HASP was prepared by Michael Baker, Jr., and approved by WDOE.

Changes made from the SAP included installation of dedicated bladder pumps in each of the wells on March 11 and 12, 2008. This was done as outlined in a letter from Baker to WDOE dated February 13, 2008.

3.1 Low-Flow Purging

A low-flow, minimal-drawdown technique was used for groundwater purging and sampling using dedicated Solinst bladder pumps constructed out of PVC body and a Teflon bladder. The low flow purging technique is described in detail in the groundwater SAP. Low-flow sampling minimizes disturbance to the aquifer and is designed to ensure that samples collected from the wells are representative of groundwater. A low pumping rate is chosen to match the laminar flow in the immediate vicinity of the sampling pump intake; thus, drawing groundwater directly from the aquifer, horizontally through the well screen, and into the pump.

3.2 Sample Collection

Samples that did not require filtering were collected into the laboratory-supplied sample containers directly from the end of the dedicated discharge hose. Groundwater samples requiring preservatives were collected in sample bottles supplied by the contract laboratory and contained the appropriate amounts of preservative solution. Sample containers for VOCs and TPH were filled completely to the top of the container, and the container cap screwed on to prevent any air remaining in the headspace of the container.

Samples collected for dissolved metals analysis and dissolved oxygen content (DOC) were field-filtered. An in-line, nitrocellulose, 0.45-micron cartridge filter was attached to the sample-discharge line. Groundwater was rinsed through the filter prior to filling the sample bottle. The sample bottle was then filled directly from the discharge outlet on the filter.

3.3 Quality Assurance/Quality Control Samples

Duplicate samples were collected at a frequency of 1 per 10 monitoring well samples. Matrix spike/matrix spike duplicate (MS/MSD) samples were collected at a frequency of 1 per 20 monitoring well samples. Trip blanks were submitted with shipments containing groundwater samples for VOC analyses. Dedicated pumps in all the wells eliminate the need for equipment blanks.

4.0 DATA MANAGEMENT AND REVIEW

The laboratory data quality was validated before use according to the procedures described in the QAPP. PBS reviews laboratory QA/QC results, trip blank analytical results and compares duplicate sample results. All analytical data is received from the laboratory in an electronic data deliverable (EDD) format to be imported into Earthsoft EQuIS database. Qualifiers from the laboratory are included as well as any qualifiers to the data as the result of data validation procedures conducted by PBS.

The analytical tables include the State of Washington MTCA levels for comparison with regulatory and risk-based criteria. MTCA Method A cleanup level values for groundwater were obtained from the MTCA Cleanup Regulation, Chapter 173-340 of the Washington Administrative Code (WAC) (WDOE, 2001). These cleanup levels are not site specific and are applicable to sites undergoing routine cleanup actions, as defined in MTCA. MTCA Method B risk-based concentrations for groundwater were obtained from the MTCA Method B levels presented in the *Volume 1, Multi-Sites Investigation Report for Camp Bonneville* (Shannon & Wilson, 1999). The MTCA Method B values are based on a Risk Calculations (CLARC) II database (based on a 10^{-6} cancer risk or a hazard quotient of 1) (WDOE, 1996; WDOE, 2001)

and are derived from formula values obtained from the February 1996 CLARC II Update (WDOE, 1996).

5.0 GROUNDWATER MONITORING RESULTS

5.1 Base Boundary at Lacamas Creek

Groundwater samples were collected from the four monitoring well pairs located at the Base Boundary at Lacamas Creek (Figure 3) on January 12 and 13, 2009. A field duplicate sample (labeled LCMW460W) was collected from Monitoring Well LCMW02D. Extra volume of groundwater was collected from Monitoring Well LCMW04S for the purpose of supplying extra water for laboratory MS/MSD samples.

Water level depths in the wells ranged from 3.83 to 4.87 feet below the top of the PVC well casings. These represent water elevations in the wells ranging from 286.15 to 287.80 feet mean sea level (MSL). December 2008 had a record snow fall for the region and on January 1, 2009, record rainfall of 2.49 inches (Portland Airport, NWS) were recorded in the region. The water near the base boundary wells was very high, although it does not appear that the wells were under water.

The laboratory analytical results are presented in Tables 2 through 4. Groundwater field parameters (i.e., pH, temperature, conductivity, ORP, dissolved oxygen, and turbidity) recorded at the time of sampling are presented in Table 5.

VOCs were not detected in any of the Base Boundary wells. No diesel, oil, or gasoline range petroleum hydrocarbons were detected in any of the Base Boundary groundwater samples. Explosive compounds, RDX, HMX, nitroglycerine, PETN, and picric acid were not detected in any of the groundwater samples. Perchlorate was not detected above the laboratory detection limit of 1 μg/L in any of the groundwater samples from the Base Boundary monitoring wells.

Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC) concentrations were below laboratory reporting limit (MRL) of 1.0 mg/L in all monitoring well groundwater samples. Total Suspended Solids were below the MRL of 10 mg/L in all samples. Bicarbonate alkalinity in the groundwater samples ranged from 40.9 to 51.8 mg/L. Inorganic ions consisting of chloride (1.34 to 2.33 mg/L), sulfate (nondetect to 1.24 mg/L), and nitrate (0.115 to 0.883 mg/L) were detected.

Total arsenic and nickel were detected in monitoring well LCMW04D (Table 3). No total metals were detected at concentrations above MTCA Method A or Method B regulatory screening levels. Dissolved arsenic was detected in LCMW04D (Table 3) but not detected at concentrations above MTCA Method A or Method B regulatory screening levels.

Laboratory analysis results for duplicate sample LCMW460W were consistent with the concentrations in the original sample LCMW02DW.

5.2 Landfill 4/Demolition Area 1

Groundwater samples were collected from monitoring wells at Landfill 4/Demolition Area 1 (Figure 4) on January 7 through 9, 2009. A field duplicate sample (labeled L4MW465W) was collected from Monitoring Well L4MW01B. Trip blanks accompanied all groundwater VOC sample containers.

Water level depths in the wells around the perimeter of the landfill ranged from 8.05 to 28.53 feet below the top of the PVC well casings. These represent water elevations in the wells ranging from 486.99 to 519.34 feet MSL. The water level in the monitoring well located downstream of the landfill (Monitoring Well L4MW07B) was 37.48 feet below the top of the PVC well casing (443.32 feet MSL). Monitoring wells along North Fork Lacamas Creek at the base of the stream ravine, downstream of Landfill 4, had water levels below the top of the PVC casing at 8.54 feet in Monitoring Well L4MW17 and 9.52 feet in Monitoring Well L4MW18 (352.94 feet and 353.32 feet MSL, respectively). December 2008 had a record snow fall for the region and on January 1, 2009, record rainfall of 2.49 inches (Portland Airport, NWS) was recorded. There was evidence that Lacamas Creek flowed over the road during the January 1, 2009 rainfall event and flooded the areas around MW-17 and MW-18. During January 7 through 9, 2009, Lacamas Creek water levels reached the top of the culverts at the road crossing near MW-17 and MW-18.

The laboratory analytical results are presented in Tables 2 through 4. Groundwater field parameters (i.e., pH, temperature, conductivity, ORP, dissolved oxygen, and turbidity) recorded at the time of sampling are presented in Table 5.

PETN and nitroglycerin, were not detected in any of the groundwater samples from shallow or deep monitoring wells. HMX and RDX were not detected in Monitoring Wells L4MW17 and L4MW18. HMX was detected in monitoring wells L4MW02A (3.2 μg/L), and L4MW02B (3.9 μg/L), HMX was detected in two other monitoring wells at estimated concentrations: L4MW03AW at 0.39 μg/L and L4MW05AW at 0.19 μg/L.

RDX was detected in monitoring wells L4MW02A (17 μg/L), L4MW02B (79 μg/L), L4MW03A (10 μg/L), L4MW03B (4.3 μg/L), L4MW04A (2.5 μg/L), and L4MW05A (3.5 μg/L); L4MW01A, L4MW01B, and L4MW07B had low estimated concentrations of RDX. All of the RDX values were below those detected during the previous sampling event.

The RDX values for L4MW01A, L4MW01B, L4MW07B, and L4MW465 (MW01B duplicate) had replicate values outside the acceptable range when analyzed by Method 8330 due to matrix interference. These samples were re-analyzed using Method 8321. These analytical results were inconsistent when comparing the results from Method 8330 so both sets of analytical data are presented. Concentrations for both analyses are very low and within the range of previous sampling events. This is an example where the analytical methods lose reproducibility when results are in the range of the MDL.

Perchlorate was detected in groundwater samples from all the Landfill 4 monitoring wells except MW17 and MW18. The concentrations range from an estimated 0.69 μg/L at L4MW01B (DUP) to 510 μg/L at L4MW02B. The highest levels of HMX, RDX, and perchlorate were found in the groundwater samples from the paired monitoring wells L4MW02A and L4MW02B.

VOCs detected at Landfill 4 monitoring well MW-02B included 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, 1,1,1-trichloroethane, and dichlorodifluoromethane, although below applicable MTCA Method A regulatory screening values. VOCs were not detected in any of the other monitoring wells.

Other than the RDX Method 8330 discrepancies, laboratory analysis results for duplicate sample L4MW465W were consistent with the concentrations in the original sample L4MW02AW. There were no differences that exceeded a RPD of 20 percent between the two samples. The RDX Method 8321 showed no difference between the original and duplicate samples.

6.0 RECENT TRENDS IN WATER QUALITY DATA

The laboratory results for the groundwater parameters were compared for the 4th Quarter 2008 event and the eight previous quarterly sampling events. These sampling quarters covered sampling periods of December 2006 through September 2008 and encompass the range of seasonal climatic (rainfall and temperature) and groundwater level conditions at the monitoring well sites. A summary of groundwater parameter data trends are listed below.

Metals; Lacamas Creek (metals are not included in the Landfill 4/Demolition Area 1 sampling)

- The number of total and dissolved metals detected and concentrations have decreased, most to below detection limits. Only one well had detections of metals during this sampling event, all below MTCA Method A screening levels. These results are attributable to the installation of dedicated pumps, low-flow purging, and sampling techniques. The dedicated bladder pumps are able to obtain much less turbid samples which decreased the total and dissolved metal concentrations.

Petroleum Hydrocarbons

- Diesel range petroleum hydrocarbons were detected in the Lacamas Creek Monitoring Well LCMW02DW at 0.15 mg/L in January 2006 but have not been detected during subsequent sampling events.

Perchlorate

- Perchlorate has shown an increasing trend in Landfill 4/Demolition Area 1 monitoring well L4MW02B since March 2008. The trend shows the high concentration (520 μg/L) at L4MW02B during the most recent sampling event, although only slightly above the September 2008 concentration (490 μg/L) and still below the historic high value of 530 μg/L in September 2006.
- Perchlorate concentrations in L4MW02A had an increasing trend from March 2008 (140 μg/L) through September 2008 (240 μg/L), however there was a decrease during the most recent sampling event to 150 μg/L.
- Perchlorate has shown an overall slight increase at L4MW03A since the March 2008, from 84 μg/L to 96 μg/L.
- Perchlorate concentrations increased from a concentration of 1.6 μg/L during the September 2008 sampling event to 36 μg/L during the most recent sampling event.
- Perchlorate has remained at about the same concentration at monitoring wells L4MW03B, L4MW04A, L4MW05A, and L4MW07B.
- Perchlorate was not detected in Landfill 4/Demolition Area 1 monitoring wells L4MW17 and L4MW18 above the MRL of 1 μg /L.

Explosives

- HMX and RDX concentrations are relatively consistent through the recent sampling events.

7.0 DATA QUALITY OBJECTIVES

The overall data quality objective is to provide data of known and sufficient quality to evaluate the physical extent and concentration ranges of chemicals of potential concern from analysis of groundwater samples and to assure compliance with environmental and health-related agencies. Data quality objectives for laboratory analysis are presented in the QAPP. Laboratory analytical data were evaluated with respect to quality assurance objectives for precision, accuracy, representativeness, comparability, and completeness parameters. The project specifications were met for all of these analytes, indicating that the sampling and analysis procedures were reproducible. The laboratory report narratives (TestAmerica) state that all quality control parameters that affect sample analysis were met.

7.1 Field Data Quality Assessment

There are no specific data quality objectives for the measurement of field parameters (such as temperature, pH, ORP, conductivity, dissolved oxygen, and turbidity). Specific conductance, temperature, ORP, dissolved oxygen, and pH was measured during purging. Turbidity is measured during sample collection. Stabilization was considered reached when three consecutive readings were within ±0.3 for pH, ±1 degrees C for temperature, ± 10 percent for specific conductance, ± 10mV for ORP, and ± 0.5 mg/L for DO.

7.2 Quality Control Sample Assessment

Trip blanks accompanied the groundwater samples for VOC analysis that were consolidated daily into one cooler and shipped to the laboratory. Trip blanks were shipped on January 7, 8, 9, 12 and 13, 2008. All five trip blanks were analyzed for VOCs and none had compounds detected above the method detection limit.

One duplicate sample was collected from each of the study areas. The duplicate samples were analyzed for the same constituents as the source sample. The RPD was calculated as the difference between the values divided by the average of the values. For samples with results greater than five times the practical quantification limit (PQL), an RPD of less than 20 percent is considered good duplication. For samples with results less than five times the PQL for analysis, the above difference between the sample and its duplicate must be less than the PQL in order to meet the quality assurance acceptance criteria. A significant difference between duplicate values for a few parameters indicates potential problems with the precision of specific analyses. A significant difference for many parameters indicates potential problems with the sample-collection procedures.

Laboratory analysis results for duplicate sample LCMW460W were consistent with the concentrations in the original sample LCMW02DW. None of the values exceeded the RPD of 20 percent. Laboratory analysis results for duplicate sample L4MW465W were consistent with the concentrations in the original sample L4MW02AW. Except for the RDX Method 8330 discrepancies, there were no differences that exceeded a RPD of 20 percent between the two samples.

7.3 Laboratory Analysis Chemical Data Quality

The analytical data quality evaluations performed by TestAmerica are presented in Appendix A with the analysis summary reports for the specific tests. Case narratives describing sample receipt, identification, and general comments by laboratory personnel are included preceding the copies of the chain-of-custody forms for each report.

No sample analytical laboratory results were rejected. The case narratives and analysis summary reports indicate that most analytical results are acceptable for use without qualification. Some individual sample results were qualified as estimated values that were low-level detections below the laboratory instrument practical quantification limits (PQL), and flagged with "J" on the laboratory summary reports.

MS/MSD duplicate analyses were performed on sample LCMW04S. All samples were received within the holding times for transport from the collection site to the laboratory. Exceptions to the collection and analysis criteria are listed below and noted in the laboratory case narrative documentation in Appendix A.

- Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC) were flagged as collected in the inappropriate sample container on sample delivery group (SDG) PSA0334 and PSA0366. However, groundwater samples were collected in a plastic bottle preserved with sulfuric acid provided by the laboratory. The DOC sample was also filtered in the field. Apparently the laboratory is modifying its requirements from plastic bottles to ambers preserved with sulfuric acid. This change will be corrected prior to the next sampling event.

- Dissolved antimony in SDG PSA0334 and SDG PSA0366 did not meet the recovery specifications in the matrix spike and matrix spike duplicate. The Blank, LCS, and Duplicate samples are all within limits, indicating the instrument was working within specifications. The MS/MSD samples indicate that dissolved antimony may be underreported. Antimony is below MDLs in both SDGs and it is typically not detected in any of the Lacamas Creek wells. The data is considered valid.

- The laboratory QA/QC for nitrate in SDG PSA0334 and SDG PSA0366 did not meet the duplicate limits, but the absolute difference between the source and the result was less than the method detection limit. Therefore the results are valid.

- HMX for SDG PSA0334 did not meet the recovery limits on the Matrix Spike Duplicate for EPA 8330 analysis. The Blank, LCS, and Duplicate samples are all within limits, indicating the instrument was working within specifications. The MS/MSD samples indicate that HMX may be underreported. Since historically HMX has not been detected in the wells included in this SDG, the data is considered valid.

- In SDG PSA0221, replication values were exceeded for RDX for samples MW-7B, MW-1B, MW-1A and MW465(duplicate) due to matrix interference. The samples were rerun but interference could not be eliminated. The samples were run by another method (HPLC 8321A) as a confirmation but since the results were inconsistent with those run originally, both sets of RDX data are reported.

All of the RDX results run under 8330 are estimated. Only the results for MW-01B and MW465 were estimated under HPLC 8321A.

- One of the bottles from MW-01B was broken at TestAmerica- Denver so there was not enough sample for the lower MRLs for the HPLC 8321 A. The elevated detection levels for this one sample and event did not significantly impact the analytical data for this project.

- In SDG PSA0221 VOC samples were sent to TestAmerica- Seattle for analysis. The lab QA/QC had 1,1-dichloroethene outside the recovery limits for the LCS duplicate. The second QA/QC sample also had an issue with the 1,1-dichloroethene results for the LCS, Matrix Spike and Matrix Spike duplicate. Since this analyte was not detected in any of the samples, the data is valid.

7.4 Deviations to Standard Procedures

During the groundwater sampling event for the 4th Quarter 2008, the deviations from standard procedures of the SAP included the use of dedicated pumps in each of the wells and eliminating the equipment blank. There was evidence that the wells MW-17 and MW-18 were flooded during the record rainfall event on January 1, 2009. Turbidity values were elevated for both of these wells. In addition, the pump in MW-18 was not functioning properly and had to be removed and reinstalled, significantly raising the turbidity measurement for this sample. Since the analytical results for these wells are within historical range for all analytes, there does not appear to have been an adverse affect to the 4th quarter results.

8.0 LIMITATIONS

This study was limited to the tests, locations, and depths as indicated to determine the absence or presence of certain contaminants. The site as a whole may have other contamination that was not characterized by this study. The findings and conclusions of this report are not scientific certainties but, rather, probabilities based on professional judgment concerning the significance of the data gathered during the course of this investigation. PBS is not able to represent that the site or adjoining land contain no hazardous waste, oil, or other latent conditions beyond that detected or observed by PBS.

PBS Engineering + Environmental is pleased to present these results for the 4th quarter of 2008 groundwater sampling event. Please contact the undersigned if there are any questions.

Sincerely,
PBS Engineering + Environmental

Barbara E. Lary, LG
Senior Geologist

Dulcy A. Berri, LG
Senior Hydrogeologist

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FIGURES

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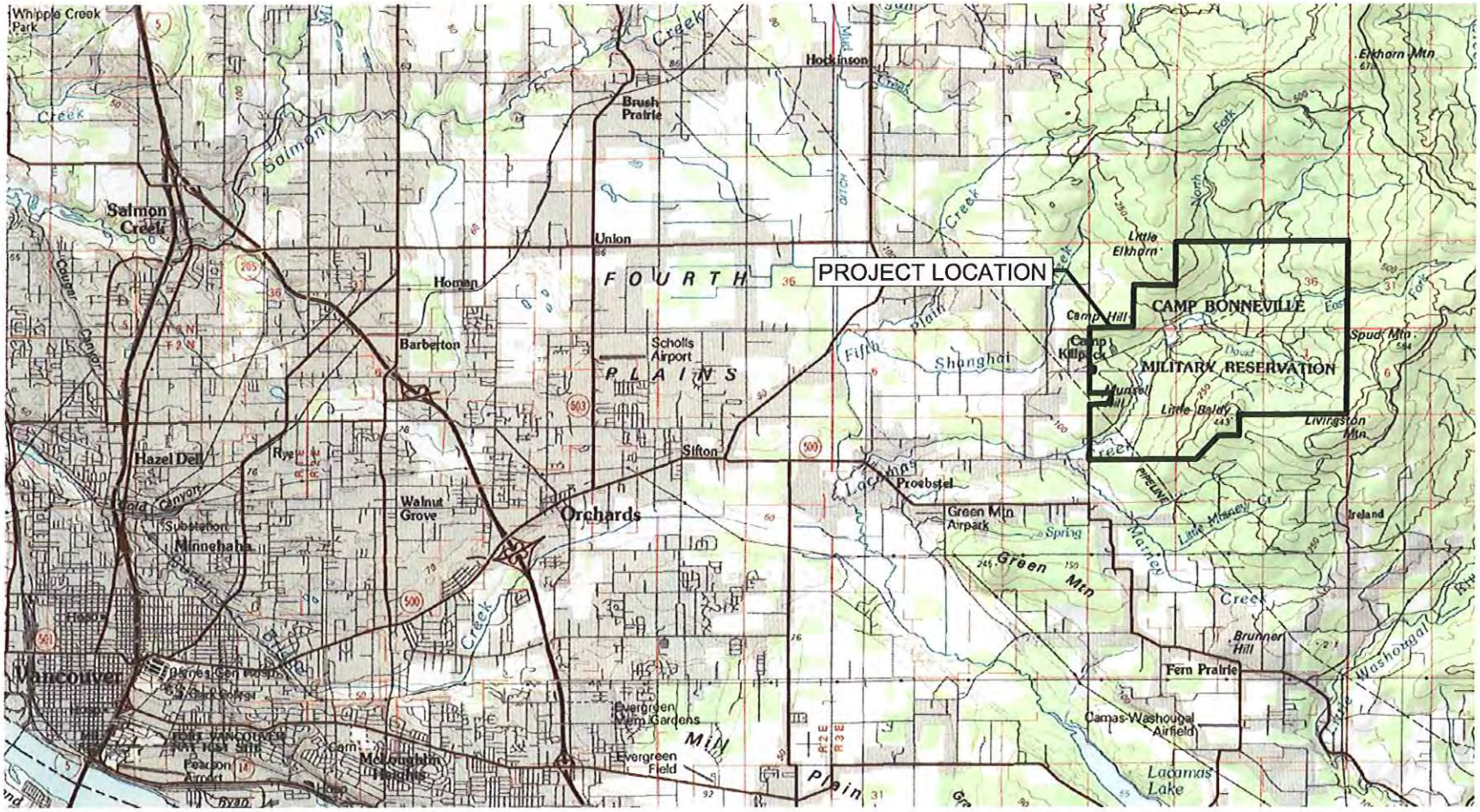

WASHINGTON

PBS

Project #: 70489.000
Task #: 6209
Date: JAN. 2008

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SITE LOCATION MAP

CAMP BONNEVILLE
CLARK COUNTY, WASHINGTON

FIGURE 1

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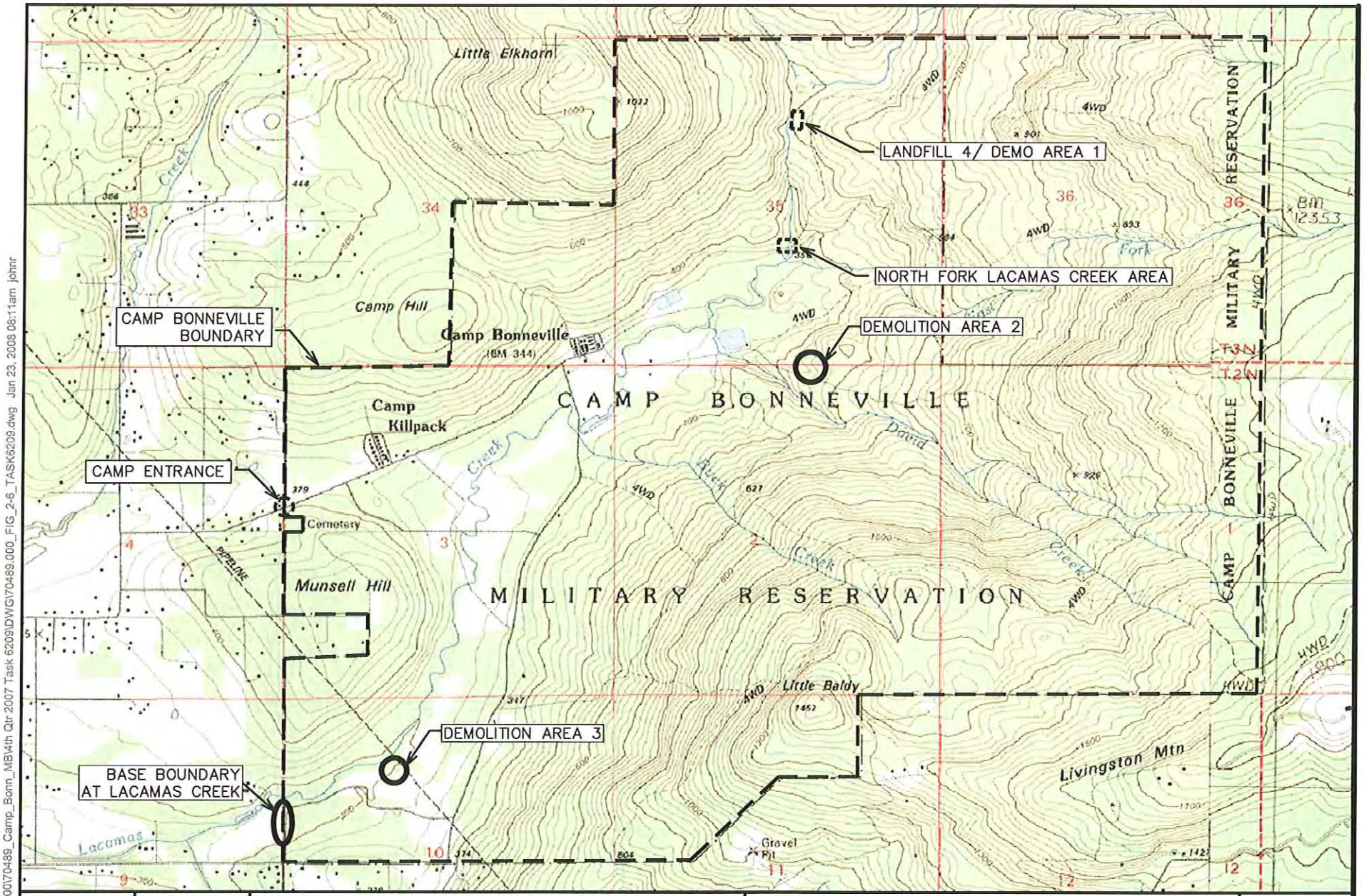

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PBS

Project #: 70489.000
Task #: 6209
Date: JAN. 2008

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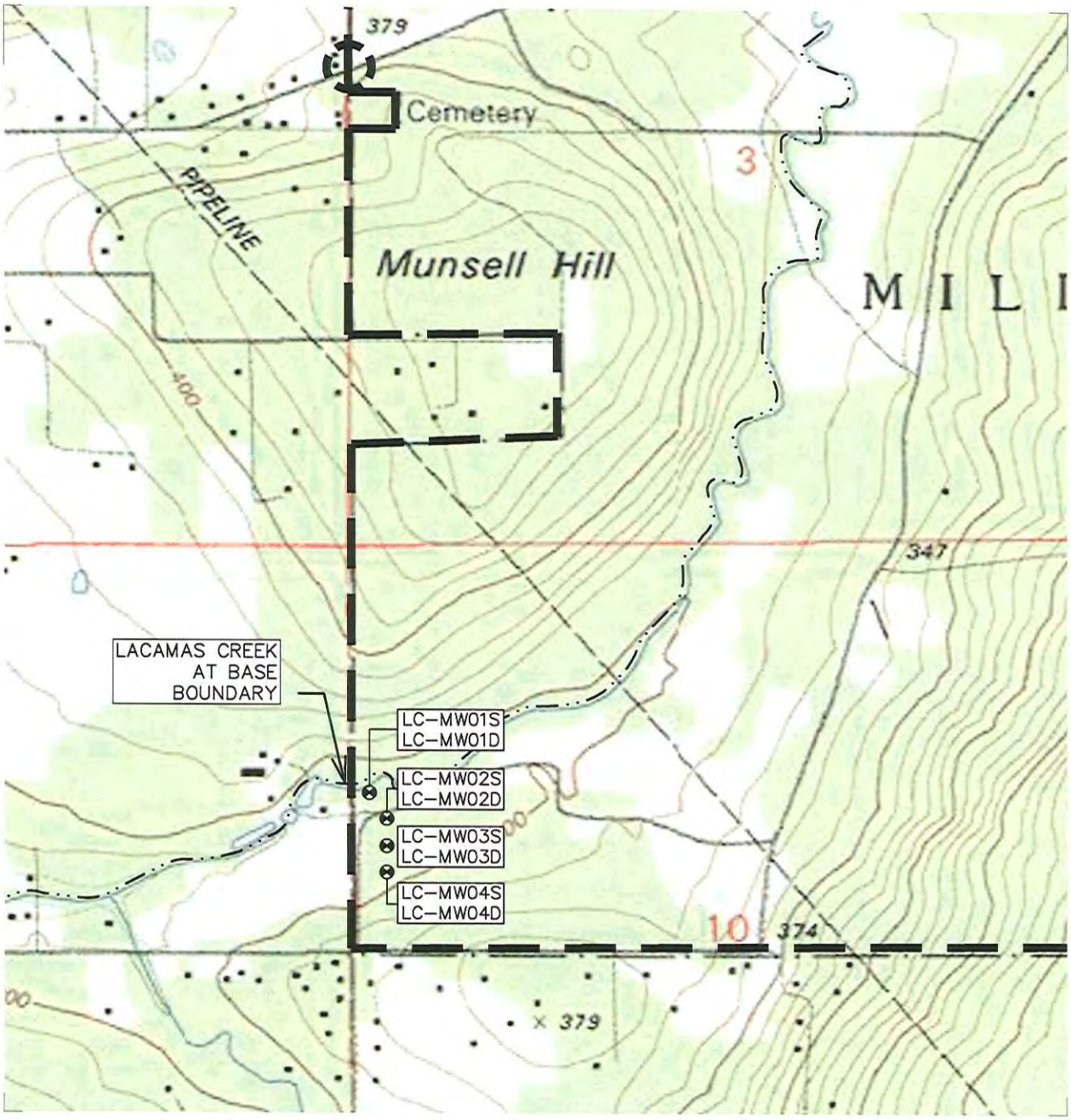
INVESTIGATION AREAS WITHIN CAMP BONNEVILLE BOUNDARY

CAMP BONNEVILLE
CLARK COUNTY, WASHINGTON

FIGURE 2



LEGEND

- LC–MW04S / LC–MW04D — MONITORING WELL AND WELL NUMBER
- LACAMAS CREEK
- BASE BOUNDARY

0 1/8 MILE 1/4 MILE 1/2 MILE

PBS	Project #: 70489.000 Task #: 6209 Date: JAN. 2008	MONITORING WELL LOCATIONS NEAR BASE BOUNDARY AT LACAMAS CREEK CAMP BONNEVILLE CLARK COUNTY, WASHINGTON	FIGURE 3

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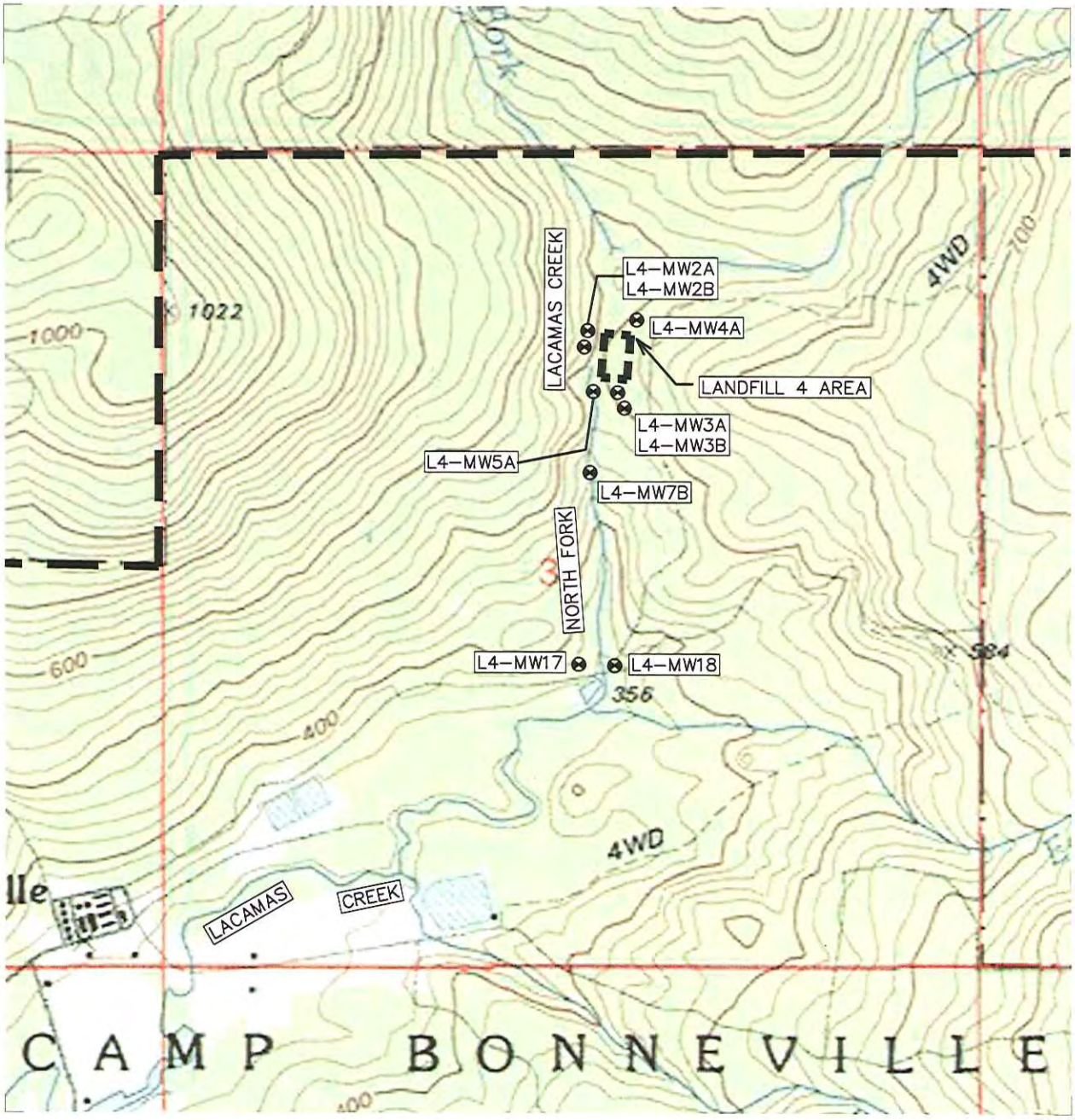

LEGEND

LC–MW2A / LC–MW2B — MONITORING WELL AND WELL NUMBER

BASE BOUNDARY

0 1/8 MILE 1/4 MILE 1/2 MILE

PBS	Project #: 70489.000 Task #: 6209 Date: JAN. 2008	MONITORING WELL LOCATIONS NEAR LANDFILL 4/DEMO AREA 1 LANDFILL 4 - LACAMAS CREEK CLARK COUNTY, WASHINGTON	FIGURE 4

TABLES

Table 2
Constituents Detected in Groundwater
4th Quarter 2008

Camp Bonneville, Vancouver, Washington

Analytes	MTCA Method A Level	LCMW01D 1/13/2009	LCMW01S 1/13/2009	LCMW02D 1/13/2009	LCMW02D (dup) 1/13/2009	RPD (<20%)	LCMW02S 1/12/2009	LCMW03D 1/12/2009	LCMW03S 1/12/2009	LCMW04D 1/12/2009	LCMW04S 1/12/2009
Petroleum Hydrocarbons (mg/L)											
Gasoline Range Organics	1000	< 80.0	< 80.0	< 80.0	< 80.0	acceptable	< 80.0	< 80.0	< 80.0	< 80.0	< 80.0
Diesel Range Organics	500	< 0.0769	< 0.0762	< 0.0762	< 0.0755	acceptable	< 0.0755	< 0.0755	< 0.0762	< 0.0755	< 0.0755
Oil Range Organics	500	< 0.481	< 0.476	< 0.476	< 0.472	acceptable	< 0.472	< 0.472	< 0.476	< 0.472	< 0.472
Anions/Cations (mg/L)											
Chloride		1.42	1.34	1.8	1.78	1.12%	1.56	1.57	1.53	1.52	2.33
Nitrate/Nitrite-Nitrogen		0.129	0.115	0.243	0.218	10.85%	0.136	0.488	0.313	0.185	0.883
Nitrite		< 0.100	< 0.100	< 0.100	< 0.100		< 0.100	< 0.100	< 0.100	< 0.100	< 0.100
Sulfate		< 1.00	< 1.00	1.06	< 1.00	5.83%	< 1.00	< 1.00	< 1.00	1.24	< 1.00
Explosives (ug/L)											
HMX		< 0.4	< 0.4	< 0.4	< 0.4	acceptable	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
RDX (8330)		< 0.2	< 0.2	< 0.2	< 0.2	acceptable	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
RDX (8321)											
Nitroglycerin		< 3	< 3	< 3	< 3	acceptable	< 3	< 3	< 3	< 3	< 3
PETN		< 2	< 2	< 2	< 2	acceptable	< 2	< 2	< 2	< 2	< 2
Picric Acid		< 0.4	< 0.4	< 0.4	< 0.4	acceptable	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Perchlorate		< 1	< 1	< 1	< 1	acceptable	< 1	< 1	< 1	< 1	< 1
General Chemistry (mg/L)											
Dissolved Organic Carbon		< 1.00	< 1.00	< 1.00	< 1.00	acceptable	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Total Organic Carbon		< 1.00	< 1.00	< 1.00	< 1.00	acceptable	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Total Suspended Solids		< 10.0	< 10.0	< 10.0	< 10.0	acceptable	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
pH		6.75	6.69	6.65	6.67	0.30%	6.51	6.56	6.57	6.75	6.51
Alkalinity, Bicarbonate (As CaCO3)		46.5	45.7	46.8	46.7	0.21%	45.7	47.1	44.6	51.8	40.9
Alkalinity, Carbonate (As CaCO3)		<5.00	<5.00	<5.00	<5.00	acceptable	<5.00	<5.00	<5.00	<5.00	<5.00
Total Alkalinity		46.5	45.7	46.8	46.7	0.21%	45.7	47.1	44.6	51.8	40.9

Table 2
Constituents Detected in Groundwater
4th Quarter 2008

Camp Bonneville, Vancouver, Washington

Analytes	MTCA Method A Level	L4MW017 1/7/2009	L4MW018 1/7/2009	L4MW01A 1/7/2009	L4MW01B 1/7/2009	L4MW01B (dup) 1/7/2009	RPD (<20%)	L4MW02A 1/8/2009	L4MW02B 1/9/2009	L4MW03A 1/9/2009	L4MW03B 1/9/2009	L4MW04A 1/8/2009	L4MW05A 1/8/2009	L4MW07B 1/7/2009
Petroleum Hydrocarbons (mg/L)														
Gasoline Range Organics	1000													
Diesel Range Organics	500													
Oil Range Organics	500													
Anions/Cations (mg/L)														
Chloride														
Nitrate/Nitrite-Nitrogen														
Nitrite														
Sulfate														
Explosives (ug/L)														
HMX		< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	acceptable	3.2	3.9	0.39 J	< 0.4	< 0.4	0.19	< 0.4
RDX (8330)		< 0.2	< 0.2	0.088 J*	0.092 J *	0.17 J*	59.54%	17	79	10	4.3	2.5	3.5	0.062J *
RDX (8321)			< 0.1	0.49	0.064 J	0.064 J	0.00%							<0.1
Nitroglycerin		< 3	< 3	< 3	< 3	< 3	acceptable	< 3	< 15	< 3	< 3	< 3	< 3	< 3
PETN		< 2	< 2	< 2	< 2	< 2	acceptable	< 2	< 10	< 2	< 2	< 2	< 2	< 2
Picric Acid		< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	acceptable	< 0.4	< 2	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Perchlorate		< 1	< 1	36	0.73 J	0.69 J	5.63%	150	510	96	43	34	41	2.4
General Chemistry (mg/L)														
Dissolved Organic Carbon														
Total Organic Carbon														
Total Suspended Solids														
pH														
Alkalinity, Bicarbonate (As CaCO3)														
Alkalinity, Carbonate (As CaCO3)														
Total Alkalinity														

NOTES

* = More than 40% RPD between primary and confirmation detector results. The lower of the two results is reported.

< 5 = not detected above the indicated method detection limit.

J = estimated. Value reported is below the method reporting limit but above the method detection limit.

mg/L = milligrams per liter

ug/L = micrograms per liter

RPD = relative percent different

Table 3
Total and Dissolved Metals
4th Quarter 2008
Camp Bonneville, Vancouver, Washington

Analyte	MTCA Method A Levels	MTCA Method B Levels	LCMW01D	LCMW01S	LCMW02D	LCMW02D(DUP)	RPD	LCMW02S	LCMW03D	LCMW03S	LCMW04D	LCMW04S
Trace Metals (ug/L)			1/13/2009	1/13/2009	1/13/2009	1/13/2009	**(<20%)**	1/12/2009	1/12/2009	1/12/2009	1/12/2009	1/12/2009
Antimony		1.4	< 1.00	< 1.00	< 1.00	< 1.00	0%	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Arsenic	5		< 1.00	< 1.00	< 1.00	< 1.00	0%	< 1.00	< 1.00	< 1.00	1.15	< 1.00
Beryllium		0.02	< 0.500	< 0.500	< 0.500	< 0.500	0%	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Cadmium	5		< 0.500	< 0.500	< 0.500	< 0.500	0%	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Chromium	50		< 2.00	< 2.00	< 2.00	< 2.00	0%	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
Copper		592	< 2.00	< 2.00	< 2.00	< 2.00	0%	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
Lead	15		< 1.00	< 1.00	< 1.00	< 1.00	0%	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Mercury	2	4800	< 0.000200	< 0.000200	< 0.000200	< 0.000200	0%	< 0.000200	< 0.000200	< 0.000200	< 0.000200	< 0.000200
Nickel		320	< 1.00	< 1.00	< 1.00	< 1.00	0%	< 1.00	< 1.00	< 1.00	2.20	< 1.00
Selenium		80	< 0.500	< 0.500	< 0.500	< 0.500	0%	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Silver		80	< 1.00	< 1.00	< 1.00	< 1.00	0%	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Thallium		1.1	< 1.00	< 1.00	< 1.00	< 1.00	0%	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Zinc		4800	< 5.00	< 5.00	< 5.00	< 5.00	0%	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Dissolved Trace Metals (ug/L)												
Antimony		1.4	< 1.00	< 1.00	< 1.00	< 1.00	0%	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Arsenic	5		< 1.00	< 1.00	< 1.00	< 1.00	0%	< 1.00	< 1.00	< 1.00	1.06	< 1.00
Beryllium		0.02	< 1.00	< 1.00	< 1.00	< 1.00	0%	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Cadmium	5		< 0.500	< 0.500	< 0.500	< 0.500	0%	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Chromium	50		< 2.00	< 2.00	< 2.00	< 2.00	0%	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
Copper		592	< 2.00	< 2.00	< 2.00	< 2.00	0%	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
Lead	15		< 1.00	< 1.00	< 1.00	< 1.00	0%	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Mercury	2	4800	< 0.200	< 0.200	< 0.200	< 0.200	0%	< 0.200	< 0.200	< 0.200	< 0.200	< 0.200
Nickel		320	< 1.00	< 1.00	< 1.00	< 1.00	0%	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Selenium		80	< 0.500	< 0.500	< 0.500	< 0.500	0%	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Silver		80	< 1.00	< 1.00	< 1.00	< 1.00	0%	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Thallium		1.1	< 1.00	< 1.00	< 1.00	< 1.00	0%	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Zinc		4800	< 5.00	< 5.00	< 5.00	< 5.00	0%	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00

NOTES:
<0.5 = not detected above the method detection limit indicated.
ug/L = microgram per liter

Table 4
Semi-Volatile and Volatile Organic Compounds Detected in Groundwater
4th Quarter 2008
Camp Bonneville, Vancouver, Washington

Analyte	MTCA Method A Levels	MTCA Method B Levels	L4MW02B 1/9/2009
VOCs (ug/L)			
1,1,1-Trichloroethane	200		21.9
1,1-Dichloroethane		800	17.5
1,1-Dichloroethene		400	6.04
1,2-Dichloroethane	5		1.58
Dichlorodifluoromethane	1600	1600	16.9

Note: No SVOCs were detected in any of the Lacamas Creek monitoring well samples. VOCs were detected in only the one monitoring well listed above.

Table 5
Field Parameters for Groundwater Samples
4th Quarter 2008
Camp Bonneville, Vancouver, Washington

Sample ID	Date	Depth to Water	Water Elevation	Temperature	Specific Conductivity	Dissolved Oxygen	pH	Oxydation Reduction Potential	Turbidity
		ft below TOC*	Feet amsl	˚ C	uS/cm	mg/l	S.U.	Millivolts	NTU
20L4MW01AW	01/07/2009	12.06	519.34	10.72	30	7.02	5.82	120.5	1.76
20L4MW01BW	01/07/2009	8.05	521.52	10.1	24	9.17	6.05	114	0
20L4MW02AW	01/08/2009	21.95	497.98	10.4	52	8.55	4.9	401.1	1.26
20L4MW02BW	01/09/2009	28.53	489.93	9.64	62	1.15	5.61	122	0.23
20L4MW03AW	01/09/2009	26.53	488.32	9.77	22	7.16	4.94	318.1	1.29
20L4MW03BW	01/09/2009	24.48	486.99	9.18	45	6.38	5.58	310.6	3.42
20L4MW04AW	01/08/2009	24.48	487.31	9.4	16	6.92	5.16	367.6	3.92
20L4MW05AW	01/08/2009	19.23	490.68	9.01	26	6.74	5.39	369.8	0.45
20L4MW07BW	01/07/2009	37.48	443.32	9.37	30	6.44	6.1	101.2	0.36
20L4MW17W	01/07/2009	8.54	352.94	10.34	212	6.61	7.35	40.2	4.34
20L4MW18W	01/07/2009	9.52	353.32	10.42	116	8.16	6.65	73.1	925.6***
20LCMW01SW	01/13/2009	3.92	286.24	10.58	86	7.12	6.68	249.8	0
20LCMW01DW	01/13/2009	4.10	286.15	10.54	90	7.52	6.74	247.1	0
20LCMW02SW	01/12/2009	4.33	286.86	11.04	85	7.98	6.75	269.2	0
20LCMW02DW	01/13/2009	4.87	286.72	10.64	91	7.47	6.68	238.4	0.05
20LCMW03SW	01/12/2009	3.91	287.00	10.75	84	7.93	6.69	264.9	0
20LCMW03DW	01/12/2009	3.94	287.04	10.54	90	7.61	6.69	265	0.05
20LCMW04SW	01/12/2009	3.83	287.80	9.8	86	7.18	6.08	276.1	0.01
20LCMW04DW	01/12/2009	4.37	287.42	10.04	96	7.75	6.98	255.4	0.23

* depth in feet measured from top of well PVC casing.

** water level in feet above mean sea level, relative to top of PVC casing elevation survey

Field parameters were measured using a YSI 556 and a flow through cell, with the exception of turbidity,
which was measured using a HF Scientific TPW Meter.

***Problems with the pump in this well required taking it out and reinstalling it several times. This well and MW-17 likely flooded during the previous week's rainstorms.

Table 6
Well Number and Construction Details
Camp Bonneville, Vancouver, Washington

Well Number in PBS Work Contract	WADOE Well Tag Number	Well Location	Measured Total Depth (ft)*	Well Log Total Depth (ft)**	Screened Interval (ft)***	Top of PVC Casing Elevation (feet above mean sea level)	Well Number on Steel Casings/Caps (CHPPM No.)
LC-MW01S	AHA-359	Lacamas Cr.	22.71	23.00	10-20	290.16	LC-MW01S
LC-MW06D	AHA-358	Lacamas Cr.	42.21	42.50	29.5-39.5	290.25	LC-MW01D
LC-MW02S	AHA-364	Lacamas Cr.	17.46	17.70	10-15	291.19	LC-MW02S
LC-MW07D	AHA-357	Lacamas Cr.	37.83	38.10	25-35	291.59	LC-MW02D
LC-MW03S	AHA-363	Lacamas Cr.	20.09	20.35	13-18	290.91	LC-MW03S
LC-MW08D	AHA-362	Lacamas Cr.	39.36	39.48	27-37	290.98	LC-MW03D
LC-MW04S	AHA-375	Lacamas Cr.	16.49	16.80	9-14	291.63	LC-MW04S
LC-MW09D	AHA-361	Lacamas Cr.	37.03	37.13	24.5-34.5	291.79	LC-MW04D
L4-MW01A	N/A	Landfill 4	30.17	30.40	N/A	531.40	L4-MW01A
L4-MW01B	AGL-482	Landfill 4	55.54	56.00	43-53	529.57	L4-MW01B
L4-MW02A	N/A	Landfill 4	40.21	40.20	N/A	519.93	L4-MW02A
L4-MW02B	AGL-483	Landfill 4	74.97	75.00	62-72	518.46	L4-MW02B
L4-MW03A	AGL-466	Landfill 4	48.71	49.00	41-46	514.85	L4-MW03A
L4-MW03B	AGL-484	Landfill 4	61.85	63.00	50-60	511.47	L4-MW03B
L4-MW04A	AGL-465	Landfill 4	46.44	46.00	33-43	511.79	L4-MW04A
L4-MW05A	AGL-467	Landfill 4	36.63	36.00	28-33	509.91	L4-MW05A
L4-MW07B	N/A	Landfill 4	58.86	58.90	46-56	480.80	L4-MW07B
L4-MW17	ALB-252	Landfill 4	17.17	17.67	5-15	361.48	L4-MW17
L4-MW18	ALB-251	Landfill 4	22.60	22.01	10-20	362.84	L4-MW18

Notes:
* = depth in feet measured from top of well PVC casing in December 2007. Sediment present at bottom of some casings.
** = casing depth in feet recorded on well log; measured from top of PVC casing
*** = screened interval reported on well completion logs; feet below ground surface
N/A = not available

APPENDIX A

TestAmerica, Analytical Reports
(Separate electronic files included on enclosed CD)

APPENDIX B

Database
(Included on enclosed CD)

APPENDIX C

List of Acronyms and Abbreviations

LIST OF ACRONYMS AND ABBREVIATIONS

Army	U.S. Army
bgs	Below Ground Surface
BRAC	Base Realignment and Closure
CHPPM	U.S. Army Center for Health Promotion and Preventative Medicine
COC	Chain-of-Custody
COPC	Chemical of Potential Concern
CWM	Clear Wide Mouth
DI	Deionized Water
DNR	State of Washington Department of Natural Resources
DOC	Dissolved Organic Carbon
DQO	Data Quality Objectives
EDF	Electronic Data Format
EO	Exploded Ordnance
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
FBI	Federal Bureau of Investigation
FSP	Field Sampling Plan
HASP	Health and Safety Plan
HE	High Explosive
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
IC	Ion chromatography
ICP	Inductively coupled plasma
IDW	Investigative Derived Waste
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management System
LQMP	Laboratory Quality Management Plan
µg/L	micrograms per liter (approximately equal ppb)
mg/L	milligrams per liter (approximately equal ppm)
MDL	Method Detection Limit
MRL	Method Reporting Limit
MS/MSD	Matrix Spike / Matrix Spike Duplicate
MTCA	Washington Model Toxics Control Act (Chapter 173-340 WAC)
NG	nitroglycerine
OE	ordnance and explosives
PA	picric acid
PCBs	polychlorinated biphenyls
PETN	pentaerythitol tetranitrate
ppb	parts per billion
ppm	parts per million
PQL	practical quantitation limit for laboratory test instrument
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAU	Remedial Action Unit
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine (Cyclonite)
RI	Remedial Investigation
RPD	Relative Percent Difference

SAP	Sampling and Analysis Plan
SDS	Sample Data Sheets
SI	Site Investigation
SOW	Statement of Work
SVOC	Semivolatile Organic Compound
TBD	To Be Determined
TIC	Tentatively Identified Compound
TNT	2,4,6-trinitrotoluene
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TSD	Treatment, Storage, and Disposal
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
US	United States
USEPA	United States Environmental Protection Agency
UXO	Unexploded Ordnance
VOC	Volatile Organic Compound
WDOE	State of Washington Department of Ecology