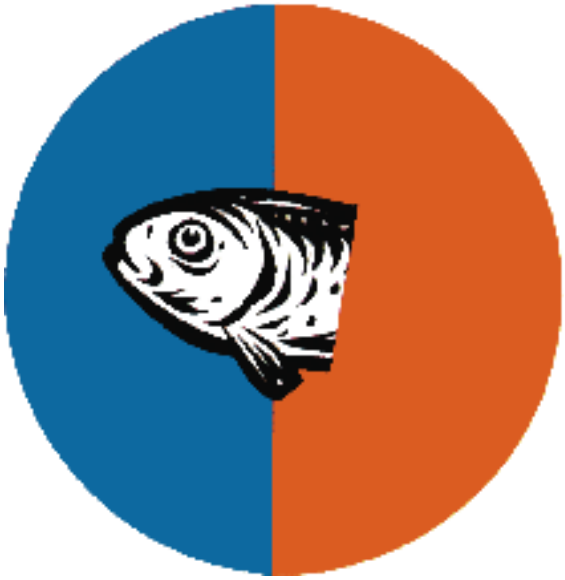
Final Report of a Pilot Project on the West Branch of Jones Run, Mill Creek Watershed, Clarion County: Stream Application of Code 60 Limestone Fines Into an AMD Affected Stream



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Mill Creek Coalition
of
Clarion and Jefferson Counties

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Clarion County

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FINAL REPORT OF A PILOT PROJECT ON THE WEST BRANCH OF JONES RUN, MILL CREEK WATERSHED, CLARION COUNTY: APPLICATION OF CODE 60 LIMESTONE FINES
December 2019

Introduction

The Clarion Conservation District, with the input of the Mill Creek Coalition of Clarion and Jefferson Counties, applied in December 2017 to the 2018 Dominion Watershed Mini Grants Program in order to initiate a pilot project using Code 60 high grade limestone fines (powder, sands, grit) to address a small but seriously affected AMD stream from decades of surface mining of coal. The West Branch of Jones Run, a tributary of Douglass Run, Mill Creek, in general does not have the correct criteria of chemistry, lacks discrete AMD flows, and has inappropriate topography for passive treatment systems. The placement of high grade limestone fines directly into the stream is one methodology that is documented to be a beneficial treatment under these situations. The Dominion Watershed Mini Grants Program through the Dominion Energy Charitable Foundation, administered by the Western Pennsylvania Conservancy, awarded a grant amount of $2,000 in March 2018. This seed grant assisted in the pursuit of additional funding to raise a total of $6,000 for this pilot project. Two other financial resources, the PA Foundation for Watersheds and the Pennsylvania Wildlife Federation each contributed $2,000 later in the year.

Background

The Mill Creek Coalition of Clarion and Jefferson Counties (MCC), including the Clarion and Jefferson County Conservation Districts and others formed in 1990 to pursue the restoration of Mill Creek from the effects of AMD throughout much of its 60 mi² watershed. Since then, the Coalition has addressed the AMD issues by steadily developing treatment strategies and systems in the upper headwaters and gradually moving to other AMD challenges downstream. Approximately $12 million has been invested in restoration efforts thus far. The MCC is presently placing more attention toward the lower subwatershed of Jones/Douglass Run.

The Jones/Douglass subwatershed of Mill Creek, located in Clarion Twp., Clarion County, consists of approximately 7200 acres (about 11 mi²) and drains into Mill Creek about one half mile downstream of Little Mill and about five miles upstream of the confluence of Mill with the Clarion River (Figure 1). The lower portion is in the PA Game Commission's Game Lands 74 (6700 acres within the Mill Creek Watershed) and includes where Jones drains into Douglass. The West Branch of Jones Run meets a south branch several hundred yards upstream of a road crossing known as the Deer Run Road Bridge, adjacent

to the upper boundary of Game Lands 74 (see star in Figure 1) and continues approximately .75 miles to Douglass, which flows about .5 miles until it meets Mill Creek.

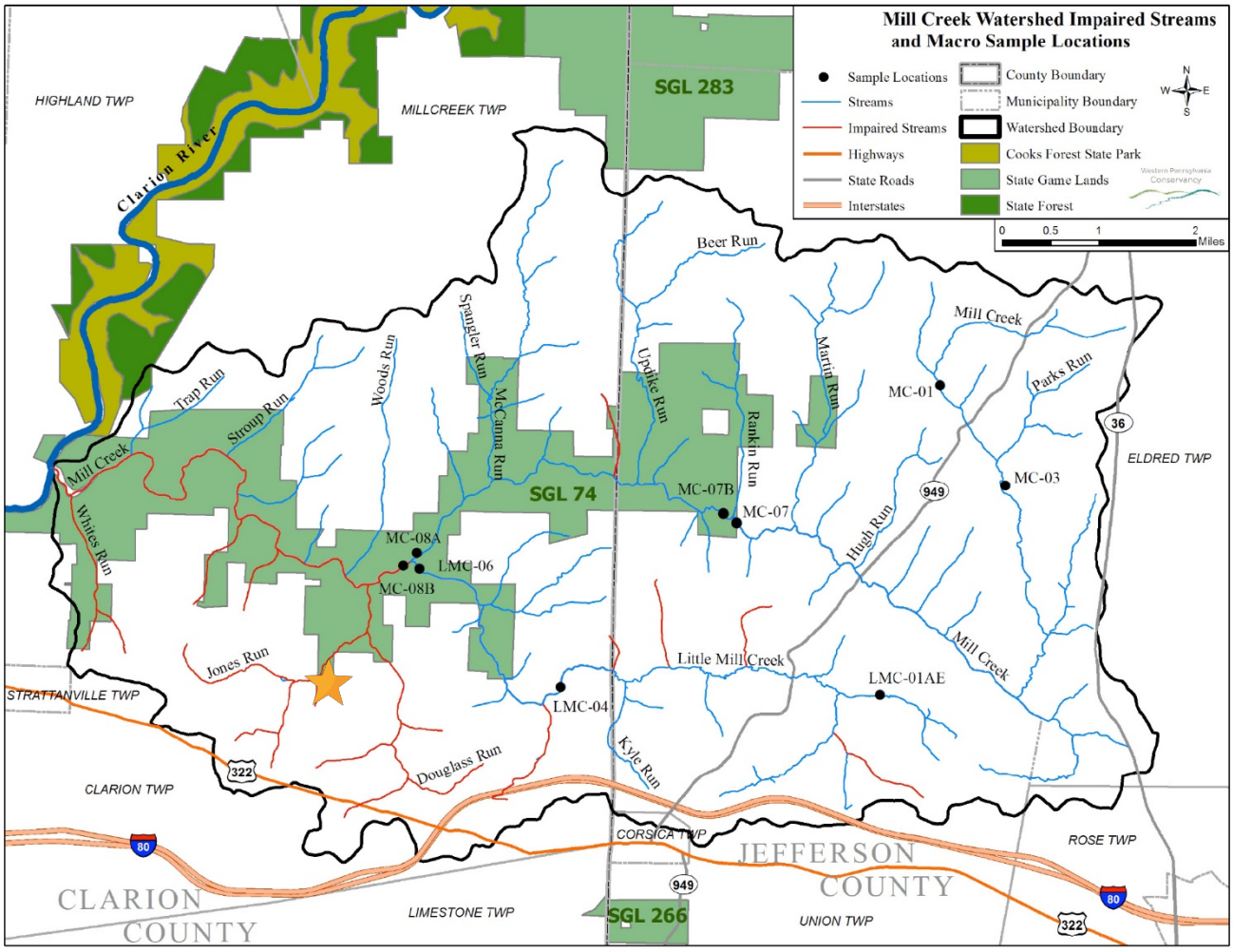

Figure 1. Overview map of the Mill Creek watershed with all named streams and unnamed tributaries in the 60 mi² watershed. In addition, the impaired streams according to DEP are highlighted in red. Note the location of the Jones/Douglass Subwatershed. Water quality and macroinvertebrate sample locations are also shown. Nine sample sites were selected by representatives of the Mill Creek Coalition. The blue streams are inhabited by Brook Trout or other fishes based on MCC experience and earlier PFBC electrofishing. The star shows the location of the Deer Run Road Bridge.

The topography of Jones/Douglass allows only a few selected sites that are amenable for passive treatment systems which require a rather flat area for the construction of an Anoxic Limestone Drain (ALD) along with one or more settling ponds for the precipitation of metals, primarily iron and the generation of alkalinity. The portion in Game Lands 74 is not readily accessible by vehicles or foot due to its ruggedness and the steepness of the hillside, along with its general remoteness. In this subwatershed, some of the AMD are seepages over a generalized area, not as one discrete flow, as it enters into the stream. In addition,

even a discrete flow would likely be located where the topography is too steep or irregular to provide sufficient space for a standard passive treatment system. This factor is common in a large portion of Jones/Douglass below the Deer Run Road Bridge. Also, the presence of aluminum and iron in the acidic conditions found in Jones/Douglass result in generally higher operating costs for a modified passive treatment system.

When Jones/Douglass empties into Mill Creek, it only contributes about 10% of the flow, but is responsible for approximately 60% of the acidity, iron, and manganese, and 80% of the aluminum to Mill Creek. The result is that the final five miles of Mill Creek is largely uninhabitable for trout and other biota. Figure 2 taken from a 1999 NRCS report on Mill Creek shows the numerous AMD sites that were identified on Jones/Douglass. In fact, almost half of the identified AMD sites on the Mill Creek watershed are found on the Jones/Douglass subwatershed. While the AMD sources in the headwaters of Douglass offer suitable locations for passive treatment systems, such locations in Jones are extremely limited.

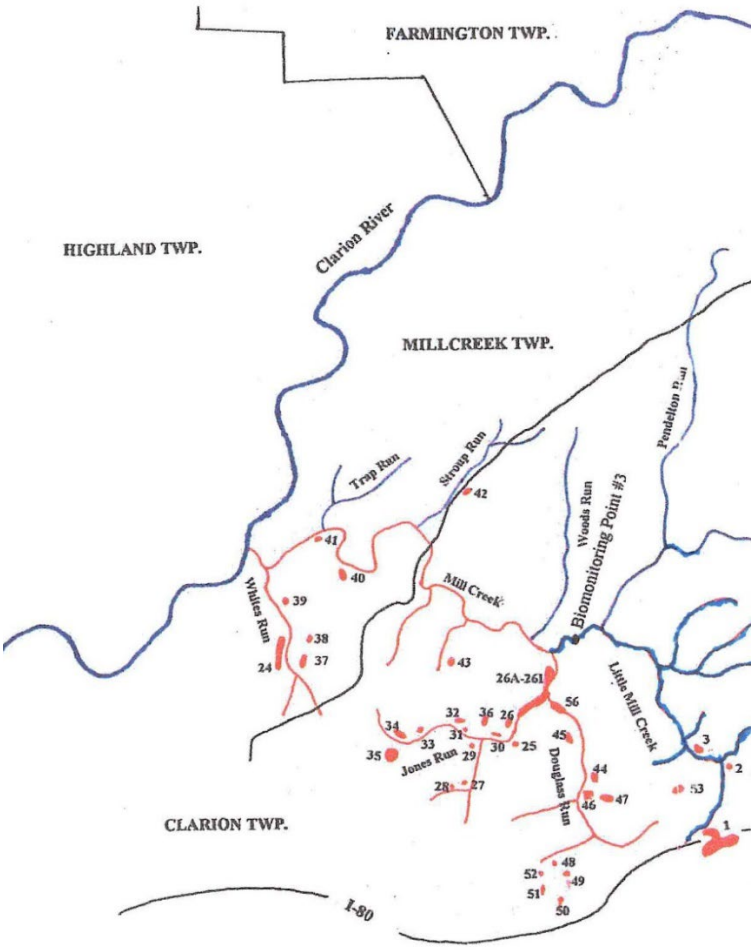

Figure 2. Lower portion of Mill Creek showing the large numbers of AMD sites identified on the Jones/Douglass subwatershed.

Douglass at 3522 acres (431 more after Jones joins it) has been moderately affected by AMD. Its easterly flow arises from an agricultural/wooded area, and has a poorly developed riffle/pool structure. It lacks fish but has crayfish and some smaller invertebrates. In the past, a large truck stop/restaurant complex that serviced adjacent I-80 traffic had its own sewage treatment system, with its effluent likely compromising the water quality of this stream. It is joined by a seriously AMD affected southerly branch which originates mainly from the toe-of-mine spoils located south of Rte. 322. A Spring season flow in 2010 measured near the Rte. 322 culvert had 70 gpm from these AMD sources with a pH of 3.7, about 100 lbs. of acidity per day, but low in metals: 1, 9 and 18 mg/l of iron, manganese and aluminum respectively. Below the confluence of the good and AMD affected stream, the pH increased to 4.9, the acidity was only 13 lbs. per day, and the amount of Fe, Mn and Al was diluted to 0.2, 0.5 and 3.3 mg/l, respectively. See Table 4 which shows improved pH values in 2017. The topography of the area south of Rte. 322 lends itself for the construction of several modified passive treatment systems to effectively treat those AMD waters. The MCC is currently pursuing a DEP grant to address the toe-of-mine spoils AMD sites. The use of high quality limestone fines or other alkaline treatment at one or two downstream sites on Douglass would ameliorate the remaining AMD issues on the lower length of Douglass, if deemed appropriate and necessary.

The West Branch of Jones Run (Figure 3), at about 1300 hundred acres, is affected by AMD resulting in acidic waters with iron, manganese and aluminum and was selected for the placement of the Code 60 limestone fines. The first mile of the stream flows within a mainly agricultural area before passing through a length affected by coal mining decades ago. Because of the seepage nature of the AMD in this area, passive treatment systems are not an option. The second segment of about .8 miles starts at the intersection of Carney Road and its 4-foot wide culvert. Coming off of Carney Road, the stream is rather flat for the first several hundred yards with the remaining segment going through the desired steeper gradient of riffles and pools which would enhance the dissolution and movement of the limestone fines. Deer Run Road runs roughly parallel to the West Branch, allowing for easy access for sampling when necessary. West Jones joins a shorter, more gently flowing southern tributary (draining about 1,000 acres) which is less affected by AMD. After the joined Jones Run waters (encompassing almost 900 acres) travel about 150 yards, it passes under the Deer Run Road Bridge and continues as a robust riffle and pool stream for about .75 miles to its convergence with Douglass Run. After the convergence, Douglass flows the remaining .5 miles in a moderate riffle/pool fashion to Mill Creek. Table 1 provides elevations and lengths of different

sections of Jones and Douglass, with calculated stream drop per 100 feet, thus showing the location of the better developed riffle pool areas.

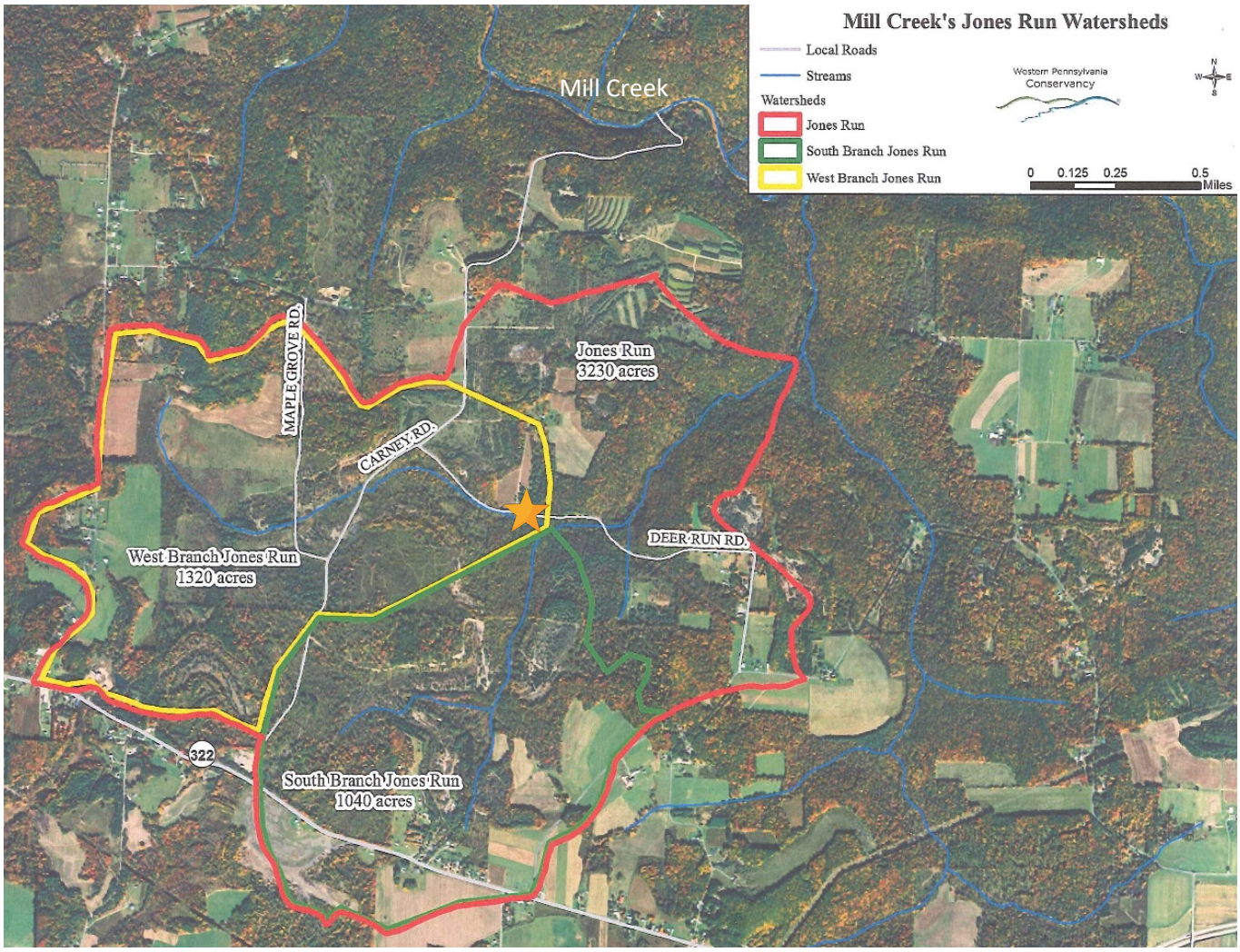

Figure 3. Outlines in red, yellow, and green colors delineate various components of Jones Run and the name of the roads which intersect the area. The star delineates where a logging road crosses South Jones. The stream is highlighted in blue.

Table 1. Stream length, elevation, and elevational drop per 100 feet for segments of Jones and Douglass Run based upon Google Earth.

Location	Elevation in Feet
Elevation of West Branch of Jones at Carney Road	1452
Elevation at convergence with West and South branches	1373
Length of West Branch of Jones from Carney Road to convergence with South Jones	4390
Elevational drop of W. Branch of Jones from Carney Road to convergence with South Jones	79
Elevational drop per 100 feet	2.0

* 700 feet were subtracted from the 4390 because the first approximate 700 feet Was absent of riffles and had dropped only about 2 feet (.3 feet/100 feet)

Elevation of South Jones at Carney Road logging road bridge 1445
Elevation of South Jones at convergence with West Jones 1373
Length of South Jones at logging road crossing to convergence with West Jones 2500
Elevational drop from logging road crossing South Jones to convergence with West branch 72
Elevational drop per 100 feet 2.9

Elevation of Jones at Deer Run Bridge 1365
Elevation at Jones/Douglass Run convergence 1265
Length of Jones from Deer run Bridge to convergence with Douglass Run 2860
Elevational drop from Deer Run Bridge to convergence with Douglass Run 100
Elevational drop per 100 feet 2.5

Elevation at Jones/Douglass Run convergence 1265
Elevation of Jones/Douglass at Mill Creek convergence 1225
Length from Jones/Douglass to convergence with Mill Creek 2704
Elevational drop from Jones/Douglass to convergence with Mill Creek 40
Elevational drop per 100 feet 1.5

Elevation of Douglass at Route 322 culvert 1562
Elevation of Route 322 Douglass at "good" Douglass 1462
Length of Route 322 to "good" Douglass 3080
Elevational drop from Route 322 Douglass to convergence with "good" Douglass 100
Elevational drop per 100 feet 3.1

Elevation of Douglass Route 322 at convergence with "good" Douglass 1462
Elevation at Jones/Douglass convergence 1265
Length from Route 322 Douglass - "good" Douglass to Jones/Douglass convergence 9402
Elevational drop Route 322 Douglass - "good" Douglass to Jones/Douglass convergence 197
Elevational drop per 100 feet 2.1

Elevation of Douglass at Asbury Road Bridge 1350
Elevation at Douglass/Jones convergence 1265
Length from Douglass at Asbury Road Bridge to Jones/Douglass convergence 3423
Elevational drop from Asbury Road Bridge to Jones/Douglass convergence 85
Elevational drop per 100 feet 2.5

Purpose

The purpose of this project was to investigate the applicability of utilizing Code 60 high quality limestone fines to address a small AMD affected stream, the West Branch of Jones Run. As a pilot project, its intent was to determine the effect of limestone fines on an approximately one-mile length of the stream for a minimal period of 1-3 months. It also was intended to evaluate whether the Clarion Twp. road crew had the flexibility in their schedule to move the limestone fines into the West Branch within a reasonable period of time from a township stockpile location to the Carney Road culvert treatment site, approximately a distance of one mile.

Procedures

Water sampling for pH and other parameters were initiated years earlier as the Coalition and DEP were investigating the whole watershed and occurred infrequently thereafter up to more recent sampling as this project was anticipated. For the upper Jones, Hedin Environmental completed a study in April 2010 (Table 2). West Branch, the first upstream sampling point in this project was the Carney Road culvert (untreated water); the second, just prior to converging with the South Branch of Jones, and then South Jones just prior to merging with the West Branch. The South Branch was less accessible than the West Branch, and while its flow was more, West Branch still had a greater loading of AMD components. Sampling also occurred with their combined flows at the Deer Run Road Bridge. Because of three culverts off of Deer Run Road, as well as various seeps, the flow at the mouth of the West Branch could increase 2x-4x in volume compared to the Carney Road culvert location. The middle culvert carries very little water and its small and intermittent flows were not measured. The upper culvert receives toe-of-mine spoils AMD from a roadside ditch on Deer Run Road and drains into the West Branch. A lower third culvert receives water from an AMD affected pond (Dilly Greenhouse AMD) several hundred yards from the north side of Deer Run Road. This drainage flows into the joined Jones above the Deer Run Bridge. These culvert flows were sampled from time to time. Therefore, water sampling at the bridge takes in the flows from the two primary culverts as well as the West and South branches of Jones. The two culvert flows travel 50-150 yards before entering their respective streams. Their total contribution to Jones is only 10-15% and is somewhat better quality water than the West Branch flow.

Working with a consultant from the Indiana office of the Western Pennsylvania Conservancy, it was noted from the April 9, 2010 study of the upper portion of Jones Run that the flow at the Carney Road culvert of 60 gpm represented a reasonable Spring flow. Because of the Deer Run culverts and various seeps, the flow at the mouth of the West Branch on April 9 tripled to about 200 gpm at that sampling period.

Table 2. Flows and chemistry for Jones Run sampling stations, April 9, 2010

											Loading	
SAMPLE ID	Flow	Lab	Cond	Alk	Acid	Fe	Mn	Al	SO_4	Acid	Fe	Al
	gpm	pH	us/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day
W. Branch @ Maple Grove Rd	49	4.30	505	0	30	0.4	6.4	3.0	192	18	0.2	1.8
W. Branch @ Carney Rd	60	3.73	531	0	64	3.0	5.6	6.1	205	46	2.2	4.4
Dilley Greenhouse AMD	27	3.86	373	0	56	0.4	5.1	6.0	155	18	0.1	1.9
W. Branch @ Mouth	184	3.25	1096	0	220	22.8	16.1	20.5	541	485	50.4	45.2
S. Jones @ Mouth	296	3.62	671	0	89	4.7	6.6	10.2	271	315	16.5	36.2
Jones Run @ Deer Run Rd Bridge	493	3.38	840	0	134	11.7	10.3	12.9	355	794	69.4	76.5

Based on the flow data, size of the West Branch watershed and its chemistry, approximately 180 tons of high grade limestone fines were estimated for this first application on the West Branch. According to the price of this Code 60 limestone, with trucking costs for 180 tons, along with its placement in the West Branch, $6,000 was necessary for the short term project.

Meanwhile, the application of the Code 60 limestone fines directly into a stream required from DEP the need to apply for a Waiver 16 permit. The Waiver 16 application necessitated acquiring macroinvertebrate data on West Branch, which was conducted on August 3, 2018 (Table 3). Three separate sites were sampled in the West Branch of Jones Run, approximately mid-way between Carney Road and the mouth of the West Branch in a well-developed riffle area. Each of three samples included two people disturbing the bottom substrate toward a D-net at the bottom of each riffle for three minutes. The samples were sorted on-site from the debris and combined to provide the data in Table 3. Figure 4 shows the West Branch at the same approximate location from which the macroinvertebrate sampling was conducted.

Table 3. Macroinvertebrate abundance in Jones Run, Clarion County from August 3, 2018.

Order	Family (if known)	Number of Individuals (n)
Megaloptera	Sialidae	19
Megaloptera	Corydalidae	2
Trichoptera	Phyrganeidae	4
Coleoptera	Dytiscidae	7
Diptera	Chironomidae	6
	Total:	38

Four orders and 5 families totaling 38 individuals were identified. The data document the poor water quality of this AMD affected branch.

On the neighboring less seriously AMD affected Douglass Run, a macrobenthic assessment conducted on June 21, 2017 yielded a total of 5 orders and 9 families with a total of 49 individuals (Table 4). Crayfish were also common at all three of the sampling sites. For contrast, in the AMD unaffected headwaters of Mill Creek and Little Mill, a comparable study will find about 8 orders, 17 families, and nearly 200 individuals.

Figure 4. Photo was taken looking upstream, at the approximate location from which the macrobenthic samples were collected, showing the riffle-pool feature along most of its length. Photo by Jen Moore.

Table 4. Stream macrobenthic assessment of three locations on upper segment of Douglass Run, Clarion County sampled on June 21, 2017. A standard 1x1 meter square, 500-micron mesh kick net was utilized. The powerline ROW intersection is located several hundred yards downstream from where the East Branch and the much smaller South Branch converge (pH 4.5). The Ashbury Rd Bridge is approximately one mile below a powerline ROW. Several AMD affected sources are located in this stretch.

Collection Site	Common Name	Order	Family	Quantity
East Branch of Douglass Run by wooden bridge, unaffected by AMD (pH 7.0).	Mayfly Nymph	Ephemeroptera	Ephemeridae	2
	Stonefly Nymph	Plecoptera	Perlidae	1
	Caddisfly Nymph	Trichoptera	Hydropsychidae	6
		Trichoptera	Limnephilidae	4
		Trichoptera	Philopotamidae	11
	Cranefly Larvae	Diptera	Tipulidae	11
	Midge	Diptera	Chironomidae	1
	Water Penny	Coleoptera	Psephenidae	2
Below powerline ROW (pH 6.5)	Stonefly Nymph	Plecoptera	Capniidae	1
	Caddisfly Larvae	Trichoptera	Hydropsychidae	5
Ashbury Rd Bridge (pH 6.0)	Caddisfly Larvae	Trichoptera	Hydropsychidae	5

The Code 16 waiver was approved in mid-August. Prior to that, a $2,000 grant from the PA Foundation for Watersheds was approved. A final $2,000 from the PA Wildlife Federation was awarded in September, which then allowed the MCC to proceed on the project.

Noting the higher volumes of water occurring in the fall of 2018 compared to the previous data presented in Table 2 that represented 2010 spring flows, the Knox office of DEP, located approximately one-half hour from the study site, took water samples on September 20 prior to the release of the limestone fines into the stream (Table 5). A briefer post release sampling was taken on December 4. The September 20 sample showed that South Jones had greater acidity and Al compared to the water samples taken on April 9, 2010 (Table 2).

Table 5. Flows, chemistry, and loading values for select Jones Run sampling stations by DEP on September 20 and December 4, 2018.

										Loading	
SAMPLE ID	Flow	Lab	Alk	Acid	Fe	Mn	Al	SO_4	Acid	Fe	Al
9/20/2018	gpm	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day
W. Jones @ Carney Rd	123	3.8	0	37.0	1.57	2.15	2.63	116.8	55	2.3	3.9
W. Branch @ Mouth	509	3.4	0	107.2	7.3	6.92	9.65	258.4	656	44.5	59.1
S. Jones @ Mouth	1248	3.7	0	62.2	1.65	3.68	6.6	193.5	933	24.7	99.6
Jones @ Deer Run Rd Bridge	1823	3.6	0	75.0	13.41	4.52	6.98	222.0	1643	74.7	152.9
12/4/2018											
W. Jones @ Carney Rd	212	4.0	2.2	30.4	1.21	2.30	3.06	123.8	77	3.1	7.8
Jones @ Deer Run Rd Bridge	1705	3.8	0	73.6	4.03	5.49	8.60	236.5	1508	82.6	176.2

The Code 60 limestone fines are available from the limestone mining facility of Graymont (PA) Inc., Pleasant Gap Plant, near Bellefonte, PA, approximately two hours from Jones Run. The company provides a 10% discount to 501(c)3 organizations; otherwise the cost is a relatively inexpensive $12.10/ton.

Starting in early August, several local trucking firms plus one in Bellefonte were invited to bid the transporting of the estimated 180 tons of limestone fines to the Clarion Twp.'s stockpile facility located at the corner of Rte. 322 and Carney Road. The site is conveniently located about one mile from the West Branch Jones culvert on Carney Road.

With the final $2,000 grant attained in late September, the trucking contract was awarded to Confer Trucking, Inc. located near Bellefonte. The first triaxle load was delivered to the stockpile facility on October 3, followed by 7 more loads, totaling 181 tons with the last load dumped directly into the West Branch of Jones Run on October 12, being the inaugural load (Figure 5).

Figure 5. The last load arrived on October 12. It was the inaugural first load directly placed into the West Branch of Jones culvert pool. Photo by Brett Whitling, Clarion News.

The precipitation for the area was down by about 4 inches from the average for the September-December quarter. It was slightly less than 2 inches in October and December, with about 4 inches in September and November. With road maintenance work and other responsibilities, the Clarion Twp. road crew was able to gradually move all the limestone fines into the West Branch within a three-week period (by the first week of November) using a Twp. truck capable of hauling about four tons per load. This size load allowed the driver greater control as to where to place the load; i.e., over the Carney Road culvert or to the left or right side of it in order to maximize the amount of limestone fines at the site. Because the stream level was down due to low precipitation in October, the Twp. road crew, on several occasions would dump enough loads of limestone fines directly over the mouth of the four-foot diameter culvert, thus forming a dam, eventually breached, resulting in a surge of water that carried the fines rapidly downstream. No doubt, a portion of it carried beyond the Deer Run Road Bridge. It also resulted in some of the fines ending up high on the stream bank for the first several hundred yards.

The MCC could afford another load (23 tons) to split between the two primary Deer Run Road culverts. Delivered on November 29, the township placed the fines at both culverts several days later. The same Twp. truck was ideally suited to dump its fines below these culverts (two-foot diameter) using a constricted tailgate that allowed for the placement of fines in the more confined culvert pool.

For the first several hundred yards below the Carney Road culvert, the West Branch has fewer riffles and a less vertical gradient than desired so it was no surprise to find that some of the limestone fines tended to build up on the bottom of this stream segment. For the first several weeks, pH measurements were taken with a La Motte Precision pH 3.0-10.5 colorimetric test kit. As pH sampling continued, it was evident that for those times when the pH values were pH 5.0 or lower, it was difficult to distinguish on the colormetric scale. As a result, an Oakton Multiparameter Meter – PCTestr 35 was utilized.

Results

When a new load of limestone fines was deposited in the stream, the water immediately turned to a grey limey color for a few hours. This coloration was even visible at the Deer Run Road Bridge site. Downstream from the culvert, as the powder, sands and grit mixture continued their movement, the pH would rise from the lower pH 3s to pH 6s. By December however, much of the stream limestone fines appeared to be largely depleted from the riffle/pool length, based on the lowering of the pH to near or at preapplication levels (Table 6). As explained earlier, this finding in part was no doubt due to the two daming events at the Carney Road culvert as well as an abundance of rain in November. Unfortunately,

there are no data beyond Deer Run Bridge due to the lack of easy accessibility to potential monitoring points downstream, such as where Jones Run flows into Douglass or Douglass meeting Mill Creek.

The 12/5 data (Table 6) at the sampled inputs of 1, 2 and 5 show the pH values of the culvert flows from December to March 1. By the time those 12/5 flows reach their downstream testing points (7, 3, and 6) the pH values remain improved. In addition, the bridge site (9) was improved at 12/5 compared to later dates. However, by the next sampling conducted in late December, the pH values have fallen, some to pre-limestone fines application levels. As noted earlier, the first several hundred yards from the culvert was a steady flow of water and lacked riffles. Because of high water events prevalent at the time of the limestone fines application and the manner in which the limestone fines were placed in the stream, some of the fines were deposited on the bank for the first 100 yards from the culvert. Other fines were stranded in shallower waters which during lower water periods became exposed. The fines continued to cover the bottom rather thickly and were easily visible for 75-100 yards short of the first riffles for months while they were gradually reduced.

Table 6. Sampling data for select West Jones sites from December 2018-March 2019 conducted with a pH meter by DEP.

Location	12/5/2018	12/26/2018	2/19/2019	3/1/2019
	pH	pH	pH	pH
1 - W. Branch @ Carney Rd	3.9	4.0	3.9	3.8
2 - Upper Culvert - Deer Run Rd	2.9	2.8	2.9	2.9
3 - Upper Culvert - Deer Run Rd @ confluence with W. Jones	4.4	3.1	3.0	3.0
4 - Jones Run, just above confluence with Deer Run Rd - upper culvert flow	n/a	3.7	n/a	n/a
5 - Dilly Culvert @ Deer Run Rd	3.9	3.8	3.8	3.8
6 - Dilly Culvert flow @ confluence with main Jones Run	6.5	n/a	4.0	3.9
7 - W. Branch @ Mouth	4.3	3.3	3.6	3.5
8 - S. Branch @ Mouth	n/a	n/a	3.7	4.0
9 - Jones Run @ Deer Run Rd Bridge	4.3	3.4	3.6	3.7

At the onset of this study, Table 2 shows 60 gpm at the Carney Road culvert tripling to nearly 200 gpm at the September 20 sampling by DEP. Similarly, Table 5 shows a limestone fines preapplication water sampling by DEP of four sites on 20 September 2018. The volume of water which flowed downstream is slightly over four times that amount, 123 gpm at the culvert to 509 gpm prior to emptying into the South Branch. The West Branch at that sampling was believed to be much closer to what was observed during the October-December period when flow rates were not taken. Lower flows through the West Branch would likely have led to higher dissolution rates and pH values due to slower and longer retention times of the limestone fines in this one mile segment. Obviously, the addition of several hundred gallons of

rapidly moving water per minute evident during this study decreased the effectiveness of the liming to raise the pH within the studied segment up to the last sampling at the Deer Run Road Bridge. Additional water from the South Branch, resulting in 1000+gpm flows had a significant dilutional effect, as well as an increased flow rate, thus reducing the time that the water has an opportunity to gain a pH improvement by the time the combined flows reach the Deer Run Bridge. Also, the higher volume means that it is unlikely that a lot of water higher in the water column (i.e., its depth) will have an opportunity to contact the stream bottom where the limestone fines are located. However, higher levels of turbulence might raise the dissolution rate somewhat by moving more of the fines off the bottom, such as occurred during the two dam events. Likely at only approximately one mile from the Carney Road culvert, a lot of the limestone fines, even the grit sized material, washed beyond the Deer Run Road Bridge, out of the studied area. It was noted earlier that whatever volume of water was at the Carney Road culvert, the volume of the stream could increase 2x-4x before it finally merged with the South Branch. Obviously the seeps, surface runoff, etc., along the stream segment had less time and distance to gain alkalinity before the water reached lower sampling points.

Summary

In summary, the generally high waters during this late fall-early winter period (compared to normally lower summer flows) was advantageous because the currents certainly aided in the downstream dispersal of the limestone fines quickly with much of it likely going beyond the Deer Run Road Bridge and beyond the scope of this study. However, it did enforce the need to plan on higher levels of limestone fines during high flow events or wet seasons. The Mill Creek Coalition will continue to collect data and then determine if a second effort of liming at more normal flows is worthwhile to pursue, particularly at a late spring-summer lower flow period. The limestone fines estimate based on spring (April 9) values resulted in not enough limestone fines available to compensate for the generally higher flows experienced in the study. Perhaps the 180 tons of limestone fines would have worked more effectively during a low summer flow period which would also be out of the hunting season.

This pilot limestone liming treatment provided an opportunity to have DEP personnel from the Cambria office of DEP visit Jones Run during the period of this study. The input from DEP allowed for the development of a generalized strategy to address the AMD issues which affect the Jones/Douglass subwatershed. DEP has considerable experience utilizing agricultural lime facilities to address the water quality issues seen in this watershed. However, whatever the chosen treatment technology, the lower five miles of Mill Creek is absolutely dependent on the successful treatment of the subwatershed if this last

critical segment of Mill Creek is once again to become a coldwater fishery and a popular destination for trout fishing activities, the recolonization of its original biota and reestablishment of former spawning areas.

Other than the West Branch culvert location for the easy placement of limestone fines, another site is available on the downflow side of the Deer Run Road Bridge. This location would be suitable for an agricultural lime, limestone fines or an active chemical treatment facility. Owner permission would be necessary, some trees would need to be removed, and an off-loading site constructed. With the flows of the West Branch and South Branch plus some other inputs, Jones Run is of sufficient size and volume at the Deer Run Road Bridge to place an effective treatment facility.

For example, the limestone fines could be added at the Deer Run Road Bridge location. With the cost of about 20 tons at approximately $30/ton to cover the limestone fines ($12/ton) and trucking of about $17/ton, it is a reasonable treatment method. Based on this study conducted at high flows for about two months of treatment and costing $6,000, it might be able to treat for 12 months for $36,000 or less. However, this cost could go substantially higher if the limestone fines for the West Branch went above the original 180 tons, especially if the chemical characteristics of the South Branch are considered, as they should be. Ideally, it would be most cost efficient to have the triaxles roughly scheduled to keep a steady year-round release of limestone fines into the stream based roughly on stream flows, perhaps not only at the West Branch culvert site, but most importantly at the Deer Run Road Bridge site if an off-loading site is constructed. In addition, as noted earlier (Table 1), the water flow directly below the Deer Run Road Bridge has a strong and very robust riffle and pool characteristics which would be ideal for fines dispersal and dissolution. The treated waters of Jones at the Deer Run Road Bridge flow about one-half mile before it joins with Douglass. Hopefully, the mixing of treated Jones and Douglass waters would result in the combined flows having a satisfactory pH and alkalinity. The stream travels about another one-half mile to Mill Creek. If treatment occurred at Carney Road, along with treatment on the South Branch, the potential for trout spawning in this upper one mile portion of the subwatershed would likely be maximized.

Obviously, with the chemical condition of the stream as well as its flow, it would take a long term dedicated effort to have and maintain a positive effect throughout this length by creating invaluable alkalinity to turn Jones and Douglass into a sustainable spawning and habitable area for trout and other fishes and the macroinvertebrate community. The costs for alternative treatment approaches such as an

agricultural lime or active chemical treatment facility need to be determined. Whatever treatment design chosen at the Deer Run Road bridge location, the treated waters will immediately flow into Game Lands 74. The costs of treating Jones as well as Douglass should be justified by not only the improved condition of those waters but also by the dramatic positive effect that they will have on the restoration of the last five miles of Mill Creek and also the Clarion River. The potential economic and environmental advantages would be substantial.

Mill Creek drains to the Clarion River, a designated National Wild and Scenic River with Recreational status in some lengths as well, and also being Pennsylvania's River of the Year 2019. In addition, I-80, minutes away from Mill Creek is the entryway into PA Wilds. Obviously, a restored Mill Creek from its headwaters to the Clarion River has the potential to expand outdoor tourism and the increase in economic growth that it can provide.

The Mill Creek watershed, covering parts of two counties, is in the coverage area of three newspapers. Two newspapers visited the pilot liming project, and a third invited a MCC representative to an in-office interview. Copies are available upon request.

Acknowledgements

As the MCC was determining the best way(s) to address the Jones/Douglass watershed, one option was to utilize high-quality (Code 60) limestone fines at one or more sites on the upper portions of the subwatershed in order to be cost effective and once again opening these streams to potential spawning of trout and other species. Mark Killar of the Western Pennsylvania Conservancy had experiences with this AMD treatment strategy at a number of streams in southwest Pennsylvania and neighboring Maryland. Based on a field visit to Mill Creek, the Jones/Douglass watershed was identified as having several potential treatment sites using this technology. The West Branch of Jones was suggested by him due to its accessibility and the relatively small size and length.

The MCC believed that a pilot project would be appropriate for the West Branch, specifically at the location of the four-foot culvert on Carney Road. The Clarion Conservation District, as a 501 (c3) entity, agreed to be the grant administrator of a 2018 Dominion Watershed Mini Grants Program through the Dominion Energy Charitable Foundation, administered by the Western Pennsylvania Conservancy. A grant award of $2,000 was announced in March 2018. During the summer months, a $2,000 grant from the PA Foundation for Watersheds, followed by $2,000 from the Pennsylvania Wildlife Federation allowed the pilot project to proceed.

In addition to the Clarion Conservation District administering the grants, Tricia Mazik, Watershed Specialist, submitted the first grant to Dominion, completed a successful application of the Waiver 16 to DEP that was approved in August 2018 for direct application of the limestone fines into Jones Run, and also assisted in some of a macrobenthic sampling of the Jones/Douglass Watershed. MCC officers and Clarion University ecology students also participated in the sampling efforts.

Clarion Twp. in which Jones/Douglass is located, has always been supportive of the MCC. For the West Branch of Jones project, the township graciously allowed the limestone fines to be stockpiled at their storage site at the corner of Rt. 322 and Carney Rd., about one mile from the Carney Rd. culvert for the West Branch. The road crew was excellent and supportive in getting the limestone fines into the stream in an expeditious manner between all their normal responsibilities.

While Hedin Environmental conducted an earlier water chemistry survey throughout the Jones/Douglass Watershed, the Knox District Mining Office of DEP agreed to acquire some of the pre- to post-project water sampling in the West Branch and South Branch of Jones. Thanks go to Ely Heferle in conducting these water sampling efforts. In addition, Peter Schuster, a Water Pollution Biologist from DEP's Northwest Regional Office in Meadville, visited the proposed limestone fines project area as well as other parts of Mill Creek and guided Tricia Mazik through the successful approval of the Waiver 16 permit.

Appreciation is extended Shaun Wessell of the Jefferson County Conservation District for his expertise with Google Earth, providing several mapping versions as well as preparing the elevation data shown in Table 1.

Landowner Shawn Smith was supportive of the project and the water sampling conducted on his property, keeping in mind that the October-December period is prime time for turkey and deer hunting opportunities which did curtail some water sampling in this woodland/stream area.

Clarion University ecology student Lisa McKenzie provided much of the early typing of tables and frequent text revisions for this report. The final editing and ultimate publication of this report was provided by PAGES (Printing and Graphics Express Services) of Clarion University.