PROJECT SL 191
TOBY CREEK WATERSHED
CLARION COUNTY PENNSYLVANIA

INTRODUCTION

GENERAL

The Toby Creek Watershed has been the subject of intensive mineral resource recovery operations for the past one hundred and fifty years. Primarily, these activities have included the surface and underground extraction, of bituminous coal and the drilling for petroleum and natural gas.

These operations, however, have had an adverse impact on the land and water environment of the Toby Creek Watershed. Most streams within the watershed are virtually devoid of aquatic life. Significant amounts of dissolved minerals in these waters has effectively disrupted the delicate biological environment. In addition, the water quality is such to preclude its use for human consumption or recreation. The pollution ultimately has its origin from abandoned mining operations. The resultant contamination known as acid mine drainage.

The land affected by past mining activities in the watershed has been greatly disrupted. Unvegetated spoil piles with little or no backfilling stand as mute testimony to this fact. The affected area is unsuitable for agricultural, commercial or conservational purposes. In addition, land of this nature is subject to severe erosion and greatly increases the sediment load to receiving streams. This further reduces the capacity of the streams to sustain aquatic life.

In order to effectively deal with acid mine drainage and its related problems, preliminary investigations are necessary. Studies of this nature identify and quantify problem areas and in turn provide the basis for effective means of dealing with the problems. The following report of the Toby Creek Watershed is one such endeavor.

The study initially involved a cursory sampling program of all streams tributary to the Toby Creek Watershed. As a result, the degree and extent of pollution due to acid mine drainage could be determined. In conjunction with this, monitoring stations were established to reveal a profile of water quality along Toby Greek and its main tributaries.

An investigation was then made of all surface and sub-surface mining operations along with oil or gas wells located within the watershed. Sources discharging acid mine drainage were identified along with a survey of. those areas capable of producing the same. Considerable public and private information was, utilized to facilitate this procedure.

Once the sources of pollution were identified, a large scale flow measurement and sampling program was initiated.. The data provided an accurate and quantitative measurement of the amount of acid mine drainage discharged to the watershed from each individual source.

An analysis of the data from all the sources revealed certain areas responsible for discharging large amounts of acid mine drainage. These areas were studied in more detail as to the conditions responsible for the pollution. This study involved disciplines of geology, hydrology, and mining engineering that were applicable to the acid mine drainage problem. However, the origins of pollution from particular sources were not readily discernible. Therefore, an exploratory drilling program was initiated to confirm suspected correlations between certain mining operations and the discharge points.

After a complete evaluation of the conditions responsible for the mine drain-. age pollution, recommendations were developed for each area. Each site was analyzed as to the engineering feasibility of various abatement alternatives. A determination was also made of the most cost effective methods. of abatement. The combination of these judgments resulted in an abatement plan for each project area in the Toby Creek Watershed. An estimate of the costs necessary to perform the proposed work were compiled for each project. The projects were assigned priorities relative to the amount of acid mine drainage each area was discharging.

It is felt that the implementation of the measures as outlined will improve the overall water quality within the Toby Creek Watershed. In addition, the proposed abatement plan will return considerable portions of land to useful and productive purposes. The resultant benefits will no doubt improve the overall quality of life for people in the immediate area.

LOCATION AND DESCRIPTION

The Toby Creek Watershed is located in the west-central portion of the Clarion River basin and directly northeast . of the Borough of Clarion. The watershed is surrounded on the east and south by the Clarion River and a number of its minor tributaries, on the west by Deer Creek and on the north by drainage

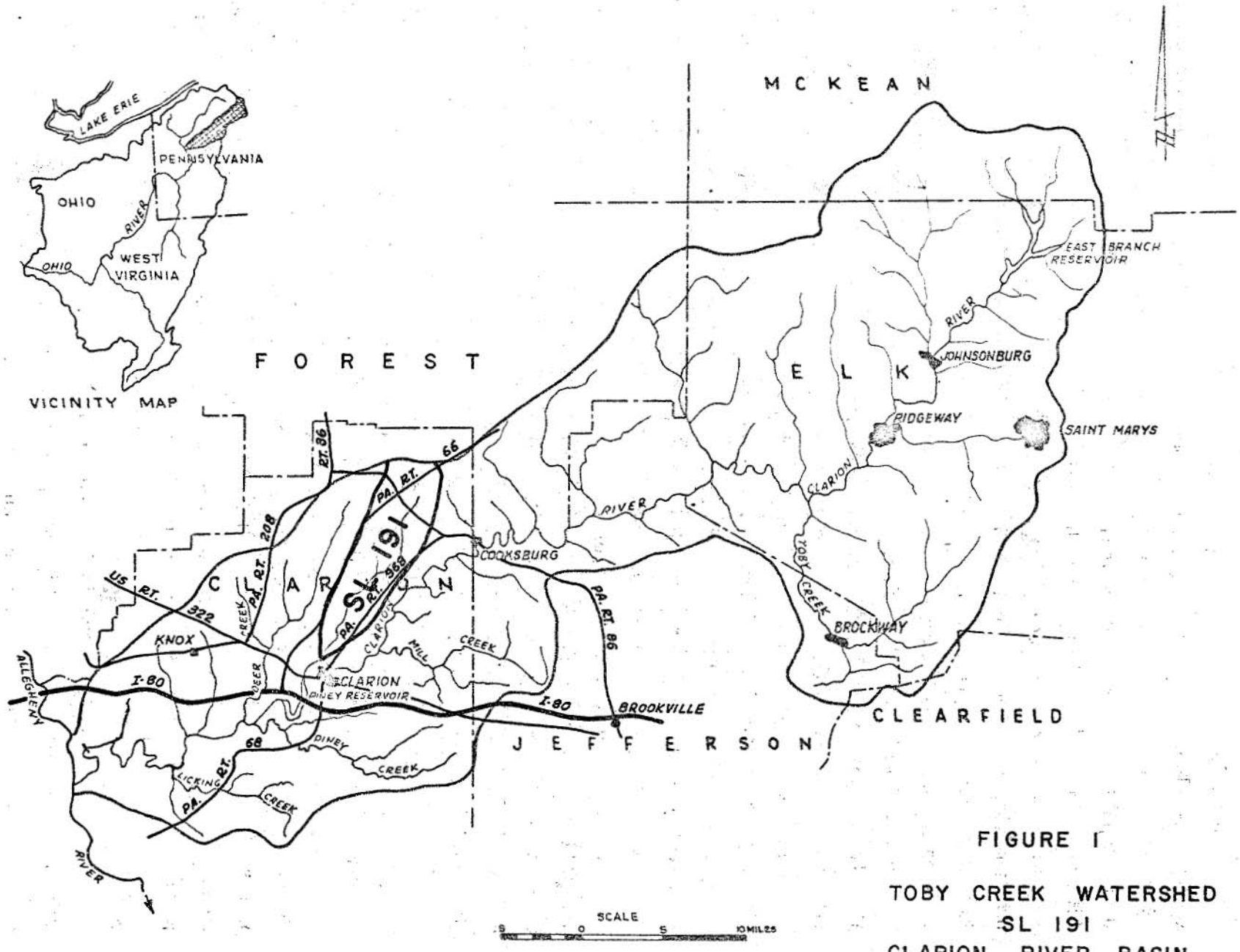

FIGURE 1

TOBY CREEK WATERSHED
SL 191
CLARION RIVER BASIN

to Tionesta-Creek. Toby Creek is fed primarily by Step Creek, Engle Run, Little Toby Creek and several smaller feeder streams.

Toby Creek rises in northeastern Clarion County and flows southwest for some 14 miles to its confluence with the Clarion River. The creek drains an area: of ˜37. square; miles and: is located entirely in Clarion County. Long and narrow in, shape, the watershed attains an average width of 2.5 miles and an approximate length of 1.3 miles. The maximum relief attained is 647" feet ranging from an elevation of 17.27, in Lucinda to elevation 1080 at the mouth of Toby Creek. The average gradient of Toby Creek is estimated to be 32 feet per mile.

Physiographically, the watershed is located in the Pittsburgh Plateau Section of the Appalachian Plateau Province. Northern portions of the study area, however, are influenced by the Allegheny High Plateau Section of the same province. Topography ranges from steep hillsides and valleys in the south to broad hilltop plateaus to the west and moderately sloped rolling hills to the north. The central portion of the watershed supports dense forest and vegetative cover while, the perimeter is characterized by farms and unreclaimed strip mines.

Several small communities. are located on the watershed boundary. Lucinda, Snydersburg, Leeper, and Crown are located on the western boundary while Miola, Helen Furnace, and Cooks Corners are found on the eastern perimeter. The watershed also falls within the limits of four municipal townships of Clarion County. They are in order of decreasing area: Farmington, Highland, Knox, and Paint Townships.

The topographic features of the Toby Creek Watershed are contained on the following 72' quadrangle series of the United States Geological Survey: Clarion, Strattanville, Lucinda, Fryburg, and Tylersburg.

The coal industry was the main economic activity in the watershed prior to the 1970's. Most of the economically recoverable coal has been exhausted. With a few exceptions; the mining; of coal in the Toby Creek Watershed has all but ceased at the present; time. Upon the decline of the coal mining and oil and gas industries, agriculture and lumbering are the major remaining economic activities in the watershed.

The entire watershed area is readily accessible by a network of secondary roads and two major highway arteries; PA Route 66 and PA Route 966. The Baltimore and Ohio Railroad traverses the entire western boundary of the watershed.

The climate is typified by invasions of sub-tropical air masses in the, summer and polar air masses in the winter. The average precipitation is 44 inches per year.

PREVIOUS INVESTIGATIONS

The Clarion River Basin of Clarion County has been partially studied' on numerous occasions beginning in the late l800's. In 1879, H.M. Chance published "The Geology of Clarion County," for the Second Geological Survey of Pennsylvania. This report was a detailed investigation on the geology and structure of post pre-Cambrian sedimentary rocks exposed in Clarion County, and discussed the present day drainage systems of the Clarion River and its tributaries. The "Foxburg-Clarion Folio #178," published by the United States Geological Survey in 1911, covered the geology, geologic history and mineral resources of the Foxburg-Clarion quadrangles. In 1943, the U.S. Public Health Service reported the 1940 acid stream conditions of certain tributaries of the Clarion River Basin.

During 1966, the Office of Water Programs of the Environmental Protection Agency in Wheeling, West Virginia conducted a 'stream quality' survey of the Allegheny River Basin as part of the overall "Appalachia Water Resources Survey." In the Clarion River area, a network of 12 stream sampling stations was established for repetitive sampling and flow measurements during 1966. Station #516 located at the mouth of Toby Creek was one such station..

A cooperative study by the Environmental Protection Agency and the Pennsylvania Department of Health was conducted from May to October of 1967. The study examined the principle mine drainage problem areas in the Clarion River Basin. Approximately 100 mining sites and 800 acres of strip-mined land were investigated in the Toby Creek Watershed. Eighty-one sites were monitored during this time period. Of these sites, 7 locations were identified as principal pollution sources and accounted for 90% of the total acid load measured.

The Mineral Industries Division of Gwin Engineers, Inc. (now Gwin, Dobson & Foreman, Inc., Consulting Engineers) published a report entitled "Preliminary Report of Mine Drainage Abatement and Land Reclamation for the United States Army Corps of Engineers in May, 1970. The study investigated the extent of acid mine drainage of six tributary watersheds to the Clarion River including Toby Creek.

A report by the Mineral Industries Division of Gwin, Dobson & Foreman, Inc. entitled Site Evaluation - DER Project SL 191-1" was performed in April, 1973.

The study investigated 230 acres of strip mined land, on State Game Lands No 72; Paint Township in the Toby Creek Watershed. (This site has been determined to be the largest single contribution of acid mine drainage to the entire Clarion River Basin. Due to its proximity to the mouth of Toby Creek, flow measurements were recorded at that location.

The total acid loads at the mouth of Toby Creek for each preceding report are summarized in Table 1.

TABLE 1.

SAMPLING AGENCY	DATE OF SAMPLING	NO. SAMPLES	FLOW (GPM)	ACID LOAD (PPD)
E.P.A.	1966	6	4500	52,380
E.P.A. & D.E.R.	6/67	1	3933	34,689
Gwin Engineers, Inc. U.S. Army Corps of Engineers	5/70	1	13,472	40,350
Gwin, Dobson & Foreman, Inc. DER SL 191-1	4/73	1	24,247	55,283
Current Study	12/73-9/74	4	21,043	41,193

The United States Geological Survey is presently conducting a study of the water quality of the Redbank Creek and Clarion River Basins. Acid mine drainage will again be monitored for Toby Creek and surrounding tributaries.

SUMMARY

The Toby Creek Watershed was the subject of an extensive investigation relative to stream pollution due to acid mine drainage. Over 180 source sampling stations were monitored over a 12-month-o period, to determine the degree and extent of mine drainage generated within the basin. Thirteen stream (13) sampling stations were established to monitor the affect the pollution was having on various reaches of Toby Creek and its major tributaries. Thegeology of abandoned mine sites and related operations were analyzed in detail to determine the conditions responsible for the formation of acid mine drainage. After an examination of all applicable data, areas were designated for pollution. abatement. General recommendations were formulated for these areas utilizing proven engineering abatement methods in acid mine drainage control. Pollution reduction and cost estimates with priorities were then developed, for each project area.

The following summary is intended to reveal the major findings and pertinent observations determined as a result of the acid mine drainage study of the Toby Creek Watershed.

1. Toby Creek is severely degraded by acid mine drainage along its entire length. All of the major tributaries within the watershed are in an acidic condition.
2. Toby Creek is a substantial and consistent acid. tributary to the Clarion River. Results of the stream sampling program show the following mineral constituents added to the Clarion River: acid - over 20 tons/day; iron - over 2 tons/day; sulphates - 40 tons/day.
3. The most concentrated sources of acid mine drainage occur near the mouth of the watershed. Approximately 30 percent of the drainage area accounts for 70 percent of the pollution.
4. Abandoned surface mines that operated in the Clarion coal and associated overburden are the major sources of acid mine drainage in the watershed. Other sources of acid mine drainage, in order of magnitude, are: flowing oil or gas wells, springs, deep mines and coal tipple runoff.
5. Pollution to local groundwater systems exiting at the surface as springs often has its origins (as determined by the drilling program) on surface mines topographically situated on ridge tops. Direct abatement of this source of pollution is not felt to be possible.

An evaluation of adjacent watersheds in the area indicates similar conditions of groundwater contamination, It would appear that the poor groundwater quality observed may be a regionalized problem and not one solely due to local conditions. However, flows from these areas may be reduced or improved upon implementation of various abatement measures in the northern Clarion County region.

6. Little neutralization is afforded to the acidity in Toby Creek due to the absence of carbonates (e.g., limestone) in the watershed. In consideration of this and other factors, it is not known whether Toby Creek can ever be returned toga non-acidic condition. However, a significant reduction in acid loading to Toby Creek and the Clarion River could be accomplished by various abatement measures designated for the watershed.
7. Strip mine reclamation is felt to be the most effective method of controlling acid mine drainage in. the Toby Creek Watershed. The plugging of flowing gas wells is felt to be the next most effective means. The total cost (1978) of acid mine drainage abatement in the Toby Creek Watershed approaches sixteen million dollars.
8. With a few exceptions, active mining in the watershed has all but ceased. Most of, the economically recoverable coal within the watershed has been exhausted.

RECOMMENDATIONS

The program of acid mine drainage. control designated for the Toby Creek Watershed is based on source abatement. It is felt that the necessity to reduce the pollution potential of the source to completely erase the contaminating agent is the most efficient and economical means of controlling acid mine drainage.

The chemical treatment of acid mine drainage was not considered at this time. The treatment process assures almost 100 percent neutralization of the pollution; however, the operation and maintenance of a treatment facility is continuous and expensive. It is felt that the following source abatement measures are the most cost-effective means of permanently eliminating the sources of acid mine drainage from the Toby Creek Watershed. This approach places emphasis on, eliminating the cause of the pollution rather than controlling the end result.

The following pollution abatement measures have. been recommended for implementation in the Toby Creek Watershed. The methods have proven to be successful for various projects designed to control or abate acid mine drainage. It is recommended that following the implementation of abatement measures, these areas be monitored and evaluated to determine the effectiveness of. the completed work.

SURFACE MINE RECLAMATION

This work involves the regrading, backfilling, contouring, and the soil treatment and planting of abandoned surface or "strip" mined land. Overall, this measure is considered to be the most important abatement method recommended for the Toby Creek Watershed.

The reclamation work could include only the regrading and contouring of minimally disturbed surface mined land. Where highwalls are exposed, however, and large spoil piles exist, this would require the complete backfilling of the site to its original contour or a terrace type grading pattern.

Backfilling to original contour essentially restores the affected land to the state prior to when it was mined. Terrace backfilling is the method by which the spoil material is graded into benches thus promoting the rapid expedition of runoff. Both techniques utilize slopes that are designed to control the damaging affects of soil erosion and subsequent sedimentation.

The spoil material in the Toby Creek Watershed, for the most part, is very permeable and potentially acid producing. Therefore, special surface compaction

may be specified for certain, areas to prevent the percolation of runoff into the subsurface.

Immediately following backfilling procedures, the land will receive soil treatment and planting. Representative samples are taken of the material on the final graded surface and are subjected to a complete soil analysis. The to ting determines the optimum amount of soil treatment necessary to achieve the desired vegetation.

The soil treatment and, planting phase of surface mine reclamation is crucial to maintaining the integrity of the reclaimed surface mine. The vegetation prohibits soil erosion and its subsequent sedimentation. A large quantity of surface water entering the reclaimed land is absorbed by the root system. This prohibits the water from permeating potentially acid producing spoil and polluting groundwater supplies. It also provides an aesthetically appealing appearance to the completed restoration work.

SURFACE WATER MANAGEMENT

This method directs the rapid: removal of surface water runoff on or around reclaimed surface mined laud. This is done to prevent recharge to potentially acid producing material of restored strip mined areas. This reclamation measure is an integral part of surface mine reclamation recommended for various areas, of the Toby Creek Watershed. Surface water management includes diversion ditches, lined channels or flumes. and the reconstruction and/or relocation of existing stream channels. Diversion ditches installed up-slope of the affected area are used to divert surface water around and away from the reclaimed mine site. Ditches located on the reclamation area are used to collect surface water and rapidly direct it into interceptor channels. These ditches are frequently used on terraces and are usually lined with impervious material .to prevent percolation into the spoil. All ditches are grass lined and are constructed to slopes ranging from 1 to 2 percent. Interceptor channels accept and direct the diversion ditch flow over the reclaimed land for disposal into existing watercourses. They are lined with impervious material. Since the channels are usually installed on steeper grades, they are usually protected with a riprap lining or temporary jute matting for vegetation. The high exit velocities are dissipated by flared riprap discharge aprons at the end of the channels.

In areas where a stream enters strip mined land, the stream channel maybe lined or relocated as necessary to prevent the water from flowing on or through acid producing material.

IMPERVIOUS COVER

Impervious covering over reclaimed strip-mined land prevents surface water infiltration into acid producing spoil. Materials utilized include gels that form an impervious soil layer and natural impervious material (clay) compacted to a certain soil density. The latter method is dependent upon the relative proximity of natural impervious material to the abatement area.

An experimental project as presently being conducted on a large strip mine in the watershed to determine the most effective means of achieving an impervious cover. This is further discussed in Project Area No. 20 of the proposed abatement plan

DEEP MINE SEALING

This method prevents the lateral discharge of acid mine drainage from openings of abandoned deep mines. The basic objective is to completely flood the deep mine workings, thereby prohibiting the contact of oxygen with sulphuric material and thus preventing the formation of acid mine drainage. All known deep mine entries within the watershed are caved and inaccessible. Therefore, it is recommended that those portals designated for closure be sealed by the remote method of deep mine sealing.

The procedure consists of drilling a series of bore holes into the mine entry and placing aggregate through the holes to form front and rear bulkheads. The cavity separating the two is filled with concrete in the same manner. A series of holes is then drilled perpendicular to the mine seal. The strata is pressure grouted to a predetermined height sufficient to flood the mine. An observation hole is then drilled into the mine to monitor the water level in the mine: All mine openings of a deep mine complex must be sealed in this manner if the inundation is to be successful.

Frequently, deep mines are intercepted by strip mine activities performed on its outcrop. This reduces the structural integrity of the outcrop barrier to contain a mine pool in the deep mine workings. Therefore, impervious barriers are required in this instance.

The successful sealing of a deep mine requires considerable knowledge of its structural geology, extent of mined-out areas, character of adjacent strata, and location of portals. Often times exploratory drilling is required to ascertain this information.

IMPERVIOUS BARRIERS

The purpose of these abatement methods is to contain the water table imposed by the flooding of a mine complex or to prohibit the seepage along the outcrop of strip mines. These measures include curtain grouting, clay packing, slurry trenching, and clay blanketing.

The construction of a grout curtain involves drilling a line of holes in undisturbed material to a depth below the coal measure. The grout can be a combination or a mixture of materials such as cement, fly ash, and bentonite, etc. The grout is pumped under pressure into the substrata, filling voids and fractures in the rock strata. This grout curtain forms a perched water table to a predetermined height which in-turn inundates the coal measure. The most practical use of curtain grouting is in conjunction with the deep mine sealing procedure.

Clay packing is recommended many times in conjunction with strip mine reclamation. Its purpose is to form an impervious barrier to prevent seepage along the stripped outcrop of a surface mine. The material utilized is frequently the clay found under the stripped out coal seam. Clay is compacted along the toe and up over reclaimed spoil, for a short distance.

The construction off a slurry trench' involves the excavation of a trench into which a clay bentonite slurry is dumped. The excavation extends to a short depth below the coal measure. As the digging continues, the excavated material is mixed with the slurry and is backfilled onto the trench. The end result is an impervious barrier constructed to a height sufficient to inundate the coal ,measure or mine workings. The trench is generally installed along a strip mine intercepting the outcrop of a deep mine complex. The trench must be excavated removing un-consolidated material. The general procedure is to backfill the strip mine to provide a bench for the excavation of the slurry trench. Upon its completion, the backfilling of the strip mine proceeds to the final grade line.

The construction of a clay blanket is installed along a strip mine intercepting the outcrop of a deep mine complex. A clay blanket requires the excavation of a trench to a depth below the coal measure. Clay is placed in the

trench and compacted in layers to an elevation necessary to inundate the coal measure. The remainder of the trench is filled-and compacted with layers of fine grained spoil material. The top of the clay blanket is backfilled to a final grade line. Sufficient natural impervious material must be available near the job site for the use of this method to be economical. This method is not recommended where large quantities of water may be expected to enter the excavation.

COAL REFUSE DISPOSAL AND MANAGEMENT

The measures recommended in this section relate to the disposition of coal refuse from active and non-active-mining operations.

Coal refuse from abandoned deep mines is not considered to be a major source of pollution to the Toby Creek Watershed. The limited extent of deep mining in the area was such to preclude the formation of large gob piles. It is, however, recommended that refuse piles located within the proposed abatement areas be properly disposed of. When abandoned stripe mines are in close proximity to the refuse sites, the waste material is excavated and transported to the strip mine for burial.

When refuse sites are isolated from potential burial sites, the material is spread and graded at the site. The material is then disced with limestone screenings where it receives a final earth covering with soil treatment and planting.

Coal refuse is presently being generated from coal processing facilities located within the watershed. They fare discussed further in the proposed abatement portion of this report. It is felt that any pollution discharged into the watershed from these sites and the responsibility for corrective actions rests solely with the owners of such facilities.

Methods to prevent pollution from these sources would include diversion ditches constructed upslope of tipples and storage areas. This would serve to channel water away from the sites and would not need treatment. In addition, ditches should be constructed downslope of the facilities to capture all runoff at the site. This flow would be directed into a series of settling and treatment ponds before being released in the watershed.

GAS AND OIL WELL PLUGGING

The abatement of acid mine drainage from abandoned oil and gas wells consists of, a) locating the source (old casing) by excavation, b) reaming the well to a pre-determined depth or acquifer source, c) grouting the hole to a certain depth, and d) plugging the remainder of the hole with concrete. Large quantities of acid mine :drainage are discharged to the Toby Creek Watershed from these sources.

EXPLORATORY DRILLING

This phase is not considered a physical abatement of acid mine drainage. The information gather during exploratory drilling operations, however, is essential for the engineering design of abatement facilities. It is included as an integral part of the overall' abatement. plan recommended for certain project areas.

Exploratory drilling is utilized for a) determining structural geology of a particular mining site relative to attitude of beds, outcrop determination fault displacement, etc., b) determining the stratigraphic relationships of a mining site (rock types, thickness of coal bed, presence of underclay), c) pressure testing strata adjacent to deep mine workings, d) determining permeability of strip mine overburden or spoil, and e) ascertaining relationships between groundwater sources and mining sites relative to location and quality of acquifers and recharge of isolated springs and wells.