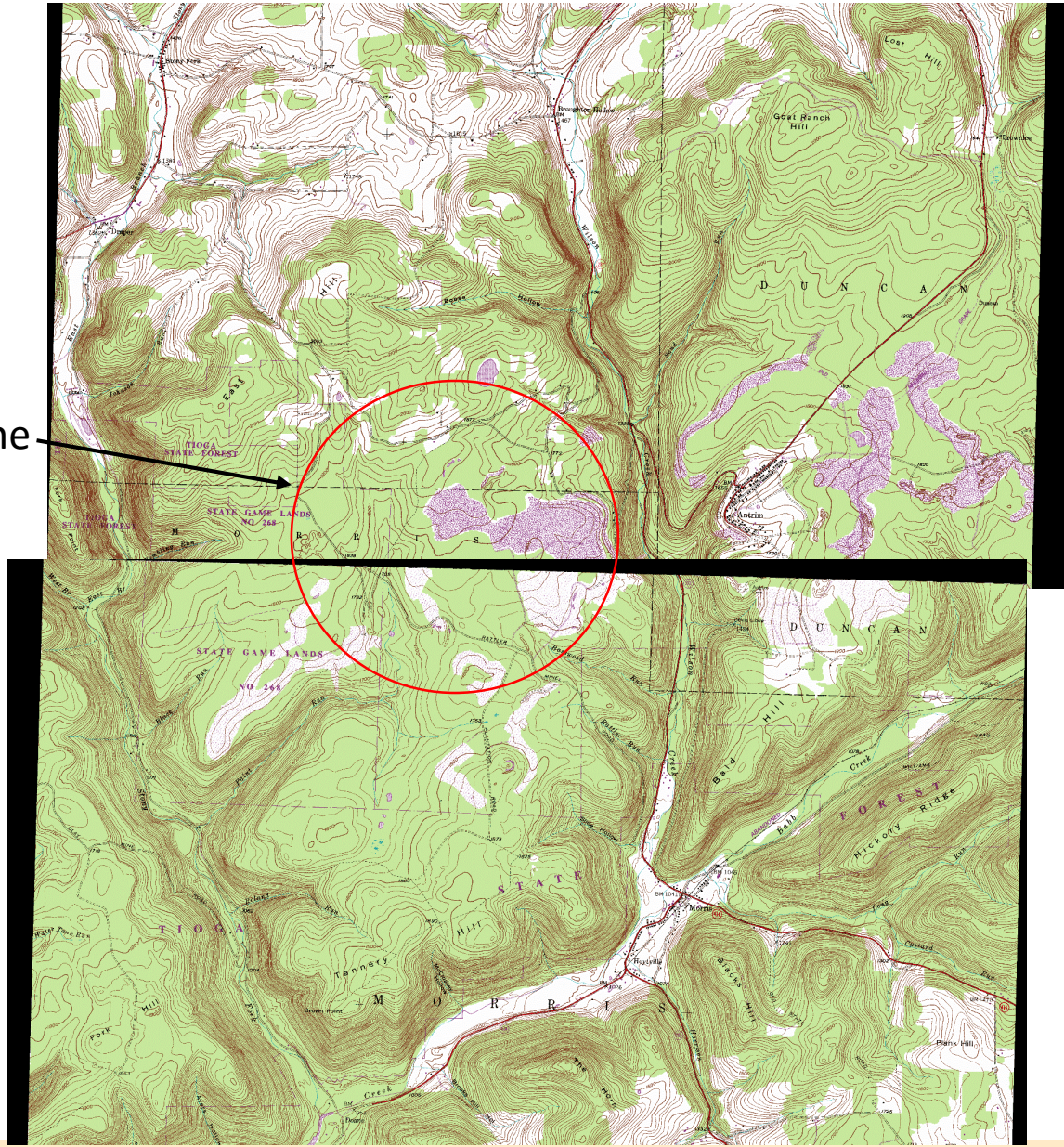


50 years of AMD Pollution and Remediation at the Anna S Mine, Tioga County, PA

Robert Hedin, Neil Wolfe, Ted Weaver, Kim Weaver
Hedin Environmental
Pittsburgh PA



Anna S Mine



<i>Mining, treatment and monitoring activities at Anna S Mine</i>	
Year	Activity
1890s – 1930s	Underground mining, Bloss seam
1976-1986	Daylighting and surface mining
1975-76	Monitoring, Operation Scarlift
1976-1984	Monitoring, USGS
1985-1989	Monitoring, Antrim Mining
1996-2000	Monitoring, PADEP and BCWA
2003-2004	Installation of passive treatment systems
2004-present	System Maintenance; Monitoring, BCWA and HE



Anna S Mine discharges

- Hunters Drift: deep mine drain, variable flow rates, highly contaminated water
- S1: deep mine entry, moderately contaminated water
- S2: surface mine discharge, least amount of flow, modestly contaminated water





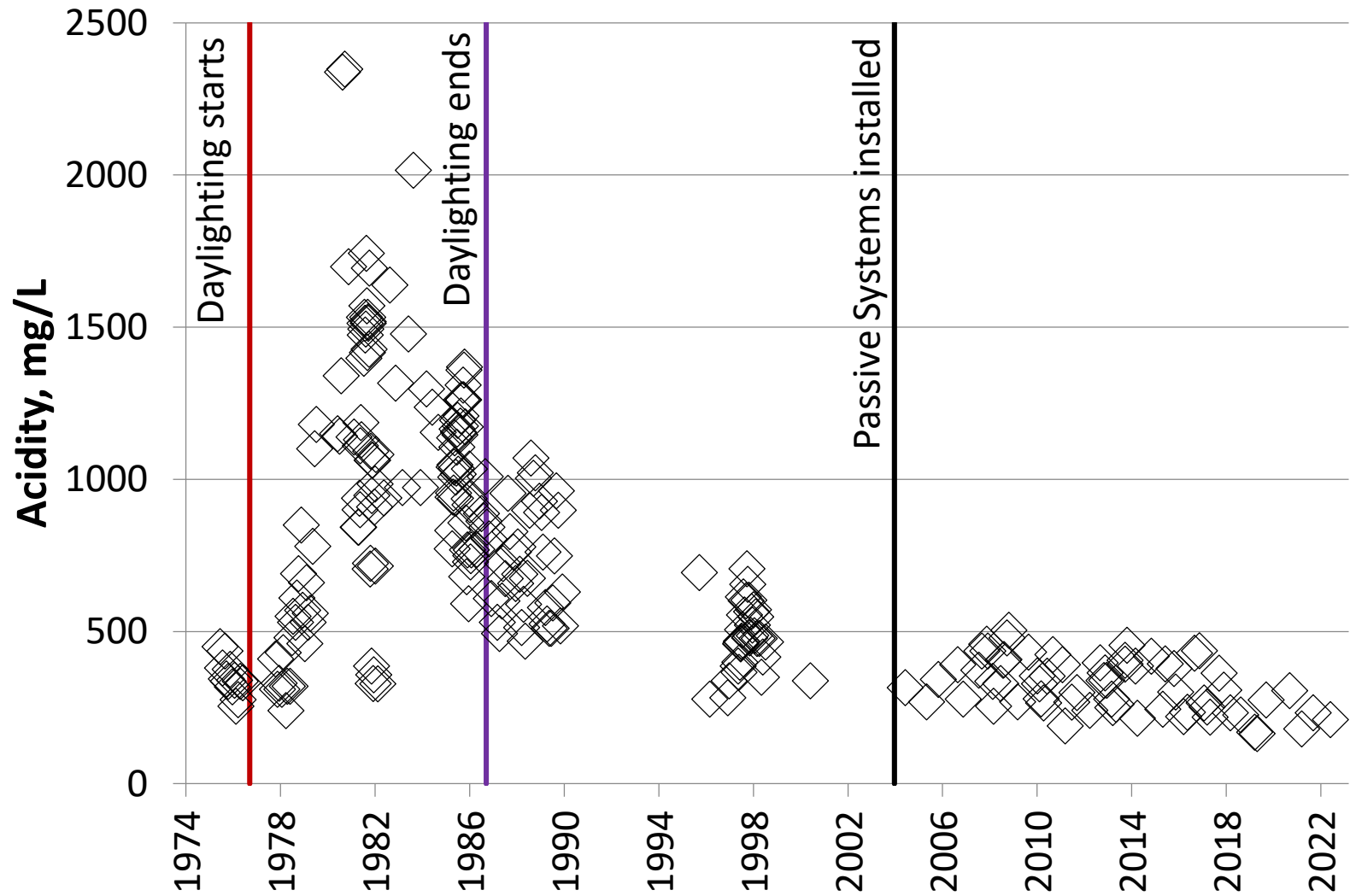


Daylighting / Remining

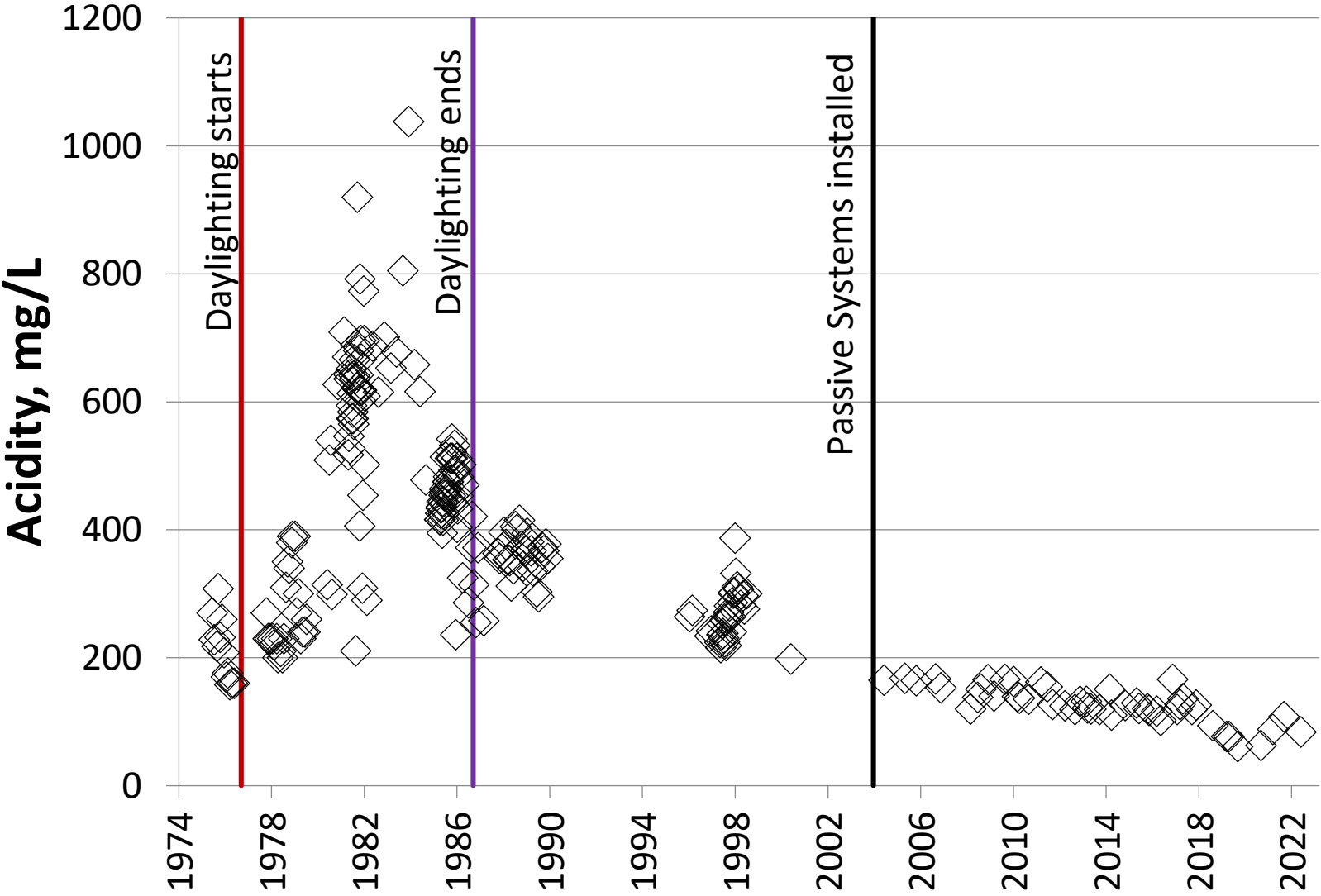
- Removal of stumps from deep mine
- Mining of Cushing coal seam above the mine
- Existing deep mine discharges avoided
- Overburden net acidic
- No alkaline addition (pre-ABA requirements)



HD Acidity, 1975 - 2022



S1 acidity, 1975-2022

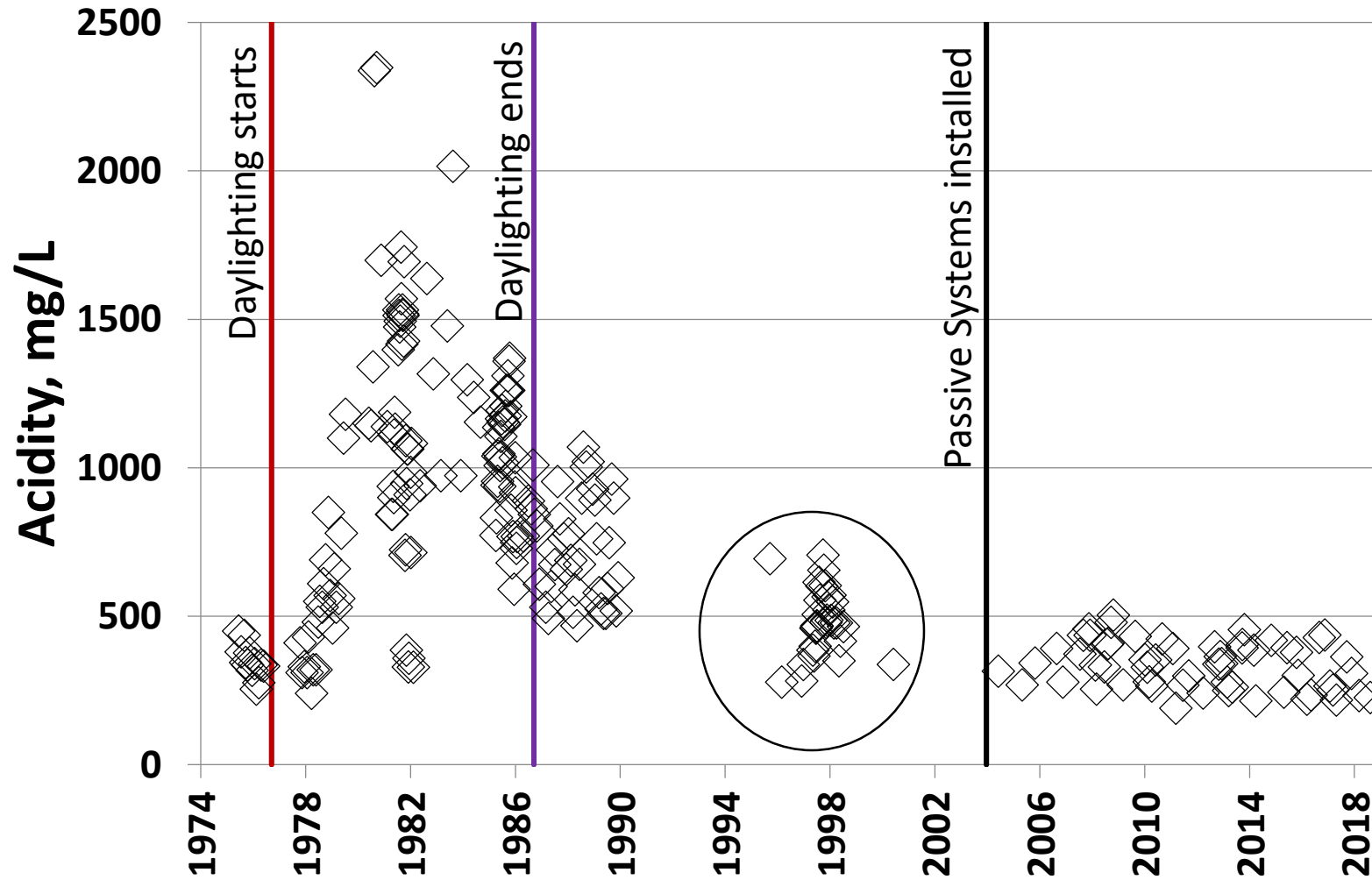


Consequences of Increased AMD

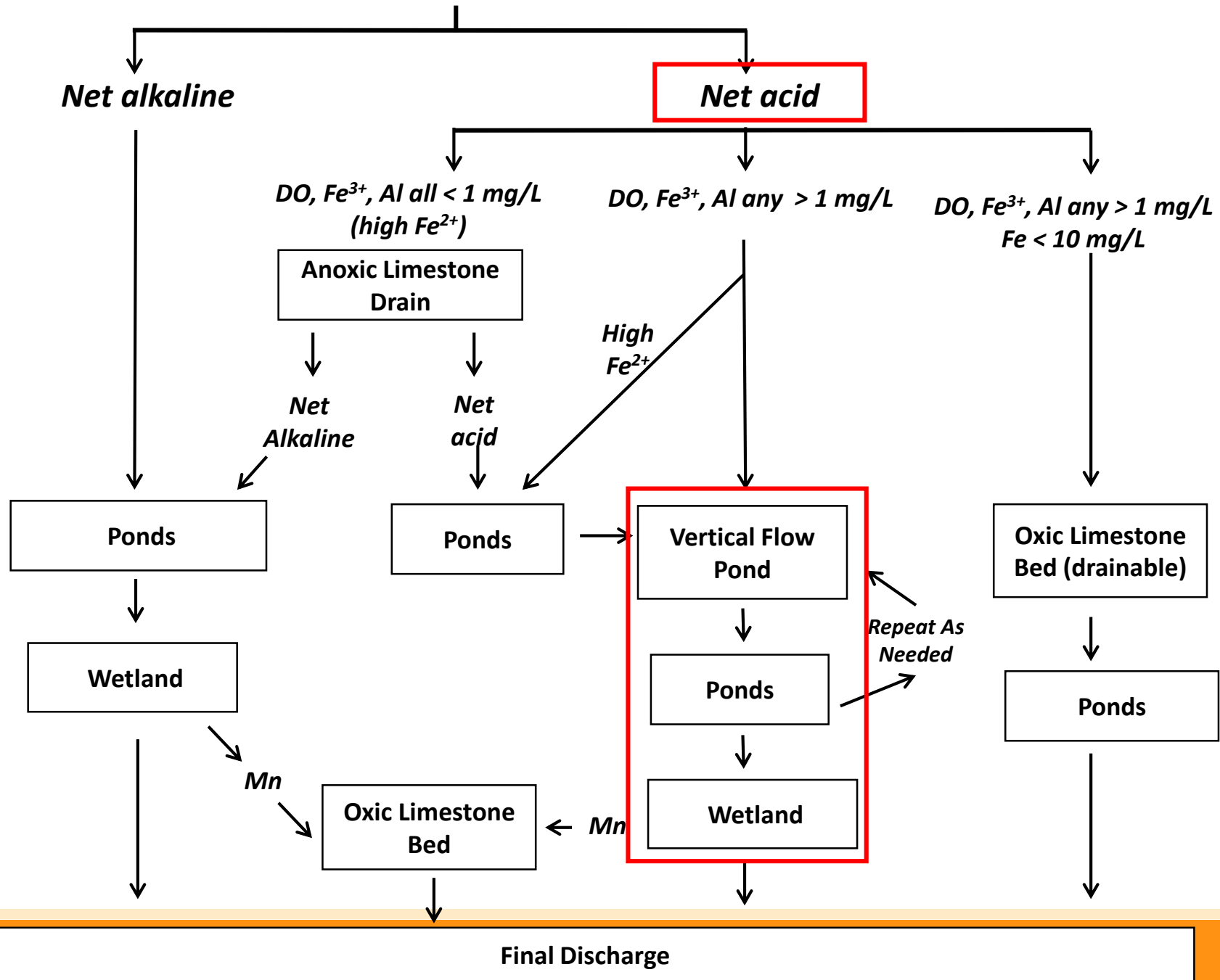
- Severely polluted 6 miles of Babb Creek
- Degraded 5 miles of Pine Creek downstream of Babb
- 1990: Fish Commission found no fish in Babb Creek below Wilson Creek
- 1990: Babb Creek Watershed Association formed
- 1996: Babb Creek placed on 303(d) list
- 1996: Antrim Mining builds lime treatment plant for Antrim discharges
- 1996: Push to install treatment on Anna S discharges

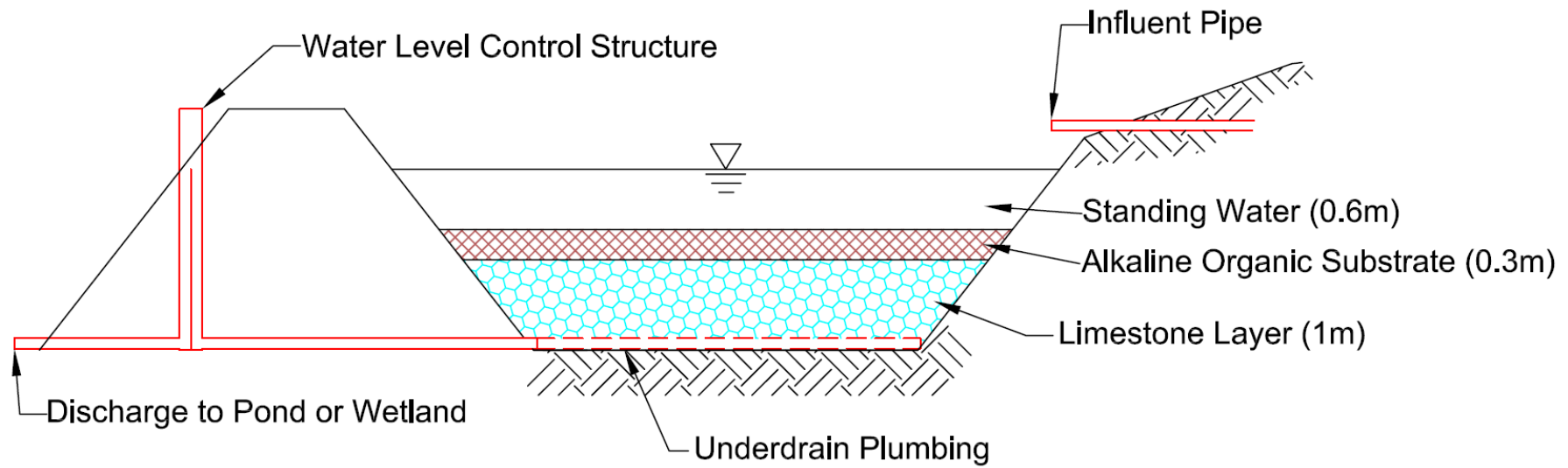


HD acidity, 1975 - 2018



Characterize Mine Water

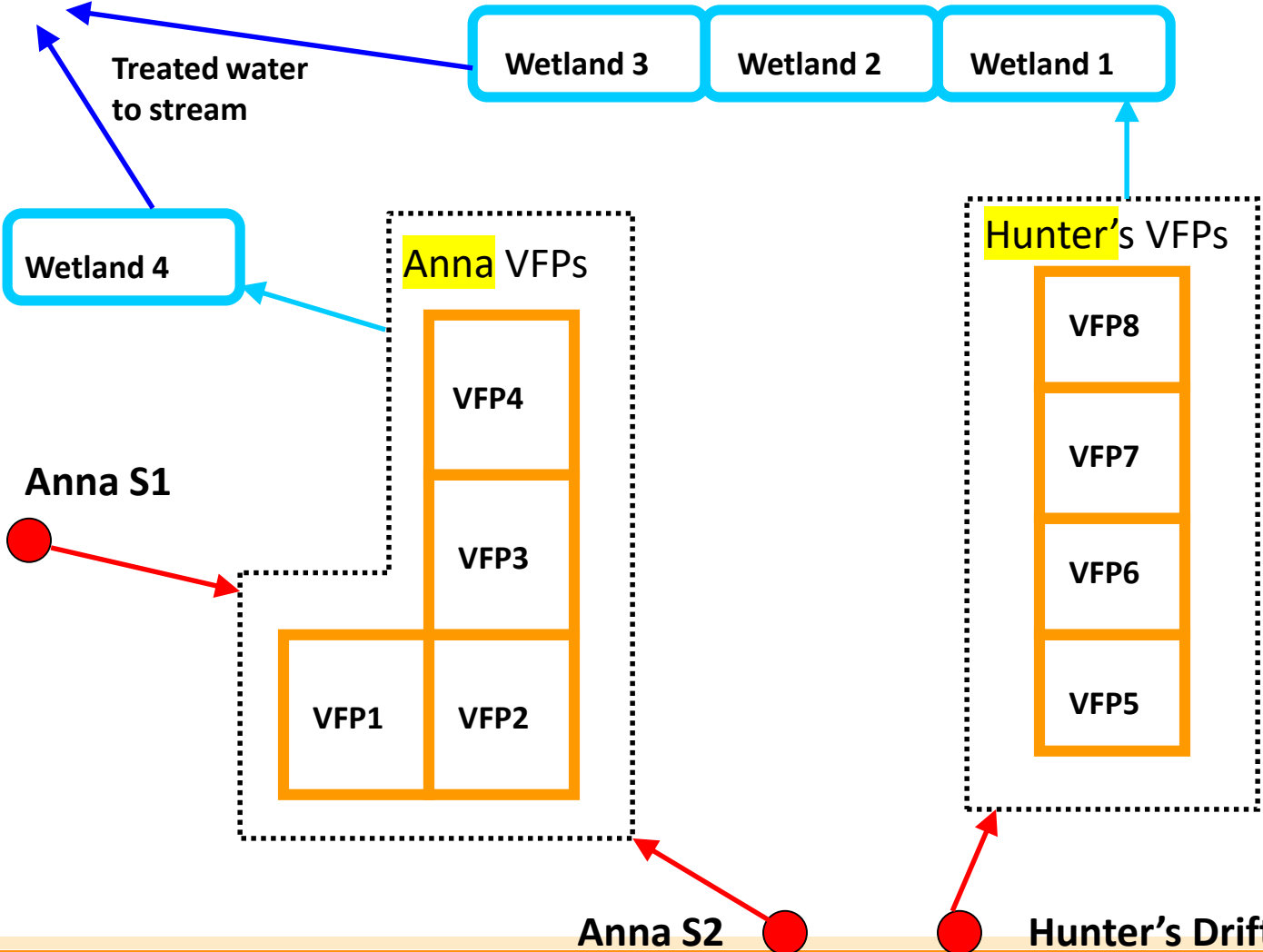


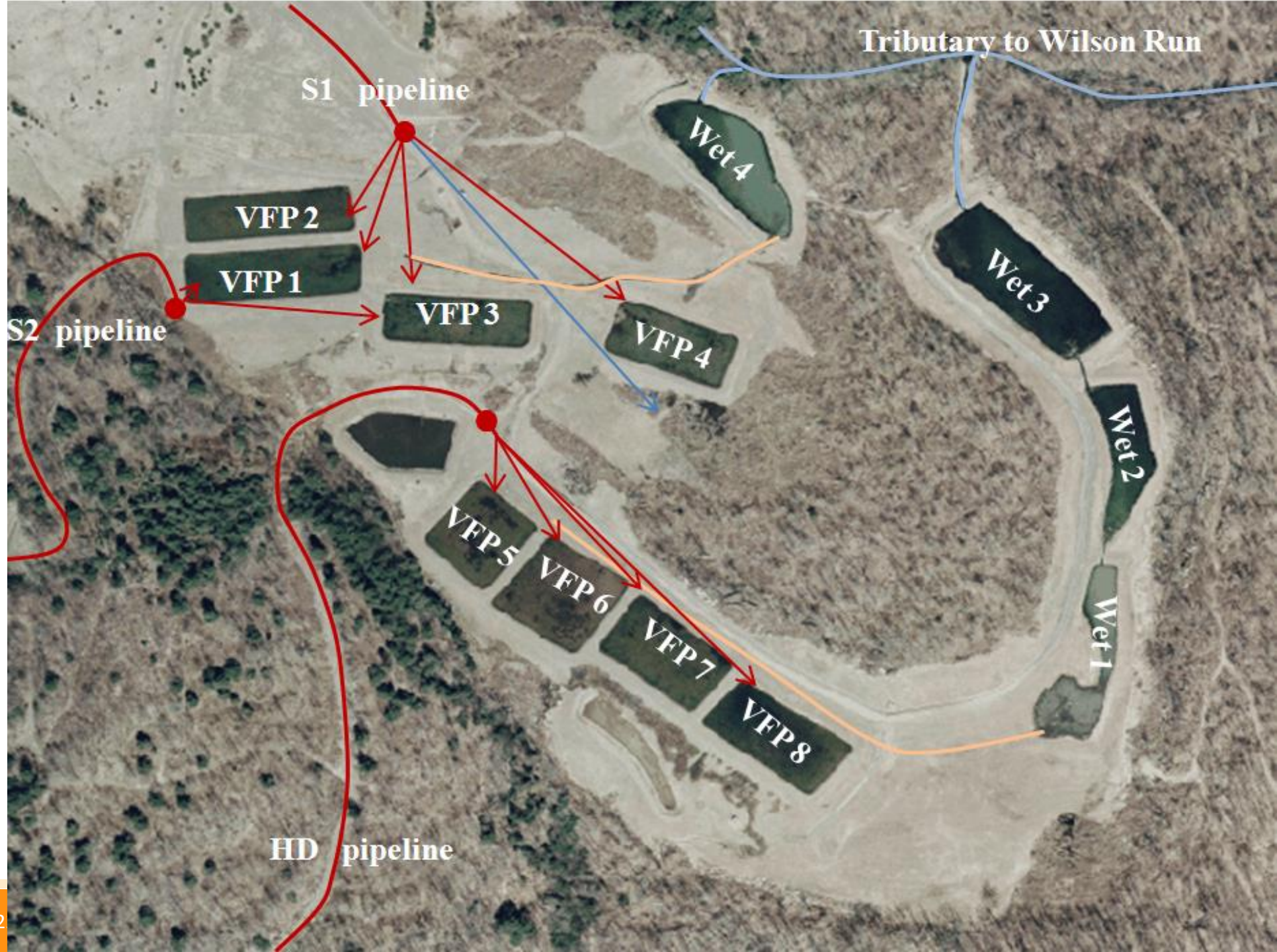






General Site Layout





Anna S Mine Complex Passive System

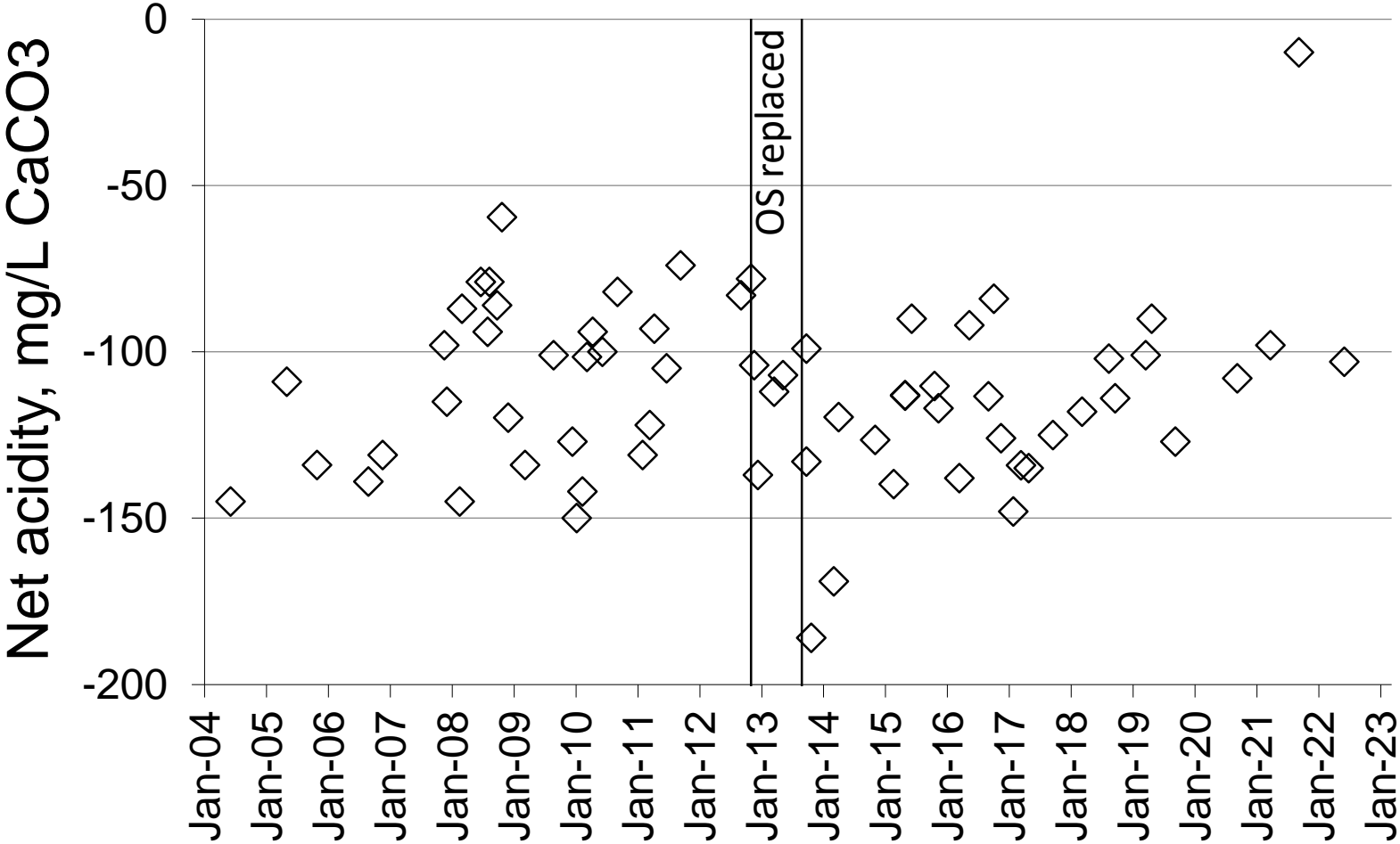
- Largest project undertaken by citizen group in PA
- \$2.5 million (2001) in state, federal, and private funds
- Three pipelines totaling 8,000 ft of pipe
- 8 vertical flow ponds covering 7 acres
 - 39,000 tons of limestone
 - 6,500 cubic yards of compost
- 4 constructed wetlands covering 4 acres



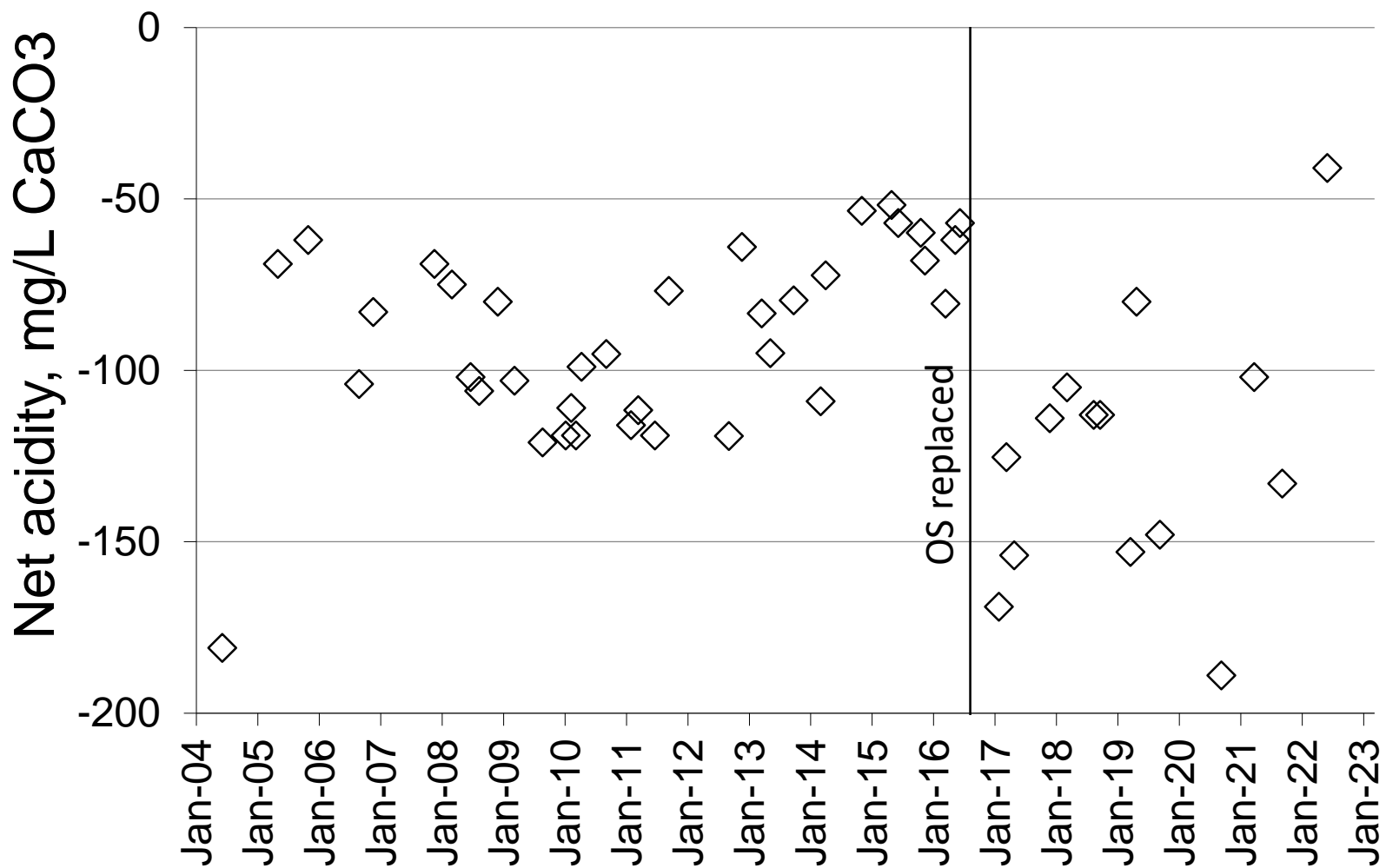
<i>Average flow and chemistry for Anna and HD treatment systems, 2004 – 2022</i>								
Point	Flow	pH	Alk	Acid	Fe	Al	Mn	SO4
	gpm		mg/L CaCO₃	mg/L	mg/L	mg/L	mg/L	mg/L
Anna System								
S1 & S2 in	210	3.2	0	116	5.5	10.1	7.0	300
VFPs out	na	7.1	160	-129	4.9	0.4	5.9	286
Final	na	7.5	134	-110	1.1	0.3	3.3	281
Hunters Drift System								
HD in	266	2.8	0	322	30.9	29.7	5.9	527
VFPs out	na	6.8	196	-125	18.2	0.5	4.9	501
Final	na	7.5	138	-112	0.5	0.2	1.8	461



HD final effluent



Anna final effluent



Maintenance of the Systems

Routine Maintenance

- Babb Creek Watershed Association
- Monthly inspections; semi-annual sampling; simple maintenance
- \$10,711 in 2018

Major Maintenance

- Activities that require fund raising and outside contracting
- Replacement of organic substrates, repairs to collection structures; access road improvements



Substrate Investigation



Substrate Investigation, Good Result



Substrate Investigation, Bad Result



Organic Substrate Rehab Process

- Isolate VFP
- Strip off existing substrate
- scarify limestone aggregate
- Place 9-12” of new alkaline substrate
- replace old substrate on top





Organic Substrate Rehabilitation

Hunters Drift VFP Rehab

- VFP8 in 2012
- VFP5, VFP6, VFP7 in 2013
- \$210,008

Anna VFP Rehab

- VFP1, VFP2, VFP3, VFP4 in 2016
- \$201,706



HD VFP investigation Sept 2022



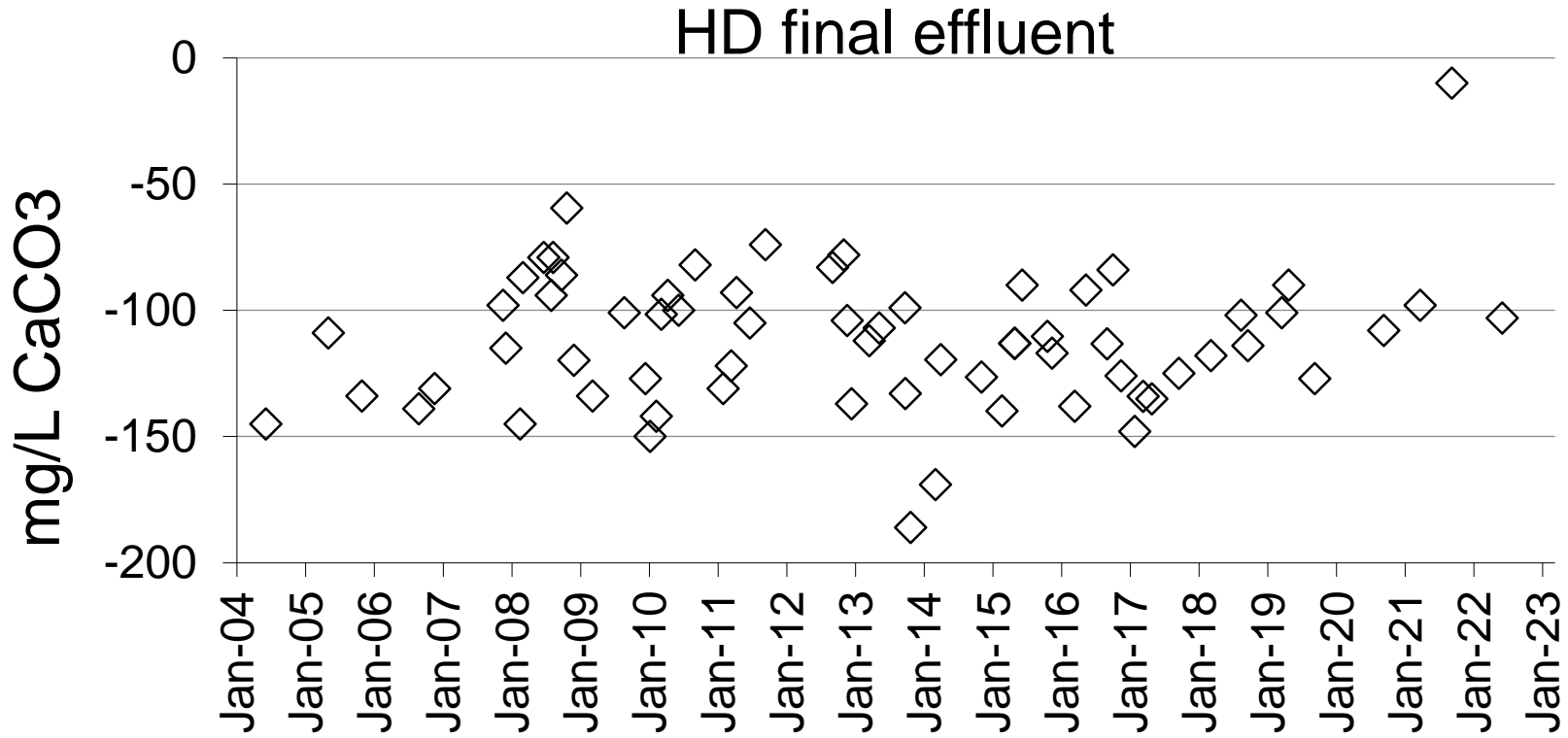
HD VFP investigation Sept 2022



Water Quality Impacts of Mining and Treatment

Year	Activity
1890s – 1930s	Underground mining, Bloss seam
1975-76	Monitoring, Operation Scarlift
1976-1986	Daylighting, Bloss and Cushing seams
1976-1984	Monitoring, USGS
1985-1989	Monitoring, Antrim Mining
1996	Babb Creek placed on 303(d) list
1996	Construction of Antrim lime plant
1996-2000	Monitoring, PADEP and BCWA
2003-2004	Construction of Anna S system
2004-present	Monitoring, BCWA and HE
2010	Babb Creek removed from 303(d) list; Sections of Babb Creek designated as Wild Trout stream
2012-2013	Hunters Drift organic substrate replacement
2016	Anna organic substrate replacement
2023(?)	Hunters Drift major maintenance





The Anna S passive system is highly effective, but is it **cost** effective?



Cost-effectiveness approach

- Collect cost and treatment performance data for Anna S and three chemical treatment facilities
- Bring all costs to 2021 using US Bureau of Reclamation Composite Cost Index
- Project 20 year costs for each system, assuming they are each built with 2021 costs (5% interest)
- Compare the annual costs to alkalinity generation (as determined from recent data)



Anna S Passive Treatment system costs: realized and adjusted to 2021			
Item	periodicity	Cost (year)	Cost, 2021*
<u>Anna S Passive Systems</u>			
Construction	One-time	\$2,215,699 (2003)	\$4,090,521
Engineering	One-time	\$301,000 (2003)	\$555,692
Routine O&M	Annual	\$10,711 (2018)	\$11,942
HD OS Replacement	Every 12 years	\$210,008 (2013)	\$256,739
Anna OS Replacement	Every 12 years	\$201,706 (2016)	\$240.780

*** Adjusted using US Bureau of Reclamation Composite Cost Index**



Anna S Passive System compared to Chemical Systems

	Anna S	Hollywood	Smail Orcutt	Brandy Camp
Technology	Passive	hydrated lime	lime slurry	lime slurry and H ₂ O ₂
owner	BCWA	PA BAMR	PA DMO	PA BAMR
Flow, gpm	470	1,913	55	1,000
Acid in, mg/L	238	224	439	43
Acid out, mg/L	-112	-15	-37	-90
Alk gen, mg/L	350	239	476	133
Alk gen, ton/yr	360	1,002	57	290
Construction	\$4,090,521	\$17,859,689	\$718,110	\$3,856,579
Engineering ^A	\$555,692	\$2,678,953	\$98,142	\$578,487
Major Maintenance	\$497,519	unknown	unknown	unknown
Annual	\$11,942	\$775,718	\$91,916	\$304,963

All costs adjusted to 2021 using USBR Composite Cost Index

^A engineering cost for Hollywood and Brandy Cam- assumed at 15% of construction cost



Anna S Passive System compared to Chemical Systems

	Anna S	Hollywood	Smail Orcutt	Brandy Camp
	passive	hydrated lime	lime slurry	lime slurry & H ₂ O ₂
	\$/yr ^A	\$/yr ^A	\$/yr ^A	\$/yr ^A
Construction	\$328,234	\$1,433,188	\$57,634	\$309,462
Engineering	\$44,590	\$214,966	\$7,875	\$46,419
Major Main	\$41,460	unknown	unknown	unknown
Routine Main	\$11,942	\$775,718	\$91,916	\$304,963
Total	\$426,226	\$2,437,492	\$157,414	\$660,844
Flow, gpm	470	1,913	55	1,000
Alk gen, ton /yr	360	1,002	57	290
\$/ton CaCO ₃	\$1,184	\$2,419	\$2,744	\$2,267
Anna S / Chem		49%	43%	52%

^Aannualized cost, 20 years, 5% interest rate



Summary

- Deep mining and surface mining has polluted Babb Creek with AMD for 120 years.
- The AMD has been successfully treated in two passive systems for the last 15 years. The reasons for the success include:
 1. Conservative treatment system design
 2. Naturally improving mine water chemistry
 3. Diligent maintenance by Babb Creek Watershed Association
- Babb Creek has been restored to a wild trout stream
- The Anna S passive system has provided treatment for ½ the cost of conventional chemical treatment.



Questions / Comments



Anna S Mine Complex

*Brought to you by the
Babb Creek Watershed Association
in partnership with*



Hedin Environmental



