

The Effect of Katahdin Iron Works On the Water Quality of Blood Brook And the West Branch of the Pleasant R

By Mark
Whiting
Maine DEP
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Background Information

- The Pleasant River is stocked with Atlantic Salmon
- This is part of the Piscataquis R watershed and it plays a part in the Penobscot R restoration
- The Howland Dam controls access. It will have a natural looking bypass channel for fish

KIW was the only large iron smelting operation in Maine, it lasted from 1840-1890



The KIW pyrrhotite is one of the world's largest sulfide deposits at 200,000,000 tons



Ore from Ore Mountain was excavated from pits such as this one





Acid Mine Drainage is found in Blood Brook



Where does acidity come from?

- (1.) $3\text{FeS}(\text{solid}) + 4\text{O}_2 + 4\text{H}_2\text{O} = 3\text{Fe}^{2+}(\text{aq}) + 3\text{SO}_4^{2-} + 4\text{H}^+$
- (2.) $4\text{Fe}^{2+}(\text{aq}) + \text{O}_2 + 4\text{H}^+ = 4\text{Fe}^{3+}(\text{aq}) + 2\text{H}_2\text{O}$
- (3.) $\text{Fe}^{3+}(\text{aq}) + 3\text{H}_2\text{O} = \text{Fe}(\text{OH})_3(\text{solid}) + 3\text{H}^+$



DEP Biomonitors Sites in the Katahdin Iron Works Area

DEP Biomonitoring Results for KIW Area

Sample No.	Date	Stream Classification	Attains	Notes
Blood Brook	1996	A	No	Algae collection, no results yet Some rock baskets were exposed by low water
Blood Brook	2003	A		
West Branch	1996	AA	No	
West Branch	2001	AA	Yes	
No Name Br	1996	A	Yes	



Blood Brook above Bridge 5/4/2010

Project Goals

Document the problems at Blood Brook

Is there an effect on the West Branch?

How far downstream can a problem be traced?

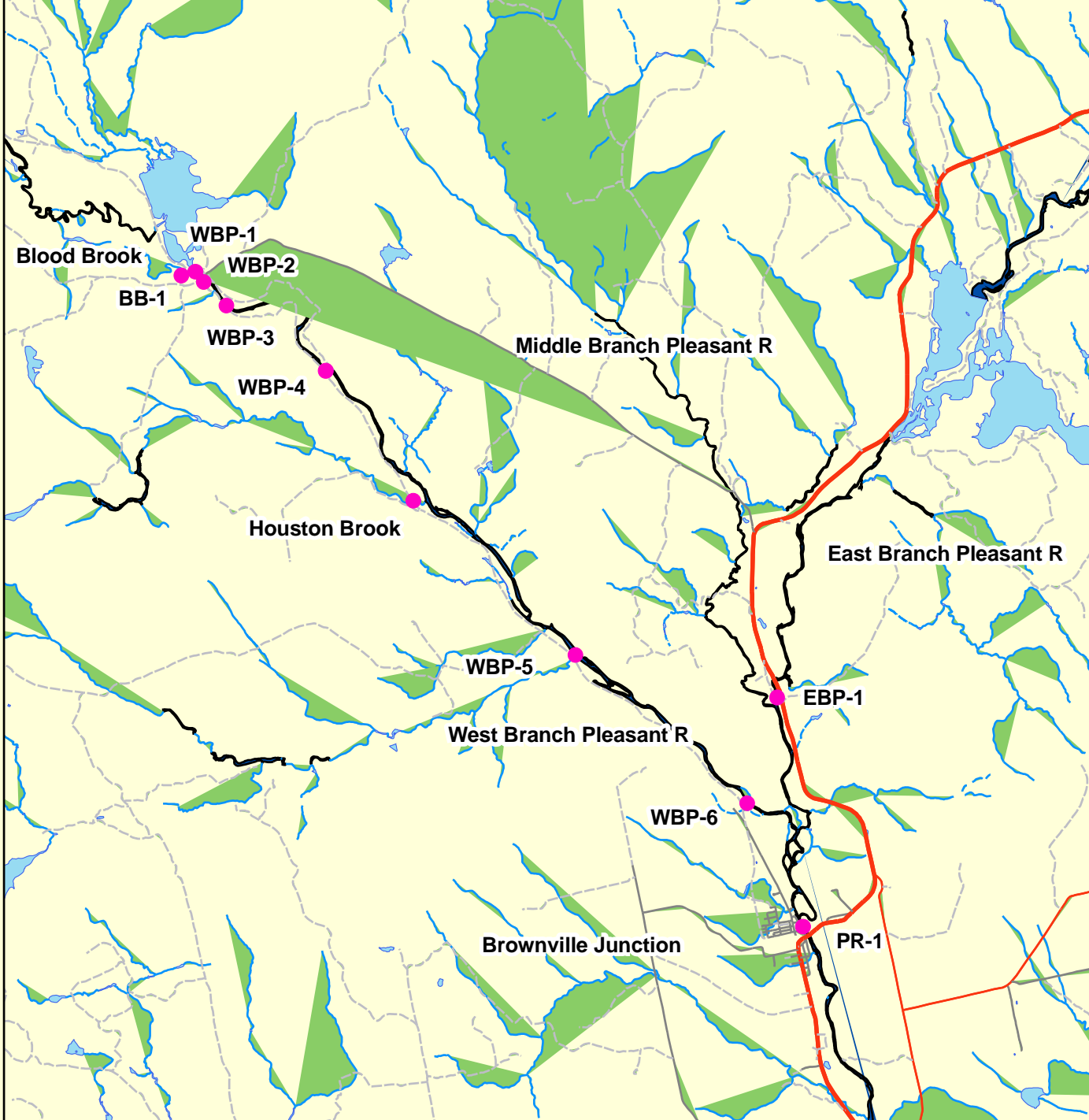
Can we find sources and can the problems be fixed?

What do we measure?

- pH, alkalinity (as Acid Neutralizing Capacity)
- Cations (Ca, Na, K, Mg) and anions (SO₄, NO₃, Cl)
- Metals, especially aluminum species (particulate Al, organic Al, and Al_x), and trace metals (esp. Fe Ni Co and Cu)

Study Design

- Water quality at Blood Brook, 2007 and 2009
- Compare water quality of the West Branch above and below Blood Brook
- Compare with control sites, Houston Br and other parts of the Pleasant & Piscataquis drainage
- Locate sources of acid mine drainage



Total Metal Thresholds in ppb

	Ag	Al	As	Be	Cd	Co	Cr (III)	Cr (VI)	Cu	Fe	Mn	Ni
Priority Pollutant	Y	N	Y	Y	Y	N	N	Y	Y	N	N	Y
Carcinogen	N	N	Y	Y	N	N	N	N	N	N	N	N
Freshwater Acute Criteria	0.23	750	340		0.42		483	16	3.07			120
Freshwater Chronic Criteria		87	150		0.08		23	11	2.36	1000	500	13.4

	Pb	Sb	Se	Si	Sn	Sr	Ti	Tl	V	Zn
Priority Pollutant	Y	Y	Y	N	N	N	N	Y	N	Y
Carcinogen	N	N	N	N	N	N	N	N	N	N
Freshwater Acute Criteria	10.5		*							30.6
Freshwater Chronic Criteria	0.41		5							30.6

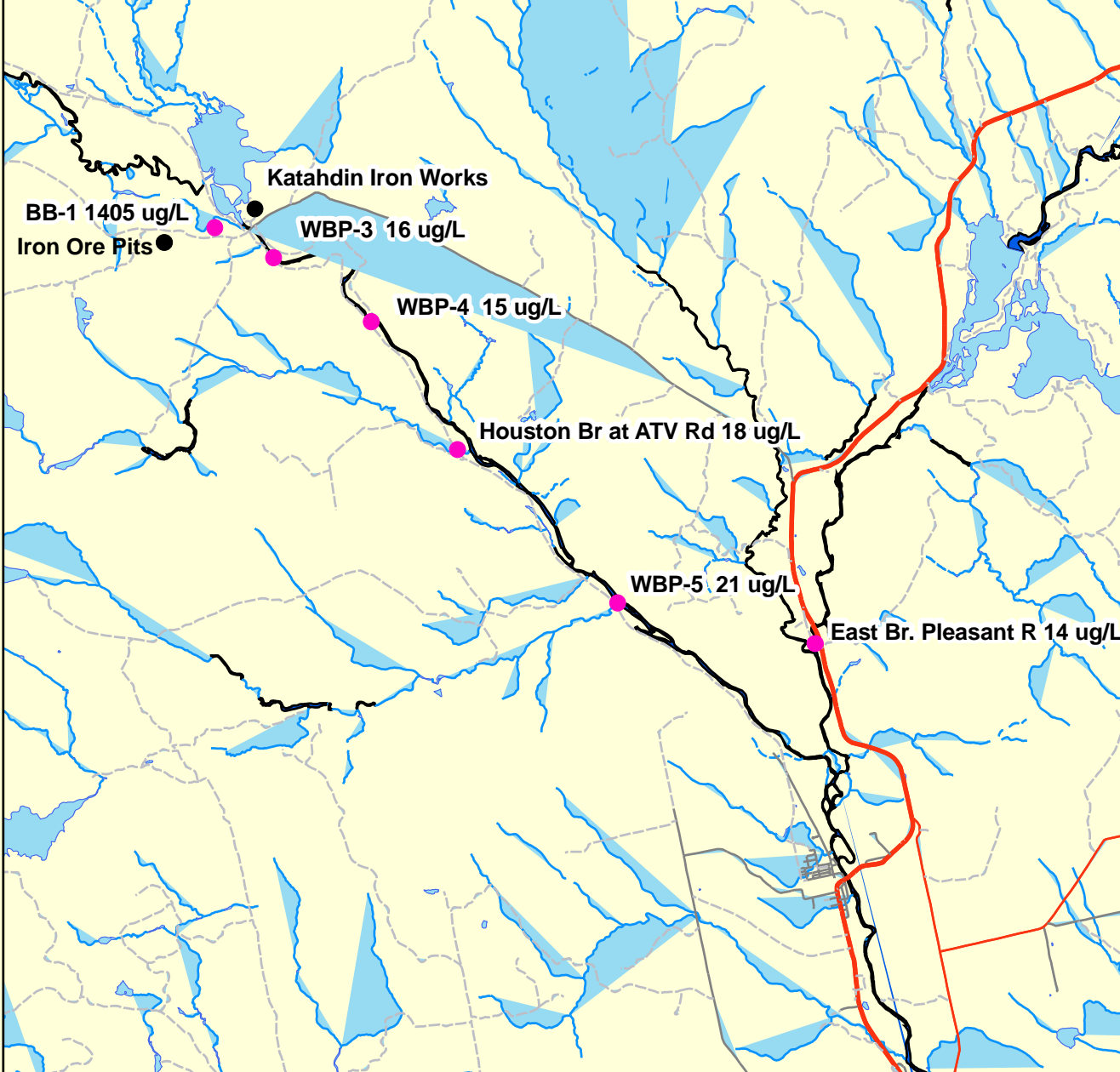
* CMC = $1((f_1/185.9)+(f_2/12.83))$ where f1 and f2 are the fractions of total Se that are selenite and selenate resp

Results - pH

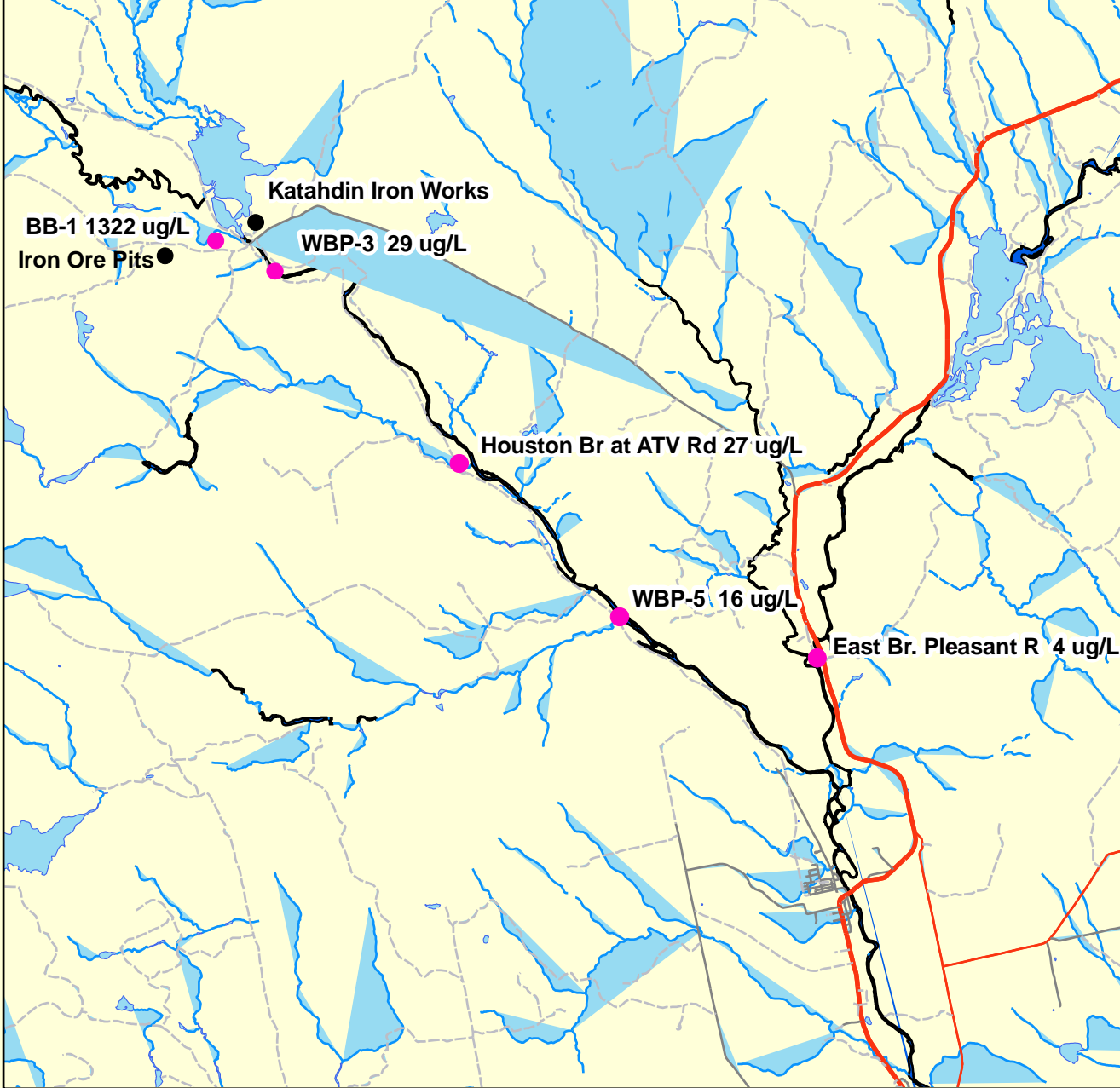
	ID	#	median	range
West Br Pleasant R above KIW	WBP-1	3	6.56	6.11-6.90
Blood Brook	BB-1	3	5.26	4.80-6.60
West Br Pleasant R below KIW	WBP-2	3	6.61	5.58-6.96
WBr Pleasant R farther below KIW	WBP-3	0		
WBr Pleasant R at end of ATV Rd	WBP-4	0		
Houston Brook ATV Bridge	HB-1	2	6.53	6.44-6.61
WBr Pleasant R above Roaring Brook	WBP-5	2	6.75	6.72-6.77
WB Pleasant R Brownville Jct on ATV Rd	WBP-6	1	6.76	
Pleasant River in Brownville at old dam site	PR-1	2	6.43	6.03-6.82
E Branch Pleasant River	EBP-1	2	6.69	6.61-6.77
Piscatiquis R at Abbott	PEN18	4	6.97	6.26-7.00
Kingsbury Stream at Coles Corner Rd	PEN19	2	6.89	6.88-6.89

Results – Aluminum (Alx, the toxic ionic form)

	Site ID	#	median ug/L	range ug/L
West Br Pleasant R above KIW	WBP-1	3	10	6-14
Blood Brook	BB-1	5	620	25-1405
West Br Pleasant R below KIW	WBP-2	3	11	5-75
WBr Pleasant R farther below KIW	WBP-3	2	22.5	16-29
WBr Pleasant R at end of ATV Rd	WBP-4	1	15	
Houston Brook ATV Bridge	HB-1	2	22.5	18-27
WBr Pleasant R above Roaring Brook	WBP-5	2	18.5	16-21
WB Pleasant R Brownville Jct on ATV Rd	WBP-6	1	13	
Pleasant River in Brownville at old dam site	PR-1	1	14	
E Branch Pleasant River	EBP-1	2	9.5	5-14
Piscatiquis R at Abbott	PEN18	4	14	6-22
Kingsbury Stream at Coles Corner Rd	PEN19	2	15.5	10-21

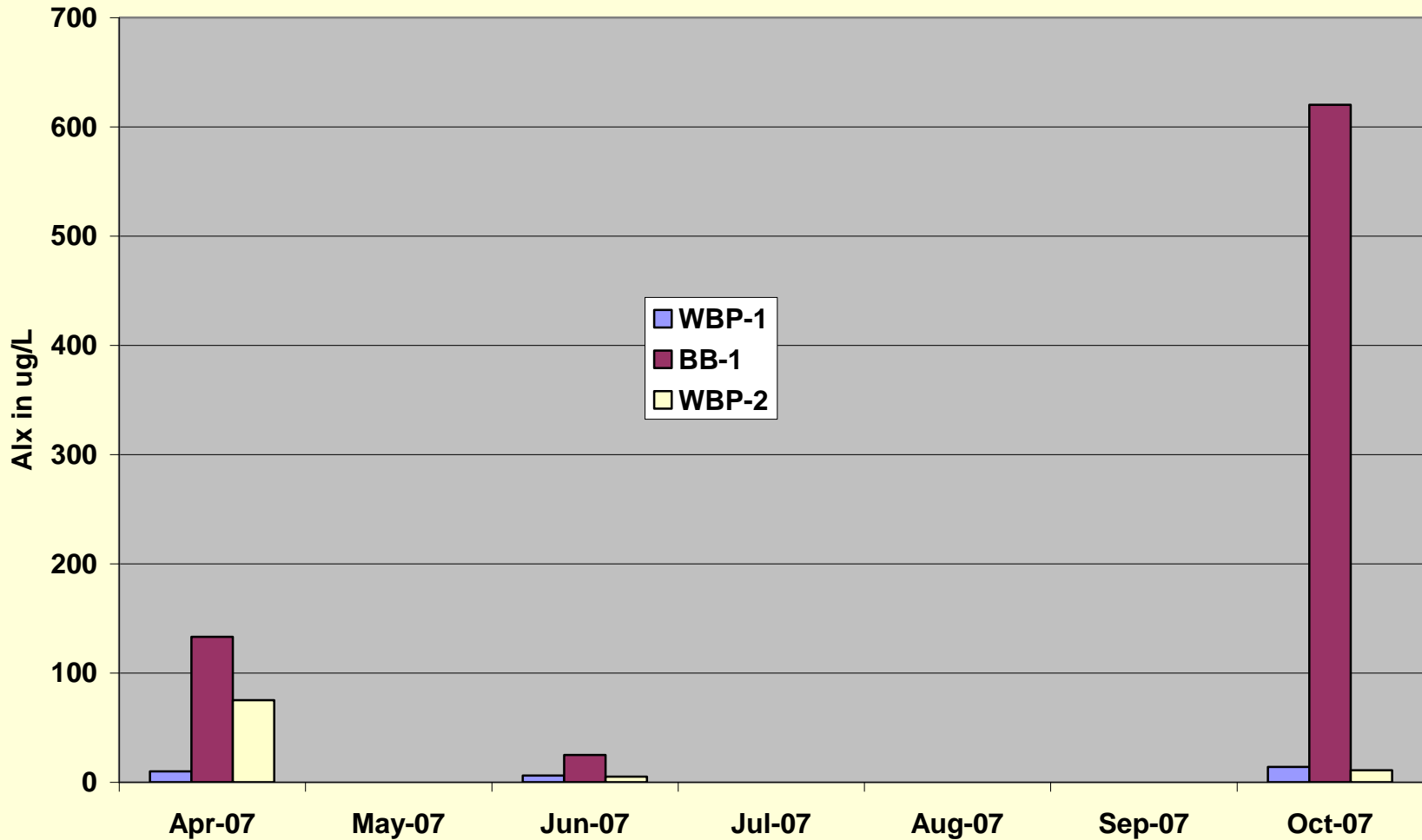


**West Branch of the Pleasant River Water Quality Monitoring,
Aix Results from May 20, 2009**

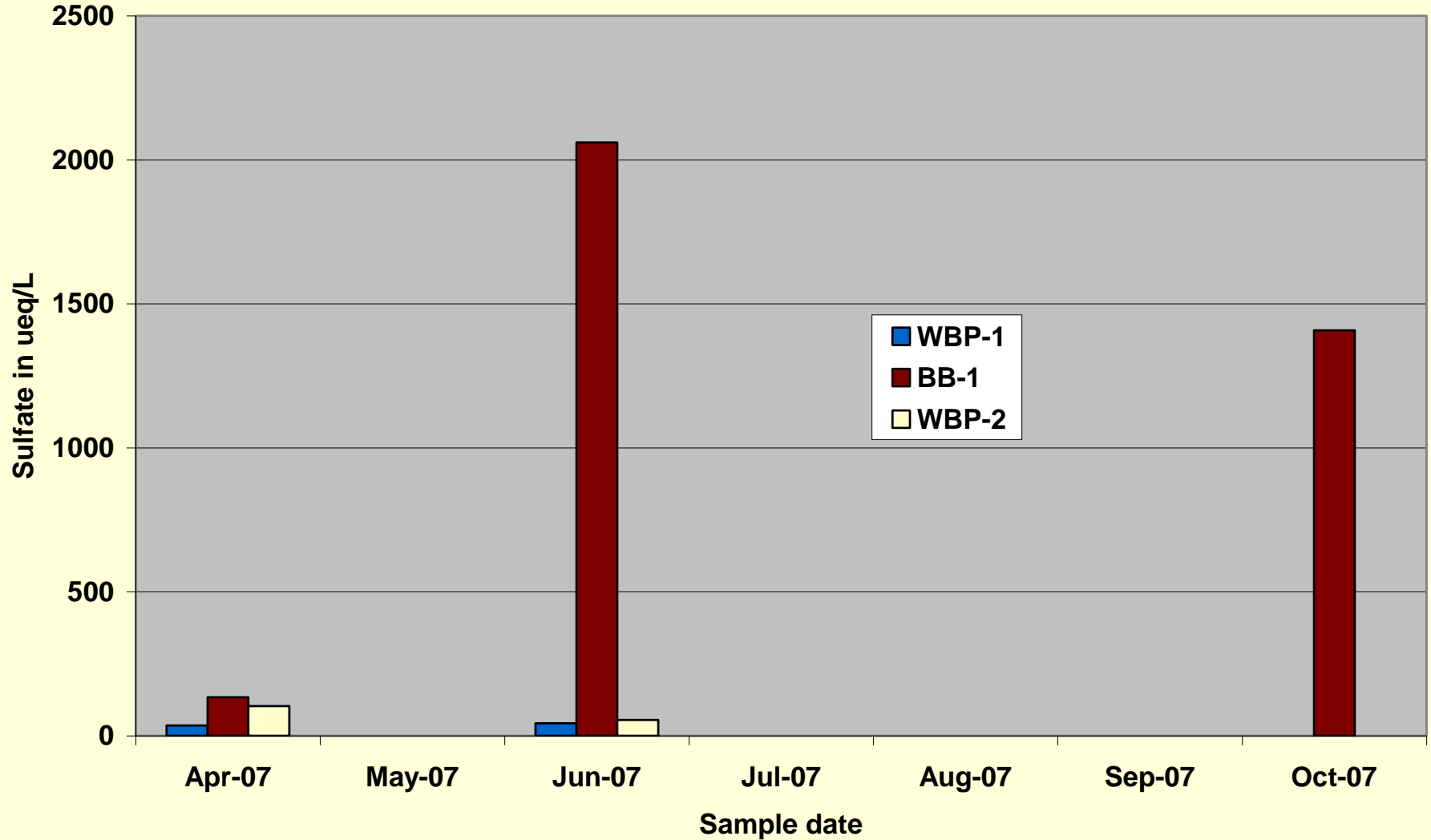


**West Branch of the Pleasant River Water Quality Monitoring,
Alx Results from October 19, 2009**

KIW A Comparison of Blood Brook with Upstream and Downstream Sites on West Branch



KIW A Comparison of Sulfate at West Branch of the Pleasant R and Blood Brook



Results – Trace Metals (total)

Sample ID		Flow	Ag µg/L	Al ug/L	As µg/L	Be µg/L	Cd µg/L	Co µg/L	Cr µg/L	Cu µg/L	Fe µg/L	Mn µg/L	Ni µg/L
WBP-1	4/25/07	melt, very high		108	<2.0		<0.5			<10	185		
BB-1	4/25/07	melt, very high		261	<2.0		<0.5			<10	406		
WBP-2	4/25/07	melt, very high		210	<2.0		<0.5			<10	336		
WBP-1	6/26/07	baseflow	<2	46	<2	<0.02	<0.50	<5	<2	<10	270	29	<2
BB-1	6/26/07	baseflow	<2	120	<2	0.03	<0.50	13.7	<2	<10	336	702	17.9
WBP-2	6/26/07	baseflow	<2	46	<2	<0.02	<0.50	<5	<2	<10	273	31	<2
PEN-18	6/26/07	baseflow	<2	37	<2	<0.02	<0.50	<5	<2	<10	62	13	<2
BB-1	10/23/07	low baseflow	<2	727	0:00	0.07	<0.50	32.0	<2	<10	369	403	36.0
WBP-6	10/23/07	low baseflow	<2	133	<2	<0.02	<0.50	<5	<2	<10	292	10	<2

Sample ID		Flow	Pb µg/L	Sb µg/L	Se µg/L	Si ug/L	Sn µg/L	Sr ug/L	Ti µg/L	Tl µg/L	V µg/L	Zn µg/L
WBP-1	4/25/07	melt, very high	<2.0									1.3
BB-1	4/25/07	melt, very high	<2.0									1.6
WBP-2	4/25/07	melt, very high	<2.0									1.4
WBP-1	6/26/07	baseflow	<2	<2	<10	2.67	<10	11	<5	<10	<5	<5
BB-1	6/26/07	baseflow	<2	<2	<10	7.23	<10	95	<5	<10	<5	<5
WBP-2	6/26/07	baseflow	<2	<2	<10	2.68	<10	11	<5	<10	<5	<5
PEN-18	6/26/07	baseflow	<2	<2	<10	1.30	<10	15	<5	<10	<5	<5
BB-1	10/23/07	low baseflow	<2	<2	<10		<10		<5	<10	<5	9
WBP-6	10/23/07	low baseflow	<2	<2	<10		<10		<5	<10	<5	<5

Results - Sources

- Several pits on Ore Mountain
- These are generally small and mostly without evidence of surface drainage
- Lowest pit by the Iron Mountain Road had some runoff after 1.02 inches of rain. The pH was 2.2 but it was a very weak flow. Any connection to Blood Brook would be a small seasonal stream.



looking downstream from log yard stream pH 2.63

Summary

- Blood Brook water quality is very bad, but it might be due to natural sources
- There is very little evidence for an impact on the West Branch (other than maybe a small local effect before mixing is complete)
- The West Branch at KIW (WBP-2) may have local sources of acidity, iron, sulfur and aluminum



Close up of iron seep 5/4/2010