THE CASSELMAN RIVER RESTORATION PROJECT[1]

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Abstract: The area along the Casselman River between Boynton and Meyersdale, PA was extensively mined in the late 1800's to early 1900's. The mining operations were room and pillar underground mining primarily on the Pittsburgh coal seem. The mined out area is approximately 5,000 acres in this deep mine complex (Shaw Mines Complex - SMQ. Three tributaries to the Casselman River are impacted by acid mine drainage (AMD). Two of them are being restored primarily by re-mining and the third has open limestone channels (OLCs) installed to remove part of the AMD produced in the SMC.

Keywords: Open Limestone Channels, Re-mining, Acid Mine Drainage

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Introduction

Prior to the spring of 1993, the Casselman River was starting to rejuvenate between Rockwood and Confluence, PA. It was a stockable fishery in this region and upstream of Boynton, PA. The water quality in area between Boynton and Rockwood, although improving, was not suitable for sustaining fish life before the catastrophic discharge of acid mine drainage (AMD).

The May 1993 acidic discharge occurred as a result of a rise in the local watertable due to a heavy snow cover that followed several years of below normal snowfall. The minerals in the long -abandoned deep mine (Shaw Mines Complex - SMQ oxidized during the drier summer and leached into solution as the watertable increased. The resulting surge of Acid Mine Drainage (AMD) was higher than the Casselman River could neutralize and the aquatic life was killed from the SMC downstream to the confluence with the Youghiogheny River.

There was some concern that the increased acidity and mineral loading would threaten the Youghiogheny River. The Casselman feeds into the Youghiogheny River, which passes through Ohiopyle State Park in neighboring Fayette County. The park attracts two million visitors annually because of its natural beauty, whitewater boating and excellent fishing. The park contains a National Natural Landmark, Femcliff Peninsula, which harbors several threatened or endangered plant species along the river's edge. A few years prior to the AMD discharge, the Pennsylvania Game Commission began to re-introduce a threatened species of otters in the Youghiogheny, and many of those otters migrated upstream into the Casselman River. A fish kill on the Youghiogheny River was averted only because the Corps of Engineers temporarily increased the discharge from Youghiogheny River Lake, a multi-purpose facility located just upstream from the confluence of the Youghiogheny and Cassehnan Rivers.

Three tributaries were identified by the Meiser and Earl study, as the main sources of the acid mine drainage (AMD). Shaw Mines Run (39% AMD load) located on the north side of the SMC. Weir- I I (17% AMD load) a single point mine discharge on the east side of the SMC. Coal Run (44% AMD load) located on the south side of the SMC.

The discharges at Shaw Mines Run and Weir- I I will be remediated by re-mining and dewatering the old mine workings. The entire flow of Shaw Mines Run and most of Weir I I will be diverted through a 2,500 ft long limestone drain (to keep the mine pool de-watered) and discharge into an oxidation/settling pond before entering the Casselman River.

The Coal Run watershed was studied by the NMLRC since June, 1993. Sources of AMD were identified and loading rates calculated for each source. This data was used to design and locate the most effective and economical treatment systems (limestone channels/drains) for the area. Design criteria was based on field studies of armored open limestone drains in West Virginia (Ziemkiewicz et.al.) and a report by Pearson and McDonnell. Laboratory scale tests (Brant and Ziemkiewicz) were also used to test the designs and develop correct retention times.

Objective

Our objective for this project was to design inexpensive low-maintenance AMD treatment systems to aid re-mining in the restoration of the Casselman River watershed to pre-event conditions. The system should also prevent this type of catastrophe from occuring in the future.

Restoration Plan

Shaw Mines Run / Weir- 11

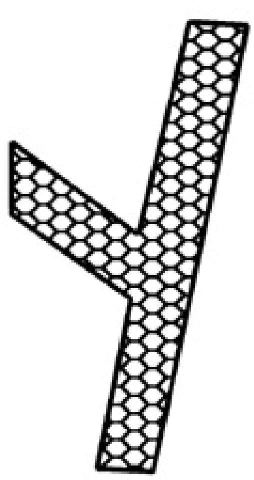


Figure I Anoxic Limestone Drain

Re-mining should have the most beneficial impact over the long term. The re-mining is taking place along Shaw Mines Run, the primary tributary from the Shaw Mines Complex into the Casselman River. Shaw Mines Run carries about 39 percent of the acid load into the Casselman River from the Shaw Mines Complex. Re-mining usually improves water quality, and it offers a no cost means of reclaimtion that can restore waterways. The watershed restoration portion of the re-mining occured in two phases. The first phase opened the area along Shaw Mines Run for the installation of a large anoxic limestone drain (ALD). The second phase will mine toward weir I I to intercept the water recharging the seep. A second ALD will be installed and connected to the first drain (figure 1). The completed ALD will be 2,5 00 ft long, 3 0 ft. wide, and 10 ft. deep and will be filled limestone that is 2 - 3 feet in diameter.

Coal Run

The first major impact of AMD to the Casselman River is Coal Run. It is responsible for about 44% (5,000 pounds/day) of the acid load from the SMC and most of the seeps are not affected by re-mining. The treatment method proposed is a series of Open Limestone Channels (OLQ.

The idea of using limestone to treat AMD is not new, but limestone will coat (armor) with iron and aluminum precipitates. This armoring was thought to be impermeable and rendered the limestone useless. However, new investigations (Ziemkiewicz et.al., and Brant and Ziemkiewicz) indicate that even armored limestone will disolve in acidic water and treat AMD at a slower rate (20%) than unarmored limestone. This research, along with a report by Pearson and McDonnell, provide the basis for the OLC designs used in Coal Run.

Open Limestone Channel Requirements

The first channel was installed in a tributary to the north branch of Coal Run during September 1995. The old mine seal at the head of the tributary discharges up to 2.7 tons of acid per day. The OLC at this location is a trapezoidal channel 1,200 feet long, 6 feet wide, and 2 feet deep installed on a 11% slope (figure 2). The diameter of the limestone used was 4 - 9 inches.

The second channel was installed in the north branch of Coal Run. The 1995/1996 winter delayed the completion until June 1996. The seeps along this drain discharge up to 3 tons of acid per day. The OLC at this location is a trapezoidal channel 2,665 feet long, 10 feet wide, and 2 feet deep installed on a 2% slope (figure 2). The diameter of the limestone used was 6 - 24 inches.

The third channel was installed in a tributary to the main channel of Coal Run during October 1996. The mine seal at the headwaters of the tributary discharges up to 6.1 tons of acid per day. The OLC at this location is a trapezoidal channel 1,500 feet long, 6 feet wide, and 2 feet deep installed on an 8% slope (figure 2). The diameter of the limestone used was a minimum of 12 inches.

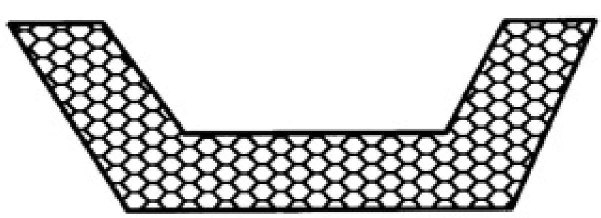
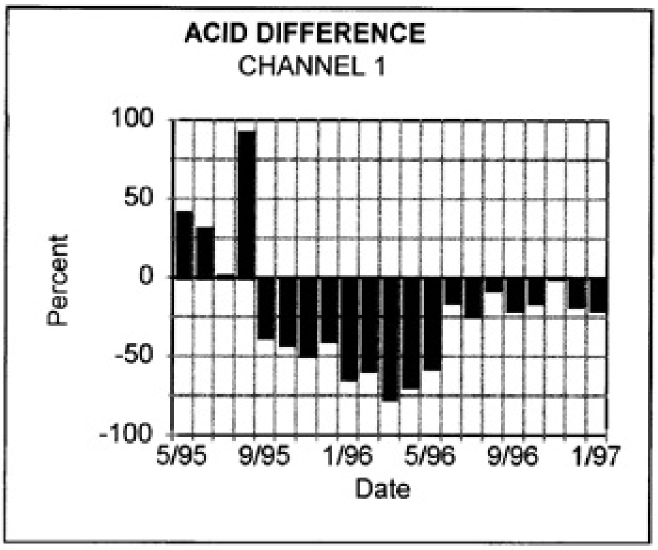


Figure 2 - Trapezoidal Open Limestone Channel

Results

Re-mining is diverting approximately 50 percent of flow from discharges and seeps in the Shaw Mines Complex to a single point and is reducing the level of the central mine pool. Alkalinity will be added to the discharge when the ALD is completed. The other half of the underground flow continues to discharge at scattered points, primarily along Coal Run.



The graph to the left shows the change in the acid loading of the first drain since May 1995. The drain has been removing acidity since it was completed in September 1995. The average acid load removal for this drain is 15%. Removal is indicated bby the negative number.

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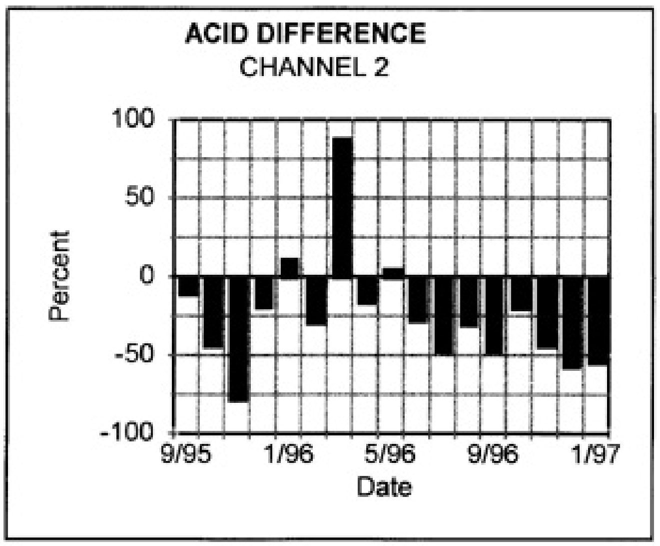

The second chart plots the acidity reduction of the second channel. This channel was started in October 1995 and finished in June 1996. The periods of acidity increase coincide with higher than normal flow rates. The average acid load removal for this drain is 38.5%.

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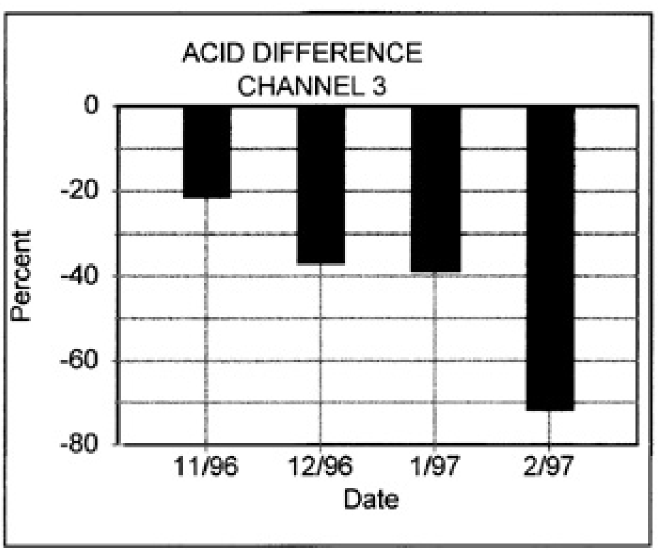

The third graph charts the acid load removal of channel 3. This channel has been removing acidity since it was completed in November 1996. The average acid load removal is 47% for the this drain.8

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Channel 1 Water Quality

influent	Units	Min.	Max.	Ave.	Effluent	Min.	Max	Ave	%Change
pH	S.U	2.3	2.8	2.6		2.6	3.4	2.8	0
Acidity	t/d	0.20	1.40	0.75		0.11	1.15	0.64	-15
Fe	t/d	0.04	0.89	0.24		0.02	0.87	0.21	-12
Mn	t/d	0.01	0.07	0.03		0.01	0.08	0.03	0
SO_4	t/d	0.41	3.35	1.72		0.32	3.21	1.61	-6
Al	t/d	0.01	0.16	0.07		0.01	0.14	0.06	-14
Ca	t/d	0.03	0.31	0.12		0.06	0.94	0.24	100
Mg	t/d	0.02	0.51	0.18		0.03	0.64	0.18	0
Flow	gpm	20	168	93		20	184	97	4

Channel 1 is the oldest OLC in the Coal Run watershed. Problems that occurred since completion were: Flooding channelized the drain leaving some areas without any limestone. The floods also washed sandstone gravel into the drain causing some plugging of the pore spaces. Higher than normal precipitation created additional discharges into the OLC. All these factors combined to lower the acidity reduction to 15 - 22%.

Channel 2 Water Quality

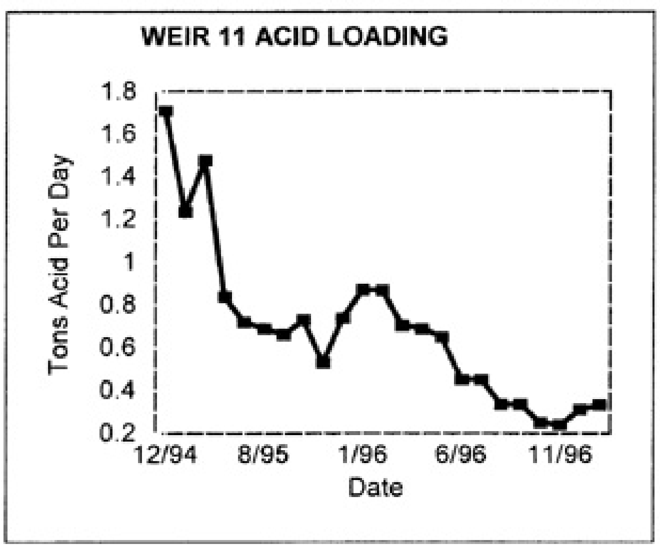
influent	Units	Min.	Max.	Ave.	Effluent	Min.	Max	Ave	%Change
pH	S.U	2.7	3.0	2.8		2.8	3.5	3.0	7
Acidity	t/d	1.18	6.09	2.6		0.77	2.62	1.60	-38
Fe	t/d	0.15	1.81	0.77		0.08	0.72	0.32	-58
Mn	t/d	0.04	0.19	0.11		0.03	0.12	0.07	-36
SO_4	t/d	4.41	12.7	7.13		2.45	10.5	5.64	-21
Al	t/d	0.08	0.33	0.19		0.06	0.18	0.13	-32
Ca	t/d	0.38	1.94	1.11		0.38	1.85	1.05	-5
Mg	t/d	0.24	1.56	0.85		0.22	1.35	0.77	-9
Flow	gpm	310	1556	694		372	2076	820	18

The flooding and higher precipitation totals for the year also had a negative impact on Channel 2. The completion date was delayed to the winter of 1995 - 1996. The flooding washed debris (leaf litter, twigs, and trash) into the drains causing some plugging. The high water levels also created additional seeps into the OLC and caused most of the AMD to flow over the top of the limestone. These factors contributed to an acid load reduction of 38%.

Channel 3 Water Quality

influent	Units	Min.	Max.	Ave.	Effluent	Min.	Max	Ave	%Change
pH	S.U	2.7	2.8	2.8		2.8	2.9	2.9	3.6
Acidity	t/d	0.06	0.21	0.15		0.05	0.13	0.08	-47
Fe	t/d	0.03	0.11	0.08		0.01	0.02	0.02	-75
Mn	t/d	0	0.01	0.01		0	0.01	0	-100
SO_4	t/d	0.24	0.50	0.36		0.21	0.33	0.26	-28
Al	t/d	0.01	0.02	0.02		0	0.01	0.01	-50
Ca	t/d	0.03	0.10	0.06		0.02	0.09	0.06	0
Mg	t/d	0.01	0.06	0.04		0.01	0.06	0.04	0
Flow	gpm	12	21	16		12	21	16	0

Channel 3 is the latest OLC to be installed. It was not affected by heavy precipitation to the extent of the first two drains. The larger sized limestone in this drain will handle higher than expected flows better than the previous drains. The average acid load reduction in this drain is 47%.



The Weir 11 chart shows the effect of re-mining on the acid load discharged from the mine seal at weir 11. The flow at this discharge was reduced to a maximum of 250 gpm from a maximum of 2,500 before re-mining. The average flow was reduced to 120 gpm from an average of 400 gpm.

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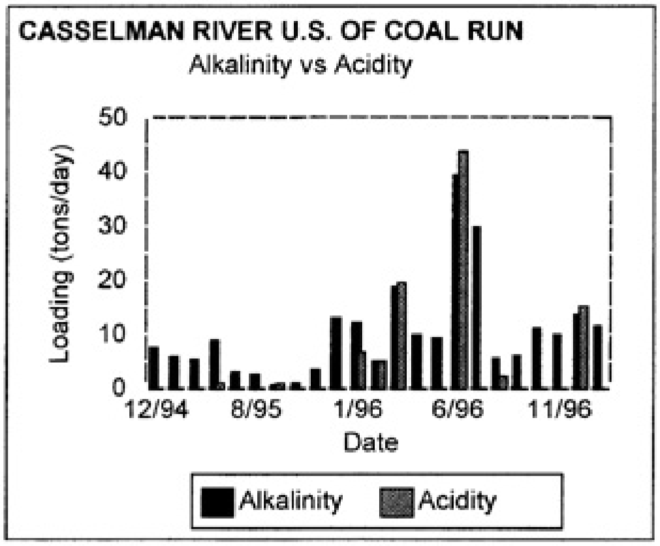

This chart shows the water quality of the Casselman River upstream of Coal Run. Alkalinity is normally greater than the acidity at this point. There are a few instances where the acidity is greater, indicating a possible seep entering the Casselman upstream of this point.

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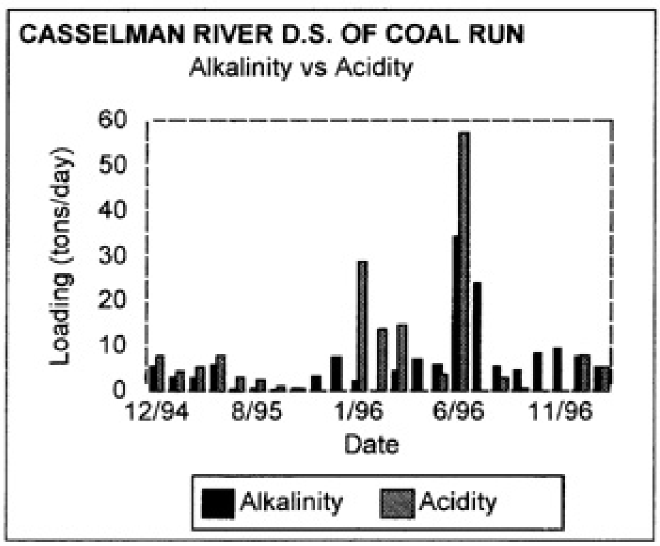

The second chart of the Casselman River quality is downstream of Weir 11. This shows a reduction in acidity at this point that coincides with re-mining toward Weir 11.

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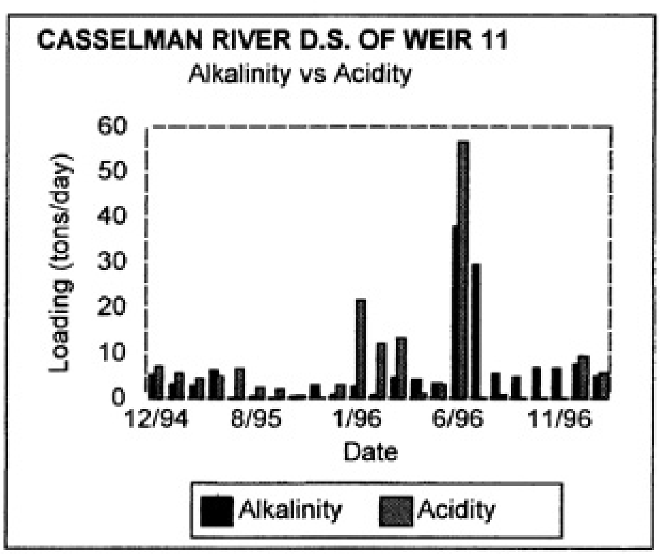

The third water quality chart of the Casselman River also shows an improvement in acidity reduction that coincides with the re-mining.

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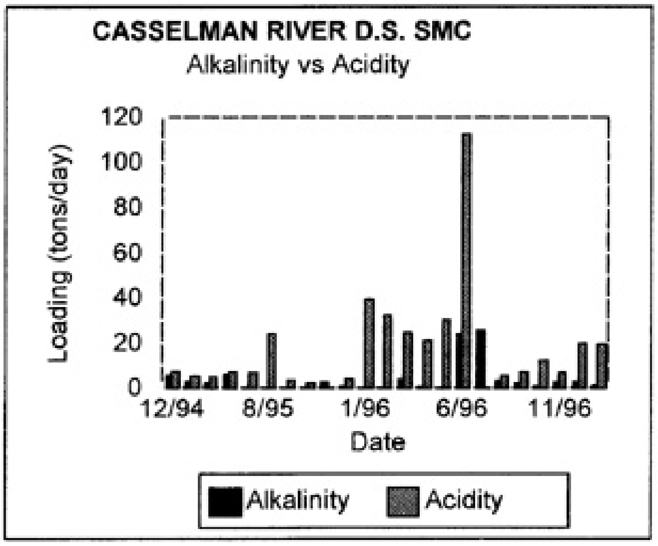
The final chart of the Casselman River quality shows some alkalinity being



The final chart of the Casselman River quality shows some alkalinity being generated at this point that was not present prior to re-mining. It also shows a decrease in the acidity once the mine pool was drained.

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Conclusions

General observations include a reduction in the sulfate load exiting the drains and calcium levels that are not as high as expected for the acidity reduction. Calculations using WATEQ indicate that the conditions exist to precipitate gypsum (CaS04). The precipitated gypsum would be covered by iron oxide and remain as part of the coating on the limestone. It could also be carried downstream as a particulate, or dissolve when a dilute slug of water goes through the drain (Rose).

The Casselman River water quality improved enough that the Pennsylvania Fish and Boat Commission stocked trout in the river between Coal Run and Weir I I during the summer of 1996. The overall water quality of the Casselman River downstream of the Shaw Mines Complex is also improving, in the fall of 1995 and throughout 1996 fish have been observed in the Casselinan River at Markelton, PA (the location of the initial fish kill). The higher than normal precipitation in 1996 should have reproduced the acid discharge that caused the initial fish kill in 1993. Data collected by the Pennsylvania Department of Environmental Protection downstream of the SMC indicates that the water quality is improving and the slug of AMD did not occur.

The results of this study indicate that the least problems occur in drains containing a 12 inch minimum size for the limestone. The second drain is constructed on a slope of 2% which is less than the 10% recommended in earlier papers suggesting that additional field studies should be completed to detennine appropriate OLC construction guidelines.

Acknowledgments

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