A-1 INTRODUCTION TO CONTRARY RUN SECTION OF THE REPORT

Section A of the report deals with the Contrary Run watershed, one of the watersheds selected for investigation as part of an overall effort of Beech Creek water quality cleanup headed by the Beech Creek Watershed Association. Contrary Run is a tributary to Sandy Run, classified as CWF (cold water fishery). As defined by DEP in Chapter 93 of the regulations, a designation of CWF indicates that the maintenance and/or propagation of fish species including the family Salmonidae and additional flora and fauna indigenous to a cold water habitat is to be protected.

The watershed is located approximately three and a half miles north of Snow Shoe, Centre County, Pennsylvania; the watershed boundary as delineated on a 7½ minute topographic map (Snow Shoe Quadrangle) is shown in Figure A-1.

The study provides information needed for the assessment of water quality degradation and sets priorities for the planned restorative action. As the surface water contamination is associated with the past surface mining operations and refuse banks, the goal of the proposed remedial measures is in permanent improvements of the watershed conditions by correcting the lack of past reclamation.

A-2 CONTRARY RUN WATERSHED CHARACTERIZATION

This section of the report contains chapters that deal with the site geologic and hydrologic conditions and current land use.

A-2.1 Geology

The Contrary Run watershed is underlain by coal-bearing strata of the Allegheny Group that is composed of three formations and includes these principal coal seams - Lower Freeport,

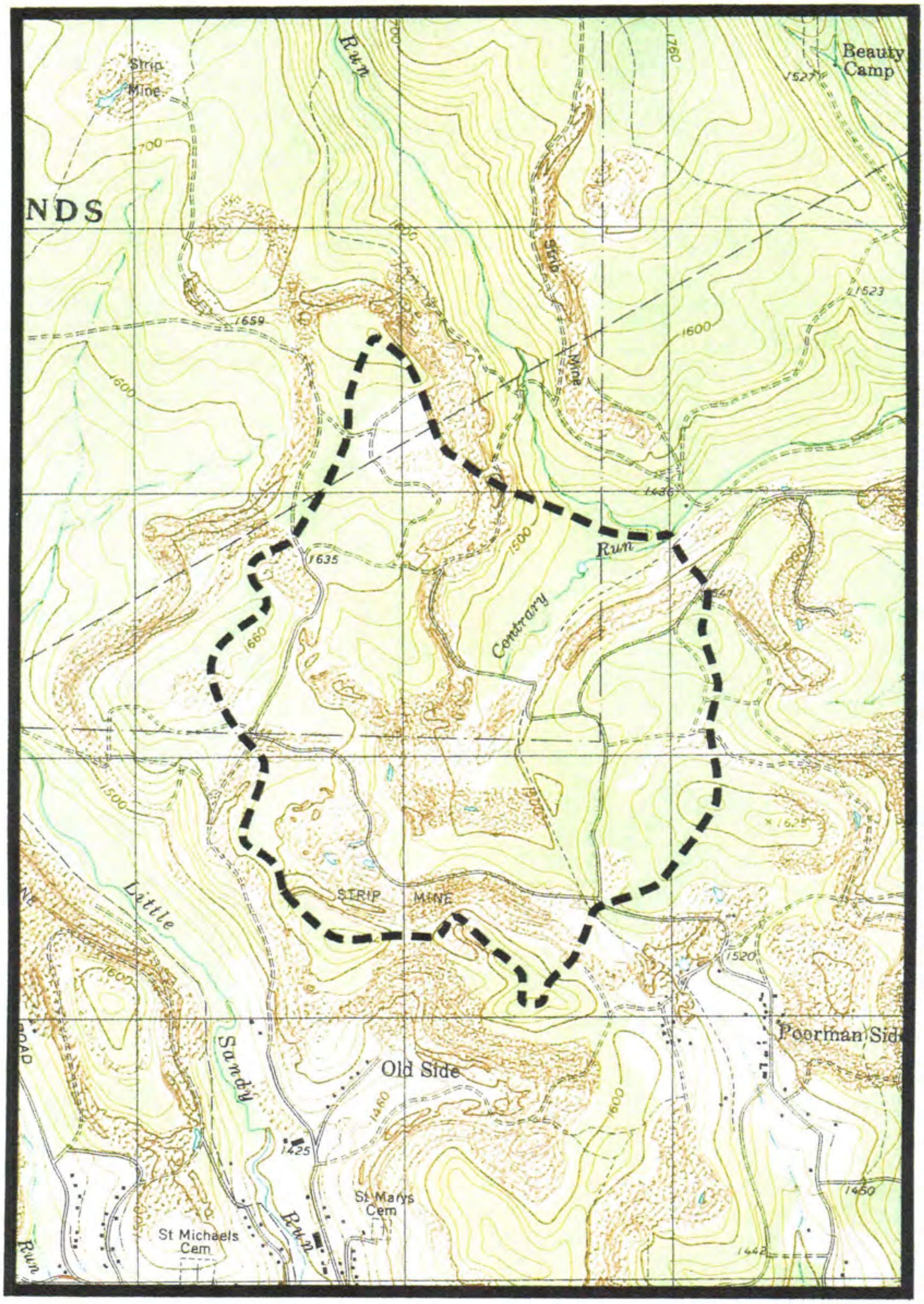

Figure A-1. Contrary Run Watershed Delineation.

Upper, Middle, and Lower Kittanning, Clarion, and Brookville that were mined in the area. The stratigraphic column prepared for the strata of the watershed is given Table A-1.

TABLE A-1. STRATIGRAPHIC COLUMN NOMENCLATURE
(modified from EDMUNDS, 1968)

Group	Formation	Member
Allegheny	Freeport	Lower Freeport coal
	Kittanning	Upper Kittanning coal
		Johnstown limestone
		Middle Kittanning coal
		Lower Kittanning coal
	Clarion Clarion A	Clarion #3
		Clarion or Clarion #2 coal
		Brookville or Clarion #1 coal
Pottsville	Mercer	Brookville or Bigler clay
		Homewood sandstone
		Upper Mercer #2 coal
		Lower Mercer #1 coal
	Connoquenessing	Connoquenessing sandstone

The nomenclature used in the stratigraphic descriptions of the site is that of Edmunds (1968) which is consistent with the common usage by the mining industry of the area, as well as with the first detailed evaluation of the Beech Creek watershed pollution and its abatement by Operation Scarlift, Project No. SL-111, 1970.

The coal-bearing strata in the watershed are exposed in several highwalls, left after the past mining operations were abandoned; in addition, information on the local geology was obtained from six drill holes placed in the stratigraphic section between the Lower Kittanning and Brookville coals, and also from records of mining operations in the adjacent watersheds.

The locations of the six drill holes are shown on Plate A-1, Land Use/Mine Map, and on the Geologic Map given in Figure A-2. The lithologic logs are given in Appendix A-1.

Exploration drill holes were placed directly above past mining operations to assess the overburden characteristics of the seam mined and to evaluate the feasibility of future coal recovery in the area. Furthermore, the placement of the drill holes was to aid in the interpretation of the local stratigraphic sequences and determine the interburden thickness between the seams, namely within the Clarion Formation. Table A-2 provides a summary of drilling results.

TABLE A-2. SUMMARY OF EXPLORATORY DRILLING

Drill Hole #	Surface Elevation *	Total Depth	Lower Kittanning Seam		Clarion Seam		Brookville Seam		Mercer Seam	
			Elevation	Thick-ness	Elevation	Thick-Ness	Elevation	Thick-ness	Elevation	Thick-ness
DH-1	1,610'	65'	--	--	1,575'	12"	1,551'	12"	--	--
DH-2	1,645'	38'	1,633'	12"	1,613'	22"	--	--	--	--
DH-3	1,520'	49'	--	--	1,493'	24"	1,475'	12"	--	--
DH-4	1,510'	70'	--	--	1,476'	12"	1,444'	12"	--	--
DH-5	1,590'	85'	--	--	1,545.5'	16"	1,518'	12"	--	--
DH-6	1,610'	64'	--	--	1,592'	11"	1,570'	No coal	1,548.5'	18"

* Not Surveyed

The oldest formation of the Allegheny Group present in the area includes the interval between the base of the Brookville (Clarion #1) coal up to the base of the Lower Kittanning coal. The thickness of the formation as verified by drilling is about 50 feet. Beside the Brookville seam, the formation also contains the Clarion seam. The uppermost Clarion #3

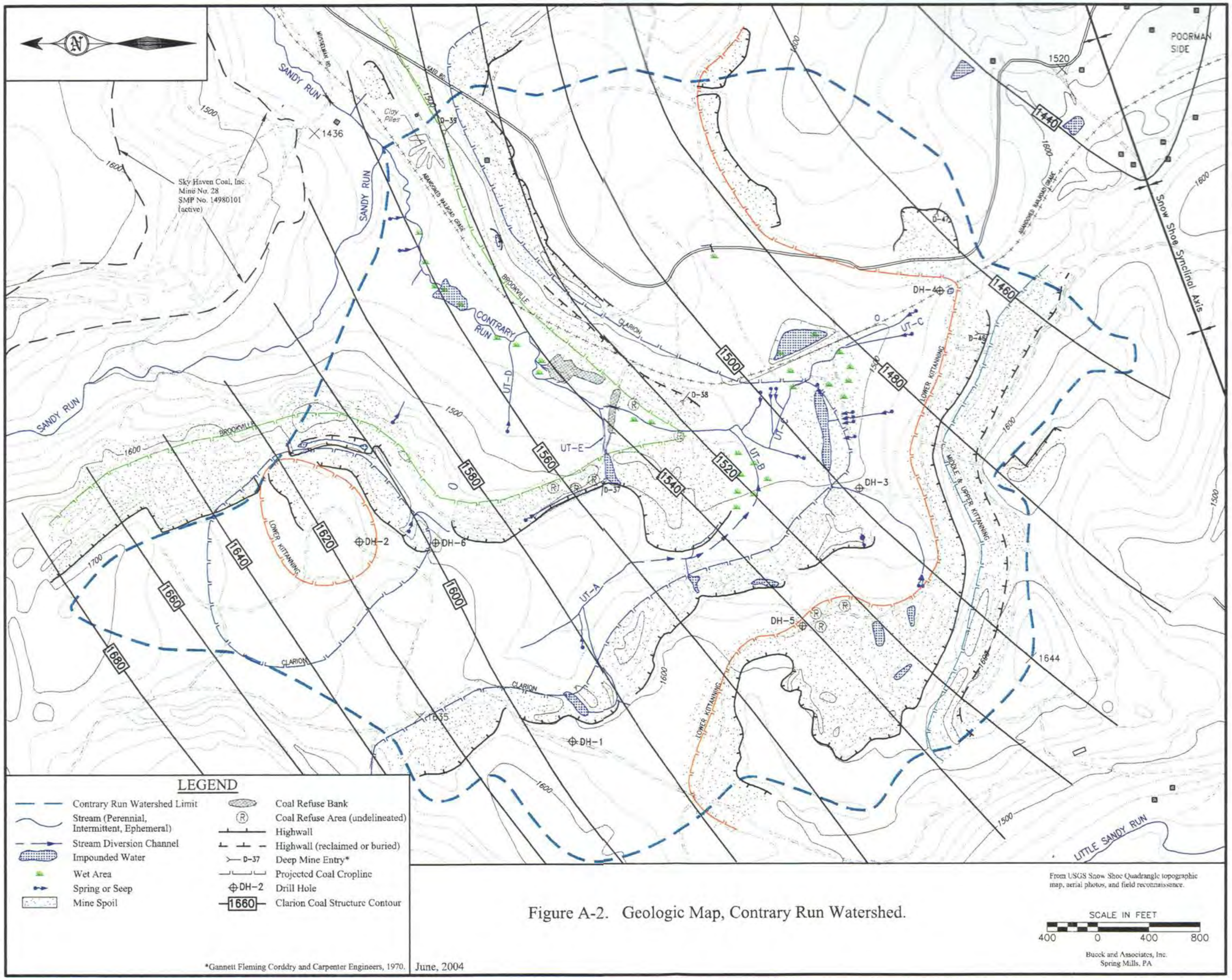

Figure A-2. Geologic Map, Contrary Run Watershed.

seam, identified and mined in the neighboring watersheds, may not be present in the area or is thin and discontinuous. The interval between the Brookville and Clarion seams ranges between 21-34 feet.

The Brookville coal mined in the central portions of the watershed is thinning out to the north and is believed to be absent where the past mining took place, mainly for the Brookville clay. However, there are no drilling data or any other available records to confirm this conjecture.

The Kittanning Formation consists of the Lower Kittanning and the Middle & Upper Kittanning coal seams. There is no drilling information available to describe the Middle and Upper Kittanning seam and its intervening section that was mined in the southern portion of the watershed. The highwall left after the coal extraction was reclaimed and thus is not accessible for inspection. The Lower Freeport seam was also mined in the southernmost section of the watershed with an abandoned highwall not exceeding 15 feet.

The local structural conditions, i.e. the overall strike of the coal-bearing strata, are shown on the structure contour map prepared for the Clarion A coal seam (see Figure A.2, Geologic Map). This figure also shows the croplines of the main coal seams present in the watershed area. The strata dip to the southeast with an average gradient of 1.8 degrees.

Structurally, the strata underlying the watershed are part of the northern limb of the Snow Shoe syncline, with its synclinal trough located immediately to the south of the watershed boundary. The syncline represents a major regional east-west trending structure that plunges to the southwest.

As the geochemical properties of the overburden strata determine the susceptibility of the overburden to AMD formation, overburden analyses were performed for composite samples collected from six drill holes (DH-1 through DH-6), drilled in June 2004.

The overburden analyses were used to perform acid-base accounting for each of the drill holes to determine the potential for the strata to produce acid mine drainage. The overburden analysis data is then used to assess the feasibility of potential remining of some of the areas where coal reserves are available and to provide an understanding of the needed alkaline addition for the existing mine spoil reclamation.

As the mined areas have different configurations and as the six drill holes are used to represent many of the mined areas, the acid-base accounting was done on a one acre section basis. For a mined area that is on a slope, this method overemphasizes the contribution of the shallower overburden, providing a conservative measure of alkaline addition rates. Threshold values of 0.5% total sulfur, neutralization potential of 60 tons/1,000 tons, and fizz present, were used. In addition, 10% of the coal seam and one foot below the coal are assumed to be spoiled and are included in the calculations. Appendix A-2 contains the overburden analysis spreadsheets. Table A-3, Summary of Overburden Analyses, contains a listing of the drill holes, the coal seams and their cover, the deficiency (tons/acre), the weight of overburden in a single acre column (tons), and the alkaline addition rates to achieve 3 tons/1,000 tons or 6 tons/1,000 tons net neutralization potential[1].

The overburden analysis for the Lower Kittanning coal seam (DH-2) indicates a deficiency of 64 tons/acre for 11 feet of cover. The Clarion coal seam cover, with 17 to 43 feet in thickness shows a deficiency ranging from 0 to 2,733 tons/acre. The highest deficiency value

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[1] All drill holes encountered at least two coal seams. The overburden analysis data for each of the drill holes were split by coal seam in Table A-3, Overburden Analyses Summary, with the deficiency, overburden tons, and alkaline addition rates calculated for each individual seam and its overburden or interburden, as well as for the entire hole. For each coal seam, one foot below the seam was included in the calculations. However, for the lower coal seam in each drill hole, the interburden begins directly beneath the coal seam above it. For example in drill hole DH-1, the data used for the Clarion coal seam calculations includes one foot below the coal seam, or 36 feet. However the data used for the Brookville is from 35 feet to 61 feet. Therefore, the deficiency, overburden tons, and alkaline addition rates are not additive when shown for the calculations for the mining of both seams together.

TABLE A-3. SUMMARY OF OVERBURDEN ANALYSES

Drill Hole	Coal Seam(s)	Cover (ft)	Deficiency (tons/acre)	Overburden (tons)	Alkaline Addition Rate (tons/acre)	
					Net NP 3 tons/1,000 tons	Net NP 6 tons/1,000 tons
DH-1	Clarion	34	203	120,810	565	928
	Brookville	59	316	92,050	592	868
	Clarion and Brookville	--	402	209,160	1,029	1,657
DH-2	Lower Kittanning	11	64	30,050	154	244
	Clarion	28	2,733	74,240	2,956	3,178
	Lower Kittanning and Clarion	--	2,797	100,620	3,099	3,401
DH-3	Clarion	25	252	91,020	525	798
	Brookville	44	2,074	65,760	2,271	2,469
	Clarion and Brookville	--	2,187	149,880	2,637	3,086
DH-4	Clarion	33	72	118,120	426	781
	Brookville	62	242	110,200	573	903
	Clarion and Brookville	--	258	224,870	933	1,607
DH-5	Clarion	43	334	159,780	813	1,293
	Brookville	71	908	100,380	1,209	1,510
	Clarion and Brookville	--	957	256,460	1,726	2,496
DH-6	Clarion	17	0	55,260	166	332
	Brookville (coal missing)	37	0	65,340	196	392
	Mercer	59	75	75,355	301	527
	Clarion, Brookville, & Mercer	--	75	209,490	703	1,332

All calculations shown are with the following thresholds: Sulfur - 0.5%, Neutralization Potential (N.P.) - 60, and Fizz - 1.
See spreadsheets in Appendix A-2.

is considered an outlier compared to the prevailing deficiencies; the next highest measured deficiency is 334 tons/acre. Excluding the outlier, the average deficiency for the Clarion overburden is 172 tons/acre. The Brookville coal seam was encountered at a depth of 44 to 71 feet in the drill holes. Like in the case of the Clarion coal seam, the Brookville deficiencies range from 0 to 2,074 tons/acre, with the high value appearing to be an outlier as well. The average calculated deficiency is at 708 tons/acre including the outlier, and 367 tons/acre, excluding the highest value. Interestingly, the deficiency of 2,074 tons/acre was present under the lowest cover conditions.

A-2.2 Hydrology

Contrary Run is a first and second order stream: a tributary to Sandy Run, which is a tributary to Beech Creek. The stream collects drainage from approximately 720 acres and is currently a continuous perennial stream only in its most downgradient segment where the stream bed remains unaffected by mining.

The past mining in the Contrary Run watershed occurred mainly in the headwaters of the stream where it significantly modified its course. A comparison of the pre-mining topography and the current landscape shows the total destruction of the Contrary Run headwaters in the southwestern portion of the watershed and a disruption of the stream channels of unnamed tributaries UT-A, UT-B, and UT-C, especially in the area of confluence with Contrary Run. The changes in the local drainage patterns will be further discussed below.

The majority of the coal bearing strata lie above the regional ground water reservoir and are characterized by perched ground water systems with intermittent saturation. The efficiency of the ground water perching depends on the integrity of the strata underlying the coal seam; the ground water flow direction is determined by the overall inclination of the seam and its "underclay". The perched systems discharge usually through a series of contact springs and seeps mapped along the coal cropline. The replacement of strata by spoils changes the hydraulic characteristics of the water bearing media, but the flow patterns remain to be controlled by the perching bed. It is believed that the stream flows derived from heavily surface mined areas are less "flashy" because of the higher storage capacity of the mine spoils and its retention capacity.

The main impact of the mining on the ground water system of the area and its recharge capacity to the local streams is associated with the past deep mining operations. The deep mine workings act as large underdrains that divert the ground water recharge downdip and in the case of the southern portion of the watershed to the southeast and away from Contrary Run and its tributaries. The subsidence in the shallow portions of the deep mine system and mine roof collapses further enhance the water diversion from the watershed by disrupting the perched system and accelerated overburden dewatering.

A-2.3 Land Use

The Contrary Run watershed is forested and was pristine until the onset of deep and surface mining. Currently, the area is used for hunting of large and small game (a large portion of the watershed is owned by the Pennsylvania Game Commission). The main impact of the past mining operations has been on the quality of local streams. Currently, there are no fish in Contrary Run.

There is one permanent residence in the northeastern portion of the watershed that is accessible by Kato Road, a township road that provides access to the eastern portion of the area. The rest of the roads are unpaved private roads.

Approximately 30 percent of the land use in the watershed area is affected by the past surface mining operations. The coal and clay mining was done from open pits (strip mining) and by subsurface (deep mining) extraction. The trees in the surface mined areas were removed and after the mining was completed, replaced either by planted stands of conifers or by volunteer trees. Some of the mined areas are barren.

The past surface and deep mining in the watershed was done in the Brookville and Clarion seams in the central and northern portions of the watershed and Lower Kittanning and Middle & Upper Kittanning seams in its southern portions. Majority of the surface mining was done before the enactment of SMCRA (Surface Mining and Reclamation Act) of 1977.

The stratigraphic and structural conditions of the coal-bearing rocks that outcrop in the watershed area are described in the preceding chapter on geology.

All deep mines and a majority of the surface mined areas were abandoned; the surface manifestation of the underlying deep mine workings is in localized subsidence and the presence of refuse banks near the past deep mine entries; surface mined areas are characterized by hummocky topography of abandoned mine spoils and the presence of highwalls that often represent a safety hazard. The mine operations often disrupted the original drainage patterns; some of the original streams were diverted into ditches to keep the stream flow from the mining pits, with stream beds mined out and replaced by mine spoils. The spoil areas often contain many undrained depressions, some of which turned into ponds.

There are several surface mined areas where the mine spoils and highwalls were reclaimed and the area planted, or partially re-graded and planted with conifers and left with abandoned highwalls.

The disruption of overburden strata with potential for AMD formation, poor surface water flow controls and the direct exposure of acid forming materials, including the coal refuse, to air and water, creates classic environmental conditions for AMD contamination. Surface water contamination is contributed to the local streams directly from seeps and springs or from runoff, while ground water contamination is more elusive but substantial as it represents all base flow recharge to the local streams.

A-3 CONTRARY RUN WATERSHED WATER QUALITY CHARACTERIZATION

A-3.1 Water Quality Survey

A field investigation of the watershed was performed to identify all surface water features such as seeps, springs, streams, and ponds, and to collect water quality and flow data for a period of at least one hydrological year. A total of fifty three sampling locations were identified and sampled. In addition, several points were selected as monitoring points, where the water quality sampling continued for the duration of the project. The identified surface water features and sampling locations are shown on Plate A-I, Land Use/Mining Map, Contrary Run Watershed.

At each sampling location field measurements consisted of flow, pH, and temperature. Flow was measured by means of a stainless steel portable 1⅜" flume, or Global Water velocity probe; where measurements could not be taken, flow was visually estimated. Field pH and temperature were measured with Hanna HI-9025C pH and temperature meter. Collected samples were analyzed for the following parameters: laboratory pH, specific conductance, alkalinity, acidity, iron, manganese, aluminum, sulfate, and suspended solids. Chemical analyses were performed by Mahaffey Laboratory, Ltd., Grampian, Pennsylvania.

Collected field data and chemical analysis results were compiled into a series of individual spreadsheets for each of the sampling sites with information on sampling site description, latitude/longitude, and surface elevation. In addition, various sources were examined for historic sampling records in the Contrary Run watershed and where current and historic sampling locations could be correlated, the spreadsheets were complemented with available historic data. Sources of information included Operation Scarlift, Project No. SL-111, 1970, by Gannett Fleming, Corddry, and Carpenter, Inc., Beech Creek Watershed Restoration Plan by Gannett Fleming in 2000, routine DEP sampling records, and Sky Haven Coal, Inc. Mine 28 (permit No. 14980101) sampling records. A water quality database for the points sampled in Contrary Run Watershed is provided in Appendix A-3.

A-3.2 Water Quality Assessment

The evaluation of the water quality of Contrary Run and its impact on Sandy Run, is based on the stream viability to support aquatic life. The main chemical components with negative impacts on stream ecological health are low pH levels and elevated concentrations of acidity and metals, all parameters known to be typical for AMD. The critical parameters in evaluating the impacts of the stream water quality on aquatic life are total aluminum and pH levels. It has been reported, for instance by J.P. Baker et al., 1996, that in general, trout abundance in streams was reduced and acid sensitive fish species were absent from the studied streams with water quality characterized by median levels of pH less than 5.0 - 5.2 and aluminum concentrations exceeding 0.1- 0.2mg/l.

The evaluation of the surface water quality and its changes throughout the Contrary Run watershed is based on the median value of field pH levels and mean concentrations of total iron, total manganese, total aluminum, and sulfate, (see Table A-4, Water Quality Summary, Contrary Run Watershed). A series of maps were prepared for each listed parameter as given in Figures A-3, A-6, A-8, A-10, and A-12; the mapped seeps, springs, and stream sections of the watershed are color coded to show the levels of each selected parameter. The levels of impacts are then classified as unimpacted (green), moderately impacted (yellow), and impacted (red), and their areal distributions within the watershed are shown on the maps. A summary of the threshold limits for each of the parameters discussed below is given in Table A-5, Threshold Values for Water Quality Ranking below.

A – 3.2.1 pH Levels and Acidity Concentrations

A median pH level of 5.0 was used to define the threshold of stream quality below which the impacts on aquatic life become significant. All points with pH values of less than or equal to 5.0 are classified as impacted and shown red. Because mining has affected the waters in this watershed, the upper median pH limit has been defined as the 30 - day average effluent limit

TABLE A-4. CONTRARY RUN WATERSHED WATER QUALITY SUMMARY

Sample Point ID	Field pH		Acidity		Alkalinity		Iron		Manganese		Aluminum		Sulfate	
	median	range	mean	range	mean	range	mean	range	mean	range	mean	range	mean	range
CT01	4.0	3.5 - 5.3	24	16 - 41	2	0 - 6	0.69	0.14 - 2.61	1.00	0.65 - 1.77	2.36	1.42 - 4.08	44	25 - 71
CT02	4.5	3.4 - 5.4	26	18 - 40	1	0 - 3	0.57	0.30 - 1.04	1.03	0.80 - 1.48	2.22	1.40 - 4.29	40	24 - 63
CT03	4.2	3.8 - 4.6	15	12 - 18	4	4 - 4	2.24	0.15 - 4.33	0.05	0.03 - 0.06	-	-	14	12 - 15
CT04	4.3	3.9 - 4.7	41	40 - 42	0	0 - 0	1.37	1.31 - 1.43	1.42	1.40 - 1.44	4.42	4.42	50	32 - 68
CT05	4.4	3.8 - 6.0	23	14 - 32	2	0 - 4	0.12	0.03 - 0.33	1.25	1.00 - 2.16	2.63	1.34 - 3.19	53	42 - 66
CT06	4.0	3.4 - 5.8	41	18 - 164	0	0 - 2	0.94	0.26 - 2.80	1.04	0.59 - 2.48	4.92	1.42 - 19.40	50	22 - 174
CT07	3.7	2.3 - 3.9	257	194-362	0	0 - 0	6.90	4.00 - 12.40	2.75	2.13 - 4.23	22.08	15.80 - 31.90	294	165 - 500
CT08	4.6	3.4 - 4.9	19	9 - 38	2	0 - 6	0.85	0.07 - 4.36	0.78	0.49 - 1.30	1.20	0.53 - 3.37	29	6 - 57
CT09	4.4	3.3 - 5.6	18	14 - 30	1	0 - 4	0.20	0.08 - 0.50	0.59	0.35 - 1.00	1.41	1.04 - 2.20	27	15 - 41
CT10	5.0	3.9 - 6.3	14	6 - 66	4	0 - 8	1.50	0.04 - 6.31	0.82	0.30 - 3.64	1.28	0.17 - 7.21	25	6 - 121
CT11	5.2	3.8 - 5.5	8	3 - 16	5	4 - 7	0.21	0.03 - 0.36	0.35	0.03 - 0.82	0.38	0.09 - 1.03	15	9 - 27
CT12	6.9	5.1 - 7.1	0	0 - 0	19	14 - 29	0.85	0.36 - 1.61	0.04	0.01 - 0.07	0.36	0.12 - 0.59	14	12 - 17
CT13	5.0	3.8 - 5.9	10	6 - 18	4	3 - 6	0.48	0.15 - 1.29	1.33	0.91 - 1.69	0.46	0.35 - 0.56	33	24 - 46
CT14	5.1	4.7 - 6.3	10	6 - 14	7	3 - 16	2.21	0.19 - 10.70	2.24	1.81 - 2.97	0.52	0.05 - 0.66	41	34 - 51
CT15	4.1	3.7 - 4.6	41	26 - 56	1	0 - 2	2.67	1.48 - 4.94	1.92	1.34 - 3.01	5.18	5.18	52	33 - 64
CT16	5.7	3.7 - 6.2	8	0 - 20	19	2 - 44	2.38	0.29 - 6.19	1.34	0.91 - 1.72	0.17	0.17	32	13 - 53
CT17	4.7	3.9 - 5.0	10	7 - 14	4	3 - 5	0.06	0.04 - 0.08	0.64	0.41 - 1.31	0.57	0.40 - 0.81	22	13 - 34
CT18	5.0	4.2 - 5.5	6	4 - 16	5	4 - 6	0.10	0.02 - 0.38	0.18	0.03 - 1.22	0.10	0.06 - 0.23	13	6 - 40
CT19	4.9	3.9 - 5.1	12	8 - 16	4	2 - 6	0.06	0.02 - 0.14	0.78	0.47 - 1.23	0.81	0.27 - 1.28	21	10 - 43
CT20	5.4	4.5 - 5.9	4	0 - 6	9	5 - 24	1.11	0.17 - 4.90	0.23	0.10 - 0.57	0.09	0.05 - 0.13	9	2 - 12
CT21	4.8	4.5 - 5.1	42	31 - 53	5	5 - 5	0.15	0.05 - 0.24	1.48	1.32 - 1.64	8.77	8.41 - 9.13	80	67 - 92
CT22	4.8	3.8 - 5.7	18	17 - 18	1	0 - 1	<0.05	<0.05 - <0.05	0.34	0.33 - 0.35	1.40	1.30 - 1.49	18	18 - 18
CT23	5.1	4.3 - 5.8	36	34 - 37	0	0 - 0	<0.05	<0.05 - <0.05	0.74	0.72 - 0.76	4.13	4.00 - 4.25	38	37 - 38
CT24	5.0	4.0 - 6.0	15	13 - 16	0	0 - 0	0.07	0.05 - 0.08	0.11	0.10 - 0.11	0.80	0.78 - 0.81	13	11 - 14

TABLE A-4. CONTRARY RUN WATERSHED WATER QUALITY SUMMARY (cont.)

Sample Point ID	Field pH		Acidity		Alkalinity		Iron		Manganese		Aluminum		Sulfate	
	median	range	mean	range	mean	range	mean	range	mean	range	mean	range	mean	range
CT25	4.8	4.0 - 5.5	33	30 - 35	0	0 - 0	0.18	0.15 - 0.20	0.22	0.20 - 0.23	2.02	1.79 - 2.25	23	21 - 24
CT26	5.2	4.7 - 5.7	58	56 - 60	0	0 - 0	0.19	0.16 - 0.21	0.67	0.60 - 0.74	8.40	6.89 - 9.90	51	45 - 56
CT27	5.0	4.4 - 5.6	11	10 - 11	4	3 - 5	<0.05	<0.05 - <0.05	0.65	0.63 - 0.67	0.73	0.73 - 0.73	30	29 - 30
CT28	5.5	5.0 - 5.9	9	8 - 10	4	3 - 5	<0.05	<0.05 - <0.05	0.74	0.73 - 0.75	0.44	0.43 - 0.45	35	32 - 37
CT29	5.3	4.8 - 5.7	9	7 - 11	4	3 - 5	<0.05	<0.05 - <0.05	0.65	0.62 - 0.68	0.36	0.32 - 0.39	32	30 - 33
CT30	5.0	4.8 - 5.1	11	9 - 13	4	3 - 4	<0.05	<0.05 - <0.05	0.80	0.66 - 0.93	0.70	0.68 - 0.71	19	17 - 20
CT31	5.6	5.6 -5.6	5	0 - 9	13	10 - 15	2.33	0.57 - 4.08	0.44	0.11 - 0.76	0.26	0.09 - 0.42	7	6 - 7
CT32	5.0	5.0	14	14	3	3	0.05	0.05	0.12	0.12	0.10	0.10	30	30
CT33	6.3	5.8 - 6.7	0	0 - 0	51	46 - 56	1.28	0.29 - 2.27	0.19	0.02 - 0.36	0.08	<0.05 - 0.10	13	11 - 14
CT34	6.6	6.0 - 7.1	0	0 - 0	71	70 - 72	1.73	1.72 - 1.73	0.30	0.19 - 0.41	0.05	<0.05 - 0.05	8	8 - 8
CT35	6.2	6.2	8	8	6	6	<0.05	<0.05	0.10	0.10	0.11	0.11	21	21
CT36	5.6	5.5 - 5.7	15	6 - 23	9	6 - 11	4.12	0.41 - 7.83	0.50	0.38 - 0.61	0.30	0.16 - 0.43	17	14 - 20
CT37	6.0	5.9 - 6.1	0	0 - 0	29	28 - 30	4.53	4.02 - 5.04	0.91	0.89 - 0.92	0.17	0.11 - 0.23	9	8 - 9
CT38	4.2	3.9 - 4.4	39	32 - 46	0	0 - 0	7.12	2.14 - 12.10	1.77	1.75 - 1.79	2.00	1.61 - 2.38	40	36 - 43
CT39	3.5	3.5	195	195	0	0	9.54	9.54	10.40	10.40	15.40	15.40	248	248
CT40	4.2	4.2	12	12	3	3	0.50	0.50	0.87	0.87	0.28	0.28	15	15
CT41	4.5	4.4 - 4.6	11	9 - 12	3	2 - 4	0.46	0.33 - 0.58	0.51	0.50 - 0.51	0.30	0.30 - 0.30	29	27 - 30
CT42	5.9	5.8 - 6.0	0	0 - 0	27	19 - 35	1.44	1.40 - 1.47	1.08	0.13 - 2.03	0.30	0.22 - 0.37	25	9 - 41
CT43	5.4	5.4	11	11	5	5	1.15	1.15	2.17	2.17	0.36	0.36	42	42
CT44	5.3	5.0 - 5.5	9	8 - 10	6	6 - 6	0.39	0.30 - 0.47	0.25	0.24 - 0.25	0.29	0.27 - 0.31	24	23 - 24
CT45	4.7	4.7	18	18	6	6	2.42	2.42	0.09	0.09	0.25	0.25	13	13
CT46	5.7	5.7	0	0	30	30	4.17	4.17	0.22	0.22	0.08	0.08	9	9
CT47	5.0	5.0	7	7	7	7	0.83	0.83	0.73	0.73	0.17	0.17	23	23

TABLE A-4. CONTRARY RUN WATERSHED WATER QUALITY SUMMARY (cont.)

Sample	Field pH		Acidity		Alkalinity		Iron		Manganese		Aluminum		Sulfate	
Point ID	median	range	mean	range	mean	range	mean	range	mean	range	mean	range	mean	range
CT48	5.6	5.6	9	9	7	7	2.92	2.92	1.03	1.03	0.34	0.34	11	11
CT49	4.5	4.5	80	80	2	2	0.08	0.08	1.72	1.72	10.50	10.50	130	130
CT50	6.7	6.7	5	5	6	6	1.41	1.41	0.20	0.20	0.35	0.35	8	8
SD7932	5.1	4.8 - 5.7	7	2 - 12	5	2 - 6	0.19	0.04 - 0.72	0.19	0.07 - 0.46	0.80	0.59 - 1.01	19	10 - 35
SD8131	4.6	4.2 - 5.0	5	4 - 6	6	6 - 6	0.08	0.05 -0.11	0.10	0.10 - 0.10	-	-	14	12 - 16
SD8141	5.3	3.9 - 6.4	5	1 - 22	6	1 - 8	0.07	0.02 - 0.20	0.06	0.01 - 0.18	0.08	0.05 - 0.11	12	6 - 19
Mine 28-9	5.1	4.5 - 7.2	3	2 - 5	8	6 - 14	<0.07	<0.07	<0.05	<0.05 - 0.05	-	-	9	2 - 36

TABLE A-5 THRESHOLD VALUES FOR WATER QUALITY RANKING			
PARAMETER	THRESHOLD LEVEL	IMPACT LEVEL	SHADED COLOR
pH	≥6.0	no impact	green
	>5.0 - <6.0	moderately impacted	yellow
	≤5.0	impacted	red
Iron	≤0.3 mg/l	no impact	green
	>0.3 - <3.0 mg/l	moderately impacted	yellow
	≥3.0 mg/l	impacted	red
Manganese	≤0.05 mg/l	no impact	green
	>0.05 - <2.0 mg/l	moderately impacted	yellow
	≥2.0 mg/l	impacted	red
Aluminum	≤0.2 mg/l	no impact	green
	>0.2 - <0.5 mg/l	moderately impacted	yellow
	≥0.5 mg/l	impacted	red
Sulfate	≤40 mg/l	no impact	green
	>40 - <250 mg/l	moderately impacted	yellow
	≥250 mg/l	impacted	red

from surface runoff from previously mined areas which have achieved the revegetation standards. These limits are known as the 30-day average "Group A" levels under 25 PA Code §87.102, the Surface Mining Regulations, which for pH is 6.0; all median pH levels of 6.0 or greater are considered characteristic of background water quality, i.e. not impacted, and are shaded green. All pH levels that are between the two values are shaded yellow.

The majority of discharges and streams, including Contrary Run, as shown in Figure A-3 for median pH levels are shaded red, indicating that median pH levels of less than 5.0 prevail in the watershed. Only discharges and tributaries to UT-C in the southeastern portion of the watershed exhibit median pH levels exceeding 6.0. A stream section of Sandy Run above its confluence with Contrary Run is color coded yellow indicating moderately impacted quality with median field pH level of 5.3, measured at SD8141.

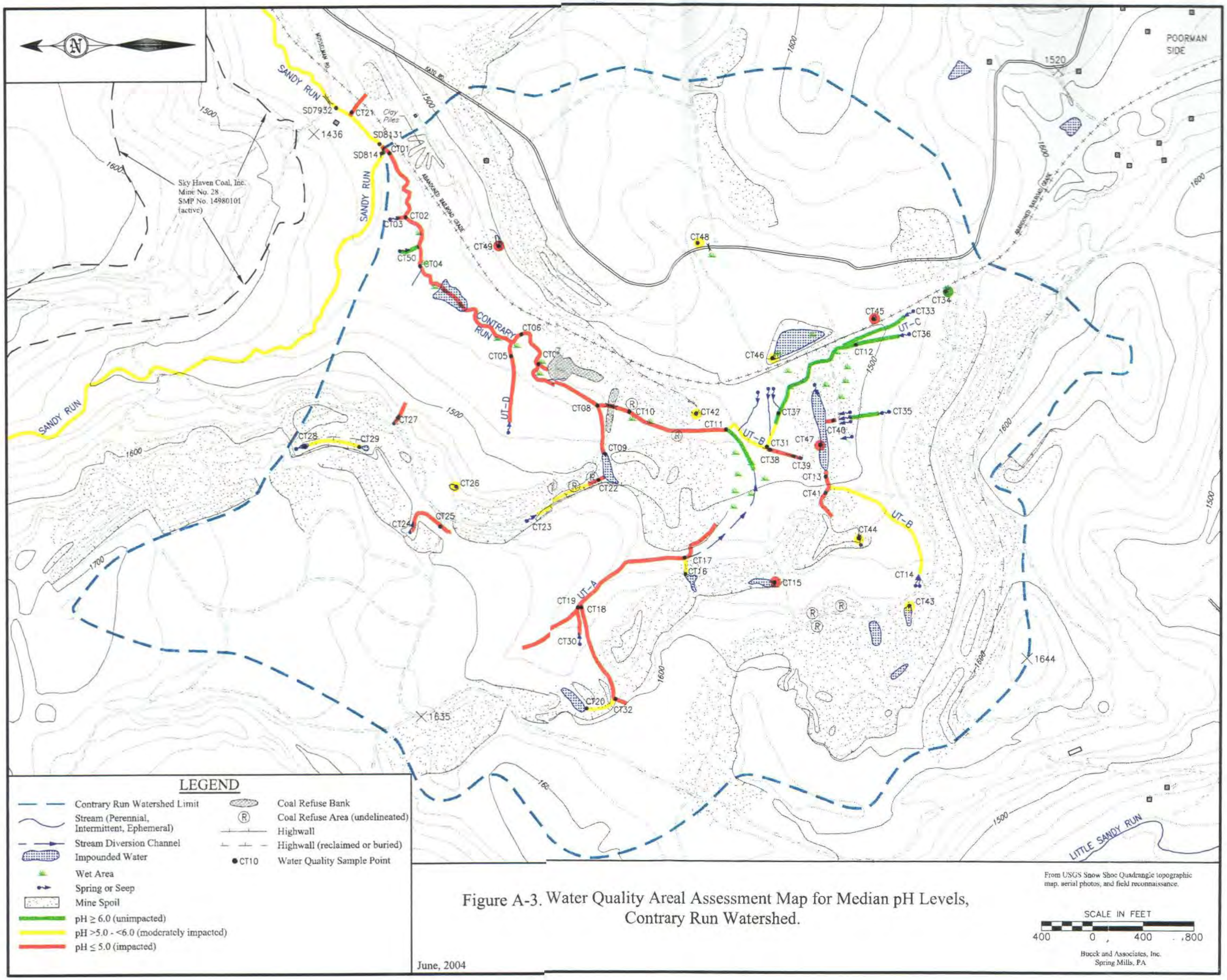


Figure A-3. Water Quality Areal Assessment Map for Median pH Levels, Contrary Run Watershed.

The impacts on Sandy Run from the Contrary Run inflow (median field pH of 4.0 at CT01) are measured at sample point SD7932, located approximately 550 feet downstream from the confluence, where the stream pH level drops to 5.1. Figure A-4 is a time-series plot of field pH levels measured at three (near confluence) points, i.e. Contrary Run point CT01 directly above inflow into Sandy Run, and Sandy Run points SD8141 (upstream) and SD7932 (downstream), of confluence with Contrary Run. The impact of Contrary Run inflow on Sandy Run quality is reflected in the lower field pH levels at the downgradient point of Sandy Run as measured in year 2002.

Net acidity concentrations are also shown in a time-series plot given in Figure A-5 for three (near confluence) points. The observed net acidity concentrations of Contrary Run are on average approximately 20 mg/l greater than those of upgradient Sandy Run. No impact on the acidity levels of Sandy Run downstream from its confluence with Contrary Run was observed when measured in year 2002; however, the neutralization of the net acidity contributed to Sandy Run by Contrary Run has resulted in lowering of the overall buffering capacity of Sandy Run.

A – 3.2.2 Total Iron Concentrations

The lower concentration limit for the total iron concentrations has been defined by the secondary maximum contaminant level (drinking water standard) of 0.3 mg/l, and all mean concentrations of ≤0.3 mg/l are shown shaded green in Figure A-6. Because mining has affected the waters in this watershed, the upper concentration limit has been defined as the 30-day average effluent limit from surface runoff of previously mined areas which have achieved the revegetation standards. These limits are known as the 30-day average "Group A" concentrations under 25 PA Code §87.102, the Surface Mining regulations, which for iron is 3.0 mg/l. Therefore, all mean iron concentrations of 3.0 mg/l or greater have been shown as red. All concentrations that exceed 0.3 mg/l but are less than 3.0 mg/l have been shown as yellow.

Figure A-4. Time Series Plots for Field pH Levels Measured at Contrary Run (CT01), Sandy Run above Confluence with Contrary Run (SD8141) and Sandy Run (SD7932) below confluence with Contrary Run

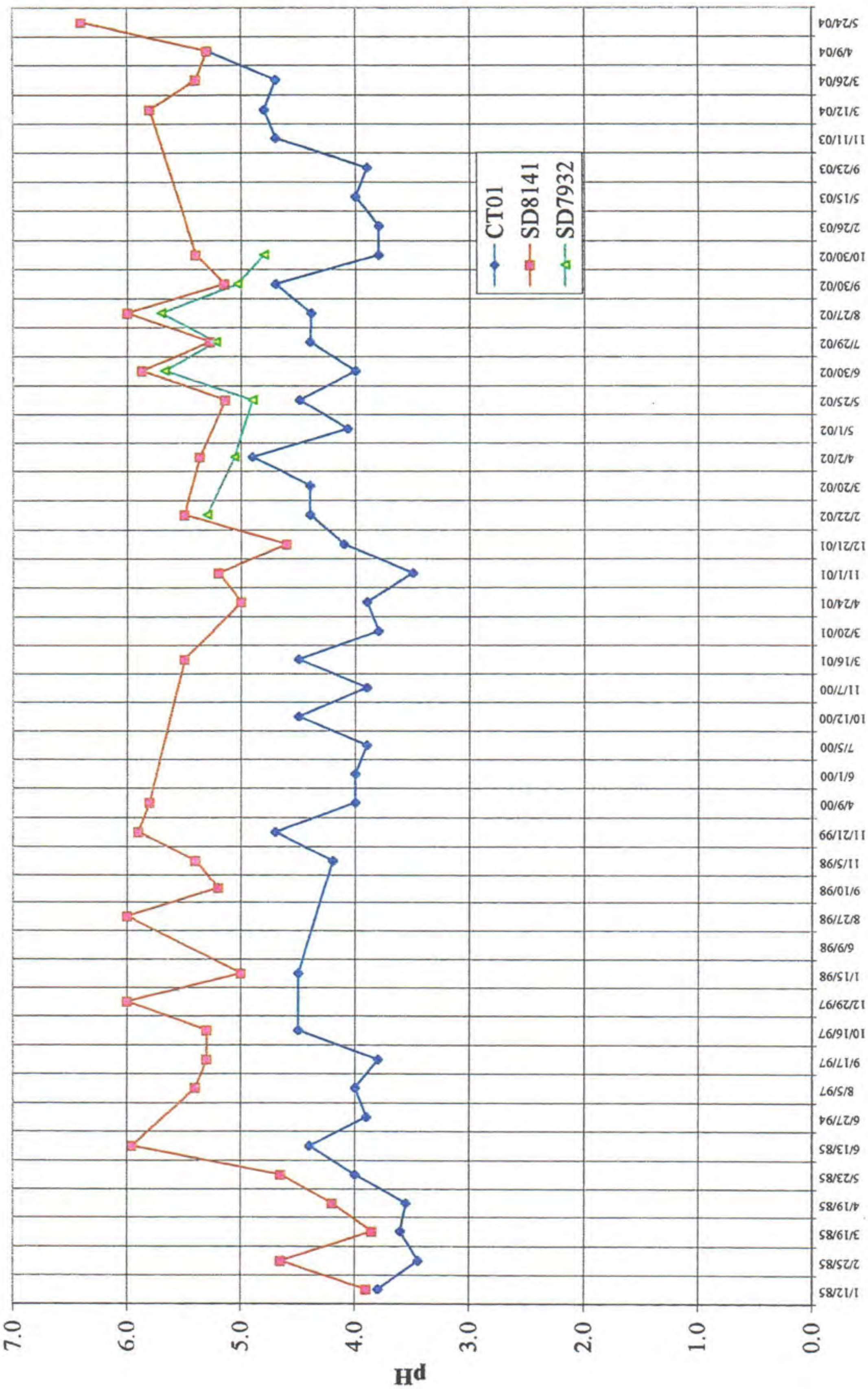
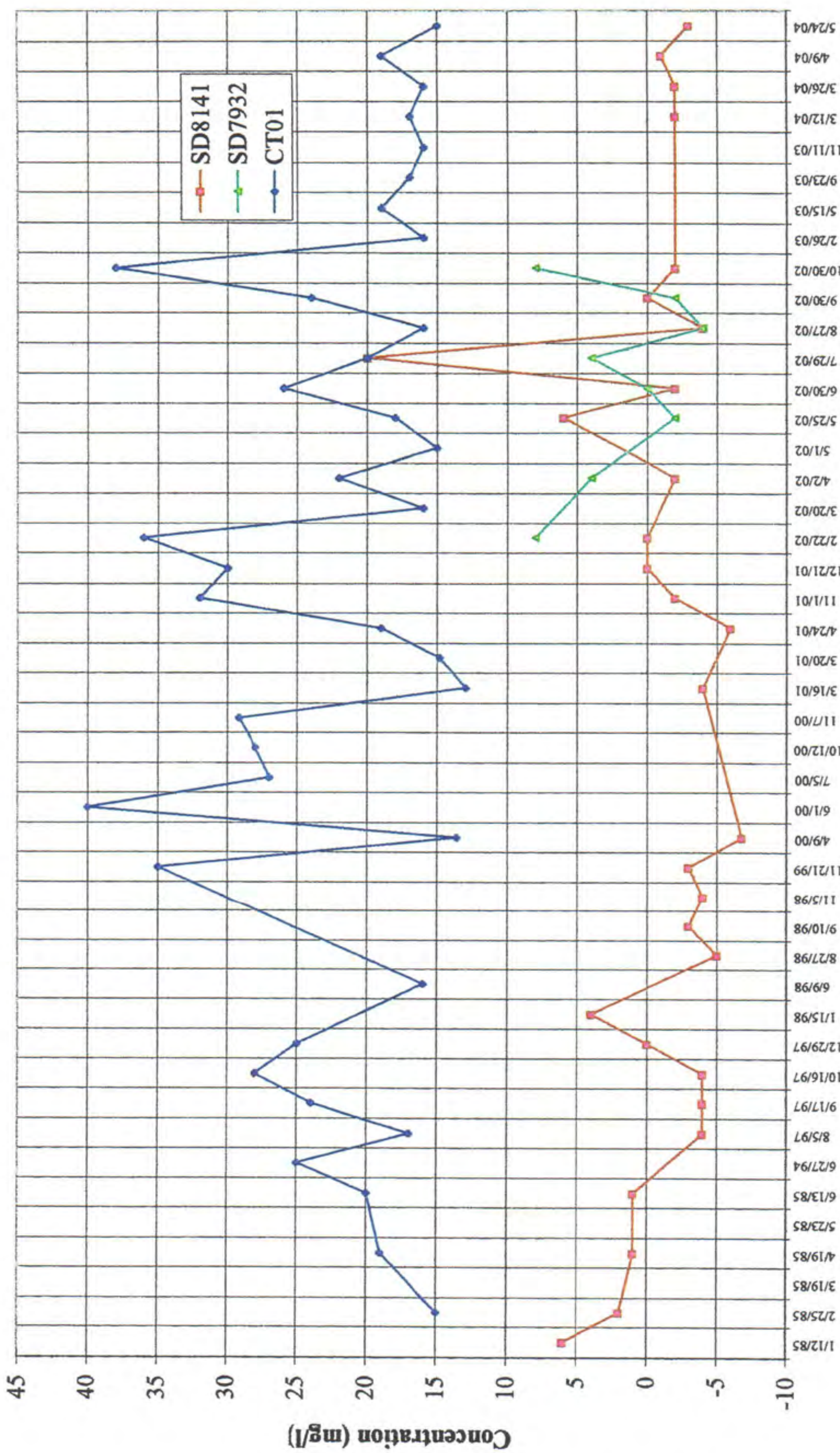


Figure A-5. Time Series Plots for Net Acidity Concentrations Measured at Contrary Run (CT01), Sandy Run above Confluence with Contrary Run (SD8141) and Sandy Run (SD7932) below confluence with Contrary Run



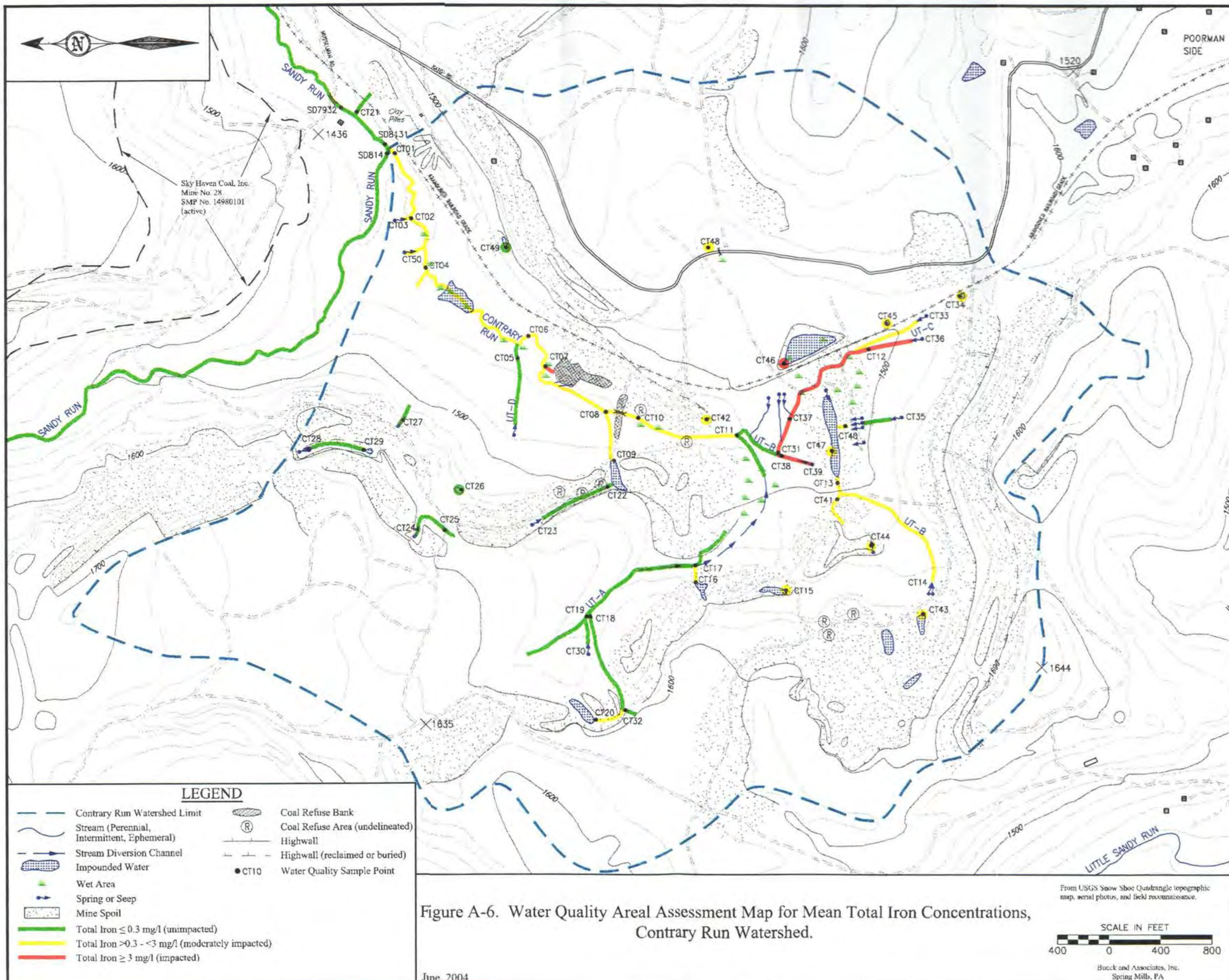


Figure A-6. Water Quality Areal Assessment Map for Mean Total Iron Concentrations, Contrary Run Watershed.

June, 2004

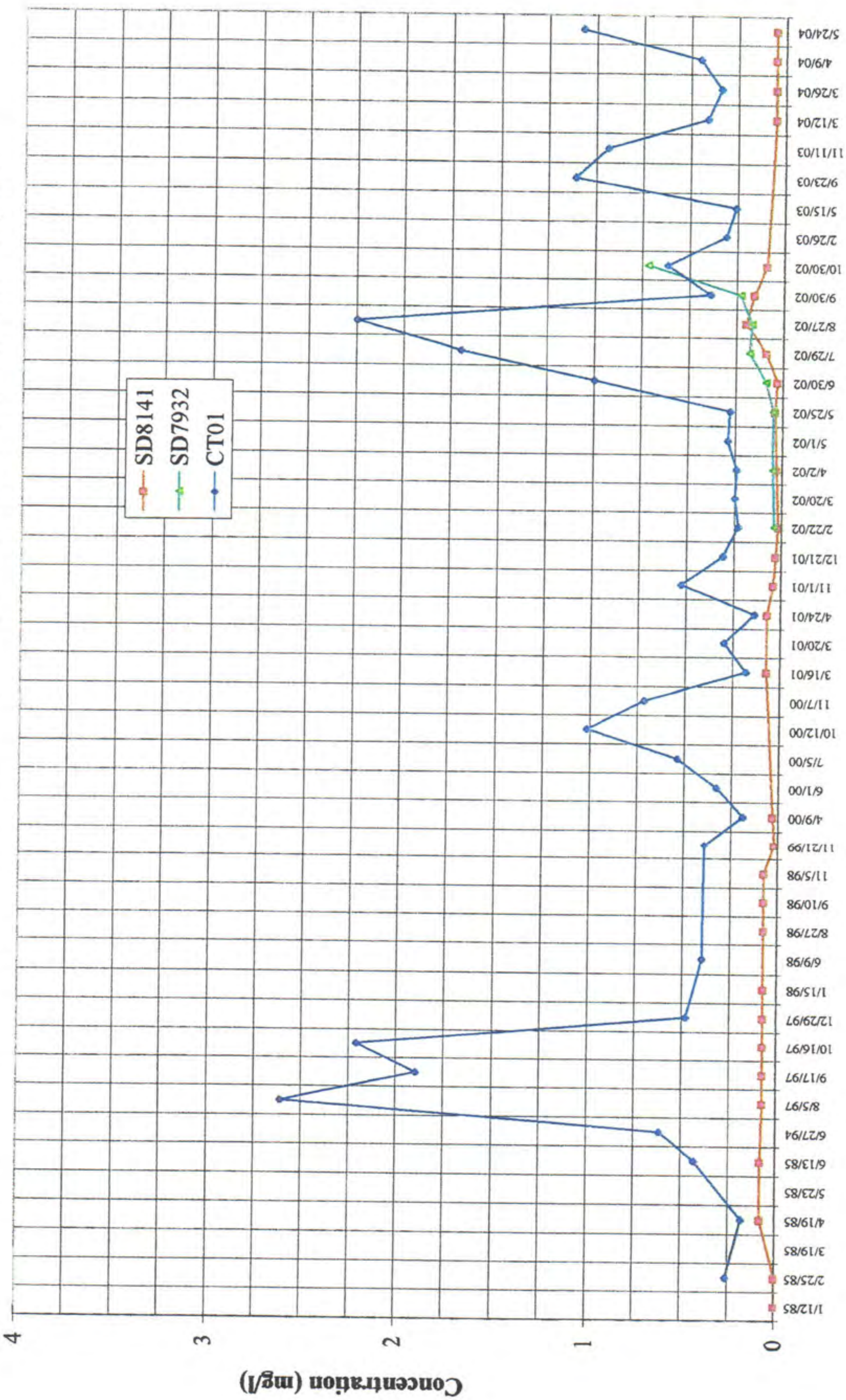
Stream quality impacts, measured by total iron concentrations over the upper threshold of 3.0 mg/l are observed only at a few sampling points throughout the watershed; the high total iron discharges originate in coal refuse bank RB-1 at point (CT07) and in the mine spoils (SM-6) measured at sample point CT39. The contribution of high iron concentration to the unnamed tributary UT-C at point CT37 and CT38 originates in the mine spoils downgradient from area SM-6 with contaminated base flow recharge to the stream. The majority of the streams and point discharges are classified in the middle concentrations range and are shown as yellow.

Total iron concentrations as measured in Contrary Run and Sandy Run are also shown in a time-series plot given in Figure A-7 for the three (near confluence) stream points. The observed total iron concentrations of Contrary Run are on average approximately 0.3 mg/l greater than those of upgradient Sandy Run. A minimal impact on the total iron concentrations of Sandy Run downstream from its confluence with Contrary Run was observed when measured in year 2002.

A – 3.2.3 Total Manganese Concentrations

The lower concentration limit for total manganese has been defined by the secondary maximum contaminant level (drinking water standard) of 0.05 mg/l, and all mean concentrations of ≤0.05 mg/l are shown green. The upper manganese concentration limit, like that for pH and iron, has been defined by the 30-day average effluent limit from surface runoff of previously mined areas which have achieved the revegetation standards (30-day average "Group A" concentrations under 25 PA Code §87.102), which for manganese is 2.0 mg/l. Therefore, all mean manganese concentrations of ≥2.0 mg/l have been shown as red. All concentrations that exceed 0.05 mg/l but are less than 2.0 mg/l have been shown as yellow.

Figure A-7. Time Series Plots for Total Iron Concentrations Measured at Contrary Run (CT01), Sandy Run above Confluence with Contrary Run (SD8141) and Sandy Run (SD7932) below confluence with Contrary Run



The distribution of the total manganese concentrations in the watershed within the defined limits is shown in Figure A-8. The majority of the point discharges and streams in the watershed show moderate levels of impact with concentrations between 0.05 mg/l and 3.0 mg/l. The highest impacts were observed at sample point CT07, downgradient from refuse bank RB-1 (mean concentration of 2.75 mg/l) and in the headwaters of the unnamed tributary UT-B (CT14, mean concentration 2.24 mg/l, and CT39, mean concentration 10.40 mg/l).

Total manganese concentrations as measured in Contrary and Sandy Runs are shown in a time-series plot given in Figure A-9 for three (near confluence) stream points. The observed total manganese concentrations in Contrary Run are on average approximately 2.0 mg/l greater than those of upgradient Sandy Run. An impact of the total manganese mean concentrations of Sandy Run downstream from its confluence with Contrary Run was observed in an increase from 0.06 mg/l to 0.19 mg/l as measured in year 2002.

A – 3.2.4 Total Aluminum Concentrations

As in the case of iron and manganese limits, the lower concentration threshold for total aluminum has been defined as the secondary maximum contaminant level (drinking water standard) of 0.2 mg/l, and mean concentrations of $\leq$0.2 mg/l are shown green. As aluminum is the metal produced by acid mine drainage that has the greatest impact on fish and macroinvertebrate life, the upper concentration limit has been defined to be 0.5 mg/l, the level that has been shown to have a severe impact on aquatic species numbers. Therefore, all mean aluminum concentrations of $\geq$0.5 mg/l have been shown as red. All concentrations that exceed 0.2 mg/l but are less than 0.5 mg/l have been shown yellow.

As shown in Figure A-10, the majority of the points sampled in the Contrary Run watershed are shown as impacted with the exception of the unnamed tributary UT-C and a headwater branch of UT-A originating at sample point CT20.

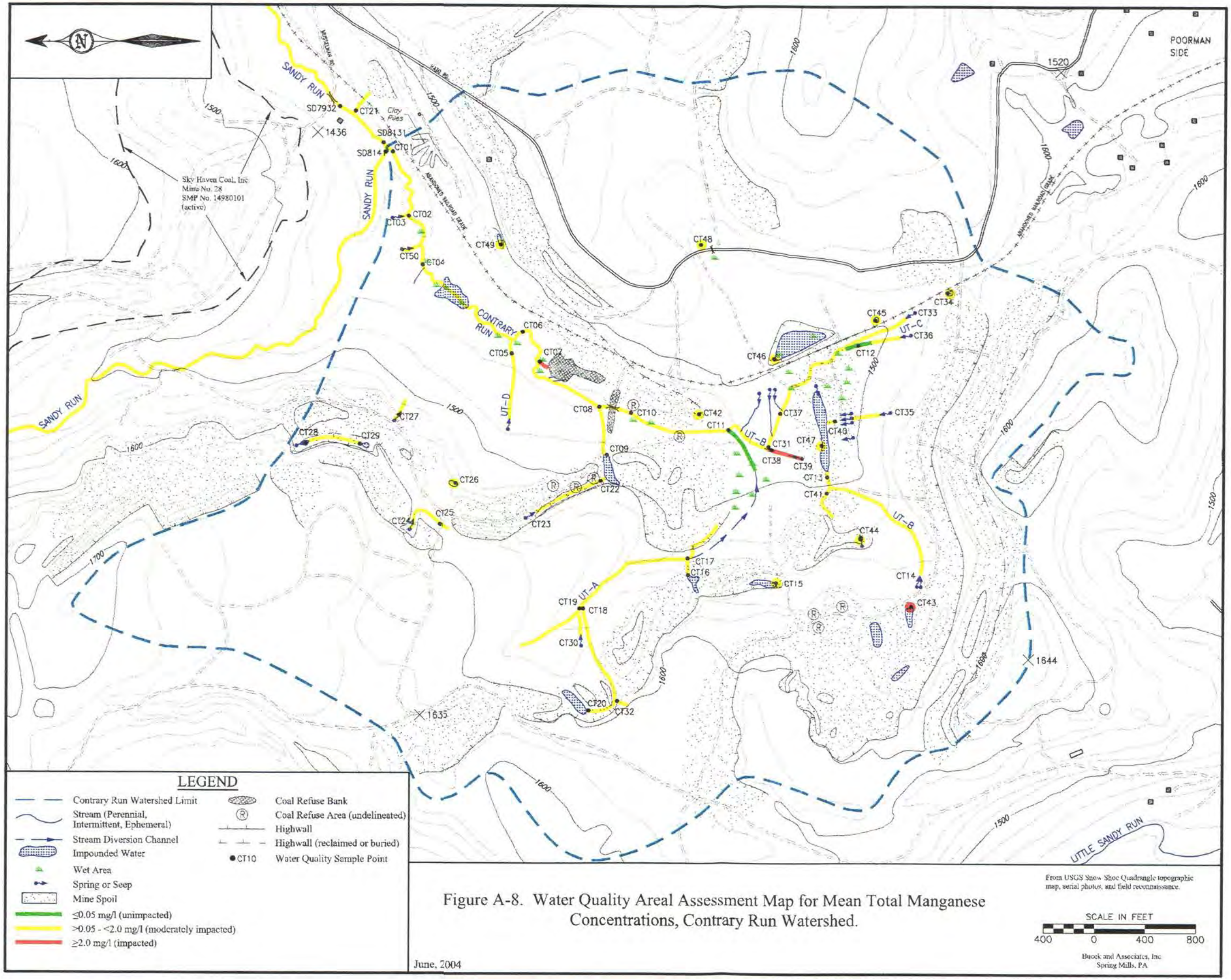
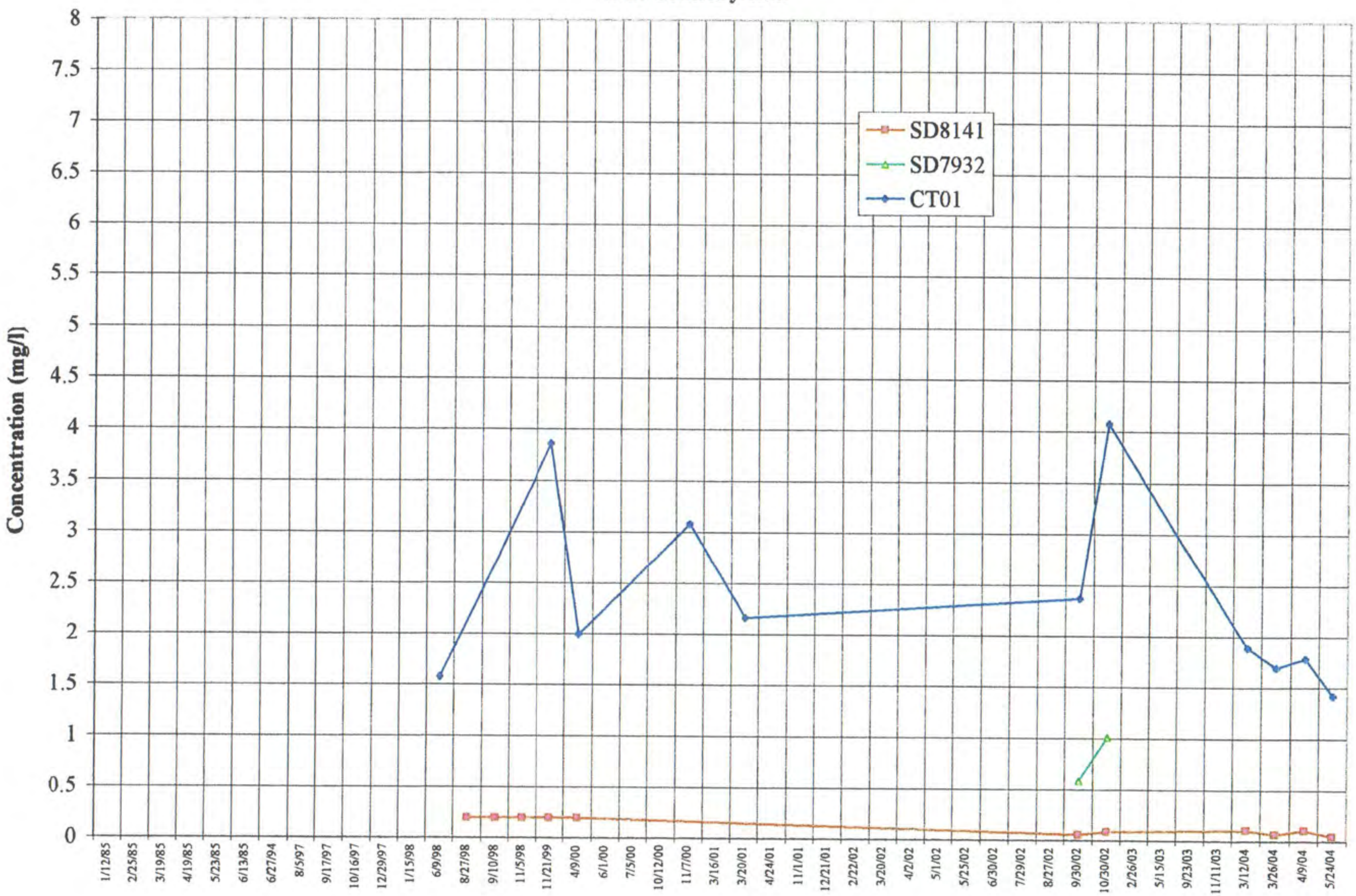


Figure A-8. Water Quality Areal Assessment Map for Mean Total Manganese Concentrations, Contrary Run Watershed.

Figure A-9. Time Series Plots for Total Manganese Concentrations Measured at Contrary Run (CT01), Sandy Run above Confluence with Contrary Run (SD8141) and Sandy Run (SD7932) below confluence with Contrary Run



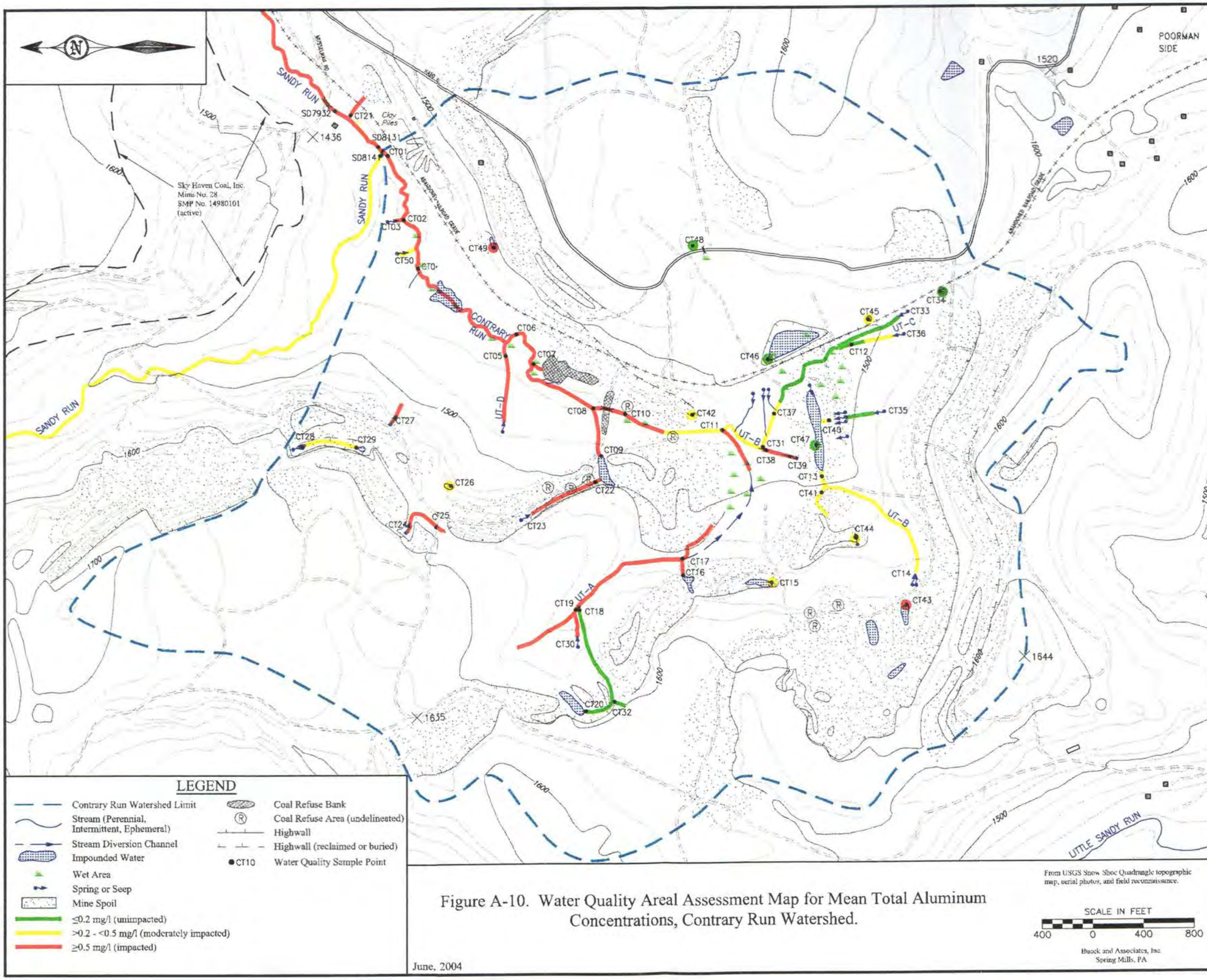


Figure A-10. Water Quality Areal Assessment Map for Mean Total Aluminum Concentrations, Contrary Run Watershed.

The most significant impact of the Contrary Run inflow on Sandy Run water quality of all the measured parameters is with respect to the observed levels of total aluminum. Sandy Run is shown as unimpacted (shown as green) upstream of its confluence with Contrary Run (mean total aluminum concentration of 0.08 mg/l at SD8141). It changes its status to impacted (shown as red) downstream from the point of confluence, with mean total aluminum concentration of 0.80 mg/l at SD7932. The mean aluminum concentration of the downstream sampling point on Contrary Run (CT01) is at 2.36 mg/l.

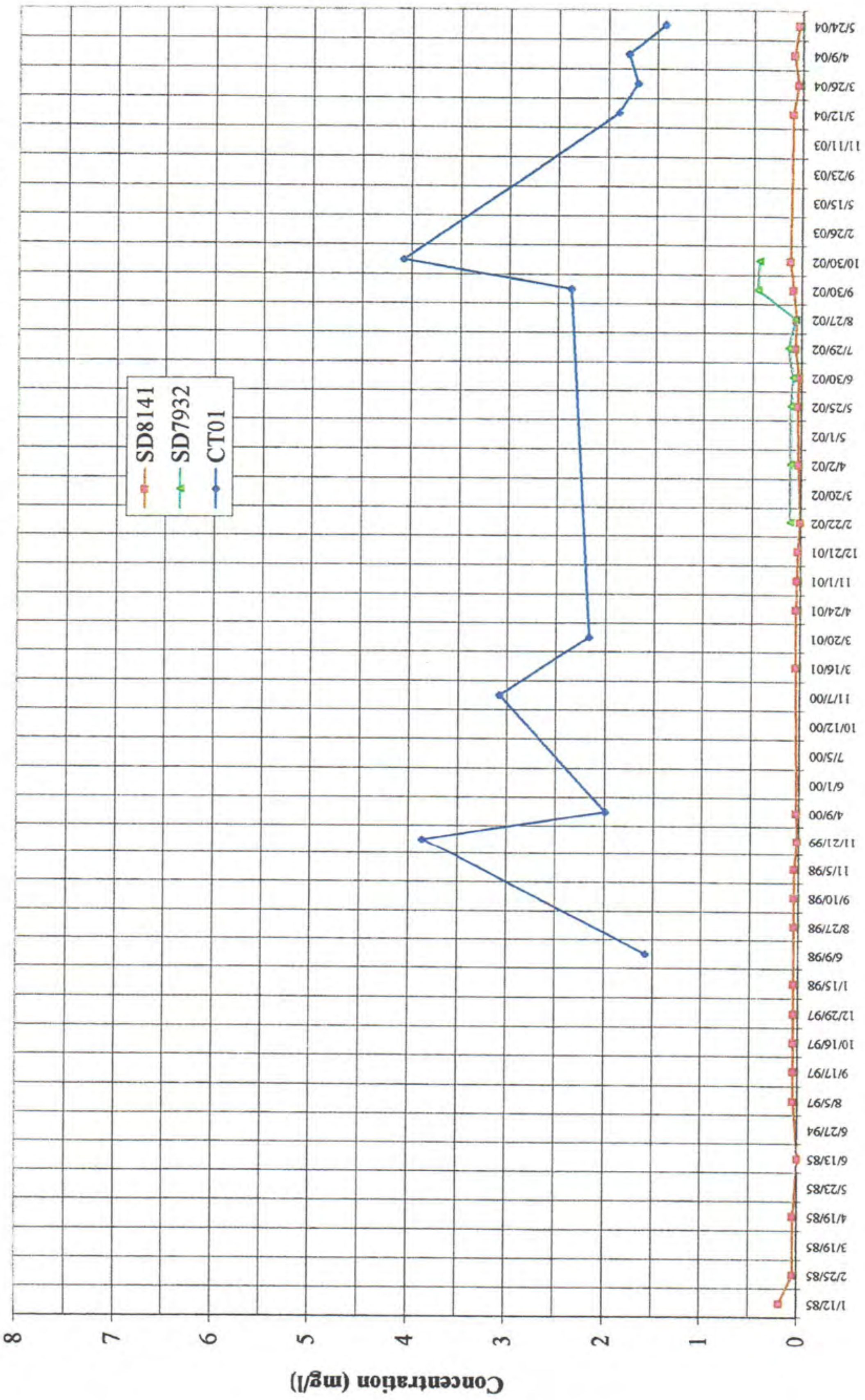
Total aluminum concentrations as measured in Contrary Run and Sandy Run are shown in a time-series plot given in Figure A-11 for three (near confluence) stream points. The observed total aluminum concentrations of Contrary Run are on average approximately 2.3 mg/l greater than those of upgradient Sandy Run. An impact on the total manganese mean concentrations of Sandy Run downstream from its confluence with Contrary Run was observed in an average increase from 0.08 mg/l to 0.8 mg/l as measured in year 2002.

A – 3.2.5 Mean Sulfate Concentrations

The determination of the lower sulfate concentration threshold is based on the baseline concentration of 40 mg/l that represents the background water quality observed in areas unaffected by mining (shown as green). The upper concentration limit of 250 mg/l was selected as the secondary maximum contaminant limit (drinking water limit). All sample points that exceed the limit are shown as red. The concentrations measured between these two values are shown as yellow (see Figure A-12).

The levels of sulfate exceeding 250 mg/l, observed in the watershed, as in the case of total iron concentrations exceeding 3.0 mg/l, are present in a discharge that originates in coal refuse bank RB-1 (sample point CT07), with mean sulfate concentration of 294 mg/l. Sample point CT39, which emanates from the surface mine area SM-6, shows mean sulfate concentration of 248 mg/l, slightly below the upper threshold value of 250 mg/l.

Figure A-11. Time Series Plots for Total Aluminum Concentrations Measured at Contrary Run (CT01), Sandy Run above Confluence with Contrary Run (SD8141) and Sandy Run (SD7932) below confluence with Contrary Run



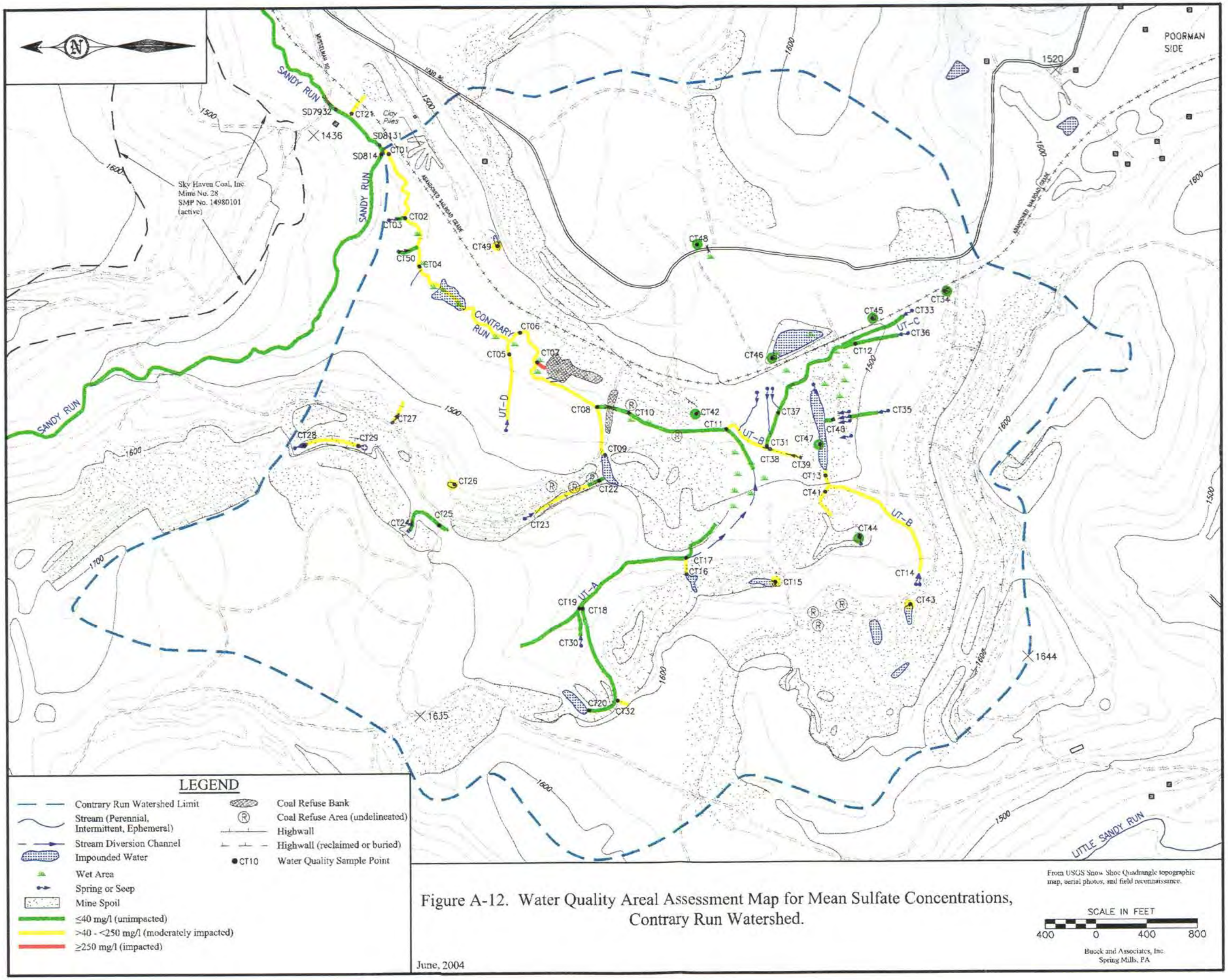


Figure A-12. Water Quality Areal Assessment Map for Mean Sulfate Concentrations, Contrary Run Watershed.

No impacts (green shaded) are observed in the water quality of unnamed tributaries UT-A and UT-C. The rest of the watershed shows moderate water quality impacts with yellow shading. There is an insignificant impact from the Contrary Run inflow (shaded yellow) on the water quality of Sandy Run, shown as green.

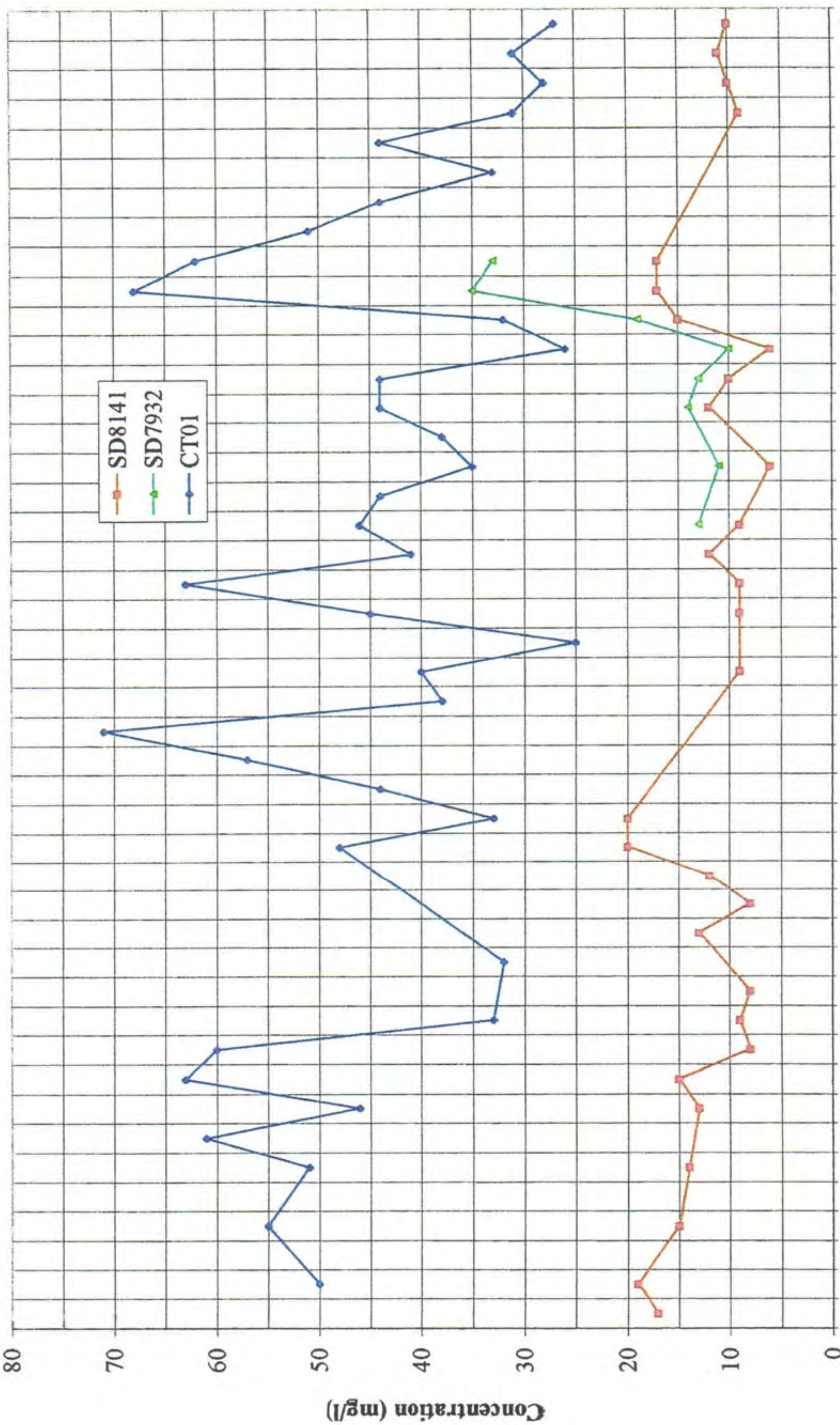
Sulfate concentrations as measured in Contrary Run and Sandy Run are shown in a time-series plot given in Figure A-13 for three (near confluence) stream points. The observed sulfate concentrations of Contrary Run are on average approximately 32 mg/l greater than those of upgradient Sandy Run. An impact on the total sulfate concentrations of Sandy Run downstream from its confluence with Contrary Run was observed in an average increase from 12 mg/l to 19 mg/l, as measured in year 2002.

A – 3.2.6 Summary of Impacts of Contrary Run Water Quality on Sandy Run Water Quality

A review of the color shaded maps and the time-series plots for each of the measured parameters (Figures A-3 through A-13) provides an insight into the mining impacts on the local streams within the watershed, as well as the overall impacts on the quality of Sandy Run. The evaluation of the overall impact of the surface water contribution from the Contrary Run watershed on Sandy Run is based on the water quality monitoring record at three sampling locations: sample point SD8141 representing Sandy Run conditions upstream from the confluence with Contrary Run, sample point CT01 representing Contrary Run conditions upstream from its confluence with Sandy Run, and sample point SD7932 representing Sandy Run conditions downstream from the confluence.

As seen from the time-series plots of field pH, net acidity, iron, manganese, aluminum, and sulfate concentrations for points SD8141 and CT01, concentrations of these parameters in Contrary Run generally exceed those in Sandy Run. For the period of record, Sandy Run acidity was on average neutralized by available alkalinity, while for Contrary Run net acidity averaged concentration of 22 mg/l. Average iron concentrations observed in Contrary Run

Figure A-13. Time Series Plots for Sulfate Concentrations Measured at Contrary Run (CT01), Sandy Run above Confluence with Contrary Run (SD8141) and Sandy Run (SD7932) below confluence with Contrary Run



were approximately eight times greater than those in Sandy Run; average manganese concentrations about sixteen times greater, average aluminum concentrations about thirty times greater, and average sulfate concentrations about four times greater.

The adverse impacts of Contrary Run pollution are reduced, to some extent, by the effects of dilution, since the Contrary Run watershed is smaller with discharge volumes generally at least an order of magnitude below that of Sandy Run. Nonetheless, Sandy Run degradation downstream from the confluence with Contrary Run is evident when comparing Sandy Run sample points SD8141 (above confluence) and SD7932 (below confluence). While flows measured at the two locations are generally of the same order of magnitude, observed concentrations of pollutants are higher at the downstream point than at the upstream point. Downstream average total iron and manganese concentrations were about three times greater than those measured upstream and total aluminum concentrations about ten times greater. The average sulfate concentrations remained about the same with small increase from 12 mg to 19 mg/l; net acidity measured at the downstream point averaged about 2 mg/l, while upstream net alkalinity was observed at 1 mg/l.

Biological assessment (fish population sampling and macroinvertebrate counts) of water quality was also used to determine the effects of the Contrary Run watershed contamination on the aquatic community of Sandy Run. Macroinvertebrates are a phyletically and ecologically diverse group of organisms that account for most of the biomass in any particular freshwater ecosystem and are, therefore, representative of the total community. Because they are so diverse and are present in the streams all year long, they are a good indicator of an aquatic ecosystem's overall health.

An aquatic biological investigation of Contrary Run and its receiving stream, Sandy Run was conducted in June 1998 by the Pennsylvania Fish and Boat Commission as part of a mining application review process. The results of the surveys were reported in a letter from Daniel J. Angelo, Fisheries Aide, Pennsylvania Fish and Boat Commission to John Varner, Bureau of Mining and Reclamation, DEP, August 3, 1998. The letter with survey results is included in its entirety in Appendix A-4.

It was reported that the Sandy Run survey revealed a good population of benthic macroinvertebrates and naturally reproducing brook trout upstream from the stream's confluence with Contrary Run. The stations below the confluence of Contrary Run showed reduced populations of macroinvertebrates, likely as a result of water quality impacts from mining activities in the Contrary Run watershed. No fish were captured in Contrary Run by electrofishing at a station 50 meters upstream from its confluence with Sandy Run.

In addition, in a Sandy Run biological survey performed in 1981, a sampling location located 335 meters downstream from the confluence with Contrary Run, was reported by the Pennsylvania Fish and Game Commission to have the following results:

- Fish present – Brook trout (1)
- Macroinvertebrate orders present - Ephemeroptera (2 Families), Plectoptera (3 Families), Coleoptera (1 Family), Trichoptera (5 Families), Odonta (2 Families), Diptera (3 Families), Megaloptera (2 Families), and Decopoda (1 Family).

Any remediation steps taken in the Contrary Run watershed will be accompanied by biological surveys of Contrary and Sandy Runs, documenting the pre- and post-reclamation water quality changes (personal communication, S. Kepler, PFBC, June 2004).

A-4 IDENTIFIED CAUSES OF CONTRARY RUN WATERSHED DEGRADATION

Abandoned surface mines and coal refuse banks are the two main AMD contributors to the Contrary Run watershed contamination. Deep mining in the area has had an insignificant impact in terms of surface water quality deterioration but has contributed to depletion of local recharge by intercepting the infiltrating water and diverting it to the adjacent watersheds.

A-4.1 Surface Mines

The surface mine operations identified within the watershed are subdivided into 14 separate mine areas (SM-1 through SM-14) some of which are further subdivided based on site specific features. Each surface mined area is characterized by geologic and geochemical conditions, past mining practices, including reclamation, and resulting water quality changes. The changes in terms of their impacts on stream water quality are ranked according to the threshold values given in Table A-5 on page 19.

The locations of the designated areas are shown on the Land Use/Mine Map, Plate A-I; descriptions of the designated areas are given below.

Surface Mine SM-1

Location – Southeastern portion of the watershed.

Site characterization - The Lower Kittanning seam was mined downdip to the existing highwall; the length of the highwall is approximately 1,450 feet, estimated height 10-15 feet. Mine spoil covers 5 acres; recharged by precipitation, mine spoil water is perched on the mine pit floor dipping to the southeast. The site is underlain and adjacent to deep mine workings; mine spoil water drains either through the pit floor into the underlying deep mine or into the adjacent deep mine openings.

Reclamation status – Mine spoil and highwall are not reclaimed.

Sample points - None.

Water quality ranking – NA.

Surface Mine SM-2

Location - Southeastern portion of the watershed.

Site characterization – The Lower Kittanning seam was mined down and across structural dip to the existing highwall; the length of the highwall is approximately 1,050 feet, estimated height 10-20 feet. Mine spoil covers 6 acres; recharged by precipitation, mine spoil water is perched on mine pit floor dipping to the southeast. The site is underlain and adjacent to deep mine workings; mine spoil water drains either through the pit floor into the underlying deep mine or into the adjacent deep mine openings.

Reclamation status – Mine spoil and highwall are not reclaimed.

Sample Points – None.

Water quality ranking – NA.

Surface Mine SM-3 (3A, 3B, 3C, and 3D)

The area is subdivided into four sections based on the reclamation status and mining impacts.

Surface Mine SM-3A

Location - Southeastern portion of the watershed.

Site characterization - The Lower Kittanning seam was mined down and across structural dip to the existing highwall; the length of the highwall is approximately 1,860 feet, estimated highwall height is 20-40 feet. Mine spoil covers 10 acres; recharged by precipitation, mine spoil water is perched on mine pit floor dipping to the southeast. It drains into the adjacent deep mine workings in the Lower Kittanning coal.

Reclamation status – Mine spoil was re-graded and re-vegetated with stands of conifers; highwall remains un-reclaimed.

Sample point – CT35.

Water quality ranking –

Water Quality Parameter	CT35
pH	Not impacted
Total iron	Not impacted
Total manganese	Moderately impacted
Total aluminum	Not impacted
Sulfate	Not impacted

Surface Mine SM-3B

Location – Southeastern portion of the watershed.

Site characterization - The Lower Kittanning seam was mined down and across structural dip to the existing highwall; the length of the highwall is approximately 350 feet, estimated highwall height is 10-30 feet. Mine spoil covers an area of 3 acres; recharged by precipitation, mine spoil water is perched on the pit floor and drains to the southeast into the adjacent deep mine working in the Lower Kittanning coal.

Reclamation status – Mine spoil and highwall are not reclaimed.

Sample points – CT33, CT34, CT36.

Water quality ranking –

Water Quality Parameter	CT33	CT34	CT36
pH	Not impacted	Not impacted	Moderately impacted
Total iron	Moderately impacted	Moderately impacted	Impacted
Total manganese	Moderately impacted	Moderately impacted	Moderately impacted
Total aluminum	Not impacted	Not impacted	Moderately impacted
Sulfate	Not impacted	Not impacted	Not impacted

Surface Mine SM-3C

Location - Southwestern portion of the watershed.

Site characterization - The Lower Kittanning seam was mined down and across structural dip to the existing highwall; the approximate length of the highwall is 3,400 feet, estimated highwall height is 25-40 feet. Mine spoil covers an area of 31 acres; they are recharged by precipitation with mine spoil water draining to the southeast into the adjacent deep mine working in the Lower Kittanning coal. Spoil water also inundates some of the depressions in the mine spoil, creating several large ponds (see Figure A-14); water from pond (CT43) seeps through the mine spoil and discharges at the toe of the spoil at sample point CT14. The flow in the discharge fluctuates in response to changes in the amount of recharge; the measured flows during the period of record range from 1 to 54 gpm (see Figure A-15).

Figure A-14. Impoundment in Lower Kittanning Mine Spoil, Mine Area SM-3C.

The coal extraction in mine area SM-3C was in the headwaters of Contrary Run. The stream bed was obliterated and replaced by mine spoil. Drill hole DH-5 located within mine area SM-3C penetrated 20 feet of the Lower Kittanning mine spoil. Overburden analyses for spoil samples indicate no net neutralization potential.

Several coal refuse piles were mapped in mine area SM-3C; the piles are approximately 1-5 feet thick and cover an area of less than 1 acre (see Figure A-16). A coal refuse sample collected from one of the piles is characterized by ash content of 12.42 percent, BTU/LB of 10,167, and total sulfur of 0.47 percent (as received).

Figure A-15. Discharge from Lower Kittanning Mine Spoil, Mine Area SM-3C, Sample Point CT14.

Reclamation status – Mine spoil and highwall are not reclaimed.

Sample points – CT14, CT43.

Water quality ranking –

Water Quality Parameter	CT14	CT43
pH	Moderately impacted	Moderately impacted
Total iron	Moderately impacted	Moderately impacted
Total manganese	Impacted	Impacted
Total aluminum	Impacted	Moderately impacted
Sulfate	Moderately impacted	Moderately impacted

Figure A-16. Coal Refuse Pile in Mine Area SM-3C.

Surface Mine SM-3D

Location – Southwestern portion of the watershed.

Site characterization - The Lower Kittanning seam was mined down and across structural dip to the existing highwall; the length of the highwall is approximately 1,070 feet, estimated highwall height is 10-20 feet. Mine spoils cover an area of 10.5 acres; recharged by precipitation, mine spoil water is perched on the pit floor and drains to the southeast, partially into the adjacent deep mine working in the Lower Kittanning coal.

Reclamation status – Mine spoil and highwall are not reclaimed.

Sample points – None.

Water quality ranking – NA.

Surface Mine SM-4

Location - Southern, southwestern, and southeastern portion of the watershed.

Site characterization - The Middle and Upper Kittanning seams were mined down and across structural dip to the southeast.

Reclamation status – Mine spoil and highwall are reclaimed.

Sample points – None.

Water quality impact ranking – NA.

Surface Mine SM-5

Location – South-central portion of the watershed.

Site characterization – Two seams (Brookville and Clarion) were extracted in mine area SM-5 of about 12 acres in size. As the Brookville seam outcrops to the north of the SM-5 mine area, the coal was extracted in box cuts, downdip, i.e. to the southeast from its outcrop; the downdip mining intercepted the regional ground water reservoir and the last abandoned box cut has filled with water (see Figure A-17). The Clarion coal outcrops in the eastern and southeastern portion of the area; the coal recovery was in shallow pits along the cropline and disrupted the original stream bed of UT-C. The shallow coal extraction areas and the stream bed are presently blocked and inundated by numerous beaver ponds.

The lake in the box cut receives drainage from the southwest, conveyed by the UT-B tributary, monitored at sample point CT13. There is no outflow from the impoundment and all inflowing water infiltrates the surrounding spoil and ground water system.

A discharge at the toe of Brookville mine spoil at sample point CT39 (see Figure A-18) seeps into the shallow ground water system and jointly with shallow ground water flow from the mined area recharges the downgradient stream UT-C. Figures A-19 and A-20 show the stream with red iron precipitating in the stream bed when the iron laden base flow enters stream water with elevated alkalinity.

Figure A-17. Impoundment in Abandoned Box Cut in Brookville Mine Spoil, Mine Area SM-5, Upgradient from Sample Point CT39.

Drill holes DH-3 and DH-4, located to the south of mine area SM-5 penetrated both the Clarion and the Brookville seams. The overburden thickness encountered in drill hole DH-3 was 25 feet to the Clarion coal and 44 feet to the Brookville coal. The overburden analysis indicates a deficiency of 252 tons/acre for the Clarion overburden and 2,074 tons/acre for the Brookville overburden; when averaged for both seams, it amounts to 2,187 tons/acre.

The overburden thickness encountered in drill hole DH-4 was 33 feet to the Clarion coal and 62 feet to the Brookville coal. The overburden analysis indicates deficiency of 72 tons/acre for the Clarion overburden and 242 tons/acre for the Brookville overburden; when combined for both seams it is 258 tons/acre.

Figure A-18. Discharge at Toe of Brookville Mine Spoil, Mine Area SM-5, Sample Point CT39

Reclamation status – Mine spoil is not reclaimed.

Sample points – CT37, CT38, CT39, CT47.

Water quality ranking –

Water Quality Parameter	CT37	CT38	CT39	CT47
pH	Not impacted	Impacted	Impacted	Impacted
Total iron	Impacted	Impacted	Impacted	Moderately impacted
Total manganese	Moderately impacted	Moderately impacted	Impacted	Moderately impacted
Total aluminum	Not impacted	Impacted	Impacted	Not impacted
Sulfate	Not impacted	Not impacted	Moderately impacted	Not impacted

Figure A-19. UT-C after Receiving Base Flow Recharge of Brookville Mine Spoil Water near Sample Point CT37.

Figure A-20. UT-C after Receiving Base Flow Recharge of Brookville Mine Spoil Water near Sample Point CT11.

Surface Mine SM-6 (6A, 6B, and 6C)

The area is subdivided into three sections based on the reclamation status and mining impacts. The surface mined areas are separated by land not impacted by mining.

Surface Mine SM-6A

Location – South-central portion of the watershed.

Site characterization – The Lower Kittanning seam was mined down and across structural dip to the existing highwall; the length of the highwall is 700 feet, estimated average highwall height is 15-20 feet. Mine spoil area is 7 acres; it is recharged by precipitation with spoil water perched on mine pit floor draining to the southeast toward an impoundment (CT-44). The drainage from the mine spoil is also conveyed by a ditch (CT41) where the drainage is currently blocked by a beaver dam (see Figure A-21).

Reclamation status – Mine spoil and highwall are not reclaimed.
Sample points – CT41, CT44.
Water quality ranking –

Water Quality Parameter	CT-41	CT-44
pH	Impacted	Moderately impacted
Total iron	Moderately impacted	Moderately impacted
Total manganese	Moderately impacted	Moderately impacted
Total aluminum	Moderately impacted	Moderately impacted
Sulfate	Not impacted	Not impacted

Figure A-21. Drainage Channel in Clarion Mine Spoil, Mine Area SM-6A.

Surface Mine SM-6B

Location – Southwest-central portion of the watershed.

Site characterization - The Clarion seam was mined at right angle (strike parallel) to the structural dip to the existing highwall; the length of the highwall is 1, 670 feet, estimated average highwall height is 15-25 feet. The current highwall conditions are shown in Figure A-22. Mine spoil covers an area of 12 acres; it is recharged by precipitation with mine spoil water draining to the southeast. The mine spoil flow is intercepted by two impoundments; the impoundment in the middle of the mine area drains at sample point CT16, the southernmost impoundment is an inundated un-drained depression within the mine spoil (sample point CT15). The outflow from the middle pond joins a stream diversion ditch of UT-A above the point where the ditch is breached and the stream overflows into the adjacent mine area SM-7 (see Figures A-23 and A-24).

Reclamation status – Mine spoil and highwall are not reclaimed.

Sample points – CT15, CT16.

Water quality ranking –

Water Quality Parameter	CT15	CT16
pH	Impacted	Moderately impacted
Total iron	Moderately impacted	Moderately impacted
Total manganese	Moderately impacted	Moderately impacted
Total aluminum	Impacted	Not impacted
Sulfate	Moderately impacted	Moderately impacted

Figure A-22. Clarion Highwall, Southwest of Sample Point CT-16, Mine Area SM-6B.

Figure A-23. Flow in Stream Diversion Channel (UT-A) near Sample Point CT17, East of Mine Area SM-6B.

Figure A-24. Breach of Stream Diversion Channel (UT-A) near Sample Point CT17, East of Mine Area SM-6B with Inflow to Mine Area SM-7.

Surface Mine SM-6C

Location – Western portion of the watershed.

Site characterization - The Lower Kittanning seam was mined down and across structural dip to the existing highwall; the length of the highwall is 1,800 feet, estimated average highwall height is 10-15 feet. Mine spoil covers an area of 15 acres; it is recharged by precipitation with spoil water draining to the southeast toward an impoundment with outflow sampled at CT20. The character of highwall and mine spoil in the vicinity of the impoundment is shown in Figures A-25 and A-26. The discharge from the pond ranges in flow during the period of record from 2 to 140 gpm. It enters the UT-A stream at sample point CT18.

Figure A-25. Clarion Highwall and Impoundment near Sample Point CT20, Mine Area SM-6C.

Figure A-26. Clarion Mine Spoil near Sample Point CT20, Mine Area SM-6C

Reclamation status – Mine spoil and highwall are not reclaimed.

Sample points – CT18, CT20.

Water quality ranking –

Water Quality Parameter	CT18	CT20
pH	Impacted	Moderately impacted
Total iron	Not impacted	Moderately impacted
Total manganese	Moderately impacted	Moderately impacted
Total aluminum	Not impacted	Not impacted
Sulfate	Not impacted	Not impacted

Surface Mine SM-7

Location – Central portion of the watershed.

Site characterization - The Clarion seam was extracted from its cropline in the Contrary Run valley updip to the northwest and downdip to the southeast. No highwall exists in the southern limit of the area where the overburden cover was less than 10 feet. A highwall surrounds the rest of the mined area at its western and northwestern limit; the length of the highwall is 1,350 feet, estimated highwall height ranges from 10 to 40 feet (see Figure A-27). Mine spoil covers an area of 15 acres; it is recharged by precipitation and by inflow from the unnamed tributary UT-A diversion ditch. The ditch that was originally constructed to divert the stream flow around the mining operation was breached where the UT-A diversion and pond overflow (CT16) join, east of the surface mine area SM-6B. The stream flows over the highwall (see Figure A-28) and infiltrates the mine spoil. It emerges downgradient in the wetland area of UT-A and UT-B confluence area as base flow recharge to Contrary Run. Mine spoil water may also contribute to the large impoundment separating areas SM-7 and SM-8A (see Figure A-29).

Figure A-27. Brookville Highwall, 500 feet Southwest from Impoundment between Mine Areas SM-7 and SM-8.

Figure A-28. Inflow into Mine Area SM-7 from Breached Stream Diversion Channel (UT-A), Downstream from Sample Point CT17.

Figure A-29. Impoundment between Mine Areas SM-7 and SM-8.

A coal refuse sample collected from one of the piles is characterized by ash content of 40.38 percent, BTU/LB of 8,306, and total sulfur of 0.54 percent (as received).

Reclamation status – Mine spoil and highwall are not reclaimed.

Sample points – CT9, CT10.

Water quality ranking –

Water Quality Parameter	CT9	CT10
pH	Impacted	Impacted
Total iron	Not impacted	Moderately impacted
Total manganese	Moderately impacted	Moderately impacted
Total aluminum	Impacted	Impacted
Sulfate	Not impacted	Not impacted

Surface Mine SM-8

Location - Central portion of the watershed.

Site Characterization - The coal extraction was done in the Clarion seam at a right angle (strike parallel) to the local structural dip. The mine area was abandoned with mine spoil covering 8 acres; highwall is 1,550 feet long and approximately 15-35 feet high. Spoil water is perched on the pit floor and drains toward a large impoundment (see Figure A-29) at the southern limit of the area. The mine spoil is recharged by precipitation and water inflow from upgradient mine area SM-9 where the outflow from the mine workings infiltrates into the shallow ground water reservoir immediately above the mine area SM-8 abandoned highwall. A spring (CT23) originates at the toe of mine spoil that was planted with a stand of conifers at the northern portion of the area. The flow from the spring continues on the pit floor and empties into the large pond at the southern end of the area below sample point CT22.

The Clarion coal was deep mined to the west and northwest of the area with one of the mine entries believed to be in the southern portion of the area.

Drill hole DH-6 placed to the north of mine area SM-8 penetrated the Clarion seam at the depth of 17 feet. The underlying Brookville seam is substituted by black shale at the depth of 40 feet; the lowest seam encountered in the drill hole is the Mercer #2 seam. The Brookville seam pinches out to the north of SM-8 mine area; all past mining in the Brookville member of the Clarion Formation to the north of mine area SM-8 was done in the Brookville clay (see the discussion of surface mine area SM-11 given below).

The overburden analysis of the strata encountered in DH-6 show no alkaline deficiency in the Clarion and Brookville overburden.

The mine spoil is covered with coal refuse that in places is up to 8 feet thick (see Figures A-30 and A-31). The thickness and distribution of coal refuse was explored in four auger holes (AH-9 through AH-12). Samples for coal refuse quality were collected from auger holes AH-10, AH-11, and AH-12 and analyzed for ash, total sulfur content, and BTU/LB values. The combined range of the ash and total sulfur values (as received) is 72.17 - 79.12 percent with an average of 76.88 percent and 0.06 to 0.12 percent with an average of 0.09 percent, respectively. The measured BTU/LB (as received) values range from 1,322 to 1,642 with 1,325 mg/l as an average.

Reclamation status – Mine spoil and highwall are not reclaimed. Mine spoil in the northern portion of the area is planted with conifers.
Sample points – CT09, CT22, CT23.
Water quality ranking –

Water Quality Parameter	CT09	CT22	CT23
pH	Impacted	Impacted	Moderately impacted
Total iron	Not impacted	Not impacted	Not impacted
Total manganese	Moderately impacted	Moderately impacted	Moderately impacted
Total aluminum	Impacted	Impacted	Impacted
Sulfate	Not impacted	Not impacted	Not impacted

Figure A-30. Brookville Mine Spoil Covered with Coal Refuse and View of Brookville Highwall, Mine Area SM-8.

Figure A-31. Brookville Spoil Area with Coal Refuse Piles, Mine Area SM-8.

Surface Mine SM-9

Location – North-central portion of the watershed.

Site Characterization – The coal extraction was done in the Clarion seam parallel to the local structural dip. The mine spoil covers 5 acres; the existing highwall is 1,200 feet long and is approximately 10 feet high (see Figure A-32). Mine spoil water is perched on the pit floor and drains through a drainage ditch (CT24 and CT25) to the south where it seeps into the shallow colluvial ground water system. This base flow emanates in an impoundment (CT26).

Figure A-32. Clarion Highwall, Mine Area SM-9.

Drill hole DH-2 located to the northwest and above the highwall of mine area SM-9 penetrated the Lower Kittanning and Clarion seams at the depths of 11 and 28 feet, respectively. The overburden analyses of the strata indicate alkaline deficiency in the Lower Kittanning overburden at 64 tons/acre and 2,733 tons/acre for the Clarion overburden, which, when combined for both seams is 2,797 tons/acre.

Reclamation status – Mine spoil and highwall are not reclaimed.

Sample points – CT24, CT25, CT26.

Water quality ranking –

Water Quality Parameter	CT24	CT25	CT26
pH	Impacted	Impacted	Moderately impacted
Total iron	Not impacted	Not impacted	Not impacted
Total manganese	Moderately impacted	Moderately impacted	Moderately impacted
Total aluminum	Impacted	Impacted	Impacted
Sulfate	Not impacted	Not impacted	Moderately impacted

Surface Mine SM-10

Location – Northeastern portion of the watershed.

Site Characterization – The Lower Kittanning coal seam was mined in an erosional remnant near the northern limit of the Kittanning Formation. The mine spoil covers 3 acres; spoil water is recharged by precipitation only with limited water accumulation in the mine spoil as no seeps were found around the periphery of the spoil area. The existing highwall is 550 feet long and 5-10 feet high.

Reclamation status – Mine spoil and highwall are not reclaimed.

Sample points – None.

Water quality ranking – NA.

Surface Mine SM-11

Location – Northern portion of the watershed.

Site Characterization - The surface mining in mine area SM-11 was done for the extraction of the Brookville clay in a series of box cut excavations. The spoils were placed to the east and southeast of the currently open box cut; the area of the spoil covers 9 acres (see Figures A-33 and A-34). A spring at the upgradient limit of the box cut (CT28) continues as flow on the pit floor until it enters an impoundment where the water infiltrates into the adjacent spoil and re-emerges at sample point CT27 at toe of the mine spoil (see Figure A-35). The perched spoil water also contributes flow to the southeast where it enters the shallow ground water system of the Contrary Run through base flow recharge. A spring, approximately 600 feet downgradient from the spoil edge, monitored at sample point CT05 shows AMD degradation. The western highwall of the box cut is 1,000 feet long and approximately 50-60 feet high (see Figure A-36). The low wall of the box cut is partially covered by spoil.

Figure A-33. Brookville Clay Mine Spoil Pile, Mine Area SM-11.

Figure A-34. Brookville Clay Mine Spoil Pile, Mine Area SM-11.

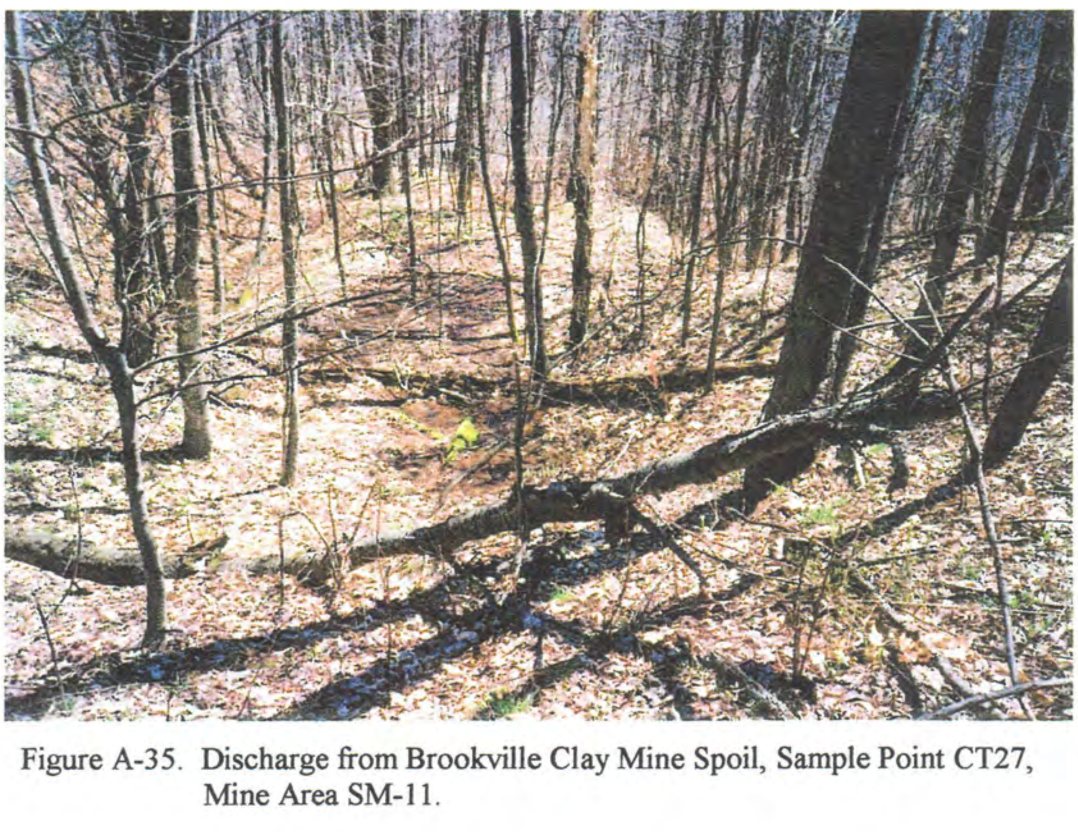


Figure A-35. Discharge from Brookville Clay Mine Spoil, Sample Point CT27, Mine Area SM-11.

Figure A-36. Brookville Clay Mine Highwall, Mine Area SM-11.

Reclamation status – Mine spoil and box cut highwalls are not reclaimed.

Sample points – CT05, CT27, CT28, CT29.

Water quality ranking –

Water Quality Parameter	CT05	CT27	CT28	CT29
pH	Impacted	Impacted	Moderately impacted	Moderately impacted
Total iron	Not impacted	Not impacted	Not impacted	Not impacted
Total manganese	Moderately impacted	Moderately impacted	Moderately impacted	Moderately impacted
Total aluminum	Impacted	Impacted	Moderately impacted	Moderately impacted
Sulfate	Moderately impacted	Not impacted	Not impacted	Not impacted

Surface Mine SM-12 (12A, 12B, and 12C)

The area is subdivided into three sections based on the reclamation status of the mined area.

Surface Mine SM-12A

<u>Location</u> - Central portion of the watershed.

<u>Site Characterization</u> - The coal extraction in the Brookville seam was downdip and at a right angle (strike parallel) to the local structural dip. The mine spoil covers 3 acres; spoil water is perched on the pit floor and drains to the southwest into the adjacent deep mine workings (see Figure A-37).

Figure A-37. Reclaimed Brookville Mine Area SM-12A with Collapsed Deep Mine Entries.

Reclamation status – Mine spoil and highwall are reclaimed.

Sample point – CT42.

Water quality ranking –

Water Quality Parameter	CT42
pH	Moderately impacted
Total iron	Moderately impacted
Total manganese	Moderately impacted
Total aluminum	Moderately impacted
Sulfate	Not impacted

Surface Mine SM-12B

Location - Central portion of the watershed.

Site Characterization - The coal extraction was of the Brookville seam at a right angle (strike parallel) to the local structural dip. The mine spoil covers approximately 2 acres; the highwall is 260 feet long and 5-10 feet high. The mine spoil is covered by coal refuse, in places several feet thick (see Figure A-38). The spoil water is perched on the pit floor and drains to the southwest into the adjacent deep mine workings.

Coal mine refuse encountered in drill hole AH-7 (to a depth of 4-8 feet) and in Pits B and C was analyzed for quality with ash content ranging from 63.50 to 66.06 percent, BTU/LB ranging from 3,491 to 4,224 and total sulfur content ranging from 0.29 to 0.40 percent (as received). The sample collected from AH-7 between 2 and 4 feet contained little coal refuse.

Reclamation status – Mine spoil are planted with a stand of conifers. The existing highwall is partially collapsed.

Sample points – None.

Water quality ranking – NA.

Figure A-38. Brookville Mine Spoil Cover with Coal Refuse, Mine Area SM-12B.

Surface Mine SM-12C

Location - Central portion of the watershed.

Site Characterization – The coal extraction was in the Brookville seam at a right angle (strike parallel) to the local structural dip. The mine spoil covers 6 acres; highwall is 940 feet long and 5 -15 feet high. The mine spoil is recharged by precipitation; it is perched on the pit floor and drains to the southwest into the adjacent deep mine workings.

Reclamation status – Mine spoil is not reclaimed; highwall is partially collapsed or buried by spoil from mine area SM-13A.

Sample points – None.

Water quality ranking – NA.

Surface Mine SM-13 (13A and 13B)

The area is subdivided into two sections based on the reclamation status of the mined area.

Surface Mine SM-13A

Location - Central portion of the watershed.

Site Characterization - The coal extraction in the Clarion seam was downdip and at a right angle (strike parallel) to the local structural dip. The mine spoil covers 4 acres; highwall is 720 feet long and approximately 20 feet high (see Figure A-39). Mine spoil water is recharged by precipitation and is perched on the pit floor sloping to the southwest; it drains in large portion into the underlying deep mine in the Brookville coal.

Reclamation status – Mine spoil is reclaimed; highwall is not reclaimed.

Sample points – None.

Water quality ranking – NA.

Figure A-39. Clarion Highwall, Mine Area SM-13A.

Surface Mine SM-13B

Location – Northern portion of the watershed.

Site Characterization – The coal extraction in the Clarion seam was downdip and at a right angle (strike parallel) to the local structural dip. The mine spoil covers 9 acres; highwall is 1,200 feet long and approximately 20 feet high (see Figure A-40). Mine spoil water is recharged by precipitation and is perched on the pit floor sloping to the southwest; the majority of mine spoil water drains into the underlying deep mine in the Brookville coal.

Reclamation status – Mine spoil and highwall are not reclaimed.

Sample points – None.

Water quality ranking – NA.

Figure A-40. Clarion Highwall, Mine Area SM-13B.

Surface Mine SM-14

Location – Northern portion of the watershed.

Site Characterization - The coal extraction in the Brookville seam was downdip and at a right angle (strike parallel) to the local structural dip. The mine spoil covers 0.7 acres; highwall is 200 feet long and approximately 10 feet high. Mine spoil water is recharged by precipitation and is perched on the pit floor sloping to the southwest; the majority of mine spoil water drains into the underlying deep mine in the Brookville coal. An impoundment in the mine spoil near the highwall was sampled at CT49.

Reclamation status – Mine spoil and highwall are not reclaimed.

Sample points – CT49.

Water quality ranking –

Water Quality Parameter	CT49
pH	Impacted
Total iron	Not impacted
Total manganese	Moderately impacted
Total aluminum	Impacted
Sulfate	Not Impacted

A-4.2 Deep Mines

The most extensive deep mining in the watershed was done in the Brookville deep mine complex used for coal extraction in the southern half of the watershed area and for clay mining to the north of it. As the coal/clay bearing strata lie on the northwestern limb of the Snow Shoe syncline that occurs to the south of the watershed, the strata dip to the southeast, determining the slope of the mining complex. The extent of the mining complex and the main deep mine entries in the area as mapped by Gannett et al., 1970 are shown in Plate A-1, Land Use/Mine Map. The shown locations of the entries do not coincide with the original entry locations as these have been mined out by subsequent surface mining.

The Brookville deep mine that underlies the northeastern portion of the watershed (deep mine entry D-39 of Gannett et al., 1970) was used for clay extraction; large piles of clay mining refuse were deposited in the valley of Contrary Run, within 200 feet of its stream bed (see Figures A-41 and A-42).

Figure A-41. Mining Refuse from Brookville Clay Deep Mine at D-39 Deep Mine Entry.

Figure A-42. Mining Refuse from Brookville Clay Deep Mine at D-39 Deep Mine Entry.

Another mine entry into the Brookville mine complex, mapped by Gannett et al. (1970) as D-38 lies in the central location of the watershed on the right bank of the Contrary Run. The entry was into a deep mine that was partially daylighted by surface mining of the Brookville coal in mine area SM-12A. Several collapsed mine entries are currently visible in the reclaimed area as shown in Figure A-37 above. Coal refuse from the Brookville mine was deposited in the adjacent surface mine area SM-7.

The Brookville deep mine complex also extends to the right bank of the Contrary Run where coal extraction in the Brookville seam was done updip in a drift mine that slopes toward the large impoundment formed after the Brookville coal was stripped in mine areas SM-7 and SM-8. Remnants of the deep mine entry are visible in the southern most portion of mine area SM-8, in proximity of the deep mine entry, mapped by Gannett et al., (1970) as D-37. Coal mine refuse generated in the deep mine was mapped throughout surface mine area SM-8.

Extensive deep mine workings also underlie the southern portion of the watershed with extraction of the Kittanning seams. The current extent of the deep mines is defined by the surface mining operations (SM-3 and SM-4) that daylighted portions of the deep mine workings along the coal seam outcrop; the current deep mine limit is thus defined by the position of the existing highwalls.

The deep mining in the Kittanning coals was done above the regional ground water system with prevailing drainage to the south outside of the Contrary Run watershed and away from the mine entries in the Contrary Run watershed. A deep mine entry into the Lower Kittanning mine, mapped by Gannett et al., 1970, as D-46 lies within surface mine area SM-3B.

Additional deep mine workings in the Lower Kittanning seam also underlie the southeastern portion of the watershed in the area of mine areas SM-1 and SM-2. The structural dip in the area is also to the southeast and away from the watershed. No deep mine discharges were mapped in the abandoned surface mines that stripped the Lower Kittanning cropline and daylighted the shallow sections of the deep mine workings. A deep mine entry mapped by Gannett et al., as D-47 is located in surface mine area SM-2.

The deep mining impacts on the surface water quality are minimal, if any. As most of the deep mine workings slope away from the watershed, the deep mine drainage does not enter Contrary Run or its tributaries. It is only the drainage from the Brookville deep mine adjacent to mine areas SM-7 and SM-8 that slopes toward the Contrary Run valley. No discharges were observed along the highwall of surface mine area SM-8 that intercepted the deep mine; the potential point of the deep mine discharge may be the large impoundment that lies directly downgradient from the deep mine workings. Water quality sampling from the impoundment at CT09 (outflow from the pond) indicates water quality ranking for median pH levels and total aluminum as impacted, total manganese and sulfate as moderately impacted, and with no impact on total iron concentrations. However, as the impoundment also receives flow from the surface mined areas SM-7 and SM-8, the contributions to the water quality impacts of the deep and surface mining are difficult to separate.

While the direct impacts of the past deep mining on the surface water of the Contrary Run watershed are minimal, the deep mining impacts on the hydrological regime of the area may be more substantial even though less obvious. The impacts of undermining large portions of the watershed relate to the presence of open deep mine workings that intercept the infiltrating water and act as drains with flow direction controlled by the slope of the mine floor. As described above, the deep mine floor in the majority of the area slopes away from the watershed and deprives the local surface waterways of recharge. The interception of the ground water recharge system by deep mine workings also diminishes the ground water reservoir capacity, thus reducing the base flow recharge to Contrary Run.

A-4.3 Coal Refuse

Coal refuse is a byproduct of past deep mining operations and is composed of materials with high potential for acid mine drainage formation. The coal refuse deposits in the Contrary Run watershed area were mapped in two modes, i.e. as distinct coal refuse banks (RB-1 and RB-2) and as coal refuse piles deposited in areas of mining spoil in surface mine areas (SM-3, SM-7, SM-8 and SM-12 described above). Fifteen exploratory auger holes were drilled in the area of coal refuse banks and in those areas of mine spoil where the thickness of the mapped coal refuse was questionable. For locations of the auger holes see Plate A-1, Land Use/Mine Map; the lithologic logs for the auger holes are provided in Appendix A-5.

Composite samples of coal refuse for testing (ash, BTU/LB, moisture, and total sulfur) were collected in September 2002 from shallow test pits A through K (for test pit locations see Plate A-1, Land Use/Mine Map) from coal refuse piles in surface mine areas and during the auger drilling on May 28, 2004. The laboratory data that provide the refuse testing results are given in Appendix A-6; Table A-6 provides the Coal Refuse Quality Testing Summary.

Two coal refuse banks (RB-1 and RB-2) were deposited in the Contrary Run valley adjacent to the stream as shown in Plate A-I. The coal refuse was generated during coal extraction from the Brookville deep mine complex.

The largest accumulation of refuse in the watershed is in coal refuse bank RB-1 located on the right bank of Contrary Run, approximately 2,000 feet from its confluence with the Sandy Run (see Figure A-43). The coal refuse was deposited on the original ground surface that parallels the stream bed and slopes to the north toward a discharge (sampling) point CT07. A view of the refuse bank from the stream bed of the Contrary Run with the point of discharge is given in Figure A-44.

The discharge point CT07 represents the most impacted discharge found in the watershed area. It has a profound impact on the quality of the Contrary Run and its receiving stream, Sandy Run. The evaluation of the coal refuse discharge quality according to the ranking specifications presented in Table A-5 (page 19) is given below.

Water Quality Parameter	CT07
pH	Impacted
Total iron	Impacted
Total manganese	Impacted
Total aluminum	Impacted
Sulfate	Impacted

TABLE A-6 COAL REFUSE QUALITY TESTING SUMMARY

Sample ID			Surface Mine or Refuse Bank	As Received		
Auger Hole/Pit	Composite/Grab	Depth (ft)		Ash (%)	Total Sulfur (%)	BTU/lb
Pit A	Grab	0 - 1	SM-7	40.38	0.54	8,316
Pit B	Grab	0 - 1	SM-12B	65.09	0.30	3,768
Pit C	Grab	0 - 1	SM-12B	66.06	0.29	3,491
Pit D	Grab	0 - 1	RB-1	62.31	0.35	4,031
Pit E	Grab	0 - 1	RB-2	57.38	0.43	5,061
Pit F	Grab	0 - 1	RB-1	49.81	0.43	6,368
Pit G	Grab	0 - 1	RB-1	40.27	0.49	8,071
Pit H	Grab	0 - 1	RB-1	44.15	0.47	7,209
Pit I	Grab	0 - 1	RB-1	45.03	0.44	7,261
Pit J	Grab	0 - 1	RB-1	61.17	0.32	3,644
Pit K	Grab	0 - 1	SM-3C	12.42	0.47	10,167
AH-1, #1	Composite	0 - 5	RB-1	65.57	0.37	3,806
AH-1, #2	Composite	5 - 10	RB-1	67.01	0.36	3,644
AH-1, #3	Composite	10 - 15	RB-1	62.44	0.43	4,549
AH-1, #4	Composite	15 - 20	RB-1	56.93	0.54	5,449
AH-2, #5	Composite	0 - 5	RB-1	55.24	0.45	5,534
AH-2, #6	Composite	5 - 10	RB-1	55.48	0.93	5,690
AH-2, #7	Composite	10 - 15	RB-1	59.93	0.55	4,963
AH-2, #8	Composite	15 - 20	RB-1	68.80	0.39	3,703
AH-3, #9	Composite	0 - 7	RB-1	65.80	0.47	3,931
AH-3, #10	Composite	7 - 10	RB-1	62.83	0.42	4,360
AH-3, #11	Composite	10 - 15	RB-1	61.22	0.49	4,740
AH-3, #12	Composite	15 - 20	RB-1	58.56	0.69	5,382
AH-4 #13	Composite	0 - 5	RB-1	65.96	0.38	3,921
AH-4, #14	Composite	5 - 10	RB-1	62.13	0.55	4,642
AH-4, #15	Composite	10 - 15	RB-1	67.02	0.35	4,005
AH-5, #16	Composite	0 - 5	RB-1	56.22	0.49	5,204
AH-5, #17	Composite	5 - 10	RB-1	60.55	0.49	4,648
AH-5, #18	Composite	10 - 15	RB-1	58.74	0.48	5,106
AH-6, #19	Composite	0 - 5	RB-1	58.44	0.48	5,026
AH-6, #20	Composite	5 - 9	RB-1	65.67	0.62	4,114
AH-7, #21	Composite	2 - 4	SM-12B	83.24	0.07	433
AH-7, #22	Composite	4 - 8	SM-12B	63.50	0.40	4,224
AH-10, #23	Composite	0 - 7	SM-8	72.12	0.09	1,503
AH-10, #24	Composite	7 - 12	SM-8	79.12	0.07	996
AH-11, #25	Composite	0 - 8	SM-8	77.25	0.07	1,322
AH-11, #26	Composite	8 - 10	SM-8	76.83	0.06	1,083
AH-12, #27	Composite	1 - 5	SM-8	78.06	0.12	1,404
AH-12, #28	Composite	5 - 9	SM-8	77.87	0.12	1,642
AH-13, #29	Composite	0 - 3	RB-2	55.16	0.46	5,585
AH-13, #30	Composite	4 - 5	RB-2	55.91	0.67	5,736
AH-13, #31	Composite	5 - 9.5	RB-2	46.24	1.21	7,208
AH-14, #32	Composite	1 - 8	RB-2	60.18	0.42	4,653
AH-15, #33	Composite	1 - 4	RB-2	62.46	0.37	4,309
AH-15, #34	Composite	4 - 7	RB-2	60.17	0.61	4,897
AH-15, #35	Composite	7 - 8	RB-2	68.19	0.29	2,439

Figure A-43. Coal Refuse Bank RB-1 with Auger Drilling Equipment.

Figure A-44. Discharge CT07 from Coal Refuse Bank RB-1.

Figure A-45 (page 77) provides a plan view and cross-sections identifying the coal refuse bank configuration. The average depth of the refuse is 17.5 feet, with the maximum depth of 25 feet encountered during the auger drilling near the northern and central portions of the bank. The total estimated volume of the refuse in the bank is 33,000 tons.

Coal refuse samples collected from the bank and analyzed as received are characterized by ash content ranging from 40.27 to 68.80 percent with average value of 59.13 percent, range of BTU/LB values from 3,644 to 8,071 with average BTU value of 4,961 and sulfur content ranging from 0.32 to 0.93 percent with average value of 0.48 percent.

Refuse bank RB-2 is located directly to the south of coal refuse bank RB-1. The coal refuse forms a road fill deposited across the Contrary Run valley as shown in Figures A-46 and A-47. Two culverts were placed in the refuse fill to convey the Contrary Run flow through the bank.

Figure A-46. Coal Refuse Bank RB-2 in the Contrary Run Valley.

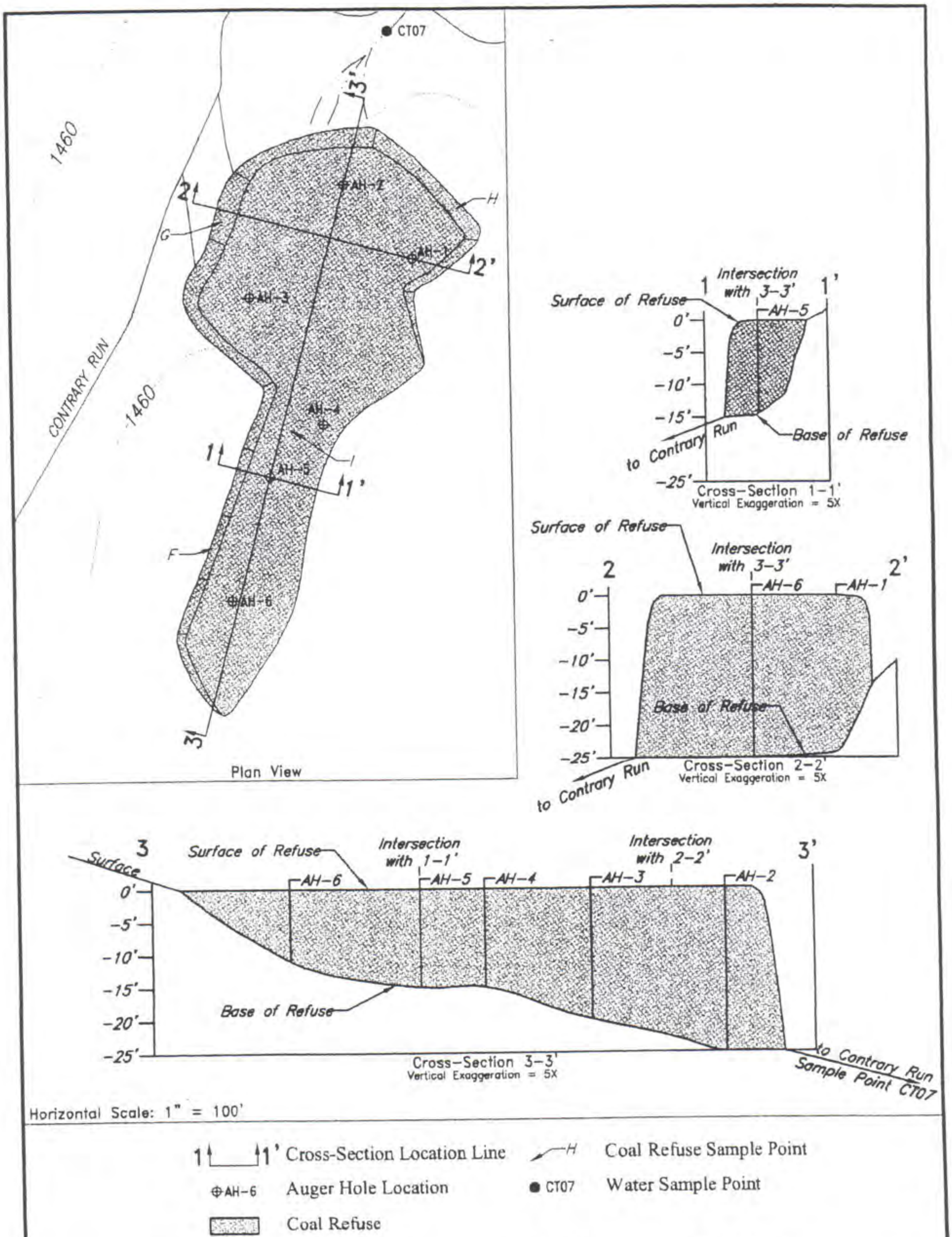


Figure A-45. Plan View and Cross-Sections for Coal Refuse Bank RB-1.

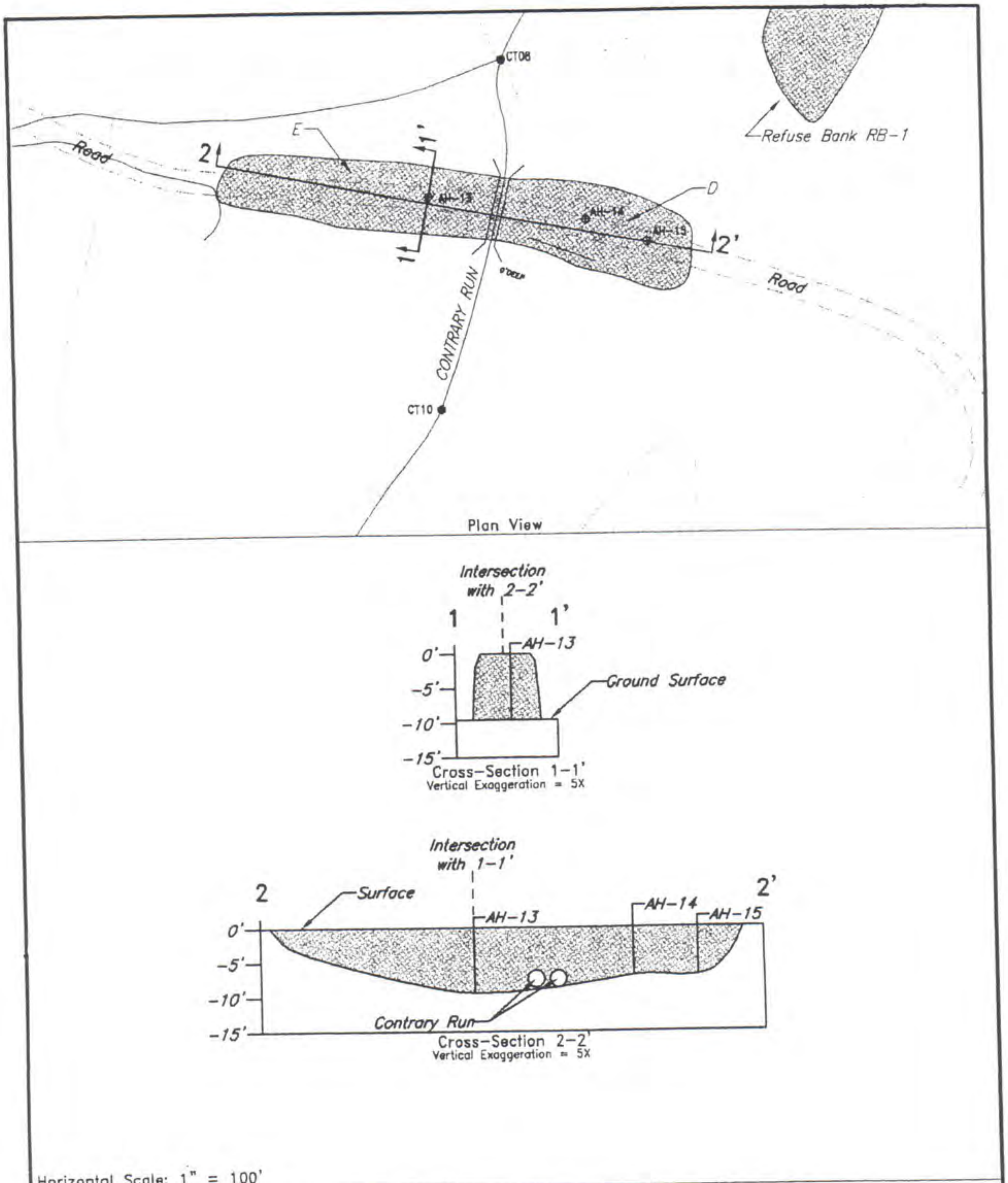
Figure A-47. Coal Refuse Bank RB-2 from the Contrary Run Valley.

Figure A-48 provides a plan view and cross-sections identifying the configuration of refuse bank RB-2. The average depth of the refuse is 8 feet, with the maximum refuse depth of feet encountered during the auger drilling where the refuse was in the center of the Contrary Run valley near the original steam bed. The total estimated volume of the refuse in the bank is 2,500 tons.

Coal refuse samples collected from refuse bank RB-2 and analyzed as received are characterized by ash content ranging from 46.24 to 68.19 percent with average value of 58.21 percent, range of BTU/LB values from 2,439 to 7,208 with average BTU value of 4,986, and sulfur content ranging from 0.29 to 1.21 percent with average value of 0.56 percent.

A-4.3.1 Coal Refuse Impacts on Contrary Run Water Quality

To quantify the extent of the Contrary Run watershed degradation caused by coal refuse, coal refuse bank RB-1 was selected and calculations of pollutional loadings for sample point CT07, located just below the coal refuse bank were performed as discussed below. The calculated



1 — 1'	Cross-Section Location Line	D	Coal Refuse Sample Point
⊕AH-6	Auger Hole Location	● CT07	Water Sample Point
	Coal Refuse		

Figure A-48. Plan View and Cross-Sections for Coal Refuse Bank RB-2.

potential inputs from the refuse were then compared to the total pollution loads carried by Contrary Run at sample point CT01. Coal refuse bank RB-1 is located less than a hundred feet from the stream and its discharge forms a defined channel that enters Contrary Run, thus allowing for measurement of flow volumes and collection of samples.

Given flow and concentration data, pollution load for each of the parameters in question was calculated as follows:

$$W = C \times Q \times 0.01202 \tag{2}$$

where W is load in lb/day, C is concentration in mg/l, Q is flow in gpm, and 0.01202 is a conversion factor. CT01 and CT07 flow and concentration data were used to calculate pollution loads at the two locations. Water quality data collected when flows could not be measured were discarded. Measured concentrations that were less than the detection limit were counted as zero. The results are summarized in Table A-7.

A comparison of the estimated pollution amounts generated by the refuse (CT07) and total Contrary Run loads calculated at point CT01 indicates that the refuse at coal refuse bank RB-1 contributes significant amounts of pollution to the stream: approximately 28% of net acidity, 53% of iron, 6% of manganese, 38% of aluminum, and 13% of sulfate. It should be emphasized that the above calculations were based on average values and, therefore, in the worst-case scenario (i.e. high flow event resulting from large amounts of precipitation) coal refuse banks can generate greater amounts of pollution.

In addition to the large coal refuse bank RB-1, coal refuse is present in four of the surface mine areas (SM-3C, SM-7, SM-8 and SM-12B) as well as the smaller coal refuse bank RB-2 (see above). Assuming similar impacts of the other coal refuse areas, the cumulative impact from coal refuse on water quality in the Contrary Run watershed is considerable.

TABLE A-7 SUMMARY OF CONTRARY RUN AT CT01 AND REFUSE BANK RB-1 AT CT07 LOADINGS FOR AMD PARAMETERS

Date Sampled	Flow (gpm)	Alkalinity (lb/day)	Acidity (lb/day)	Net Acidity (lb/day)	Iron (lb/day)	Manganese (lb/day)	Aluminum (lb/day)	Sulfate (lb/day)
Sample Point CT01, Contrary Run, above confluence with Sandy Run								
2/25/1985	850	0.00	163.47	163.47	2.66	9.09	NM	510.85
4/19/1985	1,700	0.00	408.68	408.68	3.68	25.34	NM	1123.87
6/13/1985	800	0.00	201.94	201.94	4.13	10.96	NM	490.42
6/27/1994	203	0.00	70.76	70.76	1.51	2.85	NM	148.84
8/5/1997	10	0.00	2.16	2.16	0.31	0.10	NM	5.53
12/29/1997	55	1.32	17.85	16.53	0.32	0.56	NM	21.82
6/9/1998	50	3.61	13.22	9.62	0.24	0.44	0.95	19.23
11/21/1999	2	0.07	0.91	0.84	0.01	0.04	0.09	1.15
4/9/2000	806	46.50	178.26	131.76	1.84	7.17	19.38	319.71
6/1/2000	22	0.00	10.84	10.84	0.09	0.25	NM	11.64
7/5/2000	12	0.00	4.04	4.04	0.08	0.13	NM	8.22
10/12/2000	10	0.00	3.49	3.49	0.12	0.16	NM	8.53
11/7/2000	5	0.17	1.92	1.75	0.04	0.09	0.19	2.28
3/16/2001	78	3.75	15.94	12.19	0.17	0.67	NM	37.50
3/20/2001	100	6.25	24.04	17.79	0.00	1.05	2.61	30.05
4/24/2001	201	0.00	48.32	48.32	0.34	1.76	NM	108.72
11/1/2001	45	0.00	17.31	17.31	0.29	0.76	NM	34.08
12/21/2001	225	0.00	81.14	81.14	0.84	2.38	NM	110.88
2/22/2002	156	0.00	67.50	67.50	0.43	1.71	NM	86.26
3/20/2002	61	2.20	13.93	11.73	0.18	0.65	NM	32.26
4/2/2002	290	6.97	83.66	76.69	0.84	2.96	NM	122.00
5/1/2002	603	7.25	115.97	108.72	2.10	4.71	NM	275.43
5/25/2002	314	7.55	75.49	67.94	1.06	3.02	NM	166.07
6/30/2002	30	0.00	9.38	9.38	0.36	0.31	NM	15.87
8/27/2002	2	0.00	0.38	0.38	0.05	0.02	NM	0.77
9/30/2002	36	0.00	10.39	10.39	0.17	0.77	1.03	29.42
10/30/2002	160	0.00	73.08	73.08	1.19	2.79	7.85	119.24
5/15/2003	161	0.00	38.70	38.70	0.50	1.57	NM	85.15
Average:		**3.06**	**62.60**	**59.54**	**0.84**	**2.94**	**4.58**	**140.21**
Sample Point CT07, flow from coal refuse pile RB-1								
11/1/2001	2	0.00	8.70	8.70	0.30	0.10	NM	12.02
12/21/2001	5	0.00	21.16	21.16	0.61	0.16	NM	19.83
10/30/2002	2	0.00	7.89	7.89	0.20	0.07	0.77	11.03
3/12/2004	5	0.00	11.66	11.66	0.27	0.16	1.21	14.84
3/26/2004	6	0.00	14.42	14.42	0.29	0.15	1.14	11.90
4/9/2004	3	0.00	7.28	7.28	0.16	0.10	0.76	7.83
4/28/2004	5	0.00	12.26	12.26	0.32	0.15	1.31	12.02
5/24/2004	20	0.00	50.96	50.96	1.43	0.55	5.22	56.49
Average:		**0.00**	**16.79**	**16.79**	**0.45**	**0.18**	**1.73**	**18.25**

A-5 CONCEPTUAL DESIGN OF RESTORATIVE MEASURES FOR WATER QUALITY DEGARADATION ABATEMENT

The conceptual design of restorative measures for the Contrary Run watershed addresses the water quality impacts of past mining operations on water quality degradation of Contrary Run and its receiving stream, Sandy Run. It is part of the overall plan for the Beech Creek watershed cleanup.

The first comprehensive cataloguing of surface and deep mine workings and impacts on quality of local streams and AMD pollution abatement measures was done as part of the Operation Scarlift project in 1970. The current project is an outgrowth of the Operation Scarlift and provides more detailed information on the local conditions with an updated and expanded water quality database, and a proposal for restorative measures currently practiced and tested as a result of the Surface Mining Conservation and Reclamation Act of 1977 that requires all surface mining to include reclamation with no or minimal environmental impacts.

A-5.1 Review of Current State of the Art Restorative Practices

A review of the current restorative practices in water quality controls provides a background for the selection of measures that are best suited for the restoration of the Contrary Run watershed. There are basically three general categories, each applicable for a given set of conditions. They are: (1) restoration or reclamation of the abandoned mine areas, (2) active treatment and, (3) passive treatment methods.

Reclamation of Abandoned Mine Areas

Site reclamation is used to control the source of water quality degradation and has been practiced by the mining industry for the last several decades. The practices have been also a subject of numerous research projects with the results applied in the practiced reclamation efforts through regulatory policy changes of the SMCRA implementation and enforcement.

Site reclamation includes several basic steps, such as mine spoil regrading, mine spoil handling and hydrological isolation of materials with high AMD producing potential, addition of alkaline materials, surface water runoff handling, top soil spreading, and site revegetation. Each of the steps should be performed with the site specific conditions in mind to achieve the best water quality controls.

Active Treatment of Point Discharges

Active treatment is used for controlling the water quality of point discharges with the use of chemicals and mechanical devices. Active treatment is used mostly where the source of degradation is not defined or it is not feasible to abate. The chemicals commonly used in the treatment include sodium hydroxide or sodium carbonate, hydrated lime or quick lime. Treatment with chemicals produces sludge that needs to be periodically removed; the operation of active treatment sites also requires on-going supervision and maintenance.

Passive Treatment of Point Discharges

Passive treatment technology has become the latest approach to acid mine drainage amelioration. Like the active treatment methods, this technology is used in the instances where the source of contamination at a point discharge is not known or is not easy to eliminate. It focuses on natural processes in constructed drains, wetlands, and ponds, with the acidity neutralized by added alkaline products and microbial metal removing processes. There are many variations of the passive treatment design, based on site specific conditions. The most commonly used passive treatment methods are: constructed wetlands, anoxic or oxic limestone drains, usually used in combination with sedimentation ponds and constructed wetlands; vertical flow ponds/wetlands are the latest and most innovative acid mine drainage treatment technology. The effectiveness of this treatment technology continuously improves with continuing research and development efforts.

Like the active treatment approach, passive treatment systems require various degrees of maintenance depending on the system design and complexity of used components. In general, the long term effectiveness of the passive systems without some maintenance is questionable as there are many extraneous factors that can adversely affect their function. The most common problem for maintenance of passive treatment systems is encountered when they are constructed in beaver or muskrat inhabited areas and are thus subsequently plagued with a variety of destruction, resulting in impacted function. The life span of the passive treatment structures depends on the design, and is, under optimal conditions predicted to be no more than 25 years.

A-5.2 Conceptual Restorative Plan for Contrary Run Watershed

The restoration plan discussed here is prepared with permanent improvement in mind, such that it should require no or minimal maintenance in the future. Improvement of water quality in the watershed is viewed as the highest priority task, although other land use improvement such as elimination of highwalls that represent safety hazard or regrading of steep spoil banks and their revegetation will enhance wildlife habitat. It is suited for the conditions of the watershed in a relatively remote and poorly accessible portion of the Beech Creek watershed, a major hindrance for any treatment system that requires access for maintenance.

The proposed reclamation sequence entails (1) removal of coal refuse banks, (2) restoration and/or reconstruction of surface water drainage and (3) reclamation of surface mine areas. It does not consider reclamation of abandoned deep mines as these do not contribute to any surface water degradation points in the watershed.

Coal refuse handling (removal or hydrological isolation) is the top priority in the proposed restorative plan. Coal refuse, especially when accumulated in large refuse banks (RB-1 and RB-2), contributes substantial portions of pollutant loadings and is the major contributor of AMD to the watershed.

Coal refuse quality testing was done for samples collected from coal refuse banks RB-1 and RB-2 and also from coal refuse piles mapped in mine areas SM-3C, SM-7, SM-8, and SM-12B. The results of the tests are summarized in Table A-6 (page 74). Section A-4.3 of the report provides information on the coal refuse thickness and quality, with a description of impacts on water quality degradation.

It is assumed that the coal refuse will be marketed to a power plant or a cogeneration facility. In the case where the quality of the coal refuse is not suitable for any such facility, the two coal refuse banks located directly adjacent to Contrary Run will be removed from their current location and placed at a site where they can be hydrologically isolated.

The proposed modification of the current drainage will play an essential part in the watershed restoration with emphasis on surface water flow conveyance through the area with minimal contact of surface water with mine spoil areas. The planned systematic restoration of the most effective water handling drainage system will have to precede reclamation of the abandoned surface mine areas.

Reclamation of abandoned mine sites is to complement the previous two restorative steps and is focused on the sites that contribute to the water quality degradation the most. The best available technology currently utilized in the reclamation efforts of the mining industry will be used in the restorative effort with adjustments to local conditions of each site.

Although mine site reclamation many years after abandonment may not be, in some instances, fully effective in restoring the pre-mining water quality, a well designed reclamation plan should either improve or restore the quality of the watershed that can support aquatic life. The majority of the identified discharges in the watershed are often only moderately impacted and will improve by the proposed reclamation.

The basic elements of restorative plan include several reclamation steps used in the current surface mine reclamation efforts as mandated by SMCRA. The operational steps relevant to reclamation of abandoned mine sites to be used in the Contrary Run watershed are described below.

Mine spoil regrading – The goal of mine spoil regrading is to fill the mined area, while approximating the original contour to the extent possible. The configuration of post reclamation surface at the abandoned sites will be designed with the emphasis on the most effective surface runoff plans. An effort will be made to preserve the current mine spoil areas with established vegetative cover that can be effectively incorporated into the overall reclamation plan.

Although the reclamation of the abandoned highwalls in the watershed area is not considered critical as a restorative step needed for improvement of water quality, highwall reclamation will be an integral part of the overall reclamation process as practiced in cases of active mine operations.

Elimination of standing highwalls is normally done during the site regrading, when the last cut is filled with mine spoil. However, during the reclamation of abandoned mine spoil, the upper portion of the highwall may need to be cut back to 2:1 slope and integrated with the rest of regraded mine spoil surface. In many surface mine areas, the last cuts of the abandoned sites mapped in the watershed are preserved and in most instances, sufficient volume of mine spoil is available at each site for their closure.

As a large portion of the watershed is owned and managed by the Pennsylvania Game Commission and its use by public is encouraged, the reclamation of abandoned highwall as a safety improvement of the watershed should be considered as part of the restorative plan. It is proposed that the reclamation of the abandoned mine highwalls be done in conjunction with the reclamation efforts where the prioritization of the restorative measures are based on the benefits to water quality ratio and not consider safety as a determining factor.

<u>Coal refuse handling</u> – Any coal refuse encountered during mine spoil regrading must be handled separately. If mine spoil contains large quantities of coal refuse that could not be separately handled, that portion of mine spoil will not be placed at a depth that could be inundated by mine spoil water, i.e. near pit floor. Additional alkaline addition will be considered for the mine spoil that contains coal refuse (see below).

In the cases where coal refuse can be separated but because of its poor quality, cannot be utilized in an off-site facility, it will be handled separately, deposited above the top of spoil water saturation, preferably in a form of a pod where strata below and above the coal refuse layer are compacted to prevent or limit any contact of percolating ground water with the coal refuse material.

Alkaline addition –Alkaline materials will be added to mine spoil at the rates given in Table A-8. The rates were calculated from overburden analyses of samples collected during drilling of six exploration drill holes near the Brookville and Clarion mine areas SM-3 (B,C,D), SM-5, SM-6 (A, B, C), SM-7 and SM-8 with impacted discharges. The table provides suggested addition rates for deficiencies (tons/acre) and alkaline addition rates for net neutralization potential of 3 tons/1,000 tons, and 6 tons/1,000 tons overburden.

It is suggested that the highest calculated values be used for sites with larger quantities of coal refuse or for those portions of the mine spoil fill where refuse is deposited, and for sites with impacted discharges. The minimum best management practice rates of 200 tons per acre should be used at sites that do not produce impacted discharges and where the site reclamation has low priority.

Topsoil spreading – Topsoil, if found in the mine area, shall be spread over graded mine spoil. As it is likely that at the majority, if not all, mine sites the topsoil was not separated before mining from the mine spoil and thus is not available, the top layer of mine spoil that currently serves as a growing medium will be used as the post mining surface layer to support growth.

Revegetation – The mine sites will be vegetated by grasses and legumes in the planting season, following the completion of topsoil spreading and will be planted with trees. Establishing good ground cover will in many places require addition of agricultural lime or other alkaline additives. Mulch and fertilizers will be used as well to enhance seed germination and vegetative growth. The design of the reclamation effort will consider preservation of current vegetative cover where advantageous for site land use and where it will not prevent implementation of restorative measures with the ultimate goal of water quality improvement in mind. Other practices that will enhance revegetation efforts will be considered, such as the use of biosolids.

TABLE A-8. ALKALINE ADDITION RATES FOR SURFACE MINE AREA RECLAMATION

Surface Mine Area	Coal Seam	Representative Drill Holes	Average Deficiency (tons/acre)	Average Alkaline Addition Rate (tons/acre)	
				Net NP 3 tons/1,000 tons	Net NP 6 tons/1,000 tons
SM-3B	Lower Kittanning	2	200*	154	244
SM-3C	Lower Kittanning	2	200*	154	244
SM-3D	Lower Kittanning	2	200*	154	244
SM-5	Brookville	3, 4	1,158	1,422	1,686
SM-6A	Clarion	3, 5	293	669	1,046
SM-6B	Clarion	1, 5	269	689	1,111
SM-6C	Clarion	1	203	565	928
SM-7	Brookville	6	200*	200*	392
SM-8	Clarion	6	200*	200*	332

* Minimum Best Management Practice Rate of 200 tons/acre given.

Sediment and erosion controls - Upgradient diversion ditches will be placed in areas to intercept shallow ground water inflow or surface water runoff from up-slope areas and divert this flow from mine spoil. Where possible, hay bales and silt fence will be used rather than sediment ponds. However, it may be necessary to construct ponds and collection ditches in larger mine areas, to control runoff during reclamation.

A-5.3 Reclamation Detail and Priorities

The priorities for implementation of corrective measures, i.e. the individual tasks of the restorative plan, are based on the significance of the corrective measures in amelioration of water quality degradation of the watershed. The highest ranking measure that is critical in the watershed restorative effort deals with the removal of coal refuse banks. So too is the restoration or building of an effective water handling drainage system that was either destroyed or impacted during the past mining operations. The intermediate priority measures classified as essential deal with reclamation of abandoned mine areas with impacted discharges while the low priority measures are not essential within the water quality restorative plan and their significance rests with land use improvement and elimination of highwalls as a safety hazard.

The sequence in which the individual restorative measures are described signifies the priority ranking as suggested by the author. Some of the tasks can be performed independently, while some require implementation of tasks listed previously to be effective. The background information on which the priority listing is based is contained in the main body of the report in sections A-2 through A-4. Locations of proposed restorative measures designated by their priority ranking is given on Plate II, Conceptual Restorative Plan, Contrary Run Watershed, Centre County, Pennsylvania.

A-5.3.1 High Priority - Critical Restorative Measures

Removal of Coal Refuse Banks

- Refuse bank RB-1 with a total of 30,000 tons of coal refuse and refuse bank RB-2 with a total of 2,500 tons of refuse will be excavated and removed from the watershed.

- The coal refuse should be marketed to a power plant or cogeneration facility. In the case where the quality of the coal refuse is not suitable for any such facility, the coal refuse will be removed from the stream valley and properly disposed of at a site where it can be hydrologically isolated.

- The site topography after removal of coal refuse will be reclaimed to approximate the original contour. As both coal refuse banks are located within the flood plain of Contrary Run, special care will be taken during coal refuse removal to prevent any contamination of the stream.

- Removal of coal refuse piles mapped within mine areas will be addressed below.

Reconstruction of Stream Diversion of UT-A

- Approximately 3,220 feet of UT-A and its diversion ditch will be reconstructed to convey flow from the upper reaches of UT-A around mine area SM-7 to the section where it joins UT-B.

- The area of the confluence of UT-A, UT-B, and UT-C is currently a densely vegetated, beaver inhabited wetland between mine areas SM-5 and SM-7, where large amounts of sediment derived from the upslope mine spoil were deposited in the past filling of the original stream bed. It is recommended that the wetland not be disturbed, unless there is a need for improved water conveyance from the area.

- The stream relocation such that it follows the original ditch depends on the existing gradient of the area and may be insufficient to maintain the stream channel during high flow periods. Modification or changes in the location of the stream diversion channel may be needed.

- The UT-A stream relocation and the potential need for an alternative stream channel in the wetland area may require reclamation at least of the southernmost portion of mine area SM-7.

- It is essential that a "safety zone" of at least 100 feet be kept between the edge of the wetland lowland and the reclaimed mine spoil in SM-7 as the area is an active beaver habitat and surface water flow impoundment by beavers dams is to be anticipated. The construction of a berm to prevent flooding of mine spoil in area SM-7 is recommended.

Reconstruction of UT-B Stream Channel

- Approximately 800 feet of stream channel will be reconstructed to convey surface water flow of UT-B to UT-A and to Contrary Run.

- There were originally two stream segments of UT-B that represented the headwater drainage of the subwatershed. The stream segment as mapped on the pre-mining 7½ minute quadrangle from year 1928 that was originally shown as the headwater segment of Contrary Run was eliminated by mining in area SM-3C; there is currently no distinct drainage way of the original stream segment; UT-B starts at the point of spoil discharge from area SM-3C and follows poorly defined channel through undisturbed area until it reaches the area of SM-5 where it discharges into a large box cut impoundment.

- It is recommended that a swale be constructed in mine area SM-3C to collect surface runoff and convey it to UT-B (see below).

- The water diversion of UT-B from emptying into impoundment in mine area SM-7 is prerequisite of SM-7 reclamation success.

- The reconstructed UT-B will follow the undisturbed band of land between areas SM-6A and SM 7 where 100 foot barriers at each site of the stream channel will be kept spoil free. It is essential that a "safety barrier" of at least 100 feet is kept between the edge of the two spoil area as the watershed is an active beaver habitat and surface water flow ponding by beavers dams is to be anticipated.

- The restoration of the original Contrary Run headwater channel is not considered to be of high priority and is not being recommended as part of the restoration scheme.

Restoration of UT-C Stream Channel

- Approximately 500 feet of the UT-C stream channel will be reconstructed in the area where it crosses mine area SM-5.

- Restoration of the UT-C streambed within mine area SM-5 will be done to restore surface water conveyance destroyed by mining of the shallow Clarion seam. The upper reaches of the stream that are fed by several springs downgradient from the Lower Kittanning cropline, flow into mine area SM-5 where the stream flow is interrupted by series of abandoned shallow mine pits. Currently, the area is an extensive beaver habitat and is inundated by numerous ponds.

- Some of the surface flow from the ponded areas may enter the box cut impoundment, the rest continues to flow to the southwest into the area that originally contained a stream channel of the original UT-C. Mapping of the area indicates modification of the original stream channel by sediment derived from the upgradient mine spoil and its deposition in the area. However, the area is well revegetated and has developed into a series of wetlands that likely benefit the quality of the shallow water passing through the area and thus should not be disturbed.

- The reconstructed streambed will be clay lined when crossing mine spoil. It is essential that a 100 foot barrier be maintained on both sides of the channel as it is anticipated that the active beaver community will reoccupy the area after construction. A berm shall be constructed at the western limit of the barrier area to prevent any water seepage into the adjacent Brookville mine spoil.

Reclamation of Mine Area SM-7

- Fifteen acres of abandoned mine spoil and 1,350 feet of highwall will be reclaimed in accordance with the reclamation guidelines described in section A-5.2 of the report.

- The reclamation plan will consider expansion of the wetland area near UT-A, UT-B, and UT-C confluence into the portion of SM-7 where the mine spoils are thin and could be easily relocated into the adjacent updip portions of the abandoned mine area.

- Site reclamation will include elimination of an impoundment that separates mine area SM-7 from the adjacent mine area SM-8. The regrading in the area will provide a swale or channel that will accommodate surface runoff from both areas to discharge to the existing short tributary UT-E to Contrary Run.

- A coal refuse pile identified near the eastern limit of mine area SM-7, adjacent to the deep mine entry D-38 into the Brookville mine complex, will be removed or disposed of in accordance with the reclamation guidelines described in section A-5.2 of the report. Because of the proximity of SM-7 to the deep mine entry, coal refuse may be also found incorporated within the mine spoil and should be removed if encountered.

- Alkaline addition for the SM-7 spoils will be done in accordance with the reclamation guidelines described in section A-5.2 of the report.

Reclamation of Mine Area SM-5

- Twelve acres of abandoned mine spoil will be reclaimed in accordance with the reclamation guidelines described in section A-5.2 of the report.

- The goal of the reclamation is to fill the inundated box cut left after extraction of Brookville coal with the surrounding mine spoil and to regrade the surface of the area to approximate the original contour. It is essential to prevent or minimize water infiltration into the spoils as these are known producers of AMD.

- In addition, abandoned mine spoils left after recovery of shallow Clarion coal in the eastern portion SM-5 will be reclaimed during the UT-C stream reconstruction.

- An upgradient diversion ditch will be built to intercept shallow ground water flow and surface runoff from the area to the south of SM-5 and divert the flows into the reconstructed channels of UT-C and UT-B.

Alkaline addition to the spoils will be done in accordance with the alkaline addition rates specified in section A-5.2, Table A-8 of the report, at Net NP of 6 tons/1,000 tons.

A-5.3.2 Intermediate Priority – Essential Restorative Measures

The intermediate priority restoration steps consist of reclamation of abandoned surface mine sites using the best reclamation technology available.

Reclamation of Mine Areas SM-6A, SM-6B and SM-6C

Seven acres of abandoned mine spoil and 700 feet of highwall in SM-6A, twelve acres of abandoned mine spoil and 1,670 feet of highwall in SM-6B, and fifteen acres of abandoned mine spoil and 1,800 of higwall in SM-6C will be reclaimed in accordance with the reclamation guidelines described in section A-5.2 of the report.

The reclamation of mine area SM-6A will follow the reconstruction of diversion channel UT-A stream as described above.

Regrading the area SM-6A will eliminate the existing discharge that drains from a mine drainage channel into the box cut impoundment in area SM-5.

Alkaline addition to the spoils in the area SM-6A will be done in accordance with the alkaline addition rates specified in section A-5.2, Table A-8 of the report, at Net NP of 3 tons/1000 tons.

The reclamation of mine areas SM-6B and SM-6C will be done following reconstruction of UT-A diversion channel.

Regrading in SM-6B will eliminate the existing impoundments with an overflow to UT-A diversion channel and at the southeastern limit of the spoil area.

The regrading in area SM-6C will eliminate the existing impoundment; regrading in both areas will approximate the original contour, with preferred slope toward the existing drainage ways that separate SM-6B and SM-6C and in the southernmost portion of SM-6B to the south of the undisturbed area (between SM-6B and SM-6A) that was originally a stream bed of the Contrary Run headwater stream currently obliterated by sediment from the nearby abandoned mining spoils.

Alkaline addition for SM-6B spoils will be done in accordance with the alkaline addition rates specified in section A-5.2, Table A-8 of the report at Net NP of 3 tons/1,000 tons.

Reclamation of Mine Area SM-3C

- Thirty one acres of abandoned mine spoil and 3,400 feet of highwall will be reclaimed in accordance with the reclamation guidelines described in section A-5.2 of the report.

- The headwaters of Contrary Run in area SM-3C were totally destroyed by the past mining and the stream bed obliterated by deposition of mine spoil. The reclamation of the original stream bed is not suggested as it would not provide any substantial improvement of the water quality of the watershed; any re-establishment of stream beds in areas with thick mine spoils is often difficult as the mine spoil water accumulates near the pit floor and base flow recharge to the newly reestablished stream is practically non-existent, while the streambed has to be clay lined to prevent further surface water inflow into the mine spoil. It is, however, proposed that a swale, possibly clay lined, be built during the spoil regrading with outflow to the existing UT-B for conveyance of surface water runoff.

- Alkaline addition to the spoils will be done in accordance with the alkaline addition rates specified in section A-5.2, Table A-8 of the report at Net NP of 3 tons/1,000 tons.

- Coal refuse piles from the northeastern portion of mine area SM-3C will be removed from the watershed or disposed according to the guidelines given in section A-5.2 of the report.

Reclamation of Mine Area SM-8

- Eight acres of abandoned mine spoil and 1,550 feet of highwall will be reclaimed in accordance with the reclamation guidelines described in section A-5.2 of the report.

- Contribution to Contrary Run from mine area SM-8 is via an intermittent stream fed by outflow from mine spoil impoundment, adjacent to the area at its southern limit. As mentioned above, the impoundment receives drainage from the deep drift mine D-37 located to the south of SM-8 when it discharges during wet periods and will be eliminated during reclamation of mine area SM-7.

- Coal refuse that originated in the adjacent drift mine was disposed throughout the mine spoil area and will be handled according to the guidelines given in section A-5.2 of the report.

Alkaline addition to the spoils will be done in accordance with the alkaline addition rates specified in section A-5.2, Table A-8 of the report at Net NP of 3 tons/1,000 tons.

Reclamation of Mine Area SM-10

- Five acres of abandoned mine spoil and 1,200 feet of highwall will be reclaimed in accordance with the reclamation guidelines described in section A-5.2 of the report.

- The mine spoil water does not contribute degraded flow to the stream directly but infiltrates the shallow ground water system and contributes to the stream as base flow recharge.

- Alkaline addition to the spoils will be done in accordance with the alkaline addition rates specified in section A-5.2, Table A-8 of the report at Net NP of 6 tons/1,000 tons.

Reclamation of Mine Area SM-11

- Nine acres of abandoned mine spoil and more than 1,000 feet of highwall will be reclaimed in accordance with the reclamation guidelines described in section A-5.2 of the report.

- The mine spoil water does not contribute degraded flow to the stream directly but infiltrates the shallow ground water system and contributes to the stream as base flow recharge.

- Reclamation of highwalls in the last standing box cut that are over 60 feet high would eliminate a major safety hazard of the watershed.

- As the current spoils barely support vegetation and are often bare, the revegetation of the mine spoil will require additives, to enhance vegetative cover establishment and growth, e.g. application of biosolids or other organic materials.

<u>Reclamation of Mine Area SM-12B</u>

- Two acres of abandoned mine spoil and 260 feet of highwall will be reclaimed in accordance with the reclamation guidelines described in section A-5.2 of the report.

- The main benefit of reclamation in mine area SM-12B will be the separation and removal of coal refuse found in the mine spoil. The coal refuse disposal will be done according to the specification given in section A-5.2 of the report.

- It is advisable to maintain a 100 foot spoil free barrier along the streambed; as the current spoil bank of the mine area is encroaching on the stream, the reclamation should include removal of some of the mine spoil to at least 100 feet from the stream bed.

  Alkaline addition to the spoils will be done in accordance with the alkaline addition rates specified in section A-5.2, Table A-8 of the report at Net NP of 6 tons/1,000 tons.

A-5.3.3 Low Priority – Non-Essential Restorative Measures

- Abandoned mine areas that do not contribute to watershed surface water quality degradation include SM-1, SM-2, SM-3B, SM-3D, SM-10, SM-12C, SM-13B and SM-14.

- The benefit of reclaiming the abandoned mine area and eliminating the highwalls would result in improved land use and safety.

- Site reclamation, if implemented, will be done in accordance with the reclamation guidelines described in section A-5.2 of the report.

- It is recommended that the alkaline addition to the mine spoil if reclaimed be at the rate 200 tons per acre which represents a minimum of the best management practice amendment rate.

- Reclamation and alkaline addition in mine areas where the mine spoil water drains into adjacent deep mines will benefit the quality of discharges into the adjacent watershed.

- The non-essential reclamation efforts could also include removal of extensive clay banks associated with clay extraction in the Brookville deep mine complex.

A-5.4 Watershed Remining and Reclamation

Past mining in the Contrary Run watershed extracted a portion of coal reserves underlying the area. The exploration drilling in the watershed, done as part of the project, suggests that the remaining reserves are in the Clarion coal, near mine areas SM-6 (A,B,C) and the Lower Kittanning outlier in the northwestern portion of watershed (SM-10). There are indications that the quality of overburden in the area varies significantly as indicated by overburden analyses and is reflected in needed alkaline addition (see Table A-8).

Any future mining should be done within the framework of the watershed restoration plan. If proven that the coal extraction can done without any water quality impacts and a mining permit is issued, the mining should incorporate some of the abandoned areas in its mining and reclamation plan.

The remining in the watershed and reclamation of designated areas should be done through cooperation of mining companies with the Bureau of Mining and Reclamations and the Bureau of Abandoned Mine Reclamation in devising the most economically effective and environmentally safe restoration plan.