July'

STATE OF MONTANA

DEPARTMENT OF STATE LANDS

STATE CAPITOL HELENA 59601 (406) 449-2074

June 6, 1975

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ENVIRONMENTAL QUALITY COUNCIL

Attached is an addendum to the environmental impact statement prepared by the Department of State Lands on Decker Coal Company's West Decker Mine near Decker, Montana and distributed on November 5, 1973. This addendum covers the area proposed to be disturbed under the 1975 permit and includes only additional information and modifications which have been submitted to the Department since the issuance of the original statement. The reader is referred to that statement for any information not contained herein.

All materials submitted to the Department by Decker Coal Company as part of their application for a permit pursuant to the requirements of the Montana Strip Mining and Reclamation Act (Chapter 10, Title 50, R.C.M. 1947) are on file and available for public review in the Department's offices in Helena. Any additional information or correspondence relating to the Decker mine site are also on file and available for review.

This addendum is being circulated in compliance with Section 69-6504(b)(3) of the Montana Environmental Policy Act (MEPA).

Sincerely,

Sharon M. Solomon

Sharon M. Solomon
Environmental Coordinator

SMS:ph

ADDENDUM

TO

ENVIRONMENTAL IMPACT STATEMENT

ADMINISTRATIVE ACTION - Proposed Approval of an Amendment to a Strip Mining Permit for the Continuation of Decker Coal Company's West Decker Mine near Decker, Montana

Submitted Pursuant to the Montana Environmental Policy Act Section 69-6504(b)(3), R.C.M. 1947

Prepared by

MONTANA DEPARTMENT OF STATE LANDS

HELENA, MONTANA
June 6, 1975

INTRODUCTION

On November 5, 1973, a draft environmental impact statement was released by the Department of State Lands on the proposed approval of a strip mining permit for the continuation of Decker Coal Company's mine near Decker, Montana. After consideration of the comments received in response to the statement and review of the application materials, the Department determined that Decker Coal Company and the area proposed to be permitted met the criteria set forth in the Montana Strip Mining and Reclamation Act and issued a permit to that company on December 7, 1973.

The company has now applied for an amendment to their existing restricted permit to continue to mine at the West Decker Mine. In this application, Decker has submitted some new information concerning the general mining area and in particular the area proposed to be mined in 1975. Further, some new information has been received from other sources relating to the special situations existing at the mine site. Therefore, the Department deems it necessary to issue an addendum to the original statement, supplementing but not reiterating, the information contained in that statement. The addendum will cover the current level of knowledge and the proposed mining plan for the West Decker Mine; any information in this supplement that conflicts with that in the statement will supercede the information in the statement.

GENERAL INFORMATION

On April 12, 1974, Decker Coal Company submitted an application for a 1975 permit to continue operation of the West Decker Mine (see Table I).

Table I - Legal Description of Mine Location*

Section 4	SE 1/4 SW 1/4, Portion of SW 1/4 SE 1/4, West of Highway 314
Section 8	S 1/2 SE 1/4, NE 1/4 SE 1/4
Section 9	S 1/2, E 1/2 NW 1/4, Portion of NE 1/4 West of Highway 314
Section 10	Portions of S 1/2 and NW 1/4 West of Highway 314
Section 15	Portion West of Highway 314
Section 16	All
Section 17	E 1/2, NW 1/4
Section 21	N 1/2, N 1/2 S 1/2
Section 22	Portion North and West of Highway 314

*All in Township 9 South, Range 40 East, Big Horn County, Montana.

On February 21, 1975, a restricted surface mining permit was issued to Decker allowing them to conduct miscellaneous associated surface disturbance and facility construction on one hundred (100) acres proposed in the application. This permit specifically did not authorize disturbance of any acreage for removal of overburden, spoil depositions, topsoil salvage activities preceding overburden removal, or ramp road construction.

The Department of State Lands then formally notified Decker that an additional one hundred twenty (120) days would be utilized by the Department to consider the remainder of the application and to determine if a permit should be issued to continue the mining operation.

PREPLANNING INFORMATION

Vegetation, wildlife, archaeology, soils, and most other information remains substantially the same as that in the original statement. The mining plan and areas to be disturbed are represented on the map attached at the end of this addendum.

New information has been submitted in the areas of hydrology, overburden, and concomitant reclamation problems.

Hydrology

Wayne Van Voast (Montana Bureau of Mines and Geology) is in the process of writing a final report on his work in the Decker area over the last year.

Three findings are significant:

1. SAR readings in mine discharges have dropped over the past months;
2. volume of discharge into the reservoir is lower than original predictions;
3. volume of discharge compared to volume in the Tongue River is very small, resulting in minimal effects.

These conclusions are summarized in a letter to Decker Coal Company which is included as Appendix I.

Hydrology

Overburden analyses on Decker mine site overburden were done by three unrelated laboratories on samples from three core holes. (These analyses are attached as Appendix II.) Following receipt of the analyses by the Department, copies were sent to a number of professionals in the field for their review and response. There were three specific questions which were asked:

1. Do the data indicate conditions not conducive to vegetation?
2. Where do problem conditions lie?
3. What are "red flag" levels not conducive to revegetation?

A number of responses were received, many of them indicating problem conditions with Decker's overburden. These generally were subdivided into two areas: adverse physical properties and adverse chemical properties. However, four specific areas were consistently singled out as problematic: pH, sodium absorption ratio (SAR), electrical conductivity, and particle size distribution.

Most respondants agreed that growth medium material with pH values greater than 8.5 was not conducive to revegetation. Other problems touched on by these people can be summarized as follows:

"Sodium content generally indicates potential alkaline toxicity and salts conductivity indicates potential salinity problems. Potential problems are indicated when sodium content exceeds 2-3 milliequivalents/100g and salts conductivity exceeds 3-4 millimhos. Particle size distribution indicates the relative portions of sand, silt, and clay in the sample. When clay exceeds 40-50 percent or when silt and clay exceed 70-80 percent of the sample, problems are encountered in infiltration of water, soil aeration, soil compaction, and plant growth. Water content at .3 and 15 atmospheres indicates the amount of water a particular sample will hold which is available for plant use. Soils high in sand generally hold low amounts of water while those high in silt and clay hold greater amounts of water. As noted previously, soils too high in silt and clay present other reclamation problems.

Leachate samples provide information on waters which percolate through test samples and indicate potential influences on surface and ground waters which come in contact with particular overburden in spoils. Electrical conductivity is presented in the tables in micromhos while salts content is estimated in parts per million. Salts hazard appears to increase as both electrical conductivity and salts content exceed 2000 micromhos or ppm. Sodium is expressed in milliequivalents per liter, as are calcium, magnesium, potassium, and total salts. Sodium hazard appears to increase above 2-3 meq/l. Sodium adsorption ratio (SAR) indicates the ratio of sodium to calcium and magnesium and is used to predict plant growth problems. Soils having SAR values greater than 10 are considered alkaline and are limiting to plant growth and establishment. High sodium decreases plant growth by affecting plant nutrition, water use, and soil physical properties." (Sindelar, 1973).

One further problem that was noted by soils experts was the difficulty of revegetating materials with a high percentage of clay of the montmorillonite type, especially when combined with high SAR values. Decker's overburden has a very high percentage of montmorillonite clay (see analysis - Appendix IV).

Receipt of an array of professional concerns with Decker reclamation potential prompted further inquiry by the Department. Decker was requested to provide more information; the U. S. Salinity Laboratory in Riverside, California was contacted (and recommended Mandan); and the Agricultural Research Service, Northern Great Plains Research Center in Mandan, North Dakota, was asked to analyze the overburden results and comment on the potential for reclamation at the West Decker mine site.

At this time Decker and the Agricultural Research Service both feel that reclamation is feasible. Decker bases its contention on the results of their own research, test plots established by the Agricultural Experiment Station at Bozeman, Montana, the SEAM rehabilitation area, and input from the Agricultural Research Service in Mandan. According to supplemental information provided by Decker, "They have all indicated they know of no reason why revegetation should not be accomplished using techniques as described." (Reed, 1975).

The Agricultural Research Service in Mandan reviewed the material concerning Decker's overburden and responded. That letter is included as Appendix V.

As a result of all input received at this time, the Department of State Lands is tentatively recommending six (6) special conditions for Decker's proposed permit:

1. Holding the entire amount of the reclamation bond until reclamation is successful. Normally, part

of the bond is returned as stages of reclamation progress.

2. Requiring the regraded spoils to be sloped to a flatter grade than the twelve percent (12%) required by the rules and regulations.
3. Requiring all spoils to be ripped and broken prior to retopsoiling.
4. Salvage of all topsoil materials available.
5. Establishment of test plots to research the effects of $CaCl_0$ and gypsum treatments on revegetation.
6. Placement of scoria in drainageways to facilitate movement of water.

LITERATURE CITED

Sindelar, B. W. 1973. Young's Creek Study Area Overburden Analysis. Montana State University.

Reed, J. 1975. Letter to C. C. McCall, Department of State Lands, April 22.

See also:

Farmer, E. E., R. W. Brown, B. Z. Richardson, and P. E. Pacher. 1974. Revegetation research on the Decker coal mine in southeastern Montana. U.S.D.A. Forest Service Research Paper INT-162. November.

APPENDIX I

MONTANA BUREAU OF MINES AND GEOLOGY
ROOM 111 6TH AVENUE PLAZA
3021 6TH AVENUE NORTH
BILLINGS, MONTANA 59101

March 18, 1975

Mr. Michael Penz
Hydrologist
Peter Kiewit Sons' Co.
Box 746
Sheridan, Wyo. 82801

Dear Mike,

In response to your telephone inquiry, we have examined published data on discharge and water quality of the Tongue River and have applied them to our predictions of probable mine effluents and spoils leachates in the Decker area. These interpretations are also forthcoming in our report contracted by Decker Coal Co., due in June, 1975. Our ground-water flow calculations are not yet complete, so the final interpretations will be somewhat refined from those described below.

Predictions of ground-water flow and quality can never be exact because of the many physical and chemical variables that characterize ground-water systems. For our needs, we have used greater-than-likely effluent and leachate flow rates, knowing that hypothetical effects of these will be greater than effects that will actually occur. In our publication (Montana Bureau of Mines and Geology Bulletin 93) we predicted an increasing effluent rate to about 600,000 gpd (gallons per day), about 1 cfs (cubic foot per second), for the Decker Mine; in reality the effluent rate has not increased, but appears to be decreasing. In our analyses we use 1.0 cfs to compensate for the proposed east and north Decker mines. Also, in Bulletin 93, we estimated pre-mining and post-mining flow through the Decker mine area to be about 40,000 gpd (.06 cfs); more recent calculations based on better control indicate the actual value was, and will be, about 10,000 gpd (.02 cfs). We use .1 cfs to compensate for the proposed east and north Decker mines. For chemical quality of mine effluent we use the determinations from our last sample at the Decker mine; the quality has been improving since began (we expect the trend will continue). For hypothetical chemical quality of spoils leachates we exaggerate the analysis of water from D-1 overburden (well number 9S.40E. sec. 21 CACD in Bull. 93) based upon our laboratory leachate studies. Predicted water-quality inputs to the system are summarized below:

Mine Effluent (10/1/74)	Spoils Leachate (Estimated)
Sp.C. 1490 micromhos	Sp.C. 6000 micromhos
Na 297 mg/l	Na 1470 mg/l
Ca 10.3 mg/l	Ca 27.1 mg/l
Mg 35. mg/l	Mg 20.4 mg/l
SAR 9.9	SAR 51.7

Discharge data for Tongue River at state line have been published since 1960 by the U. S. Geological Survey. They have also collected and published water-quality data for that station since 1965. We rely on the period of record 1965-73 for concurrent discharge and water-quality data At state line, near Decker, Montana (station no. 06306300), the Tongue River has an average recorded discharge of 498 cfs (Aug. 1960 - Sept. 1973). The mean annual specific conductance recorded for the period Oct. 1965 - Sept. 1973 is 663 micromhos and the average flow-weighted specific conductance for the same period is 563 micromhos. Generally, specific conductance is higher when the flow rate is low and lower when the flow rate is high. The maximum daily specific conductance recorded was 1490 micromhos on Aug. 12, 1966 and on Jan 11, 1972; they correspond to mean daily discharges of 40 and 220 cfs, respectively. The minimum daily specific conductance recorded was 196 micromhos on May 30, 1967 and June 11, 1973; they correspond to mean daily discharges of 2400 and 3430 cfs, respectively. The maximum daily discharge for the period of specific conductance records (1965-73) was 7,480 cfs on June 15, 1967 corresponding to a mean daily specific conductance of 434 micromhos. The minimum daily discharge for this same period was 20 cfs on Aug. 7, 1966 corresponding to a mean daily specific conductance of 1420 micromhos.

The mine effluent sampled on Oct. 1, 1974 had a specific conductance of 1490 micromhos. If one were to assume a flow rate of 1 cfs as to project a probable maximum impact, the effect upon specific conductance values for the river would be as follows for the extremes mentioned above1/:

Table 1.

Aug. 12, 1966 and Jan. 11, 1972 - no change
May 30, 1967 - Up 0.27% to 196.5 (not measurable)
June 11, 1973 - Up 0.19% to 196.4 (not measurable)
June 15, 1967 - Up 0.03% to 434.1 (not measurable)
Aug. 7, 1966 - Up 0.23% to 1423.3

1/based upon mass balance analyses

If, in addition, one were to hypothetically introduce spoils leachate into the system at a rate of 0.1 cfs (65,000 gpd) with a specific conductance of 6000 micromhos (probable maximum), the effect upon the river would be as follows for the same extremes1/:

Table 2.

Aug. 12, 1966 - Up 0.80% to 1502.0
Jan. 11, 1972 - Up 0.14% to 1492.0
May 30, 1967 - Up 0.40% to 196.8
June 11, 1973 - Up 0.28% to 196.5 (not measurable)
June 15, 1967 - Up 0.05% to 434.2 (not measurable)
Aug. 7, 1966 - Up 1.76% to 1445.0

1/based upon mass balance analyses

The monthly effect of mine effluent and spoils leachate upon the river in an average flow year is shown in table 3. As expected from the previous examples, impact is insignificant, 0.35% increase for mine effluent and 0.53% increase for combined mine effluent and spoils leachate.

Table 3.

	River		River + Effl.		River + Effl. + Leachate
Month	Inflow	Sp.C	Inflow	Sp.C	Sp.C
Jan.	196	802	197	805	808
Feb.	295	745	296	748	749
March	440	832	441	833	835
April	413	827	414	829	830
May	1253	519	1254	520	520
June	1969	313	1970	314	314
July	504	533	505	535	536
Aug.	187	779	188	783	786
Sept.	276	701	277	704	706
Oct.	291	748	292	751	752
Nov.	256	780	257	783	785
Dec.	203	808	204	811	814
Annual	524	563	525	565	566

Inasmuch as the mine effluent and spoils leachate considered in these analyses may be considered the worst probable cases and since the dilution capacity of the river, as shown in tables 4, 5, and 6, is similar or higher for other constituents, any impact upon the river from current and proposed mining activity at the Decker mine(s) is anticipated to be insignificant if at all measurable.

Table 4.
Tongue River at State Line (average values)

Month	Sp.C (micromhos)	Na (mg/l)	Ca (mg/l)	Mg (mg/l)	SAR	Flow (cfs)
Jan.	802	32.0	68.7	47.6	0.73	196
Feb.	745	30.1	63.9	44.3	0.71	295
March	832	43.5	67.6	49.9	0.98	440
April	827	44.8	65.0	49.5	1.02	413
May	519	22.1	47.9	26.7	0.63	1253
June	313	12.5	31.2	14.1	0.47	1969
July	533	27.0	45.1	29.6	0.77	504
Aug.	779	42.7	60.5	46.7	1.00	187
Sept.	701	33.9	58.5	43.3	0.82	276
Oct.	748	33.0	58.4	48.8	0.77	291
Nov.	780	37.4	56.4	52.1	0.86	256
Dec.	808	35.7	67.9	50.5	0.80	203
Annual	630	25.8	46.5	31.7	0.72	524

Table 5.
Tongue River with Mine Effluent

Month	Sp.C (micromhos)	Na (mg/l)	Ca (mg/l)	Mg (mg/l)	SAR	Flow (cfs)
Jan.	805	33.3	68.4	47.5	0.76	197
Feb.	748	31.0	63.7	44.3	0.73	296
March	833	44.1	67.5	49.9	0.99	441
April	829	45.4	64.9	49.5	1.03	414
May	520	22.3	47.9	26.7	0.64	1254
June	314	12.6	31.2	14.1	0.47	1970
July	535	27.5	45.0	29.6	0.78	505
Aug.	783	44.1	60.2	46.6	1.04	188
Sept.	704	34.8	58.3	43.3	0.84	277
Oct.	751	33.9	58.2	48.8	0.79	292
Nov.	783	38.4	56.2	52.0	0.89	257
Dec.	811	37.0	67.6	50.4	0.83	204
Annual	565	26.3	46.4	31.7	0.73	525

Table 6.
Tongue River with Mine Effluent and Spoils Leachate

Month	Sp.C. (micromhos)	Na (mg/l)	Ca (mg/l)	Mg (mg/l)	SAR	Flow (cfs)
Jan.	808	34.1	68.4	47.5	0.78	197.1
Feb.	749	31.5	63.7	44.3	0.74	296.1
March	835	44.4	67.5	49.8	1.00	441.1
April	830	45.8	64.9	49.5	1.04	414.1
May	520	22.4	47.9	26.7	0.64	1254.1
June	314	12.7	31.2	14.1	0.47	1970.1
July	536	27.8	45.0	29.6	0.79	505.1
Aug.	786	44.8	60.2	46.6	1.05	188.1
Sept.	706	35.4	58.3	43.3	0.86	277.1
Oct.	752	34.4	58.2	48.7	0.81	292.1
Nov.	785	39.0	56.2	52.0	0.90	257.1
Dec.	814	37.7	67.6	50.4	0.85	204.1
Annual	566	26.6	46.4	31.7	0.74	525.1

The calculations shown above seem to outline the situation pretty well. We will have more refined evaluations in a couple of months. If you have further questions, give us a call.

Wayne A. Van Voast

Wayne A. Van Voast
Hydrogeologist

Robert B. Hedges

Robert B. Hedges

APPENDIX II

Lab No.	Iden.	pH Paste	Sat'n %	Elect. Cond. mmhos/cm	Saturation Extr Cations Ca - - - - meq/liter	Mg
CH-75-12						
4045	0-10 feet	8.3	79.2			
4046	10-15	8.7	106.9	2.4		
4047	15-20	8.5	108.9			
4048	20-25	8.1	75.5	2.4		
4049	25-30	8.2	102.5	1.8		
4050	30-35	8.3	104.1	1.9	0.90	0.29
4051	35-40	8.3	82.1	2.0	0.50	0.29
4052	40-45	7.9	55.3	2.0	0.45	0.53
4053	45-50	8.0	42.0	2.4	0.58	0.45
4054	50-55	8.1	47.4	2.3		
4055	55-60	7.9	43.0	3.0	1.05	0.82
4056	60-65	7.9	43.4	3.5	0.68	0.61
4057	65-70	7.7	47.1	2.9	0.68	0.53
4058	70-71	7.8	45.4			

* Not enough sample for rerun

Lab No.	Iden.	pH Paste	Sat'n. %	Elect. Cond. mmhos/cm	Saturation Ext Cations Ca	Mg
					- - - - meq/liter	
CH-75-10						
4033	0-10 feet	7.8	38.4	3.1		
4034	10-20	8.4	38.4	2.2	1.28	3.1
4035	20-25	8.6	52.2	1.75	1.00	1.89
4036	25-30	8.6	52.3	2.3	1.00	2.87
4037	30-35	7.8	51.7	3.9	1.40	3.03
4038	35-40	8.1	48.5	3.2	1.13	1.64
4039	40-45	8.1	46.0	2.6	0.85	0.82
4040	45-50	7.8	52.0	3.4	1.00	0.82
4041	50-55	8.2	49.8	2.2	0.85	0.66
4042	55-60	8.3	41.4	1.6	0.55	0.61
4043	60-65	8.1	43.9	2.9	0.80	0.45
4044	65-66	8.2		2.8	0.95	0.37

* Not enough sample for rerun

Lab No.	Iden.	pH Paste	Sat'n. %	Elect. Cond. mmhos/cm	Saturation Extract: Cations Ca	Mg	[illegible]
					- - - - -meq/liter-		
CH-75-7							
4017	0-10 feet	8.4	45.7	.67	.09	.43	
4018	10-10.8	8.5	66.8	1.1	0.03	0.33	
4019	10.8-12.2	8.2	34.5	1.8	0.45	0.73	9[illegible]
4020	12.2-13.2	8.6	74.3	1.2	0.35	0.37	5[illegible]
4021	13.2-18.2	8.6	73.2	1.6	0.50	0.53	9[illegible]
4022	18.2-20	8.5	82.2	1.5	0.40	0.29	[illegible]
4023	20-25	8.2	103.2	1.3	0.50	0.29	9[illegible]
4024	25-30	8.2	110.5	1.4	0.35	0.29	9[illegible]
4025	30-35	8.4	94.4	1.6	0.35	0.20	1[illegible]
4026	35-40	8.4	88.5	1.3	*	*	*
4027	40-45	8.3	74.7	1.3	0.45	0.29	1[illegible]
4028	45-50	8.1	50.7	2.3	0.50	0.29	2[illegible]
4029	50-55	8.2	40.5	2.5	0.55	0.29	2[illegible]
4030	55-60	8.2	39.3	2.2	0.55	0.37	2[illegible]
4031	60-65	8.1	34.2	2.4	0.68	0.37	2[illegible]
4032	65-66	6.7	50.2	6.6			

* Not enough sample for rerun

Lab #	Your #	pH	Conductivity millimhos	Salts, ppm estimated	K meq/L	Ca meq/L	Mg meq/L	Ca+Mg meq/L	Na meq/L	Sodium adsorption ratio	Salt hazard	Soc ha
R 438	45-50	8.35	1.900	1225		.30	.25		18.98	36.50	Very Low	
439	50-55	8.4	1.850	1190		.30	.33		18.84	33.64	Very Low	
440	55-60	8.2	2.150	1390		.41	.43		21.73	33.95	Low	
441	60-65	8.2	2.150	1390		.41	.43		21.44	33.50	Low	
442	65-70	8.2	1.900	1225		.30	.33		18.83	33.63	Very Low	
443	70-71	7.8	1.800	1160		.30	.25		17.13	32.94	Very Low	

Salt	Hazard	Conductivity mmhos/cm	Description
VL	Very Low	0-1.99	Salinity effects mostly negligible
L	Low	2-3.99	Yields of very sensitive crops may be restricted
M	Medium	4-7.99	Yields of many crops restricted
H	High	8-15.99	Only tolerant crops yield satisfactorily
VH	Very High	16-	Only a few very tolerant crops yield satisfactorily

Lab #	Your #	pH	Conductivity millimhos	Salts, ppm estimated	K meq/L	Ca meq/L	Mg meq/L	Ca+Mg meq/L	Na meq/L	Sodium adsorption ratio	Salt hazard
R 420	20-25	8.6	1.750	1130		.30	1.32		16.29	18.10	Very Low
421	25-30	8.6	2.300	1490		.52	2.30		22.17	18.79	Low
422	30-35	8.3	2.700	1750		.85	2.77		26.65	19.89	Low
423	35-40	8.4	2.350	1520		.52	.96		23.20	26.98	Low
424	40-45	8.4	2.100	1350		.41	.51		21.73	32.43	Low
425	45-50	8.4	2.450	1585		.47	.56		25.30	35.14	Low
426	50-55	8.4	2.100	1350		.30	.38		21.88	37.72	Low
427	55-60	8.5	1.900	1225		.30	.33		19.99	35.70	Very Low
428	60-65	8.4	1.650	1065		.30	.16		16.71	35.55	Very Low
429	65-70	8.5	1.550	1000		.20	.16		16.43	39.12	Very Low
430	75-12 0-10	8.6	4.200	2710		1.01	2.82		42.80	31.01	Medium
431	10-15	9.0	1.200	771		.09	.16		11.14	30.94	Very Low
432	15-20	8.9	1.250	803		.15	.16		11.60	29.00	Very Low
433	20-25	8.8	1.100	706		.29	.12		11.08	24.62	Very Low
434	25-30	8.8	1.200	771		.29	.12		11.69	25.98	Very Low
435	30-35	8.7	1.100	706		.29	.08		10.39	24.16	Very Low
436	35-40	8.6	1.300	838		.20	.12		11.93	29.83	Very Low
437	40-45	8.5	1.650	1065		.20	.21		16.44	36.53	Very Low

Lab #	Your #	pH	Conductivity millimhos	Salts, ppm estimated	K meq/L	Ca meq/L	Mg meq/L	Ca+Mg meq/L	Na meq/L	Sodium adsorption ratio	Salt hazard
R 402	75-7 0'-10'	8.5	.615	394		.09	.33		6.41	14.24	Very Low
403	10-10.8'	8.5	.555	355		.09	.21		5.85	15.39	Very Low
404	10.8'-12.2'	8.7	1.100	706		.15	.43		9.91	18.70	Very Low
405	12.2-13.2	8.9	.580	372		.09	.08		5.99	19.97	Very Low
406	13.2-18.2	8.65	1.150	740		.15	.21		10.78	25.67	Very Low
407	18.2-20	8.75	.840	538		.15	.08		8.53	25.09	Very Low
408	20-25	8.7	1.050	672		.09	.08		10.39	34.63	Very Low
409	25-30	8.65	1.000	642		.09	.08		9.64	32.13	Very Low
410	30-35	8.8	1.050	672		.09	.12		10.19	30.88	Very Low
411	35-40	8.75	1.200	771		.09	.16		11.40	31.67	Very Low
412	40-45	8.7	1.350	870		.09	.12		12.84	38.91	Very Low
413	45-50	8.7	1.600	1035		.25	.16		16.71	37.13	Very Low
414	50-55	8.5	2.100	1350		.20	.16		21.87	52.07	Low
415	55-60	8.5	2.200	1425		.30	.21		23.50	47.00	Low
416	60-65	8.45	2.150	1390		.41	.16		22.61	42.66	Low
417	65-66.5	6.9	4.900	3180		5.07	2.16		53.04	27.92	Medium
418	75-10 0-10'	8.05	2.900	1885		3.67	6.79		23.79	10.43	Low
419	10-20'	8.4	2.200	1425		.63	2.15		19.41	16.59	Low

ies to: Montana Department of State Lands

a	2 pH		3 Soluble Salts	4 Sodium meq./ 100 gm.	5 Calcium meq./ 100 gm.	6 Magnesium meq./ 100 gm.	7 SAR	8 Saturation Percentage	9 Texture	
	Paste	1:5							% sand	% silt
12 0	8.9	9.2	3.50	1.05	0.06	0.08	16.5	60.4		
15	9.5	9.3	1.29	0.77	0.02	0.01	26.2	61.4		
20	9.5	9.3	1.28	0.75	0.02	0.01	26.2	59.8		
25	9.2	9.3	1.37	0.07	0.02	0.02	23.2	50.9		
30	9.2	9.3	1.39	0.70	0.02	0.02	23.2	51.4		
35	9.1	9.2	1.23	0.63	0.01	0.01	25.6	48.7		
-40	9.0	9.2	1.30	0.68	0.01	0.01	27.2	50.1		
-45	8.8	9.3	1.60	0.71	0.02	0.01	29.6	44.7		
-50	8.5	9.1	1.89	0.59	0.01	0.01	30.8	33.8		
-55	8.3	9.0	1.90	0.64	0.02	0.01	29.4	34.8		
-60	8.1	8.8	2.14	1.15	0.00	0.00	49.7	38.1		
-65	8.5	9.2	1.86	0.52	0.02	0.01	21.2	37.2		
-70	8.6	9.1	1.88	0.67	0.04	0.01	23.9	37.0		
-71	8.2	8.5	1.79	0.55	0.02	0.01	25.9	33.8		

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ea .	2 pH Paste	1:5	3 Soluble Salts	4 Sodium meq./ 100 gm.	5 Calcium meq./ 100 gm.	6 Magnesium meq./ 100 gm.	7 SAR	8 Saturation Percentage	9 Textur % sand
-7 -65	8.6	8.8	2.65	0.74	0.01	0.01	52.7	25.6	
- .5	7.0	7.5	3.70	1.62	0.11	0.05	27.2	45.1	
-10 10	8.4	8.9	2.25	0.78	0.12	0.08	9.7	38.0	
-20	8.6	9.3	2.02	0.67	0.04	0.02	21.2	32.1	
-25	8.7	9.3	1.55	0.72	0.04	0.01	21.8	44.2	
-30	8.7	9.3	2.10	0.91	0.05	0.03	24.5	42.6	
-35	8.7	9.0	1.97	0.62	0.08	0.04	27.2	46.6	
-40	8.7	9.1	1.84	0.51	0.03	0.02	17.7	41.0	
-45	8.7	9.2	1.97	0.37	0.03	0.02	12.5	36.0	
-50	8.7	9.1	1.83	0.51	0.02	0.02	17.2	42.5	
-55	8.8	9.2	1.65	0.66	0.02	0.01	33.3	40.0	
-60	8.8	9.2	1.72	0.61	0.02	0.01	27.1	33.8	
-65	8.8	9.2	1.60	0.62	0.01	0.01	31.6	36.4	
-70	8.8	9.2	1.68	0.54	0.01	0.01	28.8	32.0	

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1 Area No.	2 pH Paste	 1:5	3 Soluble Salts	4 Sodium meq./ 100 gm.	5 Calcium meq./ 100 gm.	6 Magnesium meq./ 100 gm.	7 SAR	8 Saturation Percentage	9 Texture % sand	 % silt
CH-7 0-10ft	8.6	9.2	0.92	0.32	0.02	0.02	13.3	34.9		
10-10.8	8.6	9.0	0.84	0.41	0.02	0.01	13.4	36.4		
10-8-12.2	8.9	9.4	1.36	0.36	0.02	0.01	18.8	26.5		
12-2-13.2	8.8	9.3	0.79	0.40	0.02	0.02	12.3	48.3		
13-2-18.2	8.8	9.3	1.35	0.60	0.02	0.01	26.2	42.0		
18.2-20	8.9	9.4	1.34	0.61	0.02	0.01	24.4	46.4		
20-25	8.9	9.2	1.03	0.64	0.01	0.01	30.9	55.0		
25-30	8.9	9.3	1.25	0.78	0.02	0.01	25.2	56.3		
30-35	9.0	9.2	1.53	0.90	0.02	0.01	31.0	54.4		
35-40	9.0	9.1	1.40	0.77	0.02	0.01	26.2	50.0		
40-45	9.0	9.0	1.44	0.86	0.01	0.01	33.8	51.7		
45-50	8.7	9.0	1.62	0.68	0.02	0.01	32.4	38.0		
50-55	9.1	9.1	2.46	0.80	0.01	0.0	50.8	26.7		
55-60	8.8	8.9	1.97	0.57	0.01	0.00	55.0	26.5		

APPENDIX III

Discussion of Saline-Alkaline Soils

Most saline and alkaline soils are the result of deposition of salts during evaporation from a water table. The high water table in some cases no longer exists, but rainfall may have been insufficient to remove the salts. Occasionally salinity results from a high salt parent materials, usually a marine shale.

Saline soil conditions are generally classified by the electrical conductivity of the saturation extract (EC_e) which is a function of the salt content of the soil. The saturation extract is related to the water holding capacity of the soil, usually being about twice the field capacity. The significance of electrical conductivity is that it is a measure of the salt content of the extract, and can be related to plant growth on the soil. Research has shown that the yields of many crops are restricted if the conductivity of the saturation extract exceeds 4 millimohs per centimeter, and the soil is considered to be saline. Three theories or categories of physiological effects of salts on plant growth have been studied: (1) soluble salts decrease the availability of water to plants by increasing solute suction; (2) salts act within the plant by lowering the free energy of internal water and preventing physiological processes that require water, and (3) some ions are directly toxic to plants.

Soils that have excessive concentrations of sodium are called alkaline. Ca and Mg are the principal cations found in the soil solution and on the exchange complexes of normal soils in arid regions. When excess soluble salts accumulate in these soils, Na frequently becomes the dominant cation in the soil solution. Thus, sodium may be the predominant cation to which the soil has been subjected, or it may become dominant in the soil solution, because of the precipitation of Ca and Mg compounds. As the soil solution becomes concentrated through water absorption by plants or evaporation, the solubility limits of $CaSO_4$, $CaCO_3$, and $MgCO_3$ are often exceeded, in which case they are precipitated with a corresponding increase in the relative proportion of Na. Under such conditions, a part of the original exchangeable Ca and Mg is replaced by Na. At equivalent solution concentrations, the amounts of Ca and Mg adsorbed are several times that of Na. In general, half or more of the soluble cations must be Na before significant amounts are adsorbed by the exchange complex. Therefore, a measurement of the ratio of Na to Ca and Mg is important in predicting the amount of Na that will be present on the exchange complex. Sodium-adsorption-ratio (SAR) is a measurement of this ratio, and can be used in locating soils that have high enough concentrations to be detrimental to plant growth. Soils having SAR values greater than 10 are considered alkaline, and usually produce decreases in plant growth. High Na decreases plant growth by affecting plant nutrition, and the physical properties of the soil. Alkaline soils usually have a very much reduced permeability. (Taken from Sindelar, 1973).

APPENDIX IV

Report on Clay Minerals in Overburden
Samples from Kiewitt Mining Co.

May 23, 1975

Three samples were received, labelled A, D, and F. They were dispersed in 0.001% Na_2CO_3 with the aid of ultrasound. Clays were separated by repeated centrifugation (5 times). They were analyzed by x-ray diffraction after the following treatments: Mg-saturation, air dry; Mg - saturation, ethylene glycol; K-saturation, air dry; K saturation, 350-400°C; K saturation, 500-550°C.

Smectite (swelling clay formerly called montmorillonite), chlorite, illite, kaolinite, and quartz were identified. X-ray diffraction, by itself, is not accurate for quantitative analysis but it can be used for estimates of relative abundance. Quantitative estimates were made in accordance with a procedure developed at Ohio State University. The relative abundances of each of the minerals are given in the following table.

	A	D	F
Smectite	High	Low-Mod	Very high
Chlorite	Low	Trace	Trace
Illite	Low-Mod.	High	Trace
Kaolinite	Low	Low	Trace
Quartz	Trace	Trace	Trace

In the table Very high = 75-100%
High = 50-75%
Moderate = 25-50%
Low = 5-25%
Trace = less than 5%

Murray Klages
Professor of Soils

APPENDIX V

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
NORTH CENTRAL REGION
NORTHERN GREAT PLAINS RESEARCH CENTER
P.O. BOX 459
MANDAN, NORTH DAKOTA 58554

May 8, 1975

AIRMAIL

Mr. C. C. McCall, Administrator
Reclamation Division
Montana Department of State Lands
State Capitol
Helena, Montana 59601

Dear Mr. McCall:

In response to your April 21, 1975 letter to me regarding reclamation at the Decker Mine, we have reviewed all materials you left with us and also additional data and information provided by the Decker Coal Company. With this information as background, answers to the eight specific questions in your letter are given as follows:

1. We believe data available from Decker are essentially adequate to make judgements concerning reclamation.

2. The variation in data between labs we believe is significant, and we are working to reduce this problem. However, collectively there are sufficient data to permit us to have a fairly clear understanding of the properties of the materials at Decker.

3. We would not recommend additional sampling for purposes of characterizing the materials.

4. We believe that topsoil salvage procedures are adequate.

5. We see no clear evidence that any lower strata would be superior for plant growth.

6. Generally we believe that under dryland conditions, depth of root activity is limited by depth of annual recharge of the soil water reservoir in at least 90% of the years. In the Decker area, this would probably be the upper 2-4 feet for most species. Deeper root activity would probably be the exception, and would be controlled by depth of water infiltration.

7. Use of $CaCl_2$ in a viable alternative if sufficient water is available for leaching.

8. The intent of this statement was to indicate that for vegetative growth, the maximum depth of soil material required for revegetation is probably equal to the depth of rooting. Possibly lesser depths may be satisfactory - research is in progress to obtain data.

These answers are based upon the following interpretation of the available data from Decker:

1. The pre-mined area is covered by variable thickness of several soil types. Topsoil from these soils is being stockpiled and respread to a thickness of 16-20 inches. This topsoil typically is non-saline and nonsodic. Textures are commonly sandy loams, loams, and silt loams.

2. Overburden below the surface soil is typically medium to moderately coarse textured (silt loams to sandy loams). The material is occasionally moderately saline but more frequently is only slightly saline. However, overburden is moderately to highly sodic. The important variable is thickness of nonsaline, nonsodic surface material that is available for reclamation use. Maximum efforts should be made to conserve and reutilize the limited quantities available.

3. Average annual precipitation is approximately 11 inches, pre-mining land use was livestock grazing, and pre-mining vegetation was typical of that of heavily grazed rangeland in the region--mixed cool-season and warm season perennial grasses, annual grasses (cheatgrass), and shrubs (especially sage).

4. The intent of the reclamation is to restore post-mined land to a level of productivity equal or exceeding potential (not actual) productivity prior to mining.

If these statements are correct, results of our research indicate that several alternatives are available for the reclamation plan. Unfortunately our research has not progressed to the point where we have complete scientific information on all aspects of the alternatives. It should be pointed out that our research is aimed primarily at restoration of plant growth potential. Other reclamation requirements - erosion control, hydrology, proposed land use, engineering properties, etc. - may require more stringent practices over and above those required for revegetation. Also we should point out that most of our reclamation research has been conducted on level spoils, with slopes generally in the 0 to 4% range. The Soil Conservation Service and other agencies have ample data from numerous locations over many years to prove that erosion hazard increases as the slope increases. Consequently, we do not generally conduct research on steep slopes because we are convinced that seldom should spoils in the Northern Plains be left in steep slopes - such landscapes cannot be made permanently productive. I believe this is particularly true at Decker where good topsoil is limited - save and conserve all that is possible.

Acknowledging our present lack of definitive research information on many aspects bearing on the problem at Decker, I hesitate to make specific recommendations for reclamation. However, I will make several statements which I believe should be considered in arriving at your decision on this matter. First of all I and the rest of our staff are of the opinion that spoils at Decker and at all other mines from which we have information can be reclaimed to a level of productivity equal to that existing prior to mining. Of course, generally as the severity of the problem increases, reclamation procedures become more involved and more expensive. Conceivably costs could increase to the extent that the mining company might decide the operation would not be economically profitable.

A second statement that we believe should be considered at Decker is the point made already of saving all useable soil material to respread over level spoils. Again I would like to emphasize the word level because the effectiveness of the limited topsoil supply is drastically increased as slopes are reduced. Steeper slopes are less stable, and topsoil would eventually erode off steeper slopes.

In terms of recommended reclamation treatments, we believe that the procedures presently being used at other mine sites in Montana, if properly applied, should result in establishment of economically productive vegetation. We would suggest using only those species in a mixture whose adaptability to reclaimed mined land has been proven - diluting mixtures with species that will not survive has the effect of merely reducing the effective seeding rate of adapted species.

The restricted supply of nonsodic soil material at Decker dictates one of two possible courses of action: (1) follow procedures utilized elsewhere, and respread the 16 to 20 inches of useable topsoil over level spoils; or (2) attempt to reduce adsorbed sodium content of spoils before covering with topsoil. We presently do not have good research data by which we can evaluate the permanent effects of either of these alternatives. Therefore extrapolating from just a few years of results from experiments on sodic spoils at Stanton (higher precipitation but also higher clay content than at Decker), we have reason to believe that 16 to 20 inches of good soil material respread over sodic spoils, with proper fertilization, seeding, and management, would provide a moderate level of productivity (see our recent Progress Report). In the few years we have observed these results, we have seen no deterioration of stand, but we have no information on how the vegetation will stand up under use and even abuse by grazing. Also we have not been successful to date in establishing warm-season grasses on reclaimed areas - therefore use for summer grazing would be limited. I should mention that in the undisturbed state many relatively productive soil types in the Fort Union region contain in excess of 10 percent exchangeable sodium at depths of three feet or less (see Omodt, et al, "The Properties of Important Agricultural Soils as Criteria for Mined Land Reclamation", N. Dak. Expt. Sta. Bul. 492, 1975). Whether or not this is an important criterion to use in this decision is speculative at present.

If it is decided that adequate reclamation is not possible with the procedure outlined above, one would then consider the use of amendments to reduce exchangeable sodium in the spoils. Amendments offering most promise in our judgement are gypsum and calcium chloride (applied with leaching water). Amendments would be applied prior to respreading topsoil. Members of our staff could provide instructions by which rates of amendments can be calculated. Our experiences utilizing gypsum to reduce exchangeable sodium were summarized in our recent Progress Report. Because of the coarser texture at Decker, we would expect possibly faster and somewhat more complete reaction from gypsum than was observed at Stanton. On the other hand, however, lower precipitation at Decker would probably cancel to some extent the effects of the coarser texture. Therefore I would anticipate that gypsum treatment at Decker would result in 25 to 50% reduction in exchangeable sodium in the upper 6 to 12 inches of spoils after a period of several years.

If it is decided that this reduction in exchangeable sodium is insufficient, our next recommendation would be to apply calcium chloride to the surface of spoils and move the replaced sodium below the root zone with leaching water. Without adequate data, I presume that the entire 8 foot depth of spoils could thereby be reclaimed if so desired. Since this proposal requires use of an irrigation system to apply the leaching water, a mining company may also decide to utilize this same sprinkler system to irrigate up and establish grass stands. In the fall, after the stand is established, the entire sprinkler system could then be moved and used to leach new spoils which have been levelled and treated with calcium chloride. The following year these spoils could be seeded and irrigated up and this sequence repeated in future years. Possibly mid-summer seedings of warm season grasses could be established with irrigation, thereby introducing warm season grass into the stand. I would also think this procedure would insure good stand establishment, thereby reducing reseeding expenses and hastening release from bond.

We do not presently have data on plant growth from each of these various methods of reclamation. With the relatively low annual precipitation received at Decker, we have no assurance that spoils treated with amendments will provide better vegetative growth than those without amendments. However amendments would increase the depth of nonsodic materials, which may be of importance for several other reasons such as improvement of ground water, reduction of saline seep development, greater stability, and so forth.

I believe this essentially summarizes the information we have that relates to reclamation at Decker. I hope you find this information useful in your decision on the course of action to be followed. Possibly you may want to recommend some of these alternatives on an experimental basis for several years. In any event, I am glad to see you state in your letter that all options are open. As a bit of my own personal philosophy, I look upon reclamation legislation as being evolutionary - changing to accommodate new information and conditions as they arise. As long as our objective is to return mined areas to a condition whereby their potential productivity is restored, the technical procedures may change with changing information of economic conditions. In the meantime however, I believe that if we achieve this objective, we have performed our duties to future generations, and that our present society is now paying the full cost of the energy derived from this coal.

Please contact us if you have further questions.

Sincerely,

J. F. Power
Research Leader

cc:
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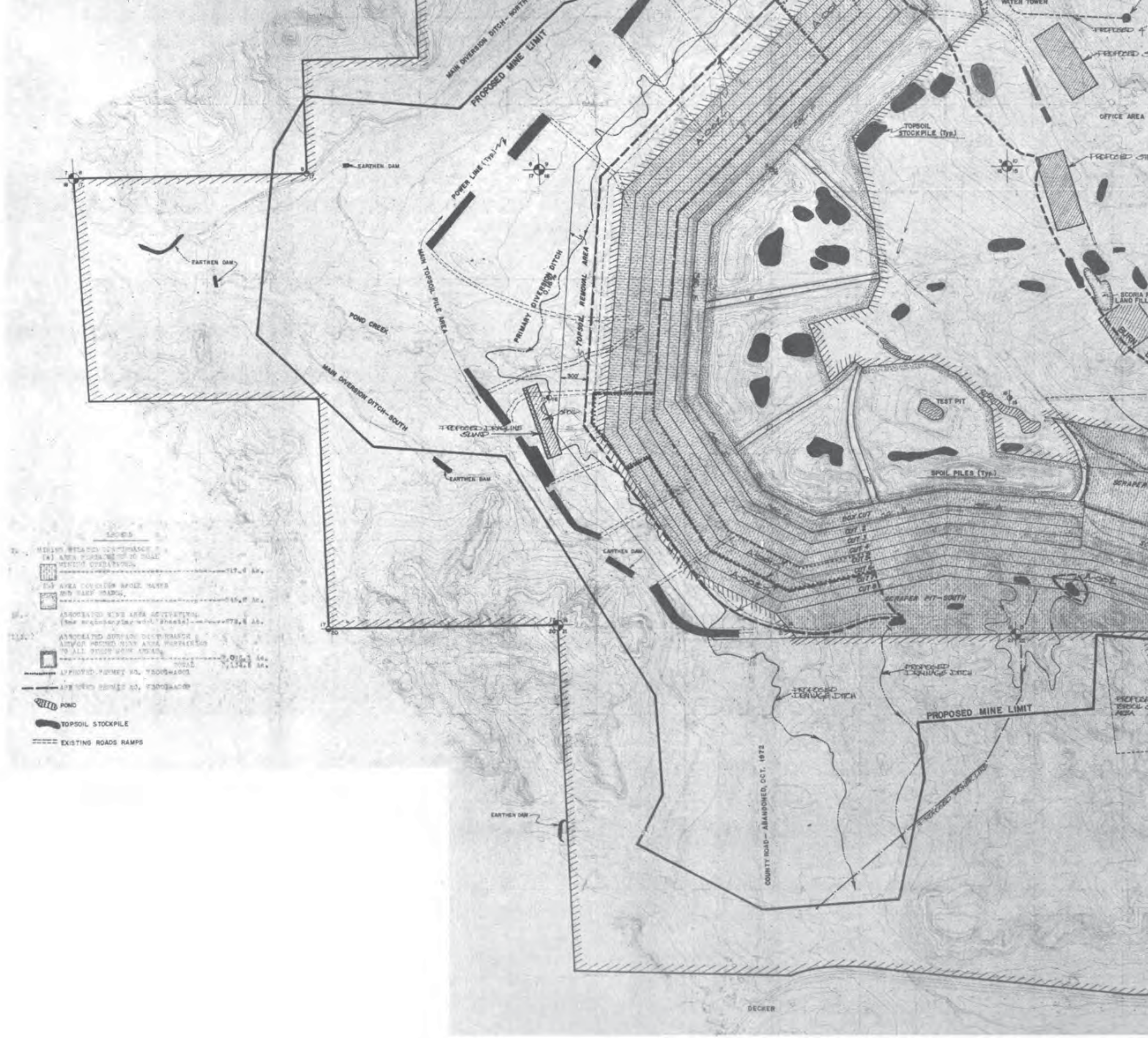
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