ABATEMENT

GENERAL CONSIDERATIONS

Objective - The objective of an abatement plan in Hillman State Park] is to eliminate, or at least minimize, acid mine drainage into the region's streams. Though not an objective, a side consideration would be to enhance the aesthetic qualities of the land with respect to its intended use.

Available Techniques - Generally two techniques are available to abate acid mine drainage: treatment and source control. The treatment technique involves treating to improve the quality of the water while source control attempts to rectify the cause of the poor water quality.

Source Control - The source control technique is considered the realistic approach to abatement of acid mine drainage in the Hillman State Park area for the following reasons:

1. Treatment techniques are generally effective and economical in situations where highly contaminated streams or large, localized sources exist. This condition does not prevail in Hillman State Park in that numerous seepage and drainage areas contribute to the total problem. Large individual discharges, such as those frequently found in deep mine areas, are easily adaptable to treatment. Sources such as these are not present in Hillman State Park.

2. Source control is a more suitable technique where, as a side consideration, overall improvement of the environment or land surface is desirable. As a state park, the Hillman area fits this qualification.

3. The cost of providing gathering facilities for a treatment system is normally prohibitive when a large number of small drainage sources exist over an extensive area.

SOURCE CONTROL METHOD

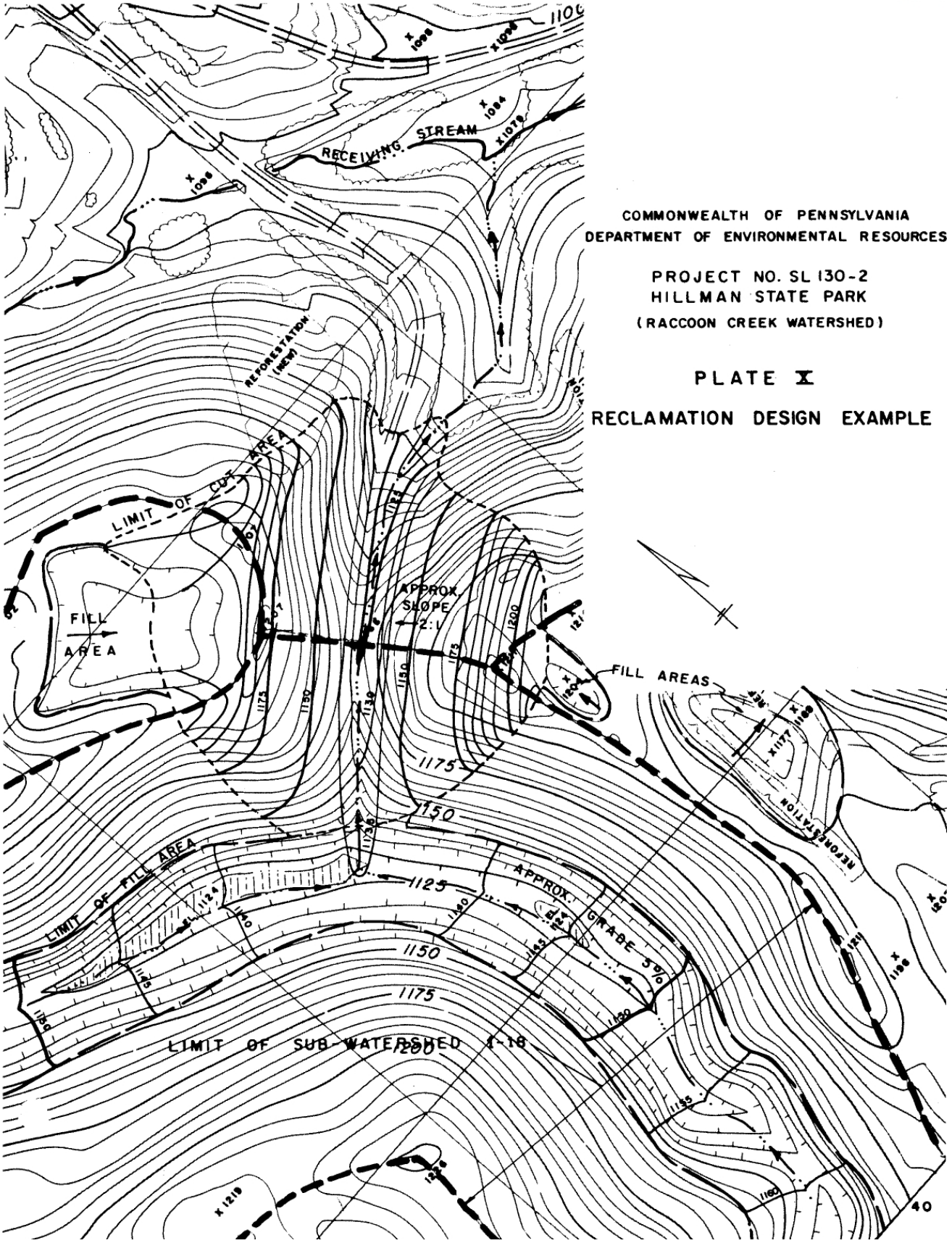
Method - The method of source control adaptable to the acid mine drainage problem of Hillman State Park is generally described in the literature as surface reclamation. Specifically, the type of surface reclamation required at Hillman State Park is the restoration of natural drainage through the performance of major earth moving. This operation would permit presently isolated sub-watersheds to be drained. Other associated work, where feasible, would be surface compacting of existing slopes to improve runoff and to provide for vegetative cover in areas of construction and adjacent areas.

The compaction performed within construction areas would not involve a high degree of compaction since a growth of suitable vegetative cover is sometimes difficult to obtain in highly compacted strip mine backfill.

Compaction of existing slopes beyond the limits of construction would generally be limited to areas where the degree of slope, possibly 15 degrees or less, would accommodate the compaction equipment. If necessary, some compaction could be performed in an ups lope-downs lope direction where stability of the equipment is a serious problem.

The vegetation program performed within and adjacent to the construction areas would generally consist of soil preparation with lime and fertilizer, and the planting of grasses and/or legumes suitable to the existing spoil material. The overall plan of providing vegetation could be integrated into the general developmental plans for the park area.

Example Reclamation Operation - A design example of the form of earthmoving proposed at Hillman State Park is shown on Plate X. The un-drained sub-watershed 1-18 is opened by excavation so that surface drainage will



COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES

PROJECT NO. SL 130-2
HILLMAN STATE PARK
(RACCOON CREEK WATERSHED)

PLATE X

RECLAMATION DESIGN EXAMPLE

result into the natural stream valley located to the northeast. The material obtained from excavation is placed within the low portions of the subwatershed to provide a grade suitable to permit the surface movement of water toward the receiving stream. A balance is struck between excavation and filling so that adequate grades are obtained, but a minimum amount of total material is moved. The Plate X example indicates both original and proposed contours, as well as the limits of cut and fill areas.

Absence of Highwalls - The method of surface reclamation adaptable to Hillman State Park is somewhat unique for the Western Pennsylvania area in that no typical highwall restoration would be performed over large strip mined areas. Highwalls do not exist in the area due to the completeness with which the surface mining was performed and the partial reclamation practices employed by the operator.

THE ABATEMENT PLAN

Summary - The overall abatement plan for Hillman State Park is summarized on the Composite Map and the tabulations contained in Appendix C.

Quick Start Areas - Possible work regions have been subdivided into four areas given the Quick Start designations I, 2, 3, and 4 for identification purposes. Sub-watersheds contained within each Quick Start are numbered with the prefix indicating the Quick Start grouping to which it belongs. (See Composite Map, Appendix C). For example, Quick Start 1 contains sub-watersheds 1-6, 1-12, 1-16, 1-18, etc. while sub-watersheds 3-1, 3-4, 3-8, etc. are contained within the Quick Start 3 area.

Groupings- Work areas within Quick Start No. 1 have been grouped to obtain a balance between required cut and fill quantities. For example, one work area within Quick Start 1 would include sub-watersheds 1-1, 1-6, 1-12, 1-15, and 1-28 (See Table 1, Appendix C).

A quantity of excavation from one sub-watershed becomes fill in another, but the total cut and fill quantities are balanced within the work area. The extent of each work area has been selected so that a contractor's earthmoving equipment could operate without having to move excessive distances to obtain fill or unload excess material. The grouping of work areas has also been made to provide a system of priority of work for the large Quick Start I area.

Justification - To determine the areas to include in the abatement plan, consideration was given to the following:

1. The severity of acid mine drainage at individual sources and the estimated contribution of specific sub-watersheds to the sources.

2. The present condition of the sub-watersheds with respect to existing ground cover and the estimated long term improvement which could result from reclamation.

3. The estimated amounts of acid mine drainage reducible in relation to reclamation cost estimates for the various sub watersheds.

4. The sub-watershed acres to be restored relative to estimated reclamation costs.

5. The possibility of creating new and undesirable acid mine discharges by destroying existing ground cover during the construction process.

Earthmoving Quantities - To perform the abatement plan, the estimated quantities of required earth movement are shown on Tables 1, 2, 3, and 4 of Appendix C for each of the four possible Quick Start areas. In addition, a summary tabulation is included as Table 5. The summary indicates the total earthmoving quantity for abatement in HiIlman State Park to be approximately 1.7 million cubic yards. The total area restored would be 801 acres.

Acid Load Reductions - Acid loadings for each Quick Start area are summarized on Table 6 in Appendix C. The estimated acid load reductions possible through reclamation within each Quick Start area are presented on Table 8. Also included on Table 8 are the estimated remaining, or residual, loads after reclamation. These load reductions were developed on the basis of

a. Estimated fractional contributions of various sub-watersheds to the defined mine drainage sources.

b. Definition of possible work areas in the more critical sub-watershed areas.

c. Estimates of acid load reductions and residuals based on an area weighting technique to account for worked versus un-worked areas and variations in watershed contributions and existing ground covers.

On the basis of total acid, the load reduction through application of reclamation measures in Hillman State Park is estimated at about 5,130 lbs/day or approximately 56% of the existing total load of 9,120 lbs/day. The corresponding residual load is 3,990 lbs/day. With respect to net acid loads, the estimated reduction is approximately 74% of the current net acid load of 6,770 lbs/day. As is apparent from the Table 8 data, the majority of the estimated load reduction is related to the Quick Start I work area.

Residual Acid Loads - The estimates of residual acid loads shown on Table 8 actually combine two estimated residual quantities. The first residual quantity represents the mine drainage which will not be abated because work in specific areas is not planned. The second residual quantity is the amount of mine drainage which is estimated to continue within work areas simply because the reclamation process will not be 100% effective. Of the total residual estimate of 3990 lbs/day indicated on Table 8, about 2890 lbs/day is estimated to result from un-reclaimed areas while 1100 lbs/day is estimated to be residual from reclaimed land.

Associated Work - To complete the proposed abatement in Hillman State Park, work required in addition to major earthmoving operations would consist of moderate regrading and surface compaction of selected slopes, and planting. The regrading and surface compaction of slopes within and adjacent to the various sub-watersheds would be performed to improve runoff toward newly graded areas and receiving streams. The planting operation would be aimed at providing vegetative cover over those areas where major earthmoving is performed and also along critical stream valley slopes where required to minimize contamination of runoff water and soil erosion.

Some effort should be made to preserve the upper soil zone, where feasible, so that this soil can be replaced on surface in construction areas. Although vegetation is sparse in many proposed work areas, the upper soil layer does contain some organic material which should prove helpful to the subsequent soil-forming process. Also, current surface materials are weathered as a result of past exposure and are less likely to add to the quantities of acid mine drainage. The delivery of topsoil from outside of

Hillman State Park, or even other regions of the park, is not believed practical in view of quantities and distances involved.

ESTIMATED COSTS

Summary - A summary of estimated abatement costs for the four possible Quick Start areas of Hillman State Park is provided on Table 9 of Appendix C. The total estimated cost for all abatement work is $1,144,000.

Development of Cost Estimates - The abatement cost estimates have been developed upon the following considerations:

I. The total estimated quantities of earthmoving involved.

2. Assumed construction completion times of ten months for Quick Start I, one month for Quick Start 2, and four months each for Quick Starts 3 and 4.

3. Estimates of equipment requirements to perform the proposed work within the assumed project completion times.

4. Estimated rental rates for the necessary equipment.

5. Allowances for performing the proposed compaction, planting and engineering supervision work.

A detailed cost estimate for the proposed Quick Start I area was submitted in a separate proposal to the Department of Environmental Resources in April 1971. Detailed cost estimates for other Quick Start areas will follow this report.

Cost Subdivision by Work Area - It may be of interest to subdivide costs within the individual Quick Start I work areas. Since earthmoving is the dominant cost item in the estimate, a ratio of cubic yards for a given work area to the total cubic yards for Quick Start I may be used to obtain an approximate cost breakdown. Table I in Appendix C provides cubic yard information by work areas.

QUICK START PRIORITIES

Summary -.The suggested priorities for performing the proposed abatement work in Hillman State Park are summarized on Table 10 in Appendix C.

Basis - Priorities for the Quick Start areas are dependent upon the severity of acid mine drainage, the estimated effectiveness of abatement, and the estimated abatement costs. To establish priorities, two key indicators were developed. The first relates cost to expected acid toad reduction and the second relates cost to acres restored to natural drainage.

Results.- All results are provided in Table 10. The work priority suggested by the key indicators, proceeding from first to last, would be Quick Start I, 3, and 4. A priority is not indicated for the Quick Start 2 area in view of the net alkalinity of the area on an average basis and thus doubtful work justification.

PRIORITIES WITHIN QUICK START NO. 1

Work Areas - Priorities for individual work areas contained within Quick Start I have been developed. The Quick Start I area is large and a priority listing provides a method by which the. work may proceed in a logical order.

Basis - The priority of work within Quick Start I was developed on the basis of cost/abatement ratios.

Results - A tabulation of results is provided on Table II in Appendix C.

CONCLUSIONS

NATURE OF POLLUTION

A Surface Problem - The problem of acid mine drainage in Hillman State Park is a result of disrupted surface drainage caused by better than fifty years of surface mining activities. Deep mining is essentially non-existent in the area and therefore is not a contributor to the overall problem.

Acid Formation - A major share of the acid mine drainage in Hillman State Park develops as runoff water is trapped within un-drained sub-watersheds. This trapped water subsequently filters through loose backfill material and ultimately exits along the banks of nearby streams. Pollution occurs as the water contacts reactive sulfur materials, both in the runoff and filtering stages. A second manner in which acid mine drainage forms in the area involves runoff and filtration of water on slopes located outside of the identified sub-watershed areas. This water also contacts reactive materials as it moves toward receiving streams both as runoff and subsurface flow.

SEVERITY OF POLLUTION

Extent - All major streams in Hillman State Park are polluted to some degree by acid mine drainage. The mine drainage is not severe according to the Commonwealth's water quality criteria and general EPA classification, but is highly undesirable with respect to the intended use of the area.

Total Acid Loads - The average and maximum total acid loads which are discharged into the major streams of Hillman State Park have been estimated as follows:

Stream	Total Acid Load, Lbs/Day Average	Maximum
Brush Run	6,400	18,600
Dilloe Run	2,350	6,800
Hogs Run	1,070	4,700
Others	780	1,300
Total	10,600	31,400

Approximately 15% of the indicated total acid loads are contributed by sources located outside the outer boundaries of Hillman State Park. Thus, the average and maximum amounts attributable to sources within the main park area, including the approximate 200 acres of private property in the central region of the park, are estimated at 9,120 lbs/day and 26,900 lbs/day respectively. A breakdown of these load values is provided in Table 6 of Appendix C.

Net Acid Loads - The net acid load, based on total acidity less alkalinity attributable to Hillman State Park sources is estimated to be 6,770 lbs/day on the average. The corresponding maximum load, on a net basis, is estimated at 23,700 lbs/day. Table 6 of Appendix C also summarizes net acid load data.

Brush Run - The predominant stream in Hillman State Park, Brush Run, enters the area in an alkaline state but, within a distance of 1/4 mile, degrades in quality as it is met by tributaries which originate in strip mined areas. Over the remainder of its 2.7 mile course east to Raccoon Creek, Brush Run remains in a variable acid flow condition. The overall water quality of Brush Run is reasonably good, normally showing a pH of 5.5 to 6.5, acidity of 0 to 200 mg/l, and sulfate between 1500 and 3000 mg/l.

Dilloe Run - Heavy acid flows occur into Dilloe Run at its headwaters in the northwestern portion of Hillman State Park but water quality improves significantly as the stream moves east toward Raccoon Creek. The general water quality of Dilloe Run indicates a pH range of 3.5 to 6.5, acidity of 200 to 1200 mg/l, and sulfate between 1000 and 5000 mg/l.

Dilloe Run discharges an estimated total acid load of some 2300 lbs/day to Raccoon Creek but study results indicate that approximately 30% of the load originates in mined areas outside of Hillman State Park.

Hogs Run - Hogs Run, a small stream in the eastern portion of Hillman State Park, exhibits variable acid flows. The quality of Hogs Run is reasonably good with a pH range of 5.8 to 6.5, acidity of 0 to 200 mg/l, and sulfate of 1000 to 3000 mg/l.

Unnamed Streams - The two minor streams located in the southeastern portion of Hillman State Park exhibit variable acid flows and together discharge an average of about 780 lbs/day of acid to Raccoon Creek. It is estimated that approximately 60% of this loading is attributable to pollution sources located outside of the Hillman State Park area.

COMPARISON TO PREVIOUS STUDY

FWPCA Results - The 1967 FWPCA study of Raccoon Creek reported some 6,600 lbs/day of net acid loading to be associated with the Brush Run and Dilloe Run sub-basins. The study also indicated a net alkalinity for Brush Run near its mouth prior to entering Raccoon Creek. The data for Brush Run and Dilloe Run was developed on the basis of one sampling.

Current Results - This survey, based on 13 months of sampling, shows an average net acid loading of about 6,460 lbs/day entering Brush Run and Dilloe Run. This result is within 2% of the preliminary figure developed in 1967 and thus is in very good agreement.

Brush Run- Although the FWPCA study reports net alkalinity for Brush Run at its mouth, the results of this survey indicates a net acidity to exist on a weighted basis. The FWPCA net alkalinity is based on a single sampling; in this survey only 4 or 30% of the 14 samplings made at the mouth of Brush Run showed a net alkalinity.

ABATEMENT

Technique - The abatement technique applicable to the problem of acid mine drainage in Hillman State Park is source control. The specific method of source control is surface reclamation.

Description of Work - The proposed abatement work in Hillman State Park consists principally of major earthmoving operations to open un-drained areas to existing stream valleys. Other work proposed is compaction and revegetation in the construction areas, compaction of selected slopes adjacent to the construction areas, and compaction and revegetation of specific slopes along selected streams.

Effectiveness - It is estimated that about 56% of the total acid load originating within Hillman State Park can be abated by performance of proposed Quick Start work. In the process, a total of 801 acres of land would be restored to natural drainage. The amount of abatement is based on estimates of sub-watershed contributions, selection of work areas, and an area weighting technique used to arrive at abated versus residual acid loads.

The estimated effectiveness of abatement, on the basis of net acid loads, amounts to an approximate 74% reduction to the current net load of 6,770 lbs/day. Table 8 in Appendix C summarizes expected acid load reductions.

Basis of Expectations - The success of surface reclamation has been proven in a number of areas over a period of years. In Hillman State Park, there is strong reason to believe that significant reductions in acid mine drainage can be achieved, principally because the drainage problem is reasonably well defined and related deep mine discharge problems will not exist. Only surface reclamation is involved; no deep mine breakthroughs or deep mine sealing problems will be encountered.

Short Term vs. Long Term Effectiveness - The 56o abatement estimate is the expected reduction to total acid load over a short term period arbitrarily defined as two growing seasons, or two years. It is reasonable to expect that effectiveness over the longer term will reach beyond this level - possibly 70% to 80%. Reduction beyond the 80% level does not appear feasible at this time since abatement of acid mine drainage sources outside of Hillman State Park is not included within the current plan and marginal non-work areas within the park will continue to produce mine drainage quantities for a number of years. Also, it is realistic to expect that some problem areas may be encountered during the abatement process.

Initial Deterioration - The construction involved in-the abatement plan will result in the exposure of fresh, reactive materials. Because of the new exposures, an initial reduction in water quality in Hillman State Park can be expected prior to general improvement. Where possible, the placement of previous surface soil layers in new construction areas will help to reduce the severity of the initial problem.

COSTS, BENEFITS AND PRIORITIES

Total Program Cost - The estimated cost of the total abatement plan for Hillman State Park is $1,144,000. The bulk of this estimated cost, $772,000, is associated with Quick Start I.

Benefits - The anticipated benefits of performing the abatement plan is an expected reduction in total acid stream loads of 5130 lbs/day and restoration of natural drainage for approximately 800 acres.

Subdivision by Quick Start Areas - Estimated abatement costs and benefits for individual Quick Start areas are as follows:

Quick Start Area	Abatement Cost	Total Acid Load Reduction Lbs/Day	Acres Restored
1	$ 772,000	3,590	490
2	38,000	150	31
3	200,000	840	179
4	134,000	550	101
Total	$1,144,000	5,130	801

Costs Per Acre - The calculated cost of the proposed surface reclamation in Hillman State Park is approximately $1430 per acre. This figure is developed from independent estimates of reclamation costs and total acres to be restored.

Comparative Costs - The comparison of reclamation costs for Hillman State Park to other areas is somewhat difficult because of the completeness with which the surface mining was performed. The Hillman property is perhaps more similar to one which has been "area" mined over extensive regions rather than "contour" mined along hillside outcrops.

In relation to reported reclamation costs for "area" mined land, the Hillman figure of $1430 per acre compares reasonably well. When compared to typical highwall restoration data, the Hillman estimate of $1430 per acre is high, but does remain within many reported ranges of cost.

The definition of restored area is a problem in attempting to compare Hillman State Park costs to available cost information for other projects. Within this study, a restored area refers to a complete work area and includes the previously undrained sub-watershed which is opened to natural drainage by the reclamation work. This definition of restored area possibly does not compare to that used to define a restored area in a typical highwall reclamation situation.

Priorities - Priorities for completion of the proposed Quick Start work have been developed on the basis of indicators relating cost to acid reduction and cost to acres restored. The established priorities are:

Priority I - Quick Start I
Priority 2 - Quick Start 3
Priority 3 - Quick Start 4

A priority is not provided for the Quick Start 2 work in view of the doubtful merits of this work at this time. For the large Quick Start I area, priorities have been established for individual work areas contained within the Quick Start area.

RECOMMENDATIONS

As a result of study of the acid mine drainage problem of Hillman State Park, the following recommendations are made:

I. Implement the abatement plan discussed in the Abatement and Conclusions sections of this report and as summarized on the Composite Map of Appendix C.

2. Perform the abatement plan in accordance with established priorities as indicated under Conclusions and Table 10 of Appendix C.

3. Obtain adequate cost data during the performance of the abatement plan. This information will prove useful in evaluating reclamation costs and methods in mined and partially reclaimed areas similar to Hillman State Park.

4. Allow for a continuing survey of acid mine drainage in the park area during and after the construction phase of the abatement program. This survey would serve as a check on the effectiveness of the abatement work.