Greens Creek

2009 FWMP Presentation

Hecla GREENS CREEK

Lower Althea (Site 60)

Tailings Area
Fresh Water Monitoring Program

- Comparison against AWQS
- Upgradient / Downgradient comparative graphs for SC, SO_4, Pb, & Zn
- Review of statistical tests for trends
- Continued collection of data from Tributary Creek (Site 9) and Lower Althea (Site 60)

Tailings Area: Shallow Wells (Peat)

- Site 58 “MW-T-00-01C”
  - Up-gradient reference site, located to the northeast of Tailings Area
- Site 27 “MW-2S”
  - Down-gradient groundwater site, located south of Tailings Area
- Site 29 “MW-3S”
  - Down-gradient groundwater site, located west of Tailings Area
- Site 32 “MW-5”
  - Down-gradient groundwater site, located west of Tailings Area

Tailings Area: Deep Wells (Glacial / Marine Till)

- Site 59 “MW-T-00-01A”
  - Up-gradient reference site, located to the northeast of Tailings Area, completed in glacial till
- Site 28 “MW-2D”
  - Down-gradient groundwater site, located south of Tailings Area, completed in marine silts/clays

Tailings Area: Surface Sites

- Site 9 “Tributary Creek”
  - Down-gradient surface site, located approximately 1 mile from the tailings pile

- Site 60 “Lower Althea Creek”
  - Down-gradient surface site, approximately ¼ mile west of Pond 7

Tailings Area
Shallow Wells (PEAT)

- Site 58 “MW-T-00-01C”
- Site 27 “MW-2S”
- Site 29 “MW-3S”
- Site 32 “MW-5”

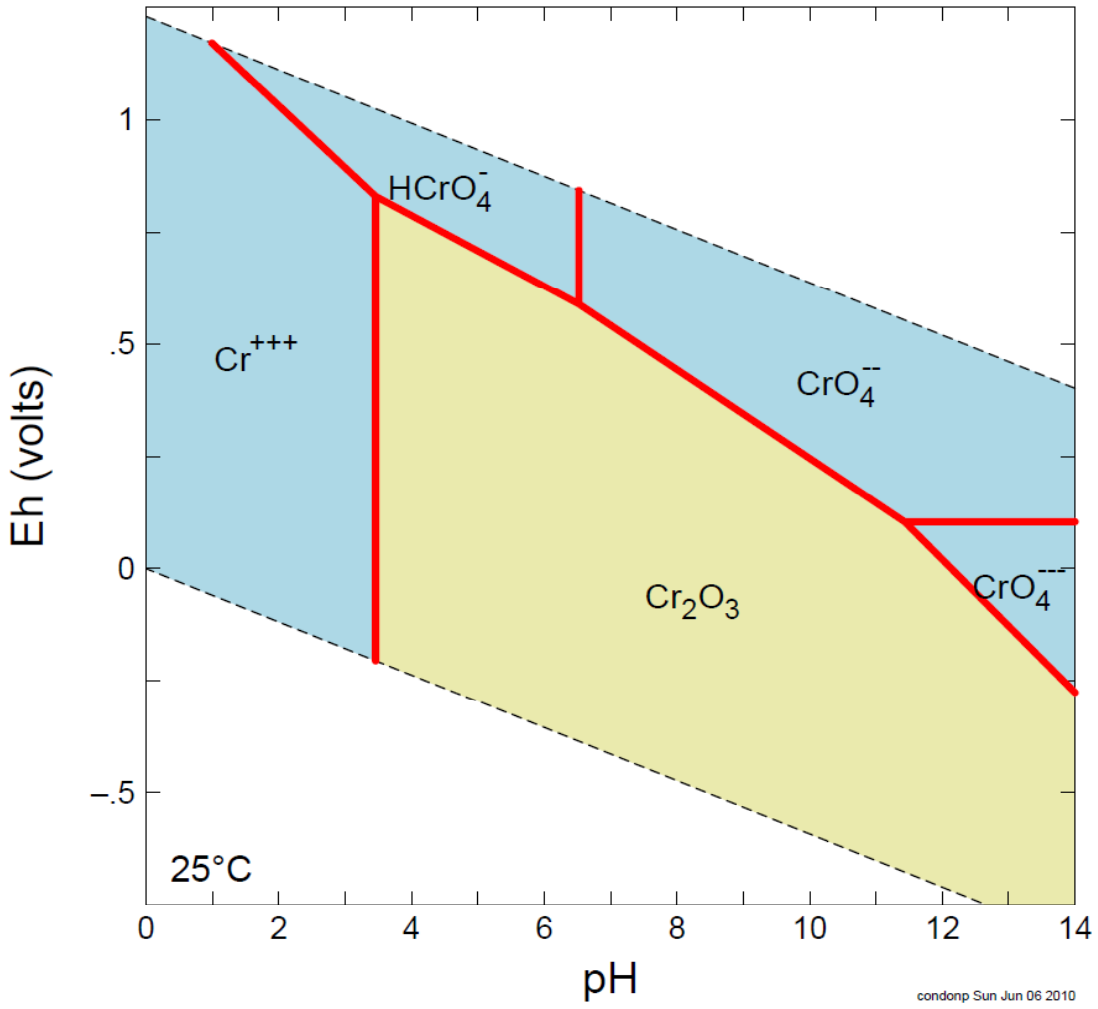
AWQS Exceedances (continued)

Site	Date	Parameter	Value	Standard	Hardness (mg/L)	Standard Type
58	5-May-09	pH Lab, su	6.12	6.5		Aquatic Life, chronic
58	22-Sep-09	pH Lab, su	6.13	6.5		Aquatic Life, chronic
58	22-Sep-09	pH Field, su	6.13	6.5		Aquatic Life, chronic
27	5-May-09	Alkalinity Total, mg/L	18.5	20		Aquatic Life, chronic
27	5-May-09	pH Lab, su	5.61	6.5		Aquatic Life, chronic
27	22-Sep-09	pH Lab, su	6.35	6.5		Aquatic Life, chronic
27	22-Sep-09	pH Field, su	6.25	6.5		Aquatic Life, chronic
29	5-May-09	Arsenic, Dissolved µg/L	11.8	10	29.1	Aquatic Life, chronic
29	22-Sep-09	Arsenic, Dissolved µg/L	11.7	10	30.5	Aquatic Life, chronic
29	5-May-09	Chromium, Dissolved µg/L	11.4	11	29.1	Aquatic Life, acute
29	5-May-09	Lead, Dissolved µg/L	0.963	0.642	29.1	Aquatic Life, chronic
29	22-Sep-09	Lead, Dissolved µg/L	1	0.676	30.5	Aquatic Life, chronic
29	5-May-09	pH Lab, su	5.18	6.5		Aquatic Life, chronic
29	22-Sep-09	pH Lab, su	5.29	6.5		Aquatic Life, chronic
29	22-Sep-09	pH Field, su	5.43	6.5		Aquatic Life, chronic
32	5-May-09	Alkalinity Total, mg/L	16.7	20		Aquatic Life, chronic
32	22-Sep-09	Alkalinity Total, mg/L	14.7	20		Aquatic Life, chronic
32	5-May-09	Chromium, Dissolved µg/L	11.6	11	10	Aquatic Life, acute
32	5-May-09	Lead, Dissolved µg/L	1.79	0.541	10	Aquatic Life, chronic
32	22-Sep-09	Lead, Dissolved µg/L	2.63	0.541	10.3	Aquatic Life, chronic
32	5-May-09	pH Lab, su	4.99	6.5		Aquatic Life, chronic
32	22-Sep-09	pH Lab, su	5.05	6.5		Aquatic Life, chronic
32	22-Sep-09	pH Field, su	5.27	6.5		Aquatic Life, chronic

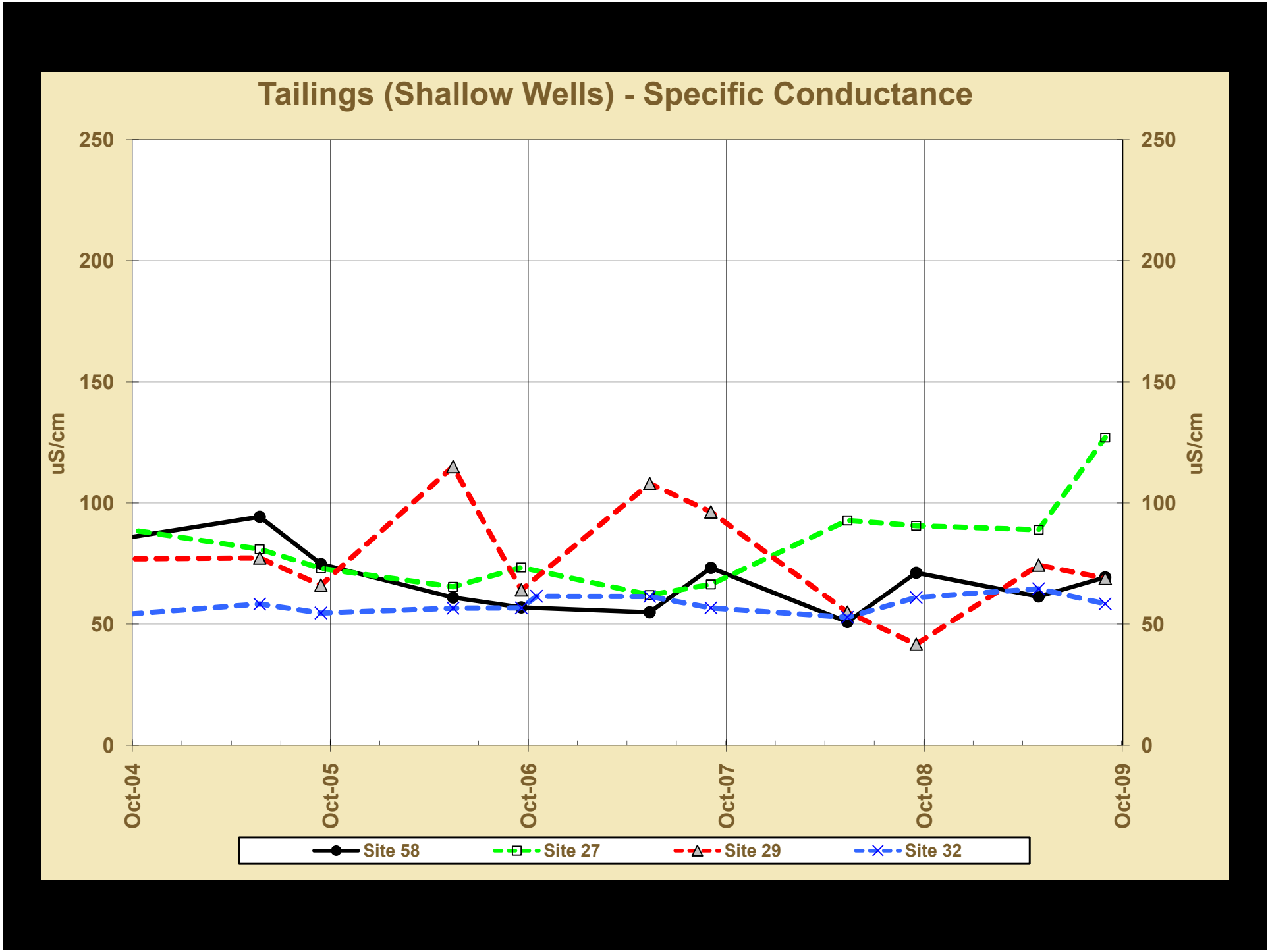
Alaska Water Quality Standards (AWQS) Exceedances

- Shallow wells continue historic trends in low pH, low alkalinity, and elevated lead.
- Shallow well sites 29 and 32 had exceedances for dissolved chromium during the May sampling.
- New, lower drinking water standard for arsenic (changed from 50 µg/l to 10 µg/l) continues to result in exceedances for arsenic at shallow well Site 29.
  1988 – present: mean = 17.1 +/- 7.3µg/L; n=105

Alaska Water Quality Standards (AWQS) Exceedances

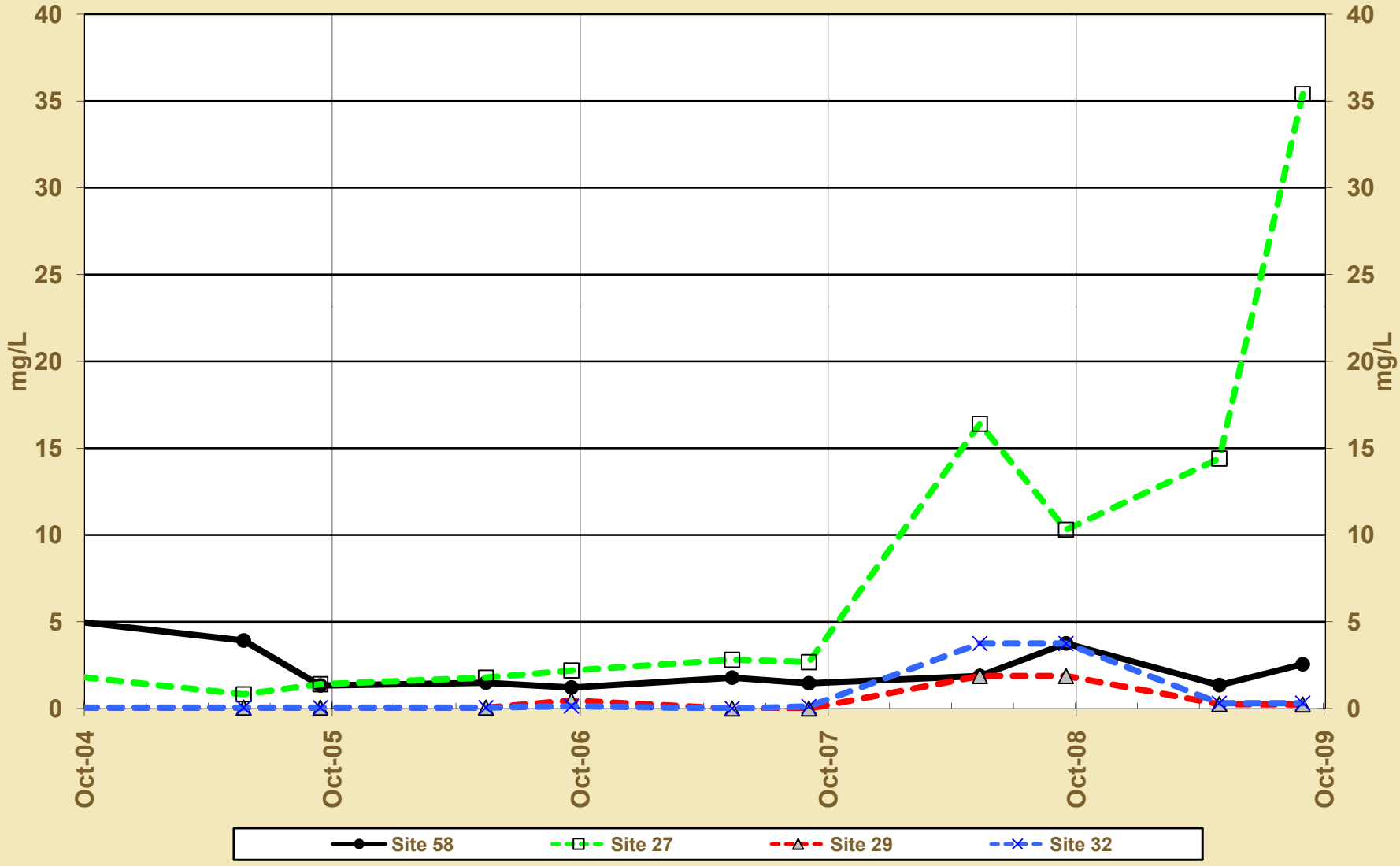


- AWQS is for Cr(VI)
- Analyzed for unspeciated dissolved chromium
- Speciation results in Cr existing as Cr(III).
- AWQS for Cr(III) is hardness dependent
- Hardness of 20mg/L results in upper limit of 24µg/L.


Tailings (Shallow Wells) - Specific Conductance
250
200
150
100
50
0
uS/cm
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Site 58
Site 27
Site 29
Site 32

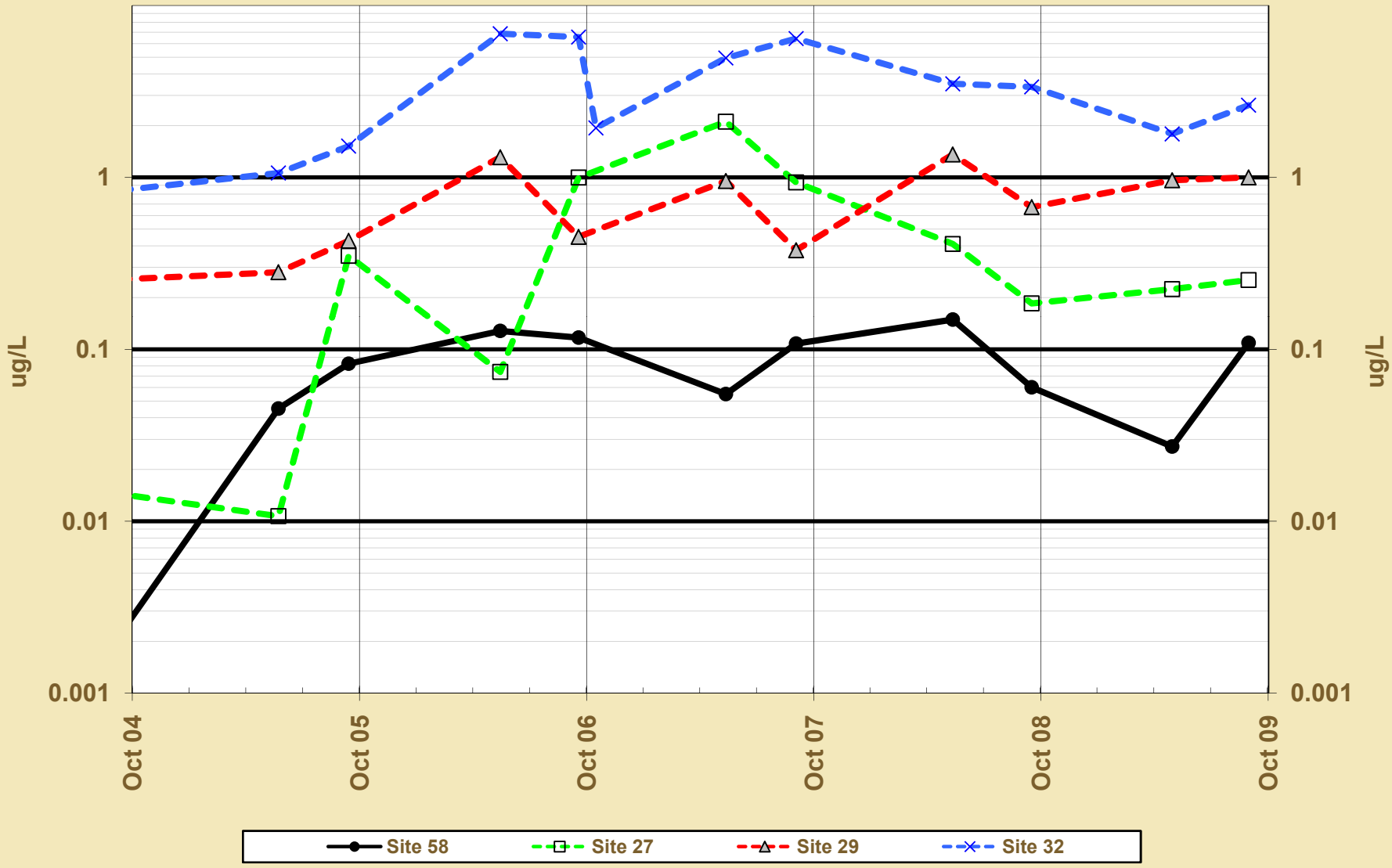
Tailings (Shallow Wells) - Total Sulfate

(Note: Value reports as <MDL plotted at MDL/2)



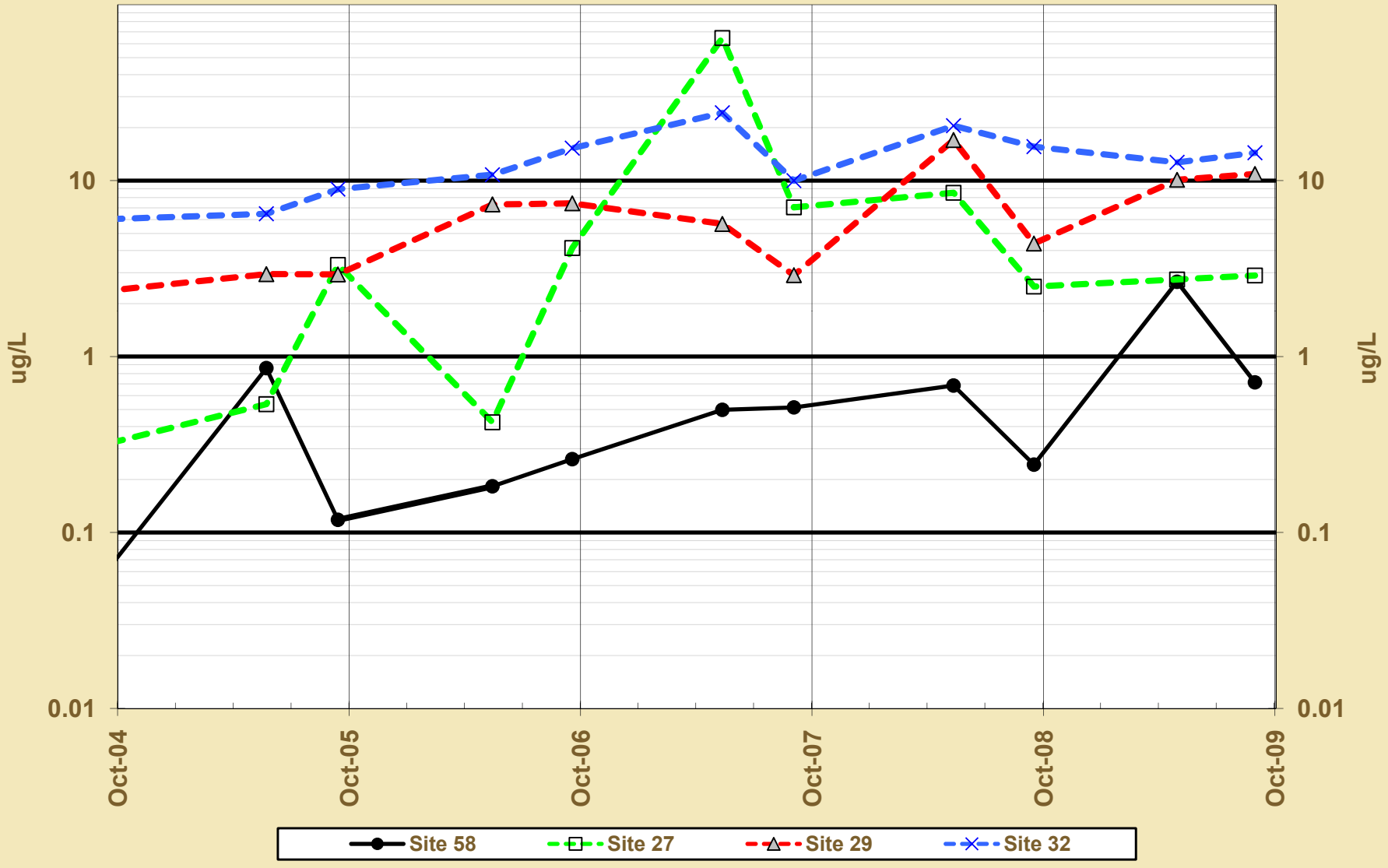
Tailings (Shallow Wells) - Dissolved Lead

(Note: Values reported as <MDL plotted at MDL/2)



Tailings (Shallow Wells) - Dissolved Zinc

(Note: Values reported as <MDL are plotted at 1/2MDL)



Tailings Shallow Wells-Statistical Trends

Hecla MINING COMPANY

2009 Water Year

Mann-Kendall Seasonal Trend Test Probabilities

Site	Cond.	pH	Alkalinity	Sulfate	Diss.-Zinc
58	0.02	0.09	0.12	0.07	0.99
27	0.82	0.55	<0.01	1.00	0.75
29	0.18	0.09	0.07	*	0.99
32	0.98	0.03	0.12	*	0.98

Sen's slope estimate

Site	µS/cm/yr	su/yr	mg/L/yr	µg/L/yr	µg/L/yr
58	-3.81				0.15
27			-2.30	2.75	
29					1.48
32	1.18				1.74

Tailings Area
Deep Wells (Glacial / Marine Till)

- Site 59 “MW-T-00-01A”
- Site 28 “ MW-2D”

AWQS Exceedances Site 28

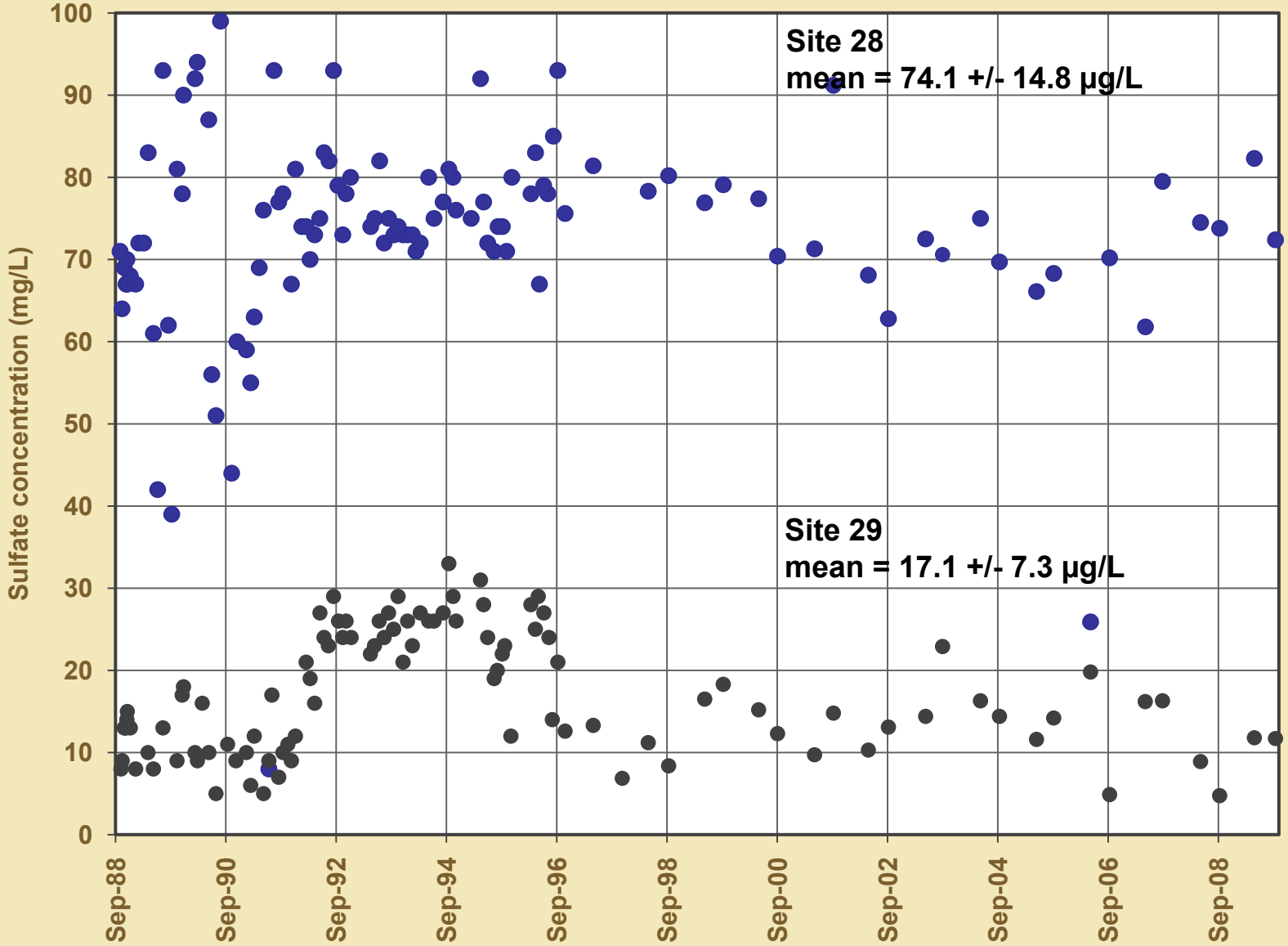
Site	Date	Parameter	Value	Standard	Hardness (mg/L)	Standard Type
28	5-May-09	Arsenic, Dissolved µg/L	82.3	10	74.9	Drinking Water
28	22-Sep-09	Arsenic, Dissolved µg/L	72.4	10	77.6	Drinking Water

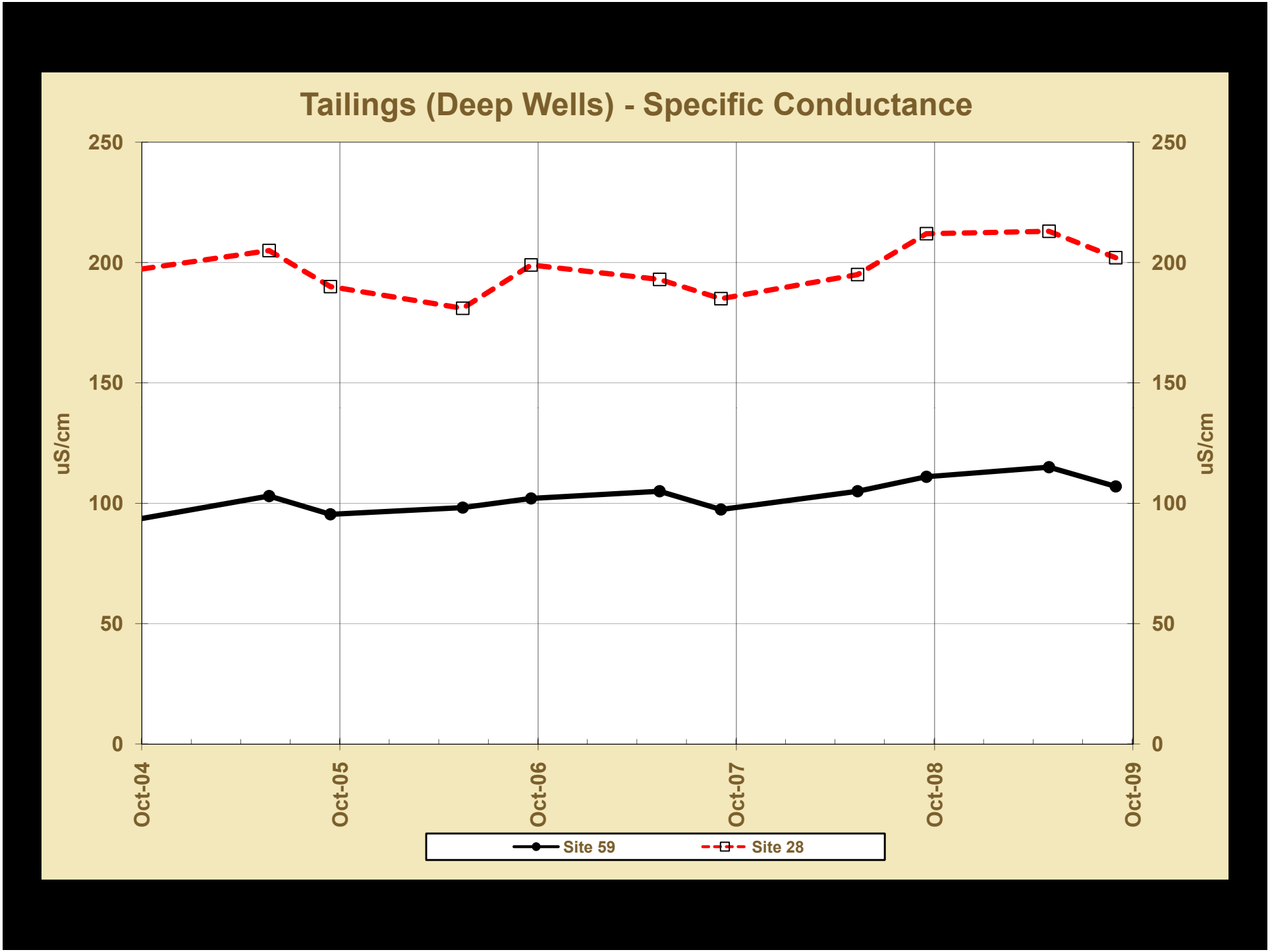
The downgradient deep well continues having arsenic levels in exceedance of the AWQS, however these values are similar to the historic measurements.

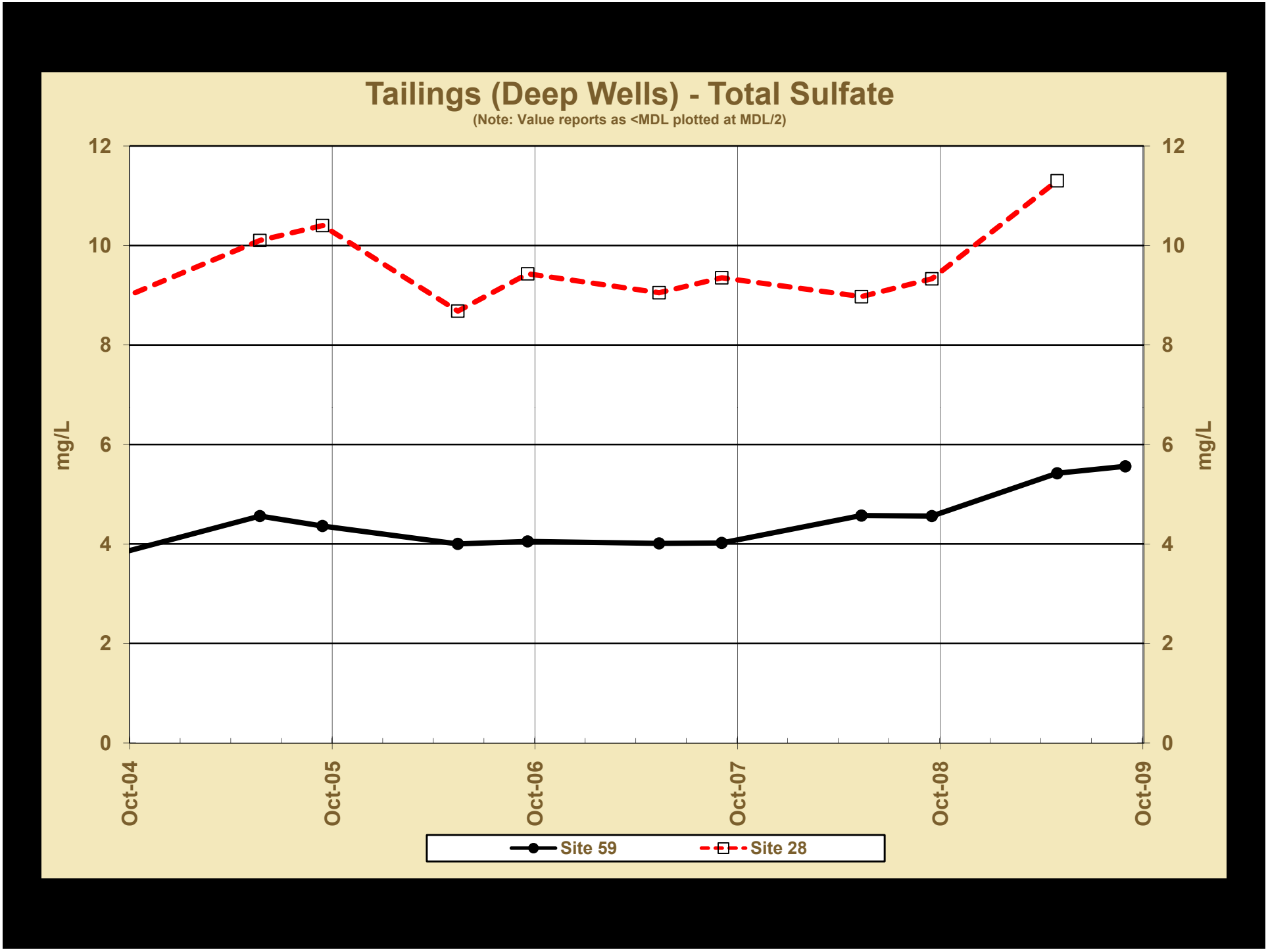
1988 – present
mean = 74.1 +/- 14.8 µg/L; n=112

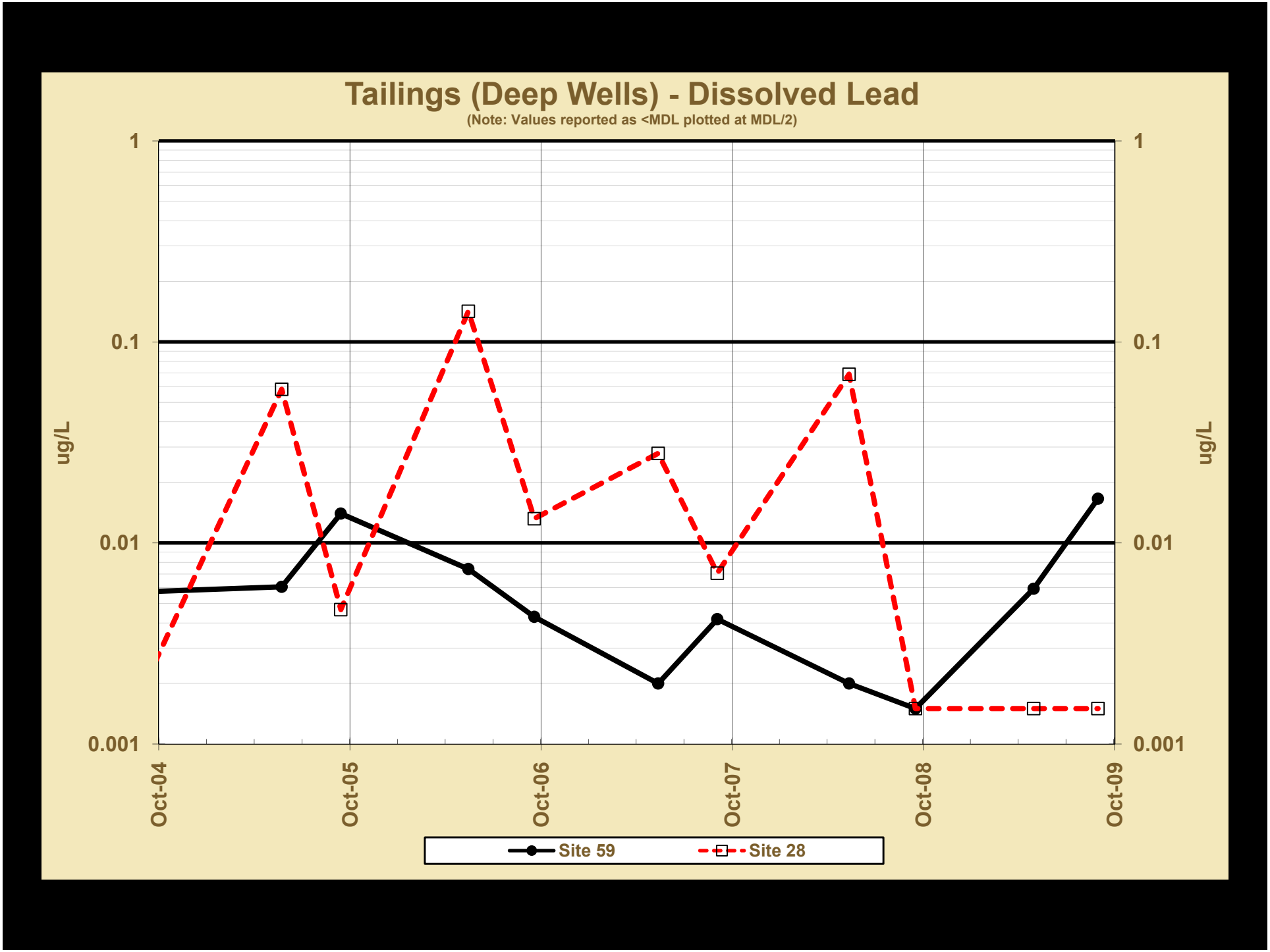
Dissolved Arsenic at Sites 29 MW-3S & Site 28 MW-2D

(Note: Values reported as <MDL plotted at MDL/2)



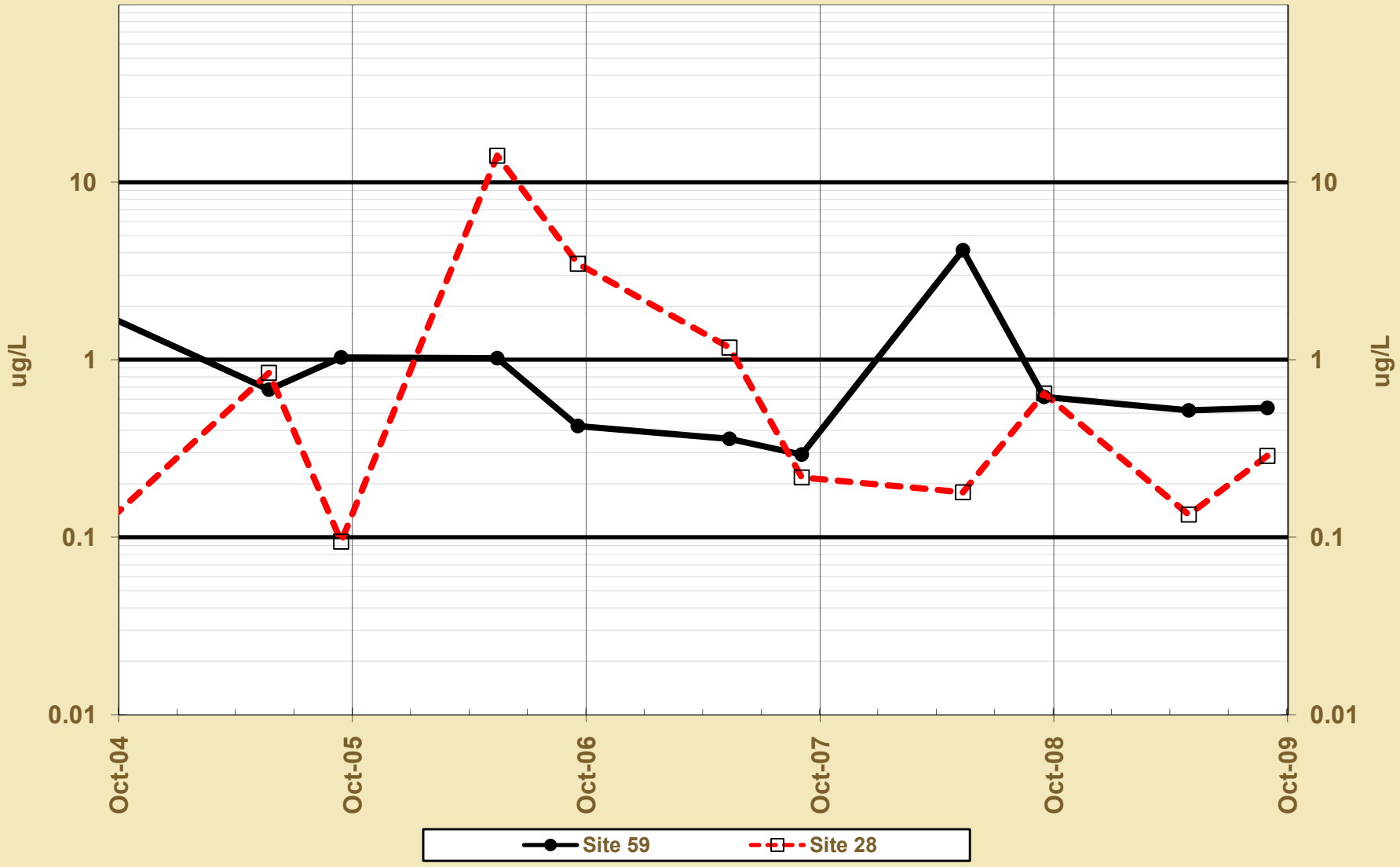

Tailings (Deep Wells) - Specific Conductance
250
200
150
100
50
0
uS/cm
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Site 59
Site 28


Tailings (Deep Wells) - Total Sulfate
(Note: Value reports as <MDL plotted at MDL/2)
mg/L
12
10
8
6
4
2
0
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Site 59
Site 28


Tailings (Deep Wells) - Dissolved Lead
(Note: Values reported as <MDL plotted at MDL/2)
1
0.1
0.01
0.001
ug/L
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Site 59
Site 28

Tailings (Deep Wells) - Dissolved Zinc

(Note: Values reported as <MDL are plotted at 1/2MDL)



Tailings Deep Wells-Statistical Trends

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2009 Water Year

Mann-Kendall Seasonal Trend Test Probabilities

Site	Cond.	pH	Alkalinity	Sulfate	Diss.-Zinc
59	1.00	0.34	0.75	0.99	0.25
28	0.66	0.55	0.07	0.50	0.66

Sen's slope estimate

Site	µS/cm/yr	su/yr	mg/L/yr	µg/L/yr	µg/L/yr
59	2.95			0.25	
28					

Tailings Area Surface Sites

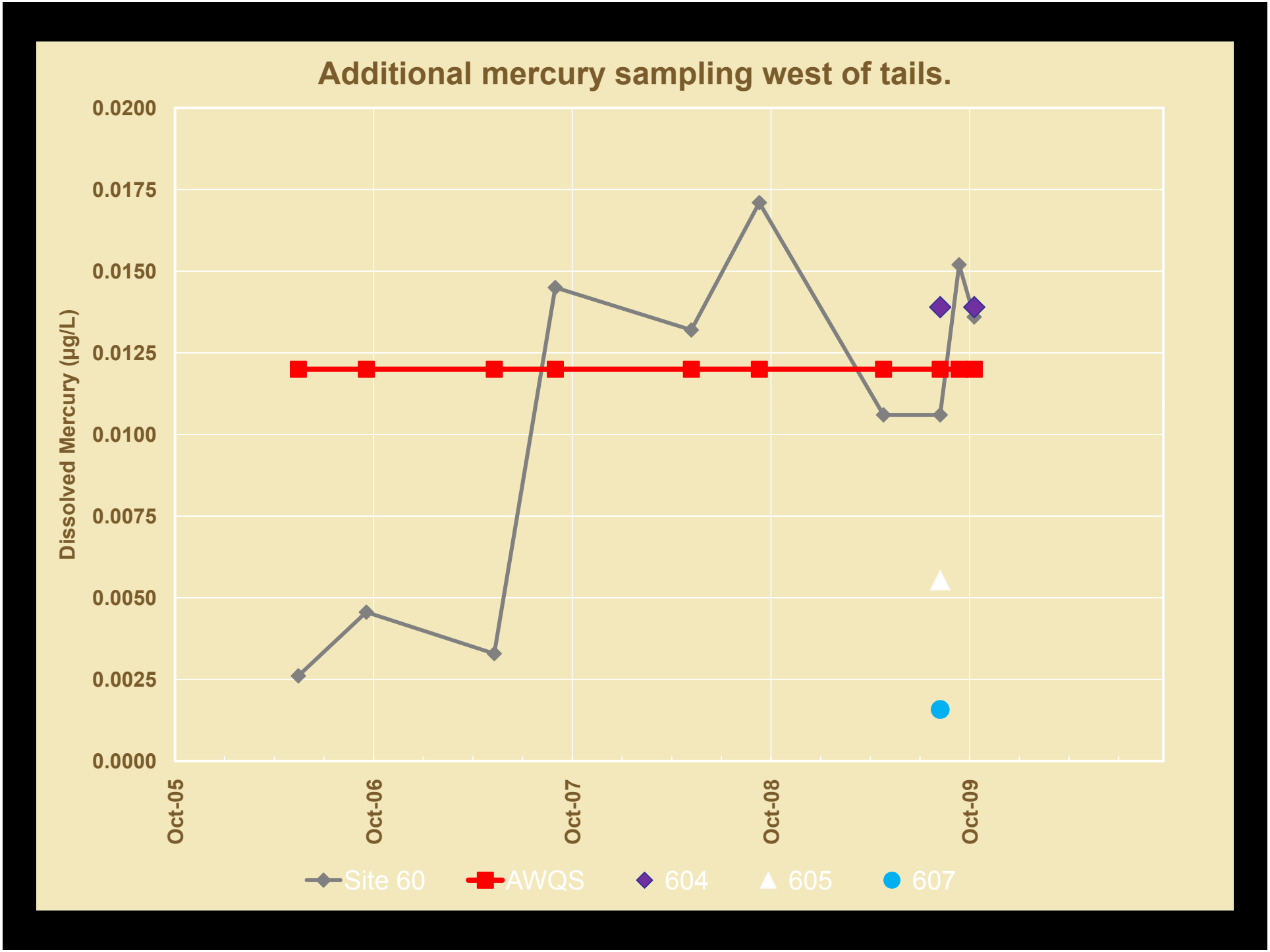
- Site 60 “Lower Althea Creek”
- Site 9 “Tributary Creek”

Site 60

- Was added to the FWMP in WY 2006.
- Was added to monitor the impact of Pond 7 on the local watershed.
- Most analytes have returned to pre-disturbance levels.

AWQS Exceedances Sites 60

Site	Date	Parameter	Value	Standard	Hardness (mg/L)	Standard Type
60	14-Oct-08	Alkalinity Total, mg/L	11.9	20		Aquatic Life, chronic
60	5-May-09	Alkalinity Total, mg/L	12.8	20		Aquatic Life, chronic
60	22-Sep-09	Alkalinity Total, mg/L	7.2	20		Aquatic Life, chronic
60	22-Sep-09	Mercury, Dissolved µg/L	0.015	0.012	36.9	Aquatic Life, chronic
60	14-Oct-08	pH Lab, su	6.45	6.5		Aquatic Life, chronic
60	5-May-09	pH Lab, su	6.33	6.5		Aquatic Life, chronic
60	22-Sep-09	pH Lab, su	5.75	6.5		Aquatic Life, chronic
60	22-Sep-09	pH Field, su	6.17	6.5		Aquatic Life, chronic


Additional mercury sampling west of tails.
Dissolved Mercury (µg/L)
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Site 60
AWQS
604
605
607

Site 9

- Was originally monitored between 1981 through 1993.
- Was added back into the monitoring plan in 2001 as a biomonitoring site.
- Additional sampling for Suite Q analytes during the months of May, July, and September.
- Continuous monitoring of turbidity, conductivity, and stage (has been problematic).

AWQS Exceedances Sites 9

Site	Date	Parameter	Value	Standard	Hardness (mg/L)	Standard Type
9	5-May-09	Alkalinity Total, mg/L	10	20		Aquatic Life, chronic
9	22-Sep-09	Alkalinity Total, mg/L	8.6	20		Aquatic Life, chronic
9	22-Sep-09	Lead, Dissolved µg/L	0.778	0.724	32.4	Aquatic Life, chronic
9	5-May-09	pH Field, su	6.21	6.5		Aquatic Life, chronic
9	7-Jul-09	pH Field, su	6.34	6.5		Aquatic Life, chronic

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STOP

Greens Creek & 1350 FWMP Sites

Greens Creek (Site 54) July 2009

Greens Creek & 1350 Sampling Sites

- Site 48 “Upper Greens Creek”
  - Up-gradient reference site
- Site 6 “ Middle Greens Creek”
  - Below the influence from the 1350, 960, 920 Mine/Mill Complex, & Site C
- Site 54 “Lower Greens Creek”
  - Referenced to Site 6, below influence of Site 23/D
- Site 13 “1350 Mine Audit Discharge East”
  - Monitors the effect of contact water from the eastern portion of the 1350 Waste Rock site.

Bruin Creek & Site 23/D Sampling Sites

- Site 49 “Upper Bruin Creek”
  - Up-gradient reference site
- Site 46 “ Lower Bruin Creek”
  - Below influence from Site 23/D

- Site 57 “MW-23-00-03”
  - Up-gradient groundwater reference site, located above Site 23
- Site 56 “MW-D-00-01”
  - Down-gradient groundwater site, located below Site D

920 Area
Fresh Water Monitoring Program

- Comparison against AWQS
- Upgradient / Downgradient comparative graphs for SC, SO_4, Pb, & Zn
- Review of statistical tests for trends and comparison of median values for selected analytes.

Greens Creek & 1350

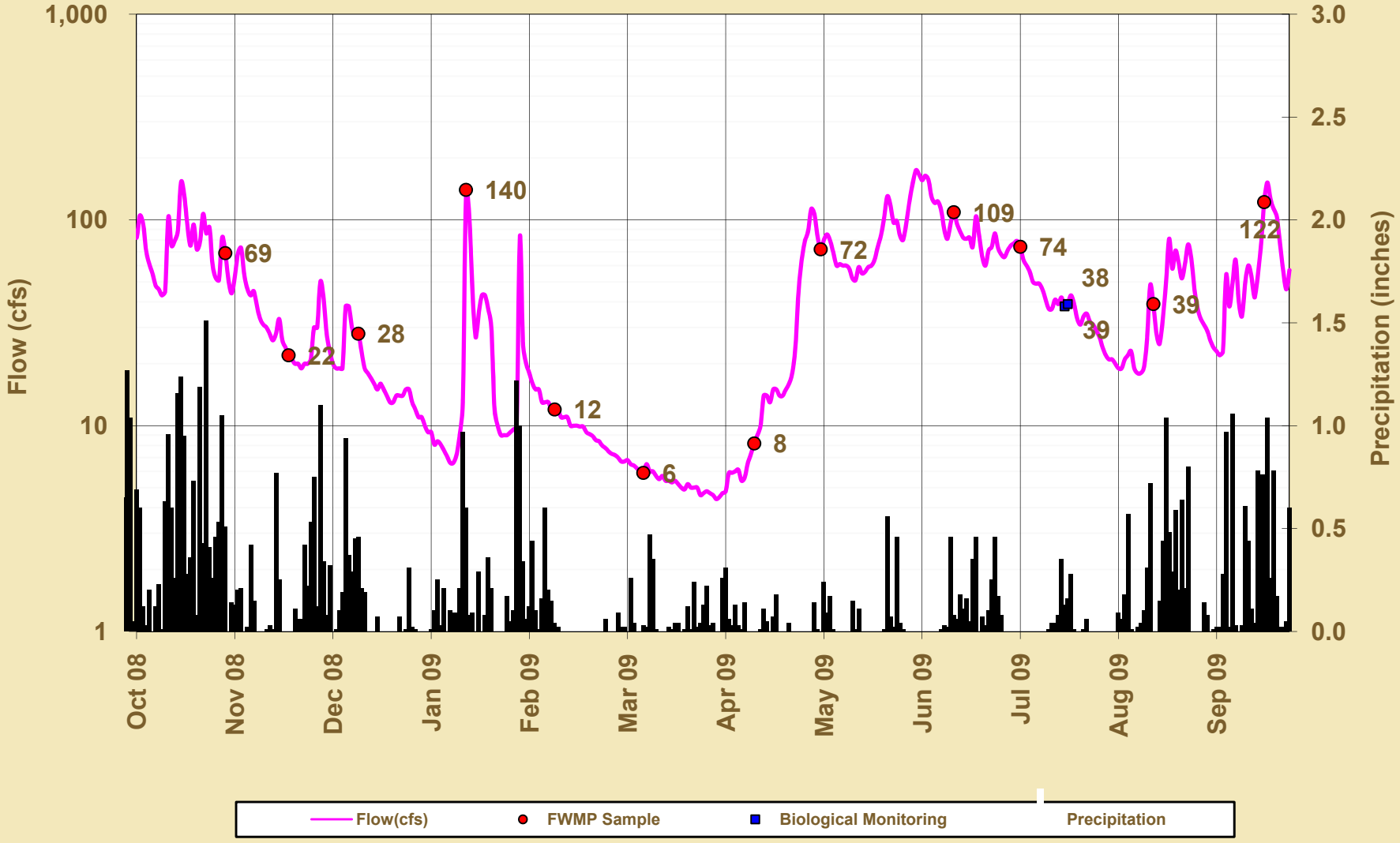
- Site 48 “Upper Greens Creek”
- Site 06 “Middle Greens Creek”
- Site 54 “Lower Greens Creek”
- Site 13 “1350 Mine Audit Discharge East”

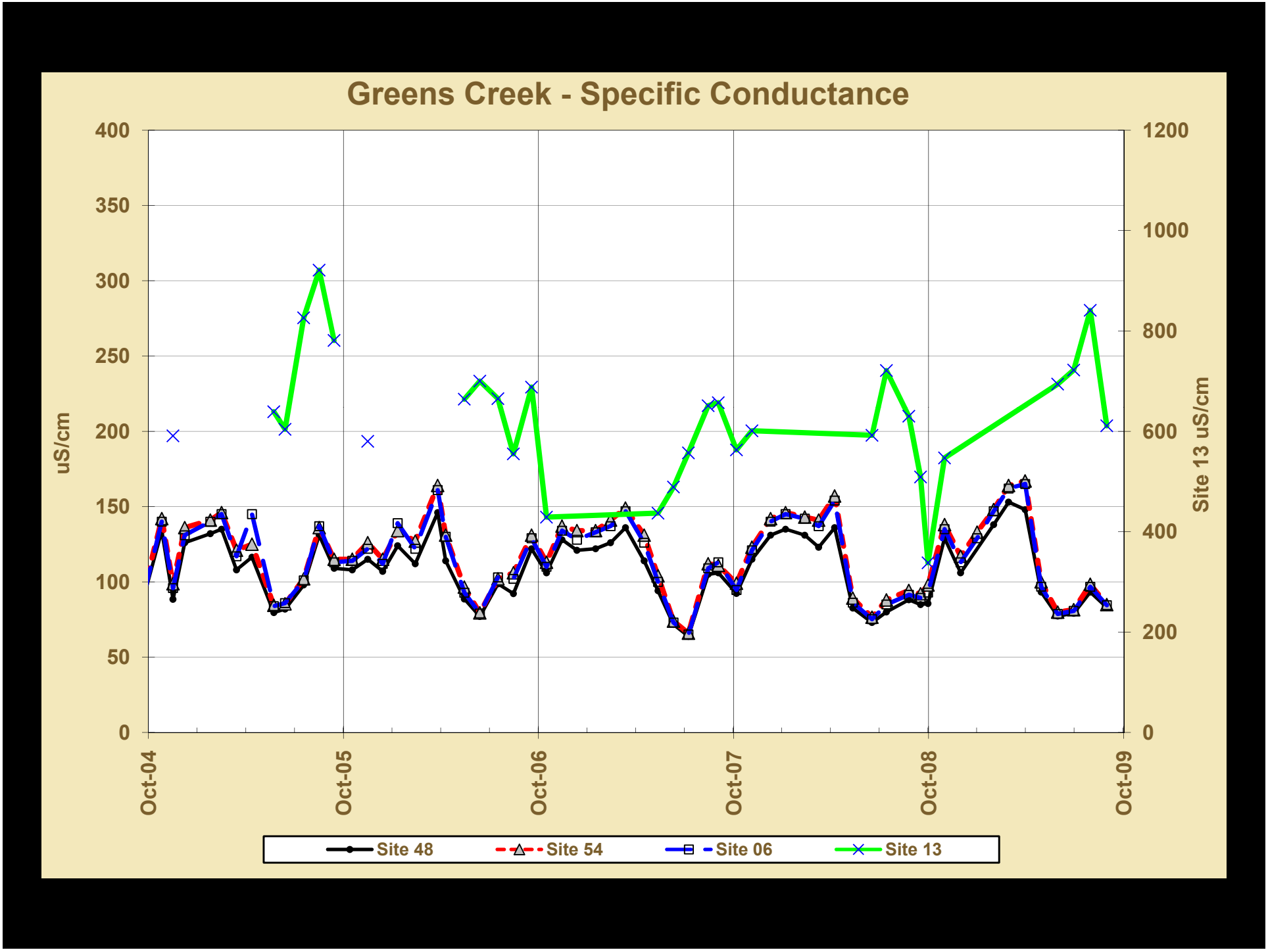
AWQS Exceedances in Greens Creek

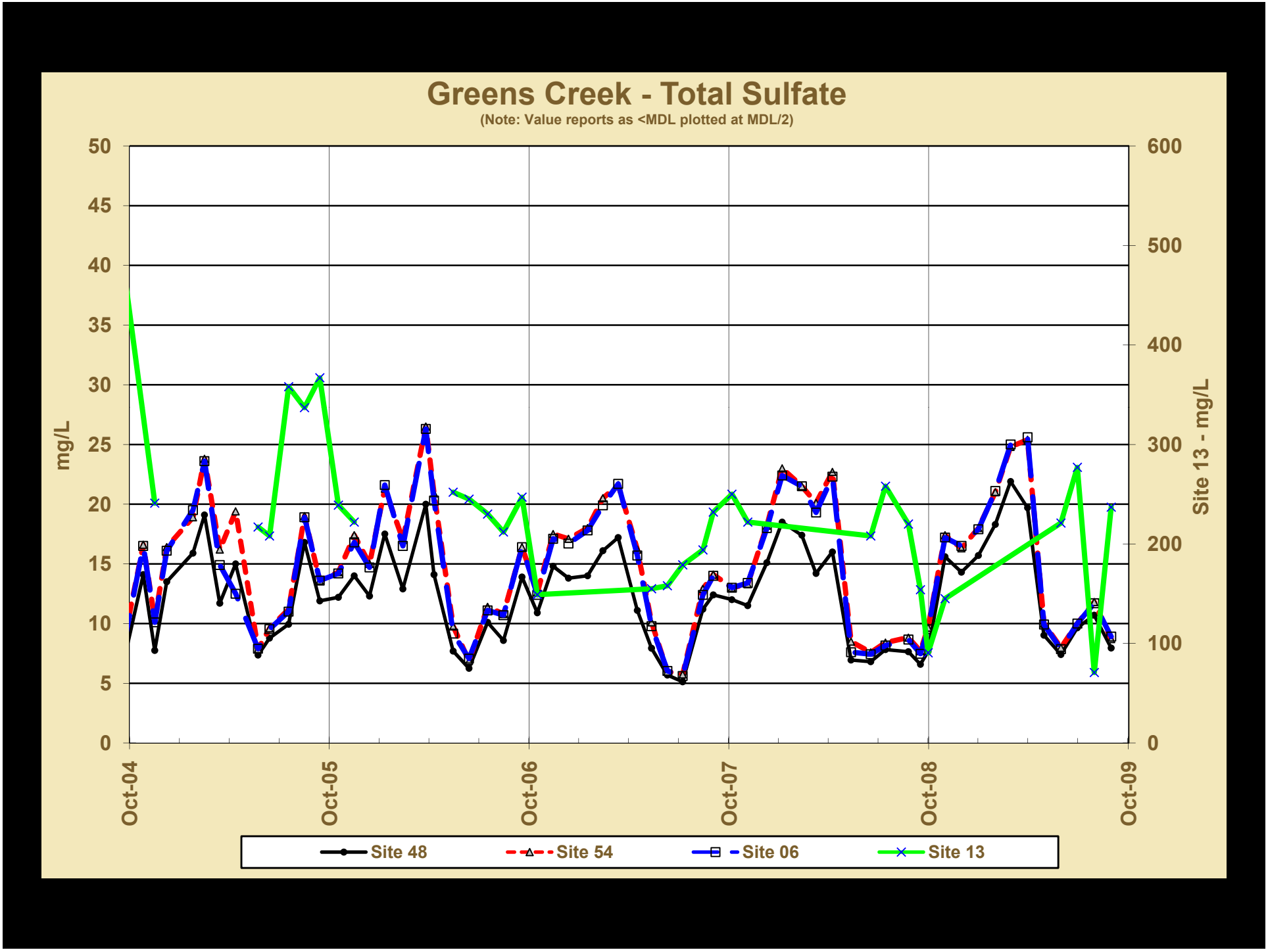
- No measured parameters exceeded AWQS for sites 48, 6 and 54.
- One exceedance was noted for sulfate at site 13.

Site	Date	Parameter	Value	Standard	Hardness (mg/L)	Standard Type
13	7-Jul-09	Sulfate-Total, mg/L	277	250		Aquatic Life, chronic

WY2009 Greens Creek Flow

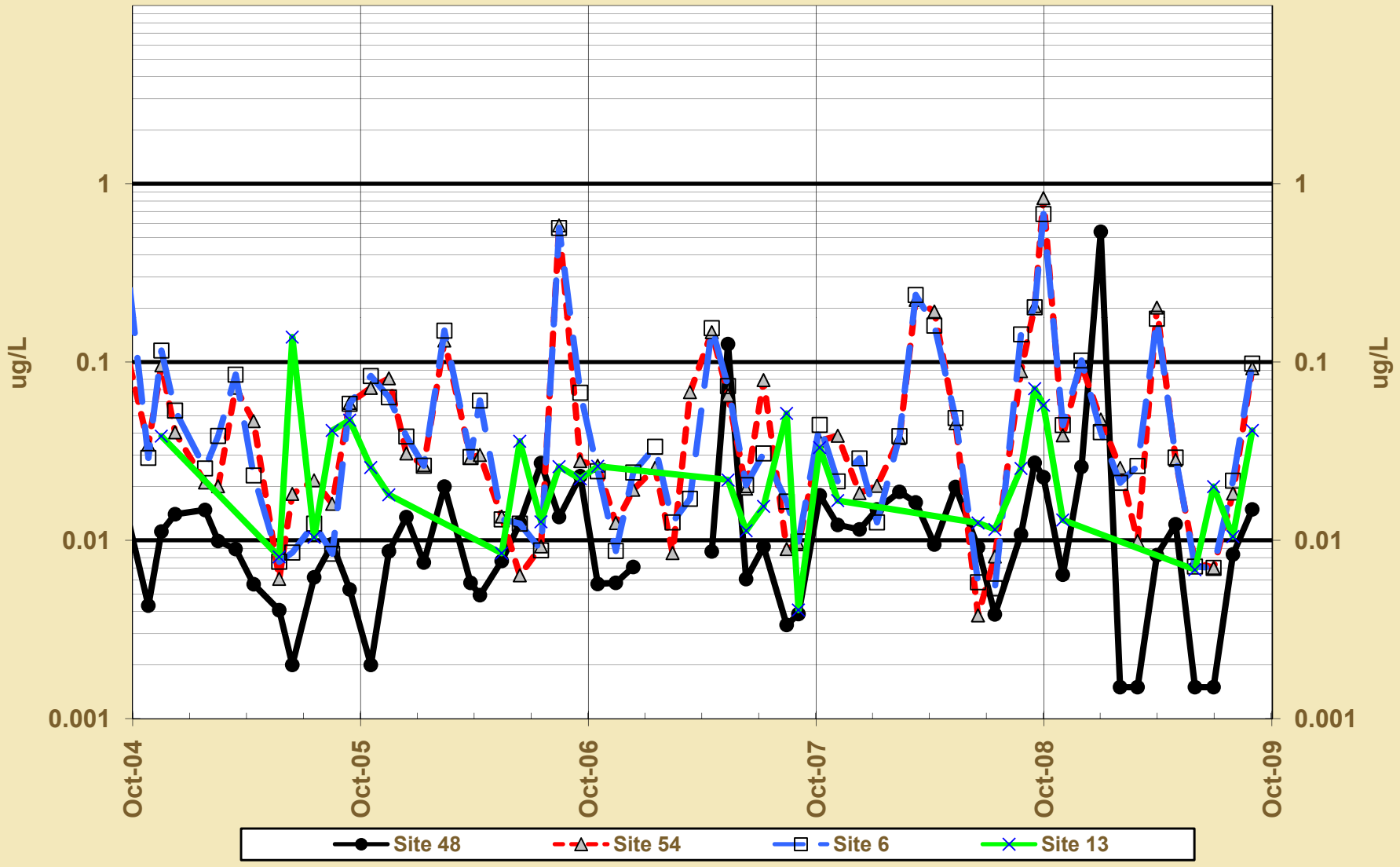



Greens Creek - Specific Conductance
uS/cm
Site 13 uS/cm
400
350
300
250
200
150
100
50
0
1200
1000
800
600
400
200
0
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Site 48
Site 54
Site 06
Site 13


Greens Creek - Total Sulfate
(Note: Value reports as <MDL plotted at MDL/2)
mg/L
Site 13 - mg/L
50
45
40
35
30
25
20
15
10
5
0
600
500
400
300
200
100
0
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Site 48
Site 54
Site 06
Site 13

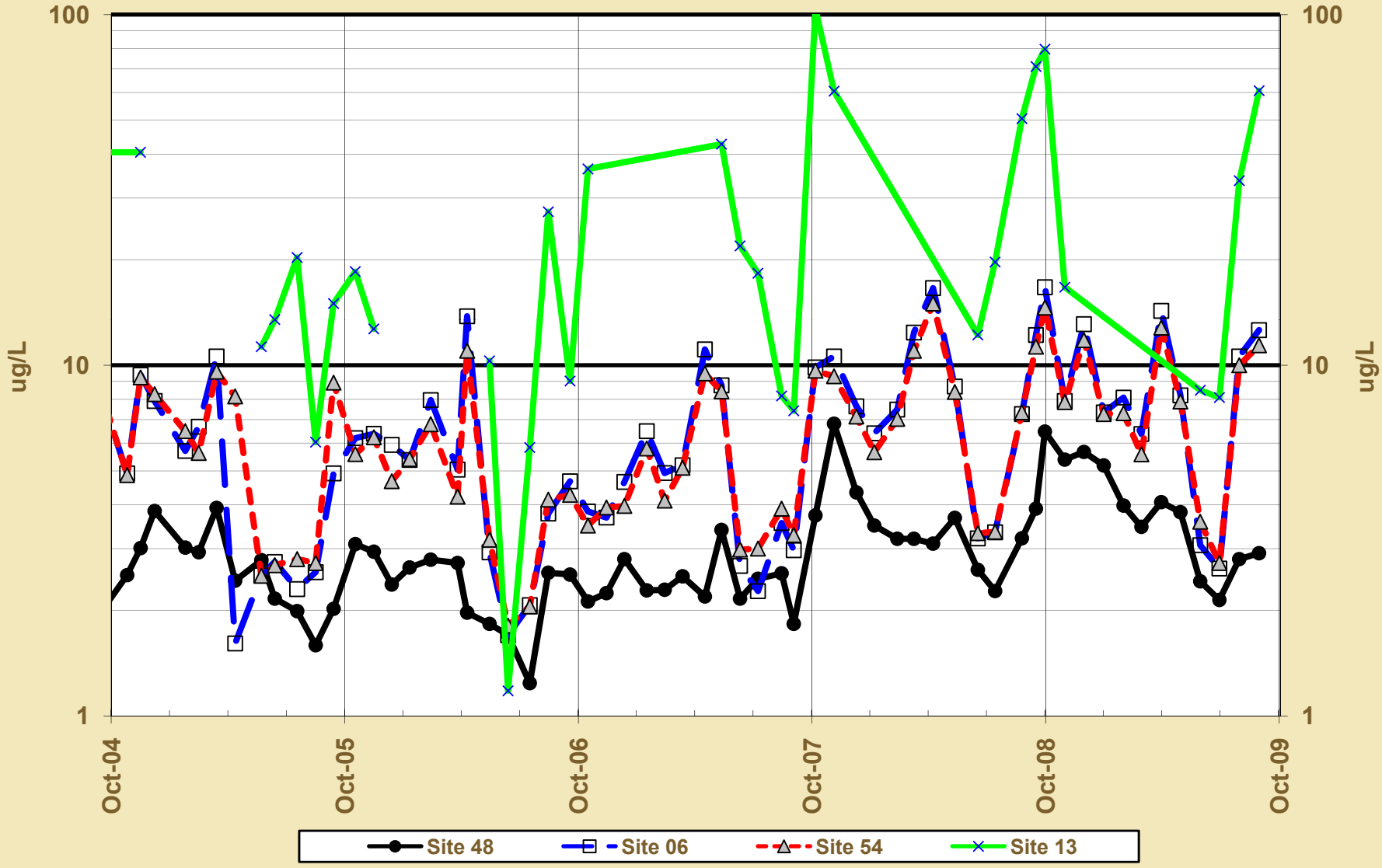
Greens Creek - Dissolved Lead

(Note: Values reported as <MDL plotted at MDL/2)



Greens Creek - Dissolved Zinc

(Note: Values reported as <MDL are plotted at 1/2MDL)



Greens Creek / 920 Area-Statistical Testing (Conductivity Graphs)

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2009 Water Year

Mann-Kendall Seasonal Trend Test Probabilities

Site	Cond.	pH	Alkalinity	Sulfate	Diss.-Zinc
48	*	<0.01	<0.01	0.78	1.00
6	*	<0.01	<0.01	0.73	0.99
54	*	0.09	<0.01	0.59	1.00
13	<0.01	0.28	<0.01	0.01	0.98

Sen's slope estimate

Site	µS/cm/yr	su/yr	mg/L/yr	µg/L/yr	µg/L/yr
48		-0.05	-1.58		0.24
6		-0.08	-1.50		0.41
54			-1.13		0.44
13	-28.50		-11.50	-22.13	2.45

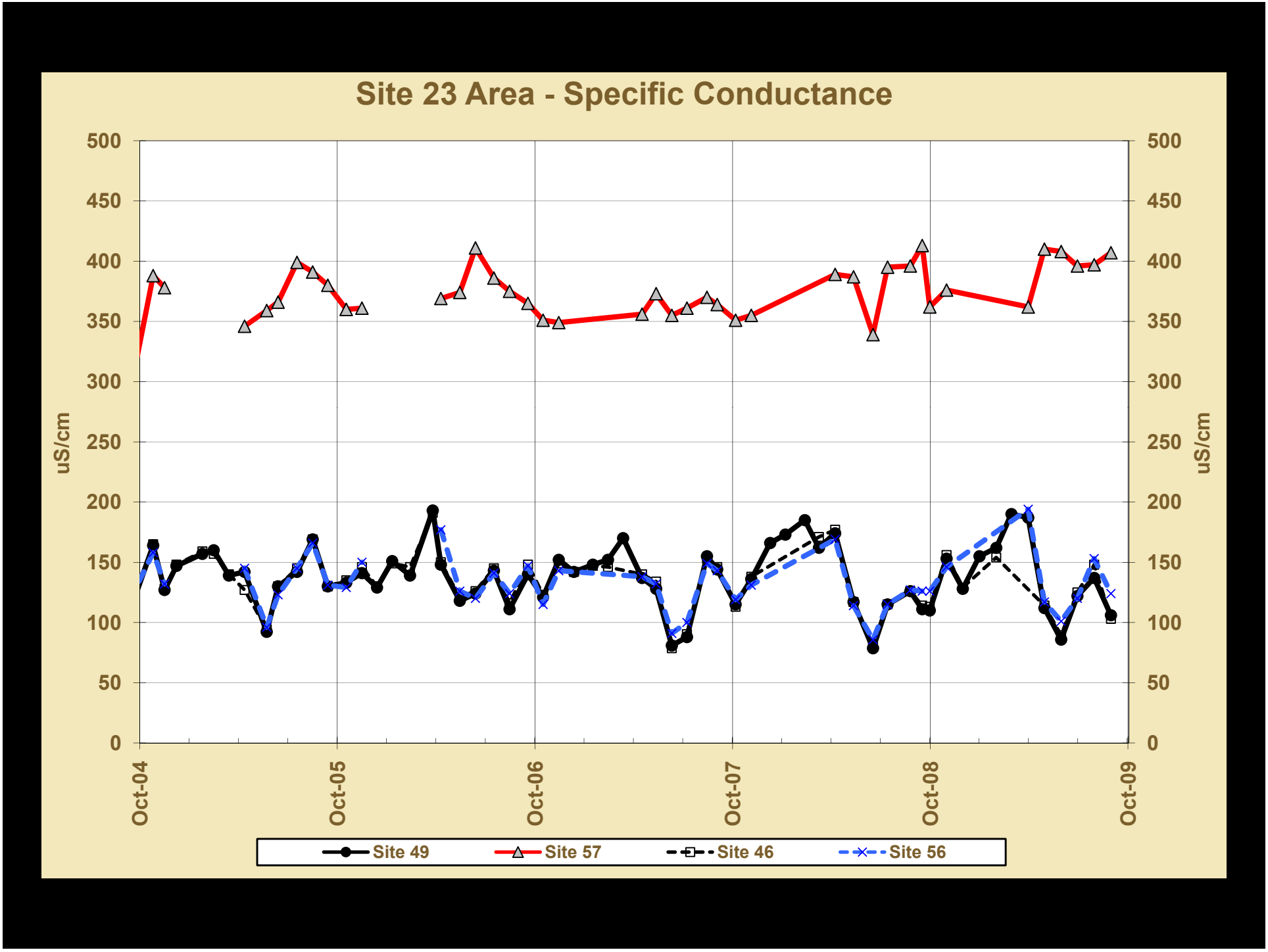
* Failed test for homogeneity

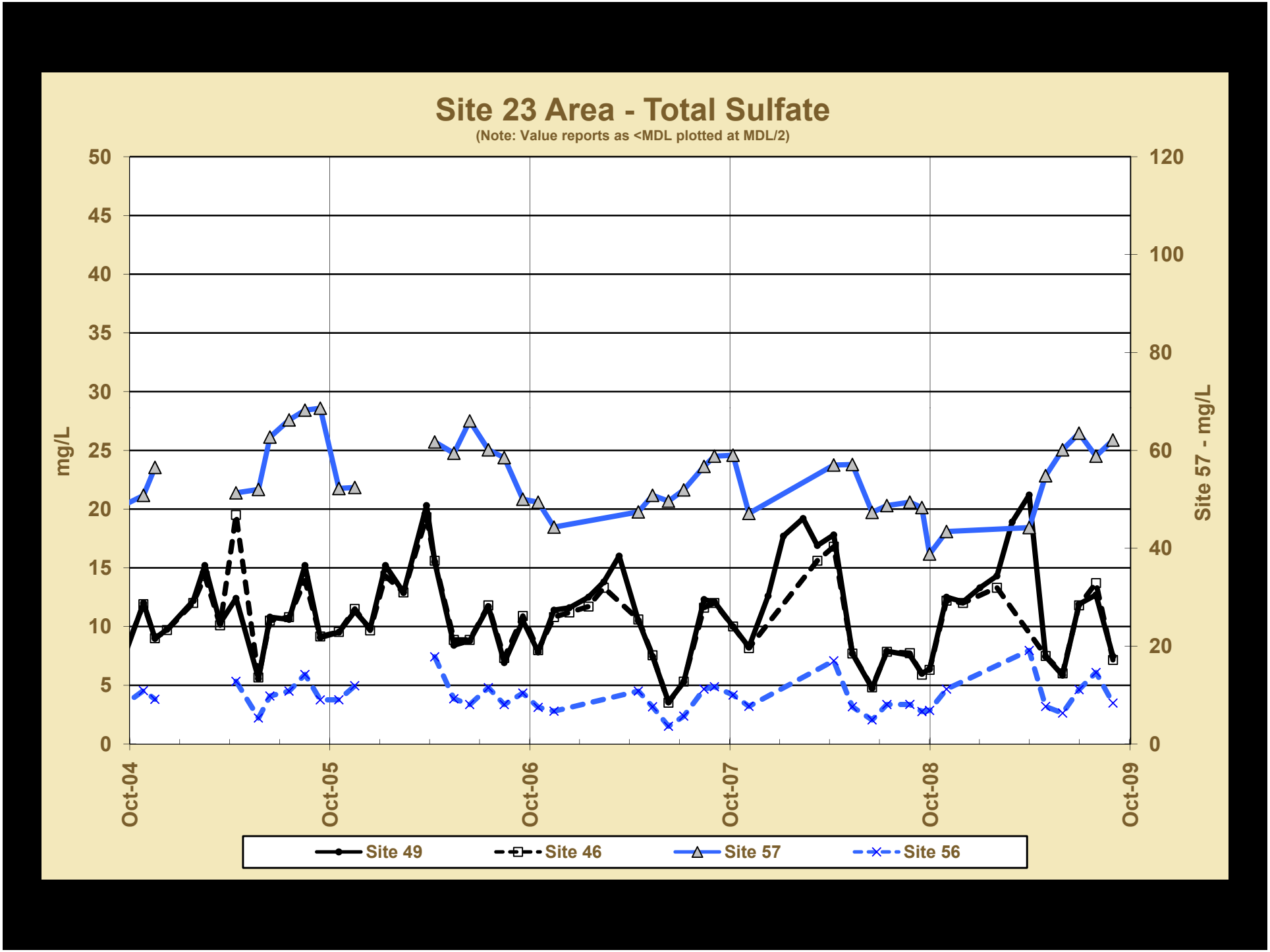
Bruin Creek
&
Site 23/D Monitoring Wells

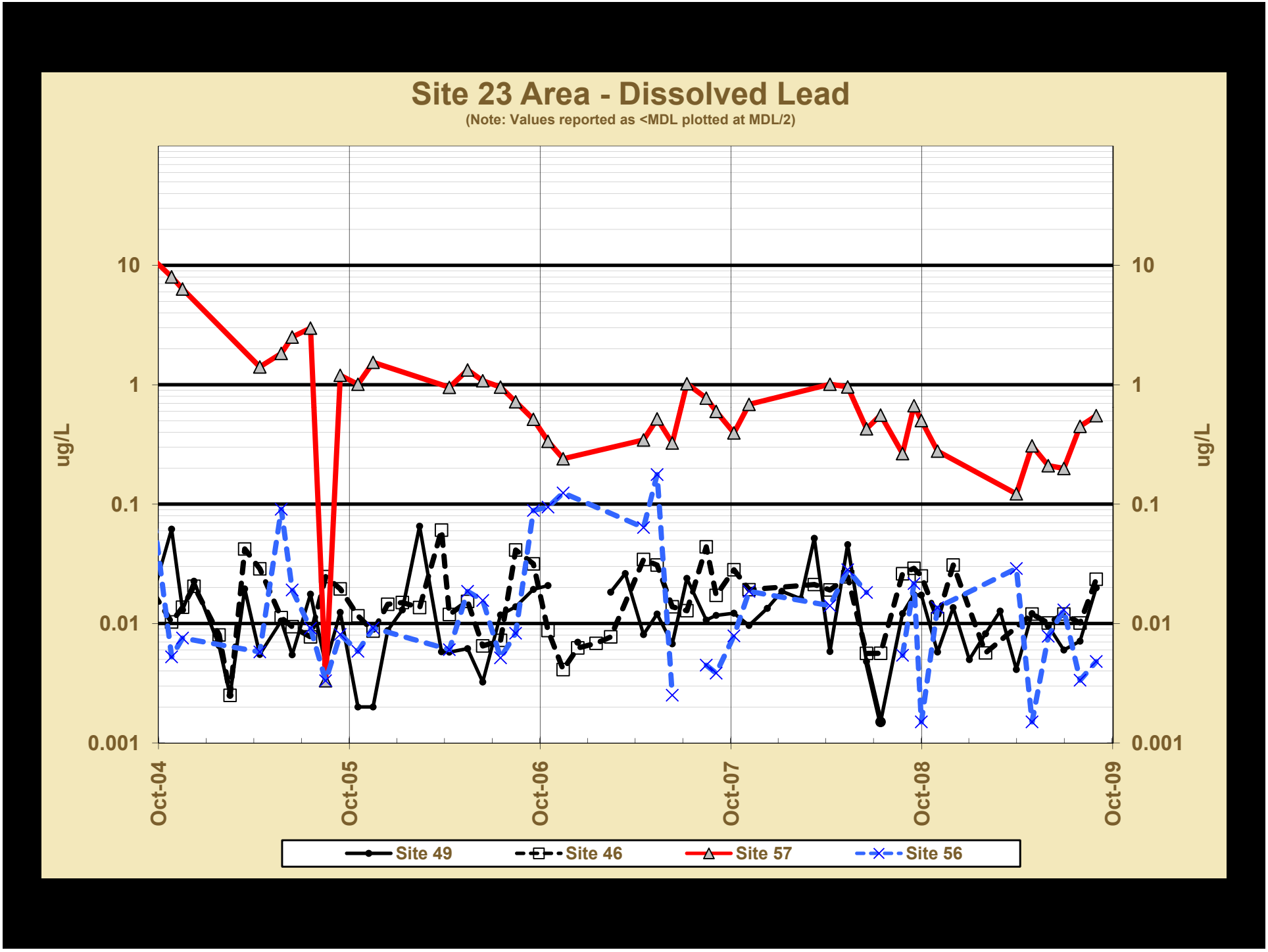
- Site 49 “Upper Bruin Creek”
- Site 46 “Lower Bruin Creek”
- Site 57 “MW-23-00-03”
- Site 56 “MW-D-00-01”

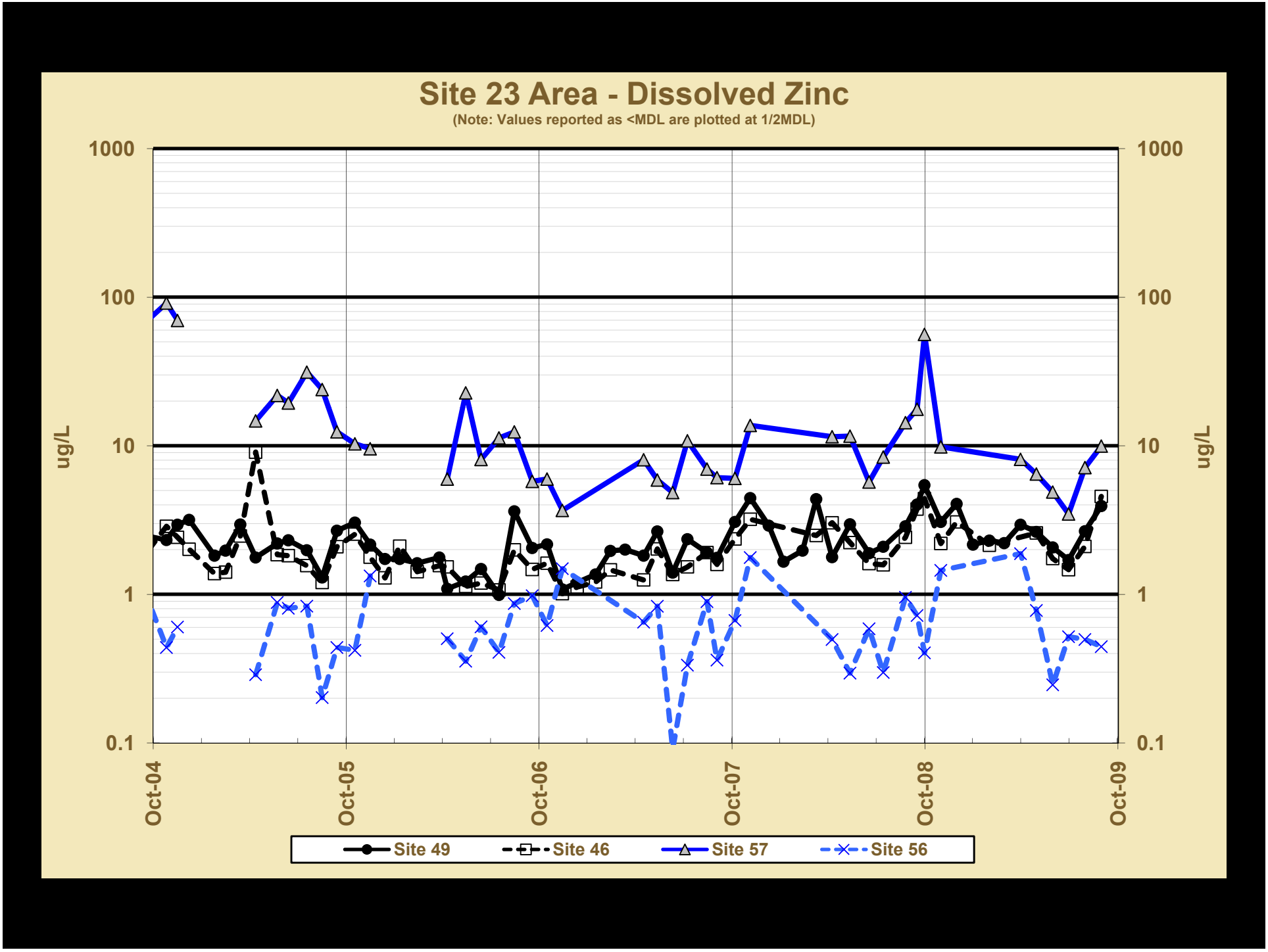
AWQS Exceedances
Bruin Creek & Site 23/D Wells

- No measured parameters exceeded AWQS for the Bruin Creek sites (49 & 46) or for the Site 23/D wells (57 & 56).


Site 23 Area - Specific Conductance
500
450
400
350
300
250
200
150
100
50
0
uS/cm
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Site 49
Site 57
Site 46
Site 56


Site 23 Area - Total Sulfate
(Note: Value reports as <MDL plotted at MDL/2)
mg/L
Site 57 - mg/L
50
45
40
35
30
25
20
15
10
5
0
120
100
80
60
40
20
0
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Site 49
Site 46
Site 57
Site 56


Site 23 Area - Dissolved Lead
(Note: Values reported as <MDL plotted at MDL/2)
ug/L
10
1
0.1
0.01
0.001
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Site 49
Site 46
Site 57
Site 56


Site 23 Area - Dissolved Zinc
(Note: Values reported as <MDL are plotted at 1/2MDL)
1000
100
10
1
0.1
ug/L
Oct-04
Oct-05
Oct-06
Oct-07
Oct-08
Oct-09
Site 49
Site 46
Site 57
Site 56

Bruin Creek - Site 23 - D Wells
Statistical Testing (pH graphs)

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2009 Water Year

Mann-Kendall Seasonal Trend Test Probabilities

Site	Cond.	pH	Alkalinity	Sulfate	Diss.-Zinc
49	*	<0.01	<0.01	0.95	0.97
46	0.11	<0.01	0.01	0.60	0.95
57	0.85	0.75	<0.01	0.08	<0.01
56	0.05	0.02	<0.01	0.50	*

Sen's slope estimate

Site	µS/cm/yr	su/yr	mg/L/yr	µg/L/yr	µg/L/yr
49		-0.04	-2.65		
46		-0.05	-1.60		
57			-4.17		-4.26
56		-0.03	-0.03		-2.63

* Failed test for homogeneity

Statistical Testing (Comparison of Means)

Assumptions:

- ↑ Conductivity
- ↓ pH
- ↑ Sulfate
- ↓ Alkalinity
- ↑ Dissolved Zinc

Sites Compared:

- downgradient – upgradient
- 06 – 48
- 54 – 06
- 46 – 49
- 56 – 57

Greens Creek & 920 Area
Statistical Testing (Comparison of Means)

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2009 Water Year
Comparison of Medians, Signed-Rank Test Probabilities

Sites	Cond.	pH	Alkalinity	SO_4	Diss-Zinc
6 - 48	**<0.01**	**1.00**	0.24	**<0.01**	**<0.01**
54 - 6	**<0.01**	0.88	<0.01	0.65	1.00

Calculated Medians

Site	Cond. (uS/cm)	pH (su)	Alkalinity (mg/l)	SO_4 (mg/l)	Diss-Zinc (ug/l)
48	**93.2**	**7.66**	35.7	**12.5**	**3.9**
6	**105**	**7.50**	35.7	**14.1**	**8.15**
54	**109**	7.44	36.9	14.1	7.87

Bruin Creek & Site 23/D Wells
Statistical Testing (Comparison of Means)

Hecla MINING COMPANY

2009 Water Year
Comparison of Medians, Signed-Rank Test Probabilities

Sites	Cond.	pH	Alkalinity	SO_4	Diss-Zinc
46 - 49	0.13	**0.94**	**<0.01**	0.82	**0.98**
56 - 57	1.00	1.00	**1.00**	1.00	1.00

Calculated Medians

Site	Cond. (uS/cm)	pH (su)	Alkalinity (mg/l)	SO_4 (mg/l)	Diss-Zinc (ug/l)
46	133	**7.74**	**50.3**	12.3	**2.65**
49	125	**7.55**	**51.6**	11.8	**2.20**
57	397	7.53	**135**	56.8	7.62
56	125	7.30	**53.7**	9.7	0.51

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STOP