

2008 FWMP Presentation

Hecla
GREENS CREEK



Tributary Creek (Site 9) March 2008

Tailings Area Fresh Water Monitoring Program



- Comparison against AWQS
- Upgradient / Downgradient comparative graphs for Specific Conductance, Total Sulfate, Dissolved Lead, and Dissolved Zinc
- 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)

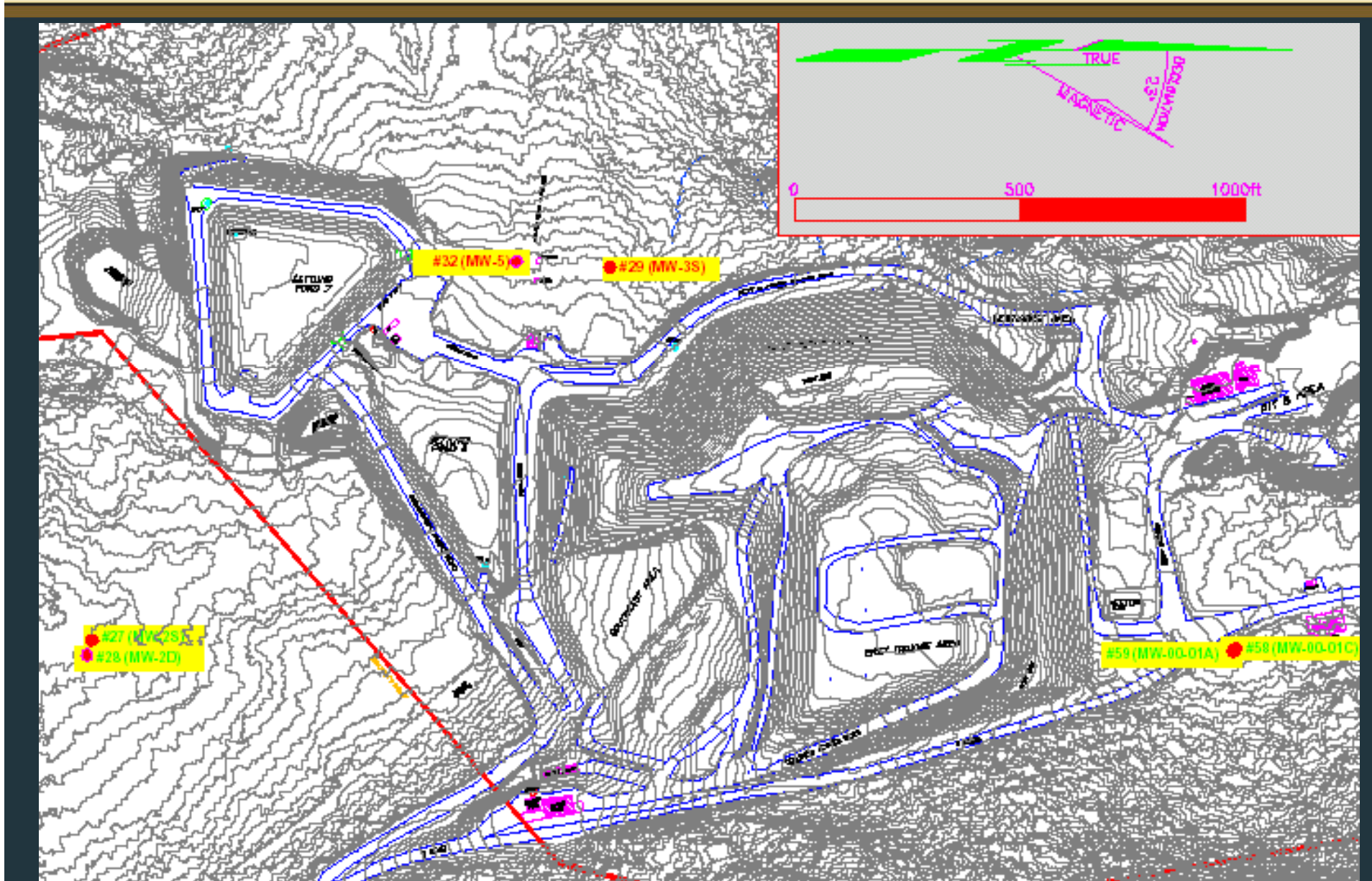
- Site 58 “MW-T-00-01C”
 - Up-gradient reference site, located to the northeast of Tailings Area
- Site 27 “MW-2S”
 - Down-gradient groundwater site, located south of Tailings Area
- Site 29 “MW-3S”
 - Down-gradient groundwater site, located west of Tailings Area
- Site 32 “MW-5”
 - Down-gradient groundwater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

- 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 Sampling Sites



Tailings Area Shallow Wells (PEAT)

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

Alaska Water Quality Standards (AWQS) Exceedances



- Shallow wells continue historic trends in low pH, low alkalinity, and elevated lead.

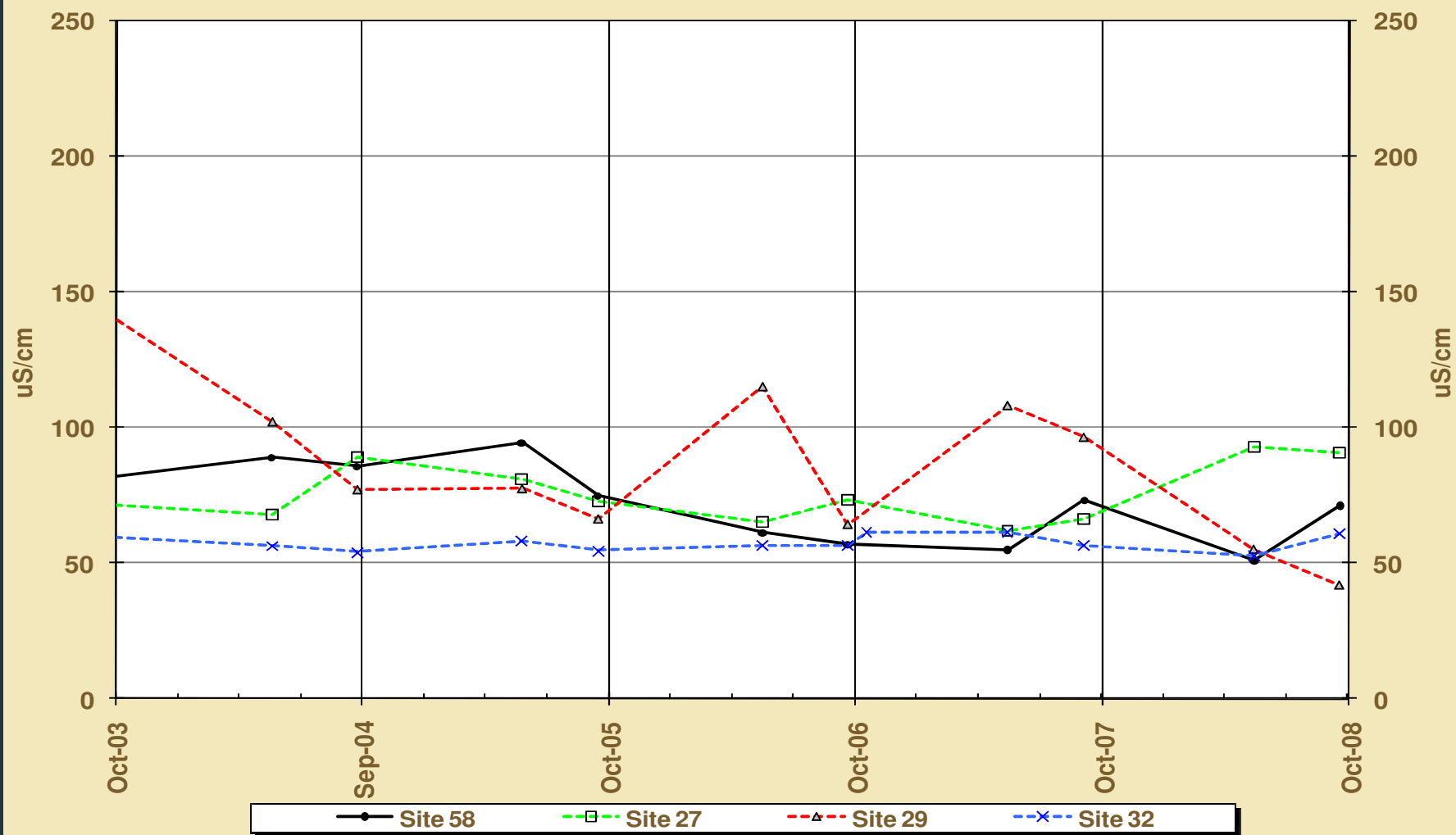
AWQS Exceedances (continued)



Site	Date	Parameter	Value	Standard	Hardness (mg/L)	Standard Type
58	14-May-08	Alkalinity Total, mg/L	17.6	20		Aquatic Life, chronic
58	17-Sep-08	Alkalinity Total, mg/L	10.5	20		Aquatic Life, chronic
58	14-May-08	pH Lab, su	6.13	6.5		Aquatic Life, chronic
58	14-May-08	pH Field, su	6.25	6.5		Aquatic Life, chronic
58	17-Sep-08	pH Lab, su	4.91	6.5		Aquatic Life, chronic
58	17-Sep-08	pH Field, su	6.05	6.5		Aquatic Life, chronic
27	14-May-08	pH Lab, su	5.81	6.5		Aquatic Life, chronic
27	14-May-08	pH Field, su	5.97	6.5		Aquatic Life, chronic
27	17-Sep-08	pH Lab, su	5.86	6.5		Aquatic Life, chronic
27	17-Sep-08	pH Field, su	6.28	6.5		Aquatic Life, chronic
29	14-May-08	Lead, Dissolved ug/L	1.36	0.56	25.8	Aquatic Life, chronic
29	17-Sep-08	Lead, Dissolved ug/L	0.672	0.54	14.7	Aquatic Life, chronic
29	14-May-08	pH Lab, su	5.21	6.5		Aquatic Life, chronic
29	14-May-08	pH Field, su	5.33	6.5		Aquatic Life, chronic
29	17-Sep-08	pH Lab, su	6	6.5		Aquatic Life, chronic
29	17-Sep-08	pH Field, su	4.96	6.5		Aquatic Life, chronic
32	14-May-08	Lead, Dissolved ug/L	3.5	0.54	9.71	Aquatic Life, chronic
32	17-Sep-08	Lead, Dissolved ug/L	3.36	0.54	9.68	Aquatic Life, chronic
32	14-May-08	Alkalinity Total, mg/L	15.2	20		Aquatic Life, chronic
32	17-Sep-08	Alkalinity Total, mg/L	15.5	20		Aquatic Life, chronic
32	14-May-08	pH Lab, su	5.05	6.5		Aquatic Life, chronic
32	14-May-08	pH Field, su	5.21	6.5		Aquatic Life, chronic
32	17-Sep-08	pH Lab, su	5.04	6.5		Aquatic Life, chronic

Specific Conductance Tailings (Shallow Wells)

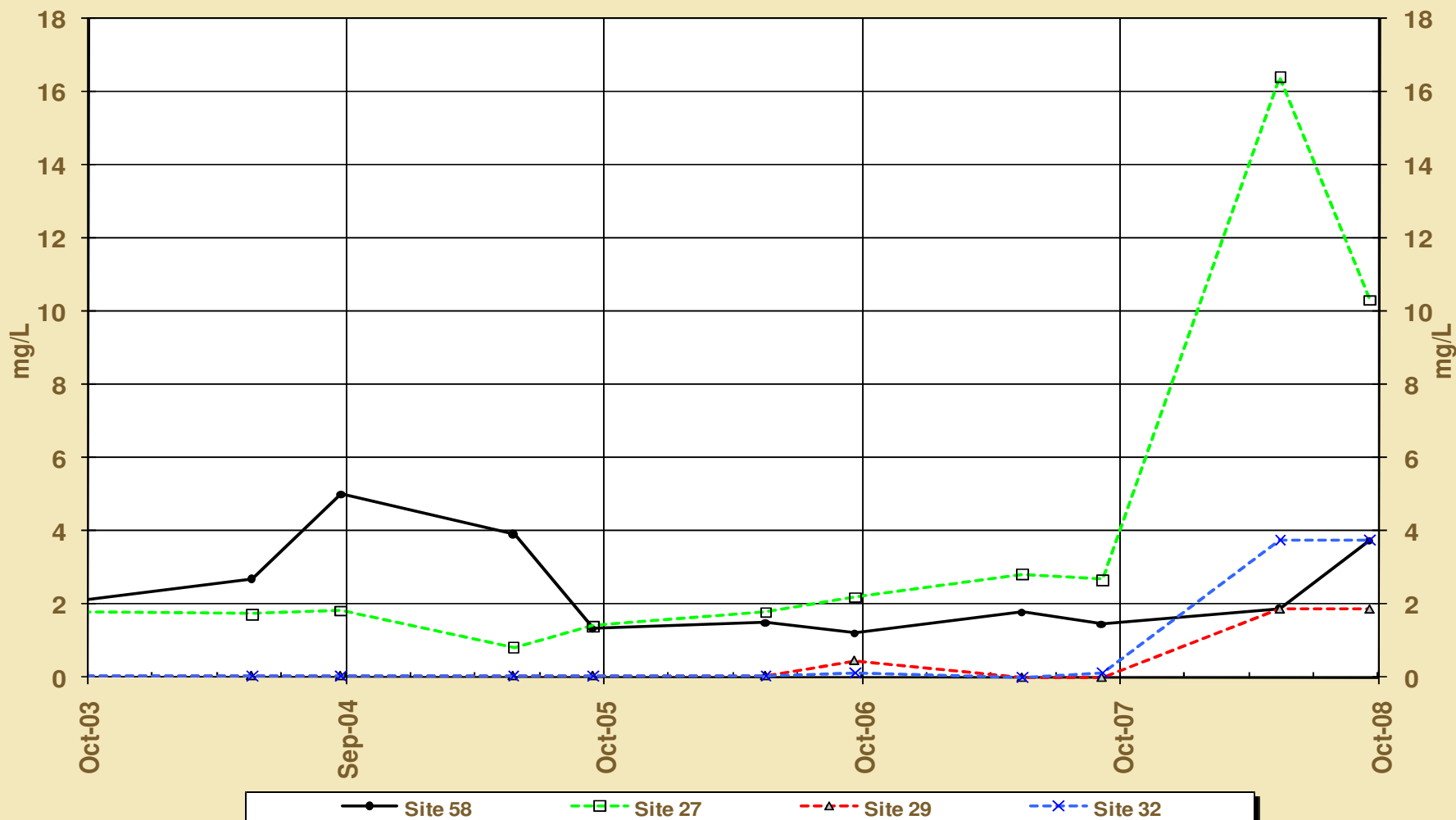
Tailings (Shallow Wells) - Specific Conductance



Total Sulfate Tailings (Shallow Wells)

Tailings (Shallow Wells) - Total Sulfate

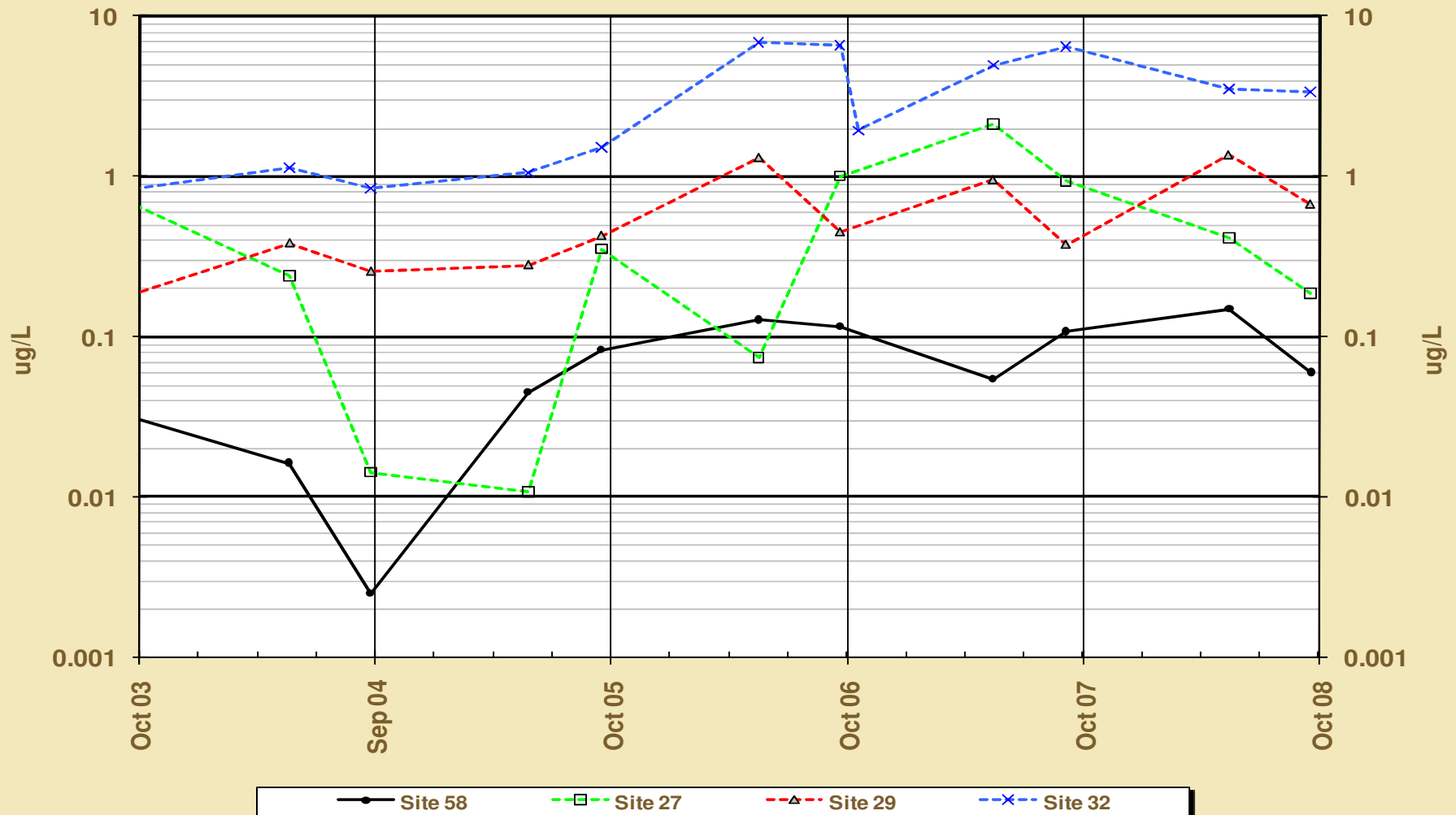
(Note: Value reports as <MDL plotted at MDL/2)



Dissolved Lead Tailings (Shallow Wells)

Tailings (Shallow Wells) - Dissolved Lead

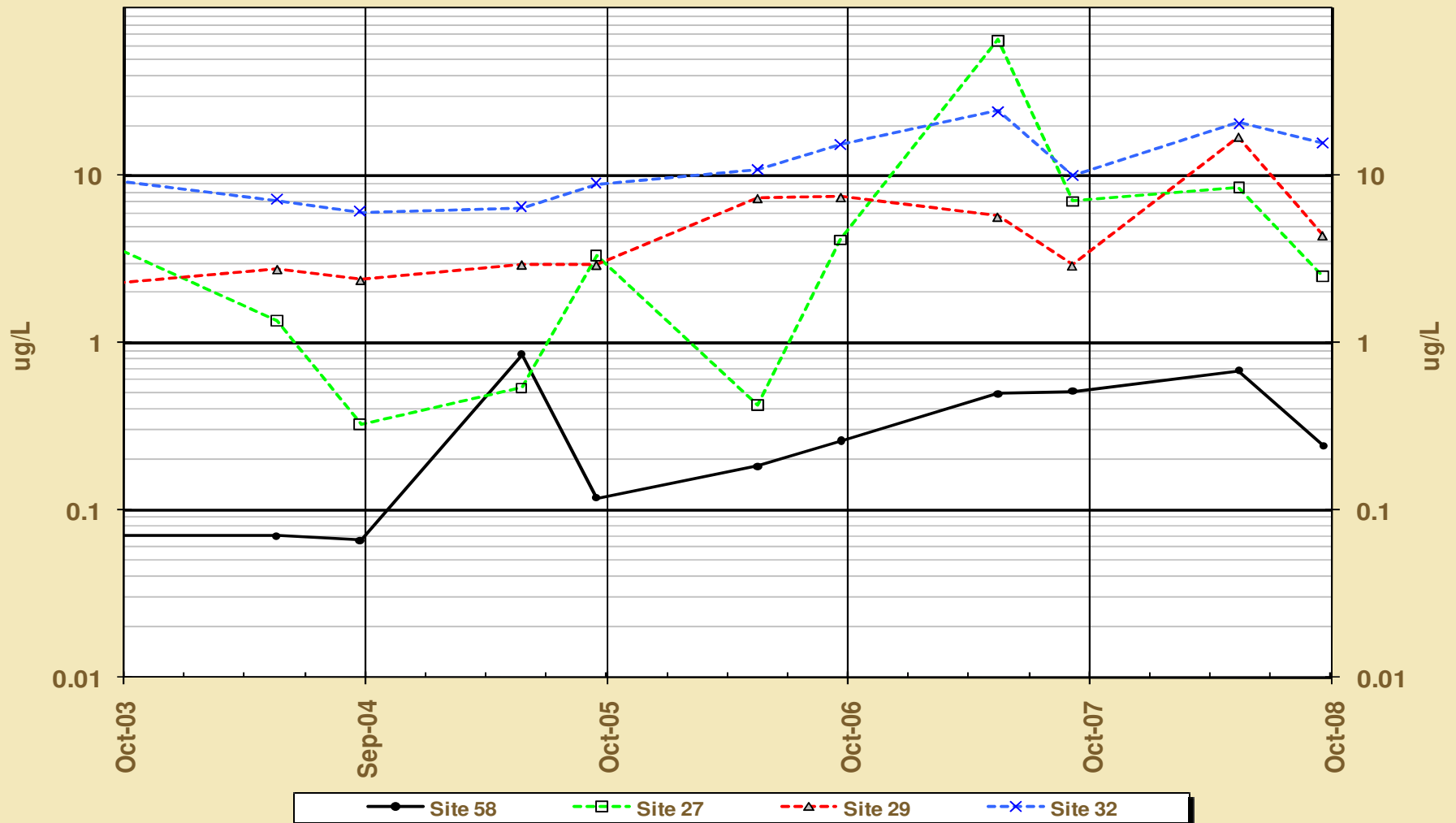
(Note: Values reported as <MDL plotted at MDL/2)



Dissolved Zinc Tailings (Shallow Wells)

Tailings (Shallow Wells) - Dissolved Zinc

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



Tailings Shallow Wells Statistical Trends

2008 Water Year

Mann-Kendall Seasonal Trend Test Probabilities

Site	Cond.	pH	Alkalinity	Sulfate	Diss.-Zinc
58	0.01	0.06	0.04	0.07	0.98
27	0.75	0.40	<0.01	1.00	0.67
29	0.12	0.02	0.07		1.00
32	0.91	<0.01	0.02		1.00

Sen's slope estimate

Site	µS/cm/yr	su/yr	mg/L/yr	µg/L/yr	µg/L/yr
58	-3.89				+0.13
27			-2.29	+0.56	
29		-0.10			+0.66
32		-0.02	-0.86		+2.08

Tailings Area

Deep Wells (Glacial / Marine Till)

- Site 59 "MW-T-00-01A"
- Site 28 " MW-2D"

AWQS Exceedances Deep Wells



Site	Date	Parameter	Value	Standard	Hardness (mg/L)	Standard Type
28	14-May-08	Arsenic Dissolved ug/L	74.5	10	74.3	Aquatic Life, chronic
28	17-Sep-08	Arsenic Dissolved ug/L	73.8	10	68.1	Aquatic Life, chronic

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

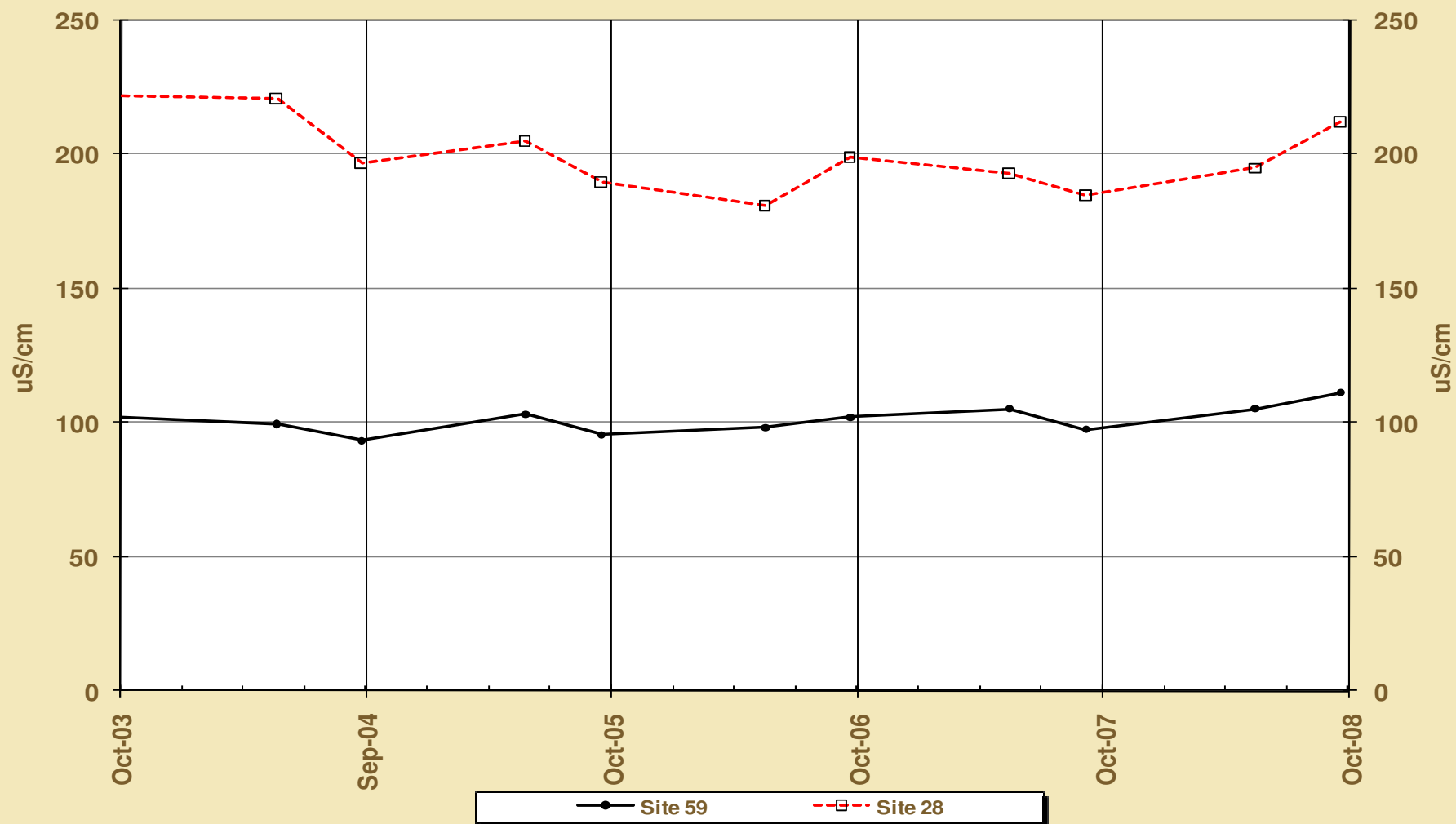
1988 – present

mean = 72 +/- 18.5 µg/L

n=113

Specific Conductance Tailings (Deep Wells)

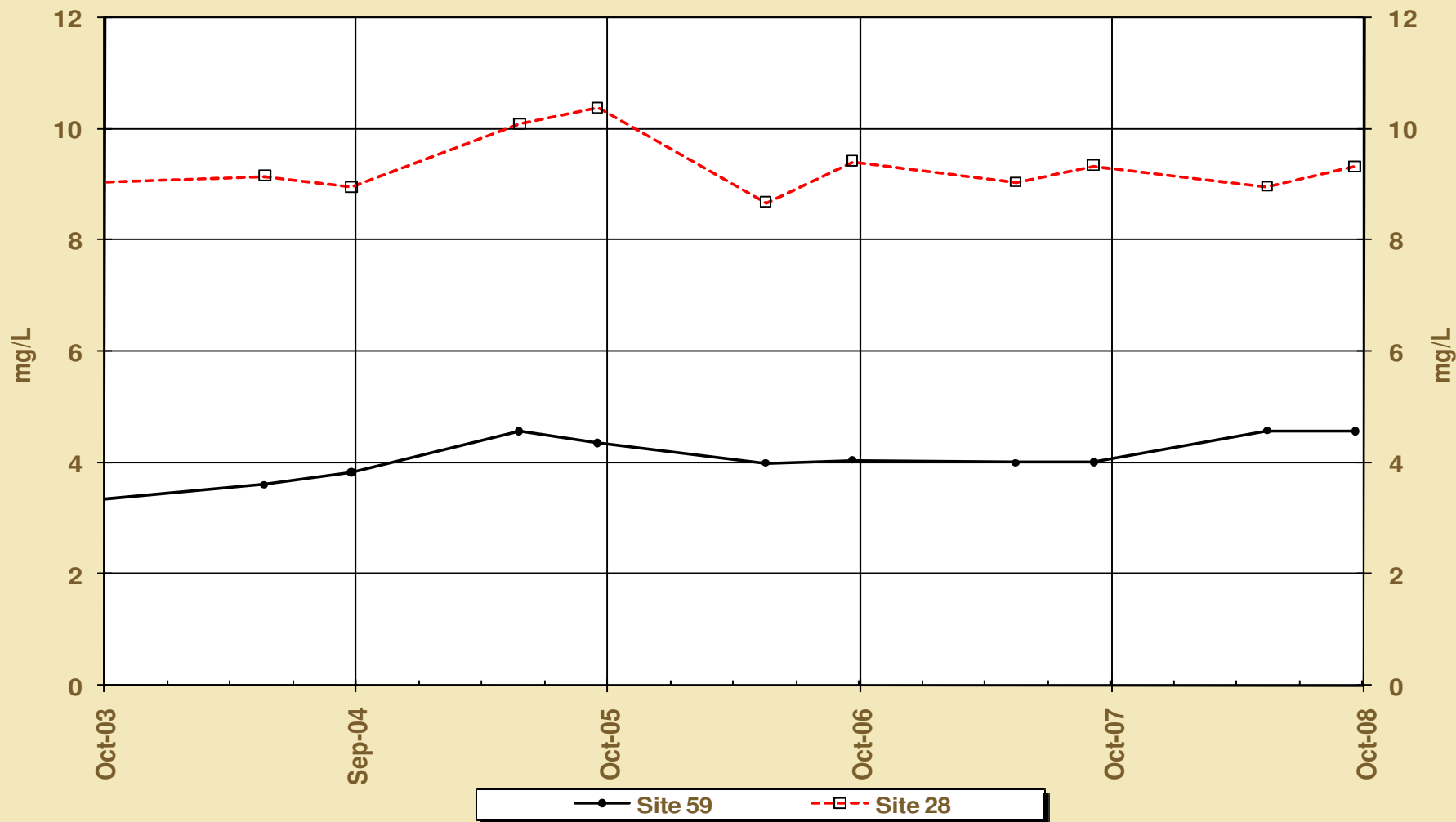
Tailings (Deep Wells) - Specific Conductance



Total Sulfate Tailings (Deep Wells)

Tailings (Deep Wells) - Total Sulfate

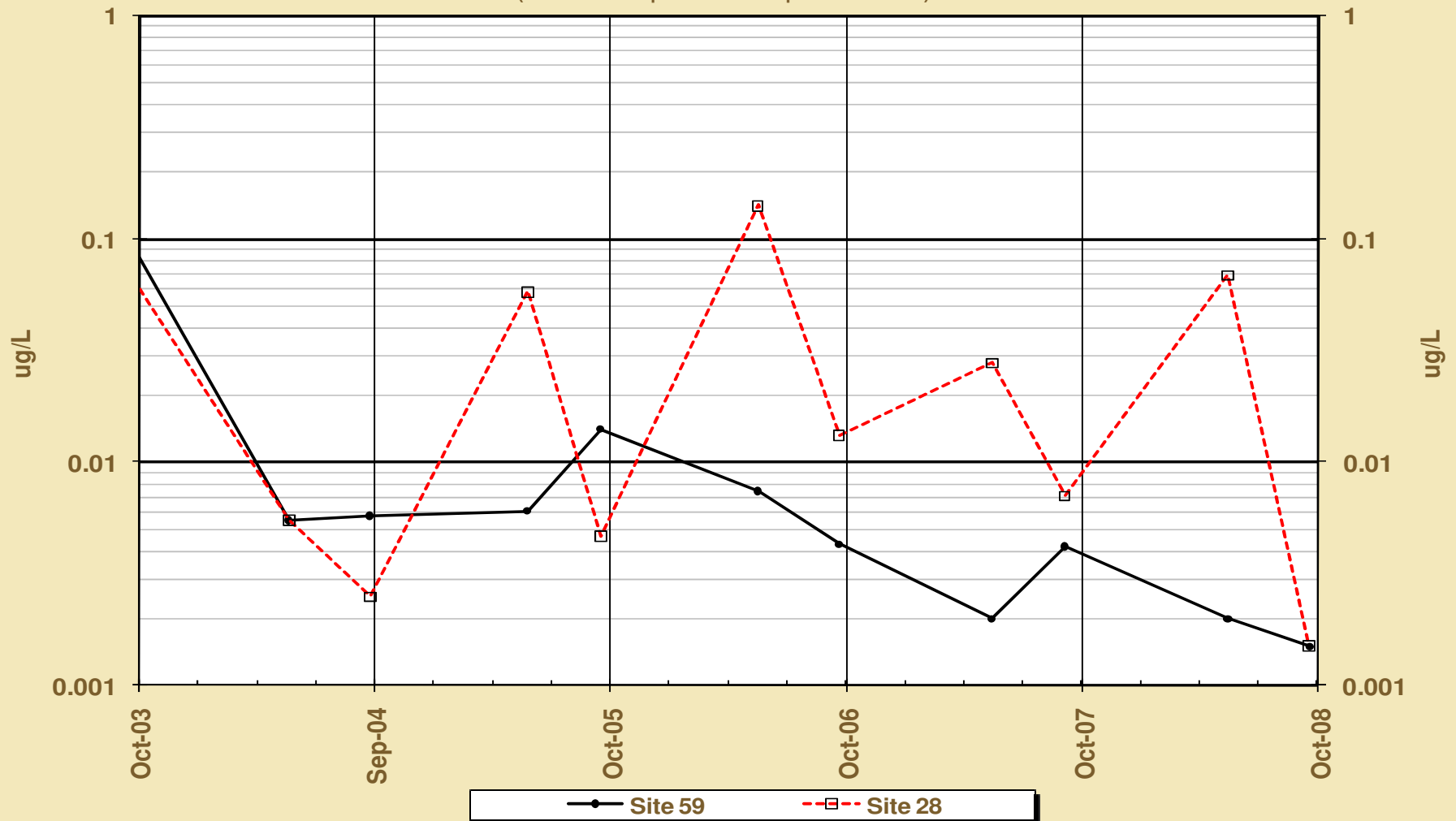
(Note: Value reports as <MDL plotted at MDL/2)



Dissolved Lead Tailings (Deep Wells)

Tailings (Deep Wells) - Dissolved Lead

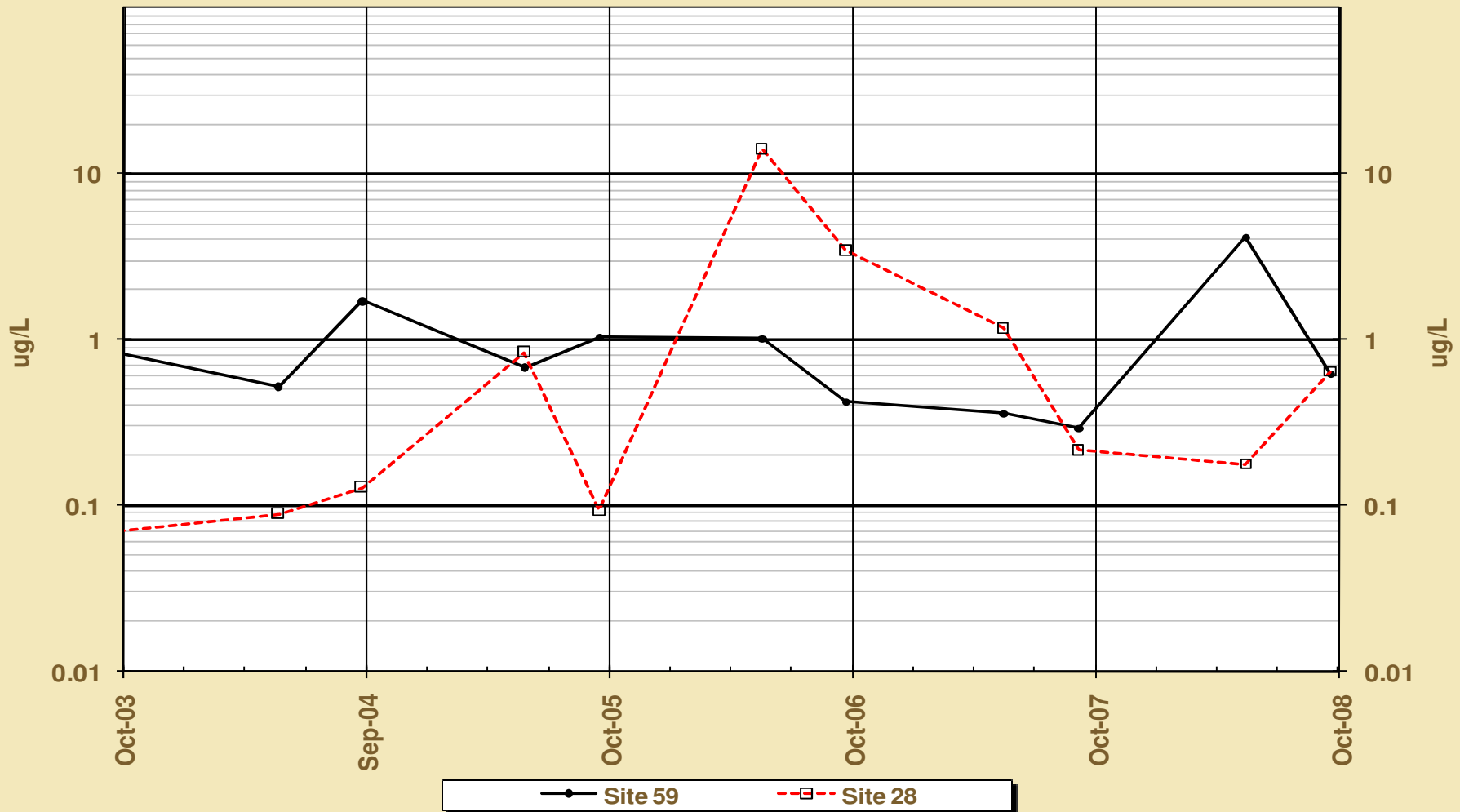
(Note: Values reported as <MDL plotted at MDL/2)



Dissolved Zinc Tailings (Deep Wells)

Tailings (Deep Wells) - Dissolved Zinc

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



Tailings Deep Wells Statistical Trends

2008 Water Year

Mann-Kendall Seasonal Trend Test Probabilities

Site	Cond.	pH	Alkalinity	Sulfate	Diss.-Zinc
59	0.98	0.30	0.45	0.99	0.50
28	0.12	0.18	0.06	0.55	0.88

Sen's slope estimate

Site	$\mu\text{S/cm/yr}$	su/yr	mg/L/yr	$\mu\text{g/L/yr}$	$\mu\text{g/L/yr}$
59	+1.83			+0.18	
28					

Tailings Area Surface Sites

- Site 60 "Lower Althea Creek"
- Site 9 "Tributary Creek"

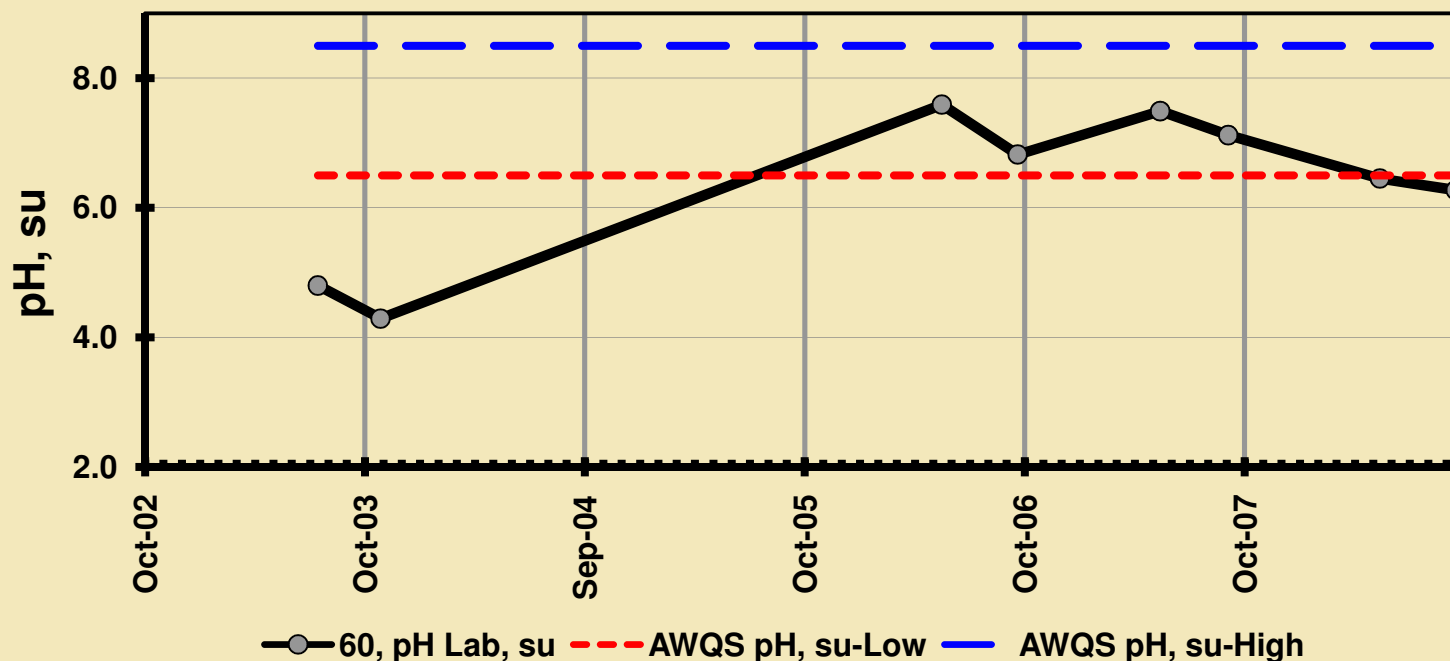
Site 60

- 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 Site 60 (Lower Althea)



Site	Date	Parameter	Value	Standard	Hardness (mg/L)	Standard Type
60	14-May-08	Alkalinity Total, mg/L	15.6	20		Aquatic Life, chronic
60	17-Sep-08	Alkalinity Total, mg/L	12.6	20		Aquatic Life, chronic
60	14-May-08	Mercury, Dissolved µg/L	0.0132	0.012		Aquatic Life, chronic
60	17-Sep-08	Mercury, Dissolved µg/L	0.0171	0.012		Aquatic Life, chronic
60	14-May-08	pH Lab, su	6.45	6.5		Aquatic Life, chronic
60	17-Sep-08	pH Lab, su	6.27	6.5		Aquatic Life, chronic



The limited amount of data for these sites prevents statistical analysis of the datasets.

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.

AWQS Exceedances Sites 9 (Tributary Creek)



Site	Date	Parameter	Value	Standard	Hardness (mg/L)	Standard Type
9	14-May-08	Alkalinity Total, mg/L	11	20		Aquatic Life, chronic
9	17-Sep-08	Alkalinity Total, mg/L	11.6	20		Aquatic Life, chronic
9	15-Jul-08	Alkalinity Total, mg/L	17.5	20		Aquatic Life, chronic
9	17-Sep-08	Lead, Dissolved ug/L	0.968	0.71	31.8	Aquatic Life, chronic

Historic alkalinity values
1985– present
mean = 14.5 +/- 5.5 mg/L
n=20

Instrumentation Site 9 (Tributary Creek)

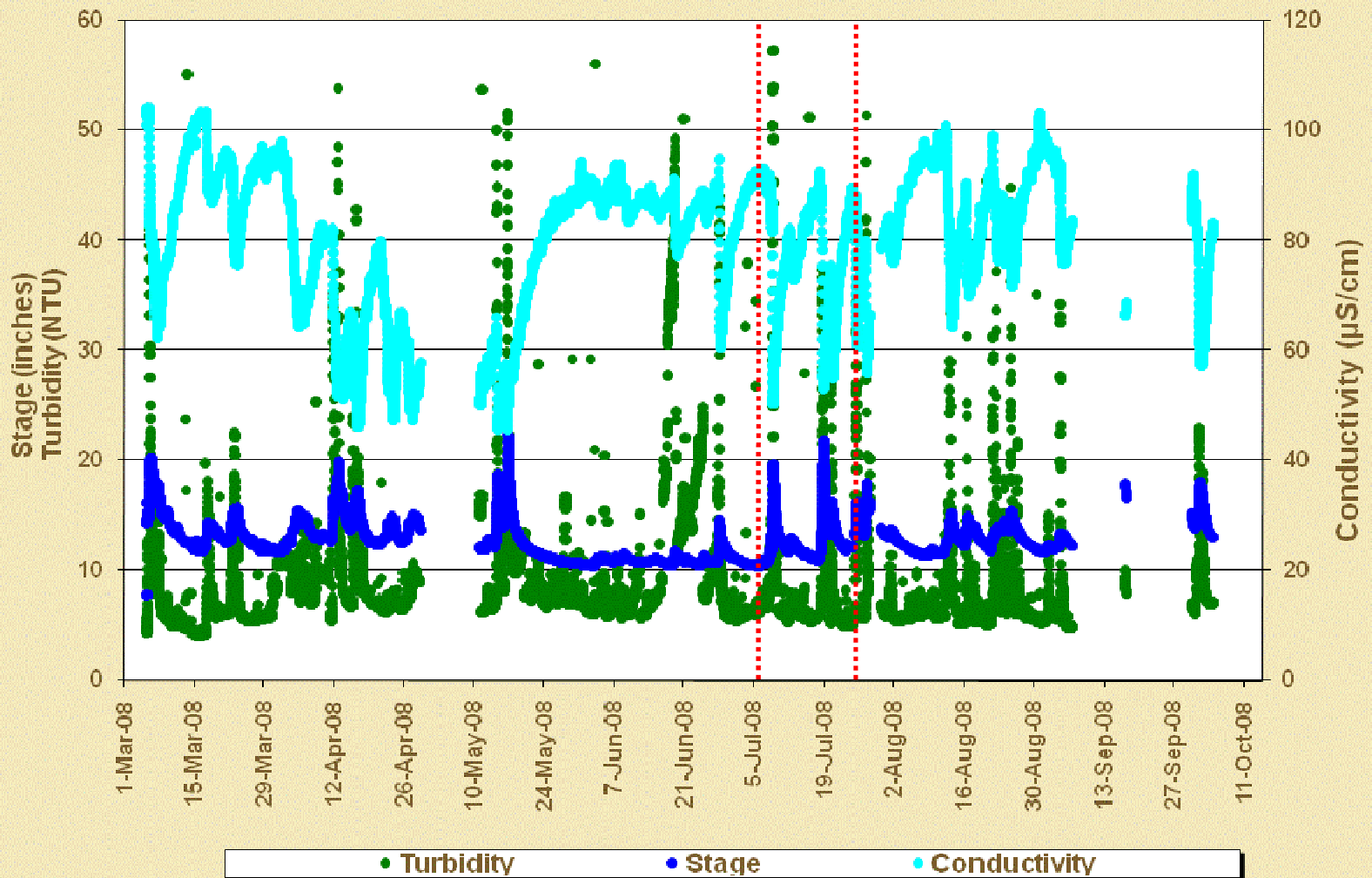


Sensors installed at Site 9

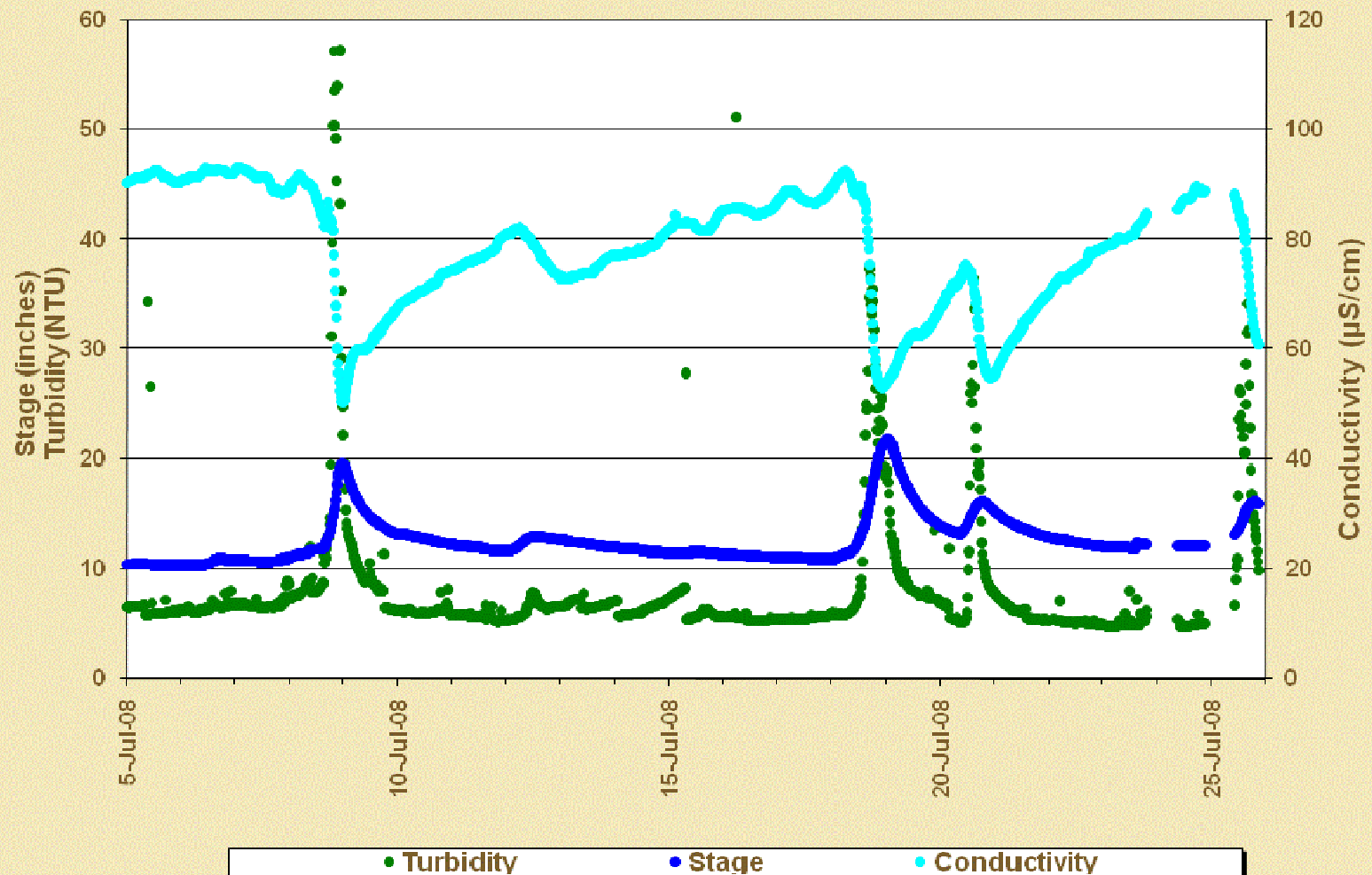
- Turbidimeter
- Conductivity Sensor
- Pressure Transducer



Preliminary data from datalogger system install at Tributary Creek.



Preliminary data from datalogger system install at Tributary Creek.



Best Management Practices



- Diversion of non-contact water
- Velocity breaks with sumps
- Additional culverts to reduce volume
- Hydro-seeding of ditches (velocity break / filter)

STOP

Greens Creek & 1350 FWMP Sites

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MINING COMPANY



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

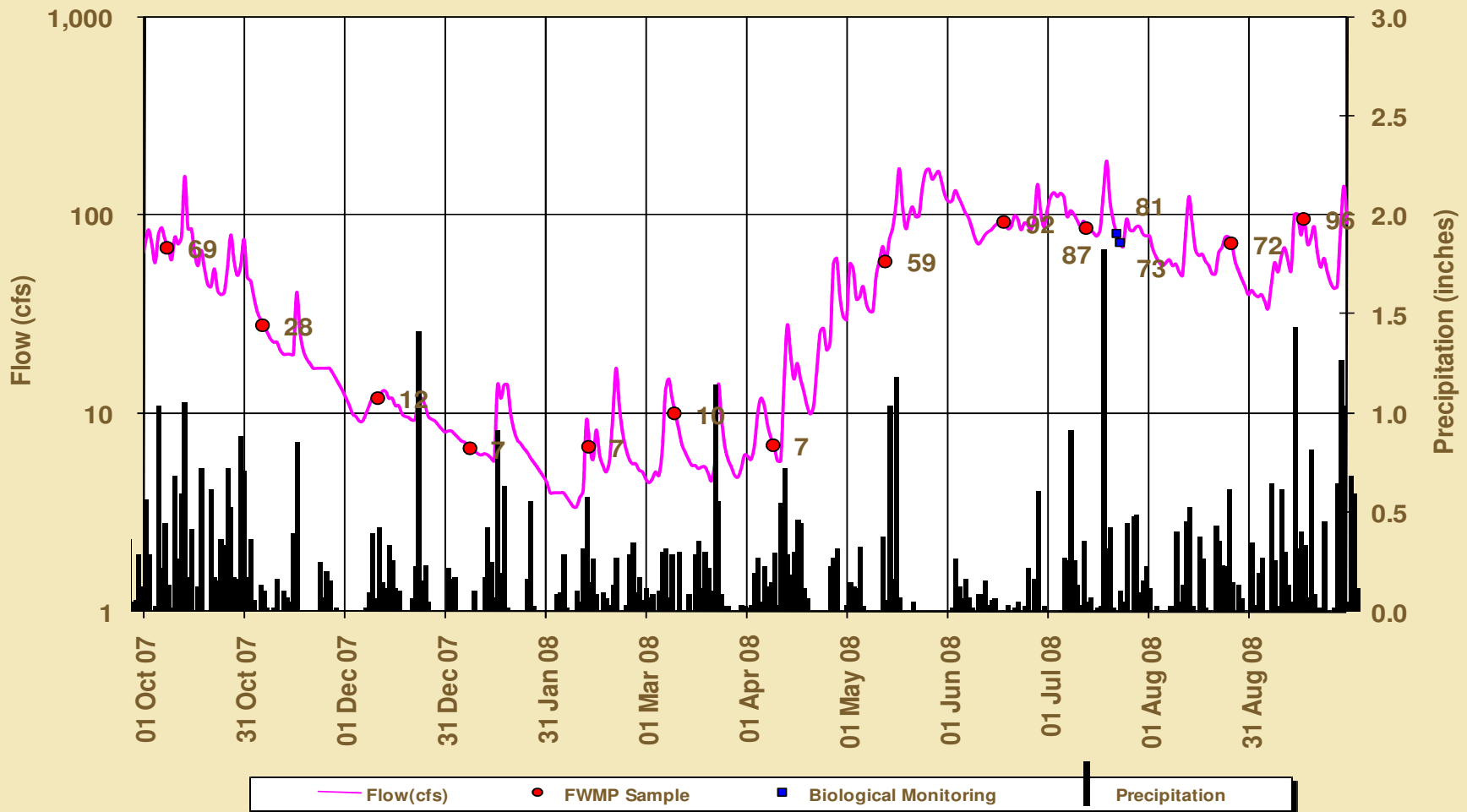


- Comparison against AWQS
- Upgradient / Downgradient comparative graphs for SC, SO₄, Pb, & Zn
- Review of statistical tests for trends and comparison of median values for selected analytes.

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"

WY2008 Greens Creek Flow



AWQS Exceedances Greens Creek & 1350

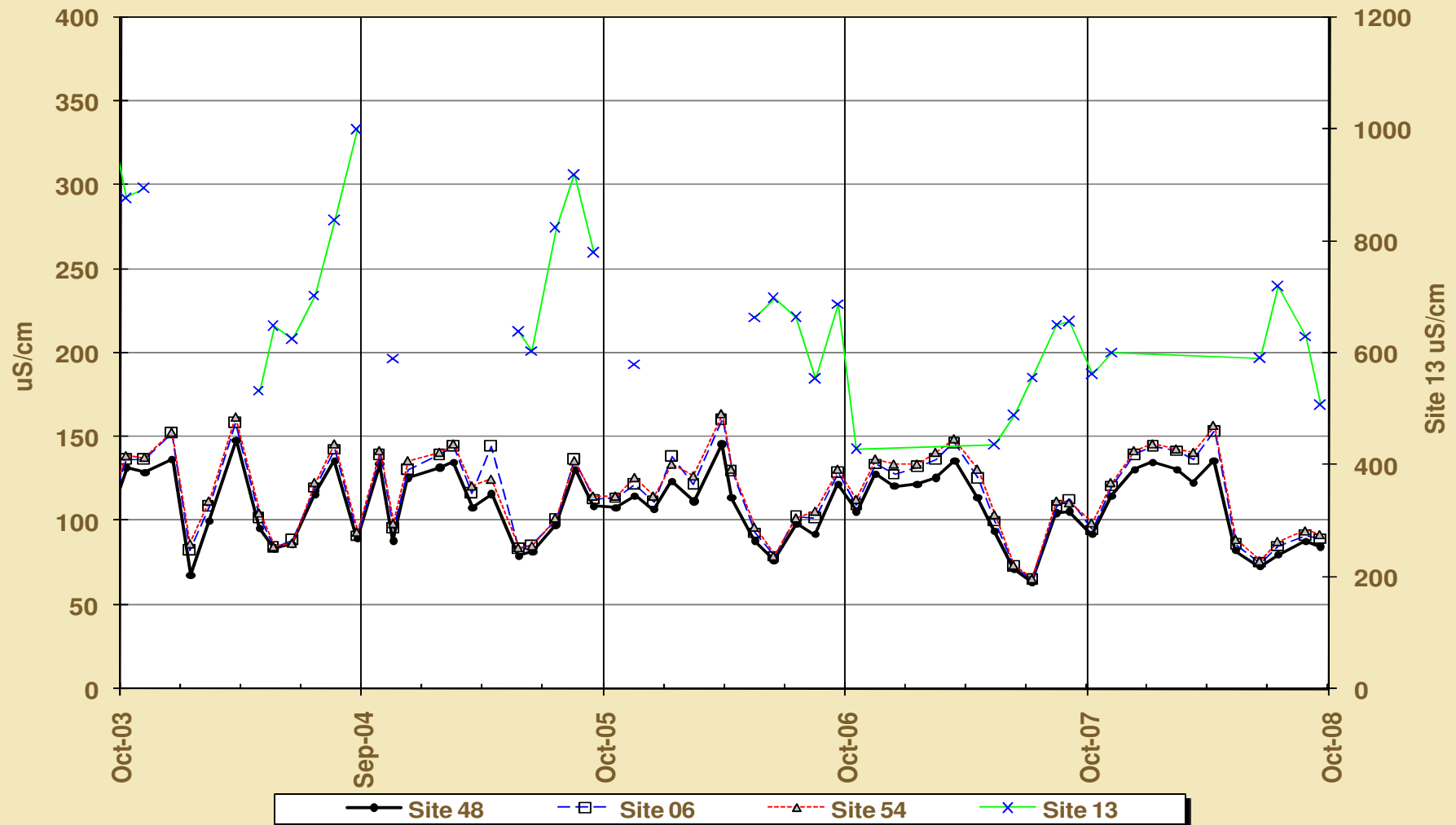


- No measured parameters exceeded AWQS for sites 48, 6, and 54.
- One exceedance was noted for sulfate at site 13.

Site	Date	Parameter	Value	Standard	Hardness (mg/L)	Standard Type
13	15-Jul-08	Sulfate-Total, mg/L	258	250		Aquatic Life, chronic

Specific Conductance Greens Creek & 1350

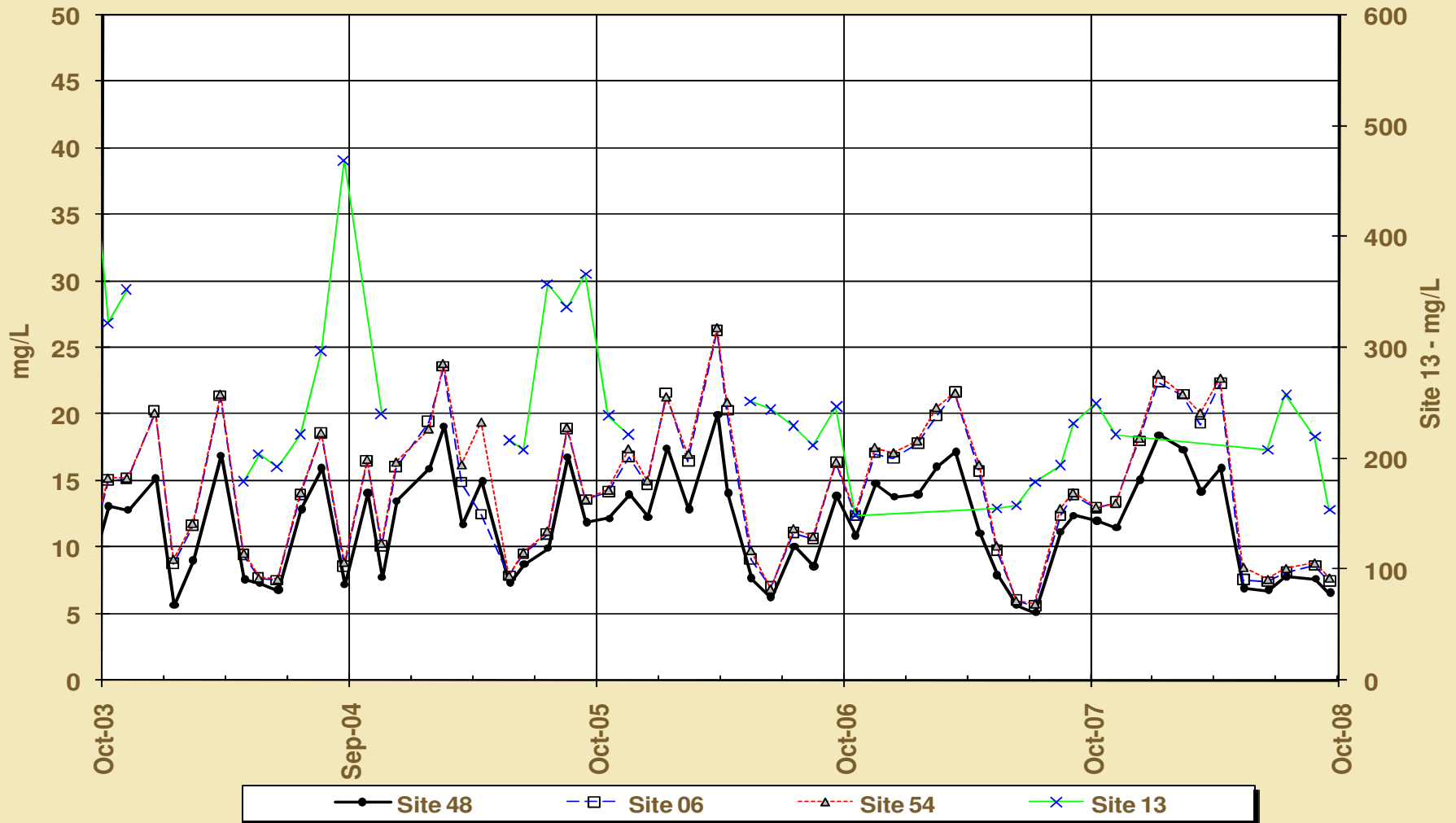
Greens Creek - Specific Conductance



Total Sulfate Greens Creek & 1350

Greens Creek - Total Sulfate

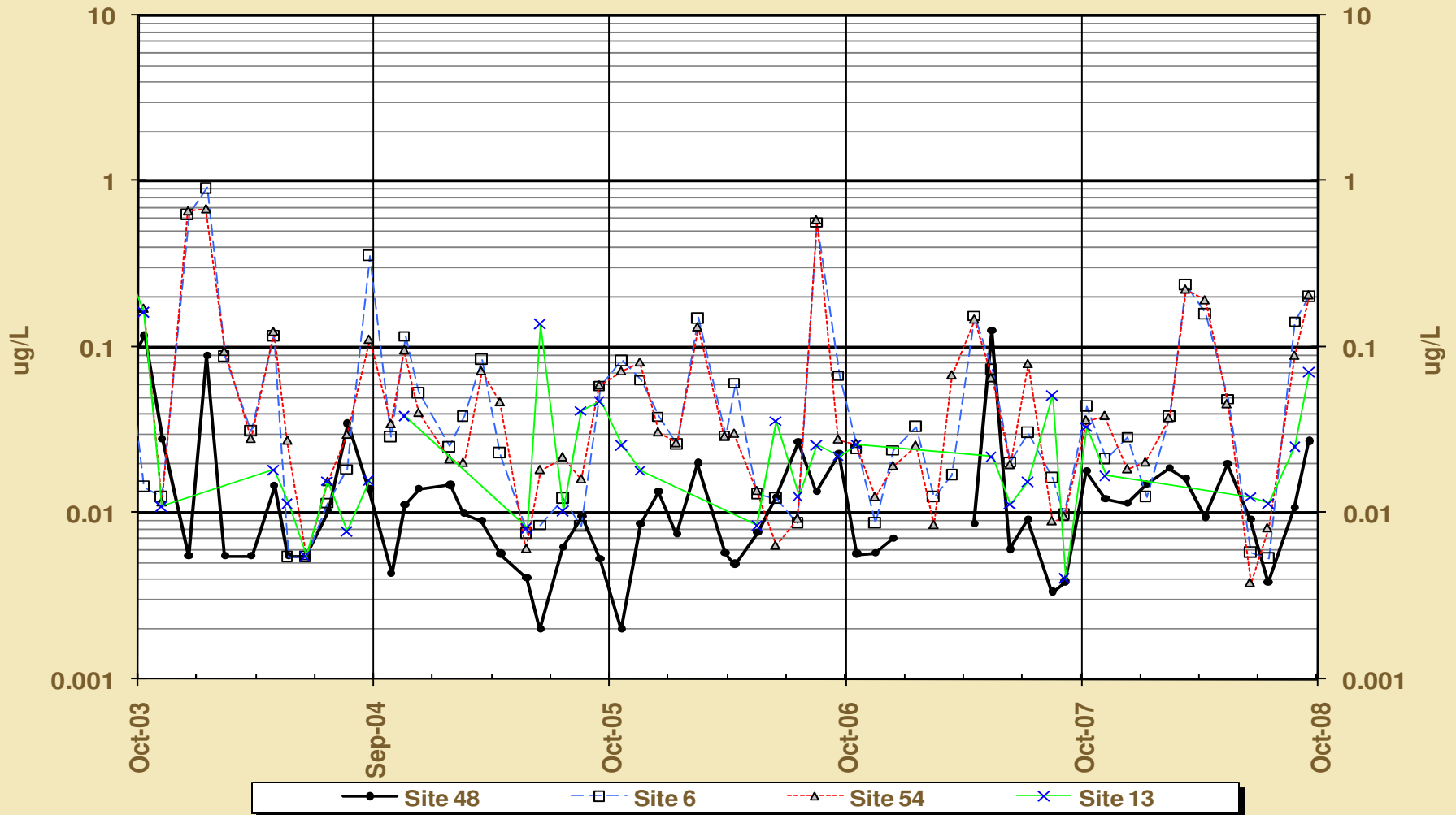
(Note: Value reports as <MDL plotted at MDL/2)



Dissolved Lead Greens Creek & 1350

Greens Creek - Dissolved Lead

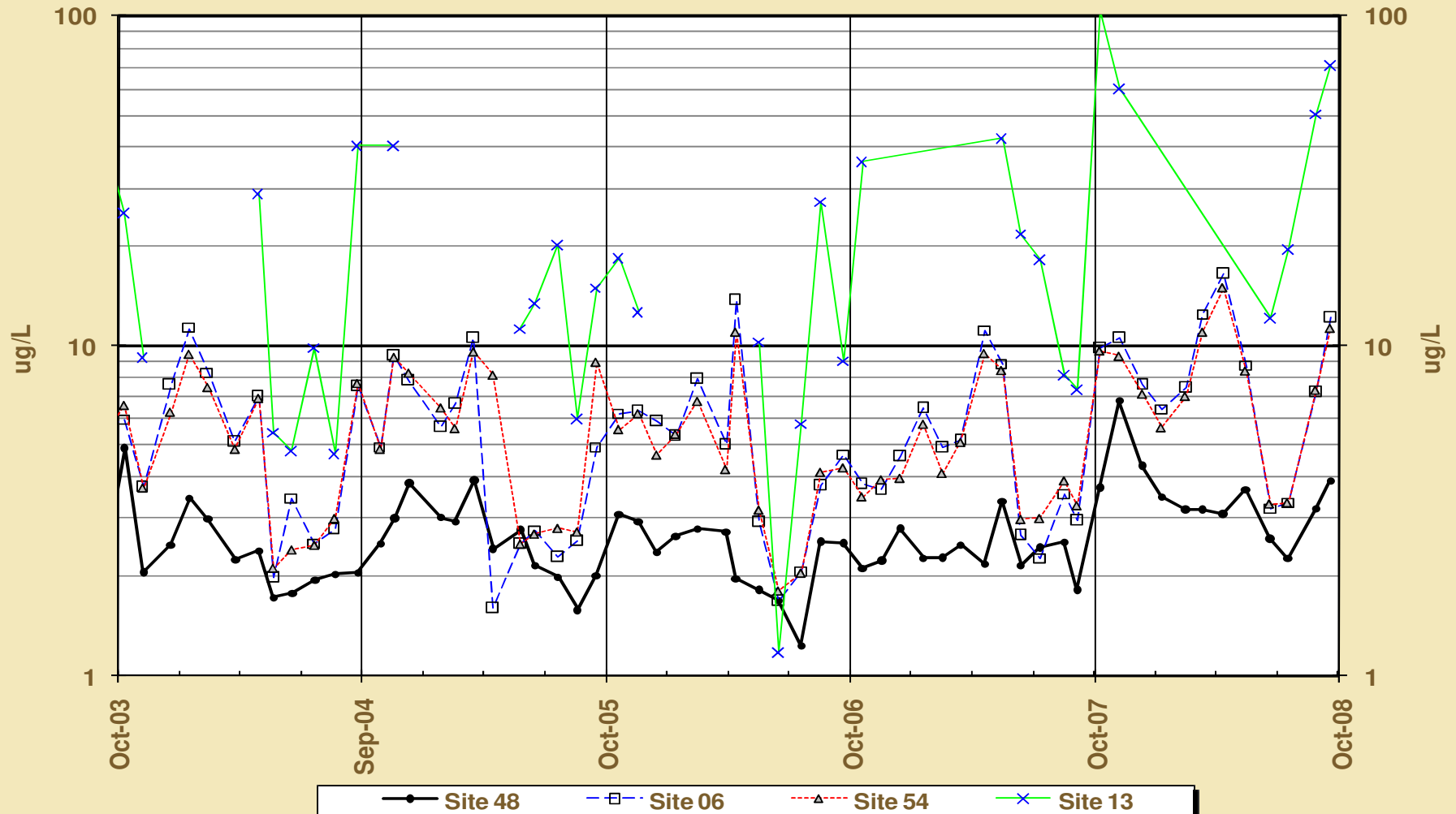
(Note: Values reported as <MDL plotted at MDL/2)



Dissolved Zinc Greens Creek & 1350

Greens Creek - Dissolved Zinc

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



Greens Creek & 1350 Statistical Trends

2008 Water Year

Mann-Kendall Seasonal Trend Test Probabilities

Site	Cond.	pH	Alkalinity	Sulfate	Diss.-Zinc
48	<0.01	<0.01	0.01	0.24	0.50
6	0.02	0.00	0.01	0.37	0.85
54	0.03	<0.01	0.04	0.50	0.99
13	<0.01	0.50	<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	-2.50	-0.07	-1.02		
6	-2.95	-0.10	-1.08		
54	-2.00	-0.10			+0.21
13	-72.38		-11.80	-29.00	+2.13

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

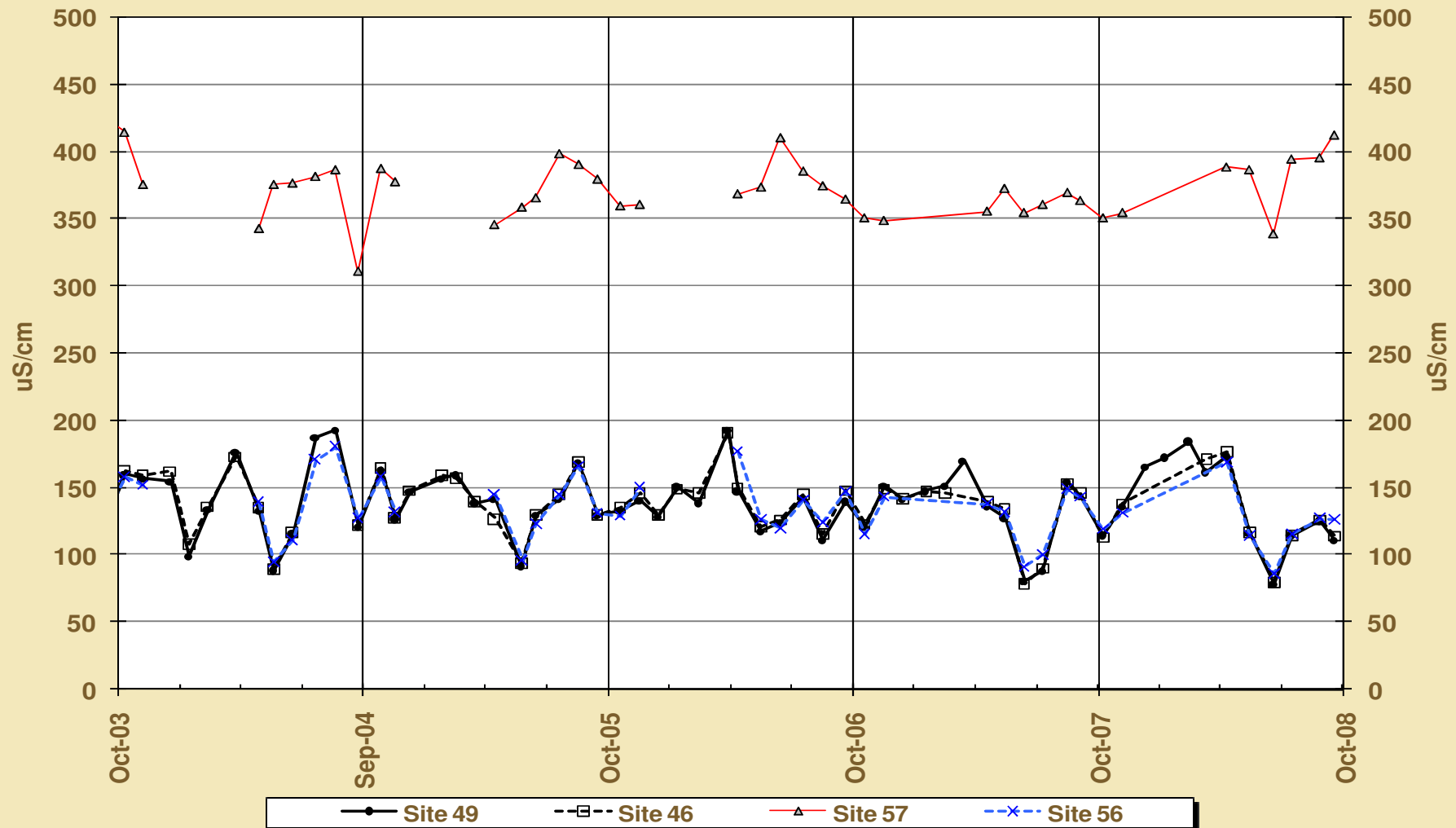
Bruin Creek & Site 23/D Wells



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

Specific Conductance Bruin Creek & Site 23/D Wells

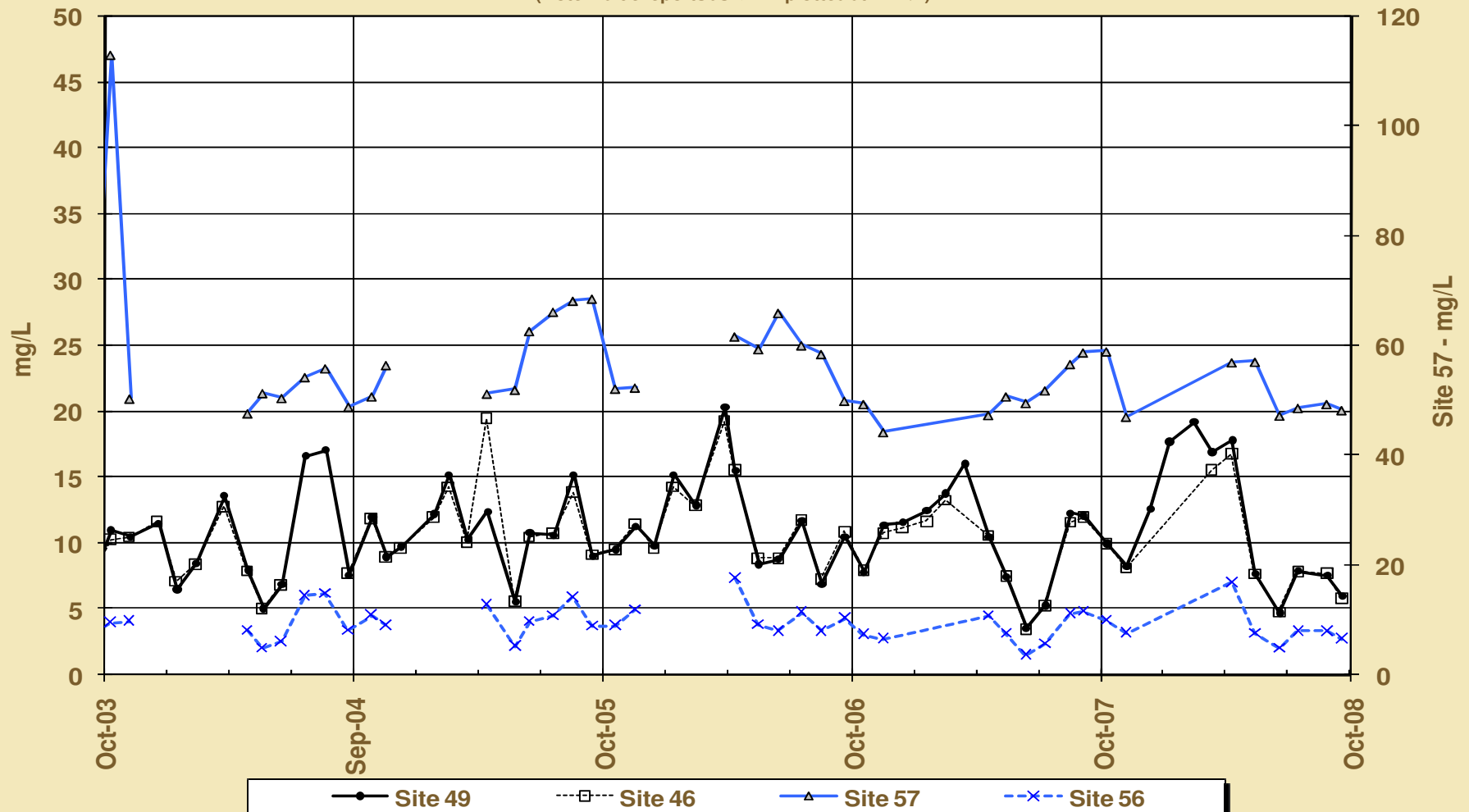
Site 23 Area - Specific Conductance



Total Sulfate Greens Creek & 1350

Site 23 Area - Total Sulfate

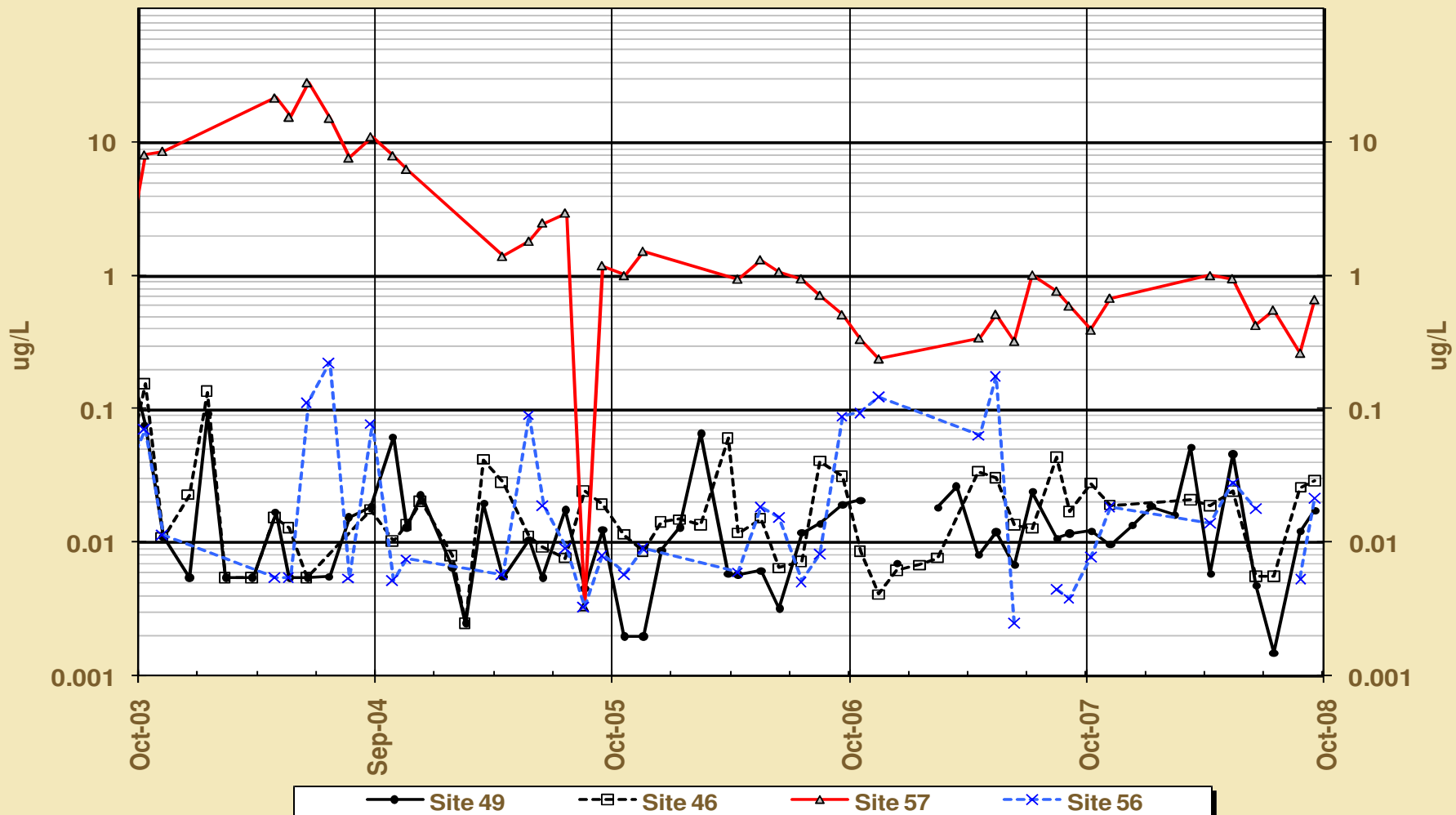
(Note: Value reports as <MDL plotted at MDL/2)



Dissolved Lead Greens Creek & 1350

Site 23 Area - Dissolved Lead

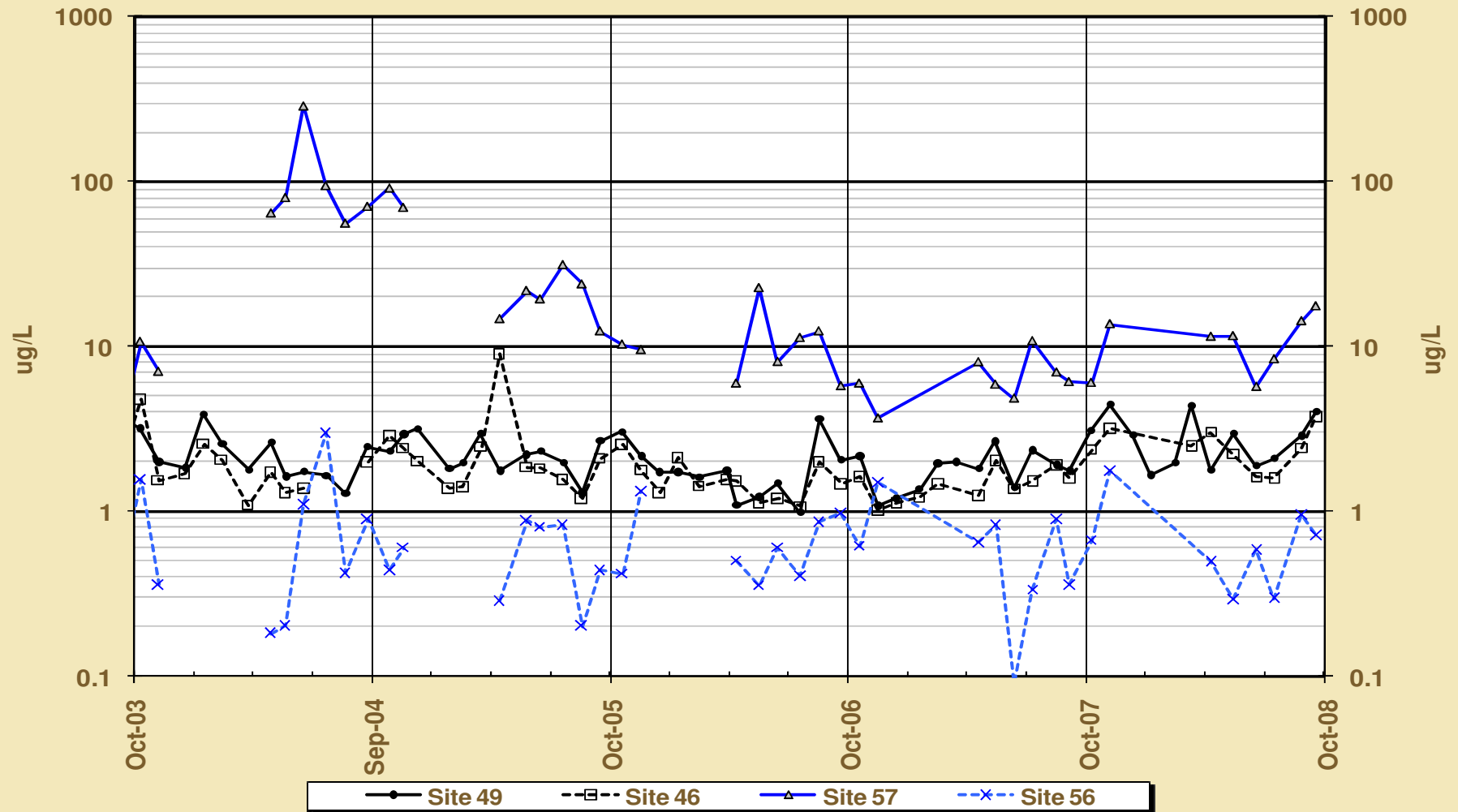
(Note: Values reported as <MDL plotted at MDL/2)



Dissolved Zinc Greens Creek & 1350

Site 23 Area - Dissolved Zinc

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



Bruin Creek & Site 23/D Wells Statistical Trends

2008 Water Year

Mann-Kendall Seasonal Trend Test Probabilities

Site	Cond.	pH	Alkalinity	Sulfate	Diss.-Zinc
49	0.29	<0.01	0.03	0.86	0.14
46	0.19	<0.01	0.17	0.55	0.15
57	<0.01	0.04	<0.01	0.09	0.47
56	0.01	0.02	0.01	0.29	0.77

Sen's slope estimate

Site	µS/cm/yr	su/yr	mg/L/yr	µg/L/yr	µg/L/yr
49		-0.07			
46		-0.08			
57	-5.83		-4.00		
56	-3.25	-0.04	-2.70		

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)



2008 Water Year

Comparison of Medians, Signed-Rank Test Probabilities

Sites	Cond.	pH	Alkalinity	SO ₄	Diss-Zinc
6 - 48	<0.01	1.00	0.02	<0.01	<0.01
54 - 6	<0.01	0.95	<0.01	<0.01	1.00

Calculated Medians

Site	Cond. (uS/cm)	pH (su)	Alkalinity (mg/l)	SO ₄ (mg/l)	Diss-Zinc (ug/l)
48	103.7	7.53	41	11.8	3.35
6	108	7.42	42.1	13.2	8.17
54	111	7.33	47.8	13.2	7.87

Bruin Creek & Site 23/D Wells

Statistical Testing (Comparison of Means)

2008 Water Year					
Comparison of Medians, Signed-Rank Test Probabilities					
Sites	Cond.	pH	Alkalinity	SO ₄	Diss-Zinc
46 - 49	0.05	0.99	0.04	0.89	0.96
56 - 57	1.00	0.95	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	131	7.61	55.6	9.1	2.89
49	117	7.47	52.4	7.9	2.42
56	388	7.45	133	49.1	11.55
57	123	7.30	49.8	7.9	0.63


STOP

Proposed changes to the FWMP schedule.



Site	Site Name	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
6	Middle Greens Creek	P	P	Q	P	Q	P	P	P	P	P	P	P
9	Tributary Creek-Lower		Q						Q		Q		Q
13	Mine Adit Discharge East	Q	Q						Q	Q	Q	Q	Q
27	Monitoring Well 2S		Q						Q		Q		Q
28	Monitoring Well 2D		Q						Q		Q		Q
29	Monitoring Well 3S		Q						Q		Q		Q
32	Monitoring Well 5S		Q						Q		Q		Q
46	Lower Bruin Creek	P	Q	Q	P	Q	P	P	P	P	P	P	P
48	Upper Greens Creek	P	P	Q	P	Q	P	P	P	P	P	P	P
49	Control Site Upper Bruin Creek	P	Q	Q	P	Q	P	P	P	P	P	P	P
54	Greens Creek below D-Pond	P	P	Q	P	Q	P	P	P	P	P	P	P
56	Monitoring Well -D-00-01	Q	Q					Q	Q	Q	Q	Q	Q
57	Monitoring Well -23-00-03	Q	Q					Q	Q	Q	Q	Q	Q
58	Monitoring Well -T-00-01C		Q						Q		Q		Q
59	Monitoring Well -T-00-01A		Q						Q		Q		Q
60	Althea Creek - Lower		Q						Q		Q		Q

 Proposed new samples.

 Proposed elimination of current samples.