THE SUGAR CREEK COAL REFUSE PILE AND MINE DRAINAGE DISCHARGE RECLAMATION PROJECT

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ABSTRACT

The Sugar Creek abandoned mine land reclamation project included the restoration of a 15-acre hazardous coal refuse pile and the passive treatment of an abandoned mine discharge, both of which were severely impacting water quality in Sugar Creek. The refuse pile was extremely steep, had little vegetation, and presented a severe health and safety hazard. The toe of the refuse pile extended into the Sugar Creek stream channel and was being eroded by the stream. The mine drainage was characterized as alkaline with moderately high iron and was severely impacting water quality and habitat in Sugar Creek downstream to the confluence of Sugar Creek and the Allegheny River. The stream bottom was heavily coated with iron precipitate severely impacting aquatic life.

The restoration project involved pulling the refuse material back from the stream channel and regrading the pile to stable slopes. Large riprap was placed along the toe of the regraded pile to prevent further erosion of the refuse into the stream. The pile was covered with limestone screenings and a soil cover prior to being revegetated. A passive mine drainage treatment system was also constructed that included a new wet seal, a settling pond, and an aerobic wetland with limestone diversions.

Preliminary monitoring of the passive treatment system and of the stream water quality of Sugar Creek downstream of the project has shown a dramatic improvement in water quality and a re-emerging community of aquatic life. Over three miles of the Sugar Creek have been restored, and this restoration has allowed for the re-establishment of indigenous aquatic life. The Sugar Creek abandoned mine land reclamation project demonstrates the results that can be achieved when combining the reclamation of health and safety hazards with environmental restoration to maximize the benefits of abandoned mine reclamation work completed under Title IV of the Surface Mining Control and Reclamation Act of 1977 (SMCRA).

INTRODUCTION

The Sugar Creek coal refuse pile and mine drainage discharge reclamation project site is located in west-central Pennsylvania along State Route 68 between the Villages of Kaylor and Bradys Bend in Bradys Bend Township, Armstrong County. Figure 1 shows a local vicinity map of the project site. The project site is also located approximately 40 miles north-northeast of the City of Pittsburgh in the middle Sugar Creek Watershed. Sugar Creek is a tributary to the

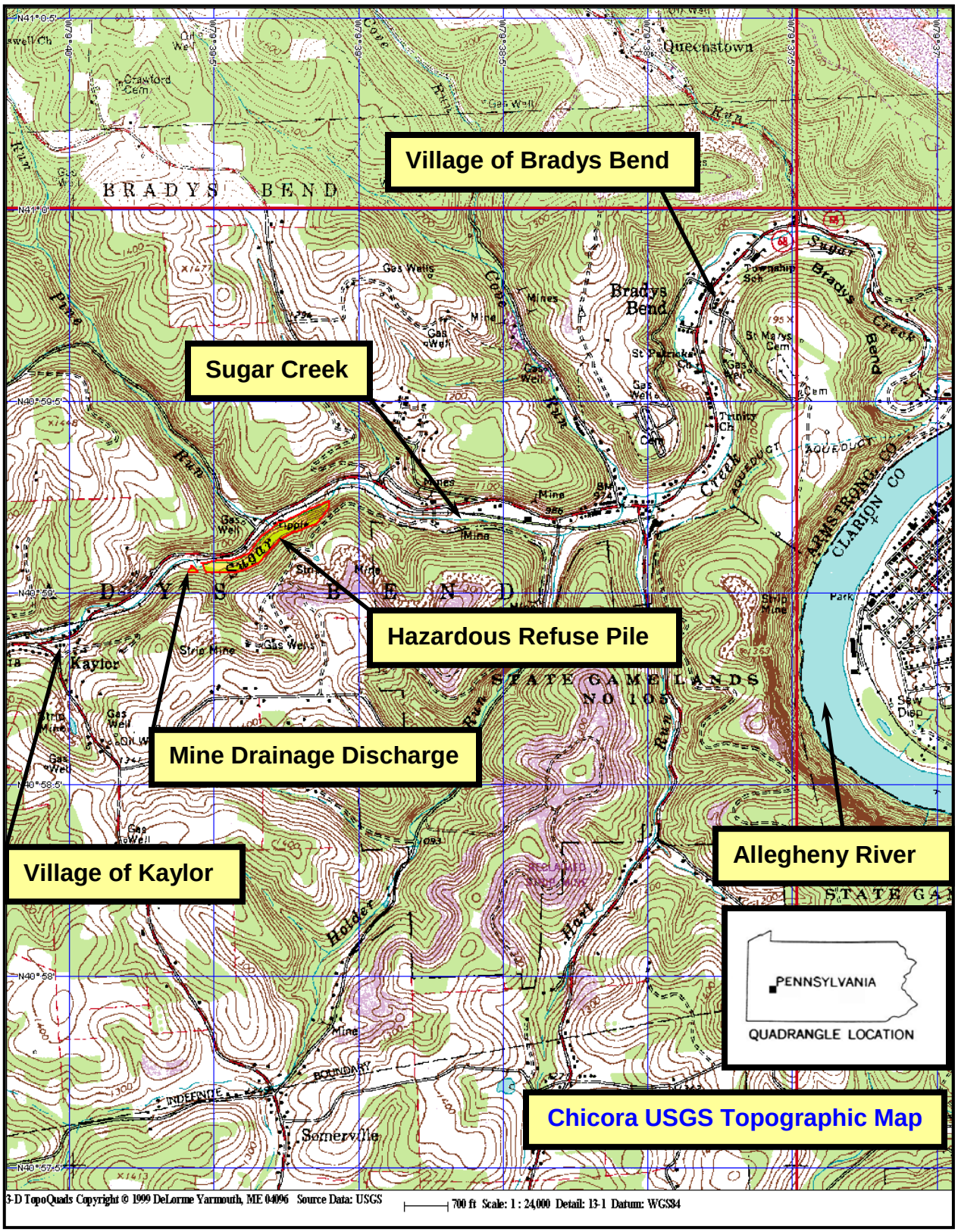

FIGURE 1 – Project Location Map (Source: DeLorme 3-D Topo Quads – 1999)

Allegheny River which combines with the Monongahela River at the point in downtown Pittsburgh to form the Ohio River.

The Sugar Creek abandoned mine land reclamation project included the restoration of a 15-acre hazardous coal refuse pile and the passive treatment of an abandoned mine discharge, both of which were severely impacting water quality in Sugar Creek. The refuse pile was inventoried on the National Abandoned Mine Land Inventory as a high-priority health and safety hazard (keyword: DPE – Dangerous Pile or Embankment). The refuse material had been cast in the stream valley immediately adjacent to the Sugar Creek stream channel. Figure 2 shows an aerial view prior to reclamation of the project site showing the hazardous coal refuse pile situated along the southern bank of Sugar Creek. The pile was extremely steep, had very little vegetation, and presented a severe health and safety hazard for area residents who were using the pile for recreational activities such as ATV riding. ATV accidents, luckily resulting in only minor injuries, had been reported prior to reclamation. The toe of the pile extended into the stream channel and was constantly being eroded and undercut by the stream. The out-slope of the remaining refuse material approached 60 degrees and was very unstable. The mine drainage discharge at the site flowed from the abandoned Snow Hill Mine operated by North Penn Coal Company from the early 1930s until approximately 1960. Figure 3 shows a photograph of the discharge and the flow-monitoring weir. The mine was operated on the Lower Kittanning or "B" coal seam. The discharge was characterized as alkaline (70 – 140 mg/l as $CaCO_3$) with moderately high iron (15 –75 mg/l). The pH was circumneutral (6.0 - 6.8 s.u.), and the flow was moderate (80 – 320 gpm). The discharge severely impacted the stream water quality and habitat for over three miles downstream of the discharge to the point where Sugar Creek flows into the Allegheny River. The stream bottom was heavily coated with iron precipitate severely impacting aquatic life.

The refuse material was pulled back from the Sugar Creek stream channel and regraded to stable slopes as part of the project. Large riprap was placed along the toe of the regraded pile for over 2,000 feet to prevent further erosion of the refuse into Sugar Creek. The pile was covered with limestone screenings and a soil cover and revegetated. A passive mine drainage treatment system was also constructed as part of the project. The system included a new wet seal with an air-trap at the discharging mine entry, a settling pond, and an aerobic wetland with limestone diversions designed to remove the primary contaminants from the mine drainage prior to discharge to Sugar Creek. Work on the project began in September 2002 and was completed in September 2003.

Preliminary monitoring of the discharge from the passive treatment system constructed as part of this reclamation project and of the stream water quality downstream of the project has shown a dramatic improvement in water quality and a re-emerging community of aquatic life. Over three miles of the Sugar Creek have been restored, and this restoration has allowed for the re-establishment of indigenous aquatic life. Fish and macroinvertebrates have already begun to return to reclaim this waterway, once polluted by mine drainage. This project is exemplary because it combined the reclamation of a significant human health and safety problem resulting from past coal mining activities with aspects to allow for the environmental restoration of the barren landscape of the refuse pile and aquatic restoration of Sugar Creek which had been contaminated by this mine drainage discharge and eroding refuse material for over forty years.

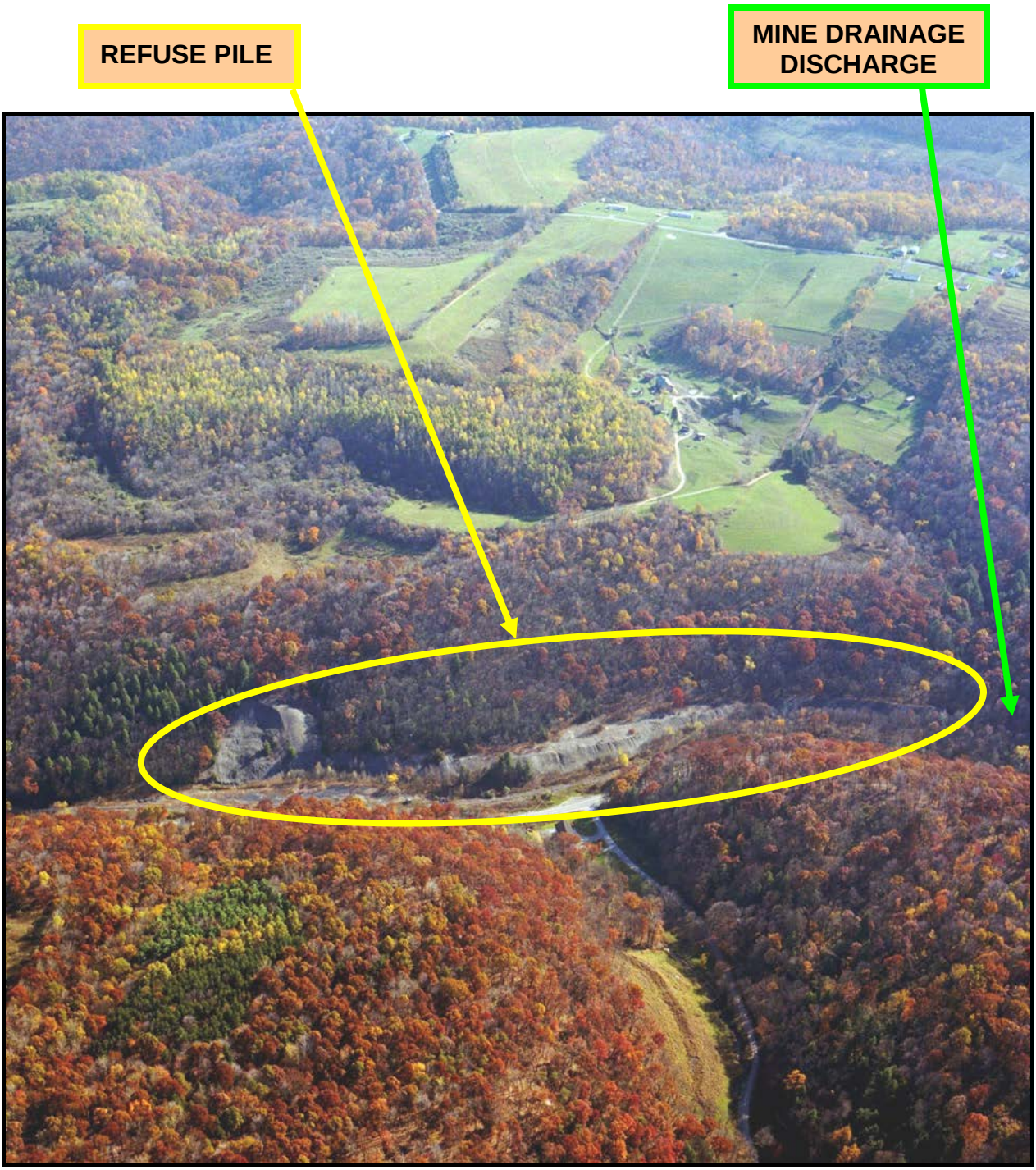

FIGURE 2 – Photograph of the Sugar Creek refuse pile and mine drainage reclamation project site prior to restoration

The Sugar Creek abandoned mine land reclamation project demonstrates the results that can be achieved when combining the reclamation of health and safety hazards with environmental restoration to maximize the benefits of abandoned mine reclamation work completed under Title IV of SMCRA.

FIGURE 3 – Photograph of the mine drainage discharge from the abandoned North Penn Coal Company's Snow Hill Mine showing the flow monitoring weir

MINING AND ABANDONED MINE PROBLEM HISTORY

The Sugar Creek watershed has a long history of both coal and non-coal mining. Non-coal mining was conducted in the area to recover clay for firebricks and to recover limestone primarily for use in the extensive steel making industry that once thrived in the area. The coal was primarily mined to fuel the brick kilns and for domestic use. The abandoned mine features at the Sugar Creek project site resulted from coal mining conducted on the Lower Kittanning or "B" coal seam. The mine, known as the Snow Hill Mine, was operated first by the Bradys Bend Coal Company and later by North Penn Coal Company. The mine began operating around 1930, and operated until circa 1960. Waste coal from the mine was conveyed to the surface and cast along the south side of Sugar Creek for approximately 2,000 feet creating the hazardous refuse pile that would remain an eyesore and safety hazard for local residents until implementation of the Sugar Creek project. Figure 4 shows a photograph of the out-slope of the pile and the heavily degraded stream channel of Sugar Creek. Approximately 340,000 tons of refuse was cast in the stream valley during the life of the mine.

Following cessation of the mining operation, the mine was abandoned and groundwater began to fill the old workings. The workings filled up to a point where mine drainage began to discharge from the main mine portal directly into Sugar Creek. The poor quality of the discharge degraded the quality of the stream and caused most of the aquatic life to be unable to survive.

FIGURE 4 – Photograph showing the extremely steep outslope of the coal refuse pile with the toe of the pile extending into the stream channel. The iron stained stream bottom of Sugar Creek is also evident in the photograph.

PROJECT BACKGROUND

The Sugar Creek abandoned mine features were first evaluated for reclamation by the Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation

(PA-DEP-BAMR) in the spring of 1992 at the request of local residents. Abandoned mine features at the site included a mine drainage discharge, several collapsed mine openings, a dilapidated coal tipple, and a 15-acre coal refuse pile with extremely steep and unstable slopes. The refuse pile qualified as a high priority health and safety hazard, and was added to the Abandoned Mine Land Inventory as an OSM Priority 2 dangerous pile or embankment (DPE). The discharging portal and associated mine drainage qualified as Priority 3 environmental degradation problems. The site was submitted for consideration along with many other sites, for funding under Pennsylvania's newly established Ten-Percent AMD Set-aside Program. By early 1993, a decision was made to further evaluate the Sugar Creek project site for possible reclamation. Preliminary contacts with all of the property owners to outline and discuss options for restoring the site were conducted during late 1993 and early 1994.

PA-DEP-BAMR established a sampling and monitoring program to analyze the deep mine discharge and its impact on Sugar Creek below the point where the discharge flowed into the stream. The sampling and monitoring for planning and project development purposes was carried out monthly from December 1994 through December 1996. During that period, the flow rate ranged from a low of 80 gpm in August 1996 to a peak of 208 gpm in April 1995. The total iron concentration ranged from a low of 18.6 mg/l in June 1996 to a peak of 73.6 mg/l in February 1996. The majority of the iron was ferrous iron. Manganese and aluminum concentrations were consistently very low (less than 1 mg/l for all sampling events except the August 1996 sampling date when the aluminum was 2.39 mg/l). The sulfates were consistently in the 150 – 300 mg/l range, and the pH was always in the range of 6.0 to 6.8. Table 1 shows a summary of the historical water quality and flow monitoring of the discharge from 1994 to early 2001. The discharge became net acidic during a short period (values highlighted in red on Table 1) when an active surface mine intercepted the up-dip extent of the abandoned Snow Hill Mine. Following backfilling and reclamation of the mine site, the discharge returned to an alkaline condition.

The impact of the discharge on the aquatic environment of Sugar Creek was also evaluated during the planning phase of the project. Water quality sampling and biological surveys conducted upstream of the discharge indicated good water quality with a diverse macroinvertebrate population that included a number of pollution intolerant genera. Chemical sampling of the stream above and below the discharge point indicated that the in-stream iron concentration rose, on average, from 0.23 mg/l upstream to 1.62 mg/l downstream. Downstream of the discharge, biological surveys demonstrated that macroinvertebrate species richness and abundance were substantially decreased. Below the discharge, the stream bottom was heavily coated with iron precipitates that were adversely affecting aquatic life. The iron coating on the creek bottom was prevalent for over three miles downstream to the point where Sugar Creek empties into the Allegheny River. Erosion of refuse material into the stream channel was also noted and shown to be further degrading the aquatic habitat of Sugar Creek below the abandoned mine site.

PROJECT DESIGN APPROACH

The Sugar Creek project was assigned for design in early 1997. Preliminary contact with the owner of the refuse material indicated that they were interested in pursuing reprocessing of

Table 1 – Summary of the mine drainage discharge monitoring for the Sugar Creek Project

Date	Q, gpm	pH	Mn, mg/l	Acidity, mg/l	Al, mg/l	T Alk $CaCO_3$, mg/l	Fe^{2+} mg/l	Fe^{3+} mg/l	Total Fe mg/l	Fe load #/day	Mn load #/day	Acidity load #/day	Al load #/day
5-May-94	175	6.2	0.451	0	0.517	102	29.1	0	29.1	61.21	0.95	0.00	1.09
2-Dec-94	165	6.5	0.421	0	0.506	82	27.03	0	25.7	50.97	0.83	0.00	1.00
1-Feb-95	165	6.6	0.404	0	0.413	98	32.5	0	32.5	64.46	0.80	0.00	0.82
12-Apr-95	208	6.5	0.378	0	0.265	86	28.56	0	26.7	66.75	0.95	0.00	0.66
27-Jul-95	94	6.3	0.481	0	0.651	120	26.52	6.38	32.9	37.17	0.54	0.00	0.74
9-Aug-95	139	6.4	0.423	0	0.233	136	29	0.6	29.6	49.46	0.71	0.00	0.39
11-Oct-95	94	6.3	0.421	0	0.326	122	26.52	0	26.4	29.83	0.48	0.00	0.37
7-Nov-95	120	6.4	0.414	0	0.291	124	31.4	0	31.4	45.29	0.60	0.00	0.42
5-Dec-95	172	6.4	0.443	0	0.367	132	35.7	0	35.7	73.81	0.92	0.00	0.76
13-Feb-96	172	6.2	0.443	72	0.651	124	34.68	38.92	73.6	152.16	0.92	148.86	1.35
14-Mar-96	100	6.4	0.456	5	0.654	124	43.35	4.05	47.4	56.97	0.55	6.01	0.79
9-Apr-96	170	6.2	0.509	12.2	0.789	114	41.82	3.18	45	91.95	1.04	24.93	1.61
15-May-96	123	5.4	0.243	15.8	0.777	8.2	0.25	1.35	1.6	2.37	0.36	23.36	1.15
11-Jun-96	136	6.4	0.395	0	0.519	82	19.95	0	18.6	30.41	0.65	0.00	0.85
2-Jul-96	155	6.2	0.412	24	1.13	70	18.9	4.3	23.2	43.22	0.77	44.71	2.11
13-Aug-96	80	6.3	0.462	16.8	2.39	78	25.5	32.8	58.3	56.06	0.44	16.15	2.30
19-Sep-96	108	6	0.43	50	1.2	72	29.58	0	29.2	37.91	0.56	64.91	1.56
17-Oct-96	172	6.2	0.533	64	0.89	90	39.78	3.62	43.4	89.73	1.10	132.32	1.84
13-Nov-96	94	6.2	0.513	12.8	0.951	72	28.05	0.05	28.1	31.75	0.58	14.46	1.07
5-Dec-96	108	6.2	0.465	16.6	0.892	82	18.48	18.12	36.6	47.51	0.60	21.55	1.16
8-Jan-97	94	5.9	0.479	44	1.66	44	28.56	4.94	33.5	37.85	0.54	49.71	1.88
11-Feb-97	123	6.2	0.517	50	0.801	80	35.19	4.81	40	59.14	0.76	73.92	1.18
5-Aug-97	123	6.4	0.463	11.8	2.26	100	29.07	7.13	36.2	53.52	0.68	17.45	3.34
2-Oct-97	168	6.4	0.463	11.8	2.26	100	29.07	7.13	36.2	73.10	0.93	23.83	4.56
6-Nov-97	171	6.6	0.398	0	0.348	140	34.17	8.03	42.2	86.74	0.82	0.00	0.72
11-Dec-97	123	6.4	0.439	0	0.852	96	32.13	0	28.3	41.84	0.65	0.00	1.26
8-Jan-98	188	6.1	0.411	56	1.52	56	18.27	2.03	20.3	45.87	0.93	126.55	3.43
11-Feb-98	108	6.3	0.482	0	0.451	120	33.66	6.74	40.4	52.45	0.63	0.00	0.59
10-Mar-98	188	6.3	0.44	0	0.87	98	30.09	5.61	35.7	80.67	0.99	0.00	1.97
14-Apr-98	108	5.7	0.55	42	5.66	36	36.2	6	42.2	54.78	0.71	54.52	7.35
12-May-98	321	5.7	n/a	n/a	n/a	26	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7-Jul-98	224	6.2	0.47	0	0.88	110	33.66	2.94	36.6	98.54	1.27	0.00	2.37
6-Aug-98	138	6.2	0.48	0	0.52	132	39.78	5.92	45.7	75.81	0.80	0.00	0.86
3-Sep-98	123	6.4	0.45	0	0.46	166	38.76	3.84	42.6	62.98	0.67	0.00	0.68
6-Oct-98	154	6.4	0.44	0	0.47	172	37.74	3.06	40.8	75.52	0.81	0.00	0.87
19-Nov-98	108	6.5	0.39	0	0.41	190	34.68	0.42	35.1	45.57	0.51	0.00	0.53
8-Dec-98	94	6.5	0.44	0	0.58	184	38.25	0.55	38.8	43.84	0.50	0.00	0.66
12-Jan-99	170	6.6	0.43	0	3.11	142	39.27	0	38	77.65	0.88	0.00	6.35
2-Feb-99	108	6.5	0.44	0	0.2	166	44.9	2.3	47.2	61.27	0.57	0.00	0.26
2-Mar-99	94	6.5	0.42	0	0.2	160	40.29	0	39.1	44.18	0.47	0.00	0.23
13-Apr-99	123	6.4	0.46	0	0.44	150	42.33	0	39.6	58.55	0.68	0.00	0.65
5-Aug-99	94	6.5	0.36	0	0.36	166	34.08	1.42	35.5	40.11	0.41	0.00	0.41
9-Sep-99	94	6.5	0.37	0	0.23	178	34.68	0	31.7	35.82	0.42	0.00	0.26
5-Jan-00	94	6.5	0.401	0	<0.2	162	33.66	5.94	39.6	44.74	0.45	0.00	n/a
8-Feb-00	123	6.6	0.44	0	<0.2	136	26.01	1.89	27.9	41.25	0.65	0.00	n/a
15-Mar-00	108	6.4	0.444	0	<0.2	156	37.23	3.07	40.3	52.32	0.58	0.00	n/a
4-Apr-00	108	6.5	0.427	0	<0.2	118	33.15	5.35	38.5	49.98	0.55	0.00	n/a
4-May-00	262	6.5	0.482	0	0.284	134	37.74	4.76	42.5	133.84	1.52	0.00	0.89
14-Jun-00	139	6.6	0.454	0	0.315	88	30.6	0	27.5	45.95	0.76	0.00	0.53
6-Jul-00	107	6.5	0.441	0	0.23	100	9.9	26	35.9	46.17	0.57	0.00	0.30
15-Aug-00	160	6.3	0.464	0	0.234	138	0.33	32.07	32.4	62.31	0.89	0.00	0.45
6-Sep-00	108	6.6	0.385	0	<0.2	136	17.53	10.77	28.3	36.74	0.50	0.00	n/a
3-Oct-00	80	6.4	0.41	0	<0.2	172	31.7	1.8	33.5	32.21	0.39	0.00	n/a
2-Nov-00	171	6.5	0.388	0	<0.2	156	34.1	0.1	34.2	70.30	0.80	0.00	n/a
7-Dec-00	94	6.7	0.401	0	<0.2	124	24.1	1.6	25.7	29.04	0.45	0.00	n/a
Statistical Analysis													
50th Percentile	123	6.4	0.44	0.0	0.52	120	31.9	2.4	35.3	51.6	0.7	0.0	0.9
70th Percentile	165	6.5	0.46	0.0	0.83	136	34.7	4.8	39.1	62.9	0.8	0.0	1.2
90th Percentile	178	6.6	0.49	42.6	1.78	166	39.8	8.9	43.9	82.5	1.0	51.2	2.6
95th Percentile	210	6.6	0.51	50.9	2.34	173	41.9	26.9	47.2	92.9	1.0	81.8	4.1
100th Percentile	321	6.7	0.55	72.0	5.66	190	44.9	38.9	73.6	152.2	1.5	148.9	7.3

the refuse for use as fuel in an electric cogeneration power plant. Because removal or regrading of some of the refuse material would be necessary to construct a passive mine drainage treatment facility at the site, design activities were put on hold while the landowners pursued their interest in reprocessing the refuse pile. By late 1999, the owners learned that the refuse material was of very poor quality and they could not generate interest from any cogeneration facilities to reprocess the refuse. Design activities were reactivated in early 2000.

Analysis of the mine drainage discharges consistently indicated that the mine water was net alkaline with a moderate to high concentration of dissolved iron. The discharge did however become net acid for a short period of time due to an active surface mining operation as explained earlier. In order to offset any future occurrences of mine water discharge that were net acid, a small anoxic limestone drain (ALD) was planned to provide alkalinity during those periods. The ALD was not constructed due to elevation constraints discovered during construction. Other engineering difficulties at this site involved the complete capture of the discharge and the very limited space to construct a passive treatment system. A small tributary to Sugar Creek had to be relocated to accommodate construction of the treatment system.

Using the discharge monitoring data collected during the evaluation and planning phase of the project, a design flow rate of 170 gpm (the 80th percentile) or 0.25 MGD was selected. A decision was also made to target the 80th percentile of the total iron concentration observed during the pre-design discharge monitoring which was 37.6 mg/L. Figure 5 shows a summary of the pre-design monitoring data and the design flow and iron concentration.

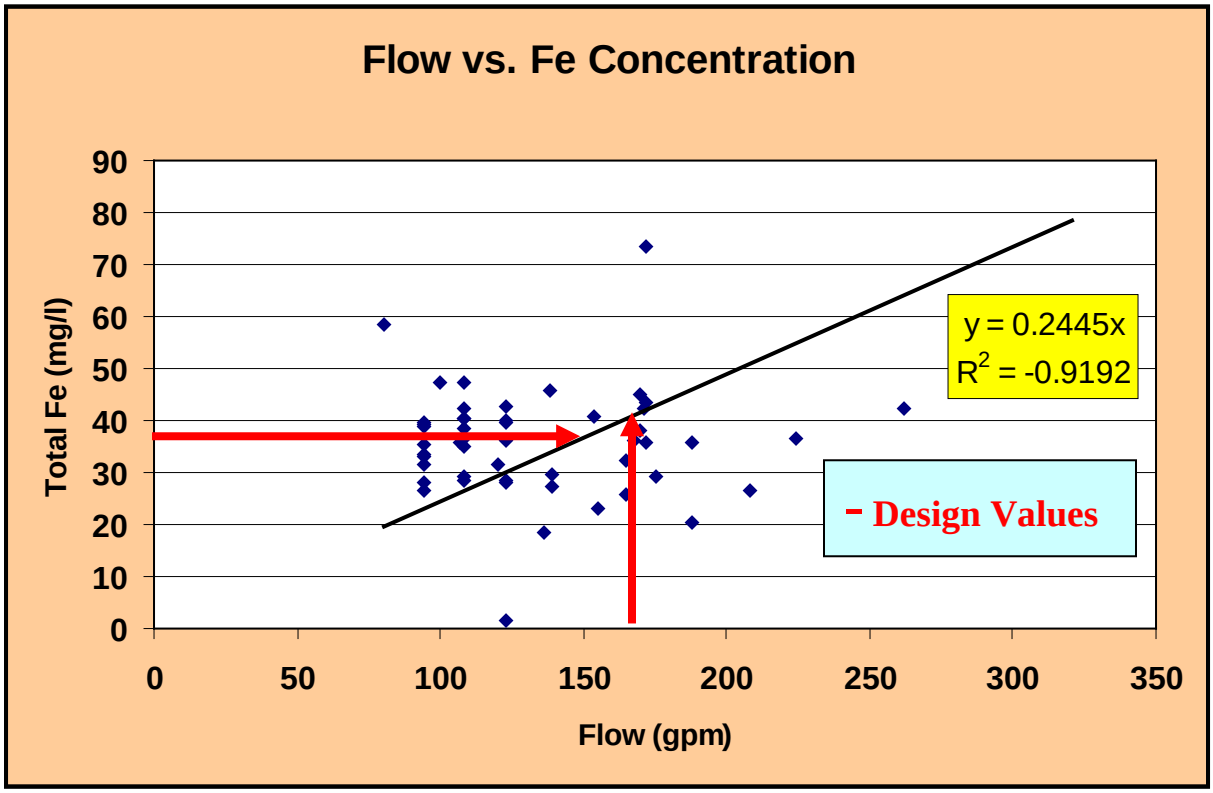

FIGURE 5 –Graph showing a summary of the pre-design flow versus total iron concentration data and the treatment system design

The design of the passive treatment system was completed using the above design criteria with consideration given to project site limitations, including topography, the need to relocate a small tributary, and proximity to Sugar Creek. The resultant design consisted of a small anoxic limestone drain, and an approximate 0.3 acre (90 feet by 145 feet) settling pond followed by a multi-chambered aerobic wetland. The system was designed to allow for the rapid aeration of the mine water and for the necessary detention to allow for the oxidation, hydrolysis and precipitation of the iron sludge. The multi-chambered aerobic wetland treatment cells total approximately 0.8 acres (80 feet by 440 feet). Analysis of the on-site soils for engineering properties indicated that the material would be acceptable for construction of the earthen pond embankments.

In order to reclaim the pile, the refuse material would need to be pulled back from the stream bank. The pile would require regrading and capping to establish more stable slopes and adequate vegetation. Erosion protection in the form of riprap lining would also be incorporated into the project design to ensure the long-term stability of the re-contoured refuse pile.

PROJECT IMPLEMENTATION CHALLENGES

Many challenges had to be overcome to implement the project including finding suitable access to the project site. Access to the site from State Route 68 would require crossing an active (at that time) railroad line and the construction of a ford crossing on Sugar Creek. Also, a small unnamed tributary to Sugar Creek that was impacted by the placement of the refuse and would require relocation in order to accommodate construction of the passive mine drainage treatment system. Finally, the old mine entry that the mine drainage had been discharging from for over forty years had accumulated a significant plume of iron precipitate at the opening and in the discharge channel leading from the entry. Rehabilitation of the opening and capture of the discharge for routing into the passive treatment system would require careful planning and close monitoring during project construction.

Several permits and approvals were required for the project including a stream encroachment waiver, a wetland encroachment waiver, a stream relocation approval, a Highway Occupancy permit for access to the site from the state highway, and an NPDES permit for discharge of stormwater from construction activities. An agreement with the owner of the railroad line, Pittsburgh and Shawmut Railroad, was also required.

CONSTRUCTION SUMMARY

The project design and permitting were completed in March 2002, and bids were opened April 25, 2002. The contract for the project was awarded to Casselman Enterprises, Inc., 150 West Union Street, Somerset, PA 15501, and a notice to proceed was issued in August 2002. Construction on the project began on September 19, 2002, and was completed on September 10, 2003. The bid price for the project was $597,060.00, and the final construction cost was $660,019.95.

The project was constructed as designed with the exception of the ALD. When the large plume of iron precipitate was removed from the face of the discharging mine entry, it became apparent that the invert of the mine opening was too low to accommodate the construction of the ALD. The limestone that was planned for use in the ALD was instead used to construct a series of four limestone diversions in the aerobic wetland. The diversions were constructed to distribute the flow more evenly throughout the aerobic wetland and to add a small amount of alkalinity to the mine water prior to discharge to Sugar Creek.

The principal items of work included 63,314 cubic yards of grading to re-contour the dangerous refuse pile slopes, 9,706 cubic yards of excavation for construction of the passive treatment system cells, placement of 22,748 cubic yards of soil cover material, construction of a new mine seal, 336 tons of high calcium carbonate ($CaCO_3$) content limestone (originally planned for use in the ALD) used for construction of limestone diversions, construction of several permanent channels, and placement of R-7 riprap for rock toe buttress to stabilize the toe of the regraded refuse pile. Figure 6 shows a photograph of the completed project with the passive mine drainage treatment system in the foreground and the re-contoured and reclaimed refuse pile in the background.

POST CONSTRUCTION MONITORING AND STREAM RESTORATION RESULTS

The treatment system went on-line in August 2003 and has been monitored for performance monthly since that time. Chemical and biological sampling of Sugar Creek has also been conducted to evaluate the effectiveness of the treatment system and to monitor the recovery of the aquatic ecosystem within Sugar Creek downstream of the project site. The primary contaminant in the mine drainage discharge was ferrous iron. Figure 7 shows the effectiveness of the treatment process in oxidizing the ferrous iron and converting it to ferric iron. While the treatment system has been in full-scale operation for only six months, Sugar Creek is already showing signs of recovery. The in-stream iron concentration within Sugar Creek below the old discharge site has consistently been below 1.0 mg/l except for a single sampling event in January 2004. Figure 8 shows in-stream total iron concentration as monitored just downstream of the treatment system. Other metals associated with the mine drainage discharge have been reduced to only trace amounts. Evidence of the severe iron coating and staining is already beginning to be flushed away. And most importantly, a macroinvertebrate study completed in November 2003 shows that the number and diversity of aquatic species is already on the increase. The total number of taxa when compared to the pre-construction survey data increased from four to seven just below the site and from seven to 12 near the mouth of Sugar Creek. The increases also show some pollution-intolerant species beginning to colonize the stream below the reclamation project site. Biological surveys conducted prior to construction showed no pollution-intolerant mayfly genera below the point where the mine drainage discharge entered Sugar Creek. The post-construction survey found three genera of mayflies downstream of the treatment system. The numbers of macroinvertebrates and the diversity of taxa are expected to continue to increase as the stream habitat recovers further. Mayfly, minnows and other fish species have also been observed in the stream below the project site providing more evidence that the stream is recovering.

FIGURE 6 – Photograph of the completed passive treatment system and the reclaimed coal refuse pile restored as part of the Sugar Creek Project

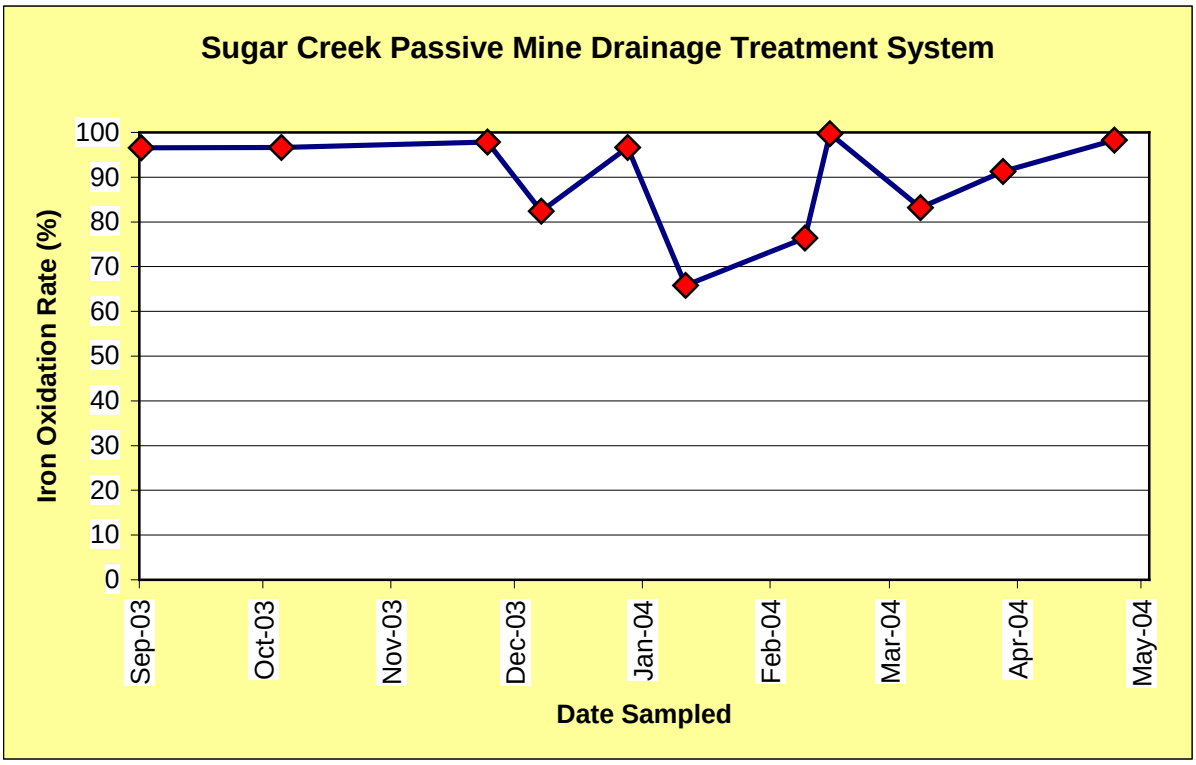

FIGURE 7 – Iron oxidation rate for the Sugar Creek passive mine drainage treatment system

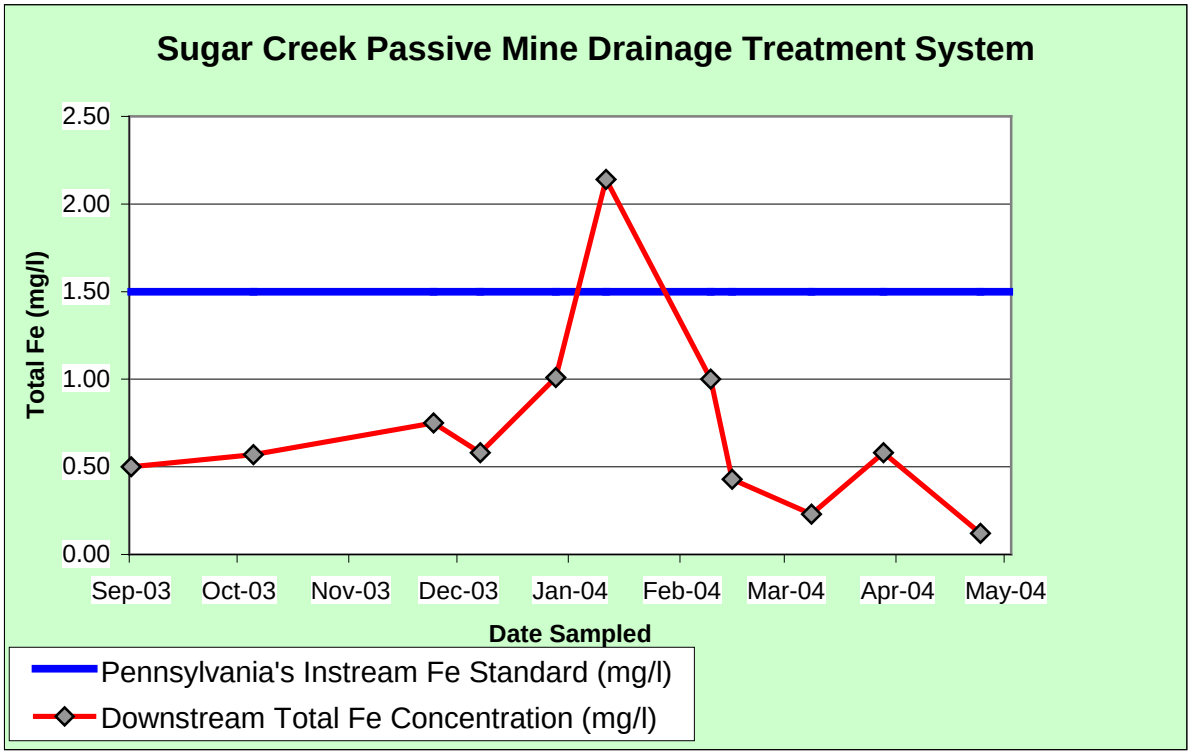

FIGURE 8 – In-stream total iron concentration monitored downstream of the treatment system in comparison with Pennsylvania's in-stream iron standard

SUMMARY

The Sugar Creek coal refuse pile and mine drainage discharge reclamation project reclaimed a 15-acre refuse pile, eliminating a significant human health and safety hazard, and coupled that effort with the construction of a passive mine drainage treatment system to treat the primary source of mine drainage in the Sugar Creek Watershed. The combined reclamation effort not only made the site safer for local residents but also dramatically improved the aesthetics of the site by converting the once barren landscape of the refuse pile into a lush green hillside. The elimination of the erosion and sedimentation problems associated with the refuse pile coupled with the treatment of the abandoned mine drainage discharge is allowing for the aquatic restoration of the lower three miles of Sugar Creek. Figure 9 shows an aerial view of the completed reclamation project including the passive mine drainage treatment system and the re-contoured and revegetated refuse pile. The restoration of Sugar Creek will allow for the re-connection of the headwaters of the stream to the much larger Allegheny River providing spawning areas for native fish and enhanced recreational opportunities for local residents. The re-contouring of the refuse pile to more gentle slopes and the revegetation of the barren refuse pile material will provide improved wildlife habitat for deer, turkey and other native wildlife. This project is exemplary because it combined the reclamation of a significant human health and safety problem resulting from past coal mining activities with aspects to allow for the environmental restoration of the barren landscape of the refuse pile and aquatic restoration of Sugar Creek which had been contaminated by this mine drainage discharge and eroding refuse material for over forty years. The Sugar Creek abandoned mine land reclamation project demonstrates the results that can be achieved when combining the reclamation of high-priority

health and safety hazards with environmental restoration to maximize the benefits of abandoned mine reclamation work completed under Title IV of SMCRA.

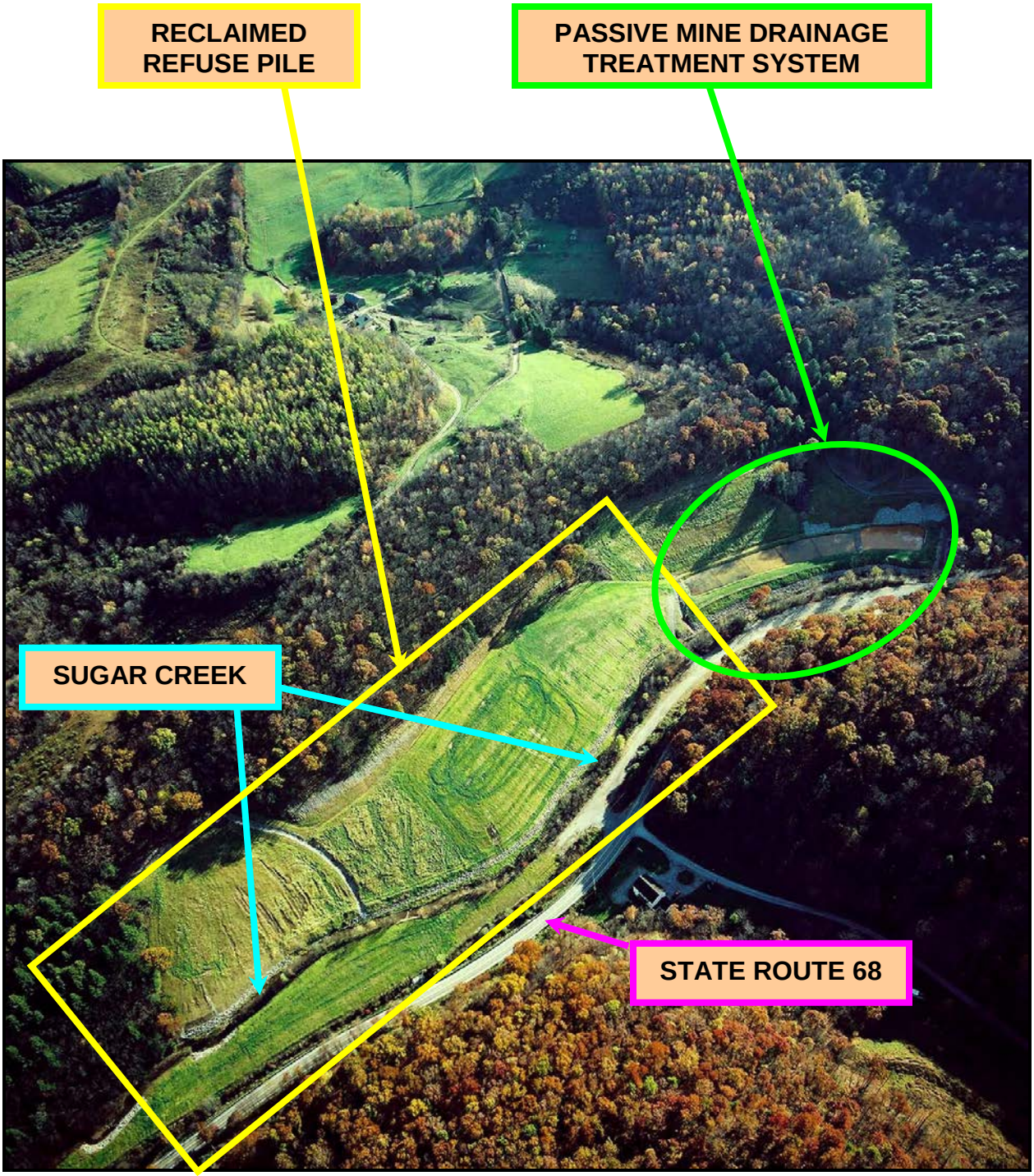

FIGURE 9 – Photograph of the Sugar Creek Refuse Pile and Mine Drainage Reclamation Project Following Restoration

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