

EVALUATION OF POLLUTION ABATEMENT PROCEDURES IN MORaine STATE PARK

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INTRODUCTION

A research project, Federal Water Pollution Control Administration #14010 DSC and Pennsylvania Department of Mines and Mineral Industries #CR 85, is being performed by Gwin Engineers, Inc. in the Moraine State Park in Butler County, Pennsylvania.

This project is a "follow-up" on the various mine drainage abatement projects which have been or will be completed during the three year period of the research program. This project started August 1, 1968 and will run through to August 1, 1971. The paper presented at this time will serve as a progress report of the research program.

The remedial methods being evaluated consists of strip mine reclamation, deep mine "wet" seals, grouting, surface sealing, refuse pile removal and oil well plugging. Water quantity and quality measurements are being made at approximately 85 sampling points at least once a month throughout the watershed area. An evaluation of this data will indicate the relative effectiveness of the mine drainage abatement procedures.

LOCATION AND DESCRIPTION OF THE AREA

The project area comprises about 25 square miles. It is located in a portion of the 58.5 square mile Muddy Creek watershed, in Franklin, Brady, Muddy Creek, and Worth Townships, Butler County. It is bordered on the north by the Slippery Rock Creek watershed and is located 5 miles south of the town of Slippery Rock. It is further situated about 35 miles north of Pittsburgh and approximately 9 miles northwest of Butler. The towns of Muddy Creek, Unionville, and Prospect border the Moraine State Park and project area on the east and south. On the west and southwest are located the communities of Shawood Park and Portersville.

When completed, the park will consist of 15,990 acres of land with a 3,225-acre lake. The area will offer facilities for boating, swimming, fishing, picnicking, ice skating, skiing, playgrounds, natural areas, tent and trailer camping and organized group camping.

GEOGRAPHY

Topography

The project area is a dissected plateau - a part of the Appalachian Plateaus province. The topography is expressed as hilly country of moderate relief. Hills are flat topped generally ranging from 1,160 feet in elevation on Muddy Creek to 1,525 feet at the top of the highest hills.

Drainage

The area is drained by Muddy Creek and its tributaries - Swamp Run, Shannon Run, Big Run, and Bear Run from east to west. Muddy Creek is a tributary of Slippery Rock Creek. The confluence of the two streams is just southwest of Grant City about three miles west of Moraine Park. Muddy Creek and its tributaries meander through a fairly broad valley system created by the Pleistocene ice sheet. The valley system ranges from about 500 feet to 3,500 feet in width. Muddy Creek has a very slight gradient dropping from an elevation of 1,200 feet at the eastern end of the park to an elevation of 1,160 feet at the western end. This drop of 40 feet occurs over a lineal distance of about 40,000 feet.

GEOLOGY

Surface formations in the project area are the sedimentary strata of the Conemaugh and Allegheny Formations of Pennsylvania Paleozoic Age, along with the unconsolidated deposits of Pleistocene and Recent Age. The strata lie nearly flat - dipping approximately 3% to the southeast - with the general slope slightly modified by minor folds. The Conemaugh and Allegheny Formations attain a thickness of about 800 feet and consist chiefly of a sequence of consolidated relatively thin-bedded shales, siltstones, and sandstones. The sequence also includes several seams of coal and the Vanport Limestone.

The flat valley sections of the park area contain unconsolidated deposits which mark the southern limits of the Wisconsin Pleistocene glacial advance. These deposits consist of sandy deltaic sediments overlying lacustrine laminated silts and plastic clays ranging in thickness from a few feet on the margin to 80 feet in the middle of the valley. Generally, the unconsolidated glacial material intercepts the bedrock at or near the Middle Kittanning coal seam along the valley walls.

The mineable coal seams in the park area are in both the Allegheny and Conemaugh Formations. However, the Brush Creek coal of the Conemaugh Formation and the Freeport coal seams of the Allegheny Formation are very erratic and have been mined only by strip mining methods in small areas. All of the deep mining and most of the strip mining in the park area has occurred in the Middle Kittanning or "C" seam of coal. This is a fairly persistent seam averaging 36 inches in thickness. This seam, however, is a high sulphur coal resulting in a considerable amount of acid drainage.

POLLUTION ABATEMENT PROCEDURES

The following pollution abatement projects have been completed or are presently being performed in the Moraine State Park watershed area.

1. Deep Mine Sealing

This project consists of the construction of double bulkhead grout seals installed through drill holes and pressure grouting in the adjacent strata of the applicable mine entries. It has been estimated that a total of 73 seals in individual mine opening will be required. These deep mine "wet" seals are being installed in the deep mine openings with the mine workings to the rise and where major discharges of acid water are emanating.

Because all of the mine entries were caved at the portal, the location and installation of the mine seals in the entries were performed through drilling procedures. After the installation of the mine seals in the entries, curtain pressure grouting operations were performed. Pressure grout curtains were also placed in seepage areas along applicable sections of the outcrop and above the highwall in certain strip mine areas. Observation drill holes are placed in a location behind the mine seals in each of the entries or series of entries, and in the main body of each of the major mining areas. The purpose of this project is to provide a water-tight seal in the mine entry and adjacent strata; causing the mine to flood and, as a result, either cutting off or reducing the exposure of air to pyrite.

This work, Project SL-105-3, is being performed by the B.H. Mott & Inc. The construction work started in February 1969 and was 72% by December 31, 1969. The total construction costs for this estimated at \$1,112,450. The general construction details and an drawing of the deep mine seals are indicated on Figure 1.

2. Strip Mine Reclamation

This reclamation work includes backfilling abandoned strip mine areas, soil treatment and planting, and the construction of diversion ditches and slope drain flumes. The backfilling consists of both approximate original contour and terrace type restoration. Within the park boundary there is a total of 462 acres requiring backfilling; 444 acres are either completed or under contract plus 18 acres in the Southwest area scheduled to be bid in the near future. There are an additional 265 acres of strip mined areas within the park boundary that were restored by the mine operator in a satisfactory manner. Outside of the park boundary, but within the physical Muddy Creek watershed, there is a strip mined area of about 30 acres that should be included in an abatement project.

The strip mine reclamation projects started in May 1967 with the ASMD-1 Project. This work was performed by A.D. Davis for 177.5 acres. Other contracts since then include part of Project MD-8C for a total of 47 acres by Wagner and Hartle; Project SL-105-1 two areas by Trans-Continental for 104.6 acres and 60.1 acres and one area by A.D. Davis for 45.8 acres; Project SL-105-1A by Goodal for 8.7 acres. The strip mine reclamation costs varied from a low of \$420 per acre to a high of \$2300 per acre. The total estimate for the existing contracts plus the proposed reclamation is \$720,000. Figure 2 indicates backfill and drainage details in the strip mine reclamation projects.

3. Refuse Pile Removal

This project consisted of the removal of 14 mine refuse piles and burial of this material in strip mine areas requiring reclamation work. This work, part of Project MD-8C, was performed under two contracts: A.D. Davis removed 82,347 CY for a total of \$103,757 and Wagner and Hartle removed 134,721 CY for \$190,486. The cost per cubic yard of material removed varied from \$1.00 to \$1.54 per cubic yard. This work was performed in 1967 and 1968.

4. Surface Sealing

Project SL-105-2 included sealing 23 mine drifts, slopes and air shafts with clay and other suitable material where the body of the mine workings lie to the dip. This contract was performed by L. McMasters Company for \$28,000. The work was started in January 1969 and completed in May 1969.

5. Well Plugging and Miscellaneous

In addition to the mine drainage pollution abatement projects, there were other projects to control pollution from other sources. These included well plugging, and landscaping and planting. The well plugging projects included plugging a total of 422 abandoned oil, gas and water wells at a cost of \$378,292. The landscaping and planting projects were performed in order to prevent erosion and eliminate excessive turbidity in the park area.

METHOD OF INVESTIGATION

As part of the Mine Drainage Project MD-8, a total of 85 weirs were installed at all known mine drainage discharge points. Periodic sampling and flow measurements were started in May 1967. Since that time water samples have been collected at least once a month. These samples were analyzed and tabulated on periodic report sheets indicating the flow in gallons per minute, pH, and the alkalinity, acidity, iron and manganese in both milligrams per liter and pounds per day. This sampling program has been continued as part of the present research project. This mine drainage data serves as the basis for the values computed in this paper.

In order to evaluate the results of the abatement projects, the mine drainage data has been divided into five periods of six months duration each, starting with July 1, 1967 and ending with December 31, 1969.

The various mine drainage abatement areas have been classified into 18 deep mine areas and 6 strip mine areas. Each one of the deep mine areas consists of one to five mine entries into a particular mine. Each of the strip mine areas consists of a group of strip mines in a general location. The location of the applicable deep and strip mine areas are indicated on the map (Figure 3.)

After examining the mine drainage data from this area over a period of two and a half years, acidity was considered to be the major component. Thus, the criteria for the effectiveness of the mine drainage abatement projects is the comparison of the total pounds of alkalinity and acidity on a six months basis as computed from the mine drainage data. The tabulation of total pounds of alkalinity and acidity for both the deep mine and strip mine areas are indicated on Figure 4.

DISCUSSION OF RESULTS

Figures 5 through 20 indicate the total pounds of both alkalinity and acidity plotted for the various discharges at six-month intervals. The following is a discussion of the discharges as indicated on the graphs.

Total of Deep Mine and Strip Mine Discharges (Figure 5)

Figure 5 shows the totals for both the deep mines and strip mines over the past 2½ years. The most significant change in total acidity was the drop from 117,000 pounds during the first half of 1968 to 28,000 pounds during the last half of 1969. The reduction in acidity from the 100,000 pound range in the last half of 1967 and first half of 1968 to the 80,000 pound range in the last half of 1968 and the first half of 1969 was due chiefly to the strip mine reclamation work, the large reduction from 80,000 pounds in the first half of 1969 to 28,000 pounds in the last half of 1969 was the result of the deep mine sealing project.

Total Deep Mine Discharges (Figure 6)

The total pounds of acidity produced from all the deep mines was not appreciably affected by changes in climatic conditions as can be noted by the values for the last half of 1967 and the first half of 1968. It is difficult in many cases to differentiate between the deep mine discharges and strip mine discharges in some locations. Because of this; much of the acid reduction shown during the last half of 1968 was in part due to back-filling strip mines in several areas which prevented water from entering into deep mines. The total deep mining sealing project was 72% completed on December 31, 1969. An improvement from the 96,000 pounds of acidity produced prior to the deep mine sealing project to 23,000 pounds produced during the last half of 1969 indicates a reduction of 76% in acid loading from the deep mines.

Total Strip Mine Discharges (Figure 7)

The production of both alkalinity and acidity in the strip mine discharges are directly affected by the climatic conditions. During the last half of 1967, there was very little rainfall. The increase in precipitation during the first six months of 1968 and 1969 is reflected in the values indicated. The acidity produced by the strip mines varies greatly with the weather conditions. During dry periods, the deep mines produced 99% of the acid and the strip mines about 1%. Under normal to wet conditions, the deep mines produced 80% and the strip mines 20%.

During the last half of 1969 the total pounds of alkalinity (5,181 pounds) about equalled the total pounds of acidity (5,484 pounds). The strip mine reclamation work was 80% completed on December 31, 1969.

Deep Mine Discharges

Wimer Mine (Figure 8)

The Wimer Mine is located outside of the park boundary in the Northwest area of the watershed. A deep mine sealing project is being planned. There has been no deep mine reclamation at this mine. The acid loading at the mine varied from about 5,000 pounds to 2,000 pounds.

Alben Mine (Figure 9)

The Alben Mine is also located outside of the park boundary in the Northwest area of the watershed. This mine shows fairly steady acid loading of over 5,000 pounds. No deep mine reclamation work in progress.

Fox Mine (Figure 10)

The Fox Mine shows a total acid reduction of 90%; 6,330 pounds down to 636 pounds. The reduction of acid in 1968 and the first part of 1969 was in part due to the strip mine reclamation work preventing water from entering the deep mine. The reduction during the last half of 1969 was due to the mine sealing project. The deep mine sealing project was 85% complete on December 31, 1969.

Salzano Ross Mine (Figure 11)

Prior to the deep mine sealing project, the Salzano Ross Mine complex had been the largest acid producing mining area in the Moraine State Park. The climatic conditions had a noticeable effect relative to the production acid. During the normally dry seasons, July to December, the mine produced about 26,000 pounds of acid; from January to June, the wet seasons, the mine produced an average of 33,000 pounds of acid. The mine sealing project was started in June 1969 and was completed in August 1969. Prior to sealing the mine had a discharge with a pH 2.8 to pH 3.1 and a flow of 5 to 20 G.P.M.; after sealing the flow has varied 0 to a maximum of 5 G.P.M. with a pH 6.3 to pH 6.8. This mine has a 100% reduction in production of acid.

Lindsey Mine (Figure 12)

The Lindsey Mine is located near the Northeast end of the park. The deep mine sealing project was started in August 1969 and was 65% completed on December 31, 1969.

Lincoln Mine (Figure 13)

The Lincoln Mine is located in the Northeast end of the park. Prior to any reclamation work, the Lincoln Mine was producing about 20,000 to 25,000 pounds of acid every six months. The initial reduction in acid to about 12,000 pounds was due chiefly to the refuse pile removal and strip mine reclamation work in reducing the amount of water from entering the mine. The additional reduction to 4,800 pounds was the result of the deep mine sealing project. This mine has been one of the more difficult mines to seal. The deep mine sealing project began in February 1969 and was 90% complete on December 31, 1969. Additional work may be required in this area. The mine presently has an acid reduction factor of 78%.

Kildoo Mine (Figure 14)

The Kildoo Mine is located in the Northeast end of the park. Prior to the mine sealing project, the Kildoo mine produced about 18,000 pounds of acidity every six months. This mine is also a difficult mine to seal, the sealing project was started in February 1969 and was 85% complete on December 31, 1969. During the last six months of 1969, the mine produced 5,200 pounds of acidity indicating an acid reduction factor of 71%.

Strip Mine Discharges

Southwest Strip Areas (Figure 15)

Prior to the start of reclamation work in this area, the total production of acidity over the total production of alkalinity had a ratio of about 10 to 1. Since the reclamation work has started the acidity to alkalinity ratio has been reduced to 2 to 1. The reclamation work was 80% completed on December 31, 1969 and consists of 120 acres of affected area.

Northwest Strip (Figure 16)

This area consists chiefly of the first strip mine reclamation work in the park. This work was being completed about the same time the mine drainage sampling program was starting. During the last six months of 1967 the total acidity exceeded the total alkalinity at a ratio of about 2 to 1 (78 to 42). Since that time the total alkalinity has varied from 1100 pounds to 6800 pounds while the acidity has always been less than 100 pounds.

Northeast Strip (Figure 17)

Prior to the reclamation work in this area, the acidity exceeded the alkalinity at a ratio of about 2 to 1. The reclamation work was started in the first half of 1969 and was 65% completed on December 31, 1969. At that time the acidity to alkalinity ratio was $1\frac{1}{2}$ to 1.

Hilliard Strip (Figure 18)

Prior to the reclamation work, the Hilliard strip had an acidity to alkalinity ratio of about 10 to 1. The strip mine reclamation work was started in the first half of 1969 and was 65% completed on December 31, 1969. At that time the alkalinity exceeded the acidity (762 to 615).

East Outside Strip (Figure 19)

This is an area of about 20 to 30 acres of affected area immediately east of park boundary on the north side of Muddy Run. There has been no reclamation work scheduled for this area because it is strip mine lands beyond the park boundary. Over the past 2½ years, this area has been producing about 400 to 4,000 pounds of acidity every six months.

Southeast Strip (Figure 20)

This is an area which had fairly erratic flows. Reclamation work was started during the last half of 1969 and was 65% complete on December 31, 1969.

Additional Results

In examining the overall results, we obtained flow and chemical data on Muddy Creek near Nealey (Weir No. 85) from 1967 until July 1969, when this sampling point was inundated due to the rising pool level. The water quality at this point ranged between a pH 6 and a pH 7 during that two year period. Data from other sources indicate that Muddy Creek varied from a pH 5 to pH 7 during years 1963 to 1966.

Starting in September 1969, water samples have been taken on a monthly basis at six locations in the pool. The chemical analysis has indicated good water quality with very little change from month to month. The following is a tabulation of data obtained at the six locations in the pool during September and December, 1969.

September, 1969

<u>Location</u>	<u>pH</u>	<u>Alk</u>	<u>Acid</u>	<u>Iron</u>	<u>Mn.</u>
Cooper	7.6	86	0	0.5	0
Nealey	7.2	68	0	1.9	1.0
Isle	7.0	72	0	1.6	0.7
422 East	7.1	76	0	1.1	0
NW Run	7.0	74	0	0.9	2.0
Outlet	7.0	76	0	1.1	3.5

December, 1969

<u>Location</u>	<u>pH</u>	<u>Alk</u>	<u>Acid</u>	<u>Iron</u>	<u>Mn.</u>
Cooper	7.1	56	0	0.5	0.2
Nealey	7.0	44	0	0.4	0
Isle	6.9	24	0	3.2	0
422 East	7.2	56	0	1.5	0
NW Run	7.1	70	0	1.0	0.8
Outlet	7.1	66	0	1.2	2.5

CONCLUSIONS

The investigation and evaluation of the pollution abatement procedures have been limited primarily to deep mine sealing and strip mine reclamation projects. The refuse pile removal, surface sealing and well plugging projects were necessary in removing potential pollution hazards from the area. It was estimated the amount of pollution that would have been produced from the rock dump islands, the mine appurtenances, and abandoned wells under or near the water level of the new dam would have caused serious problems if these projects had not been carried out prior to the inundation.

The gates of the dam were closed on May 15, 1969. By the end of the year, 1969, the 3,225 acre lake was about half full by volume. Water samples taken from six locations in the pool from September through December indicate an alkalinity ranging from 20 to 90 P.P.M. If the pollution abatement projects had not been performed, it is very likely the pool would have had "acid" areas.

The hydraulic deep mine sealing project was 72% completed on December 31, 1969. This project has shown an improvement in water quality of 76%, by reducing the acidity from 96,000 pounds to 23,000 pounds. Of the 23,000 pounds, there are 9,000 pounds produced from mines (Wimer and Alben) that had no reclamation work to date.

The strip mine discharges were far more erratic than the deep mine discharges. In the strip mines the production of alkalinity and acidity generally varied directly with the amount of precipitation. The deep mine discharges did not vary much with climatic conditions. Prior to and during much of the strip mine reclamation work the amount of acidity produced was 2 to 4 times greater than the alkalinity; except for the last six months of 1969 when acidity was about equal to the alkalinity. The strip mine reclamation work was 80% completed on December 31, 1969.

Observations made in this study indicate the deep mines produced about 99% and the strip mines 1% of the acidity during dry weather; under wet to normal conditions, the ratio changed to a minimum of 80% for deep mines and a maximum of 20% for strip mines.

After completion of all the pollution abatement projects, I believe it is unrealistic to assume an overall 100% reduction in acidity. An estimate of about 80% to 90% total improvement could be expected.



FIGURE 2

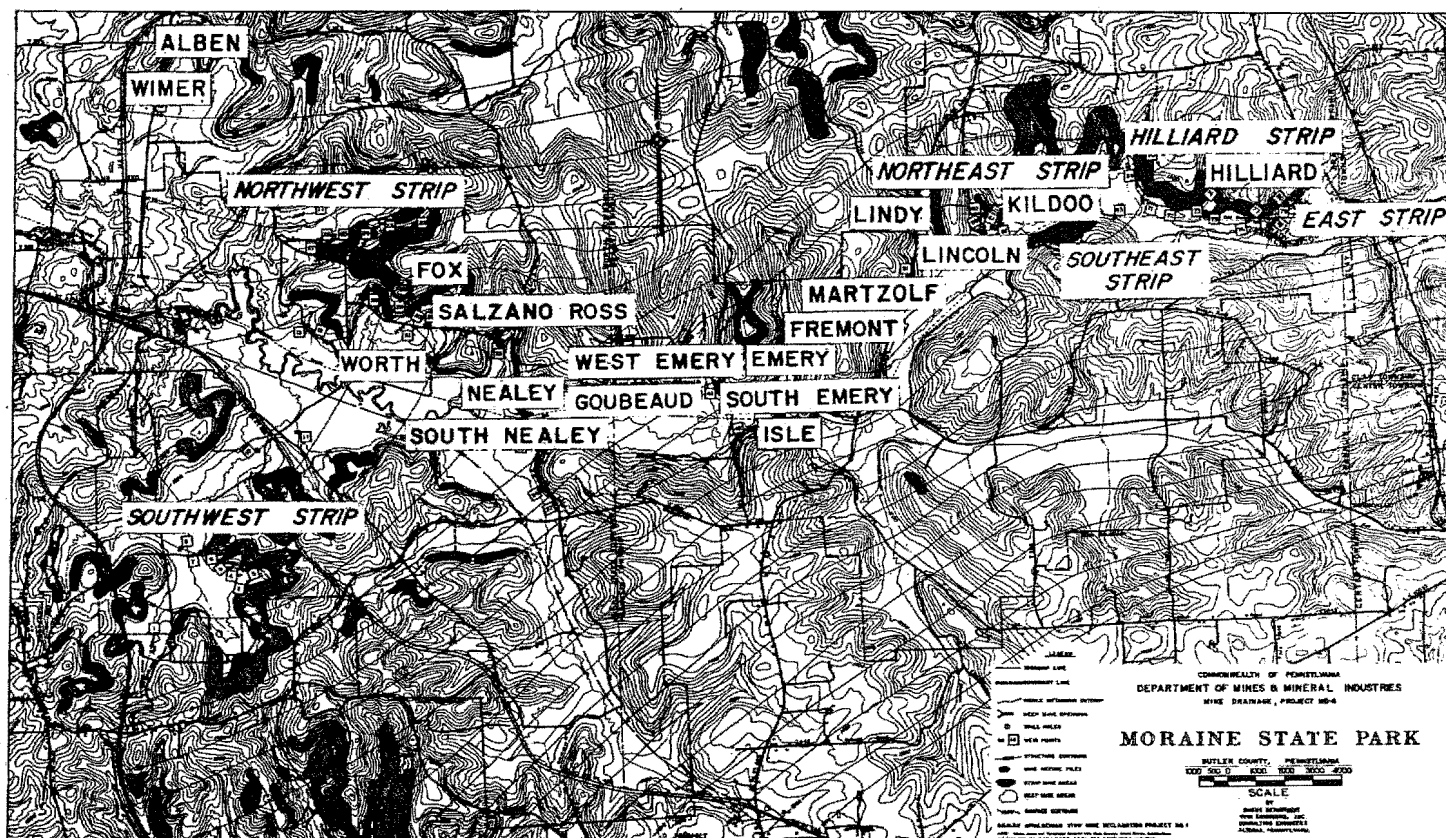


FIGURE 3

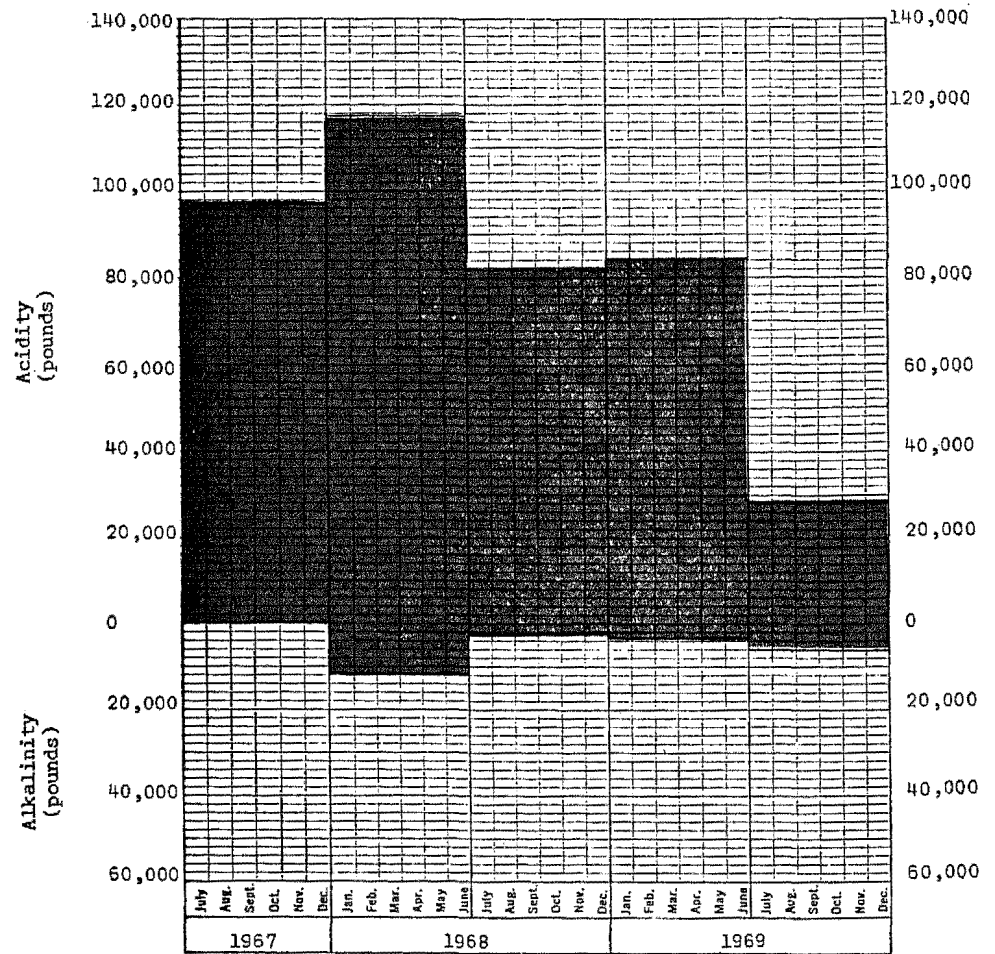
TABULATION OF TOTAL POUNDS OF ALKALINITY AND ACIDITY
FOR DEEP MINE AREAS

Deep Mine Areas	1967		1968				1969			
	July to December		January to June		July to December		January to June		July to December	
	Alkalinity	Acidity	Alkalinity	Acidity	Alkalinity	Acidity	Alkalinity	Acidity	Alkalinity	Acidity
Wimer	0	3,870	0	5,292	0	3,219	0	3,018	0	2,202
Alben	0	5,400	0	6,150	0	7,362	0	5,403	0	6,258
Fox	0	6,330	0	3,627	0	3,060	24	2,199	0	636
Salzano Ross	0	25,920	0	30,690	0	26,580	0	34,560	78	0
South Nealey	0	1,850	6	5,190	18	78	0	396	0	0
Nealey	0	830	6	120	0	726	9	96	0	0
Goubeaud	0	180	0	165	0	468	0	33	0	0
West Emery	0	54	87	24	3	456	63	132	60	39
Emery	0	2,200	45	261	27	201	15	156	129	1,065
South Emery	0	900	36	0	30	69	21	66	6	129
North Emery	105	900	72	12	57	240	99	120	84	69
Fremont	108	0	0	0	15	12	21	123	87	9
Isle	27	183	99	246	6	99	159	165	246	0
Martzolf	3	414	9	138	12	360	66	207	81	195
Lindey	0	4,236	9	4,575	0	3,174	24	2,052	0	2,163
Lincoln	0	25,494	12	19,974	0	12,387	0	10,080	0	4,797
Kildoo	0	18,020	0	18,240	0	16,857	0	11,184	0	5,250
Hilliard	27	99	69	1,020	132	264	159	573	78	198
	270	96,880	450	95,724	300	75,612	660	70,563	849	23,010

TABULATION OF TOTAL POUNDS OF ALKALINITY AND ACIDITY
FOR STRIP MINE AREAS

Strip Mine Areas	1967		1968				1969			
	July to December		January to June		July to December		January to June		July to December	
	Alkalinity	Acidity	Alkalinity	Acidity	Alkalinity	Acidity	Alkalinity	Acidity	Alkalinity	Acidity
Southwest	0	0	714	5,922	216	1,383	396	4,584	939	2,091
Northwest	42	78	6,753	30	1,137	51	1,785	99	1,632	45
Northeast	0	57	4,056	10,320	441	651	351	4,296	1,128	1,692
Hilliard	0	0	120	2,190	117	1,011	330	393	762	615
East Outside	0	444	0	3,060	0	1,431	3	4,005	0	1,041
Southeast	198	24	186	6	730	1,630	105	681	720	0
	240	603	11,829	21,528	2,641	6,157	2,970	14,058	5,181	5,484

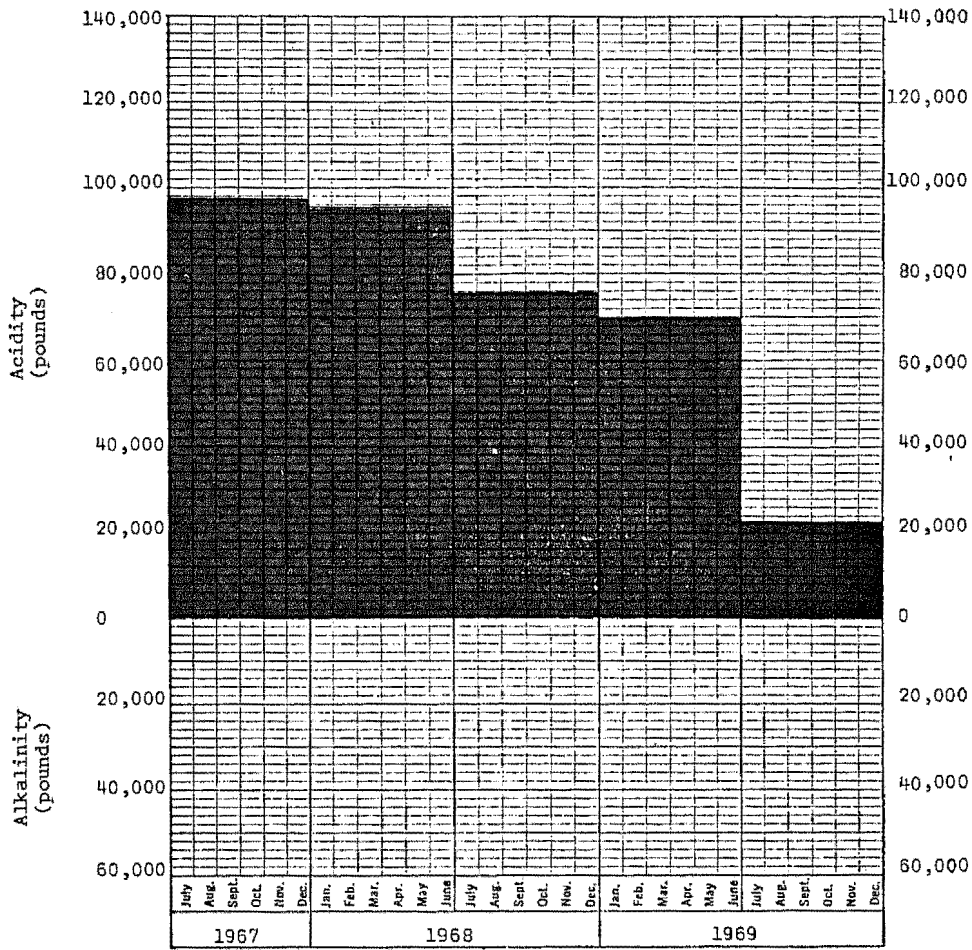
FIGURE 4



TOTAL OF DEEP MINE & STRIP MINE DISCHARGES

Pounds of alkalinity and acidity

FIGURE 5



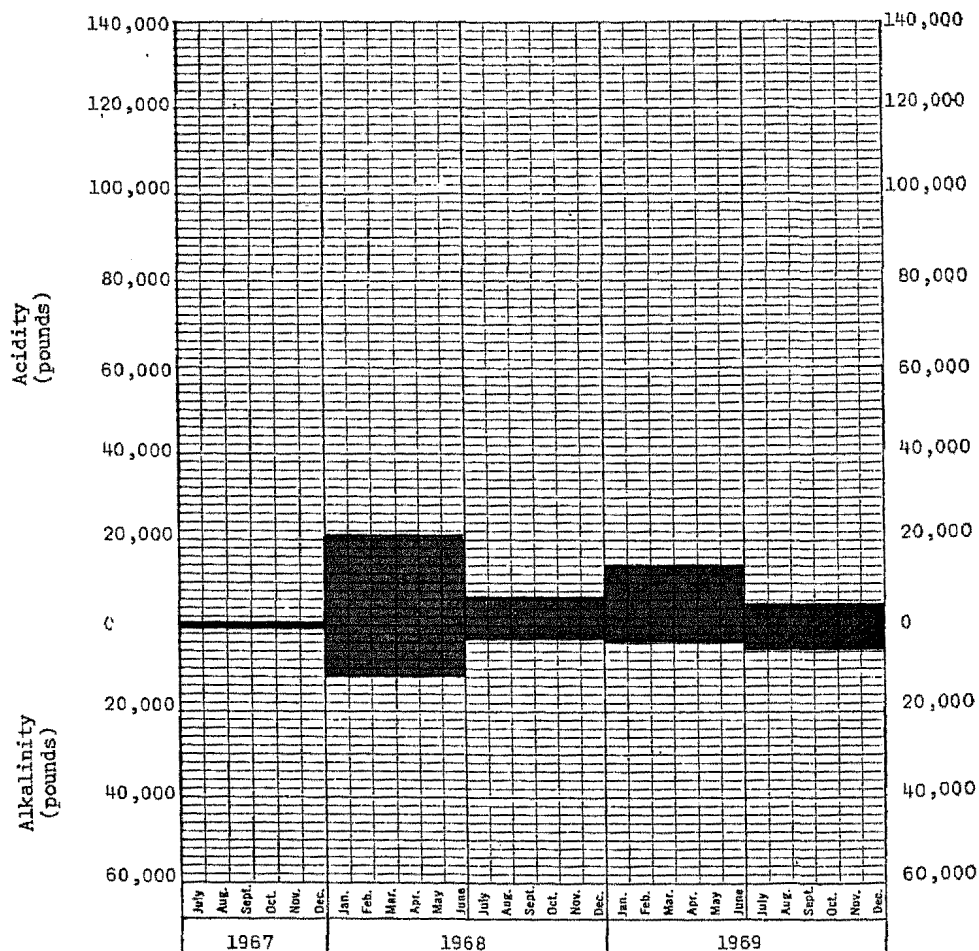
TOTAL DEEP MINE DISCHARGES

Pounds of alkalinity and acidity

Deep mine sealing project began February 1969

Project 72% completed - December 31, 1969

FIGURE 6



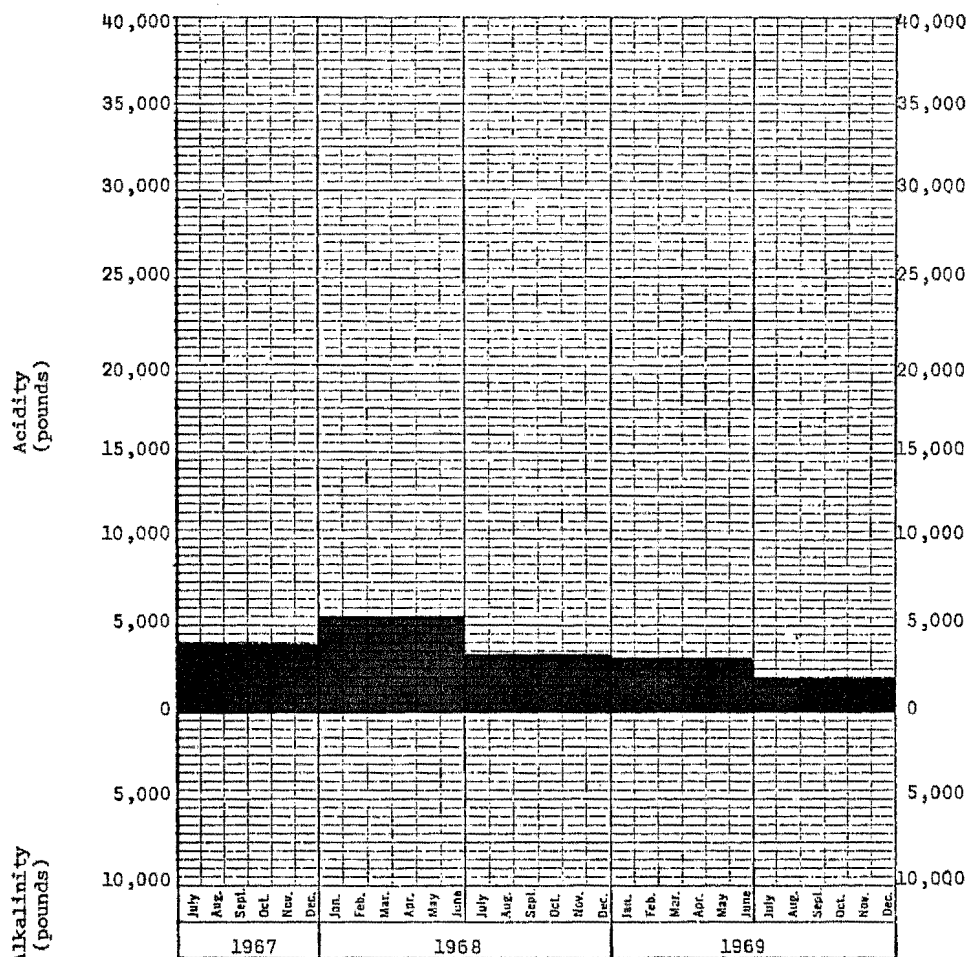
TOTAL STRIP MINE DISCHARGES

Pounds of Alkalinity and Acidity

Strip mine reclamation work started June 12, 1967

All strip mine reclamation 80% complete -
December 31, 1969

FIGURE 7



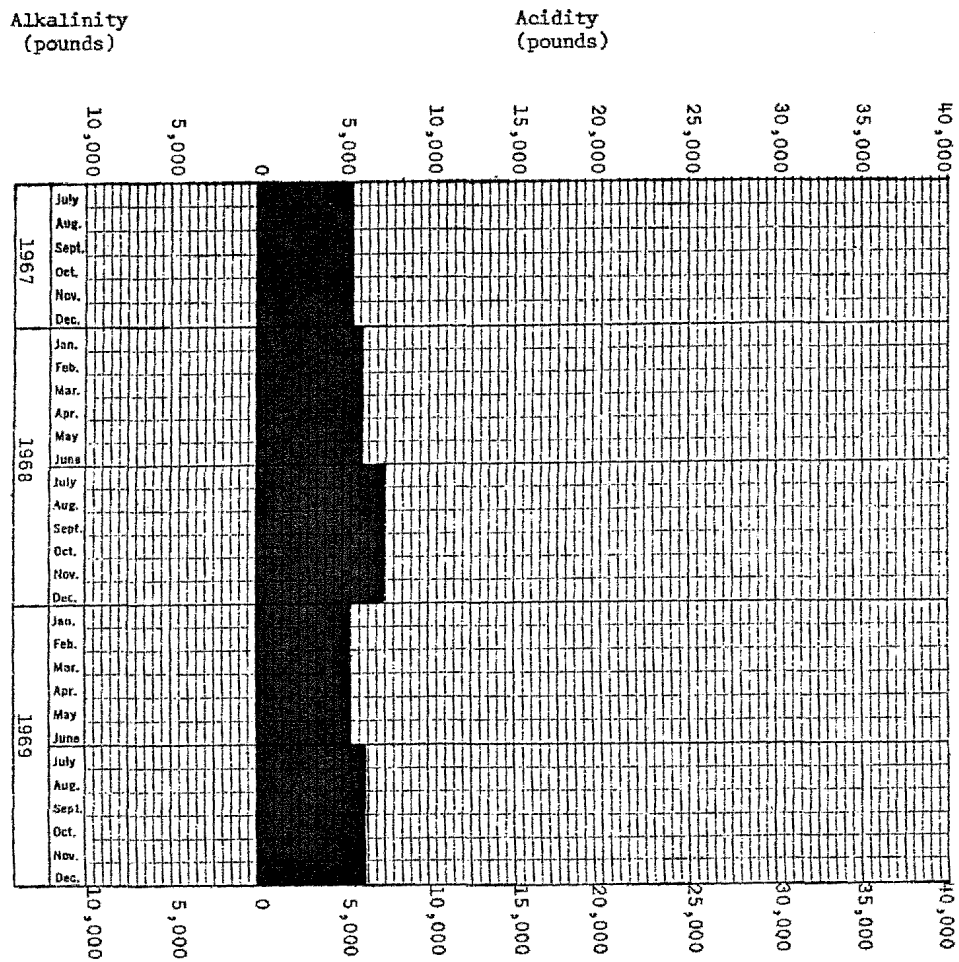
DEEP MINE DISCHARGES

WIMER MINE

Deep Mine Sealing Project Planned

No reclamation work in progress

FIGURE 8



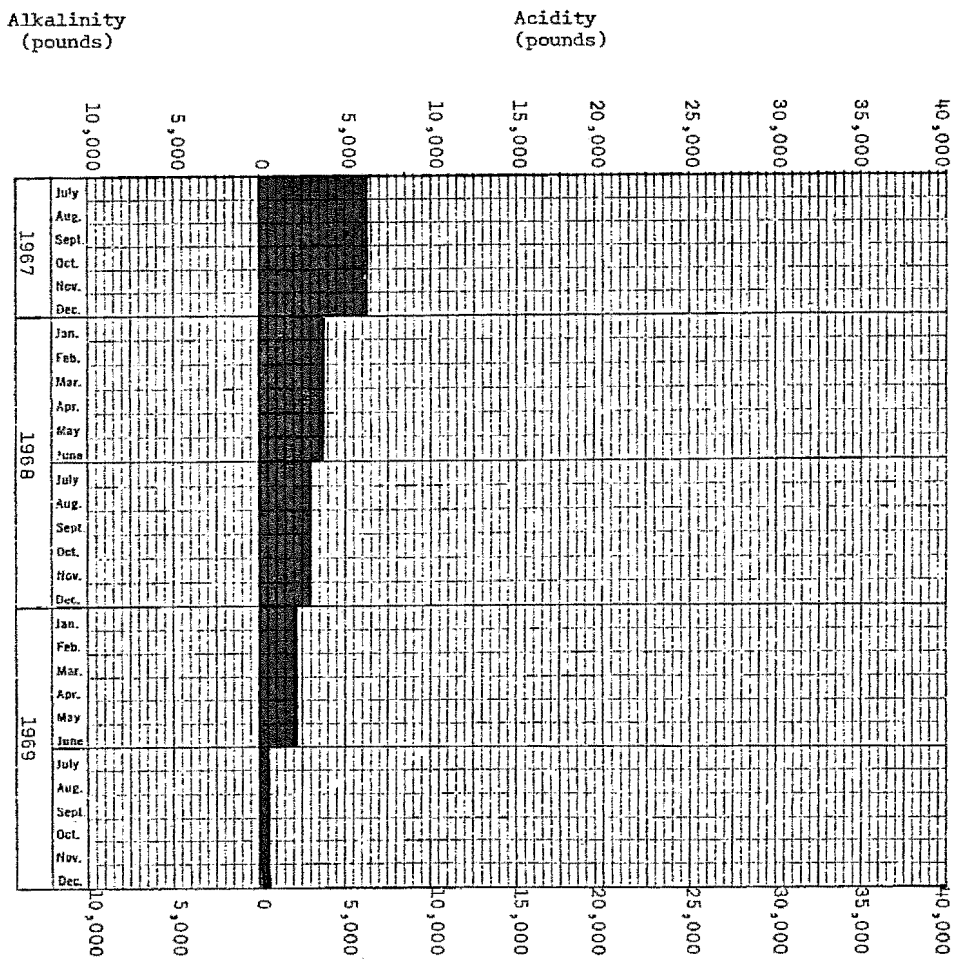
DEEP MINE DISCHARGES

ALBEN MINE

Deep Mine Sealing Project Planned

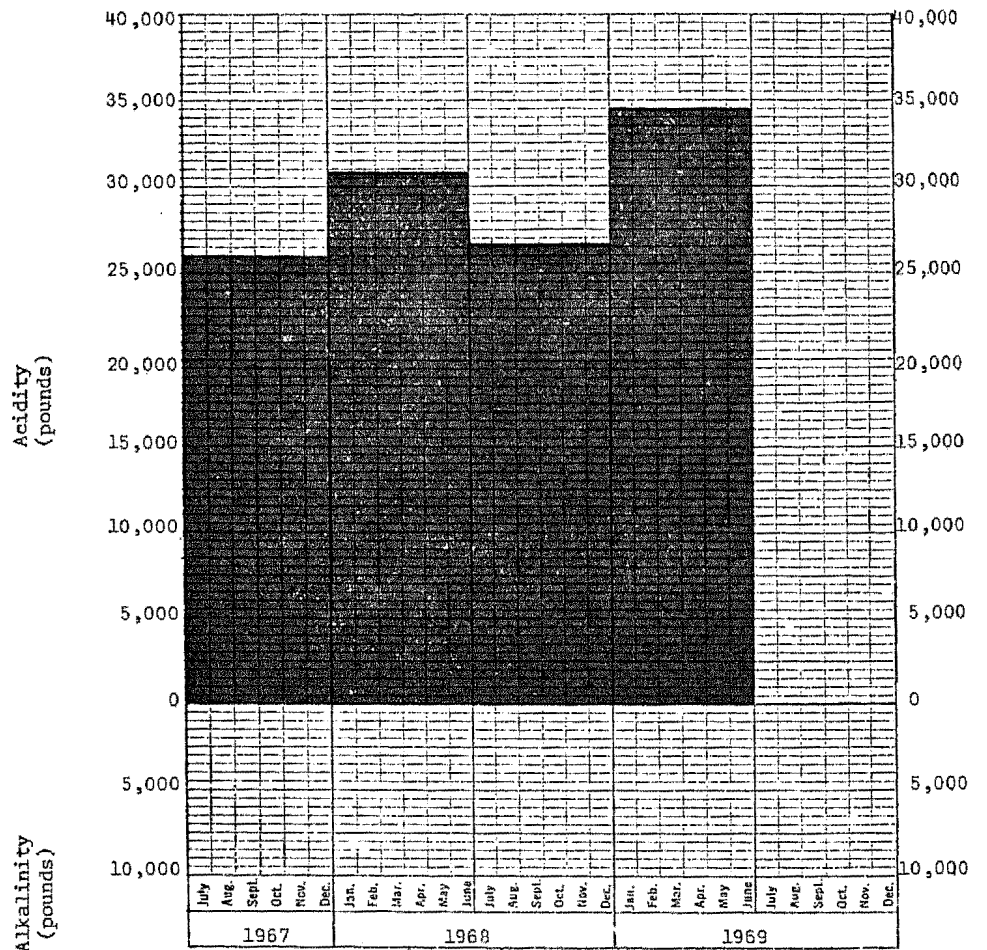
No reclamation work in progress

FIGURE 9



Deep Mine Sealing Project Began July 1969
Project 85% Complete Dec. 31, 1969

FIGURE 10



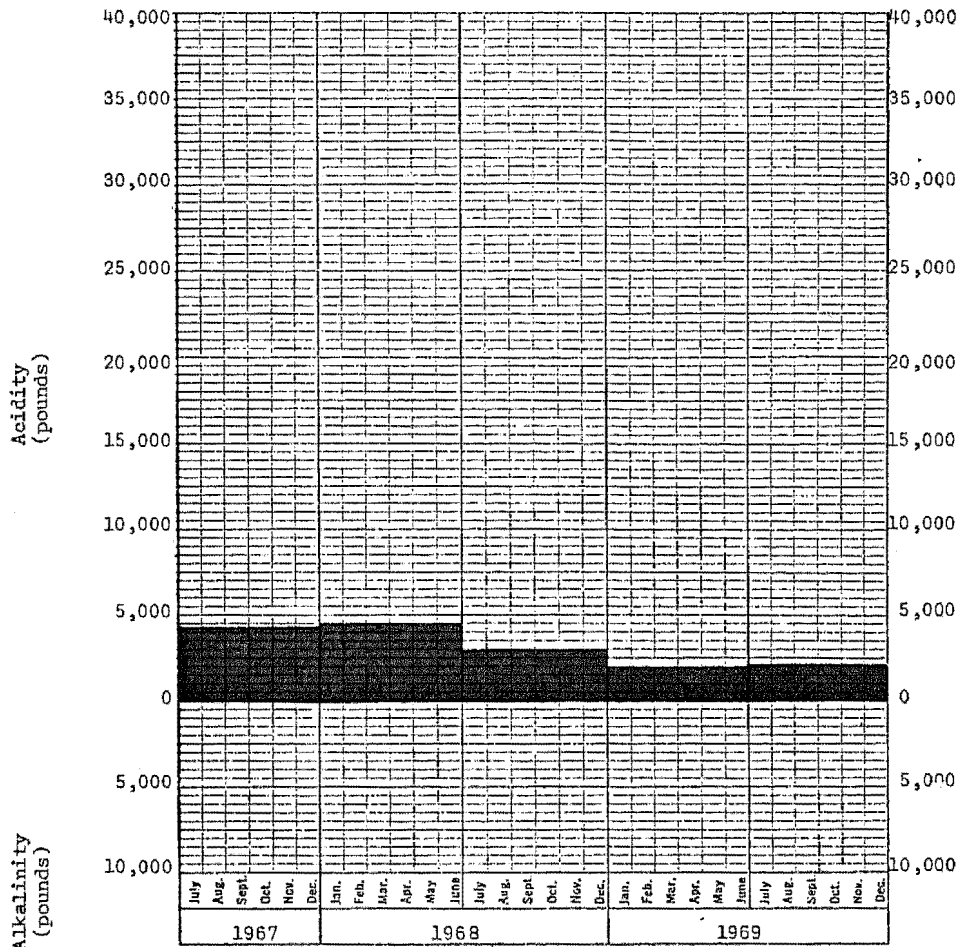
DEEP MINE DISCHARGE

SALZANO ROSS MINE

Deep Mine Sealing Project began June 1969

Project 100% Complete Dec. 31, 1969

FIGURE 11



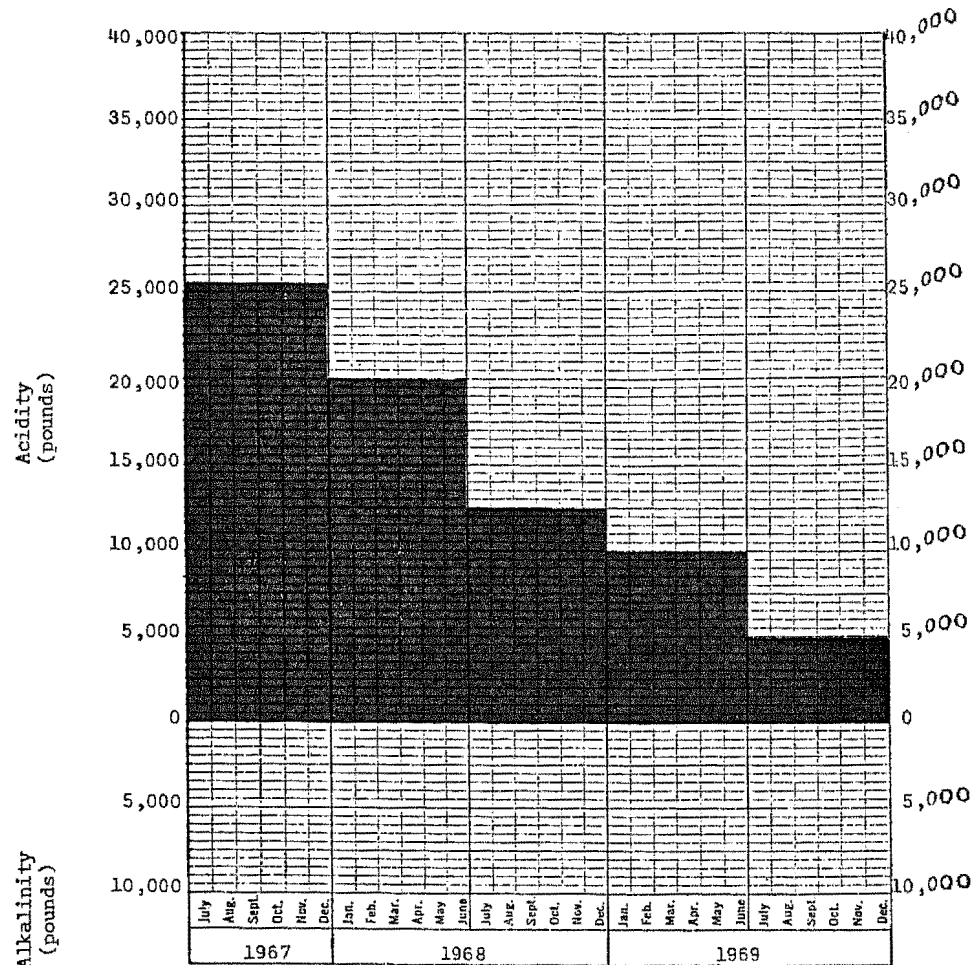
DEEP MINE DISCHARGES

LINDEY MINE

Deep Mine Sealing Project Began August 1969

Project 60% Complete December 31, 1969

FIGURE 1.2



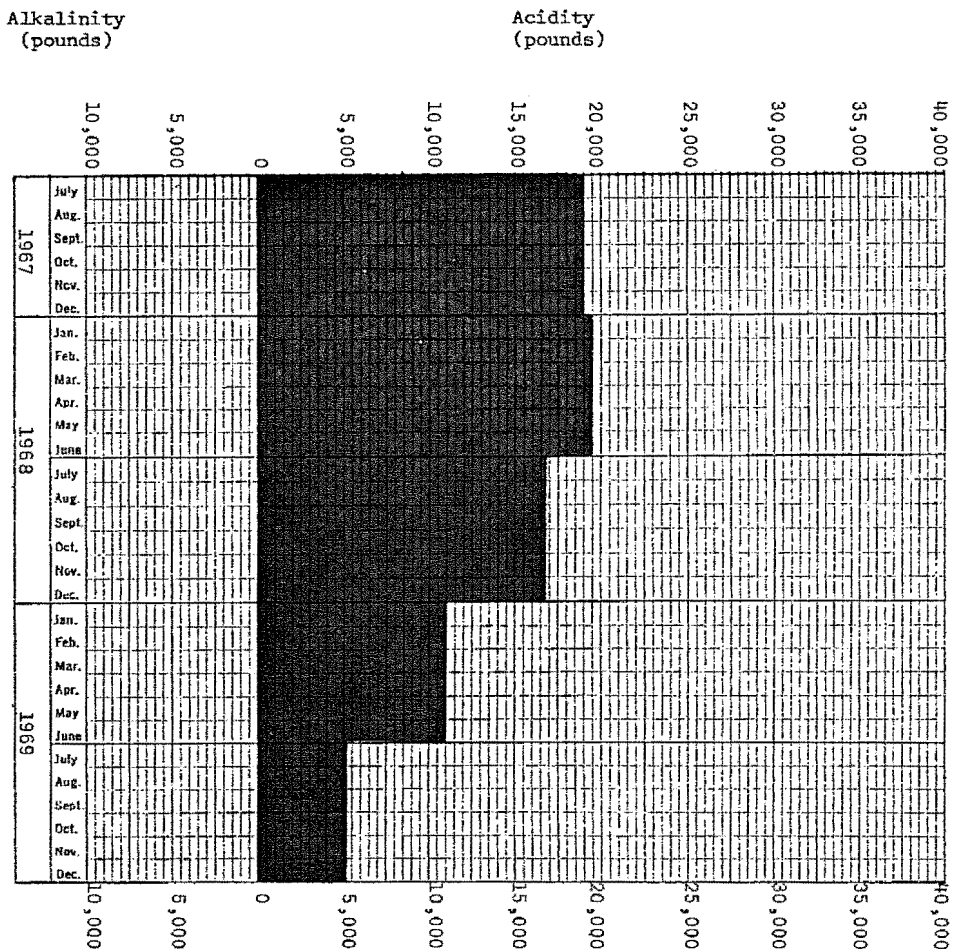
DFEP MINE DISCHARGE

LINCOLN MINE

Deep Mine Sealing Project Began February 1969

Project 90% Complete December 31, 1969

FIGURE 13



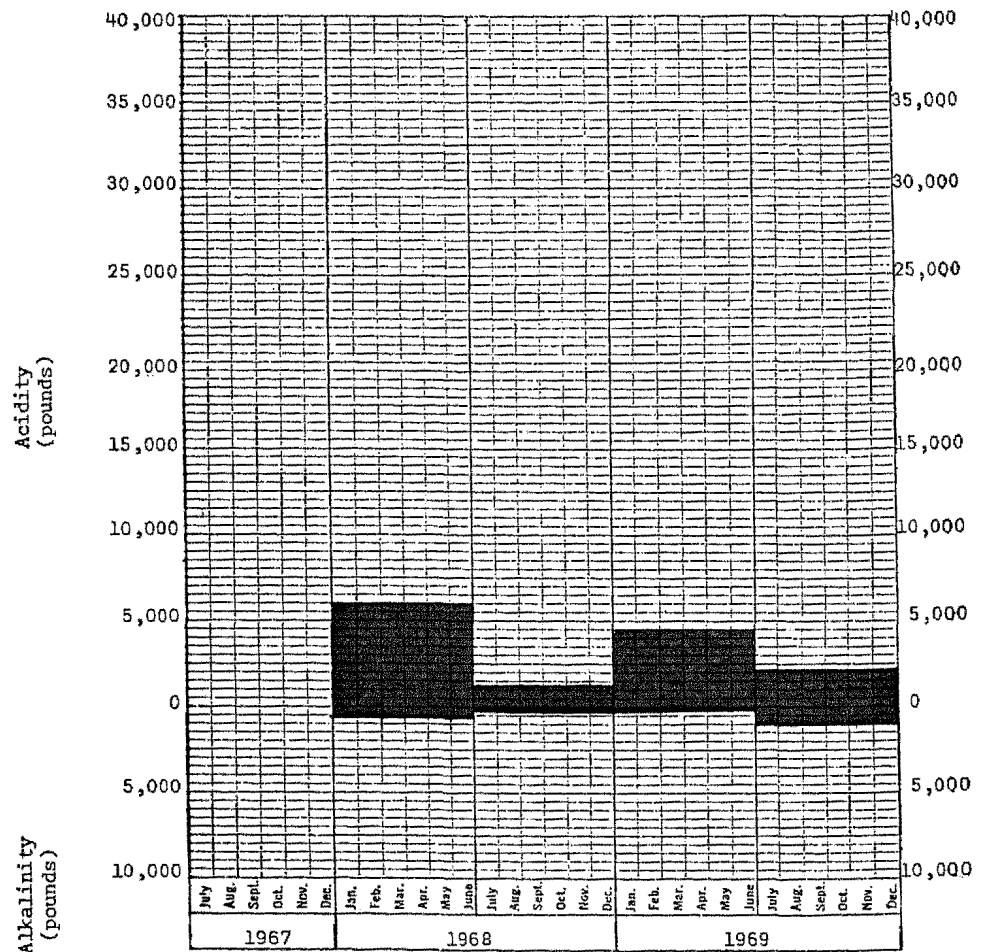
DEEP MINE DISCHARGE

KILDOO MINE

Deep Mine Sealing Project Began February 1969

Project 85% Complete December 31, 1969

FIGURE 14



STRIP MINE DISCHARGES

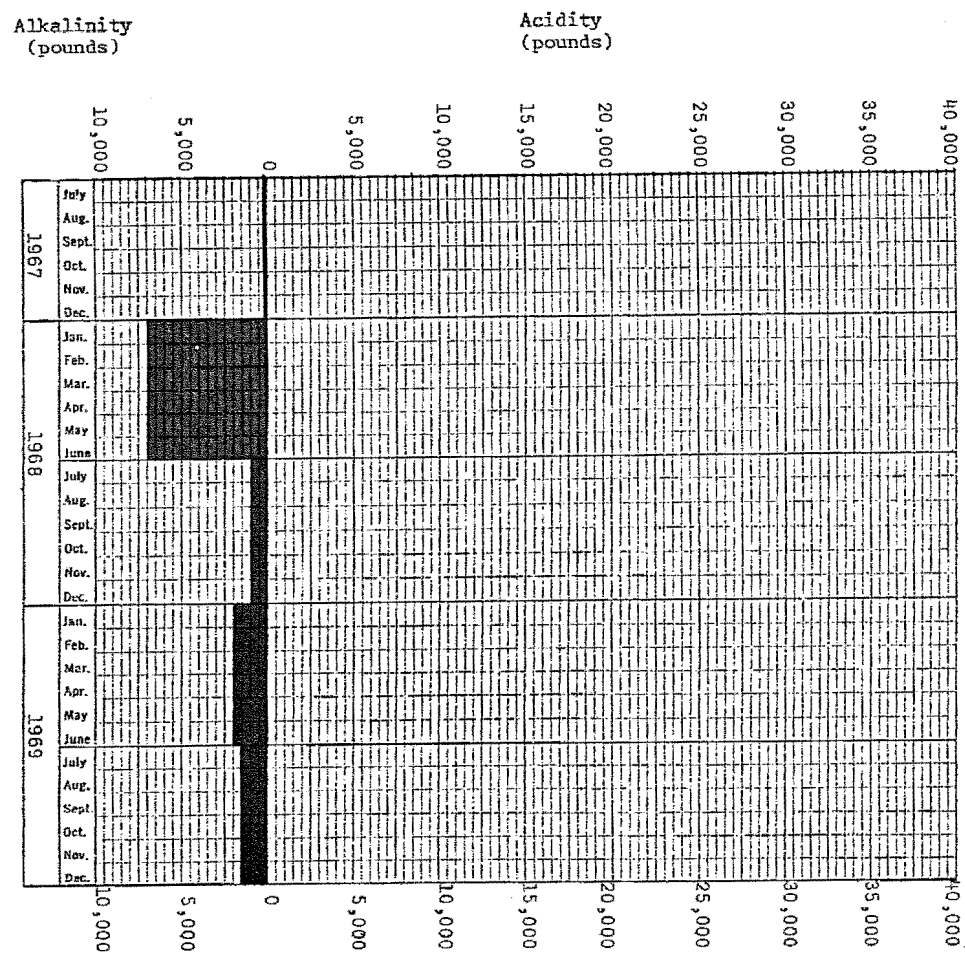
SOUTHWEST STRIP

Reclamation work begun in last half of 1969

Project 80% Complete - December 31, 1969

120 acres - Total affected area

FIGURE 15



STRIP MINE DISCHARGES

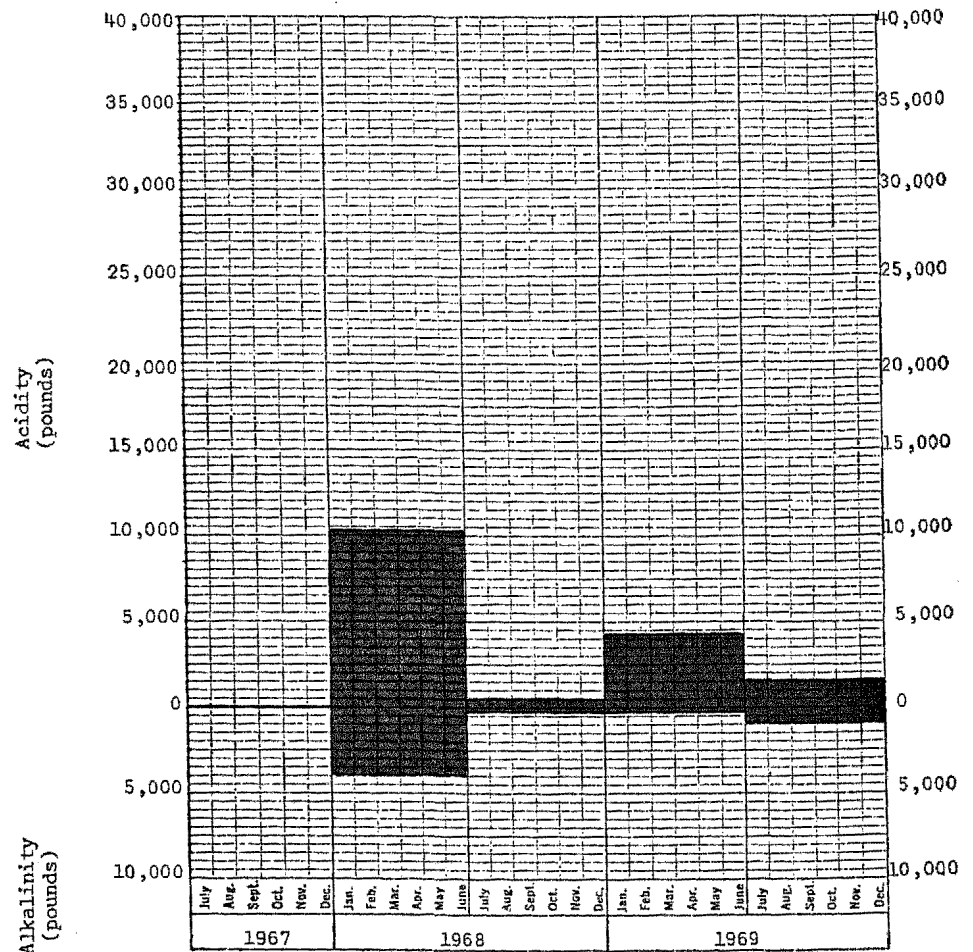
NORTHWEST STRIP

Reclamation work began 1967

Project 100% Complete December 31, 1969

177 acres total affected area

FIGURE 16



STRIP MINE DISCHARGES

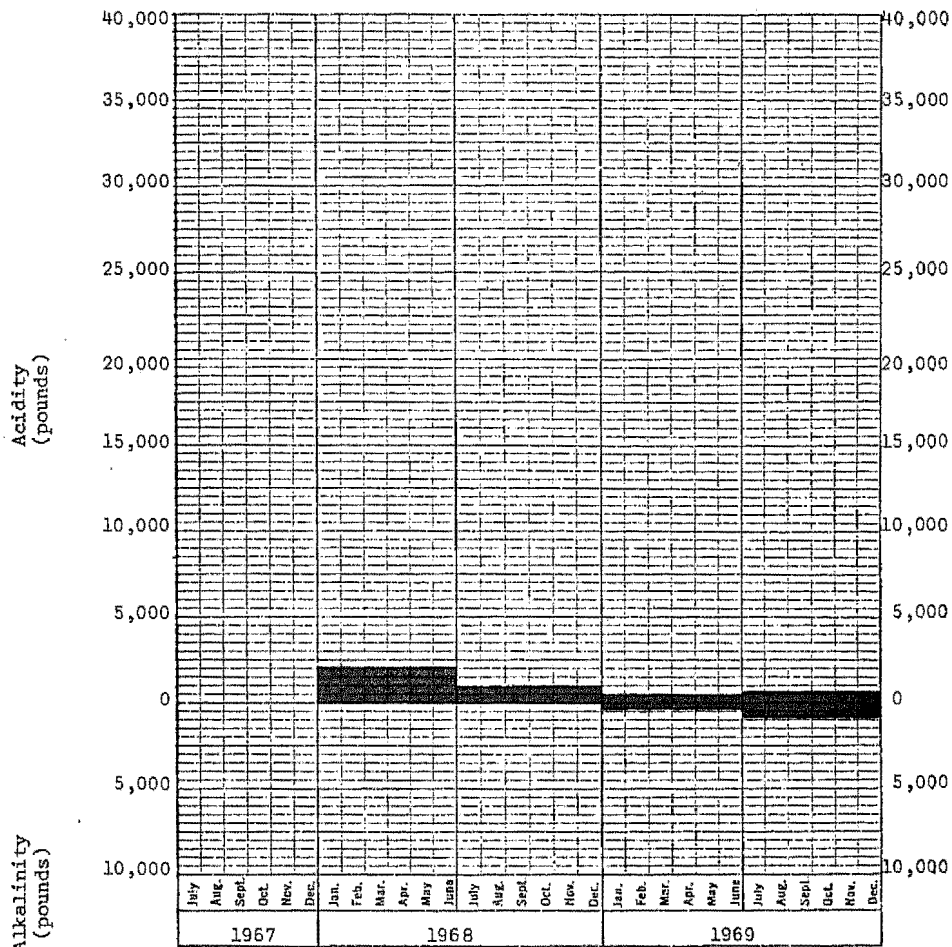
NORTHEAST STRIP

Reclamation work began first half 1969

Project 65% Complete December 31, 1969

75 acres total affected area

FIGURE 17



STRIP MINE DISCHARGES

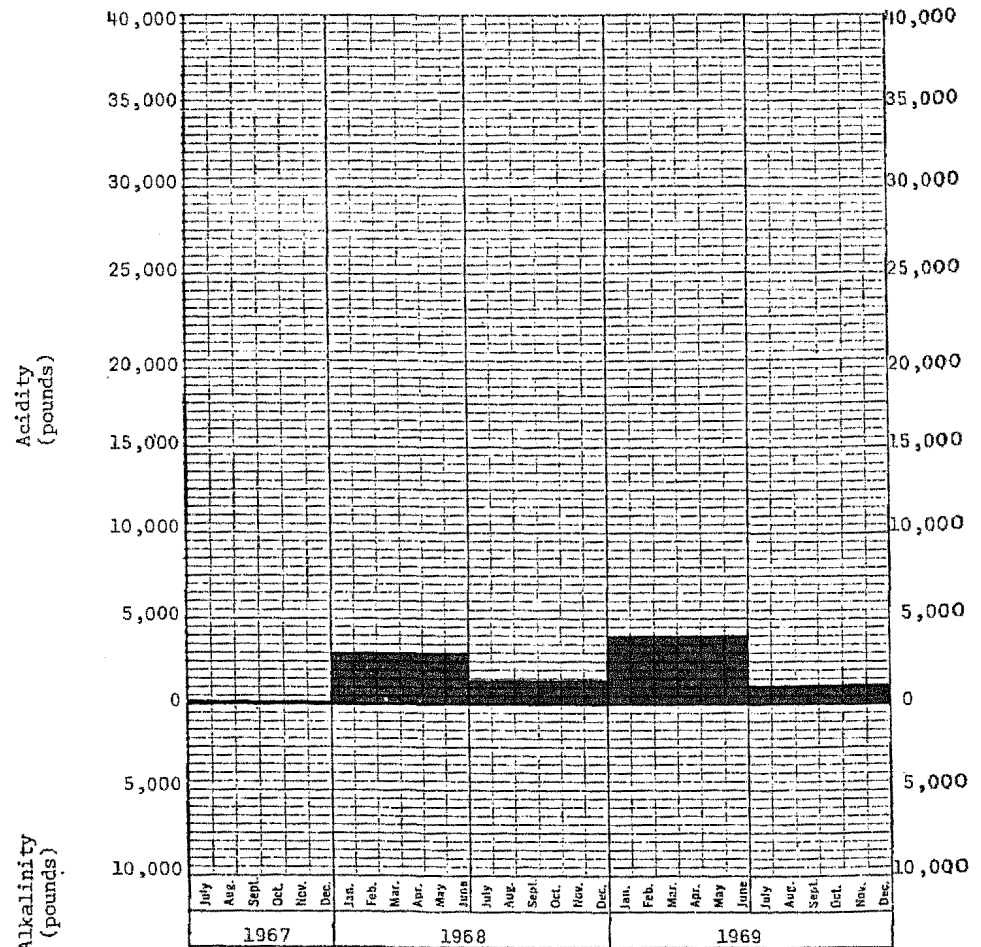
HILLIARD STRIP

Reclamation work began first half of 1969

Project 65% Complete December 31, 1969

50 acres total affected area

FIGURE 18



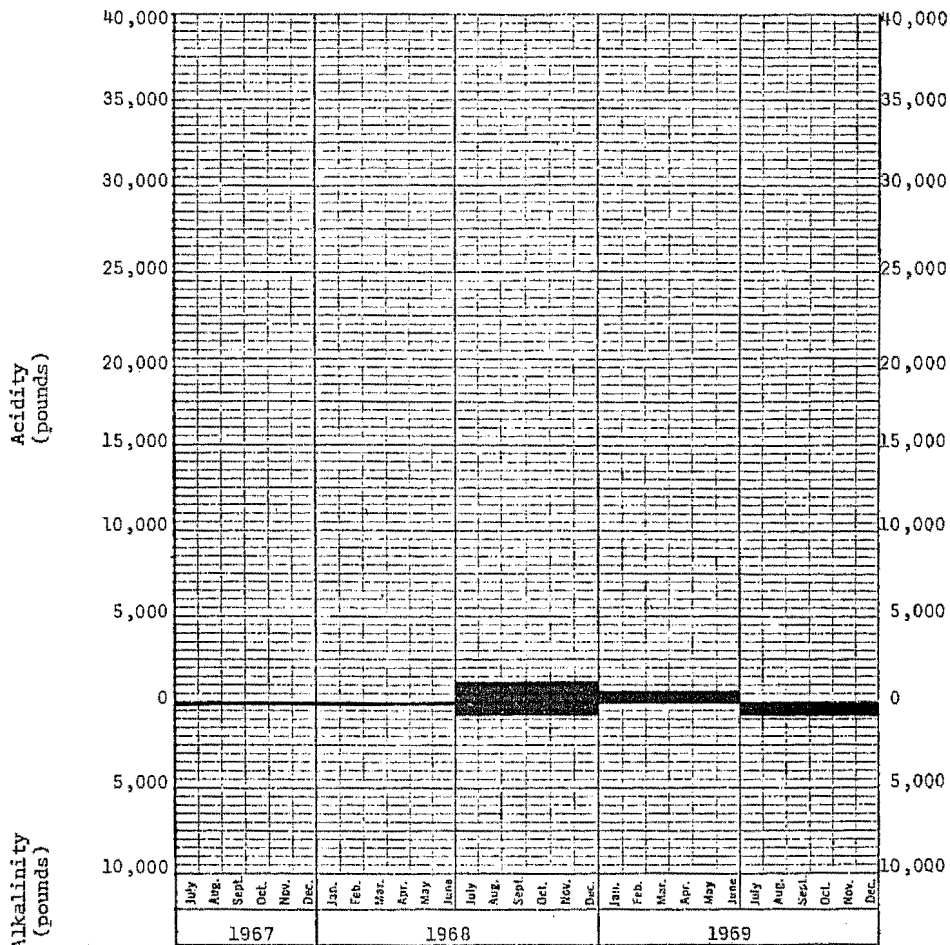
STRIP MINE DISCHARGES

EAST AREA (OUTSIDE PARK)

No reclamation work in progress

20 acres total affected area

FIGURE 19



STRIP MINE DISCHARGES

SOUTH EAST AREA

Reclamation work began last half 1969

Project 65% Complete December 31, 1969

25 acres total affected area

FIGURE 20