Reclamation of Refuse Piles using Fluidized Bed Combustion Ash in the Blacklick Creek Watershed, Pennsylvania

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Questions of the Study

- How has the water quality of the drainage from the refuse piles changed in response to the removal of the refuse and the placement of fluidized bed combustion (FBC) ash?
  - Also how has the water quality of the groundwater changed?
- How have the loadings of acid mine drainage pollutants from the refuse pile drainage changed?
- How has the water quality of the receiving streams changed as the refuse piles were reclaimed?

Study Sites

- Five sites are included in the study (listed in the order that they were permitted)
  - Revloc #1 (Surface Mining Permit No. 11880201)
  - Colver (Surface Mining Permit Nos. 11900201 & 11970201)
  - Revloc #2 (Surface Mining Permit No. 11960202)
  - Nanty Glo West (Surface Mining Permit No. 11020202)
  - Nanty Glo East (Surface Mining Permit No. 11070202)

Revloc #1, Revloc #2, Nanty Glo West, and Nanty Glo East sites are operated by Ebensburg Power Company.

Colver site is operated by Maple Coal Company.

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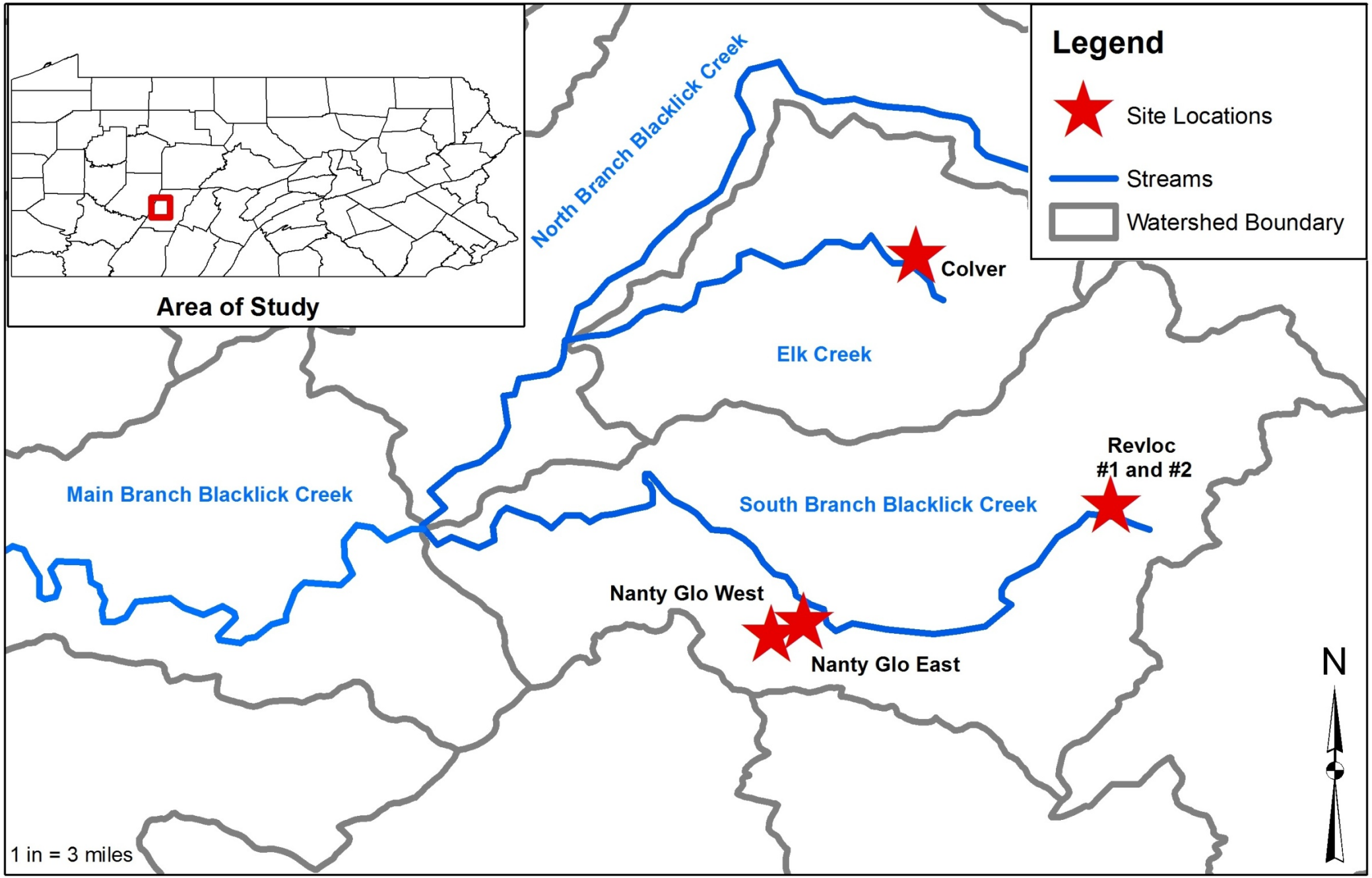


All five sites are located in Cambria County

Site Description and Permitted Activities

- All five sites are abandoned pre-SMCRA coal refuse piles that have been permitted for refuse reprocessing.
- The sources of the refuse were underground mines that were predominantly mining the Lower Kittanning coal seam.
  - Refuse is removed from the site, screened, and hauled to a nearby FBC power plant:
    - Ebensburg Power Company in Ebensburg, PA
    - Colver Power Plant in Colver, PA operated by Inter-Power/Ahl-Con Partners, L.P

Basics of Fluidized Bed Combustion

- Coal Refuse and limestone are added to the furnace forming the bed material.
  - ~20% limestone by weight
- During combustion jets of air cause the solids to be fluidized (suspended in the furnace).
- Both Ebensburg and Colver power plants utilize circulating fluidized bed (CFB) technology.
  - With a CFB, as the flue gas and suspended solids rise inside the furnace, the solids are separated and a portion is returned to the bed (i.e., recirculated).

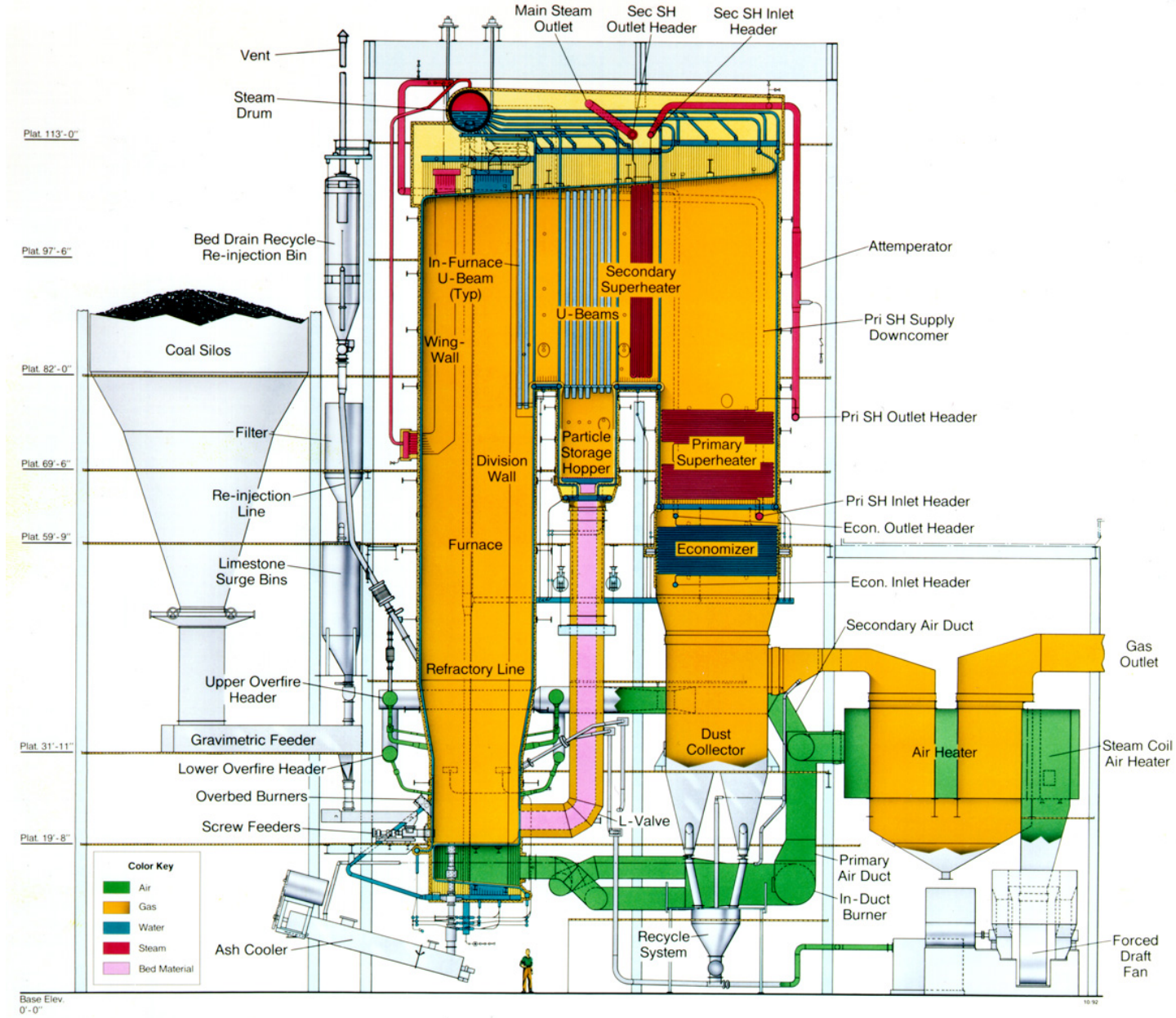


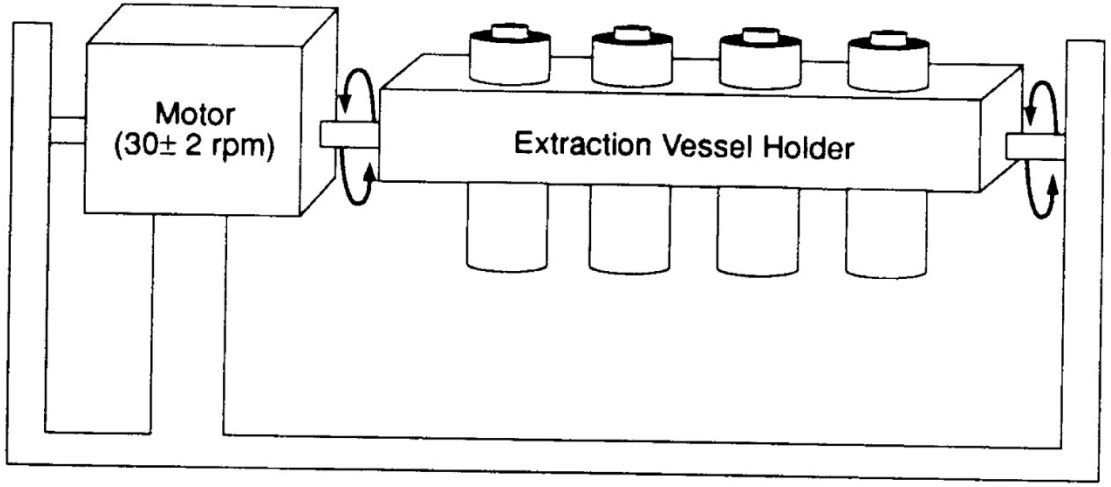
Diagram provided by Ebensburg Power Company

- FBC ash is placed on the site with the reject refuse material.
- FBC Ash has pozzolonic (cementicious) characteristics, which cause it to harden and encapsulate the refuse material

Reject refuse material being spread on top of a layer of ash
Photo from Nanty Glo West on May 7, 2010

Properties of FBC Ash

- Certification must be obtained from PADEP before FBC ash from a power plant can be placed on a site.
- The certification process involves running the Synthetic Precipitation Leachate Procedure (SPLP) on samples of fresh ash.
  - The procedure is used to determine what constituents in the ash may be mobilized once the ash comes into contact with precipitation water.



Apparatus in which the ash sample and fluid are combined in a vessel and then agitated.
Diagram from SW-846 Test Method 1312: Synthetic Precipitation Leaching Procedure Document from the Environmental Protection Agency

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Properties of FBC Ash

- Average percentage of $CaCO_3$ measured from the ash
  - Ebensburg Power Plant = 19.8%
  - Colver Power Plant = 24.7%

Average SPLP Ash Leachate Water Quality		
	Ebensburg Power Plant (45 samples total)	Colver Power Plant (52 samples total)
pH (SU)	12.09	12.41
Calcium (mg/L)	708	1,744
Chloride (mg/L)	11.4	18.8
Magnesium (mg/L)	0.60*	0.70**
Potassium (mg/L)	41.2	6.08
Sodium (mg/L)	16.9	6.73
Sulfate (mg/L)	936	1,585

* Only detected in 1 out 33 samples

** Only detected in 8 out of 35 samples

Properties of FBC Ash

- Trace element concentrations of leachate from Ebensburg Power Plant
- Barium and chromium were detected in more than 50% of the total number of samples.

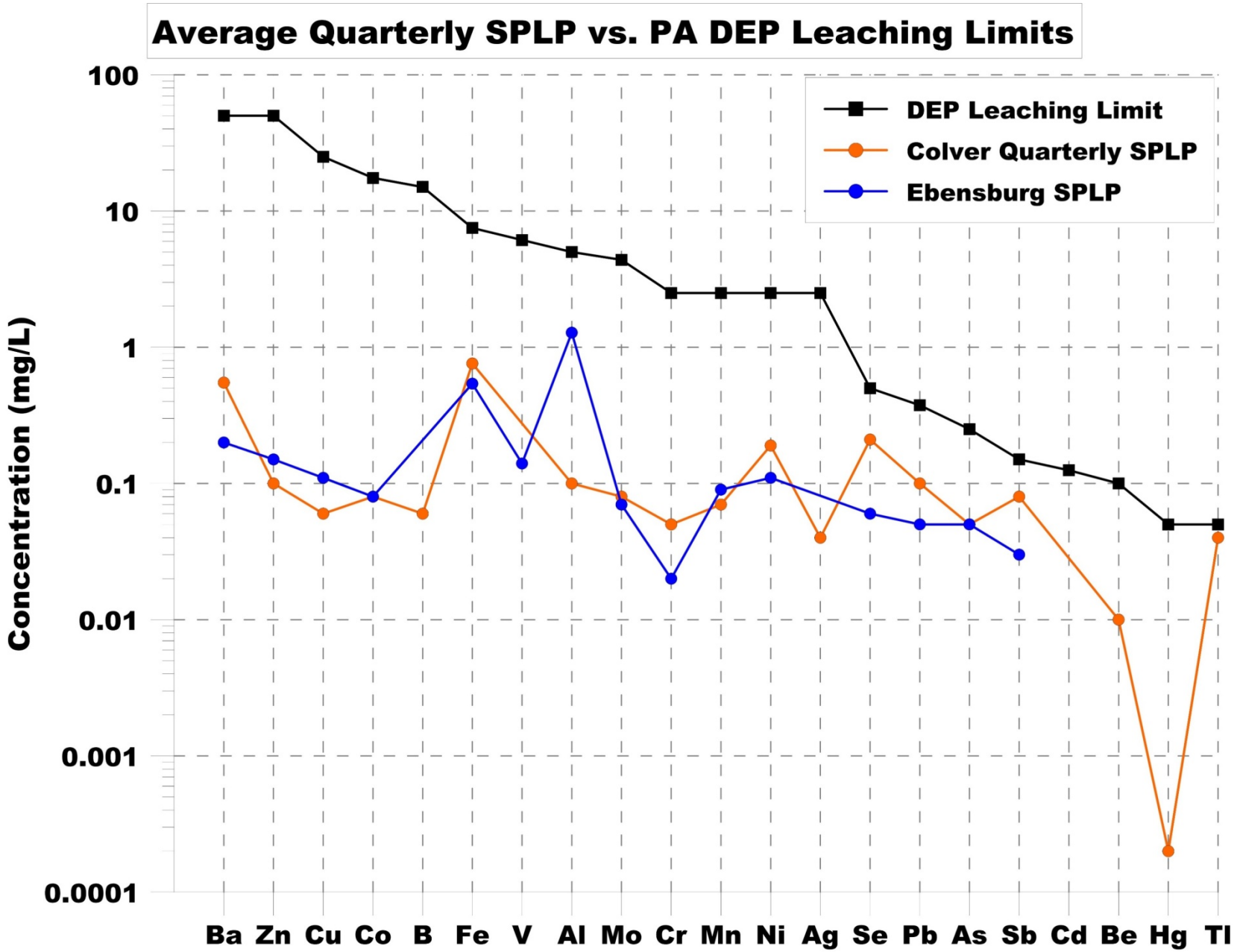
	Number of Detections	Average Concentration (mg/L)
Iron	5 out of 45 (11%)	0.54
Aluminum	9 out of 45 (20%)	1.28
Manganese	3 out of 45 (7%)	0.09
Antimony	2 out of 45 (4%)	0.03
Arsenic	1 out of 45 (2%)	0.03
Barium	39 out 45 (87%)	0.20
Beryllium	No Detections out of 33 samples	
Boron	No Detections out of 45 samples	
Cadmium	No Detections out of 45 samples	
Chromium	34 out of 45 samples (76%)	0.02
Cobalt	No Detections out of 43 samples	
Copper	3 out of 45 samples (7%)	0.11
Lead	7 out of 45 samples (16%)	0.05
Mercury	No Detections out of 45 samples	
Molybdenum	2 out of 45 samples (4%)	0.07
Nickel	1 out of 45 samples (2%)	0.11
Selenium	4 out of 45 (9%)	0.06
Silver	No Detections out of 41 samples	
Thallium	No Detections out of 33 samples	
Vanadium	2 out of 39 samples (5%)	0.14
Zinc	3 out of 45 samples (7%)	0.15

Properties of FBC Ash

- Trace element concentrations of leachate from Colver Power Plant
- Barium, chromium, and molybdenum were present in more than 50% of the total number of samples.
- Arsenic, lead, and selenium were detected in more than 30% of the total number of samples.

	Number of Detections	Average Concentration (mg/L)
Iron	4 out of 52 (8%)	0.76
Aluminum	1 out 52 (2%)	0.10
Manganese	10 out of 52 (19%)	0.07
Antimony	1 out of 52 (2%)	0.078
Arsenic	16 out of 52 (31%)	0.05
Barium	44 out of 52 (85%)	0.55
Beryllium	2 out of 44 (5%)	0.01
Boron	5 out of 52 (10%)	0.06
Cadmium	No Detections out of 52 samples	
Chromium	42 out of 52 (81%)	0.05
Cobalt	1 out of 44 (2%)	0.08
Copper	7 out of 52 (13%)	0.06
Lead	17 out of 52 (33%)	0.10
Mercury	2 out of 52 (4%)	0.0002
Molybdenum	30 out of 52 (58%)	0.08
Nickel	6 out of 52 (12%)	0.19
Selenium	22 out of 52 (42%)	0.22
Silver	4 out of 42 (10%)	0.04
Thallium	4 out of 41 (10%)	0.04
Vanadium	No Detections out of 44 samples	
Zinc	11 out of 52 (21%)	0.10

- The measured concentrations of the constituents were consistently less than the Department's leaching limits.
- The graph to the right shows the how the average measured concentrations of different constituents in the leachate compared to the leaching limit.
    - Note: The average on the graph does not include the samples that were below the detection limit.



Amount of Refuse Removed and Ash Placed

	Total Tons of Refuse Reprocessed (metric tons)	Total Tons of Ash Placed (metric tons)
Revloc #1	2,401,233	2,305,433
Revloc #2*	154,758	857,500
Nanty Glo West	1,306,945	1,294,584
Nanty Glo East	1,104,932	428,027
Colver	3,772,507	7,216,569
Total	**8,740,375**	**12,102,113**

*There were years where the tonnage data was not available for the Revloc #2 site therefore the actual total amounts may be higher

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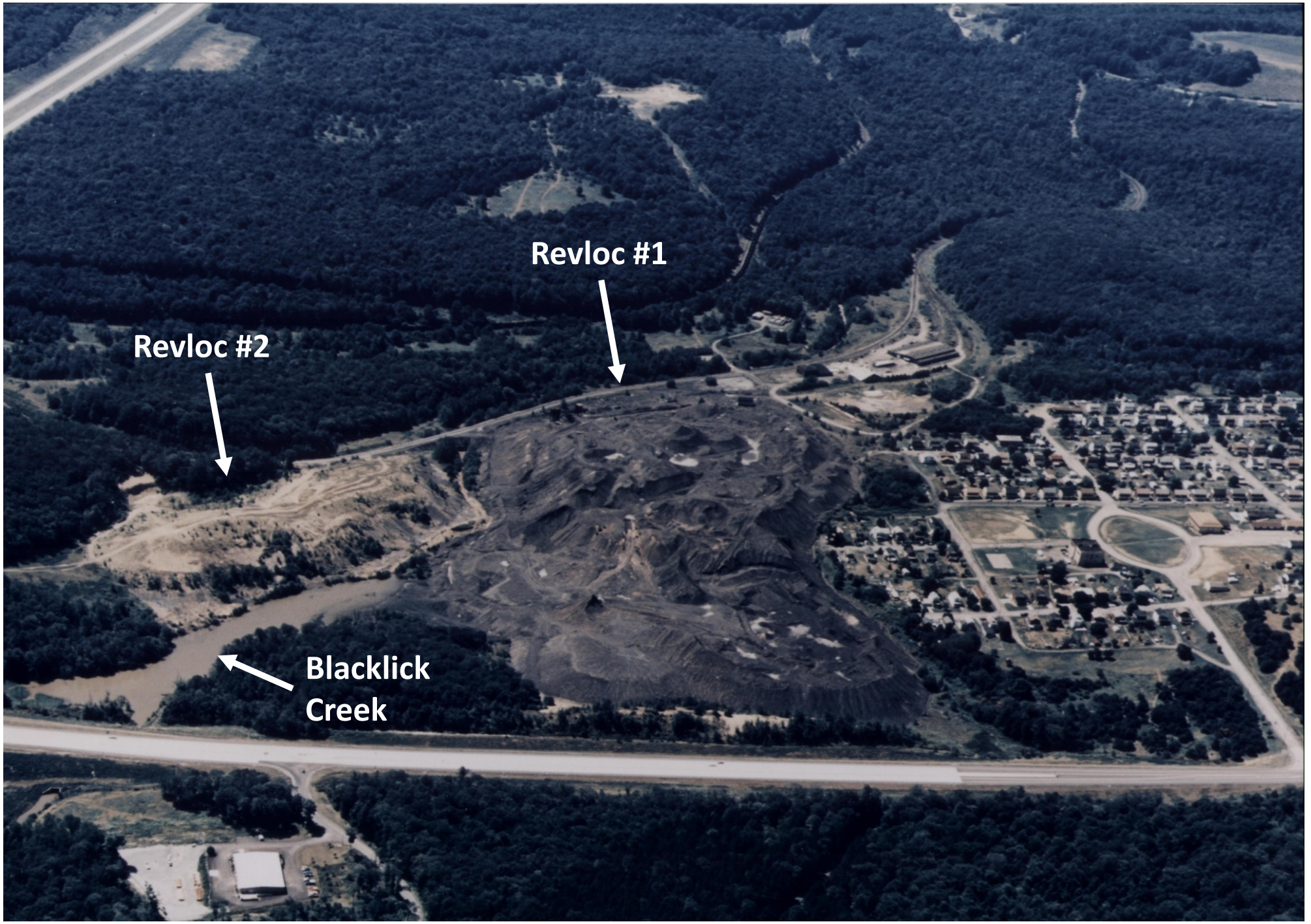
Water Monitoring at the Sites

- Among the five study sites there are a total of 23 total discharges that were degraded by the refuse piles.
- These discharges were covered under PADEP's Subchapter F remining regulations.
  - The loadings of acidity, iron, aluminum, and manganese had to be monitored and reported on a monthly basis.
  - The permittee does not incur treatment liability for the discharge unless it is determined that the water quality was been degraded compared to its pre-mining baseline pollutional loading.
- Some of discharges were selected to be ash monitoring points.
  - In additional to the monthly subchapter F loadings a discharge sample was required to be collected and analyzed quarterly for the same constituents that are measured in the leachate testing.
- Monitoring wells were installed to evaluate the groundwater.
- *Note: All concentrations reported in this presentation are total, not dissolved.*

Revloc Refuse Piles 1989

Prior to reclamation

Refuse piles cover ~ 58 acres



Revloc
Refuse Piles
2004

During reclamation

Revloc #1
Refuse Pile
2014

After reclamation

Revloc #2
Refuse Pile
2014

After reclamation

Revloc #1

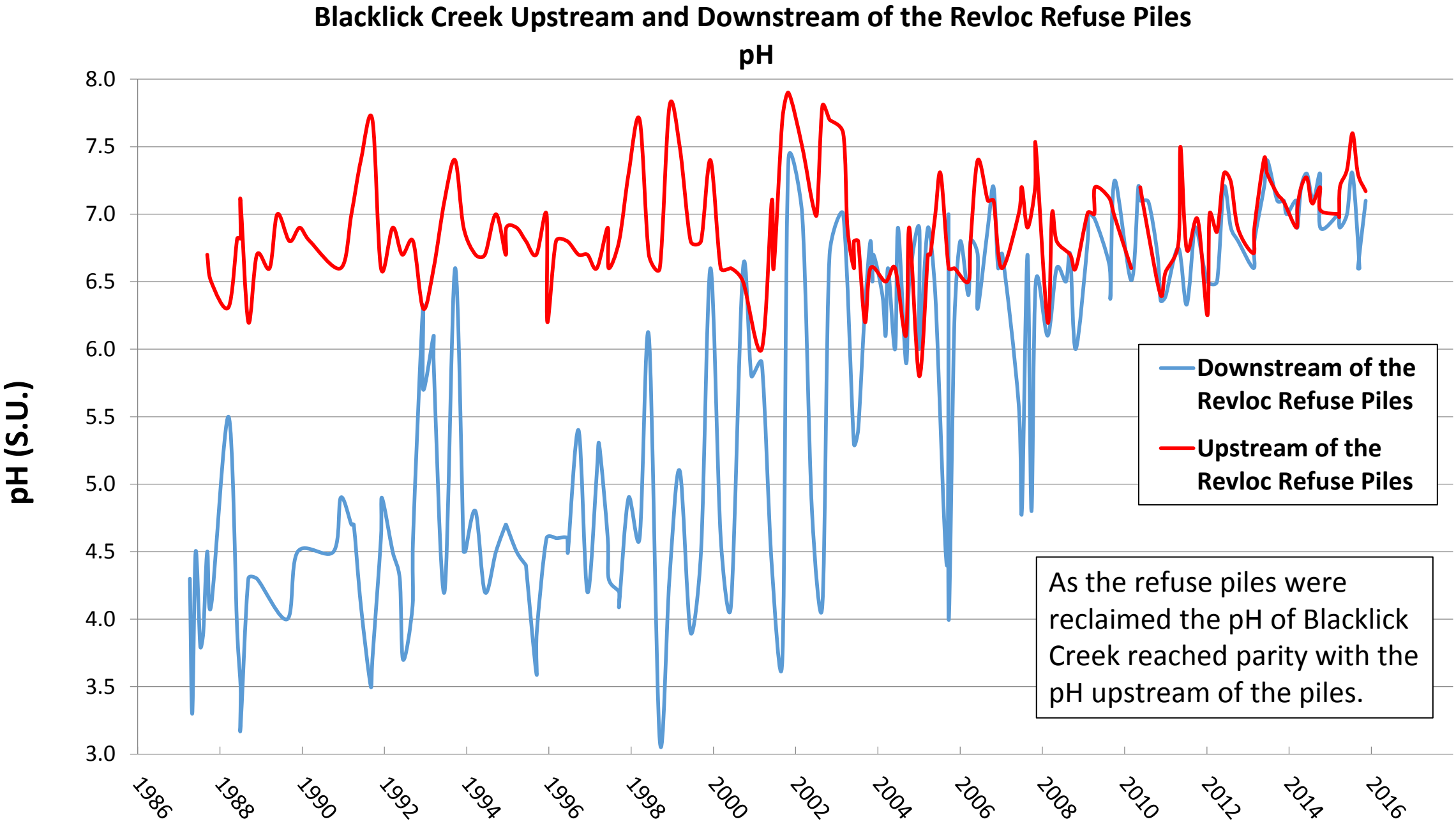
- Six discharges total
  - 2 became net alkaline
  - 4 remained acidic but with diminished pollutant loadings

	Average Baseline Loading April 1987-April 1990	Average Post-reclamation Loading January 2012-September 2016	Percent Reduction
Acidity (kg/day)	637	29.1	95
Iron (kg/day)	1.22	0.08	93
Aluminum (kg/day)	80.4	4.53	94
Manganese (kg/day)	2.55	0.68	73
Sulfate (kg/day)	692	231	67

Revloc #2

- Two discharges total
  - Both became net alkaline
  - Another small, acidic seep was later observed and added as a monitoring point.

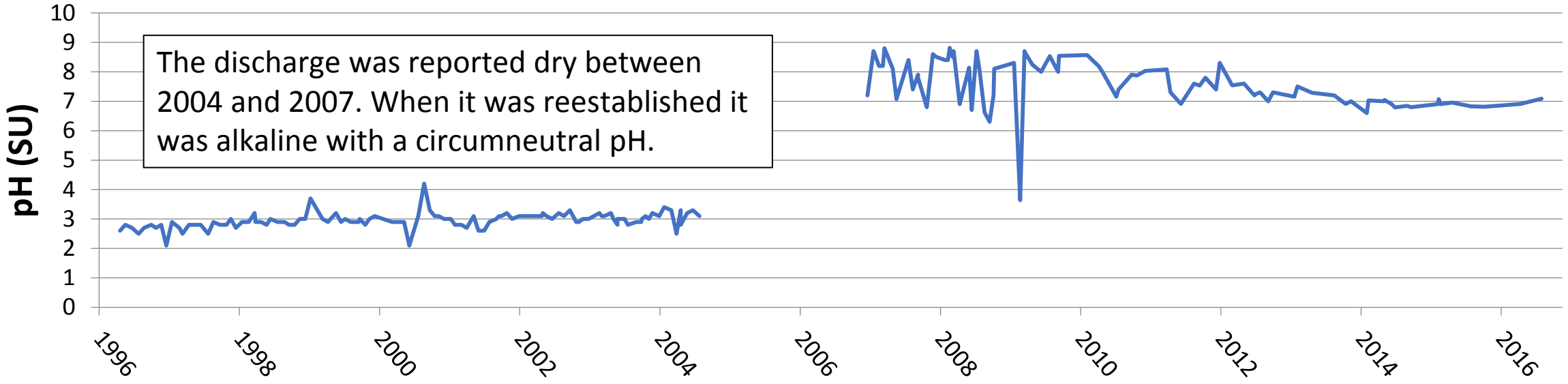
	Average Baseline Loading May 1996-July 1997	Average Post-reclamation Loading October 2012-September 2016	Percent Reduction
Acidity (kg/day)	168	9.14	95
Iron (kg/day)	3.30	0.01	99.6
Aluminum (kg/day)	28.5	0.02	99.9
Manganese (kg/day)	5.97	0.03	99.4
Sulfate (kg/day)	368	63.9	83

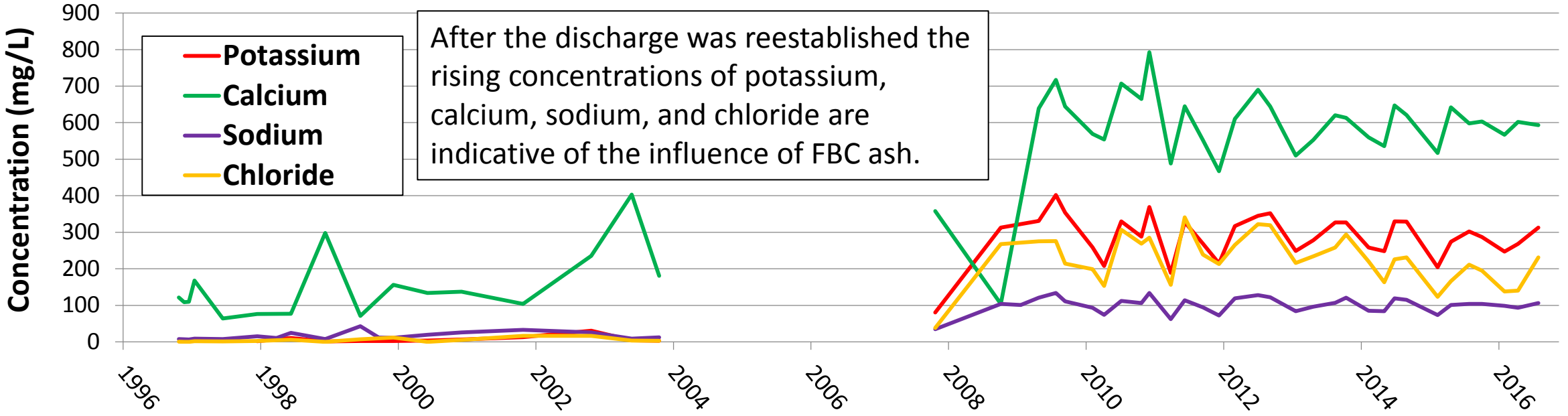

Blacklick Creek Upstream and Downstream of the Revloc Refuse Piles
pH
pH (S.U.)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Downstream of the Revloc Refuse Piles
Upstream of the Revloc Refuse Piles
As the refuse piles were reclaimed the pH of Blacklick Creek reached parity with the pH upstream of the piles.

Ash Monitoring at the Revloc Refuse Piles

- There are five monitoring wells that are used to monitor the effects of the FBC ash placement.
- No influence from the FBC ash has been observed in any the wells.
- There has been no degradation of the baseline groundwater quality observed since reclamation began.
- Monitoring point R2A, which collects drainage from the Revloc #2 refuse pile, was also an ash monitoring point.

Monitoring Point R2A - Discharge from the Revloc #2 Refuse Pile

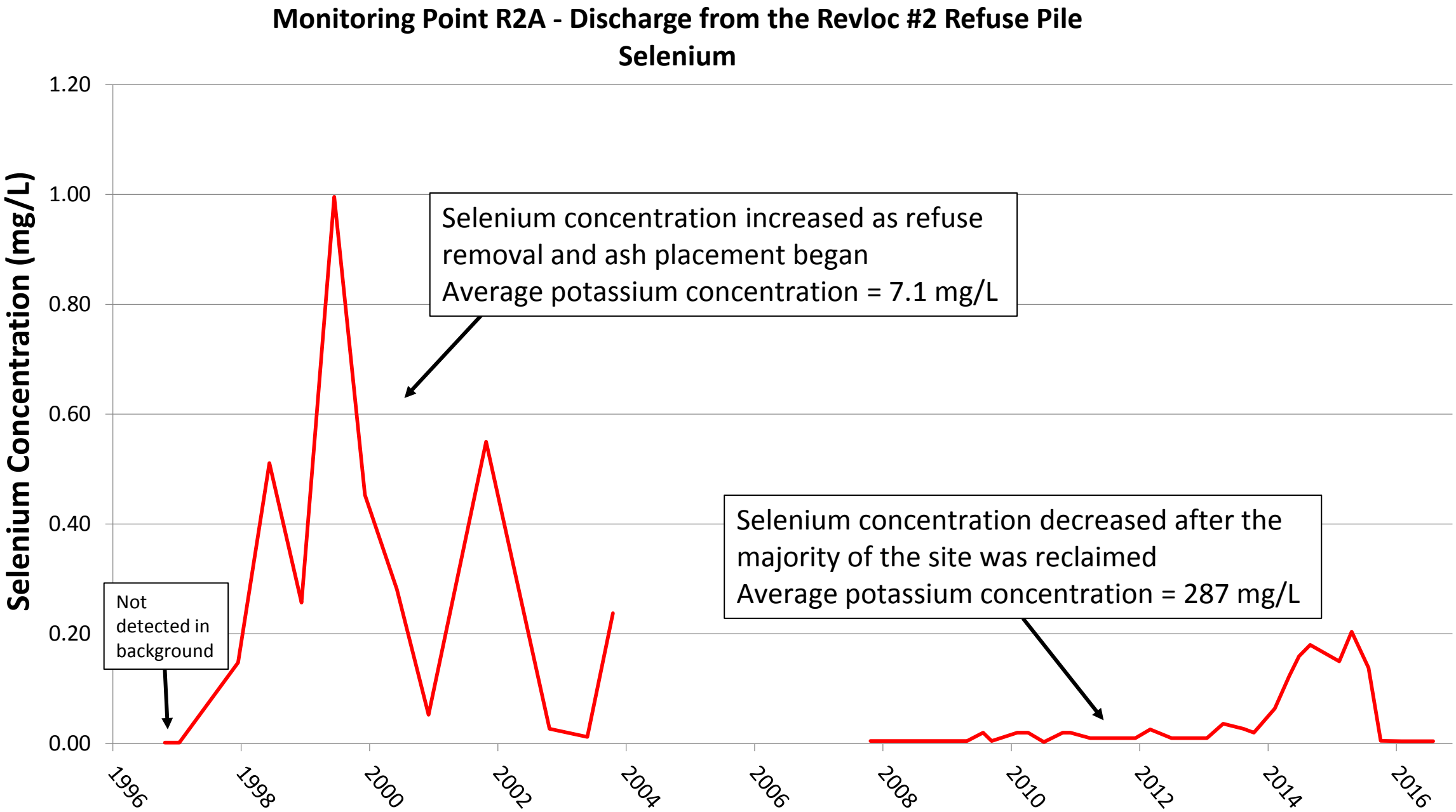




Monitoring Point R2A –Discharge from the Revloc #2 Refuse Pile

- Five background samples were collected from the R2A discharge prior to any disturbance of the refuse pile or placement of FBC ash.
  - During the time the background samples were collected not all constituents were required by the Department (ex. Antimony, Beryllium, Boron, etc.).
- The background samples were compared to the samples collected after reclamation was completed.
  - ↓ indicates decreased concentration compared to background.
  - ↑ indicates increased concentration compared to background.
  - = indicates no significant difference between the background concentration and the latest data.
- The only constituent with a higher concentration in the post-reclamation samples compared to the background samples was selenium.

	Average Baseline Concentration 1996-1997 (mg/L)	Average Post-reclamation Concentration 2012-2016 (mg/L)
Antimony	Not Measured	0.02
Arsenic ↓	0.24	0.02
Barium	No detections (at limit of 0.2 mg/L)	0.05
Beryllium	Not Measured	0.005 (one detection out of 16 samples)
Boron	Not Measured	0.03 (two detections of 16 samples)
Cadmium ↓	0.08 (one detection out of five samples)	0.002 (four detections out of 16 samples)
Chromium ↓	0.16 (one detection out of five samples)	0.002 (two detections out of 16 samples)
Cobalt ↓	Not Measured	0.03 (five detections out of 16 samples)
Copper ↓	0.94	0.02 (9 detections of out 16 samples)
Lead ↓	0.28	0.02 (6 detections out of 16 samples)
Mercury	No Detections	No Detections
Molybdenum	Not Measured	0.02 (eight detections of out 16 samples)
Nickel ↓	5.95	0.01 (three detections of out 16 samples)
Selenium ↑	No Detections	0.10 (11 detections out of 16 samples)
Silver	No Detections (at limit of 0.06 mg/L)	0.02 (five detections of out 16 samples)
Thallium	Not Measured	0.01 (five detections of out 16 samples)
Vanadium	Not Measured	No Detections
Zinc ↓	3.68	0.03 (three detections out of 16 samples)


Monitoring Point R2A - Discharge from the Revloc #2 Refuse Pile
Selenium
Selenium Concentration (mg/L)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Selenium concentration increased as refuse removal and ash placement began
Average potassium concentration = 7.1 mg/L
Not detected in background
Selenium concentration decreased after the majority of the site was reclaimed
Average potassium concentration = 287 mg/L

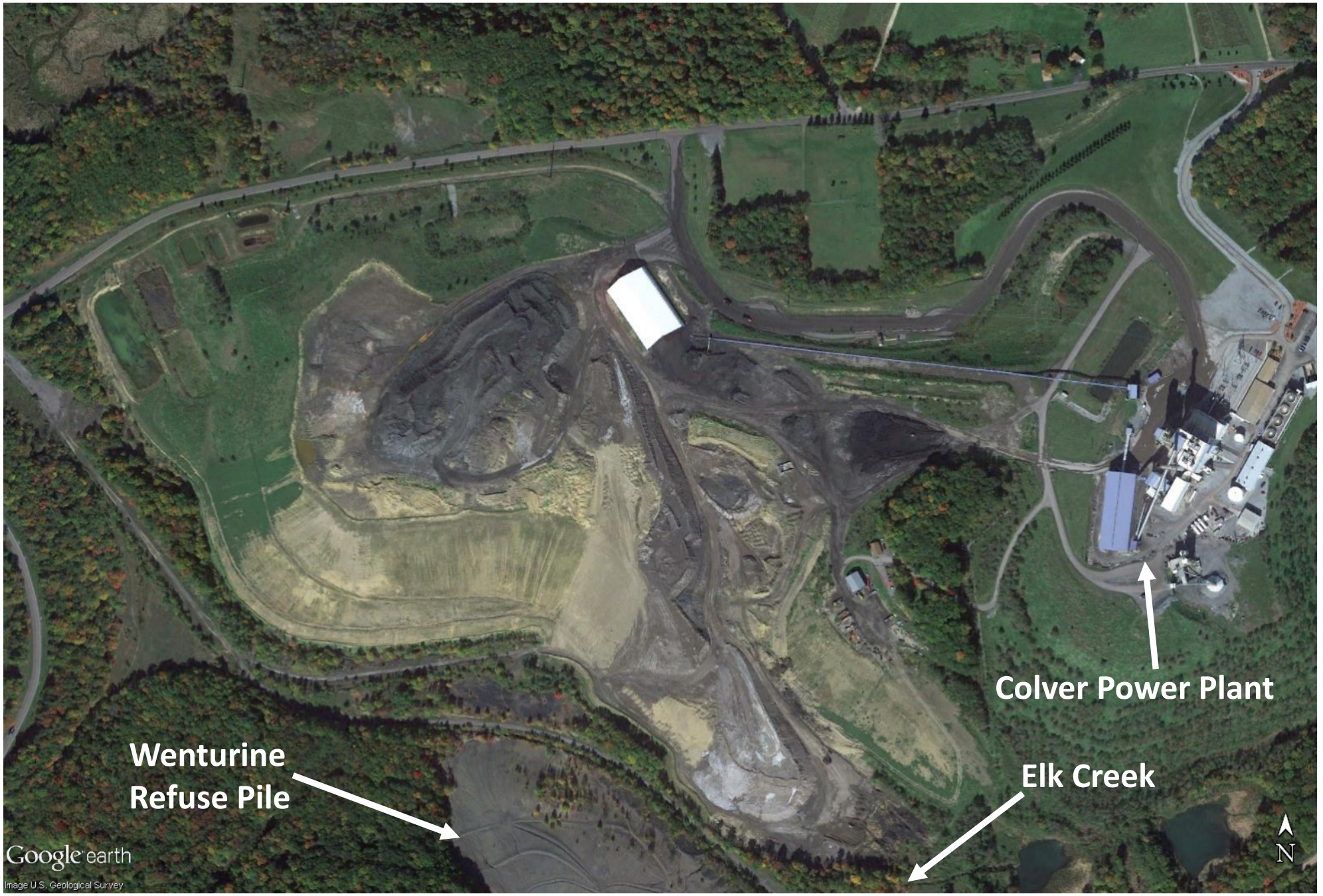
Colver Refuse Pile 1993

Prior to reclamation

Refuse pile covers ~ 92 acres

Colver Refuse Pile 2011

During reclamation



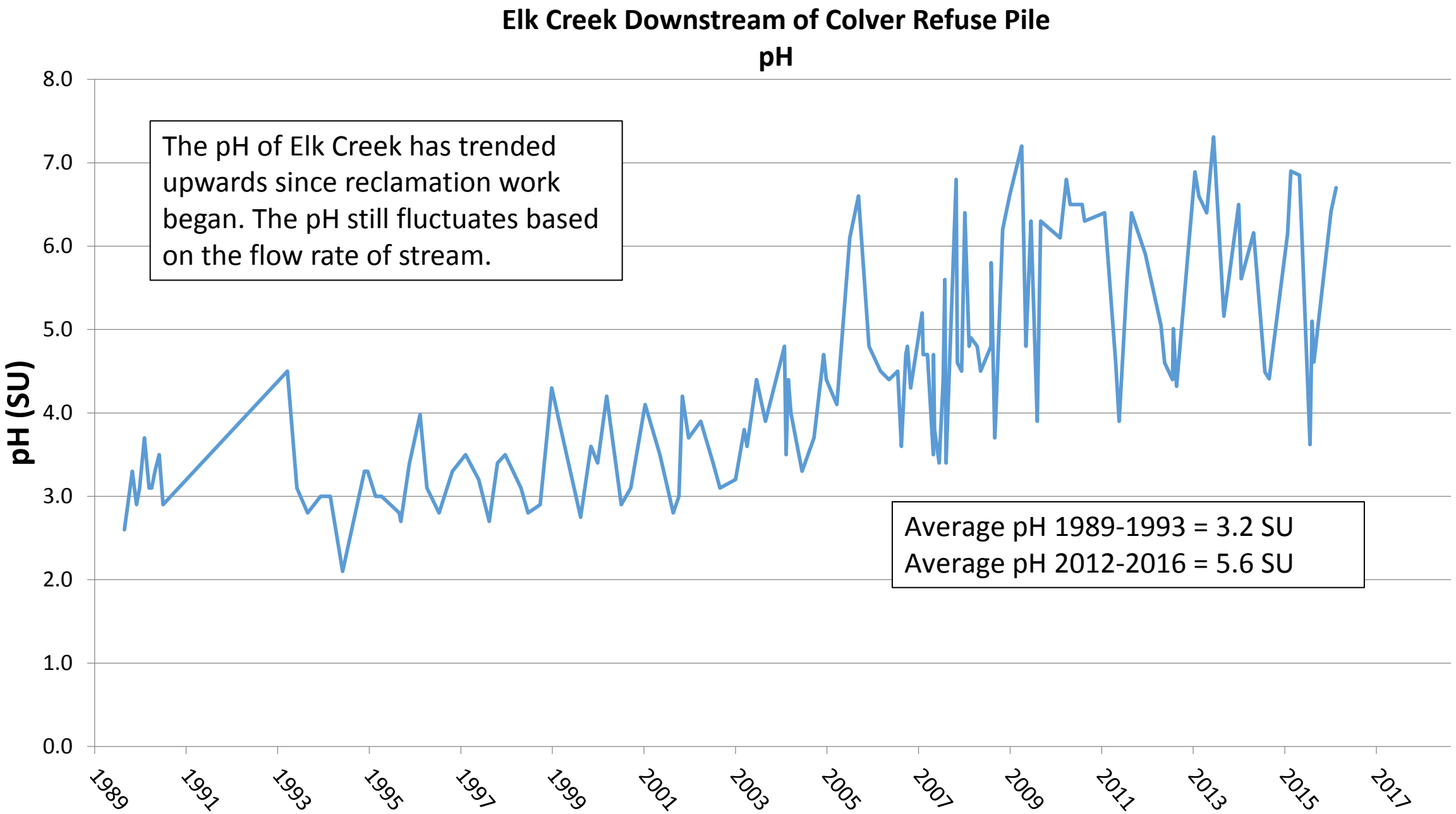
Colver
Refuse Pile
2015

During reclamation

Colver

- Three discharges total
  - Two became net alkaline
  - One is intermittently net alkaline.

	Average Baseline Loading December 1989-May 1991	Average Loading January 2012-June 2016	Percent Reduction
Acidity (kg/day)	1,985	0.83	99.9
Iron (kg/day)	741	0.64	99.9
Aluminum (kg/day)	174	0.09	99.9
Manganese (kg/day)	5.85	0.12	98


Elk Creek Downstream of Colver Refuse Pile
pH
pH (SU)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
The pH of Elk Creek has trended upwards since reclamation work began. The pH still fluctuates based on the flow rate of stream.
Average pH 1989-1993 = 3.2 SU
Average pH 2012-2016 = 5.6 SU

Ash Monitoring at the Colver Refuse Pile

- There are four monitoring wells that are used to monitor the effects of the FBC ash placement.
  - Upgradient wells MW1 and MW4
  - Downgradient wells MW2 and MW3

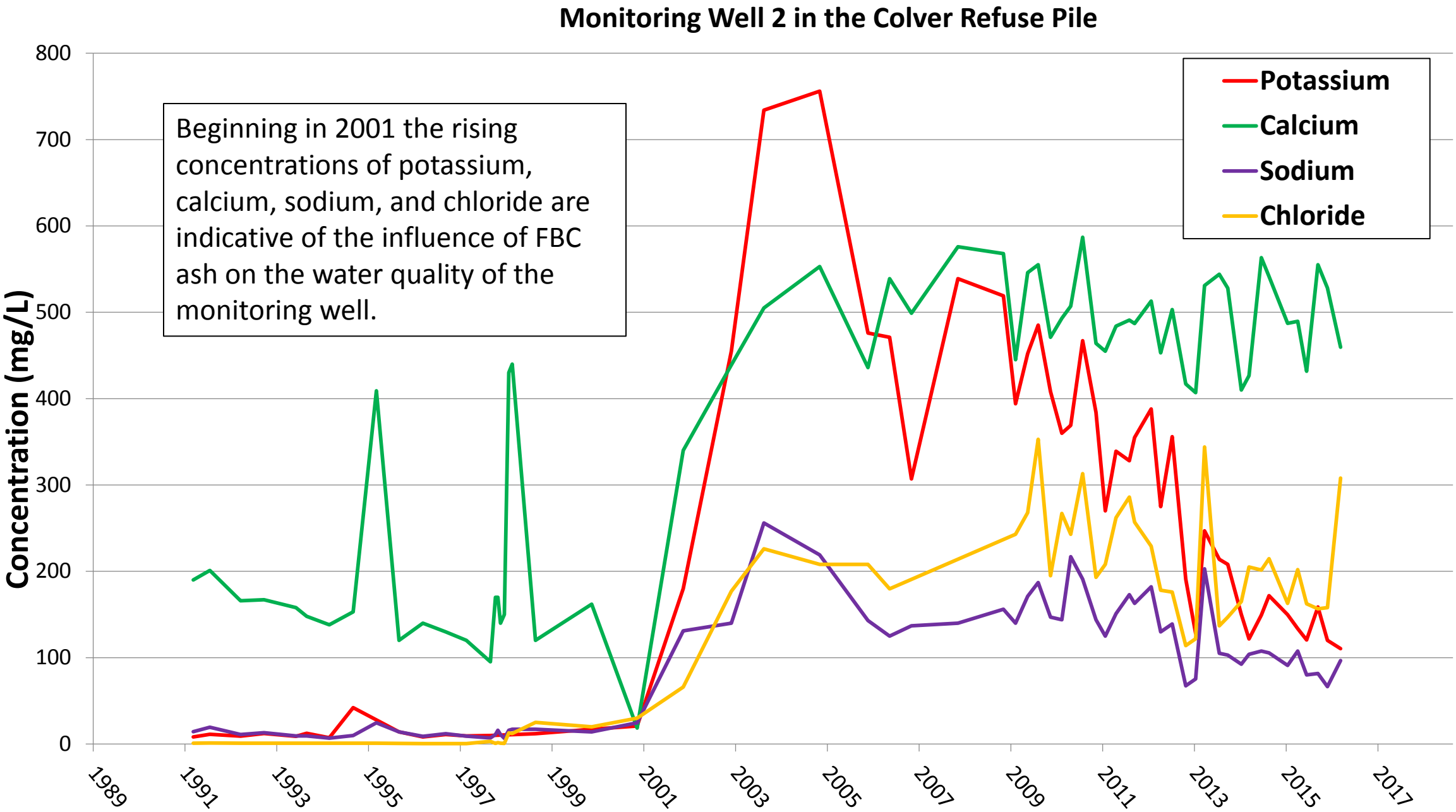
- The water quality of the downgradient monitoring wells MW-2 and MW-3 was influence by the ash placement.

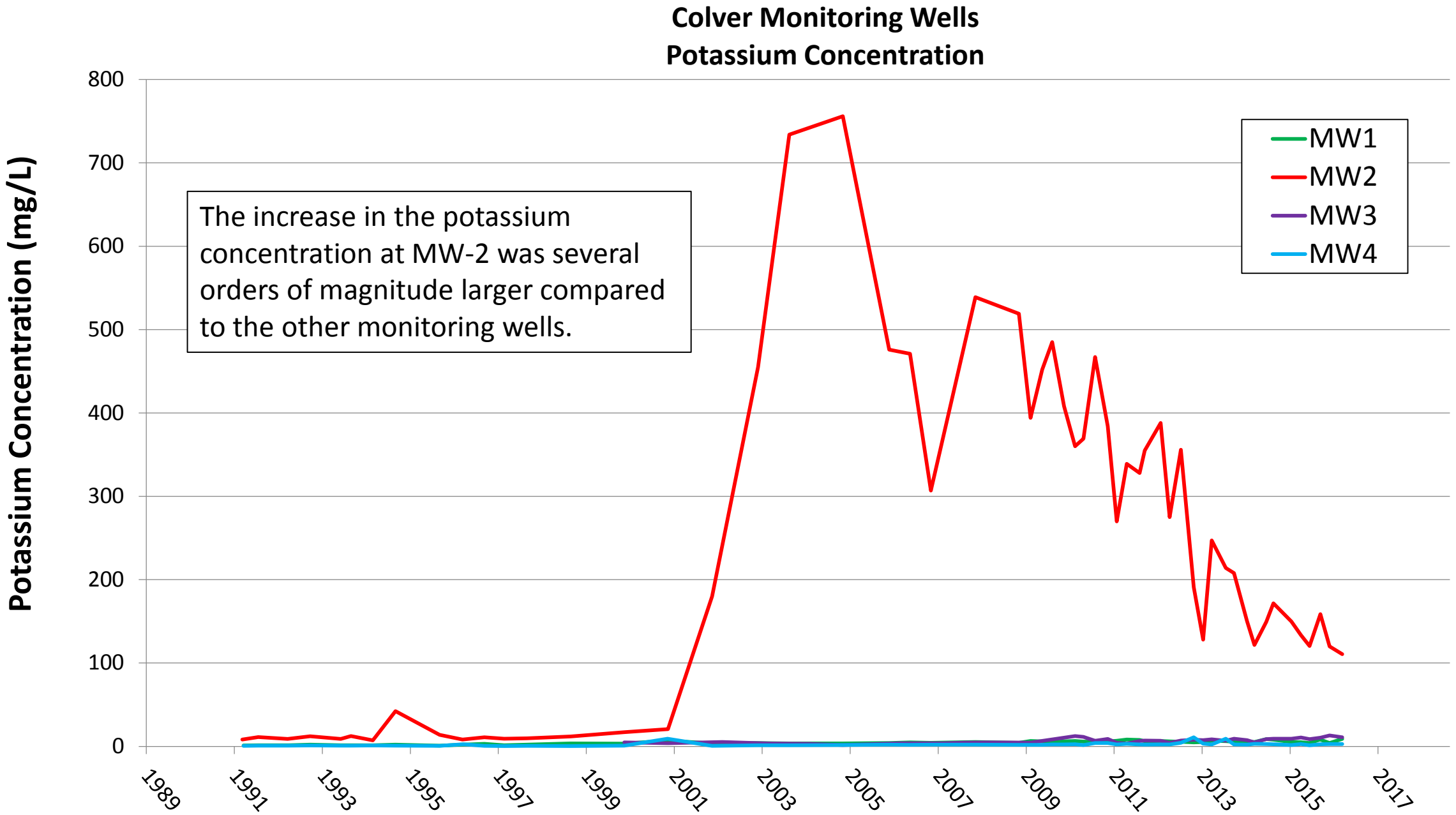
- Two of the discharges from the refuse pile were also sampled quarterly starting in 1997 as part of ash monitoring.
  - SW-4A and SW-23

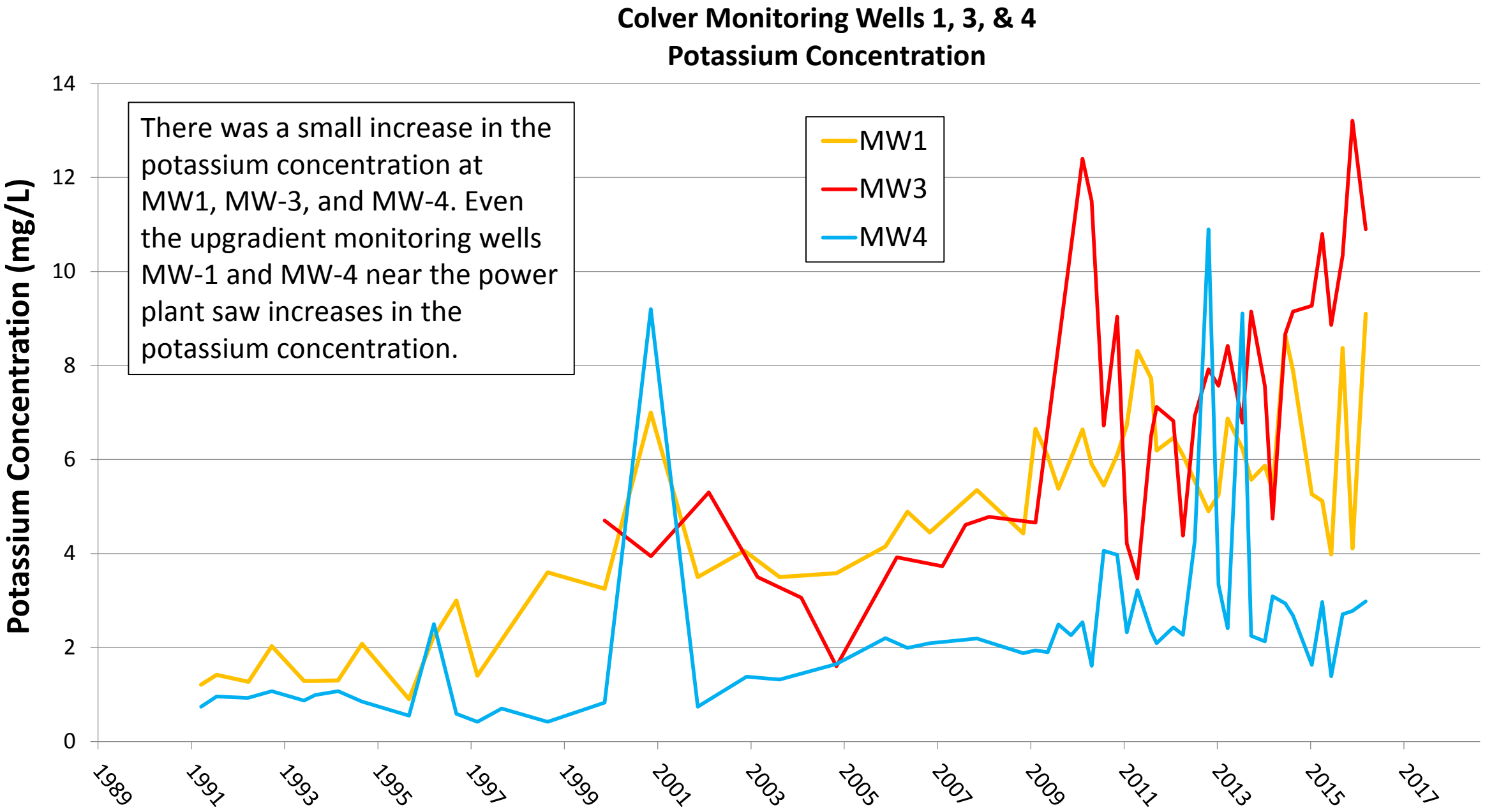
Monitoring Well 2 in the Colver Refuse Pile

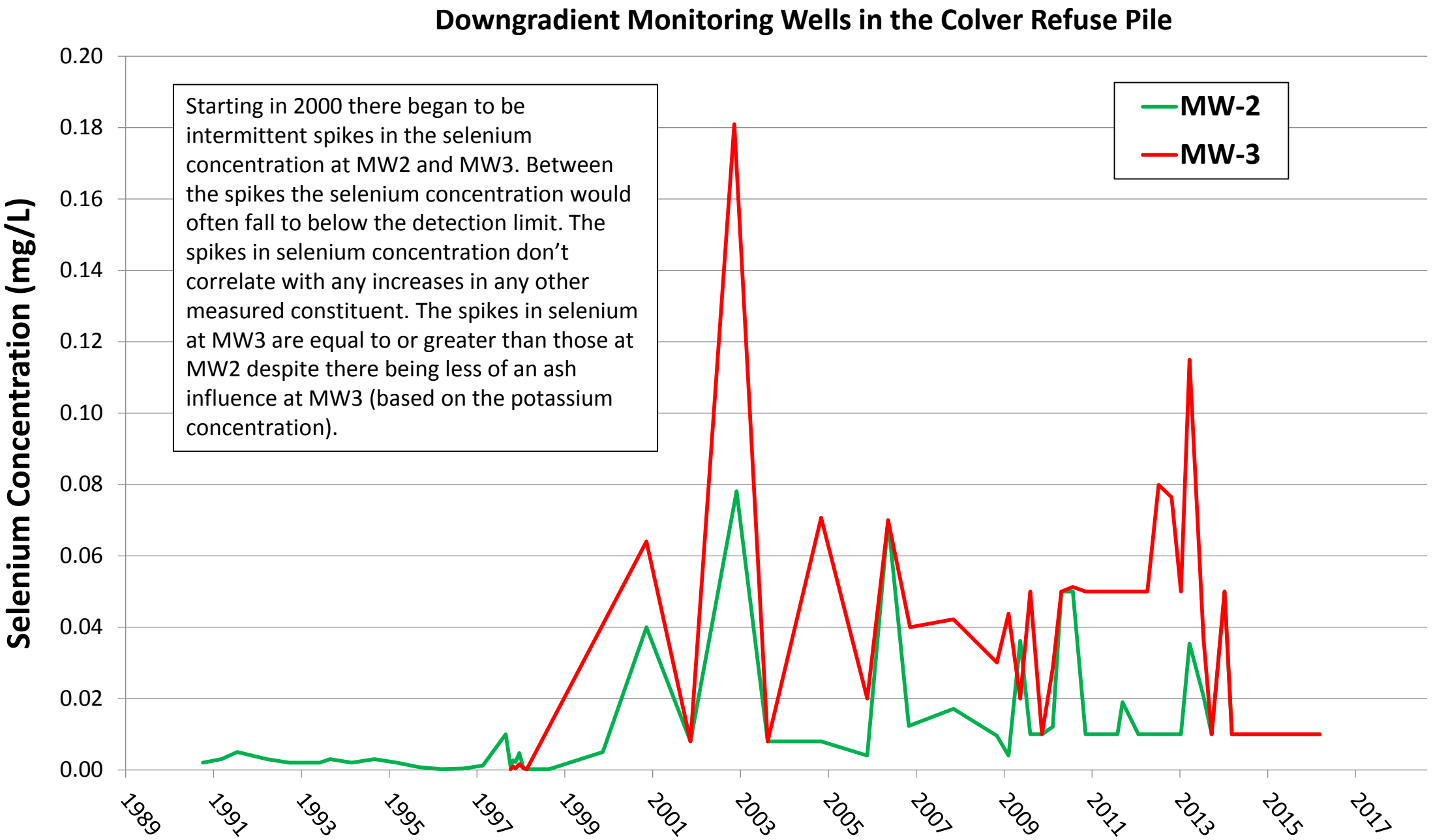
- Nine background samples were collected from Monitoring Well 2 prior to placement of FBC ash.
  - During the time the background samples were collected not all constituents were required by the Department (ex. Antimony, Beryllium, Boron, etc.).
- The background samples were compared to the samples collected after reclamation was completed.
  - ↓ indicates decreased concentration compared to background.
  - ↑ indicates increased concentration compared to background.
  - = indicates no significant difference between the background concentration and the latest data.
- The only constituent with a higher concentration in the post-reclamation samples compared to the background samples was selenium.

	Average Baseline Concentration 1990-1994 (mg/L)	Average Concentration 2012-2016 (mg/L)
Antimony	Not Measured	No Detections
Arsenic ↓	1.18	0.40
Barium ↓	0.06 (four detections out of nine samples)	0.01 (ten detections out of 18 samples
Beryllium	Not Measured	0.003 (ten detections out of 18 samples)
Boron	Not Measured	0.02 (five detections out of 18 samples)
Cadmium ↓	0.15 (seven detections out of nine samples)	0.009 (three detections out of 18 samples)
Chromium ↓	0.37	0.02 (six detections out of 18 samples)
Cobalt	Not Measured	0.16
Copper ↓	1.10	0.02 (seven detections out of 18 samples)
Lead ↓	0.19 (six detections of out nine samples)	0.02 (13 detections out of 18 samples)
Mercury =	0.0004 (one detection out of nine samples)	No Detections
Molybdenum	Not Measured	0.01 (two detections out of 18 samples)
Nickel	Not Measured	0.08 (17 detections of the 18 samples)
Selenium ↑	0.003 (eight detections out of nine samples)	0.03 (two detections out of 18 samples)
Silver ↓	1.8 (one detection out of nine samples)	0.03 (eight detections out of 18 samples)
Thallium	Not Measured	0.03 (nine detections out of 18 samples)
Vanadium	Not Measured	0.03 (three detections out of 18 samples)
Zinc ↓	2.69	0.21


Monitoring Well 2 in the Colver Refuse Pile
Beginning in 2001 the rising concentrations of potassium, calcium, sodium, and chloride are indicative of the influence of FBC ash on the water quality of the monitoring well.
Potassium
Calcium
Sodium
Chloride
Concentration (mg/L)
800
700
600
500
400
300
200
100
0
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017


Colver Monitoring Wells
Potassium Concentration
Potassium Concentration (mg/L)
800
700
600
500
400
300
200
100
0
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
MW1
MW2
MW3
MW4
The increase in the potassium concentration at MW-2 was several orders of magnitude larger compared to the other monitoring wells.


Colver Monitoring Wells 1, 3, & 4
Potassium Concentration
There was a small increase in the potassium concentration at MW1, MW-3, and MW-4. Even the upgradient monitoring wells MW-1 and MW-4 near the power plant saw increases in the potassium concentration.
MW1
MW3
MW4
Potassium Concentration (mg/L)
0
2
4
6
8
10
12
14
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017

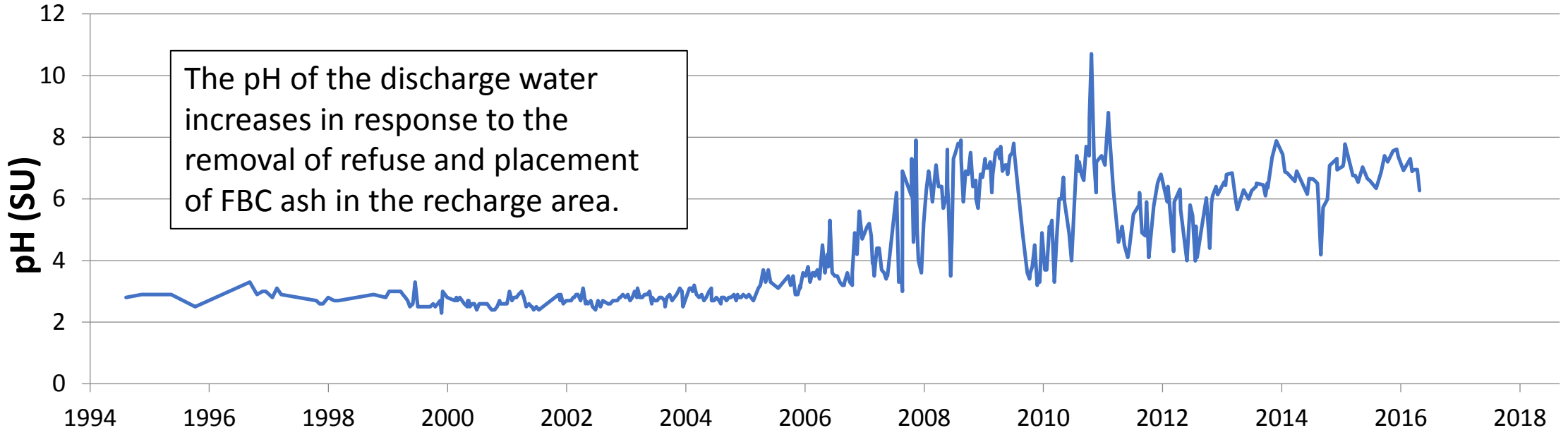

Downgradient Monitoring Wells in the Colver Refuse Pile
Starting in 2000 there began to be intermittent spikes in the selenium concentration at MW2 and MW3. Between the spikes the selenium concentration would often fall to below the detection limit. The spikes in selenium concentration don't correlate with any increases in any other measured constituent. The spikes in selenium at MW3 are equal to or greater than those at MW2 despite there being less of an ash influence at MW3 (based on the potassium concentration).
MW-2
MW-3
Selenium Concentration (mg/L)
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017

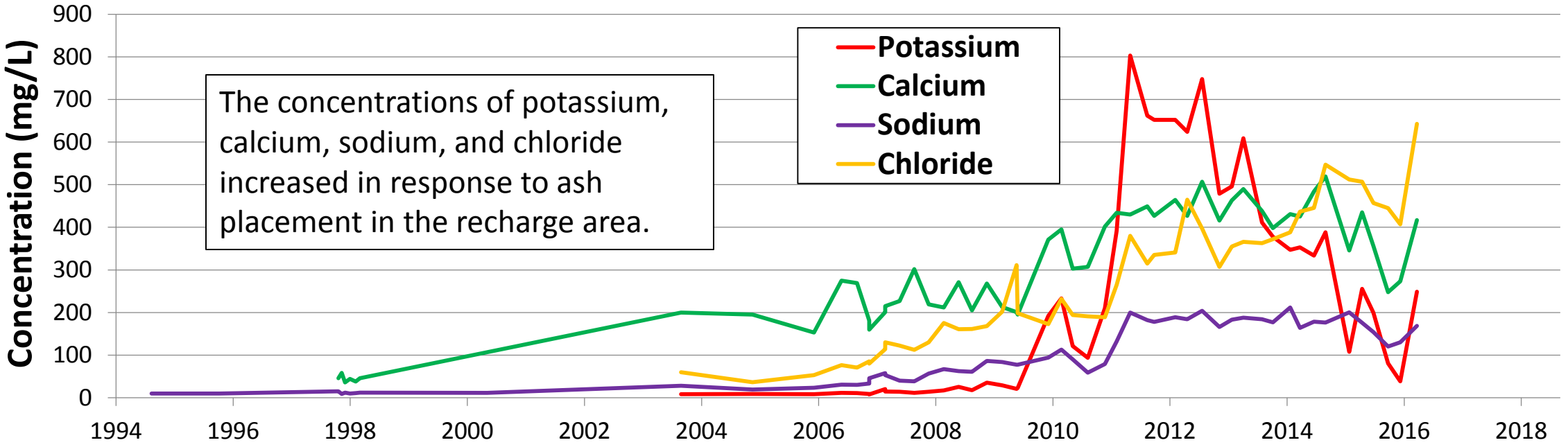
Monitoring Point SW-4A – Discharge from the Colver Refuse Pile

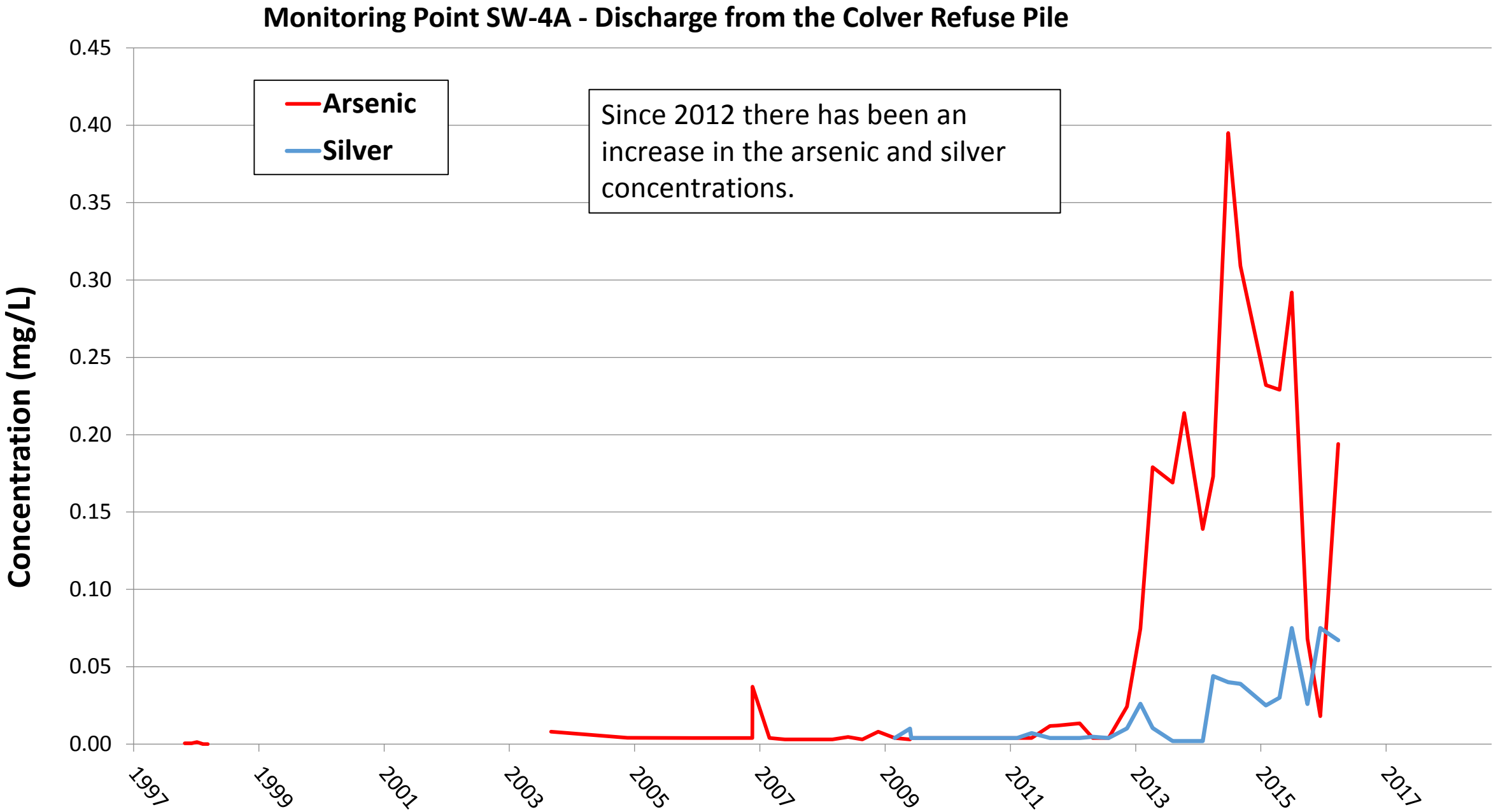
- Six background samples were collected of drainage from the refuse pile after there had been placement of FBC ash but before the water chemistry showed any influence from the ash.
  - During the time the background samples were collected not all constituents were required by the Department (ex. Antimony, Beryllium, Boron, etc.).
- The background samples were compared to the samples collected after reclamation was completed.
  - ↓ indicates decreased concentration compared to background.
  - ↑ indicates increased concentration compared to background.
  - = indicates no significant difference between the background concentration and the latest data.
- The only constituents with a higher concentration in the post-reclamation samples compared to the background samples were selenium and arsenic.

	Average Baseline Concentration 1997-1998 (mg/L)	Average Concentration 2012-2016 (mg/L)
Antimony	Not Measured	0.47 (three detections out of 18 samples)
Arsenic ↑	0.0008 (three detections out six samples)	0.17 (16 detections out of 18 samples)
Barium	Not Measured	0.03
Beryllium	Not Measured	0.002 (two detections out of 18 samples)
Boron	Not Measured	0.04 (16 detections out of 18 samples)
Cadmium =	0.0004 (four detections out of six samples)	0.004 (two detections out of 18 samples)
Chromium ↓	0.03 (five detections out of six samples)	0.004 (six out of 18 samples)
Cobalt	Not Measured	0.02 (seven detections out of 18 samples)
Copper =	0.01 (three detections out of six samples)	0.02 (four detections out of 18 samples)
Lead ↓	0.01 (five detections out of six samples)	0.008 (eight detections out of 18 samples)
Mercury =	0.0009 (two detections out of six samples)	No Detections
Molybdenum	Not Measured	0.02 (eight detections out of 18 samples)
Nickel ↓	0.04	0.01 (seven detections out of 18 samples)
Selenium ↑	0.0007 (five detections out of six samples)	0.03 (13 detections out of 18 samples)
Silver	Not Measured	0.04 (13 detections out of 18 samples)
Thallium	Not Measured	0.006 (two detections out of 18 samples)
Vanadium	Not Measured	0.02 (five detections out of 18 samples)
Zinc ↓	0.06	0.02 (13 detections out of 18 samples)

Monitoring Point SW-4A - Discharge from the Colver Refuse Pile





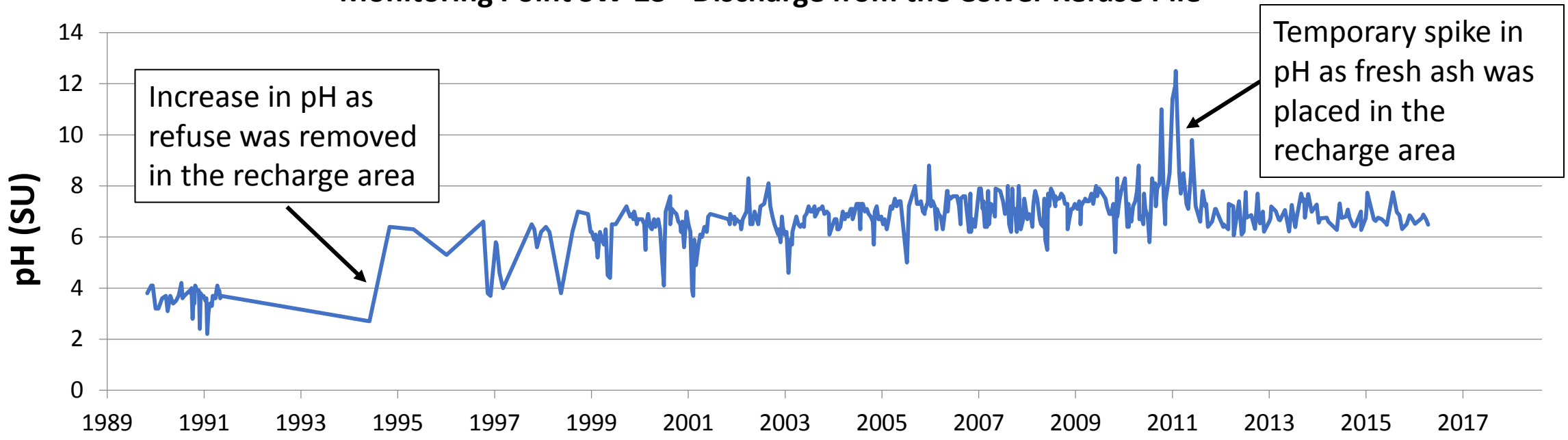

Monitoring Point SW-4A - Discharge from the Colver Refuse Pile
Arsenic
Silver
Since 2012 there has been an increase in the arsenic and silver concentrations.
Concentration (mg/L)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017

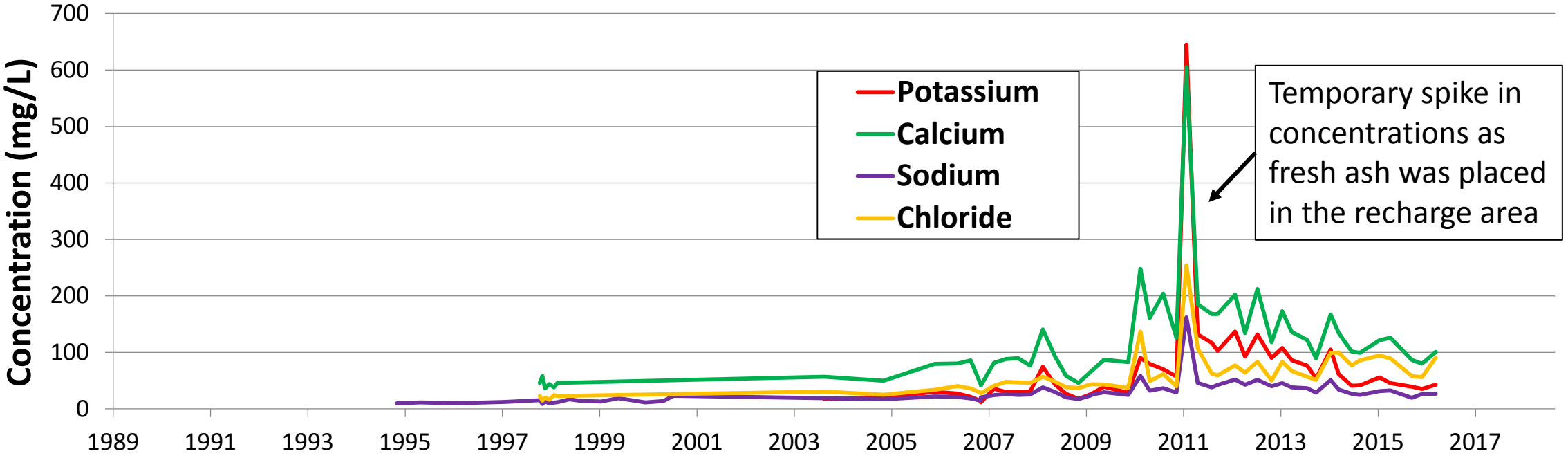
Monitoring Point SW-23 – Discharge from the Colver Refuse Pile

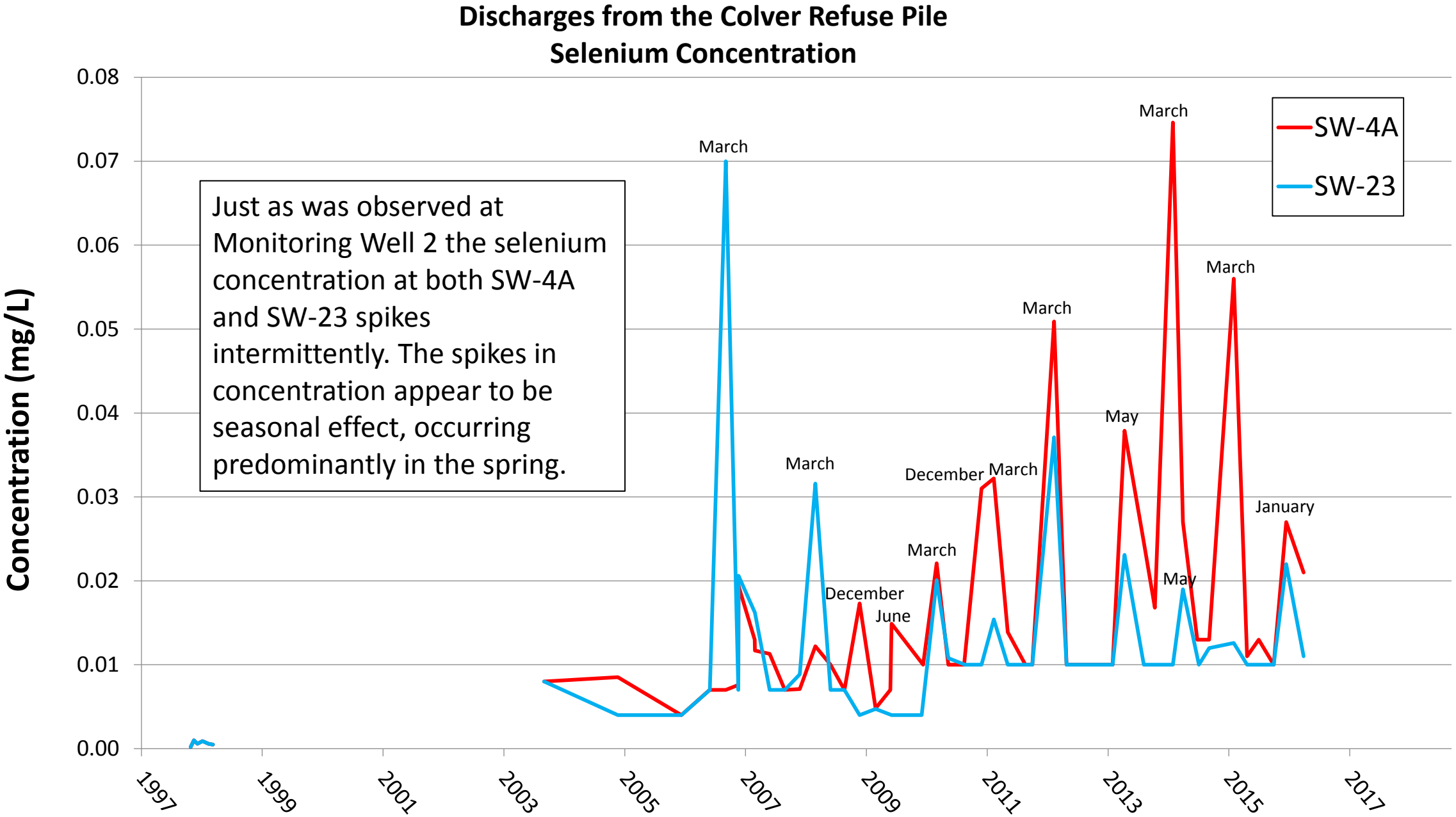
- Six background samples were collected of drainage from the refuse pile after there had been placement of FBC ash but before the water chemistry showed any influence from the ash.
  - During the time the background samples were collected not all constituents were required by the Department (ex. Antimony, Beryllium, Boron, etc.).
- The background samples were compared to the samples collected after reclamation was completed.
  - ↓ indicates decreased concentration compared to background.
  - ↑ indicates increased concentration compared to background.
  - = indicates no significant difference between the background concentration and the latest data.
- The only constituent with a higher concentration in the post-reclamation samples compared to the background samples was selenium.

	Average Baseline Concentration 1997-1998 (mg/L)	Average Concentration 2012-2016 (mg/L)
Antimony	Not Measured	No Detections
Arsenic =	0.0008 (three detections out of six samples)	0.007 (three detections out of 17 samples)
Barium	Not Measured	0.03
Beryllium	Not Measured	No Detections
Boron	Not Measured	0.02 (ten detections out of 17 samples)
Cadmium ↓	0.0004 (four detections out of six samples)	No Detections
Chromium ↓	0.03 (five detections out of six samples)	0.002 (one detection out of 17 samples)
Cobalt	Not Measured	No Detections
Copper =	0.01 (three detections out of six samples)	0.02 (two detections out of 17 samples)
Lead ↓	0.01 (five detections out of six samples)	0.009 (two detections out of 17 samples)
Mercury ↓	0.0009 (two detections out of six samples)	No Detections
Molybdenum	Not Measured	No Detections
Nickel ↓	0.04	0.01 (one detection out of 17 samples)
Selenium ↑	0.0007 (five detections out of six samples)	0.02 (seven detections out of 17 samples)
Silver	Not Measured	0.01 (nine detections out of 17 samples)
Thallium	Not Measured	0.006 (one detections out of 17 samples)
Vanadium	Not Measured	0.05 (four detections out of 17 samples)
Zinc ↓	0.06	0.04 (16 detections out of 17 samples)

Monitoring Point SW-23 - Discharge from the Colver Refuse Pile






Discharges from the Colver Refuse Pile
Selenium Concentration
Concentration (mg/L)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
SW-4A
SW-23
Just as was observed at Monitoring Well 2 the selenium concentration at both SW-4A and SW-23 spikes intermittently. The spikes in concentration appear to be seasonal effect, occurring predominantly in the spring.
March
March
March
December
March
March
May
March
January
December
June
March
May

Nanty Glo West Refuse Pile 2004

Prior to reclamation

Refuse pile covers ~ 34 acres

Nanty Glo West Refuse Pile
2001

Receiving stream (Pergrin Run) at the toe of the refuse pile

Prior to reclamation

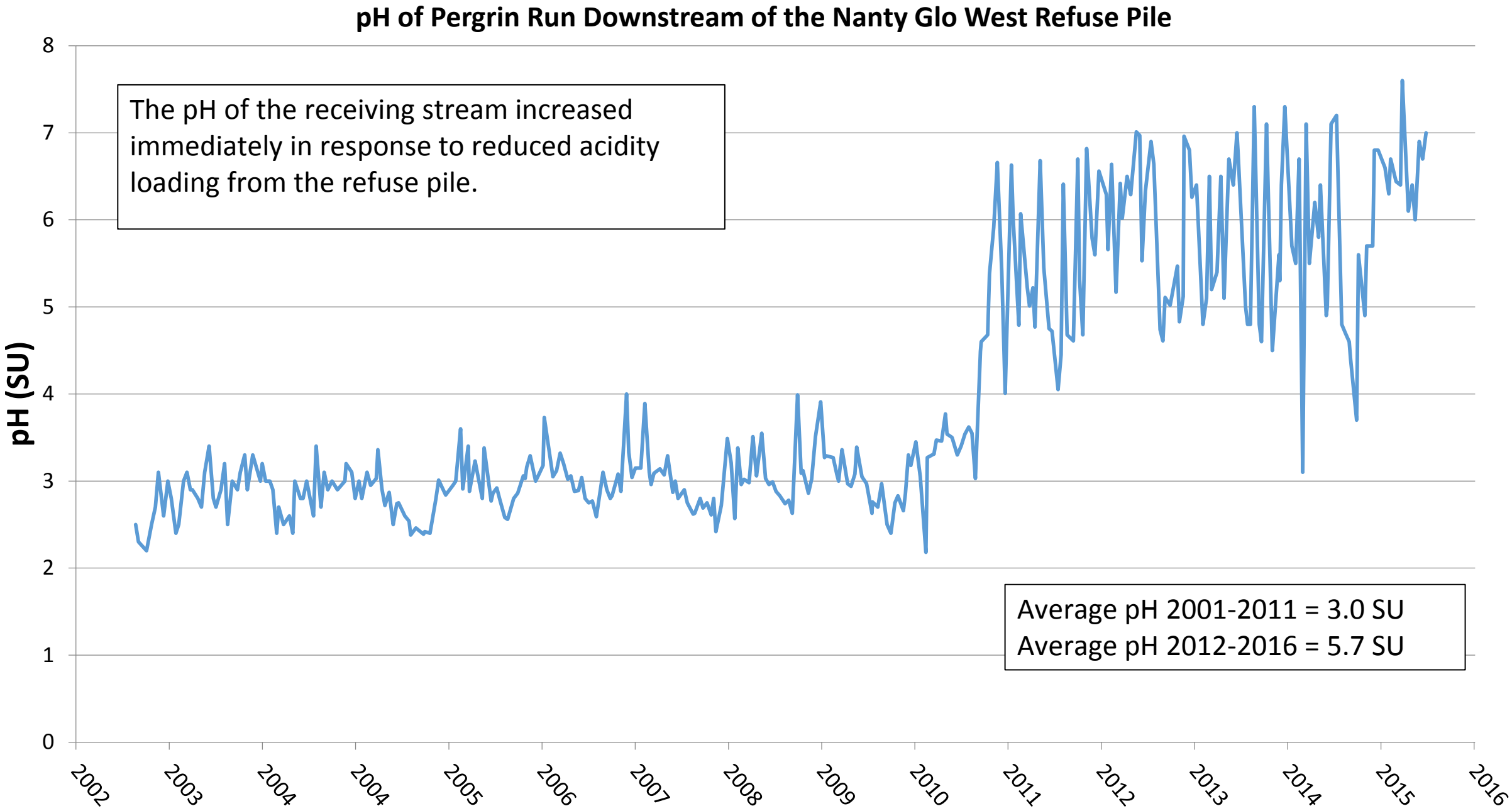
Nanty Glo West Refuse Pile
2014

During reclamation

Nanty Glo West

- Eight discharges total
  - Seven discharges were combined in a French drain, which remained acidic but with a reduced pollutional loading.
  - The other discharge is now normally dry.

	Average Baseline Loading November 2001 - November 2004	Average Loading January 2013 - August 2016	Percent Reduction
Acidity (kg/day)	637	32.2	95
Iron (kg/day)	117	2.50	98
Aluminum (kg/day)	62.9	4.0	94
Manganese (kg/day)	0.90	0.40	56
Sulfate (kg/day)	746	116	84


pH of Pergrin Run Downstream of the Nanty Glo West Refuse Pile
The pH of the receiving stream increased immediately in response to reduced acidity loading from the refuse pile.
Average pH 2001-2011 = 3.0 SU
Average pH 2012-2016 = 5.7 SU
pH (SU)
0
1
2
3
4
5
6
7
8
2002
2003
2004
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

Ash Monitoring at the Nanty Glo West Refuse Pile

- There is one monitoring well that is used to monitor the effects of the FBC ash placement.
- At this time the monitoring well shows no influence from the ash placement.
- Three of the discharges from the refuse pile were also sampled quarterly as part of ash monitoring.
  - The French drain was later sampled as an ash monitoring point once the discharges were combined.
  - Background data was provided with the permit application so the pre and post-mining concentrations can be compared.

Discharge from the Nanty Glo West Refuse Pile

- Eight background samples were collected of drainage from the refuse pile prior to any refuse removal or placement for FBC ash.
  - During the time the background samples were collected not all constituents were required by the Department (ex. Antimony, Beryllium, Boron, etc.).
- The background samples were compared to the samples collected after reclamation was completed.
  - ↓ indicates decreased concentration compared to background.
  - ↑ indicates increased concentration compared to background.
  - = indicates no significant difference between the background concentration and the latest data.
- No constituents had a higher concentration in the post-reclamation samples compared to the background samples.

	Average Baseline Concentration 2002-2004 (mg/L)	Average Concentration 2013-2016 (mg/L)
Antimony	Not Measured	0.01 (five detections out of 15 samples)
Arsenic ↓	0.68	0.02 (ten detections out of 15 samples)
Barium	Not Measured	0.09 (three detections out of 15 samples)
Beryllium	Not Measured	0.008 (one detection out of 15 samples)
Boron	Not Measured	0.09 (14 detections out of 15 samples)
Cadmium	Not Detected (at 0.05 mg/L limit)	0.002 (12 detections out of 15 samples)
Chromium ↓	0.43	0.02
Cobalt	Not Measured	0.25
Copper ↓	2.41	0.24
Lead ↓	0.28	0.02
Mercury	Not Detected	Not Detected
Molybdenum	Not Measured	Not Detected
Nickel ↓	3.54	0.46
Selenium ↓	0.59	0.09 (six detections out of 15 samples)
Silver	Not Measured	0.01 (five detections out of 15 samples)
Thallium	Not Measured	0.002 (six detections out of 15 samples)
Vanadium	Not Measured	0.04 (seven detections out of 15 samples)
Zinc ↓	2.30	0.74

Nanty Glo East Refuse Pile 2004

Prior to reclamation

Refuse pile covers ~ 50 acres

Southern End of the Nanty Glo East Refuse Pile
2014

During reclamation

Nanty Glo East

- Four discharges total
  - All four discharges remained acidic but with a reduced pollutional loading.

	Average Baseline Loading December 2003 - April 2005	Average Loading January 2015 - September 2016	Percent Reduction
Acidity (kg/day)	1,399	133	91
Iron (kg/day)	153	8.00	95
Aluminum (kg/day)	121	17.0	86
Manganese (kg/day)	8.00	2.00	75
Sulfate (kg/day)	1,983	278	86

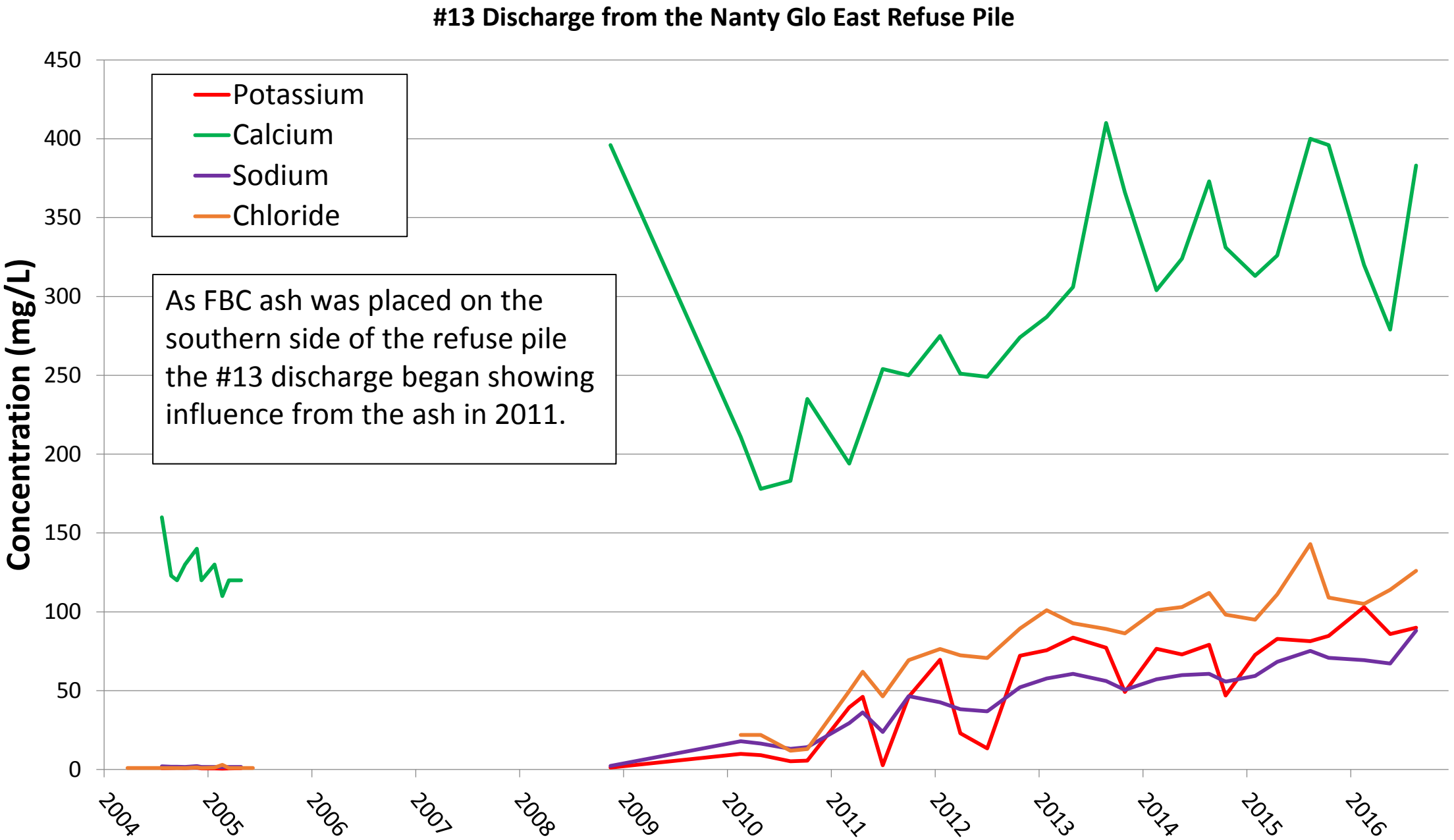
Ash Monitoring at the Nanty Glo East Refuse Pile

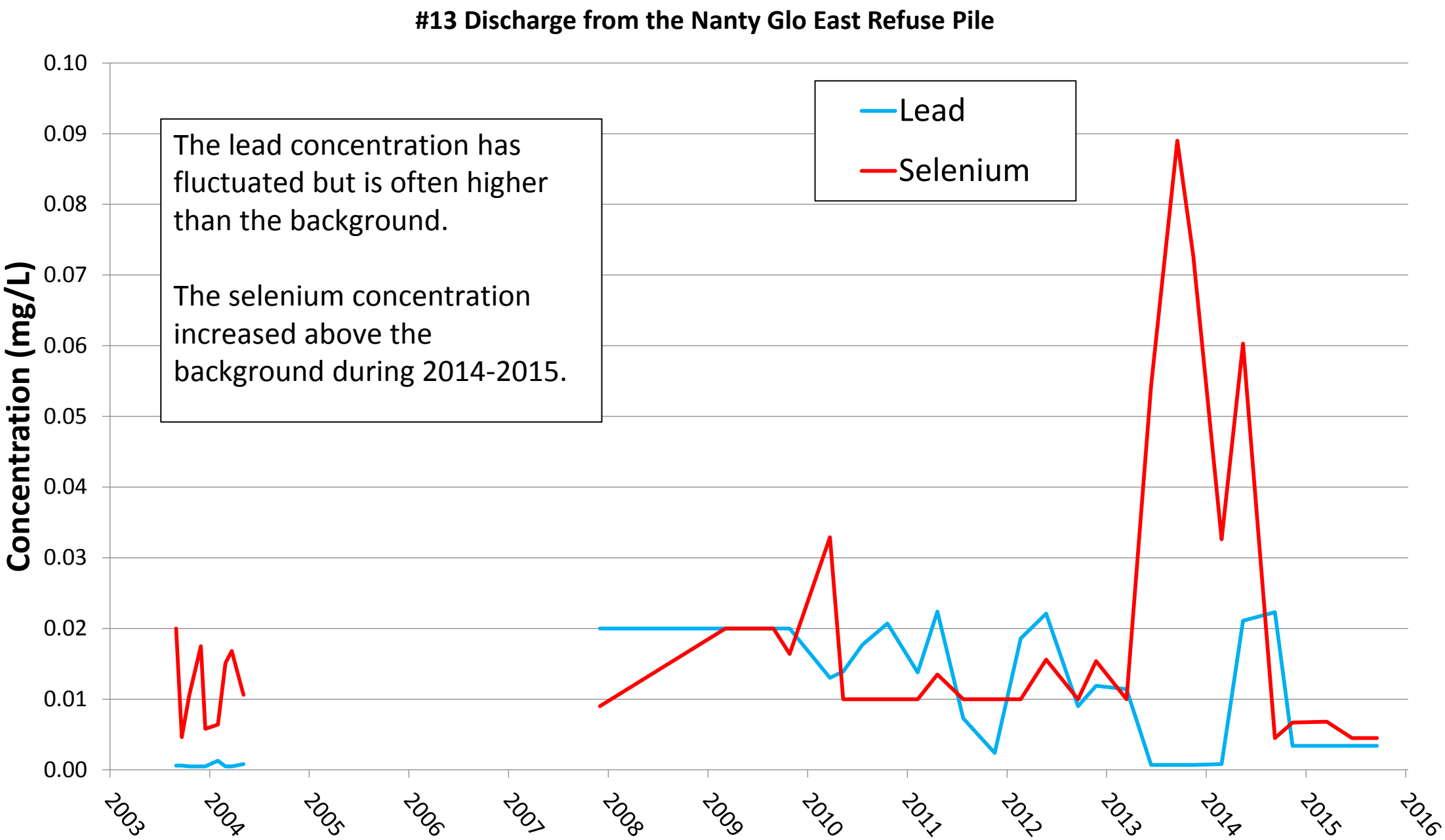
- There are three monitoring wells that are used to monitor the effects of the FBC ash placement.
- At this time none of the monitoring wells show any influence from the FBC ash placement.
- Two of the discharges from the refuse pile were also sampled quarterly as part of ash monitoring.
  - #13 and #14
  - At this time only discharge #13 shows any influence from FBC ash.

#13 Discharge from the Nanty Glo East Refuse Pile

- Eight background samples were collected from monitoring point 13 prior to any refuse removal or placement for FBC ash.
  - During the time the background samples were collected not all constituents were required by the Department (ex. Antimony, Beryllium, Boron, etc.).
- The background samples were compared to the samples collected after reclamation was completed.
  - ↓ indicates decreased concentration compared to background.
  - ↑ indicates increased concentration compared to background.
  - = indicates no significant difference between the background concentration and the latest data.
- Selenium and lead had a higher concentration in the post-reclamation samples compared to the background samples.

	Average Baseline Concentration 2003-2005 (mg/L)	Average Concentration 2015-2016 (mg/L)
Antimony	Not Measured	0.007 (one detection out of seven samples)
Arsenic ↓	0.04 (eight detections out of nine samples)	0.02 (three detections out of seven samples)
Barium	Not Measured	0.06 (four detections out of seven samples)
Beryllium	Not Measured	0.01
Boron	Not Measured	Not Detected
Cadmium ↓	0.02 (five detections out of ten samples)	0.004
Chromium ↓	0.09	0.02
Cobalt	Not Measured	0.37
Copper ↓	0.51	0.13
Lead ↑	0.001 (six detections out of ten samples)	0.01 (three detections out of seven samples)
Mercury	Not Detected	Not Detected
Molybdenum	Not Measured	Not Detected
Nickel ↓	0.91	0.56
Selenium ↑	0.01 (nine detections out of ten samples)	0.03 (four detections out of seven samples)
Silver	Not Measured	Not Detected
Thallium	Not Measured	0.0005 (four detections out of seven samples)
Vanadium	Not Measured	0.06 (one detection out of seven samples)
Zinc ↓	1.91	1.16


#13 Discharge from the Nanty Glo East Refuse Pile
Concentration (mg/L)
450
400
350
300
250
200
150
100
50
0
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Potassium
Calcium
Sodium
Chloride
As FBC ash was placed on the southern side of the refuse pile the #13 discharge began showing influence from the ash in 2011.


#13 Discharge from the Nanty Glo East Refuse Pile
Concentration (mg/L)
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Lead
Selenium
The lead concentration has fluctuated but is often higher than the background.
The selenium concentration increased above the background during 2014-2015.

Total Reductions in Loading to the Blacklick Creek Watershed

	Total Average Baseline Loading	Total Average Recent Loading	Total Reduction	Percent Reduction
Acidity (kg/day)	4,826	204	4,622	96
Iron (kg/day)	1,016	11	1,004	99
Aluminum (kg/day)	467	26	441	94
Manganese (kg/day)	23	3	20	87
Sulfate (kg/day)	3,789	689	3,100	82

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Conclusions

- Reclamation of the refuse piles using FBC ash has greatly diminished the loadings of pollutants to the Blacklick Creek watershed.
- The placement of FBC ash has changed the chemistry of the water discharging from the piles.
  - Increasing concentrations of potassium, sodium, chloride, and calcium.
  - There have been a few observed increases in the trace elements that are part of the ash monitoring:
    - An increase selenium was observed at four out of five sites.
    - Increases in lead, silver, and arsenic were observed at one discharge.
- Water monitoring is required for ten years after the date of the last ash placement on a refuse reprocessing site.
  - Of the five sites in this study the first to complete the ten year monitoring requirement will be Revloc #2 in 2018.

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Fishing Derby on South Branch Blacklick Creek
Nanty Glo, PA
April 23, 2016

Thank You!
Any Questions?

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