MANGANESE REMOVAL AT A LOWER pH WITH TRAPZENE: RESULTS OF FIELD TRIALS

by

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The trapzene field trial was performed at Robinson Phillips Coal Company refuse site near Marianna, in Wyoming County, West Virginia. This site historically experienced acid mine drainage problems for fifteen (15) to twenty (20) years. The site has refuse from the Sewell, Gilbert, and Red Ash coal seams mined in Wyoming County. The Red Ash coal seam refuse is believed to be the source of acid mine drainage, which was the first refuse material to be disposed at the site. Total sulfur on the Red Ash coal seam ranges from 0.7 to 1.3 percent, with the pyritic sulfur being approximately 0.6 to 0.9 percent.

Water emanating from the pile ranges from 3.2 to 3.8 in pH, acidity 99.6 to 170.6 mg/L, iron 21.1 to 29.4 mg/L, manganese 12.5 to 14.3 mg/L, aluminum 3.2 to 4.1 mg/L, sulfates 680 to 2,054 mg/L, conductivity 1,845 to 1,996 u/cm, dissolved solids 1,145 to 1,378 mg/L, calcium 171 to 209 mg/L, and magnesium 90 to 120 mg/L.

Two (2) sumps were selected for monitoring the treatment with trapzene. The water from these sumps discharged into two (2) ponds where more treatment could be performed utilizing caustic, if needed, to insure compliance with the NPDES program. The sumps were chosen for primarily three (3) reasons.

1. To see if trapzene could effectively remove metals,
2. To see if trapzene alone could neutralize the acid mine drainage, and
3. To compare sludge generation to sodium hydroxide treatment.

A ten (10) percent slurry of trapzene was used to obtain a 0.25 g/liter dosage proportional to flow in order to duplicate lab tests performed by West Virginia University. A skid was set up at the site which contained a mixer to constantly mix the trapzene slurry, and an air pump was used to feed the trapzene into the acid mine drainage. An existing small mixing box was utilized to give the slurry contact more time and better mixing with the acid mine drainage. The treatment was started on May 29, 1991, and the sumps were sampled on May 30, 1991; eighteen (18) hours after the slurry of trapzene was introduced in the raw water entering Sump 1. The pH of the water going into the sump was regulated at 6.0 to see if oxidation of manganese could be achieved at a lower pH than normally used for manganese removal.

The pH of the Sump 1 discharge was 7.0, with no measurable acidity. Iron was 4.2 mg/L, manganese 2.6 mg/L, aluminum 2.0 mg/L, and alkalinity 53.0 mg/L. The Sump 2 discharge has a pH of 7.2, with no measurable acidity, iron 1.0 mg/L, manganese 1.6 mg/L, aluminum 1.2 mg/L, and alkalinity 48.0 mg/L. Data similar to this was collected on June 4 and 5, 1991,

as shown on the data sheet.

On June 6, 1991, the trapzene flow was cut back to see at what point the manganese level would rise out of compliance according to the NPDES standard of 2.0 mg/L. The pH at the point of treatment was near 5.0. Sump I at the discharge point, proved to have a 6.2 pH, with no measurable acidity, iron 3.5 mg/L, manganese 4.9 mg/L, alkalinity 52.2 mg/L, and aluminum 1.7 mg/L. Sump 2 discharge proved to have a 6.3 pH, with no measurable acidity, iron 0.8 mg/L, manganese 3.8 mg/L, alkalinity 37.4 mg/L, and aluminum 1.1 mg/L. The treatment rate was maintained, and samples were collected from the sumps, which again almost duplicated the data on June 7, 1991.

After reviewing the analytical data and observing the sludge generation, it was concluded that:

1. Metals did precipitate, and at a lower pH manganese was removed,
2. Acid neutralization was achieved, and
3. Sump 1 was approximately one-third full of sludge after a ten (10) day trial. (These sumps had to be cleaned every two (2) weeks when sodium hydroxide was used.) Sludge production was reduced substantially (60 - 70 percent), and a more stable and compact sludge was produced.

Westover, Pennsylvania

The site consists of a small, heated shed located between two (2) retention ponds located at the base of an old coal strip mined hill side. The upstream pond acts as a reservoir for a seep of acid runoff from the immediate hillside as well as a control point for several upstream ponds acting as similar collection points. The downstream pond acts as a reaction vessel and sludge settling basin for treated water. The shed has been historically used as a metering and mixing point for caustic treatment of the water as well as a testing area for briquet treatment. Within the shed is a concrete channel running down the middle of the floor with a removable weir and a small sump pit at the downstream end of the shed. The sump is drained by a twelve (12) inch PVC elbow with the end pointing to the bottom of the sump. The sump volume was approximately eight (8) cubic feet, and had flow rates of five (5), twenty (20), and fifty (50) gallons per minute.

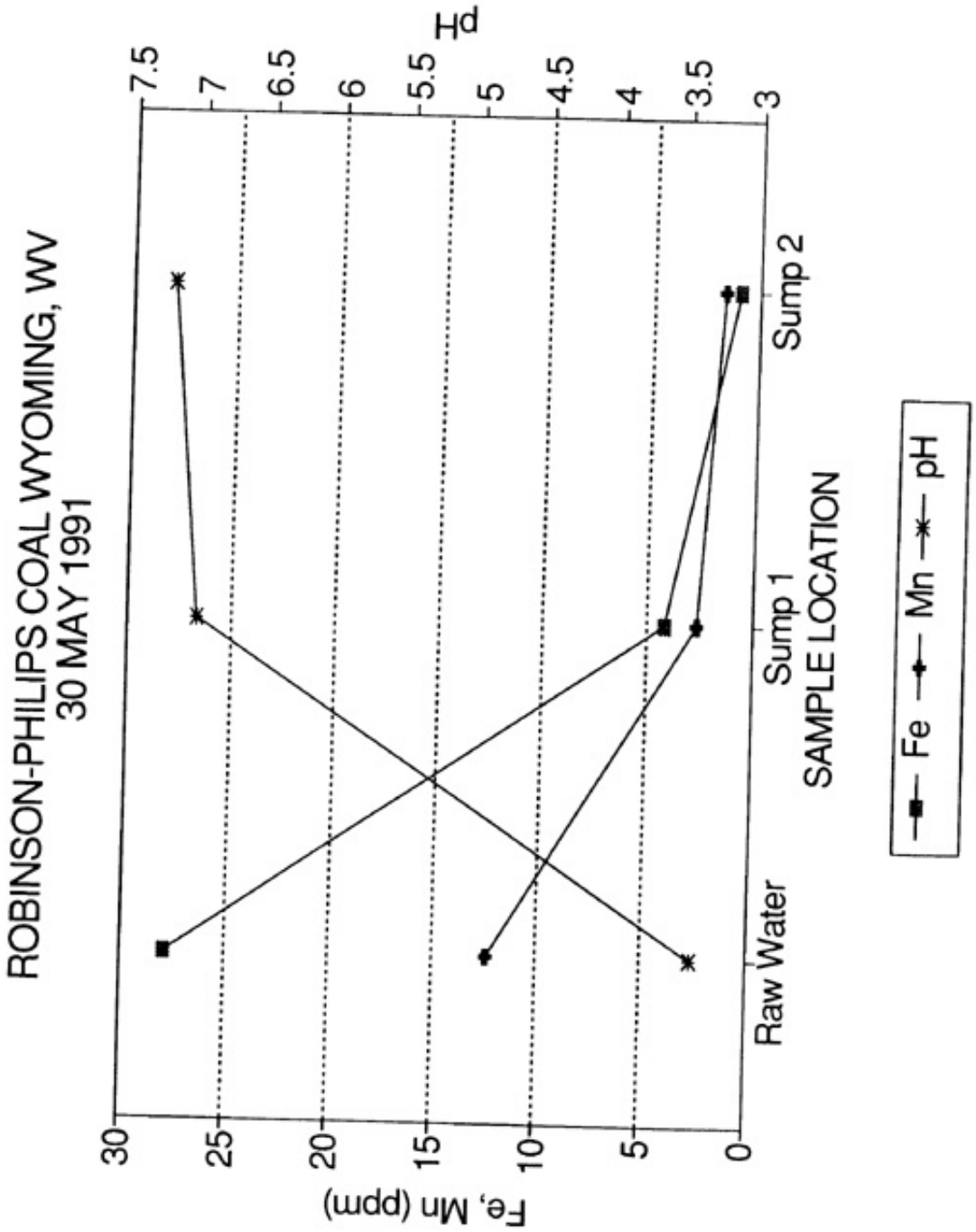
The raw water had a pH of 4.2, with an average metals content of 102.0 mg/L manganese, 0.7 mg/L iron, and 28.0 mg/L aluminum. The acidity averaged 411.0 mg/L. A feed rate of 0.63 grams/liter proved adequate to reduce the metals to an average of 2.66 mg/L manganese, 0.1 mg/L iron, 0.34 mg/L aluminum, and acidity was less than 1.0 mg/L. The pH at the pond discharge averaged 7.94. On one (1) day of the trial, the pH was dropped to 5.5 at the outfall of the pond, and the manganese content rose to 28.4 mg/L. Trapzene was then mixed with water and sprayed on the pond which proved successful in reducing an out of compliance manganese level to meet standard limits within a very short time.

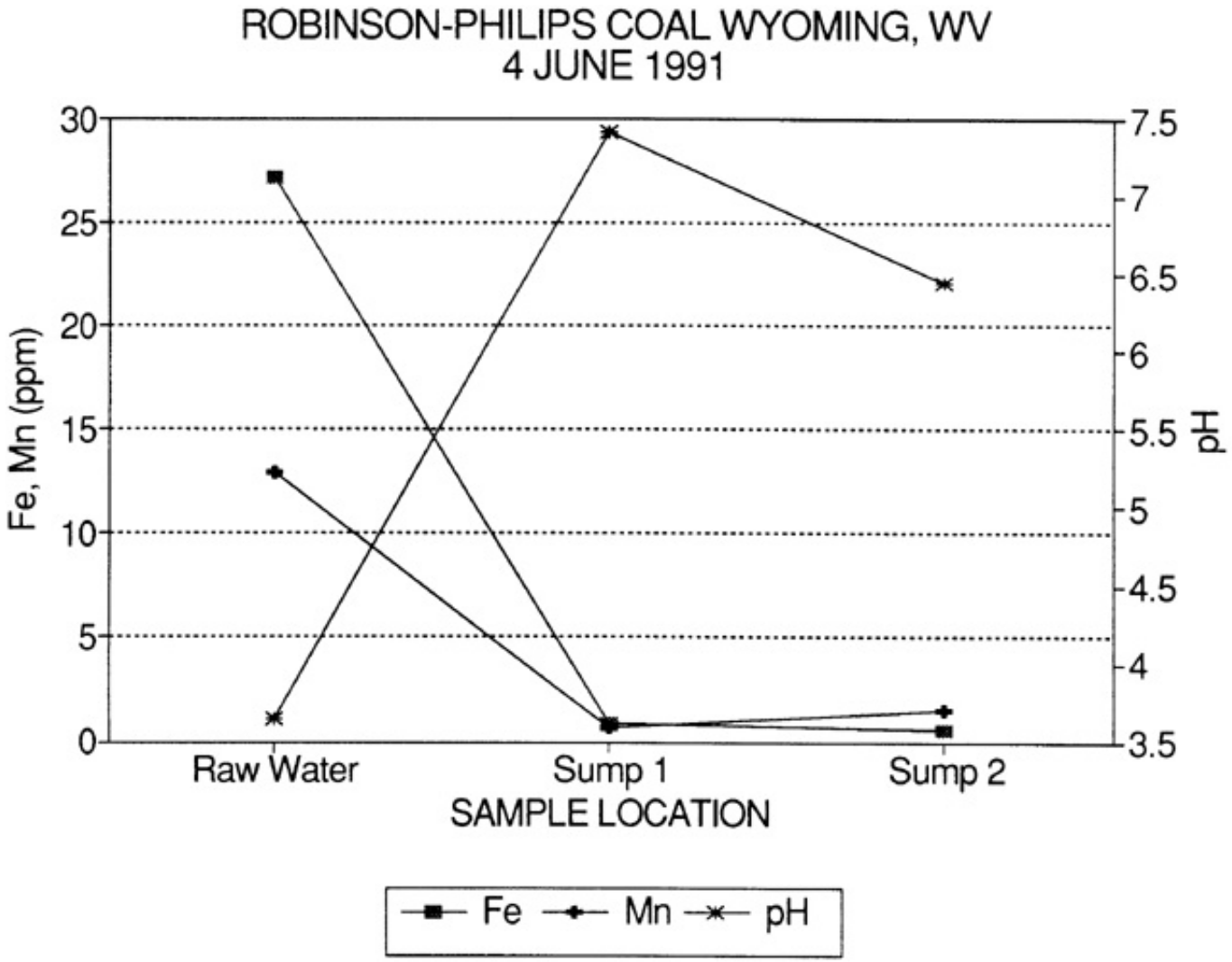
Future Trials

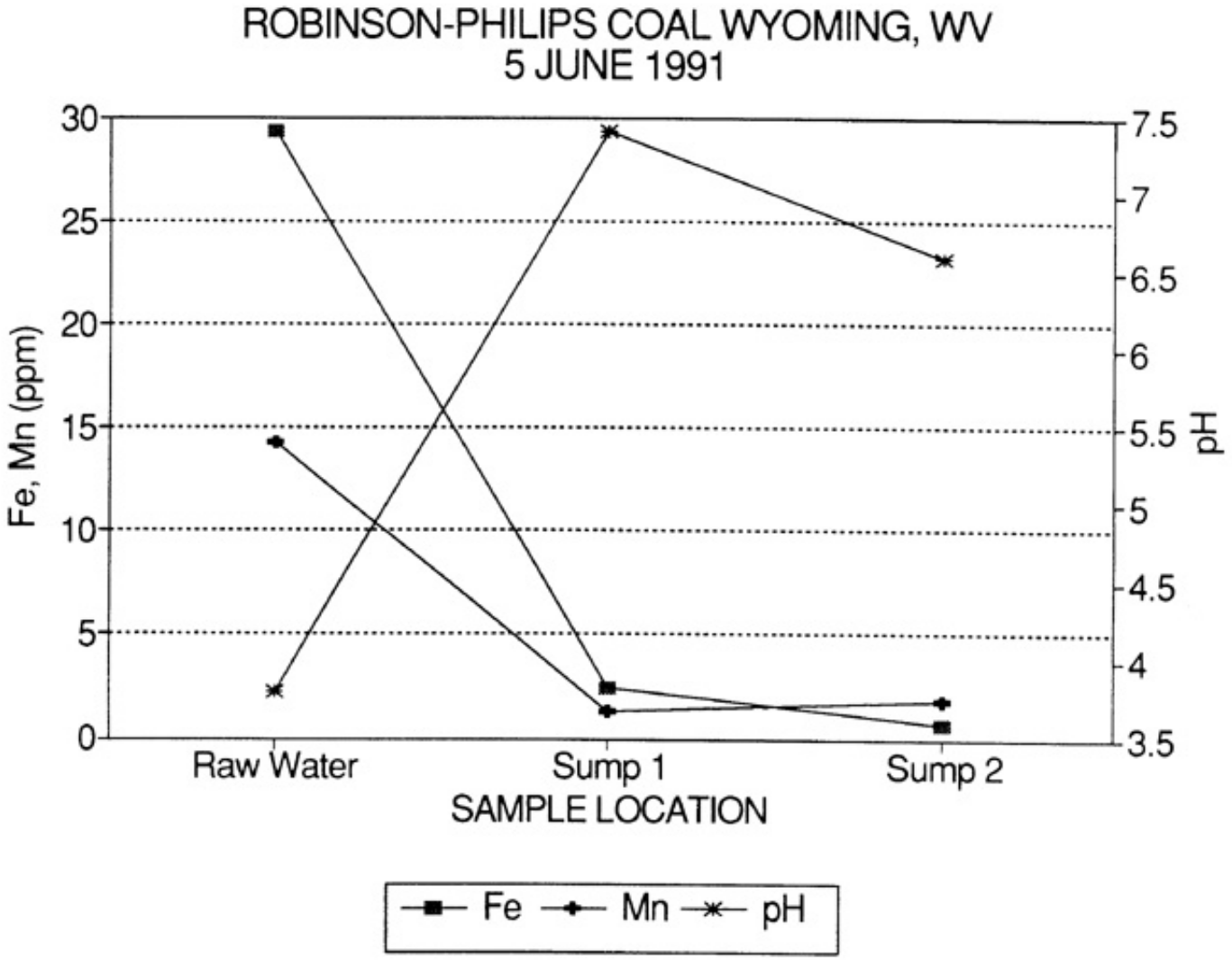
Presently, a trial is being performed at Omega Mining Company near Morgantown, West Virginia. A dry feed system is being utilized instead of the slurry mixture. An in-line aeration

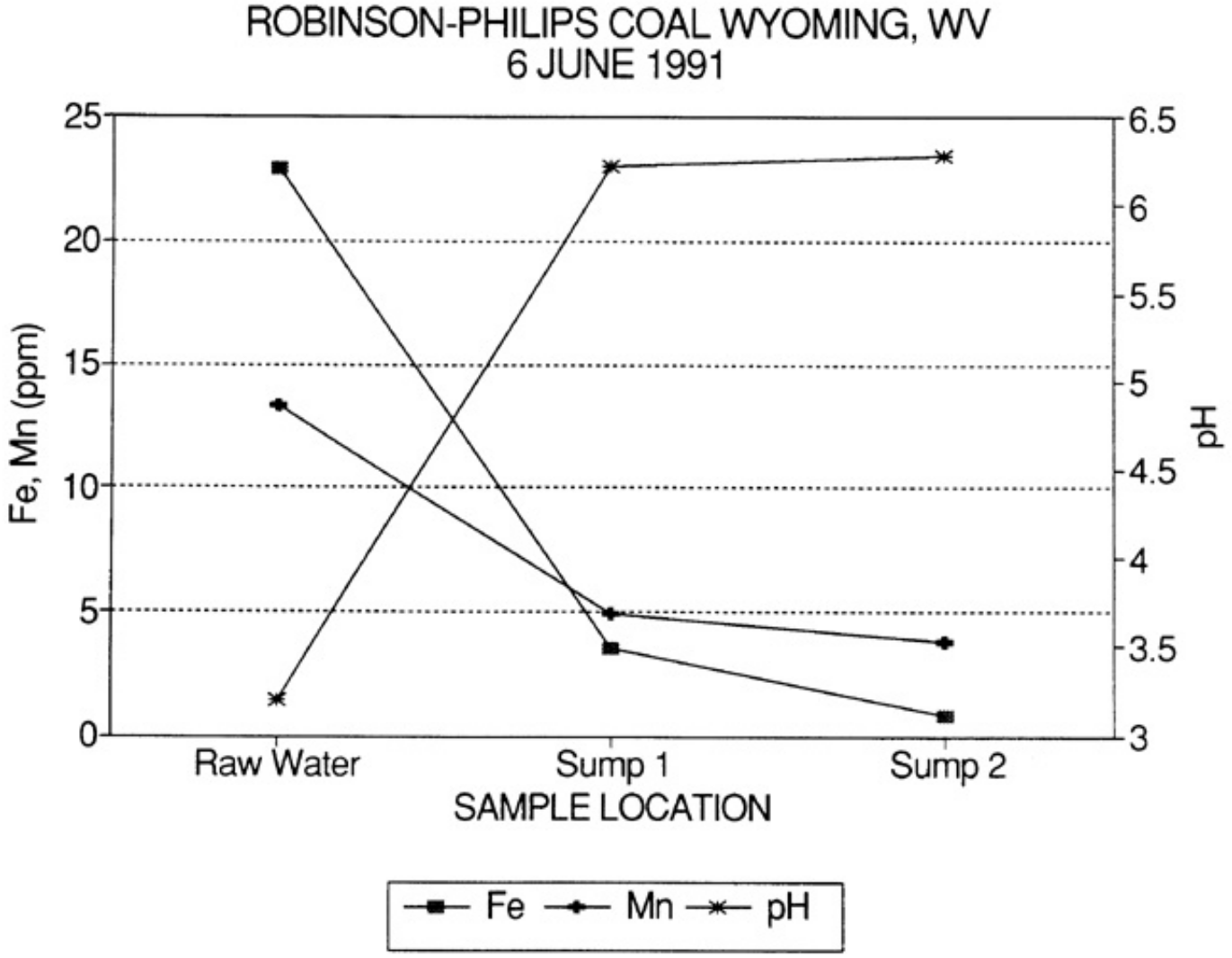
system designed by Techni-Flow, Inc. will also be utilized to see if oxidation is enhanced, and chemical use reduced.

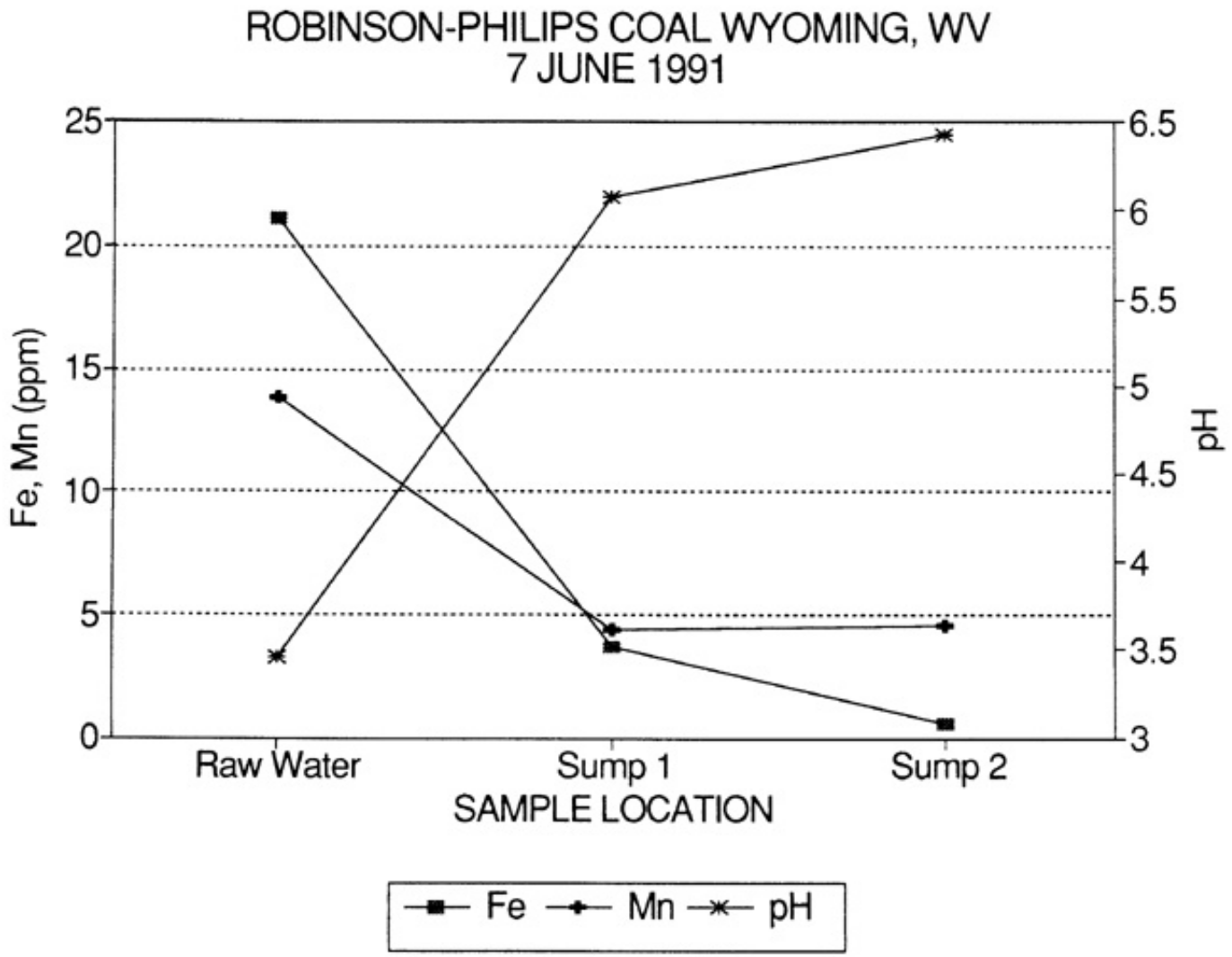
Also, another trial is planned at Shrewsbury Coal Company near Belle, West Virginia, to utilize briquettes for low flow sites. This trial will determine if oxidation of manganese can be achieved especially with sediment ditches of on-bench drainage design. Trapzene briquettes will be available for this trial in approximately two (2) weeks.




ROBINSON-PHILIPS COAL WYOMING, WV
4 JUNE 1991
Fe, Mn (ppm)
pH
30
25
20
15
10
5
0
7.5
7
6.5
6
5.5
5
4.5
4
3.5
Raw Water
Sump 1
Sump 2
SAMPLE LOCATION
Fe
Mn
pH


ROBINSON-PHILIPS COAL WYOMING, WV
5 JUNE 1991
Fe, Mn (ppm)
30
25
20
15
10
5
0
7.5
7
6.5
6
5.5
5
4.5
4
3.5
pH
Raw Water
Sump 1
Sump 2
SAMPLE LOCATION
Fe
Mn
pH


ROBINSON-PHILIPS COAL WYOMING, WV
6 JUNE 1991
25
20
15
10
5
0
Fe, Mn (ppm)
6.5
6
5.5
5
4.5
4
3.5
3
pH
Raw Water
Sump 1
Sump 2
SAMPLE LOCATION
Fe
Mn
pH


ROBINSON-PHILIPS COAL WYOMING, WV
7 JUNE 1991
25
20
15
10
5
0
Fe, Mn (ppm)
6.5
6
5.5
5
4.5
4
3.5
3
pH
Raw Water
Sump 1
Sump 2
SAMPLE LOCATION
Fe
Mn
pH

Robinson-Phillips Coal Company FLOW=150 GPM

Date	Location	Fe ppm	Mn ppm	pH ppm	Acid ppm	Alk. ppm	Al ppm	SO4 ppm	Cond. u/cm	TDS ppm	TSS ppm	Ca ppm	Mg ppm	Lab #
5/30/91	Raw Water	27.9	12.5	3.4	170.6	0.2	3.7	680	1933	1160	24	209	120	91-106911
5/30/91	Sump 1	4.2	2.6	7.0	0.2	53.0	2.0	950	1858	1207	34	236	111	91-106909
5/30/91	Sump 2	1.0	1.6	7.2	0.2	48.0	1.2	760	1836	1230	28	256	99	91-106910
6/04/91	Raw Water	27.2	12.9	3.7	146.6	0.2	4.1	1707	1908	1145	14	179	90	91-107366
6/04/91	Sump 1	1.0	0.7	7.4	0.2	48.2	1.3	1750	1802	1261	30	240	76	91-107367
6/04/91	Sump 2	0.6	1.5	6.5	0.2	36.8	1.0	1701	1749	1189	18	222	78	91-107368
6/05/91	Raw Water	29.4	14.3	3.8	143.6	0.2	4.1	2054	1933	1276	12	177	92	91-107546
6/05/91	Sump 1	2.4	1.3	7.4	0.2	36.2	1.3	1267	1995	1376	36	239	80	91-107547
6/05/91	Sump 2	0.7	1.8	6.6	0.2	48.2	1.1	1247	1825	1260	14	236	94	91-107548
6/06/91	Raw Water	22.9	13.3	3.2	99.6	0.2	3.2	1840	1996	1378	4	175	104	91-107869
6/06/91	Sump 1	3.5	4.9	6.2	0.2	52.2	1.7	2150	1855	1243	8	222	86	91-107870
6/06/91	Sump 2	0.8	3.8	6.3	0.2	37.4	1.1	1493	1834	1247	6	227	78	91-107871
6/07/91	Raw Water	21.1	13.8	3.5	150.6	0.2	3.6	1467	1845	1254	4	171	100	91-107872
6/07/91	Sump 1	3.7	4.4	6.1	0.2	48.0	2.2	1514	1812	1250	22	218	94	91-107873
6/07/91	Sump 2	0.6	4.6	6.4	0.2	40.6	0.8	1425	1779	1246	4	225	80	91-107874

WESTOVER, PENNSYLVANIA

POND OVERFLOW DATA

DAY	DAY#	pH	Mn	Fe	Al	SO4	ACIDITY	ALK.	COND.	S.S.
11/24	20	8.00								
11/15	21	7.80	2.58	0.13	0.3	1676	0	36	4750	4.3
11/16	22	8.20	2.82	0.10	0.4	1230	0	48	4900	3
11/17	23	8.20	2.43	0.13	0.32	1838	0	41	4800	5.7
11/18	24	8.00	2.41	0.13	0.25	1664	0	40	4900	4.7
11/19	25	7.90	2.59	0.09	0.34	2000	0	44	4800	3.3
11/20	26	8.00	3.15	0.12	0.43	1400	0	44	4800	3
11/21	27	7.90	2.79	0.01	0.3	2200	0	46	4700	3.3
11/22	28	7.50	2.68	0.12	0.41	1524	0	38	3900	6.3
11/23	29	5.50	28.4	0.06	1.85	1162	4	10	1880	13.7
AVERAGE		7.94	2.68	0.10	0.34	1692		42	4694	4.2

* DATA SUPPLIED BY FMC

WESTOVER, PENNSYLVANIA

RAW WATER DATA

DAY	DAY#	pH	Mn (ppm)	Fe	Al	SO4	ACIDITY	ALK.	COND.	S.S.
10/21		4.10	93.78	0.95	26.8	1400	460	2	4750	0.7
10/26	1	4.11	94.60	0.60	26.80	1292	408	2	4700	2.7
10/27	2	4.00	93.00	0.72	26.50	1050	452	0	4400	0.3
10/28	3	4.10	100.80	1.04	27.10	1328	400	2	5000	3.3
10/29	4	4.10	100.20	0.93	27.93	1003	646	4	4900	3.7
10/30	5	4.10	99.40	0.84	27.77	919	680	4	4900	4.0
10/31	6	4.10	103.00	0.58	29.83	1958	312	8	5000	2.7
11/01	7	4.10	104.80	0.72	28.54	1400	383	3	4800	3.7
11/02	8	4.20	100.50	0.49	27.0	1382	385	5	4900	4
11/03	9	4.20	101.80	0.61	27.30	1230	420	2	4900	4
11/04	10	4.20	120	0.57	25.3	1480	384	4	4800	1.7
11/05	11	4.20	101.9	0.68	28.25	1440	328	4	4900	2.7
11/06	12	4.20	100.4	0.72	27.47	1718	348	8	4900	3.3
11/07	13	4.20		0.81	27.3	1400	362	2	4900	3
11/08	14	4.20	105.4	0.58	28.9	1258	369	5	4900	3
11/09	15	4.20	101.1	0.38	28.7	1228	403	7	4900	3.7
11/10	16	4.20	102.3	0.52	27.8	1181	380	6	4900	2.7
11/11	17	4.20	104.9	0.54	29.6	1328	389	3	4900	3
11/12	18	4.50	101.9	0.62	27.48	1524	388	2	4900	3
11/13	19	4.20	103.6	0.41	24.1	1362	408	4	4800	5
11/14	20	4.20	99.1	0.55	26	1436	557	1	4800	0.3
11/15	21	4.20	107.5	0.41	26.7	1230	368	6	4950	2.3
11/16	22	4.20	101.8	0.51	26.9	1230	354	10	4900	5
11/17	23	4.20	102.5	0.54	26.43	1838	322	2	4800	5.3
11/18	24	4.20	104.5	0.54	23.89	860	370	2	4750	3.7
11/19	25	4.20								
11/20	26	4.20								
11/21	27	4.20								
11/22	28	4.80								
11/23	29	4.54	26.2	0.15	6.85	886	64	6	1300	6.7
AVERAGE		4.20	102.1	0.66	28.27	1398	429	4	5052	3.2

* DATA SUPPLIED BY FMC