EXHIBITS
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<u>EXHIBIT A</u>

Commonwealth of Pennsylvania

Department of Environmental Resources

Mine Drainage Abatement Measures for

the Shamokin Creek Watershed

IDENTIFICATION OF COAL VEINS

Name Of Vein	Number Of Vein (1)	Geologic Formation	Watershed Occurrence Persistent	Watershed Occurrence Local
Tunnel	19	Post-Pottsville		X
Peach Mountain	18	Post-Pottsville		X
Little Tracy	17	Post-Pottsville		X
Tracy	16	Post-Pottsville		X
Little Diamond	15	Post-Pottsville	X	
Diamond	14	Post-Pottsville	X	
Little Orchard	13	Post-Pottsville	X	
Orchard	12	Post-Pottsville	X	
Primrose Top Split	11 T	Post-Pottsville		X
Primrose	11	Post-Pottsville	X	
Not Named	10 3/4	Post-Pottsville		X
Rough	10 1/2	Post-Pottsville	X	
Not Named	10 1/4	Post-Pottsville		X
Holmes	10	Post-Pottsville	X	
Not Named	9% or L	Post-Pottsville		X
Four Foot	91/2	Post-Pottsville	X	
Mammoth Top Split	9	Post-Pottsville	X	
Mammoth Local Split	9 B	Post-Pottsville		X
Mammoth Middle Split	8Y2	Post-Pottsville	X	
Mammoth Bottom Split	8	Post-Pottsville	X	
Skidmore	7	Post-Pottsville	X	
Skidmore Leader	7 L	Post-Pottsville		X
Seven Foot Leader	6 L	Post-Pottsville		X
Seven Foot	6	Post-Pottsville	X	
Buck Mountain Top Split	5 T	Post-Pottsville		X
Buck Mountain	5	Post-Pottsville	X	
Not Named	D	Pottsville		X
Not Named	C	Pottsville		X
Not Named	B	Pottsville		X
Not Named	A	Pottsville		X
Lykens Valley (Little Buck Mountain)	4	Pottsville	X	
Whites	3	Pottsville		X
Lykens Valley	2	Pottsville		X
Lykens Valley	I	Pottsville		X

(1) Based on United States Geological Survey information.

<u>EXHIBIT B</u>

Commonwealth of Pennsylvania

Department of Environmental Resources

Mine Drainage Abatement Measures

for the Shamokin Creek Watershed

DESCRIPTION AND STATUS OF MINE

<u>DRAINAGE DISCHARGE POINTS</u>

Discharge Point (1)	Description	Status
1	Continuous seepage from refuse pile caused by springs and surface water runoff.	Infiltrates into Midvalley deep mine workings. Contributes to flow and pollution load of Discharge Point 5.
2	Continuous seepage from refuse pile caused by springs and surface water runoff.	Infiltrates into Midvalley deep mine workings. Contributes to flow and pollution load of Discharge Point 5.
3	Continuous seepage from refuse pile caused by springs and surface water runoff.	Infiltrates into Midvalley deep mine workings. Contributes to flow and pollution load of Discharge Point 5.
4	Continuous discharge through drainage tunnel from isolated deep mine workings and portions of Midvalley deep mine workings.	Infiltrates into Midvalley deep mine workings. Contributes to flow and pollution load of Discharge Point 5.
5	Continuous discharge from mine water pool in Midvalley deep mine workings by overflow across barrier pillar.	Fifty percent enters North Branch Shamokin Creek; fifty percent infiltrates into Richards deep mine workings and contributes to flow and pollution load of Discharge Points 19 and 20.
6	Intermittent discharge of springs and surface water runoff through strip mine.	Contributes to flow and pollution load of Shamokin Creek.
7	Intermittent seepage through refuse pile from impoundment of surface water.	Contributes to flow and pollution load of Shamokin Creek.
8	Intermittent seepage from refuse pile caused by springs and surface water runoff.	Contributes to flow and pollution load of Locust Creek.
9	Continuous discharge through refuse pile caused by infiltration of a portion of Locust Creek, and intermittent springs and surface water runoff.	Contributes to pollution load of Locust Creek with negligible increase in flow.

Discharge Point (1)	Description	Status
10	Continuous discharge through refuse pile caused by infiltration of a portion of Locust Creek, and intermittent springs and surface water runoff.	Contributes to pollution load of Locust Creek with negligible increase in flow.
II	Continuous seepage from refuse pile caused by springs and surface water runoff.	Contributes to flow and pollution load of Locust Creek.
12	Continuous overflow from pool in strip mine interconnected with mine water pool in Excelsior deep mine workings.	Contributes to flow and pollution load of Shamokin Creek.
13	Intermittent seepage from isolated deep mine workings through caved drift entry.	Infiltrates into Enterprise deep mine workings. Contributes to flow and pollution load of Discharge Point 12.
14	Intermittent discharge from isolated deep mine workings through drift entry.	Infiltrates into Enterprise deep mine workings. Contributes to flow and pollution load of Discharge Point 12.
15	Continuous discharge from mine water pool in isolated portions of Excelsior-Corbin deep mine workings through drift opening.	Contributes to flow and pollution load of Shamokin Creek.
16	Intermittent seepage through spoil banks from water impounded in isolated strip mine.	Contributes to flow and pollution load of Quaker Run.
17	Intermittent flow from springs and surface water runoff over coal measures.	Contributes to flow of Quaker Run.
18	Continuous seepage from backfilled strip.	Contributes to flow of Quaker Run.
19	Continuous discharge from mine water pool in Scott deep mine workings through subsidence area.	Contributes to flow and pollution load of Quaker Run.
20	Continuous discharge from mine water pool in Scott deep mine workings through open cut in strata.	Contributes to flow and pollution load of Quaker Run.
21	Continuous discharge from mine water pool in Maysville deep mine workings through relief borehole.	Contributes to flow and pollution load of Quaker Run.

Exhibit B (Continued)

Discharge **<u>Point (1)</u>**	**<u>Description</u>**	**Status**
22	Continuous seepage through strata from isolated portions of Royal Oak deep mine workings.	Contributes to flow and pollution load of Shamokin Creek.
23	Continuous discharge from mine water pool in Big Mountain deep mine workings through seepage in strata.	Contributes to flow and pollution load of Buck Run.
24	Continuous seepage through strata from mine water pool in Buck Ridge deep mine workings.	Contributes to flow and pollution load of Buck Run.
25	Continuous seepage through strata from mine water pool in Buck Ridge deep mine workings.	Contributes to flow and pollution load of Buck Run.
26	Continuous seepage through strata from mine water pool in Buck Ridge deep mine workings.	Contributes to flow and pollution load of Buck Run.
27	Continuous seepage through strata from mine water pool in Buck Ridge deep mine workings.	Contributes to flow and pollution load of Buck Run.
28	Intermittent seepage from refuse piles caused by springs and surface water runoff.	Contributes to flow and pollution load of Shamokin Creek.
29	Continuous discharge through strata from Royal Oak deep mine workings.	Contributes to flow and pollution load of Shamokin Creek.
30	Intermittent seepage from refuse piles caused by springs and surface water runoff.	Contributes to flow and pollution load of Shamokin Creek.
31	Intermittent seepage from strip mine.	Infiltrates into Greenough deep mine workings. Contributes to flow and pollution load of Discharge Points 19 and 20.
32	Continuous discharge from Natalie deep mine workings through drainage tunnel obliterated by refuse piles.	Infiltrates into Hickory Ridge deep mine workings. Contributes to flow and pollution load of Discharge Points 50, 51,52, and 53.
33	Intermittent discharge from isolated portion of Hickory Ridge deep mine workings through drift entry.	Infiltrates into Hickory Ridge deep mine workings. Contributes to flow and pollution load of Discharge Points 50, 51, 52, and 53.

Discharge Point (1)	**Description**	**Status**
34	Intermittent discharge from isolated portion of Hickory Ridge deep mine workings through drift entry.	Infiltrates into Hickory Ridge deep mine workings. Contributes to flow and pollution load of Discharge Points 50, 51,52, andl53.
35	Intermittent discharge from isolated portion of Hickory Ridge deep mine workings through drift entry.	Infiltrates into Hickory Ridge deep mine workings. Contributes to flow and pollution load of Discharge Points 50, 51,52, and 53.
36	Continuous discharge from mine water pool in Buck Ridge No.1 deep mine workings through drainage tunnel.	Contributes to flow and pollution load of Coal Run.
37	Intermittent overflow from pool in isolated strip mine.	Contributes to flow and pollution load of Carbon Run.
38	Intermittent overflow from pool in isolated strip mine.	Contributes to flow and pollution load of Carbon Run.
39	Intermittent overflow from water impounded in isolated strip mine.	Contributes to flow and pollution load of Carbon Run.
40	Continuous seepage through spoil banks from water impounded in isolated strip mine.	Contributes to flow and pollution load of Carbon Run.
41	Intermittent seepage off coal measures.	Contributes to flow of Carbon Run.
42	Continuous discharge from deep mine workings through drainage tunnel obliterated by strip mine.	Contributes to flow and pollution load of Carbon Run.
43	Intermittent seepage from refuse pile caused by springs and surface water runoff.	Contributes to flow and pollution load of Carbon Run.
44	Continuous flow from springs and surface water runoff over coal measures.	Contributes to flow and pollution load of Carbon Run.
45	Intermittent seepage through strata from isolated deep mine workings.	Contributes to flow of Carbon Run.

Discharge Point (1)	**Description**	**Status**
46	Continuous discharge through refuse pile caused by infiltration of a portion of Carbon Run, and intermittent springs and surface water runoff.	Contributes to flow and pollution load of Carbon Run.
47	Continuous discharge through refuse pile caused by infiltration of a portion of Carbon Run, and intermittent springs and surface water runoff.	Contributes to flow and pollution load of Carbon Run.
48	Continuous discharge from deep mine workings through drainage tunnel obliterated by strip mine.	Contributes to flow and pollution load of Carbon Run.
49	Continuous discharge from mine water pool in Stirling deep mine workings through abandoned slope entry.	Contributes to flow and pollution load of Carbon Run.
50	Continuous seepage through strata from mine water pool in Cameron deep mine workings.	Contributes to flow and pollution load of Shamokin Creek.
51	Continuous seepage through strata from mine water pool in Cameron deep mine workings.	Contributes to flow and pollution load of Shamokin Creek.
52	Continuous seepage through strata from mine water pool in Cameron deep mine workings.	Contributes to flow and pollution load of Shamokin Creek.
53	Continuous discharge through aban-doned air shaft from mine water pool in Cameron deep mine workings.	Contributes to flow and pollution load of Shamokin Creek.
54	Continuous seepage from refuse pile caused by springs and surface water runoff.	Contributes to flow and pollution load of Shamokin Creek.

(1) See Plates II-A, II-B, IV-A, and IV-B for locations of Mine Drainage Discharge Points.

EXHIBIT C

Commonwealth of Pennsylvania

Department of Environmental Resources

Mine Drainage Abatement Measures for the Shamokin Creek Watershed

ASSUMPTIONS AND CALCULATIONS USED TO ESTABLISH

COMBINED WATERSHED DESIGN MINE DRAINAGE VOLUMES

Design Average Mine Drainage Volume

Estimated total average yearly precipitation in the watershed over the period of record (1904-1969) = 43.83 inches

Acreage contributing surface-water runoff and ground water to watershed mine drainage discharges

Within watershed	= 28,558
Outside watershed	330
Total	28,888

Acreage on Locust Creek watershed contributing only surface-water runoff to watershed mine drainage discharges = 1 ,110

Locust Creek Flow contributes an estimated eight percent of its flow to watershed mine drainage discharges

Runoff Coefficient
Mined area contributing to watershed mine drainage discharges = 0.1047

Forty-seven percent of the total precipitation on the mined area assumed lost to the atmosphere by evaporation and transpiration

Precipitation on the mined area contributing to watershed mine drainage discharges

Total precipitation

$$= 43.83\ \frac{\text{inches}}{\text{year}} \times \text{affected acreage} \times 43{,}560\ \frac{\text{sq ft}}{\text{acre}} \times \frac{1\ \text{ft}}{12\ \text{in}} \times 7.48\ \frac{\text{gal}}{\text{cu ft}} \times \frac{1\ \text{year}}{365\ \text{days}}$$

Total precipitation on acreage contributing surface-water runoff and ground water = 94.2 mgd

Total precipitation on Locust Creek watershed which contributes only surface-water runoff = 3.62 mgd

Losses on acreage contributing surface-water runoff and ground water

Surface-water runoff direct to surface streams

0.1047 x 94.2 mgd = 9.86 mgd

Evaporation and transpiration

0.4 7 x 94.2 mgd = 44.27 mgd

Contribution to watershed mine drainage discharges from acreage contributing surface-water runoff and groundwater = 40.07 mgd

Contribution to watershed mine drainage discharges from Locust Creek

0.08 x 0.1047 x 3.62 mgd = 0.03 mgd

Total contribution to watershed mine drainage discharges = 40.1 mgd

Design Wet Weather Mine Drainage Volume

Estimated total average precipitation in the mined area from December through April over the period of record (1904-1969) = 15.93 inches

Acreage contributing surface-water runoff and ground water to watershed mine drainage discharges = 28,888

Acreage on Locust Creek watershed contributing only surface-water runoff to watershed mine drainage discharges = 1,110

Locust Creek flow contributes an estimated 10 percent of its flow to watershed mine drainage discharges

Runoff coefficients
Mined area contributing to watershed mine drainage discharges
First 3 1/2 months = 0.05
Last 1 1/2 months = 0.135

Forty-seven percent of the total precipitation on the mined area assumed lost to the atmosphere by evaporation and transpiration

Twenty-nine percent of net precipitation over first 3 1/2 months contributes to watershed mine drainage discharges during last 1 1/2 months

Precipitation on the mined area contributing to watershed mine drainage discharges
Total precipitation

$$= \frac{15.93 \text{ inches}}{5 \text{ months}} \times \text{affected acreage} \times 43{,}560 \frac{\text{sq ft}}{\text{acre}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times 7.48 \frac{\text{gal}}{\text{cu ft}} \times \frac{1 \text{ month}}{30 \text{ days}}$$

Total precipitation on acreage contributing surface-water runoff and ground water = 83.3 mgd
Total precipitation on Locust Creek watershed which contributes only surface-water runoff = 3.2 mgd

For acreage contributing surface-water runoff and ground water
Total precipitation over first 3 1/2 months
83.3 mgd x 105 days = 8,746.5 mg
Losses during first 3 1/2 months
Surface-water runoff direct to surface streams
0.05 x 8,746.5 mg = 437.33 mg
Evaporation and transpiration
0.47 x 8,746.5 mg = 4,110.86 mg
Balance of total precipitation over first 3 1/2 months contributing surface-water runoff and ground water to mine drainage discharges over last 1 1/2 months
(8,746.5 mg - 4,548.19 mg) x 0.29 = 1,217.5 mg

For Locust Creek watershed which contributes only surface-water runoff
Total precipitation over first 31/2 months
3.2 mgd x 105 days = 336 mg
Surface-water runoff direct to stream
0.05 x 336 mg = 16.8 mg
Contribution of surface-water runoff over first 3Y2 months to Locust Creek flow during last 1 1/2 months
16.8 mg x 0.29 == 4.87 mg

For acreage contributing surface-water and ground water
Total precipitation over last 1 1/2 months
83.3 mgd x 45 days = 3,748.5 mg
Losses during last 1 1/2 months
Surface-water runoff direct to surface streams
0.135 x 3,748.5 mg = 506.05 mg
Evaporation and transpiration
0.47 x 3,748.5 mg = 1,761.8 mg
Contribution to mine drainage discharges from surface-water runoff and ground water during last 1 1/2 months
1,480.65 mg from last l 1/2 months + 1,217.5 mg from first 3 1/2 months = 2,698.15 mg or 59.96 mgd

For Locust Creek watershed which contributes only surface-water runoff
Total precipitation over last 1 1/2 months
3.2 mgd x 45 days == 144 mg
Surface-water runoff direct to stream
0.135 x 144 mg = 19.44 mg
Contribution of surface-water runoff to Locust Creek flow during last 1 V2 months
19.44 mg from last 1 1/2 months + 4.87 mg from first 3 1/2 months = 24.3 mg or 0.54 mgd
Contribution of Locust Creek flow to watershed mine drainage discharges
0.1 a x 0.54 mgd = 0.054 mgd

Total contribution to watershed mine drainage discharges = 60.0 mgd

Design Maximum Mine Drainage Volume

Estimated total 24 hour accumulation of rainfall that will occur no more frequently than once every 10 years = 4.53 inches

Acreage contributing surface-water runoff and ground water to watershed mine drainage discharges = 28,888

Acreage on Locust Creek watershed contributing only surface-water runoff to watershed mine drainage discharges = 1,110

Locust Creek flow contributes an estimated 36 percent of its flow to watershed mine drainage discharges

Runoff coefficient
Mined area contributing to watershed mine drainage discharges = 0.135

Forty-seven percent of the total rainfall on the mined area assumed lost to the atmosphere by evaporation and transpiration

Total rainfall on the area contributing to surface-water runoff and ground water to watershed mine drainage discharges = $4.53 \frac{\text{inches}}{\text{day}} \times 28{,}888 \text{ acres} \times 43{,}560 \frac{\text{sq ft}}{\text{acre}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times 7.48 \frac{\text{gal}}{\text{cu ft}} = 3{,}553$ mgd

Losses
Surface-water runoff direct to surface streams
0.135 x 3,553 mgd = 479.7 mgd
Evaporation and transpiration
0.47 x 3,553 mgd == 1,670 mgd

Contribution to watershed mine drainage discharges from acreage contributing surface-water runoff and ground water = 1,403.3 mgd

Total rainfall on Locust Creek watershed contributing only surface water runoff to watershed mine drainage discharges = $4.53 \frac{\text{inches}}{\text{day}} \times 1{,}110 \text{ acres} \times 43{,}560 \frac{\text{sq ft}}{\text{acre}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times 7.48 \frac{\text{gal}}{\text{cu ft}}$ = 136.5 mgd

Contribution of Locust Creek flow to watershed mine drainage discharges
0.36 x 0.135 x 136.5 mgd = 6.7 mgd

Total contribution to watershed mine drainage discharges = 1,410 mgd

EXHIBIT D

Commonwealth of Pennsylvania
Department of Environmental Resources

Mine Drainage Abatement Measures
For the Shamokin Creek Watershed
DESIGN MINE DRAINAGE VOLUMES, MAJOR CONSTITUENTS
AND CHARACTERISTICS AT EACH DISCHARGE POINT

	Design Average						Design Wet Weather						Design Maximum					
			Total Iron		Acid (as $CaCO_3$)				Total Iron		Acid (as $CaCO_3$)				Total Iron		Acid (as $CaCO_3$)	
Discharge Point (1)	Avg. Daily Rate (mgd)	pH Range	mg/l	lbs/day	mg/l	lbs/day	Avg. Daily Rate (mgd)	pH Range	mg/l	lbs/day	mg/l	lbs/day	Avg. Daily Rate (mgd)	pH Range	mg/l	lbs/day	mg/l	lbs/day
1	0.014	2.7-3.0	9.0	1.1	670	78.3	0.026	2.8-3.0	7.1	1.5	605	131.0	0.441	2.8-3.0	6.5	23.9	550	2,020.0
2	0.106	2.8-2.9	16.3	14.4	915	809.0	0.143	2.8-2.9	11.9	14.2	895	1,070.0	3.110	2.8-2.9	10.0	260.0	850	22,100.0
3	0.005	2.8-3.1	31.0	1.3	785	33.0	0.009	2.9-3.1	20.6	1.5	655	49.2	0.136	2.9-3.0	15.0	17.0	600	681.0
4	0.343	3.3-3.5	1.9	5.4	80	229.0	0.678	3.4-3.5	1.5	8.5	70	396.0	12.800	3.4-3.5	1.0	107.0	55	5,870.0
5	7.230	3.0-3.8	41.2	2,490.0	260	15,700.0	9.720	3.1-3.2	33.5	2,720.0	220	17,800.0	149.000	3.1-3.3	30.0	37,300.0	195	242,000.0
6	0.003	4.2-7.0	0.9	0.0	5	0.1	0.071	4.2-4.7	1.3	0.8	25	14.8	0.096	4.2-4.7	1.5	1.2	10	8.0
7	0.001	3.5-4.0	0.3	0.0	145	1.2	0.002	3.5-4.0	0.3	0.0	140	2.3	0.013	3.5-4.0	0.2	0.0	130	14.1
8	0.000	-	-	0.0	-	0.0	0.004	2.6-3.9	10.1	0.3	555	18.5	0.035	2.6-3.9	5.0	1.5	520	152.0
9	0.024	2.5-2.7	52.9	10.6	720	144.0	0.045	2.5-2.7	52.6	19.8	660	248.0	0.768	2.5-2.7	40.0	256.0	615	3,940.0
10	0.077	2.6-3.0	15.8	10.2	385	247.0	0.121	2.7-3.0	11.0	11.1	285	288.0	2.440	2.7-3.0	9.0	183.0	230	4,670.0
11	0.130	2.9-3.2	3.9	4.2	445	483.0	0.256	3.0-3.2	2.4	5.1	335	716.0	4.160	3.0-3.2	2.0	69.0	230	7,980.0
12	7.040	2.9-5.2	58.9	3,460.0	185	10,900.0	10.400	2.9-3.8	61.5	5,340.0	175	15,200.0	299.000	2.9-3.8	75.0	187,000.0	175	437,000.0
13	0.000	-	-	0.0	-	0.0	0.012	4.6-5.0	0.1	0.0	25	2.5	0.170	4.6-5.0	0.2	0.3	40	56.7
14	0.005	3.6-4.0	0.4	0.0	35	1.5	0.020	3.6-4.0	0.5	0.1	30	5.0	0.270	3.6-4.0	0.7	1.6	30	67.6
15	0.625	2.9-3.8	75.5	394.0	290	1,510.0	0.687	2.9-3.2	92.1	528.0	270	1,550.0	20.500	2.9-3.2	102.0	17,400.0	260	44,500.0
16	0.000	-		0.0	-	0.0	0.004	5.0-6.5	0.8	0.0	20	0.7	0.060	5.0-6.5	1.2	0.6	15	7.5
17	0.002	6.2-7.5	2.8	0.1	-15	0.0	0.005	6.2-7.2	2.5	0.1	-10	0.0	0.480	6.2-6.8	2.0	8.0	-10	0.0
18	0.008	5.3-7.4	2.7	0.2	- 5	0.0	0.018	6.5-7.4	2.9	0.4	-15	0.0	0.244	6.5-7.4	4.5	9.2	-15	0.0
19	7.760	3.0-5.1	55.4	3,590.0	155	10,000.0	11.600	3.0-3.1	59.6	5,770.0	145	14,000.0	286.000	3.0-3.1	62.0	148,000.0	150	358,000.0
20	2.050	2.9-5.2	44.9	768.0	185	3,160.0	2.280	2.9-5.2	47.7	908.0	180	3,420.0	75.300	2.9-5.2	50.0	31,400.0	200	126,000.0
21	2.050	5.0-6.7	62.2	1,060.0	45	770.0	2.280	5.0-6.7	54.5	1,040.0	35	666.0	30.000	5.0-6.7	52.0	13,000.0	35	8,760.0
22	0.080	3.1-5.8	29.1	19.4	100	66.8	0.121	3.1-5.7	28.0	28.3	110	111.0	2.890	3.1-5.6	25.0	603.0	135	3,260.0
23	1.110	3.0-3.3	19.9	184.0	170	1,570.0	2.580	3.1-3.2	24.3	523.0	160	3,440.0	69.000	3.1-3.2	48.0	27,600.0	155	89,200.0
24	0.057	3.1-3.5	1.2	0.6	160	76.1	0.083	3.3-3.5	1.0	0.7	155	107.0	1.820	3.3-3.5	0.5	7.6	140	2,130.0
25	0.024	3.0-3.3	1.0	0.2	160	32.0	0.030	3.1-3.3	0.8	0.2	155	38.8	0.768	3.1-3.5	0.5	3.2	110	705.0
26	0.068	3.2-3.6	0.7	0.4	130	73.8	0.089	3.5-3.6	0.5	0.4	110	81.6	2.180	3.5-3.6	0.3	5.5	100	1,820.0
27	0.083	3.0-3.3	1.0	0.7	165	114.0	0.096	3.1-3.3	0.6	0.5	155	124.0	2.660	3.1-3.3	0.5	11.1	125	2,780.0
28	0.011	3.1-3.6	6.7	0.6	150	13.8	0.057	3.1-3.6	15.2	7.2	130	61.8	0.225	3.1-3.6	17.0	31.9	125	235.0
29	0.382	3.1-5.5	13.6	43.4	70	223.0	0.498	3.1-3.9	14.9	61.9	90	374.0	11.900	3.1-3.9	20.0	1,990.0	100	9,930.0
30	0.015	3.3-3.4	0.5	0.1	210	26.3	0.033	3.3-3.4	0.5	0.1	210	57.8	0.867	3.3-3.4	0.6	4.3	200	1,450.0
31	0.008	3.8-4.1	0.2	0.0	45	3.0	0.020	3.8-4.1	0.2	0.0	45	7.5	0.380	3.8-4.1	0.5	1.6	60	190.0
32	0.012	3.2-3.4	1.8	0.2	230	23.0	0.023	3.2-3.3	0.7	0.1	250	48.0	0.320	3.2-3.3	0.5	1.3	275	734.0
33	0.008	4.2-4.6	0.2	0.0	35	2.3	0.018	4.2-4.6	0.1	0.0	30	4.5	0.250	4.2-4.6	0.1	0.2	30	62.6
34	0.000	-	-	0.0		0.0	0.003	3.2-3.4	1.4	0.0	85	2.1	0.040	3.2-3.4	1.5	0.5	95	31.7
35	0.002	3.0-3.4	0.9	0.0	65	1.1	0.007	3.0-3.4	0.9	0.0	65	3.8	0.110	3.0-3.4	1.0	0.9	70	64.3
36	1.570	4.0-7.0	21.4	280.0	5	65.5	2.090	4.0-7.0	19.1	333.0	25	436.0	16.200	4.0_7.0	17.0	2,300.0	30	4,060.0
37	0.000	-	-	0.0	-	0.0	0.002	4.9-6.0	0.8	0.0	40	0.7	0.030	4.9-6.0	1.0	0.3	50	12.5

Exhibit D (Continued)

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	Design Average						Design Wet Weather						Design Maximum					
			Total Iron		Acid (as $CaCO_3$)				Total Iron		Acid (as $CaCO_3$)				Total Iron		Acid (as $CaCO_3$)	
Dis-charge Point (1)	Avg. Daily Rate (mgd)	pH Range	mg/l	lbs/day	mg/l	lbs/day	Avg. Daily Rate (mgd)	pH Range	mg/l	lbs/day	mg/l	lbs/day	Avg. Daily Rate (mgd)	pH Range	mg/l	lbs/day	mg/l	lbs/day
38	0.216	4.6-4.8	0.1	0.2	25	45.1	0.694	4.7-4.8	0.2	1.2	15	86.9	12.200	4.7-4.8	0.2	20.4	15	1,530.0
39	0.047	3.7-5.2	5.5	2.2	35	13.7	0.086	3.8-4.1	5.7	4.1	35	25.1	0.634	3.8-4.1	6.0	31.7	50	265.0
40	0.190	5.2-6.6	1.5	2.4	20	31.7	0.351	5.2-6.3	0.6	1.8	30	87.9	2.560	5.2-6.3	1.0	21.4	50	1,070.0
41	0.005	6.0-7.2	7.0	0.3	-60	0.0	0.006	6.0-7.2	2.8	0.1	-65	0.0	0.160	6.0-7.2	1.8	2.3	-75	0.0
42	0.608	3.2-5.6	33.5	170.0	75	381.0	0.778	3.2-3.4	36.6	238.0	70	454.0	6.050	3.2-3.4	40.0	2,020.0	55	2,780.0
43	0.024	3.4-3.9	1.4	0.3	290	58.1	0.051	3.5-3.9	1.5	0.6	275	117.0	0.586	3.6-3.9	2.0	9.8	320	1,560.0
44	0.121	5.0-7.5	2.1	2.1	10	10.1	0.203	5.0-7.5	1.2	2.0	15	25.4	1.200	5.0-7.5	1.0	10.0	30	300.0
45	0.029	6.5-8.2	1.0	0.2	- 25	0.0	0.051	6.6-8.2	1.6	0.7	- 25	0.0	1.100	6.6-8.2	3.0	27.5	- 30	0.0
46	0.067	3.2-3.3	0.5	0.3	205	115.0	0.118	3.2-3.3	0.4	0.4	210	207.0	2.140	3.2-3.3	0.2	3.6	225	4,000.0
47	0.003	2.8-3.0	4.9	0.1	330	8.3	0.003	2.8-3.0	4.1	0.1	305	7.6	0.096	2.8-3.0	3.5	2.8	370	296.0
48	0.130	6.2-7.6	14.0	15.2	-25	0.0	0.204	6.2-7.6	21.0	35.8	-15	0.0	2.860	6.2-7.6	30.0	716.0	-10	0.0
49	6.340	3.1-6.0	47.9	2,530.0	145	7,670.0	10.200	3.1-5.4	45.9	3,900.0	120	10,200.0	243.000	3.1-5.2	40.0	81,100.0	115	233,000.0
50	0.100	2.9-4.6	76.4	63.8	425	355.0	0.150	2.9-3.1	69.9	113.0	495	620.0	3.890	2.9-3.1	95.0	3,080.0	600	19,500.0
51	2.940	2.8-3.4	92.0	2,260.0	540	13,200.0	3.830	2.8-3.2	34.1	3,010.0	590	18,900.0	99.600	2.8-3.2	96.0	79,800.0	635	528,000.0
52	0.060	3.0-3.4	115.0	57.6	635	318.0	0.080	3.0-3.2	118.0	78.0	685	457.0	2.070	3.0-3.2	120.0	2,070.0	700	12,100.0
53	2.420	2.8-3.2	84.0	1,700.0	555	11,200.0	4.780	2.8-3.0	74.4	2,970.0	585	23,300.0	124.000	2.8-3.0	72.0	74,500.0	600	621,000.0
54	0.038	2.8-3.3	51.4	16.3	1,140	361.0	0.060	3.0-3.3	44.6	22.3	780	391.0	0.979	3.0-3.3	55.0	449.0	750	6,120.0
TOTAL	44.241			19,160.1		80,123.8	65.776			27,702.9		115,355.5	1,497.788			711,404.2		2,812,013.0
	(44.2 MGD)			(9.58 *TID)*		(40.1 T/D)	(65.8 MGD)			(13.9 T/D)		(57.7 T/D)	(1,500 MGD)			(356 T/D)		(1,410 T/D)

(1) See Plates II -A, II -B, IV-A, and IV-B for locations of Mine Drainage Discharge Points.

EXHIBIT E

Commonwealth of Pennsylvania

Department of Environmental Resources

Mine Drainage Abatement Measures for

the Shamokin Creek Watershed

DESIGN POLLUTION LOADS TO WATERSHED STREAMS

	Design Average			**Design Wet Weather**			**Design Maximum**		
Dis-charge Point(l)	**Volume (mgd)**	**Total Iron lbs/day**	**Acid (as $CaCO_3$) lbs/day**	**Volume (mgd)**	**Total Iron lbs/day**	**Acid (as $CaCO_3$) lbs/day**	**Volume (mgd)**	**Total Iron lbs/day**	**Acid (as $CaCO_3$) lbs/day**
1	No Data								
2	No Data								
3	No Data								
4	No Data								
5	3.615	1,245.0	7,850.0	4.860	1,360.0	8,900.0	74.500	18,650.0	121,000.0
6	No Data								
7	0.001	0.0	1.2	0.002	0.0	2.3	0.013	0.0	14.1
8	0.000	0.0	0.0	0.004	0.3	18.5	0.035	1.5	152.0
9	0.024	10.6	144.0	0.045	19.8	248.0	0.768	256.0	3,940.0
10	0.077	10.2	247.0	0.121	11.1	288.0	2.440	183.0	4,670.0
11	0.130	4.2	483.0	0.256	5.1	716.0	4.160	69.0	7,980.0
12	7.040	3,460.0	10,900.0	10.400	5,340.0	15,200.0	299.000	187,000.0	437,000.0
13	No Data								
14	No Data								
15	0.625	394.0	1,510.0	0.687	528.0	1,550.0	20.500	17,400.0	44,500.0
16	0.000	0.0	0.0	0.004	0.0	0.7	0.060	0.6	7.5
17	0.002	0.1	0.0	0.005	0.1	0.0	0.480	8.0	0.0
18	0.008	0.2	0.0	0.018	0.4	0.0	0.244	9.2	0.0
19	7.760	3,590.0	10,000.0	11.600	5,770.0	14,000.0	286.000	148,000.0	358,000.0
20	2.050	768.0	3,160.0	2.280	908.0	3,420.0	75.300	31,400.0	126,000.0
21	2.050	1,060.0	770.0	2.280	1,040.0	666.0	30.000	13,000.0	8,760.0
22	0.080	19.4	66.8	0.121	28.3	111.0	2.890	603.0	3,260.0
23	1.110	184.0	1,570.0	2.580	523.0	3,440.0	69.000	27,600.0	89,200.0
24	0.057	0.6	76.1	0.083	0.7	107.0	1.820	7.6	2,130.0
25	0.024	0.2	32.0	0.030	0.2	38.8	0.768	3.2	705.0
26	0.068	0.4	73.8	0.089	0.4	81.6	2.180	5.5	1,820.0
27	0.083	0.7	114.0	0.096	0.5	124.0	2.660	11.1	2,780.0
28	0.011	0.6	13.8	0.057	7.2	61.8	0.225	31.9	235.0
29	0.382	43.4	223.0	0.498	61.9	374.0	11.900	1,990.0	9,930.0
30	0.015	0.1	26.3	0.033	0.1	57.8	0.867	4.3	1,450.0
31	No Data								
32	No Data								
33	No Data								
34	No Data								
35	No Data								
36	1.570	280.0	65.5	2.090	333.0	436.0	16.200	2,300.0	4,060.0
37	0.000	0.0	0.0	0.002	0.0	0.7	0.030	0.3	12.5

Exhibit E (Continued) Page 2

Dis-charge Point(l)	Design Average			Design Wet Weather			Design Maximum		
	Volume (mgd)	Total Iron lbs/day	Acid (as $CaCO_3$) lbs/day	Volume (mgd)	Total Iron lbs/day	Acid (as $CaCO_3$) lbs/day	Volume (mgd)	Total Iron lbs/day)	Acid (as$CaCO_3$) lbs/day
38	0.216	0.2	45.1	0.694	1.2	86.9	12.200	20.4	1,530.0
39	0.047	2.2	13.7	0.086	4.1	25.1	0.634	31.7	265.0
40	0.190	2.4	31.7	0.351	1.8	87.9	2.560	21.4	1,070.0
41	0.005	0.3	0.0	0.006	0.1	0.0	0.160	2.3	0.0
42	0.608	170.0	381.0	0.778	238.0	454.0	6.050	2,020.0	2,780.0
43	0.024	0.3	58.1	0.051	0.6	117.0	0.586	9.8	1,560.0
44	0.121	2.1	10.1	0.203	2.0	25.4	1.200	10.0	300.0
45	0.029	0.2	0.0	0.051	0.7	0.0	1.100	27.5	0.0
46	0.067	0.3	115.0	0.118	0.4	207.0	2.140	3.6	4,000.0
47	0.003	0.1	8.3	0.003	0.1	7.6	0.096	2.8	296.0
48	0.130	15.2	0.0	0.204	35.8	0.0	2.860	716.0	0.0
49	6.340	2,530.0	7,670.0	10.200	3,900.0	10,200.0	243.000	81,100.0	233,000.0
50	0.100	63.8	355.0	0.150	113.0	620.0	3.890	3,080.0	19,500.0
51	2.940	2,260.0	13,200.0	3.830	3,010.0	18,900.0	99.600	79,800.0	528,000.0
52	0.060	57.6	318.0	0.080	78.0	457.0	2.070	2,070.0	12,100.0
53	2.420	1,700.0	11,200.0	4.780	2,970.0	23,300.0	124.000	74,500.0	621,000.0
54	0.038	16.3	361.0	0.060	22.3	391.0	0.979	449.0	6,120.0

(1) See Plates II-A, 11-B, IV-A, and IV-B for locations of Mine Drainage Discharge Points.

EXHIBIT F

Commonwealth of Pennsylvania

Department of Environmental Resources

Mine Drainage Abatement Measures

for the Shamokin Creek Watershed

DESIGN AVERAGE MINE DRAINAGE VOLUMES

IN ORDER OF MAGNITUDE

Rank	Discharge Point(l)	Volume (mgd)	Cumulative Volume (mgd)	Percent of Total Volume
1	19	7.760	7.760	19.3
2	12	7.040	14.800	36.8
3	49	6.340	21.140	52.6
4	5	3.615	24.755	61.6
5	51	2.940	27.695	68.9
6	53	2.420	30.115	74.9
7	21	2.050	32.165	80.0
8	20	2.050	34.215	85.1
9	36	1.570	35.785	89.0
10	23	1.110	36.895	91.8
11	15	0.625	37.520	93.4
12	42	0.608	38.128	94.9
13	29	0.382	38.510	95.9
14	38	0.216	38.726	
15	40	0.190	38.916	
16	11	0.130	39.046	
17	48	0.130	39.176	
18	44	0.121	39.297	
19	50	0.100	39.397	98.1
20	27	0.083	39.480	
21	22	0.080	39.560	
22	10	0.077	39.637	
23	26	0.068	39.705	
24	46	0.067	39.772	99.1
25	52	0.060	39.832	
26	24	0.057	39.889	
27	39	0.047	39.936	99.5
28	54	0.038	39.974	
29	45	0.029	40.003	
30	9	0.024	40.027	
31	43	0.024	40.051	
32	25	0.024	40.075	
33	30	0.015	40.090	
34	28	0.011	40.101	
35	18	0.008	40.109	
36	41	0.005	40.114	

Rank	**Discharge Point(l)**	**Volume (mgd)**	**Cumulative Volume (mgd)**	**Percent of Total Volume**
37	47	0.003	40.117	
38	17	0.002	40.119	
39	7	0.001	40.120	100.0
40	8	0.000	40.120	
41	16	0.000	40.120	
42	37	0.000	40.120	100.0

(1) See Plates II-A, II-B, IV -A, and IV-B for locations of Mine Drainage Discharge Points.

EXHIBIT G

Commonwealth of Pennsylvania

Department of Environmental Resources

Mine Drainage Abatement Measures
for the Shamokin Creek Watershed

DESIGN AVERAGE MINE DRAINAGE IRON QUANTITIES
IN ORDER OF MAGNITUDE

Rank	Discharge Point(l)	Iron (lbs/day)	Cumulative Iron (lbs/day)	Percent of Total Iron
1	19	3,590.0	3,590.0	20.1
2	12	3,460.0	7,050.0	39.4
3	49	2,530.0	9,580.0	53.5
4	51	2,260.0	11,840.0	66.1
5	53	1,700.0	13,540.0	75.6
6	5	1,245.0	14,785.0	82.6
7	21	1,060.0	15,845.0	88.5
8	20	768.0	16,613.0	92.8
9	15	394.0	17,007.0	95.0
10	36	280.0	17,287.0	
11	23	184.0	17,471.0	97.6
12	42	170.0	17,641.0	
13	50	63.8	17,704.8	99.0
14	52	57.6	17,762.4	
15	29	43.4	17,805.8	99.5
16	22	19.4	17,825.2	
17	54	16.3	17,841.5	
18	48	15.2	17,856.7	
19	9	10.6	17,867.3	
20	10	10.2	17,877.5	
21	11	4.2	17,881.7	
22	40	2.4	17,884.1	
23	39	2.2	17,886.3	
24	44	2.1	17,888.4	
25	27	0.7	17,889.1	
26	24	0.6	17,889.7	
27	28	0.6	17,890.3	
28	26	0.4	17,890.7	
29	43	0.3	17,891.0	
30	41	0.3	17,891.3	
31	46	0.3	17,891.6	
32	25	0.2	17,891.8	
33	18	0.2	17,892.0	
34	45	0.2	17,892.2	
35	38	0.2	17,892.4	

Rank	**Discharge Point(l)**	**Iron (lbs/day)**	**Cumulative Iron (lbs/day)**	**Percent of Total Iron**
36	47	0.1	17,892.5	
37	30	0.1	17,892.6	
38	17	0.1	17,892.7	100.0
39	7	0.0	17,892.7	
40	8	0.0	17,892.7	
41	37	0.0	17,892.7	
42	16	0.0	17,892.7	100.0

(1) See Plates II -A, II -B, IV-A, and IV -B for locations of Mine Drainage Discharge Points.

EXHIBIT H

Commonwealth of Pennsylvania

Department of Environmental Resources

Mine Drainage Abatement Measures
for the Shamokin Creek Watershed

DESIGN AVERAGE MINE DRAINAGE, ACID QUANTITIES
IN ORDER OF MAGNITUDE

Rank	Discharge Point(1)	Acid (lbs/day)	Cumulative Acid (lbs/day)	Percent of Total Acid
1	51	13,200.0	13,200.0	18.6
2	53	11,200.0	24,400.0	34.4
3	12	10,900.0	35,300.0	49.7
4	19	10,000.0	45,300.0	63.8
5	5	7,850.0	53,150.0	74.8
6	49	7,670.0	60,820.0	85.6
7	20	3,160.0	63,980.0	90.1
8	23	1,570.0	65,550.0	92.3
9	15	1,510.0	67,060.0	94.4
10	21	770.0	67,830.0	95.5
11	11	483.0	68,313.0	
12	42	381.0	68,694.0	
13	54	361.0	69,055.0	
14	50	355.0	69,410.0	
15	52	318.0	69,728.0	98.1
16	10	247.0	69,975.0	
17	29	223.0	70,198.0	
18	9	144.0	70,342.0	
19	46	115.0	70,457.0	99.1
20	27	114.0	70,571.0	
21	24	76.1	70,647.1	
22	26	73.8	70,720.9	99.5
23	22	66.8	70,787.7	
24	36	65.5	70,853.2	
25	43	58.1	70,911.3	
26	38	45.1	70,956.4	
27	25	32.0	70,988.4	
28	40	31.7	71,020.1	
29	30	26.3	71,046.4	
30	28	13.8	71,060.2	
31	39	13.7	71,073.9	
32	44	10.1	71,084.0	
33	47	8.3	71,092.3	
34	7	1.2	71,093.5	100.0
35	17	0.0	71,093.5	
36	48	0.0	71,093.5	

Rank	**Discharge Point(l)**	**Acid (lbs/day)**	**Cumulative Acid (lbs/day)**	**Percent of Total Acid**
37	41	0.0	71,093.5	
38	45	0.0	71,093.5	
39	18	0.0	71,093.5	
40	8	0.0	71,093.5	
41	37	0.0	71,093.5	
42	16	0.0	71,093.5	100.0

(1) See Plates II -A, II -B, IV -A, and IV -B for locations of Mine Drainage Discharge Points.

<u>**EXHIBIT I**</u>

Commonwealth of Pennsylvania
Department of Environmental Resources

Mine Drainage Abatement Measures
for the Shamokin Creek Watershed

CONSTITUENTS AND CHARACTERISTICS OF

<u>**VARIOUS WATERSHED STREAMS**</u>

Stream Sampling Station(l)	pH			Total Iron (mg/l)			Alkalinity (as $CaCO_3$) (mg/l)			Acidity (as $CaCO_3$) (mg/l)			Sulfate (mg/l)			Aluminum (mg/l)	Manganese (mg/l)	Total Solids (mg/l)
	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Average	Average
S-1	3.2	3.2	3.1	8.0	10.7	4.4	0	0	0	143	152	128	561	682	490	-	-	-
S-2	3.1	3.2	3.1	17.1	24.3	9.0	0	0	0	156	184	112	588	682	50	-	-	-
S-3	3.2	3.3	3.1	22.2	25.7	14.7	0	0	0	178	192	164	593	606	528	-	-	-
T-l	6.8	8.4	5.9	0.7	1.5	0.3	11	32	0	8	16	0	57	88	30	1.8	0.4	174
LK-l	6.7	7.3	5.5	0.6	1.6	0.1	9	40	0	7	24	0	17	42	12	1.8	0.2	85
M-l	6.8	7.2	5.4	0.5	1.4	0.1	1	4	0	8	24	0	11	15	8	0.1	0.1	105
B-1	6.4	6.7	5.6	0.8	1.9	0.4	1	4	0	11	24	0	12	21	9	0.1	0.2	91
S-4	3.2	3.4	3.1	32.2	43.6	21.8	0	0	0	169	204	128	588	670	508	6.1	7.1	1,287
T-2	6.6	7.0	5.3	0.6	1.5	0.2	0	0	0	16	32	4	24	84	8	3.7	0.1	83
TR-l	6.7	7.6	6.5	0.3	0.8	0.1	0	0	0	12	28	0	13	28	6	0.1	0.1	78
S-5	3.3	3.6	3.1	42.4	94.0	29.2	0	0	0	169	216	104	600	690	500	5.1	7.8	1,909
S-6	4.3	6.1	3.3	38.4	115.3	19.8	0	0	0	86	104	52	476	530	368	4.6	2.5	882
F-l	6.9	7.5	6.6	2.5	4.7	0.6	56	100	0	2	16	0	71	154	33	1.3	0.2	452
S-7	3.5	4.3	3.2	37.6	126.2	1.6	0	0	0	124	168	92	497	590	492	1.8	6.2	1,072
CA-l	3.5	4.5	3.3	40.1	78.7	17.3	0	0	0	81	116	52	556	672	476	1.7	6.1	1,036
CA-2	3.8	4.1	3.3	2.9	7.8	0.6	0	0	0	79	100	60	263	352	134	5.6	3.9	461
S-8	3.5	4.7	3.2	42.1	178.9	14.2	0	0	0	110	148	60	528	640	438	3.3	6.6	945
CO-l	6.5	7.5	4.8	10.2	20.9	5.5	10	40	0	9	56	0	262	490	184	2.6	2.5	533
S-9	3.1	3.3	2.9	35.6	70.5	16.7	0	0	0	146	192	120	604	672	470	3.9	6.5	1,094
0-1	3.1	3.2	3.0	43.8	106.3	29.1	0	0	0	115	152	88	652	710	464	2.1	8.2	1,159
0-2	3.3	5.9	3.0	48.2	95.6	30.9	0	0	0	140	188	44	604	682	114	1.8	4.8	1,190
0-3	6.9	7.1	6.3	5.5	10.6	3.7	65	112	12	0	0	0	55	86	21	5.4	1.1	399
S-lO	3.1	3.4	2.9	39.2	79.8	18.5	0	0	0	154	212	92	540	642	258	6.4	7.0	870
S-11	3.1	3.4	3.0	39.2	87.4	20.9	0	0	0	149	200	92	497	640	284	7.0	6.8	970
S-12	4.1	6.4	3.3	18.8	36.5	5.2	0	0	0	135	240	16	372	770	130	7.6	5.6	746
L-l	3.6	4.4	3.2	1.8	3.8	0.7	0	0	0	135	216	64	353	440	202	4.2	1.3	550
S-13	4.1	6.5	3.1	15.6	33.4	2.8	0	0	0	172	408	16	410	670	130	8.3	6.3	709
NB-l	3.2	3.4	3.0	22.6	35.4	3.8	0	0	0	203	288	132	469	710	328	9.2	6.4	739
NB-2	3.1	3.5	3.0	34.8	45.4	19.5	0	0	0	255	312	200	456	590	380	11.8	6.4	715
S-14	6.9	7.2	6.7	2.7	3.8	1.3	40	108	0	2	16	0	65	120	34	0.1	0.2	733

(1) See Plates I, II-A, and II-B for locations of Stream Sampling Stations.

EXHIBIT J

Commonwealth of Pennsylvania
Department of Environmental Resources

Mine Drainage Abatement Measures
For the Shamokin Creek Watershed

PERTINENT DESIGN AND COST DATA FOR THE

RECOMMENDED ABATEMENT PLAN

	Estimated Mine Drainage Reduction				Average Annual Cost						Cost For 300 Years	
					First 30 Years			Next 270 Years				
	Volume (mgd)	Iron (lbs/ day)	Acid (Ibs/ day)	Project Cost	Fixed	Operation and Maintenance	Per Ton of Acid Removed (2)	Fixed	Operation and Maintenance	Per Ton of Acid Removed (2)	Total	Per Ton of Acid Removed (2)
I. Preventive Measnres (1)												
1. Coal Run-Clear 12,152 feet of stream channel; line 14,210 feet of stream channel; reconstruct 10,425 feet of stream channel; construct 22,455 feet of surface water diversion ditches; restore five strip mines and a portion of another comprising 39 acres; remove a portion of a refuse bank	0.350	249.2	1,516.0	$ 377,200.	$ 27,410.	$ 14,602.	$152.	$ 1,503.	$ 13,341.	$ 53.59	$ 5,266,100.	$ 63.37
2. North Branch of Shamokin Creek-Clear 4,580 feet of stream channel; reconstruct and line 21,470 feet of stream channel; construct 21,480 feet of surface water diversion ditches; restore 6.9 acres of a strip mine; shore one deep mine entry	0.852	311.0	1,433.6	$ 394,000.	$ 28,633.	$ 12,714.	$158.	$ 5,113.	$ 12,144.	$ 65.87	$ 5,899,320.	$ 75.00
3. Carbon and Furnace Runs Reconstruct and line 8,160 feet of stream channel; reconstruct and line 5,280 feet of surface water diversion ditches and stream channel; construct 12,920 feet of surface water diversion ditches; clean and repair 3,200 feet of existing flumes; restore two strip mines comprising 12.6 acres; restore a 69 acre refuse area; restore one 6.3 acre sub sidence area	0.888	347.4	1,291.8	$ 1,162,800.	$ 84,550.	$ 15,889.	$426.	$ 2,956.	$ 5,974.	$ 38.00	$ 5,424,300.	$ 77.00

Exhibit J (Continued)

Page 2

	Estimated Mine Drainage Reduction				Average Annual Cost						Cost For 300 Years	
					First 30 Years			Next 270 Years				
	Volume (mgd)	Iron (lbs/ day)	Acid (lbs/ day)	Project Cost	Fixed	Operation and Maintenance	Per Ton of Acid Removed (2)	Fixed	Operation and Maintenance	Per Ton of Acid Removed (2)	Total	Per Ton of Acid Removed (2)
Preventive Measures (Cont.)												
4. Locust Creek-Clear 8,925 feet of stream channel; reconstruct and line 17,520 feet of stream channel; construct 10,420 feet of surface water diversion ditch; restore a 3.13 acre test area; restore a 44 acre refuse area	0.367	63.5	1,146.8	$ 595,200.	$ 43,242.	$ 10,983.	$259.	$ 2,295.	$ 7,666.	$ 47.66	$ 4,316,000.	$ 68.84
5. Tributary of Sham ok in Creek near Excelsior Village Reconstruct and line 8,925 feet of stream channel; place 405 feet of reinforced concrete pipe; reopen culvert under a private road	0.543	266.7	838.0	$ 149,000.	$ 10,823.	$ 400.	$ 73.35	$ 2,600.	$ 400.	$ 19.61	$ 1,146,700.	$ 25.00
6. Headwaters of Shamokin Creek-Reconstruct and line 6,070 feet of stream channel; place 120 feet of reinforced concrete pipe	0.277	122.4	372.0	$ 131,000.	$ 9,517.	$ 214.	$143.	$ 777.	$ 214.	$ 14.60	$ 559,500.	$ 27.46
7. Quaker Run-Reconstruct and line 740 feet of stream channel; restore two strip mines comprising 23 acres; restore a one acre portion of a subsidence area	0.126	61.4	229.0	$ 163,500.	$ 11,917.	$ 1,751.	$327.	$ 73.	$ 20.	$ 2.92	$ 435,000.	$ 34.69
Subtotal	3.403	1,421.6	6,827.2	$ 2,972,700.	$216,092.	$ 56,553.	$219.	$ 15,317.	$ 39,759.	$ 44.00	$ 23,055,000.	$ 62.00

Exhibit J (Continued)

	Estimated Mine Drainage Reduction				Average Annual Cost							
					First 30 Years			Next 270 Years			Cost For 300 Years	
	Volume (mgd)	Iron (tons/ day)	Acid (tons/ day)	Project Cost	Fixed	Operation and Maintenance	Per Ton of Acid Removed (2)	Fixed	Operation and Maintenance	Per Ton of Acid Removed (2)	Total	Per Ton of Acid Removed (2)
II. Collection Systems and Treatment Measures (1)												
1. Collection System Three boreholes, each with casing and pump				$ 191,250.	$ 13,894.	$ 15,310.		$ 8,173.	$ 15,310.		$ 7,216,500.	
Treatment Measures One plant located along Shamokin Creek north of and 500 feet downstream from Shamokin City with design loadings of 5.054 mgd, 1.87 tons per day iron and 11.48 tons per day acid				$ 2,036,000.	$147,915.	$ 232,044.		$ 109,683.	$ 232,044.		$ 103,665,000.	
2. Collection System 2,700 feet of PVC pressure pipe; 340 feet of lined channel; three boreholes, each with casing and pump; breach barrier pillar between two major underground mine water pools				$ 530,730.	$ 38,394.	$ 66,761.		$ 23,439.	$ 66,761.		$ 27,508,500.	
Treatment Measures One plant located along Shamokin Creek at approximately 2,500 feet southwest of Strong Village with design loadings of 12.101 mgd, 2.56 tons per day iron and 9.51 tons per day acid				$ 2,133,450.	$154,995.	$ 254,608.		$154,995.	$ 254,608.		$ 122,880,900.	
3. Collection System 10,170 feet of conveyance sewers; 1000 feet of PVC pressure pipe; three bore holes with casings				$1,108,707.	$ 75,286.	$ 31,063.		$ 61,126.	$ 31,063.		$ 28,081,500.	

	Estimated Mine Drainage Reduction				Average Annual Cost						Cost For 300 Years	
					First 30 Years			Next 270 Years				
	Volume (mgd)	Iron (tons/ day)	Acid (tons/ day)	Project Cost	Fixed	Operation and Maintenance	Per Ton of Acid Removed (2)	Fixed	Operation and Maintenance	Per Ton of Acid Removed (2)	Total	Per Ton of Acid Removed (2)
Collection Systems And Treatment Measnres (Cont.)												
Treatment Measures												
One plant located along Shamokin Creek at approximately 500 feet upstream from Brady Village with design loadings of 10.708 mgd, 2.46 tons per day iron and 6.18 tons per day acid				$ 1,963,500.	$142,648.	$ 209,785.		$142,648.	$ 209,785.		$105,729,900.	
4. Collection System												
3,400 feet of conveyance sewer; 2,660 feet of PVC pressure pipe; eight boreholes, each with casing and pump				$ 871,613.	$ 61,947.	$ 35,886.		$ 41,859.	$ 35,886.		$ 23,926,200.	
Treatment Measures												
One plant located along Shamokin Creek southeast of and 500 feet upstream from Shamokin City with design loadings of 7.305 mgd, 1.25 tons per day iron and 4.53 tons per day acid				$ 1,610,400.	$116,996.	$ 173,347.		$ 116,996.	$ 173,347.		$ 87,102,900.	
Subtotal	35.10	7.54	31.70	$10,445,650.	$752,075.	$1,018,804.	$153.	$ 658,919.	$1,018,804.	$145.	$506,111,400.	$146.
III. Total For Preventive Measures, Collection Systems and Treatment Measures	38.50	8.25	35.11	$13,418,350.	$968,167.	$1,075,357.	$159.	$674,236.	$1,058,563.	$135.	$529,166,400.	$138.

(1) See Plates IV -A and IV -B for locations of Preventive Measures, Collection Systems and Treatment Measures.
(2) Calculated on basis of Design Average conditions.

EXHIBIT K

Commonwealth of Pennsylvania

Department of Environmental Resources

Mine Drainage Abatement Measures for the Shamokin Creek Watershed

MINE DRAINAGE DISCHARGE POINTS AFFECTED BY THE RECOMMENDED ABATEMENT PLAN

Abatement Measures (1)	Discharge Point Eliminated (2)	Discharge Point Reduced (2)	Discharge Point Treated (2)	Design Average Pollution Loads Abated: Volume (mgd)	Iron (tons/day)	Acid (tons/day)
Preventive Measures						
1. Headwaters area of Shamokin Creek. Reconstruct and line 6,070 feet of stream channel; and place 120 feet of pipe.		19,20		0.277	0.061	0.186
2. Tributary of Shamokin Creek near Excelsior Village. Reconstruct and line 8,925 feet of stream channel; place 405 feet of pipe; and reopen one culvert.		12		0.543	0.133	0.419
3. Coal Run. Reconstruct 7,465 feet, clear 12,152 feet, and line 14,210 feet of stream channel; construct 22,455 feet of surface-water diversion ditches; remove a portion of a refuse area; and restore six strip mines comprising 39 acres.	31	19,20,50 51,52,53		0.350	0.125	0.758
4. North Branch of Sham ok in Creek. Reconstruct and line 21,470 feet, and clear 4,580 feet of stream channel; construct 21,480 feet of surface-water diversion ditches; shore one deep mine entry; and restore 6.9 acres of one strip mine.		5,19,20		0.852	0.156	0.717
5. Locust Creek. Reconstruct and line 17,520 feet, and clear 8,925 feet of stream channel; construct 10,420 feet of surface-water diversion ditches; restore one 3.13 acre test area; and restore one 44 acre refuse area.	9,10,11	12, Mahanoy Creek		0.367	0.032	0.573

Exhibit K (Continued)

Abatement Measures (1)	Discharge Point Eliminated (2)	Discharge Point Reduced (2)	Discharge Point Treated (2)	Design Average Pollution Loads Abated Volume (mgd)	Iron (tons/day)	Acid (tons/day)
6. Quaker Run. Reconstruct and line 740 feet of stream channel; restore two strip mines comprising 23 acres; and restore a one acre part of a subsidence area.		19,20,50, 51,52,53		0.126	0.031	0.114
7. Carbon and Furnace Runs. Reconstruct and line 13,440 feet of stream channel; construct 12,920 feet of surface.water diversion ditches; clean and repair 3,200 feet of flumes; restore one 69 acre refuse area; restore five strip mines comprising 63.6 acres; and restore one 6.3 acre subsidence area.	43,46,47	49,50,51, 52,53		0.888	0.174	0.646
Subtotal				3.403	0.71	3.41
Treatment Measures						
1. Collect and treat at 2,500 feet southwest of Strong Village			5,19,20	12.101	2.35	9.51
2. Collect and treat at 500 feet upstream from Brady Village			12,15,21, 36	10.708	2.28	6.18
3. Collect and treat at 500 feet upstream from Shamokin City			23,24,25, 26,27,29, 49	7.305	1.13	4.53
4. Collect and treat at 500 feet downstream from Shamokin City			50,51,52, 53	5.054	1.78	11.48
Subtotal				35.168	7.54	31.70
Total				38.571	8.25	35.11

(1) See Plates][V -A and IV -B for locations of Abatement Measures.
(2) See Plates IV -A and IV -B for locations of affected Mine Drainage Discharge Points.

EXHIBIT L

Commonwealth of Pennsylvania
Department of Environmental Resources

Mine Drainage Abatement Measures for the Shamokin Creek Watershed

ANTICIPATED CONSTITUENTS AND CHARACTERISTICS OF VARIOUS WATERSHED STREAMS

Stream Sampling Station(1)	pH			Total Iron (mg/l)			Alkalinity (as $CaCO_3$) (mg/l)			Acidity (as $CaCO_3$) (mg/l)		
	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum
S-1	6.7	7.2	6.0	0.8	2.0	0.4	16	30	4	0	0	0
S-2	6.8	7.3	6.2	1.0	2.2	0.5	20	36	6	0	0	0
S-3	6.9	7.4	6.3	1.2	2.5	0.6	24	40	8	0	0	0
T-l	6.8	8.4	5.9	0.7	1.5	0.3	11	32	0	8	16	0
LK-l	6.7	7.3	5.5	0.6	1.6	0.1	9	40	0	7	24	0
M-l	6.8	7.2	5.4	0.5	1.4	0.1	1	4	0	8	24	0
B-1	6.4	6.7	5.6	0.8	1.9	0.4	1	4	0	11	24	0
SA	7.0	7.5	6.5	1.5	2.9	0.8	30	55	10	0	0	0
T-2	6.6	7.0	5.3	0.6	1.5	0.2	0	0	0	16	32	4
TR-l	6.7	7.6	6.5	0.3	0.8	0.1	0	0	0	12	28	0
S-5	7.2	7.7	6.7	2.0	3.4	1.2	32	60	12	0	0	0
S-6	7.0	7.5	6.5	1.5	2.8	0.8	29	55	10	0	0	0
P-l	6.9	7.5	6.6	2.5	4.5	1.2	50	75	20	0	0	0
S-7	7.1	7.6	6.6	1.8	3.2	1.0	28	50	10	0	0	0
CA-l	7.0	7.4	6.5	7.5	12.0	3.6	18	30	4	0	0	0
CA-2	5.0	5.6	4.4	2.0	5.2	0.5	0	0	0	20	36	10
S-8	7.3	7.8	6.8	2.0	3.2	1.0	30	55	10	0	0	0
CO-l	7.0	7.6	6.5	1.0	1.5	0.4	40	65	15	0	0	0
S-9	7.2	7.7	6.7	1.5	2.8	0.8	30	50	10	0	0	0
0-1	7.8	8.4	7.4	1.0	1.5	0.6	70	100	30	0	0	0
0-2	7.0	7.4	6.4	2.8	6.2	1.4	60	105	30	0	0	0
0-3	6.9	7.1	6.3	5.0	8.8	3.2	60	110	28	0	0	0
S-1O	7.1	7.6	6.6	1.9	3.2	1.0	22	35	10	0	0	0
S-11	6.9	7.4	6.4	1.6	2.8	0.7	17	30	4	0	0	0
S-12	7.0	7.5	6.5	2.5	3.6	1.2	20	32	8	0	0	0
L-l	4.0	4.6	3.6	3.2	5.5	1.5	0	0	0	50	70	25
S-13	7.3	7.8	6.8	3.4	5.0	1.8	24	36	10	0	0	0
NB-l	5.0	5.6	4.4	1.2	2.5	0.6	0	0	0	20	32	8
NB-2	4.8	5.4	4.0	1.6	3.2	0.8	0	0	0	24	36	12
S-14	6.7	7.5	6.5	2.5	3.5	1.2	30	45	10	0	0	0

(l) See Plates I, II -A, and II -B for locations of Stream Sampling Stations.