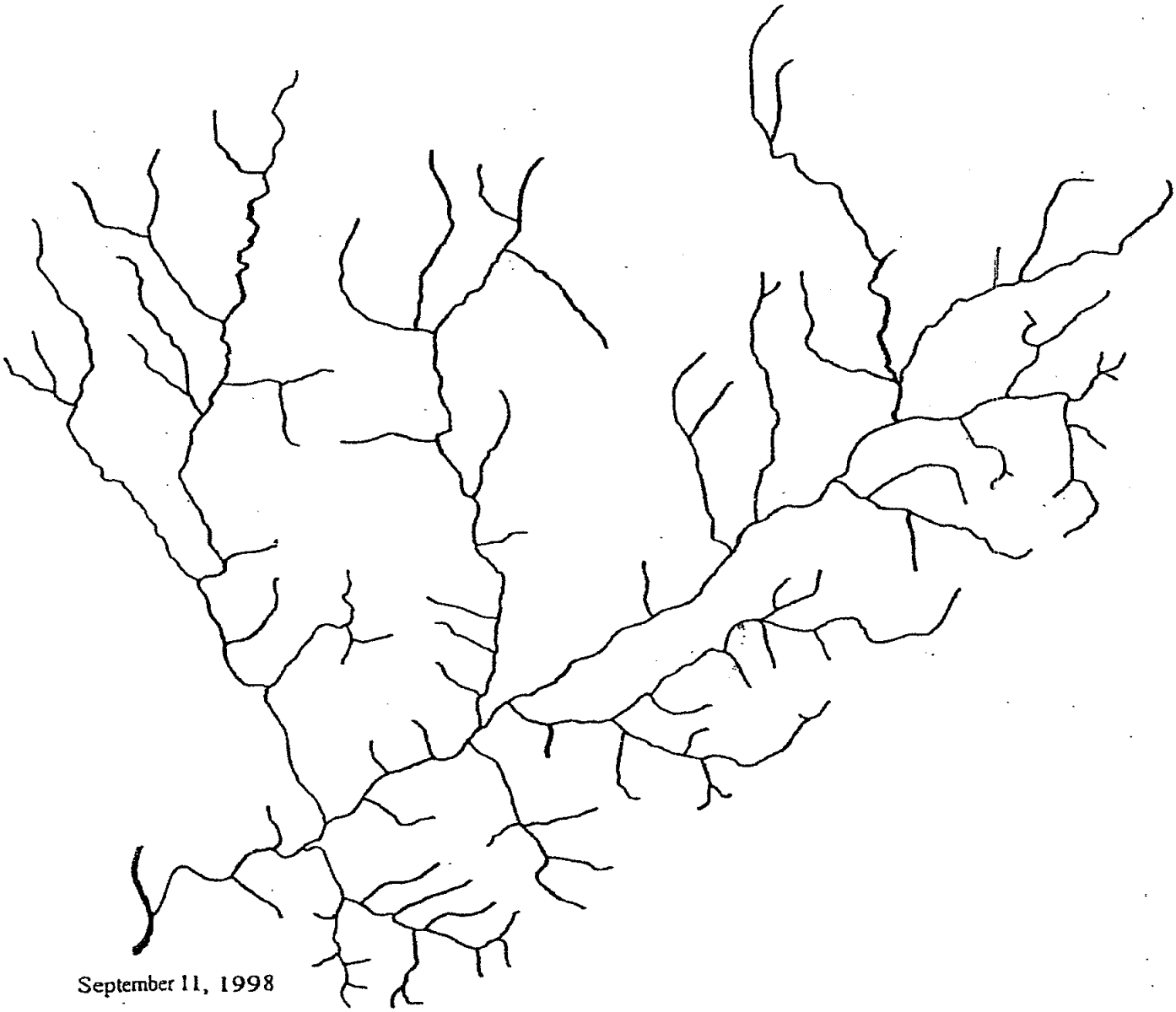
Babb Creek Watershed Restoration Plan



September 11, 1998

Prepared by:

Corey Cram
Hydrogeologist and Babb Creek Watershed Coordinator
Pennsylvania Department of Environmental Protection
Bureau of District Mining Operations
Hawk Run District Mining Office

TABLE OF CONTENTS

BABB CREEK WATERSHED PLAN

INTRODUCTION

PURPOSE

The Department of Environmental Resources, Bureau of Mining and Reclamation has initiated a Comprehensive Mine Reclamation Strategy (CMRS) in an attempt to address selected watersheds in the state on a holistic approach. The objective of this project is to focus existing mine reclamation programs, local watershed efforts, and state and federal government agencies in addressing the pollution within a watershed. It is believed that more can be accomplished by focussing efforts and the limited resources that are available to obtain measurable stream recovery than can be accomplished by spreading efforts and resources and effort across the state in a more random and less focused effort.

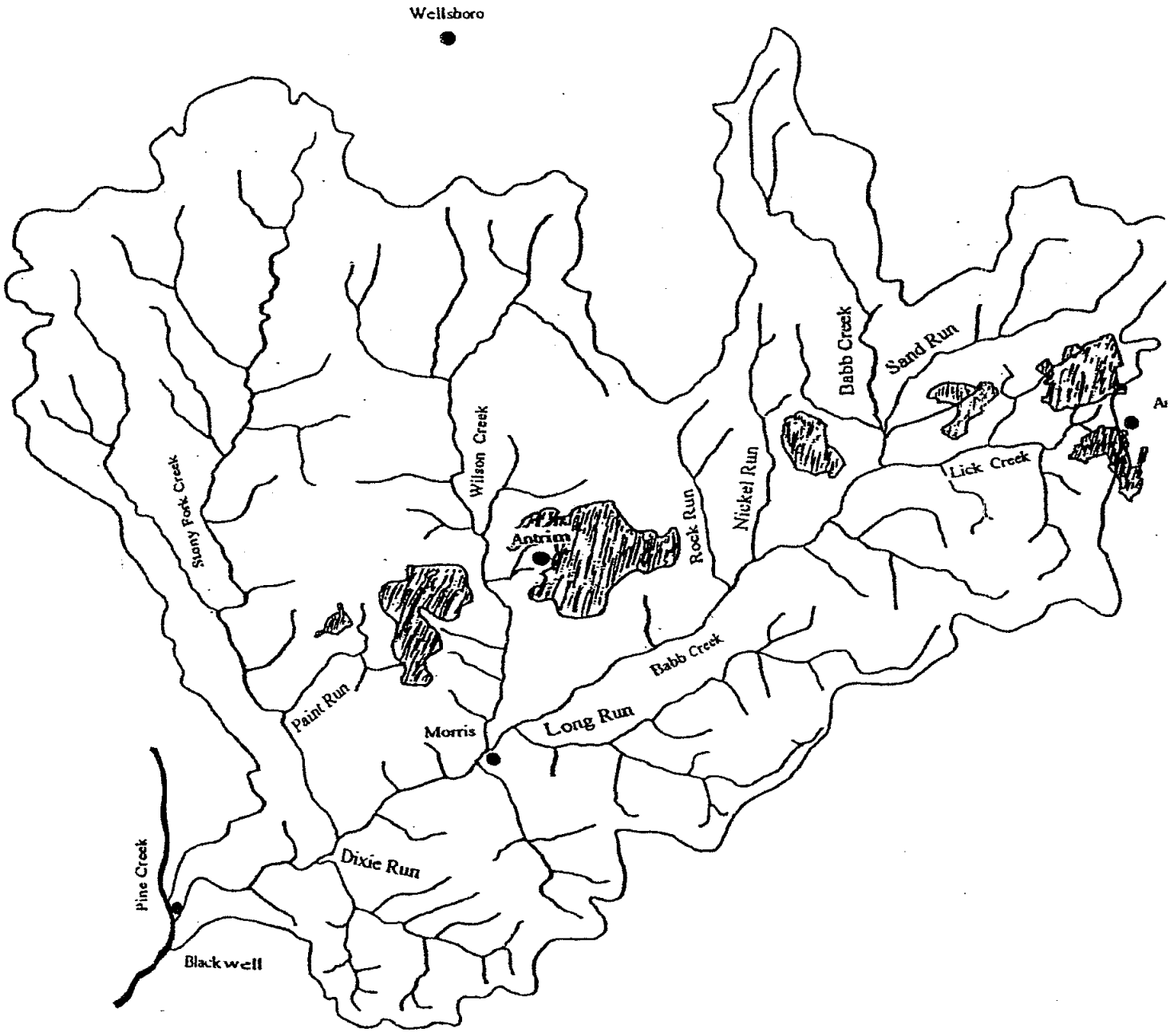
BACKGROUND

The Babb Creek Watershed is located in North Central Pennsylvania, occupying the southern portion of Tioga County and a small portion of Lycoming County. The area within the watershed consists of 129 square miles, most of which is administered by the Tioga State Forest and the Pennsylvania Game Commission. Other land uses within the watershed include agriculture, mining (no active mining operations) and rural residential properties with small communities scattered throughout the area.

The village of Morris, formerly a center for lumber, coal mining and tannery industries, is located at the mouth of Wilson Creek at the junction of State Routes 287 and 414 in the center of the watershed. The formerly large mining town of Arnot lies at the eastern margin of the watershed near State Route 15, while the formerly prosperous town of Antrim lies in the center of the watershed. In the western section is the village of Stony Fork and at the mouth of Babb Creek, at the southwest corner of the watershed, is the village of Blackwell.

TOPOGRAPHY AND DRAINAGE

Babb Creek is one of the principal tributary tributary streams to Pine Creek, which is a nationally recognized fishery. In addition to fishing the Pine Creek area is one of the state's year-round recreation areas that is celebrated for its wildlife, fish, wilderness, and scenic beauty. The confluence of Babb Creek and Pine Creek is at the town of Blackwell and marks the southern end of "Pennsylvania's Grand Canyon" in the Pine Creek Gorge Natural Area. Recently, large sections of an abandoned railroad in the



Location Map of the Babb Creek Watershed, showing the major streams, towns, and underground mining complexes. Mining complexes from right to left are as follows: Arnot (No. 1 and No. 2), Klondike, Bear Run, Antrim, Anna S, and Rattler.

Gorge, have been converted to a recreational trail and has resulted in an increased number of visitors to the area.

The watershed area in located in the glaciated upland plateau section of the Appalachian Physiographic Province. The plateau is strongly dissected by stream valleys which drain the area to the south and west. Rolling glaciated uplands with 100 to 150 feet of relief characterize the upper reaches of the watershed. The lower portion of the watershed near the main trunks of Babb Creek, Stony Fork Creek, and Wilson Creek is deeply incised and forms steep-sided, V-shaped valleys. Elevations in the basin range from a low at the confluence of Babb Creek and Pine Creek of 860 feet above sea level to the valley ridges along the main trunk of Babb Creek at over 2200 feet above sea level.

Babb Creek has three main tributaries: Stony Fork Creek, Wilson Creek, and Lick Creek. Other tributaries include: Dixie Run, Harrison Run, Long Run, Nickel Run, Bear Run, Sand Run, and other unnamed tributaries. Stony Fork Creek and Wilson Creek are the largest contributors of flow to Babb Creek. Babb Creek with its three major tributaries form a dendritic drainage pattern. The Stony Fork Creek subbasin forms the westernmost boundary of the watershed. It is formed by two branches, each flowing south which join into Stony Fork Creek and discharge to Babb Creek at a point approximately three miles from the mouth of Babb Creek. Wilson Creek originates from headwater streams just south of Wellsboro and flows approximately 10 miles south to join Babb Creek at the village of Morris. The headwaters of Lick are formed by mine discharges near the village of Arnot. The stream flows west approximately 3.5 miles to join Babb Creek at a location approximately one mile upstream from the abandoned mining village known as Landrus.

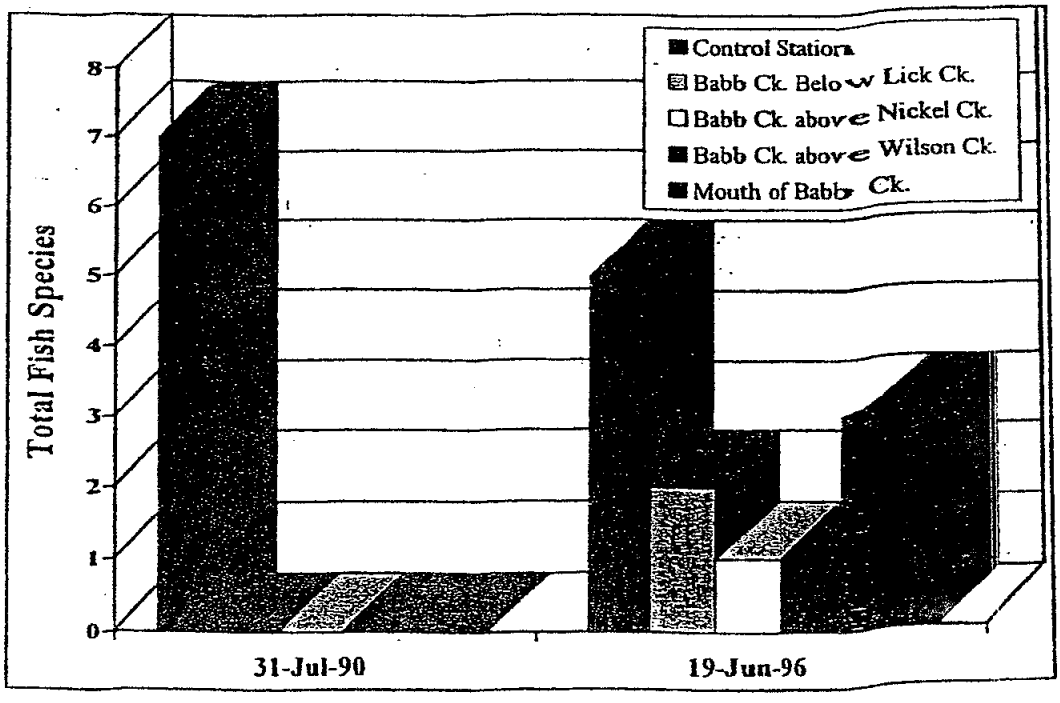
SUMMARY AND CONCLUSIONS

With the exception of the Rattler Mine and its mine discharges, there are mine drainage treatment projects for every significant pollution source in the watershed either in place or planned to be accomplished by the year 2000. The past couple of years have provided opportunities to treat the Anna S Mine Complex discharges, discharges that were always believed to be cost prohibitive through the traditional means of watershed restoration we have applied. The treatment of the Bear Run Discharges by the Stott Mining Company is also a big boost that will accelerate the restoration of the upper Babb Creek watershed.

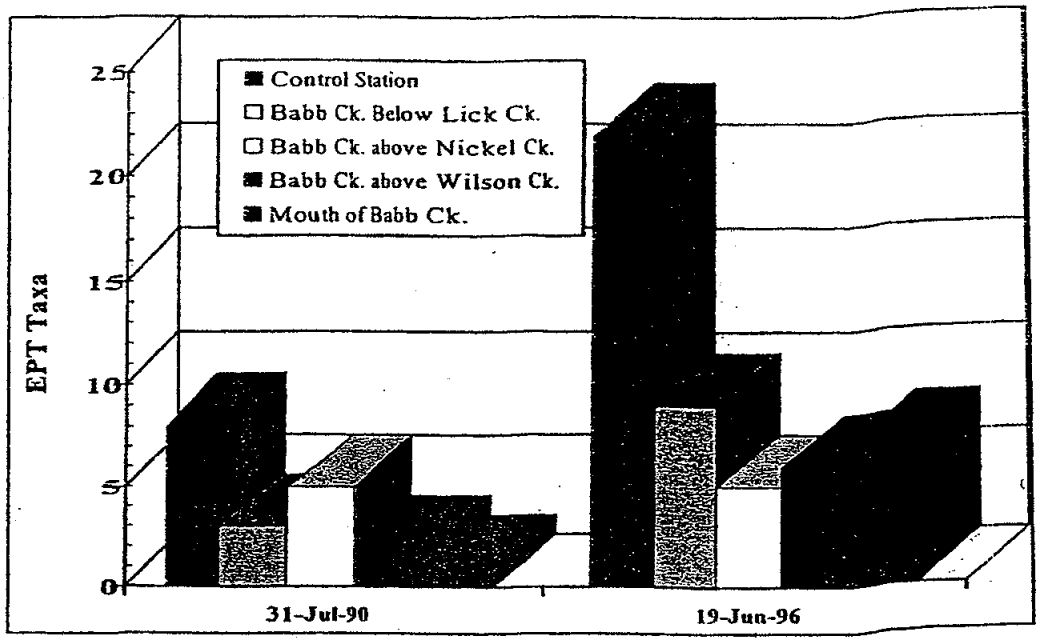
The success of the restoration of the Babb Creek watershed to date has been the result of many dedicated people from a variety of backgrounds that have laid their personal agendas aside and are committed to restoring the Babb Creek watershed. These same people have demonstrated initiative and creativity in tackling problems that were traditionally considered to be technically impossible or outside of the reach of governmental bureaucracy and fiscal limitations.

The following two charts are the result of stream surveys conducted by the PFBC in 1990 and 1996. No treatment or abatement had been accomplished prior to the 1990 stream survey and it can be seen that the watershed, other than the control station, was void of fish and had limited acid-sensitive macroinvertebrate species. In 1996 five

diversion wells had been constructed, however the maintenance was limited and not producing good results. The Antrim treatment facility was functioning. Even the limited treatment of the diversion wells a dramatic increase in the number of EPT Taxa (caddis flies, may flies, and stone flies) was observed as well as one or more different species of fish where there were none before in the headwaters of the watershed. The same improvement was observed lower in the watershed where the stream benefited from the treatment of the diversion wells and Antrim's treatment.



Number of Fish Species resulting in 1990 and 1996 Stream Surveys.



Number of Acid-Sensitive Taxa (Caddis Flies, May Flies, and Stone Flies) resulting in 1990 and 1996 Stream Surveys.

The success of the Babb Creek Watershed efforts to date have been significant in the number of hours that many dedicated individuals have committed to the work. The project has demonstrated that a stream can be restored if the limited human and fiscal resources are focused within a watershed in a cooperative manner.

The ultimate restoration of Babb Creek to a stockable fishery and swimable stream hinges upon: 1) the long-term continued treatment at the Antrim Mining Co. treatment plant, 2) the construction and maintenance of passive treatment systems by Waste Management of Pennsylvania, and 3) continued operation and maintenance of the numerous diversion wells and other treatment systems constructed in the watershed. These can be accomplished through continued cooperation of those involved in the Babb Creek task force and through the management of a non-profit organization created for the purpose of overseeing the operation and maintenance of treatment systems in the watershed and seeing to the general welfare of the watershed as different issues arise.

RECOMMENDATIONS

It is necessary that there be means of characterizing the watershed through intensive water sampling, flow measurements, and field reconnaissance. Private individuals and private professionals have limited means of accomplishing this; Government (local, county, state, or federal) generally is better suited to do this type of data collection.

Following data collection the information must be compiled and analyzed. Compilation can be done by most with limited resources. Data analysis to determine the

magnitude, scope, and location of problems is best done by trained scientists and technical specialists. The same is even more true for designing and implementing solutions to complex watershed problems. It is rare that persons and resources to accomplish these tasks exist within the local watershed or sportsmens organization. Private professionals often provide some guidance on a volunteer basis but they are not in a position to dedicate many hours or resources. Government (local, state, or federal) has the personnel, resources, and means to provide help and guidance to willing hands and strong backs that are dedicated to accomplishing a common goal.

To accomplish even the simplest of reclamation or remediation projects it requires funding. In the case of Babb Creek, the organization, PEDF, secured funding through a court settlement with a mining company after water degradation took place following mining. A grassroots organization with built-in funding (however limited) is the exception rather than the rule. There must be an increased quantity of funds available to accomplish watershed restoration. Funding sources must be diverse in their target rather than highly focused resulting in grant access for only select watershed problems.

Efforts in the Babb Creek Watershed have demonstrated that a marginally impacted watershed can be restored through cooperation of dedicated government employees, private individuals, and industry. Success hinges upon a local core of dedicated citizens that are united and focused on a common goal. Without a local group of volunteers to catalyze and run the program, no amount of funding or technical guidance will provide leadership resulting in successful watershed restoration. All contributors to the effort must be united and not seeking to fulfill personal or professional agendas.

While each watershed is unique in its problems and potential, there are many common themes that apply to successful watershed restoration. There is very little literature or other information available regarding the basic steps one should take when taking on a watershed project or tackling a restoration project. Also, little is available for the layman to refer to for potential solutions to apply to watershed problems, problems that have been encountered by many but not documented and passed on. More information pertinent to watershed restoration must be made available. This should be done through a variety of media (conferences, internet sites, books, video, etc.).

GEOLOGY

The geologic strata in the watershed consists primarily of the coal-bearing Pennsylvanian-aged Allegheny Group. The Blossburg syncline traverses the watershed from Pine Creek on the west to Arnot on the east. This results in strata that gently dips toward the synclinal axis which is roughly near the north valley ridge along the main trunk of Babb Creek and then in the valley bottom of Lick Creek.

There are six coal seams present, these are the A, B, C, C', D, and E Coal Seams and are locally referred to as the Bear Creek, Bloss, Cushing, Morgan, Seymour, and Rock Vein Coal Seams respectively. The Bloss Seam is the principal mined coal in the area. This seam is tentatively correlated with the Lower Kittanning Coal of Western Pennsylvania. The Bloss Coal in the Babb Creek Area is reported to be a double-bedded

coal totaling 5-8 feet or more in thickness. The two splits tend to be separated by a layer that ranges from a few inches to 16 feet. The Cushing (C), Morgan (C'), and Seymour (D) Seams were also mined but represent a small portion of the total resources removed from the basin. The Rock Vein (E) Coal Seam may be completely eroded away in this local area.

More recent glacial deposits are present at the head of Lick Creek. The valley floor near the village of Arnot is comprised of unconsolidated glacial moraine. The glacial fill consists of sediments ranging from clay to cobbles and occasional boulders.

MINING

MINING HISTORY

Coal was discovered at Blossburg in 1792, with the first drift opening in 1815. The first mines in the Babb Creek Watershed were probably opened in the Arnot area around 1865. These mines included the Arnot #1, Arnot #2, and the Klondike Mines. Other mines were opened east of Arnot along Johnson Run which flows east to the Tioga River. In 1866 the Blossburg Coal Mining and Railroad Company was formed to develop the mines. In 1881 a standard gauge railroad was built from Arnot to Morris. A year later a sawmill was built and the community of Landrus was established. Later, in 1888, the Bear Run Mines were opened on the northern flank of Babb Creek opposite Landrus. Favorable exploration on lands at the headwaters of Bridge Run resulted in the opening of the Antrim Mine around 1870 by the Fall Brook Coal Company. The same company opened the Anna S Mine on the west side of the Wilson Creek Valley in the late 1890's. The Rattler Mine was opened in the early 1900's by the Tioga Coal Company.

There is evidence that over 4,000 acres of coal were deep-mined in the Babb Creek Watershed, primarily on the Bloss (B) Coal Seam. Production of coal from mines in Tioga County declined at the turn of the century as a result of increased production in Clearfield County. (source, Babb Creek Mine Drainage Project, Operation Scarlift, 1976. Boyer Kantz and Assoc.)

In the 1970's and 1980's mining activities in the watershed became more widespread as companies including Eastern Mining, P & M Mining, and Antrim Mining began strip-mining previously unmined upper seams and daylighting portions of the seams deep-mined earlier. The majority of the surface mining in the watershed was focused on the Antrim and Anna S Mine Complexes near Wilson Creek.

ABANDONED MINE LAND INVENTORY

In the Babb Creek watershed, there are large coal refuse piles at or near the main entrance to each of the underground mines. In the case of the Arnot Mines, the refuse is spread out in many different areas on the west side of town and around the large ponds

and wetlands on the valley floor. Much of the refuse is in contact with the water and has the potential to generate acid mine drainage.

The Klondike Mine has a very large refuse pile near the main entry where the coal was separated from the reject material. The coal was hauled away in railroad cars and the coal refuse or bony was left in a huge pile. At the Klondike Mine the refuse pile is more of an eyesore rather than a source of pollution. PEDF coordinated with the Department of Conservation and Natural Resources, Tioga State Forest and contracted Ed Signor of Signor Bros. Contracting to regrade the pile and then apply soil and soil amendments to revegetate the pile. Reclamation was done in the summer of 1998 and was accomplished almost exclusively through private funds and initiative.

The Bear Run Mine is located at the top of the Babb Creek valley and it was convenient to dump the refuse down the valley wall when the coal and other material was brought out of the mine decades ago. This is another site where the refuse is doing little to impact the water quality of the streams of the area. Part of the refuse pile will serve as a construction site for the vertical flow treatment system Stott Mining is scheduled to construct in 1998.

The Antrim Mine also has a large amount of refuse deposited near the main entry, the Antrim No. 1 discharge. The town of Antrim has grown up around the mine refuse and now much of the refuse is hidden. The refuse at this site is also contributing little to the pollution of the streams.

The Anna S Mine, like the Bear Run Mine, is located at the top of the valley wall and there it was also very convenient to dump the refuse down the steep precipice. A very large pile or bank of refuse extends from the mouth of the Anna S Mine down to Wilson Creek, over 400 feet below. In this case the refuse extends all the way to Wilson Creek and in addition to being the biggest eyesore and the most obvious mining impact, the refuse causes sedimentation to the stream. Because of the steepness of the valley wall removal would be difficult and also cost prohibitive at this time.

The main entry of the Rattler Mine also includes a very large pile of refuse. This pile has some seepage at the base that is very similar mine drainage similar in quality to the water discharged from the mine. Should the alkaline grout project go forward at some date the refuse pile will be regraded, capped with an impervious cap, and revegetated.

Following underground mining around the turn of the century and into the 1940's, the Anna S Mining Complex was the target of surface mining activities in the 1960's through the early 1980's. Some of the earliest strip mining was pre-SMRCRA and there are some areas of pits and highwalls in the area.

Near the ghost town of Landrus and in the floodplain of Babb Creek a 3,000-foot railroad grade was built using coal and coal refuse. Analysis of the material suggests that the material could be cleaned and used in a coal-fired power plant. Recently, Pennsylvania Power and Light was shown the sight and expressed interest in removing the material as a public service. In recent years, Babb Creek has meandered and is now eroding the material.

COAL RESERVES AND REMINING POTENTIAL

The Babb Creek watershed sits on the eastern fringe of the bituminous coal fields and has limited coal reserves. Coal is generally found only at the top of some of the hills

and topographic high areas in the watershed. Because of the structural deformation of the strata and the location of the Blossburg Syncline, coal is generally located on the northern hinge of the axis or on the north side of the watershed. Where coal is present it is often limited to the lowermost seam(s).

Underground mining in the late 19th century and early 20th century left only isolated pockets of coal left in the area. Much of these areas were late strip mined in the 1960's through the early 1980's. Coal reserves are primarily limited to the 'B' or Bloss Seam. Mining on this seam in the area and elsewhere in the region has had very negative effects, producing very severe mine drainage. Currently there are no active coal mining operations in Tioga County. The nearest mining operation is in Lycoming County to the south. It is highly unlikely that future mining will take place in the watershed because of the lack of reserves, lack of miners in the area, lack of a nearby market, inaccessibility to the limited reserves, and the Departments mandate to insure that the waters of the Commonwealth of Pennsylvania are not degraded would likely preclude issuance of permits.

STREAM QUALITY AND POLLUTION SOURCES

The Babb Creek Watershed contains three large subbasins that have been impacted by mining and acid mine drainage. Currently, the major trunk of Babb Creek and also the Lick Creek Subbasin are considered to be polluted by acid mine drainage. These streams exhibit water quality that is considered marginal for aquatic life including cold water fish species and also benthic organisms. Rock Run is a small tributary stream to Babb Creek. The pollution it contributes from the Bear Run Mine is very high and comparable to the acid loading in Lick Creek. However, at the confluence of Rock Run and Babb Creek, Babb Creek is sufficiently large that the effect is not so pronounced. Wilson Creek has its headwaters in agriculture and forested areas that are underlain by alkaline bedrock. This results in a stream that exhibits a net alkalinity and a mild buffering capacity. The buffering in the streams is negated by the influx of acidity produced primarily in the Anna S and Antrim Mines. Wilson Creek is the greatest contributor of pollution loadings of all the streams in the Babb Creek Watershed. Stony Fork Creek also has its headwaters in an area that produces net alkaline water. This stream is impacted by the Rattler Mine. In this case, the large volume of slightly buffered water is able to neutralize the smaller volume of acidic water produced in the mines.

LICK CREEK

Lick Creek is one of the principal headwater tributaries to Babb Creek. The Arnot #1, Arnot #2, and Klondike Deep Mines and a reclaimed strip mine lie within the Lick Creek Subwatershed.

Arnot #1 Mine

The Arnot #1 Mine is located south and west of the village of Arnot and on the southern flank of the Blossburg Syncline. This means that the mine is free flowing and drains to the north to Lick Creek on the western side of the mine and to Sawmill Creek (a

tributary stream outside the watershed boundary) on the eastern side of the mine. The mine was developed on the Bloss Coal Seam and the mine lies on the Babb Creek-Johnson Run Drainage Divide. The result of this is that only a portion of the water discharging from the mine enters the Babb Creek Watershed (see the maps included in the Appendix).

A total of three mine discharges flow from the mine. A mine discharge on the western portion of the mine flows to Lick Creek. The 1976 Scarlift Report characterized this discharge as having very low flow (0.042 cfs/19 gpm), a pH of 5.6, low metals, acidity, and sulfate concentrations and a slightly net alkalinity.

An additional mine discharge is located just west of Arnot. Currently, the Arnot Sportsman's Club as a Pennsylvania Fish and Boat Commission cooperative nursery is raising trout in the excess water that is not used as drinking water for the town. Recent sampling revealed a pH of 5.8, low metals and acidity concentrations and a net alkalinity. This water flows to the pond on the east side of the state road that runs north-south across the valley floor connecting Arnot and Wellsboro. A culvert is present under the road allowing for interconnection and flow between the ponds on either side of the road. The watershed boundary is indistinct and may shift under different flow conditions and various stages of ponded water. This mine is not considered a contributor of pollution to the watershed except possibly for the sulfate loading which is occurring.

Arnot #2 Mine

The Arnot #2 Mine was also developed on the Bloss Seam and was mined up-dip to the north. Three drift entries discharge mine drainage. Approximately 620 acres of coal that averaged 30 inches in thickness were mined. Mining was initiated on the eastern side of the mine and entries were developed as the mine progressed westward. Successive entry development was required because the mine developer robbed the pillars to the point that the mine collapsed. The easternmost discharge flows to the pond on the eastern side of the township road that runs across the valley floor. It appears that under most conditions the receiving stream of this discharge is Johnson Run and eventually the Tioga River. This discharge has an average flow of 0.51 cfs (230gpm). It has an average pH of 4.8, low metals concentration and an average net acidity of 20 mg/l.

The center drift that has the lowest average discharge rate (0.16 cfs or 72 gpm) and is referred to as discharge no. 2 of the Arnot No 2 Mine. It exhibits an average pH of 3.4, a net acidity of 75 mg/l, and low metal concentrations. This discharge lies in the Johnson Run Basin and flows to the large headwater pond area. However, it has the potential to flow to Lick Creek under the right conditions. A diversion well has been constructed by Ed Signor of Arnot to treat the water at this mine discharge. This treatment system and all other constructed and planned treatment systems or projects will be addressed in detail later in the plan.

The Arnot #2 drift on the western end of the mine is referred to as discharge no. 4 and has a smaller average flow rate (0.40 cfs or 180 gpm) than discharge no. 2 (0.51 cfs) but it has a greater acidity concentration and is the greatest contributor of acid loading of all the Arnot #1 and #2 Mine Discharges. This discharge has an average pH of 3.3, a net acidity of 96 mg/l, and low metals concentrations (1 mg/l iron and 4 mg/l aluminum). Although this is the greatest headwater contributor of pollution loadings, the only significant pollutants are acidity and to a smaller extent aluminum. A Successive

Alkalinity Producing System (SAPS) and Anoxic Limestone Drain (ALD) combination system was built in the fall of 1996 to treat this mine drainage.

Klondike Mine

The Klondike Mine is located approximately 2.5 miles west of Arnot. It was developed around the turn of the century and abandoned around 1930-1935. Access to the mine is along the abandoned railroad siding that connected the mining district to the main railroad near Blossburg. The Klondike Mine was also developed on the Bloss Seam and was mined in an up-dip direction to the north. The coal dips to the south at a very gentle angle in the southern portion of the mine and rises more sharply in the northern portion of the mine. There are three drift entries into the mine; two of them flow mine drainage.

The easternmost discharge may have been a watercourse and was locally referred to as the Davis Drift and appears to be a watercourse designed to drain water from the mine. The discharge flows at an average rate of approximately 150 gpm, has a pH of 3.1, and flows directly into Red Run, a tributary stream of Lick Creek. In September of 1995 two diversion wells were constructed to treat the waters of Red Run at a location approximately 600 feet below the discharge. Prior to the diversion well treatment, the entire length of Red Run was sterile and lifeless.

The second acid mine discharge is the main entry of the Klondike Mine. This point has a chemistry that is significantly different than the chemistry exhibited by the Davis Drift. The main entry flows water at an average rate of 180 gpm. The discharge exhibits a pH of 2.9, an acidity concentration of 170 mg/l, a iron concentration of 9 mg/l, and an aluminum concentration of 10 mg/l. A smaller scaled diversion well was constructed in 1993 to address this mine discharge.

Lick Creek is the most upstream tributary stream of Babb Creek that has been affected by mining and the resulting acid mine drainage. The acid mine discharges producing the degradation in Lick Creek and subsequently in Babb Creek are the two Klondike discharges and the two westernmost discharges on the Arnot #2. The overall water quality resulting from Lick Creek mixing with Babb Creek is seen downstream to the mouth of Wilson Creek. This evidence suggests that degradation in Lick Creek is having a significant effect on the watershed down to Wilson Creek and remediation of Lick Creek could rejuvenate the same stream segment.

Lick Creek at the confluence of Babb Creek has a pH of 5.2, a slight net acidity, and aluminum concentrations that are marginal for stream life. Babb Creek at this point has not been significantly impacted by acid mine drainage pollution. The stream has a pH of 6.6, a net alkalinity, and metals concentrations that represent background values. After the two streams mix, Babb Creek exhibits a pH of 5.7, acidity almost equals alkalinity, and aluminum hydroxide precipitates on the stream bottom.

Bear Run Mine

The Bear Run Mine was developed on the Bloss seam like all the main mine comlexes in the watershed. The seam averaged 46 inches in the mine and the coal seam rises to the north. The mine is located near the Babb Creek valley wall near the mouth of Lick Creek. The mine used a large inclined plane to bring the coal to the valley floor.

The main mine entry is located on a narrow bench of the valley's northern flank. From this point the coal was mined up the rise of the coal to the north. The mine drainage is characterized by a pH of 3.1, very high acidity concentrations and elevated iron concentrations. The second entry is located approximately one-fourth of a mile east of the main entry, this discharge has historically had a smaller flow than the main entry discharge. However, following some exploration and limited daylighting of the secondary entry, the main entry has a very constant flow of 50-60 gpm and the secondary entry discharges any additional flow from the mine. Both the main entry and the secondary entry discharge directly to Babb Creek. Much of the mined area lies in the Nickel Run Watershed but none of the drainage flows to this stream. Monthly water samples and flow measurements are taken in preparation for the Stott Mining Company to design and construct a passive treatment system for these two discharges to mitigate a reclamation liability elsewhere.

Lower in the watershed near the town of Morris, Long Run flows into Babb Creek. Long Run is another subbasin that contributes alkalinity to the main trunk of Babb Creek. Long Run has good water quality and a native trout population. At the confluence of these streams Babb Creek is a large stream. Upstream from Long Run, Babb Creek has a pH of 5.5, a very slight net acidity, and metals concentrations that are of little concern. Below Long Run, Babb Creek has a slightly higher pH of 5.8.

WILSON CREEK

Wilson Creek is one of the largest subbasins in the Babb Creek Watershed. The stream headwaters originate in agriculture, forest, and rural residential areas. The headwater water quality is very good; the stream has a circumneutral pH, a net alkalinity, and a native trout population. However, the Antrim and Anna S underground mining complexes along with more recent surface mines grossly pollute Wilson Creek.

Antrim Mining Complex

Mining in the Antrim area was initiated in 1872 and continued until the early 1900's. It is believed that the underground mines were later reopened in the 1940's for limited activities of pillar removal. These mines primarily worked the B loss Seam but the Cushing (C), Morgan (C'), and Seymour (D) Seams were also mined. At this location in the watershed the coal measures are preserved in the axis of the Blossburg Syncline.

The Antrim Mine, located east of the village of Antrim was the largest of the deep mines in the Antrim Area and also the largest contributor of acid mine drainage. The mine was developed on the Bloss seam, but it is believed that the Cushing coal was also removed within the same operation. Because the mining was located near the axis of the syncline, groundwater intercepted by the mine was directed in a down-dip fashion where it discharged at the main entry of the Antrim No. 1 Mine. The Backswitch Mine which is located north of the village is the next largest deep mine in the Antrim Area and also contributes a great deal of pollution to the Wilson Creek.

The Jones and Brague Mining Company conducted surface mining on the Seymour Coal Seam in the 1960's and 1970's. Later in the 1980's the Antrim Mining Company also conducted surface mining in the Antrim area including the Backswitch,

Antrim #1, Devil's Elbow, Cushing, VanOrder, and Rolling Run Operations. Many of these operations such as the Backswitch and Antrim #1 operations included daylighting of the old deep mines on the Bloss (B) Seam.

Anna S Mining Complex

West of the village of Antrim and on the west side of Wilson Creek is the Anna S. Mining Complex. This mining complex is located approximately 2 miles north of Morris. The mine is located on the Blossburg Syncline Axis approximately 500 feet above the Wilson Creek valley floor. The main entry is located at the top of the west side of the Wilson Creek valley. A large refuse dump extends from the main entry to the valley floor.

A discharge flows from the main entry. It exhibits a pH of 3.1, a net acidity of 300 mg/l, 10 mg/l iron, and flows at an average of 0.91 cfs (417 gpm). A second mine entry referred to as Hunter's Drift is located at the head of Basswood Run. It exhibits a pH of 2.9, a net acidity of 450 mg/l, 38 mg/l iron, and flows at an average of 0.87 cfs (390 gpm). Hunter's Drift was constructed at an elevation well below the coal seam and designed to drain the water from the mine. Because of this, the discharge can flow very high quantities of very severely mine drainage during high flow conditions. These two acid mine discharges provide a significant pollution loading to Wilson Creek and Babb Creek. A small strip mine is located at the north end of the Anna S. Mine where the Anna S No. 2 discharge is located, and there is a very small deep mine on the Bloss (B) Seam which is referred as the Mitchell Mine. These areas also produce acid mine drainage but the pollution loading is very small compared to the discharges at the main entry of the Anna S. Mine and at the Hunter's Drift.

Harrison Run is a source of alkaline water, it meets Babb Creek a short distance below Morris and Wilson Creek. The water from Harrison Run does little to affect the acid mine drainage impacted water of Babb Creek at this point other than to provide a small amount of dilution.

STONY FORK CREEK

Stony Fork Creek is one of the largest subbasins in the watershed. The subbasin is bounded on the east by the Wilson Creek subbasin and on the west by the Pine Creek watershed. Much of the headwaters area of the subbasin is a agriculture and rural residential land use while the lower part of the subbasin is largely forested. Stony Fork Creek Stony Fork Creek has a net alkalinity and pH that supports a viable aquatic community from its headwaters to its mouth at Babb Creek.

Rattler Mine

The Rattler Mine composes the westernmost coal reserves in the watershed and in the Blossburg Coal Basin. Only the Bloss Seam is present in the area and it has been extensively mined both underground and on the surface. It is believed that the underground mine operated from early in the 1900's to 1958. The mining complex was approximately 250 acres in size and the Bloss seam was reported to be 42 inches thick. A northwest-southeast trending wrench fault extends through the Rattler Mine. Following

deep mining activities, approximately 150 acres were daylighted around the perimeter of the mine.

Three mine discharges flow from the mine in the direction of the dip of the rocks and discharge along its southwest edge. These acid mine discharges are the most severely polluted of all mine discharges in the watershed. The water from the mine has a pH of 2.6-2.8 and very high metals concentrations. Flow rates are relatively low because of the limited extent of mining activities in the area. The mine drainage flows to Paint Run, a tributary of Stony Fork Creek. Even though the mine drainage is very severe in its nature, Stony Fork Creek is alkaline and absorbs the negative effects of Paint Run.

The following table lists the mine discharges in the watershed and the steps that have been taken or are planned to abate or treat the acid mine drainage. A description of the individual mine discharges and the associated treatment follows the table.

POLLUTION SOURCE INVENTORY

Mine Discharge	Mine	Receiving Stream	Type of Treatment	Date (anticipated) Constructed	Cost to complete
Discharge to Sawmill Run	Arnot No. 1	Johnson Run (Tioga River)	None needed (alkaline water)		
C8-9	Arnot No. 1	Johnson Run (Tioga River)	None needed (water supply)		
C8-7	Arnot No. 1	Lick Creek	None needed (alkaline water)		
No. 1	Arnot No. 2	Johnson Run (Tioga River)			
No. 2	Arnot No. 2	Lick Creek	Diversion Well	November 1997	$10,000
No. 4	Arnot No. 2	Lick Creek	SAPS-ALD	December 1996	$200,000
Davis Drift	Klondike	Red Run (Lick Creek)	2 Diversion Wells	September 1995	$15,000
Main Entry	Klondike	Lick Creek	Sm. Diversion Well	July 1994	$4,000
Secondary Entry	Bear Run	Babb Creek	Vertical Flow Treatment Sys.	(1999)	($100,000)
Main Entry	Bear Run	Babb Creek	Vertical Flow Treatment Sys.	(1999)	($300,000)
Antrim / Backswitch	Antrim	Wilson Creek	Waste Lime Chemical Treatment Plant	1997	$1,600,000
Mitchell	Anna S	Wilson Creek	Upflow Bed / Diversion Well	(1998)	($20,000)
Anna S No. 1	Anna S	Wilson Creek	Vertical Flow Treatment Sys.	(1999)	
Anna S No. 2	Anna S	Wilson Creek	Vertical Flow Treatment Sys.	(1999)	
Hunter's Drift	Anna S	Wilson Creek	Vertical Flow Treatment Sys.	(1999)	($2.2 mil for the three discharges)
A2-2	Rattler	Paint Run (Stony Fork Ck.)	Alkaline Grout Injection	Unknown	unknown
A2-3	Rattler	Paint Run (Stony Fork Ck.)	Alkaline Grout Injection	Unknown	unknown
A2-4	Rattler	Paint Run (Stony Fork Ck.)	Alkaline Grout Injection	Unknown	unknown

POTENTIAL REMEDIATION

ARNOT NO. 2 MINE

The uppermost discharge in the watershed that pollutes the streams is the Arnot No. 2 Mine, discharge No. 2. This discharge has a relatively small flow of water and is acidic with low metals concentrations. The discharge is located on Tioga State Forest Property. In November of 1997, Ed Signor of Arnot constructed a diversion well to treat

the mine drainage. Corey Cram of DEP's Hawk Run District Mining Office designed the treatment system for Ed. To date the system has consistently produced alkaline water.

The discharge flows to a large shallow pond that was created when the mine blew out in the 1940's. Mr. Signor is securing the necessary permits to modify the pond through earthmoving activities to improve the potential of the pond as a fishery now that the water quality has improved because of the diversion well treatment.

The No. 4 discharge of the Arnot No. 2 Mine is the next source of pollution in the watershed. This discharge has a variable flow rate that can be as low as 50 gpm or as high as 600+ gpm. In December of 1996, a passive treatments system was completed at this site. The project was completed with EPA 104(b)3 grant money and also private donations. The EPA grant was $130,000 and the Pennsylvania Environmental Defense Foundation (PEDF) was the project sponsor and made up the balance of the project cost which amounted to $70,000.

The treatment consists of a vertical flow treatment system followed by an anoxic limestone drain. The raw water has a pH of 3.5 and a net acidity concentration of 50-100 mg/l. The treated water has a pH of 6.6-7.0 and a net alkalinity concentration of 150-200 mg/l. The pH of Lick Creek almost a half mile below the treatment system is reported to have increased from 4.6 to 6.2 as a result of the passive treatment.
A large (approximately six acre) pond lies below the discharge and its water quality has improved and now resembles the treated water's pH rather than the mine water pH. The Pennsylvania Fish and Boat Commission (PFBC) placed cages with live fish in the water in the spring of 1997 and experienced good results. Following the live fish test, approximately 120 bluegill and perch were stocked by the PFBC in the summer of 1997. In the summer of 1998 the PFBC will evaluate the survival of the bluegill and perch and consider creating a warm-water fishery in the pond.

In 1990, when the Babb Creek watershed was identified as a major contributor of pollution to Pine Creek and suppressing the mayfly hatches for five miles of Pine Creek, a number of people evaluated Babb Creek and potential treatment of acid mine drainage. PEDF, Penn State University, and DEP cooperated in constructing two diversion wells to treat acidity present in Lick Creek downstream from the Arnot Mines. These were the second and third diversion wells built in the United States and still a relative new and innovative. The systems required some modifications in 1992, but have functioned well for eight years now and have proven to be a low-cost, low-technology, treatment device that most local sportsmen or watershed groups can construct, operate, and maintain.

KLONDIKE MINE

The Klondike Mine has two discharges that affect Lick Creek, in the upper reaches of Babb Creek. A diversion well was constructed in 1994 to treat the water flowing from the main entry. This diversion well has provided a good source of some alkalinity, but hit has been less effective in providing adequate treatment because it is treating more severe mine drainage. Currently a passive treatment system is being constructed that will provide good, long-term treatment that will take the place of the higher-maintenance diversion well. The new treatment system is being constructed through EPA funds and also private grants and donations.

The second discharge from the Klondike mine is referred to as the Davis drift. In 1995 two diversion wells were constructed to treat this water. These have been the most effective and efficient diversion wells built in the watershed and maybe also elsewhere in the state. These treatment devices consistently increase the pH from 4.0 to 6.5-7.0 and treat all of the water all of the time.

BEAR RUN MINE

The Bear Run Mine has two discharges of significance, these are the main entry and a secondary entry located one-quarter mile east of the main entry. The DEP has proposed that the Stott Mining Company treat these two mine discharges with a vertical flow treatment system located at each of the two discharge. Treatment at this location will yield the restoration of Babb Creek down to the confluence of Wilson Creek to a viable stockable fishery. Construction is scheduled for the 1999.

ANTRIM MINE COMPLEX

Antrim Mining Company's daylighting operations on the Antrim underground mine complex resulted in increased production of acid mine drainage from the Antrim No. 1 and Backswitch discharges. While the Department was conducting an investigation of the degradation caused by Antrim Mining and preparing for litigation, Robert W. McCullough Jr. of the Pennsylvania Environmental Defense Foundation (PEDF) filed suit in federal court against Antrim Mining Co.

The investigation and intents of the Department along with the civil suit caused Antrim Mining to propose a negotiated settlement. In December 1991 the Antrim Mining entered into a Consent Order and Agreement with PaDEP to provide permanent treatment for the two deep mine discharges. Along with the permanent treatment of the Antrim No. 1 and Backswitch discharges, Antrim was required to: 1) cease strip mining operations and reclaim all its mining sites; 2) establish a Babb Creek Trust Fund with an initial payment of $25,000, and $0.25 paid to the trust fund for each ton of waste hauled in to Phoenix Resource's (a sister company of Antrim Mining) landfill; 3) the trust fund would be managed by two representatives from PEDF and one from Antrim Mining; and 4) the Trust Fund monies would be solely used for remediation of acid mine drainage within the Babb Creek Watershed.

James P. Barr and Robert McCullough were appointed by PEDF to be the organization's managers of the trust fund. In addition to them, Neil Hedrick of Antrim Mining is a member of the committee.

Antrim Mining was formerly treating these discharges with a hydrated lime treatment plant. The plant treated the mine drainage to an average pH of 8. The average flow treated is 2.2 cfs (1000 gpm) and the treated flow is reported to be as high as 11 cfs (5000 gpm) during high flow periods. The Antrim Mining Treatment Plant has a very significant impact on the water quality of Wilson Creek and Babb Creek. Were it not for the treatment at Antrim, the Babb Creek water quality below Wilson Creek would be severely degraded rather than the current marginal state.

More recently, in 1997 Antrim Mining has constructed a new treatment plant that uses a waste lime product and is locates so that pumping the mine water to the treatment site is not necessary. Antrim Mining's intention is to have a plant that will be more cost efficient to operate. This saves money for Antrim Mining in the short-term. More

importantly to Antrim, it significantly decreases the treatment trust fund that Antrim is required to fund. The fund is required by the Commonwealth and is designed to be sufficient money to operate and maintain the treatment system for a minimum period of 50 years. Antrim Mining has no more mining interests and it is anticipated that once the treatment system is functioning properly and the treatment trust fund is completely funded that Antrim Mining will dissolve.

In 1998 Phoenix Resources was sold to USA Waste and the landfill is receiving large quantities of waste to the landfill. This has made a source of income for the Babb Creek Trust Fund.

Currently Antrim Mining has contracted RNS Services, Inc. a sister company of Antrim Mining to operate the waste lime treatment facility.

Jim Barr and Bob McCullough are organizing a non-profit organization that will be in a better position to operate and maintain treatment devices in the watershed and see to the continued restoration of Babb Creek. The non-profit organization can also serve as an entity to operate the treatment plant in the event that Antrim Mining liquidates after funding the 50-year treatment trust.

ANNA S MINE COMPLEX

The Mitchell Mine is a small mine adjacent to the Anna S Mine complex, it has a mine discharge that has very high acidity and metals concentrations. In the fall of 1998, PEDF under the advisement of DEP's Hydrogeologists Corey Cram and Joe Schueck has planned to construct two semi-passive treatment systems to treat the Mitchell Mine discharge. These include a limestone upflow bed and a diversion well. The property is owned by an individual and a local sportsmen's club. It is anticipated that the landowners will cooperate in the construction of treatment systems to abate pollution in the watershed. Funding for the project came from fines levied against a local trucker who was conducting illegal hauling activities. The trucker indicated that he would like a portion of the fines to go toward restoring Babb Creek and DEP was able to direct the funds in that manner.

Waste Management of Pennsylvania, Inc. (WMPA) owns the Halfway Coalyard Mining Co., States No. 1 mining operation in Snowshoe Township, Centre County. This site has numerous acid mine discharges. The mine drainage is discharging near the stream where collection and treatment is difficult. WMPA expends from $250,000-$400,000 annually in an effort to collect and treat the mine drainage. The mine drainage contains high concentrations of metals that preclude passive treatment. The treated water flows to Beech Creek, which has been severely impacted and polluted by mining both above and below the States No. 1 site. The pollution is so severe that the entire length of Beech Creek is sterile and lifeless.

WMPA has proposed providing equal treatment elsewhere in exchange for a release of treatment liability at the States No. 1 site. The Department has entertained the proposal and provided the following stipulations: 1) the proposed treatment site must have a equal or greater acid and iron load; 2) the water must be treated to the same Best Professional Judgement (BPJ) standards as outlined in PA Code 87.102 for conventional or 87.102 (e) for passive treatment; and 3) the treatment must produce a stockable and fishable stream. WMPA agreed to the requirements, but could not identify a location that would satisfy the three requirements. The Anna S No. 1, Anna S No. 2, and Hunter's

Drift mine discharges were identified as discharges that could be treated passively, the acid and iron loads were in excess of the mitigated site, and it has been demonstrated that treatment of these discharges will result in the restoration of the lower section of Babb Creek.

WMPA is securing landowner permission to conduct additional data collection (soil testing, drilling, mapping, etc.) and ultimately passive treatment construction activities. WMPA has mapped the area in detail and has determined that there is land available for treatment.

The treatment proposed for the combined flow of the Anna S No. 1 and No. 2 discharges, by WMPA consists of six to eight vertical flow treatment systems followed by a constructed wetland and a polishing pond. The multicomponent system will be sized to treat a 90th percentile event, which is the equivalent of 420 gpm. Flows greater than 420 gpm will bypass the passive treatment and be treated with chemical treatment to a minimum pH of 6 and be mixed with the passively treated water prior to being discharged.

The treatment proposed for Hunter's Drift is slightly less rigorous because the NPDES monitoring point will be established at the Anna S No. 1 and 2 treatment site. The Hunter's Drift treatment system will be six to eight vertical flow treatment systems sized to treat a 90th percentile flow event, which is 495 gpm. Flows greater than 495 will bypass the system and remix with the treated water prior to being discharged to Basswood Run.

In April of 1998 DEP drafted a draft consent order and agreement to forward to WMPA for comment. The DEP and WMPA are still finalizing details of the Consent order. Construction is anticipated for the summer of 1999.

RATTLER MINE

The Rattler Mine has three mine discharges that have the most severe mine drainage of all discharges in the watershed. The mine drainage is considered to be too severe for passive treatment to be an option. We have designed a project intended to abate the production of acid from the mine through alkaline grout injection into the mine. The project involves the beneficial use of alkaline fly ash mixed with baghouse lime and water to create a slurry that could be injected into the underground mine through drill holes. The grout or cement would coat the floor of the mine and encase the acid-forming materials in a durable and highly alkaline capsule.

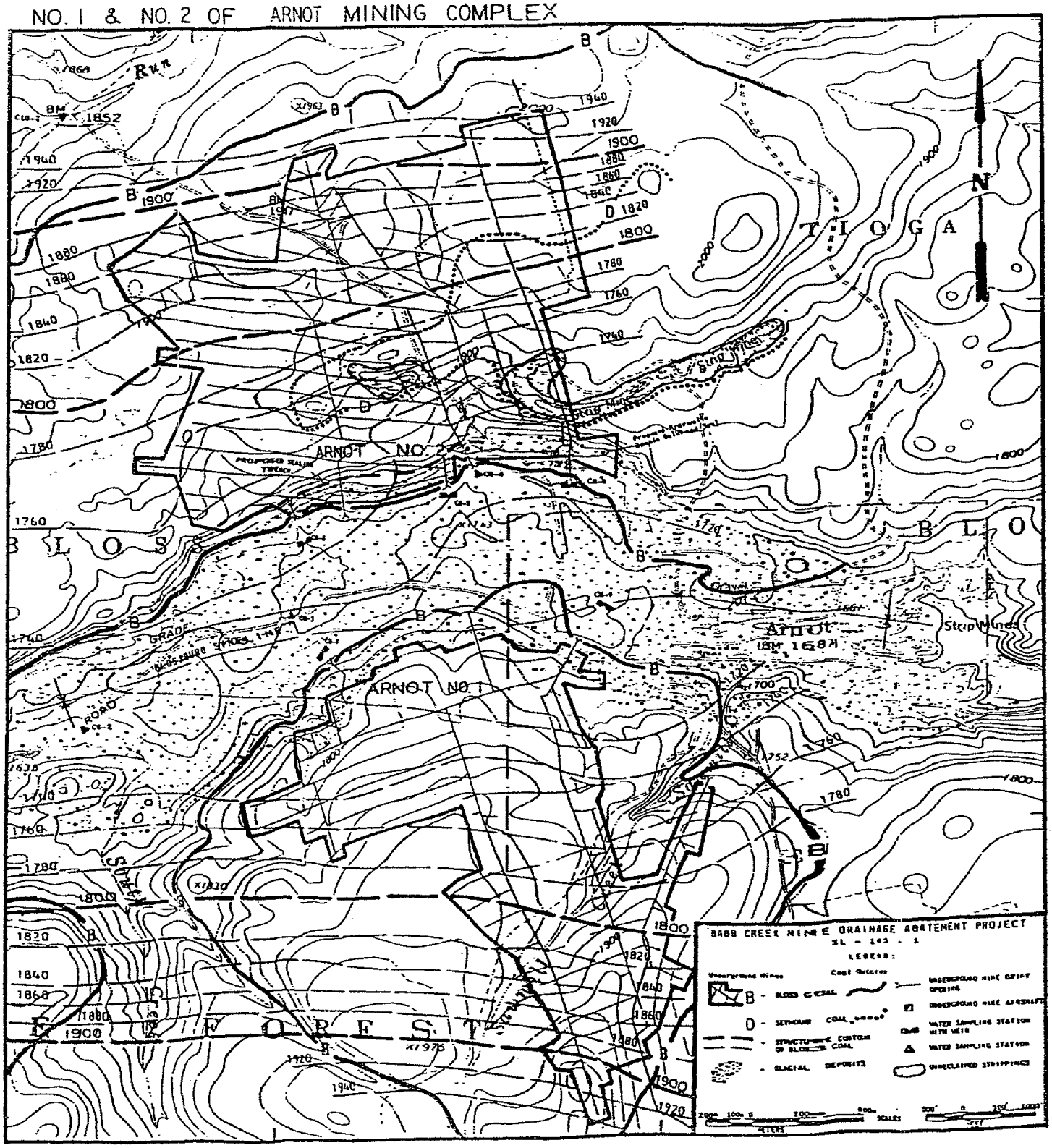
In 1996 it appeared that a contractor and source of ash were available to do the project by means of a no-cost contract with the Commonwealth of Pennsylvania. However, conditions in the market involving the availability of ash as well as the public's perception and sometimes opposition have changed.

To date there is no project scheduled to abate the mine drainage as well as reclaim some abandoned mine lands. Eventually the right combination of ash source, contractor, etc. will present itself and the project will proceed.

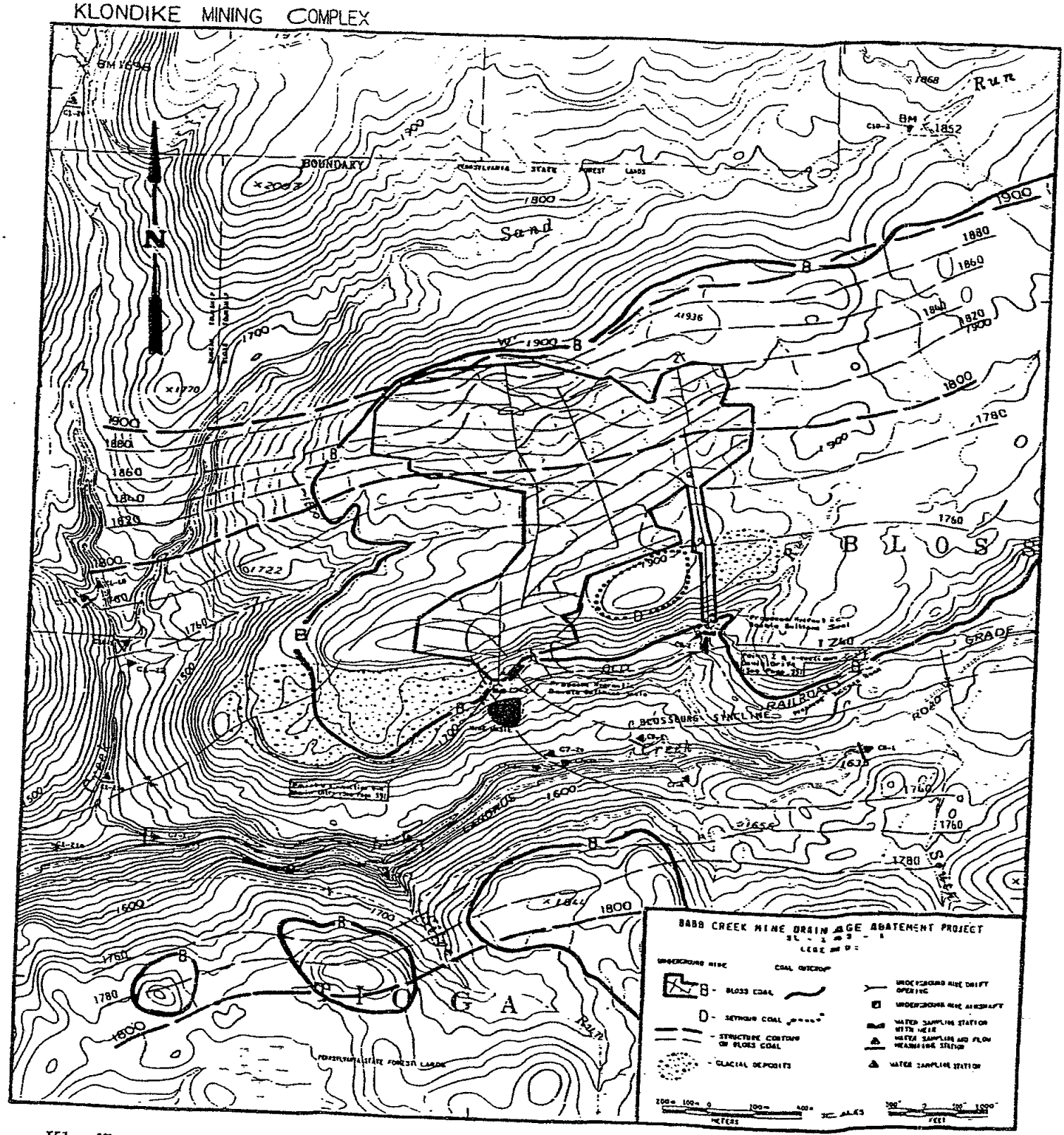
The project is considered a much lower priority than other mines and mine discharges in the watershed. The mine drainage flows to Stony Fork Creek which is highly alkaline and absorbs the acidity load. Abatement of the mine drainage will result in an improvement of stream water quality, but will not restore any stream mileage by itself.

APPENDIX

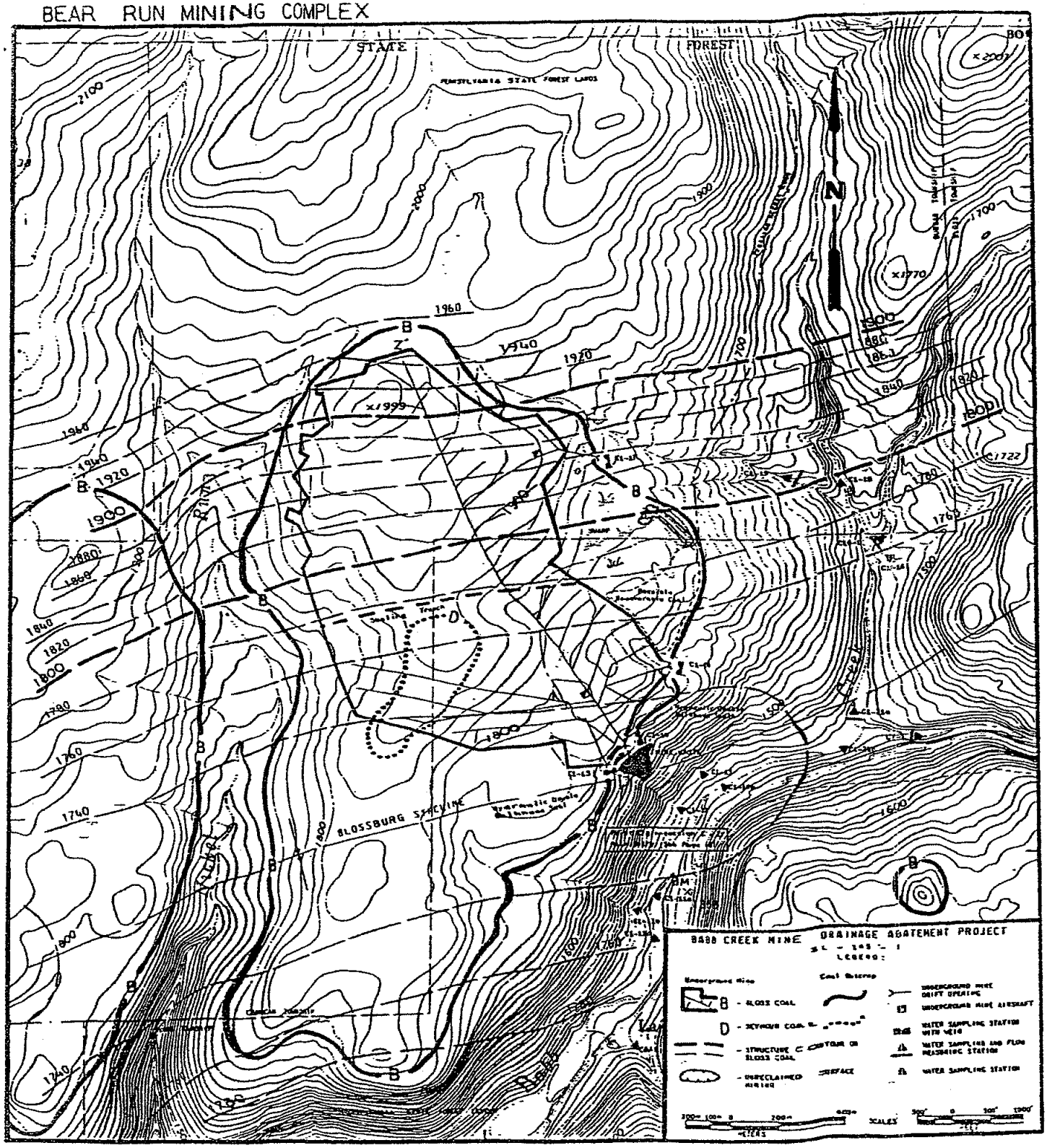
Mining Complex Maps (Arnot No. 1 and 2, Klondike, Bear Run, Antrim, Anna S, and Rattler Mine Complexes)



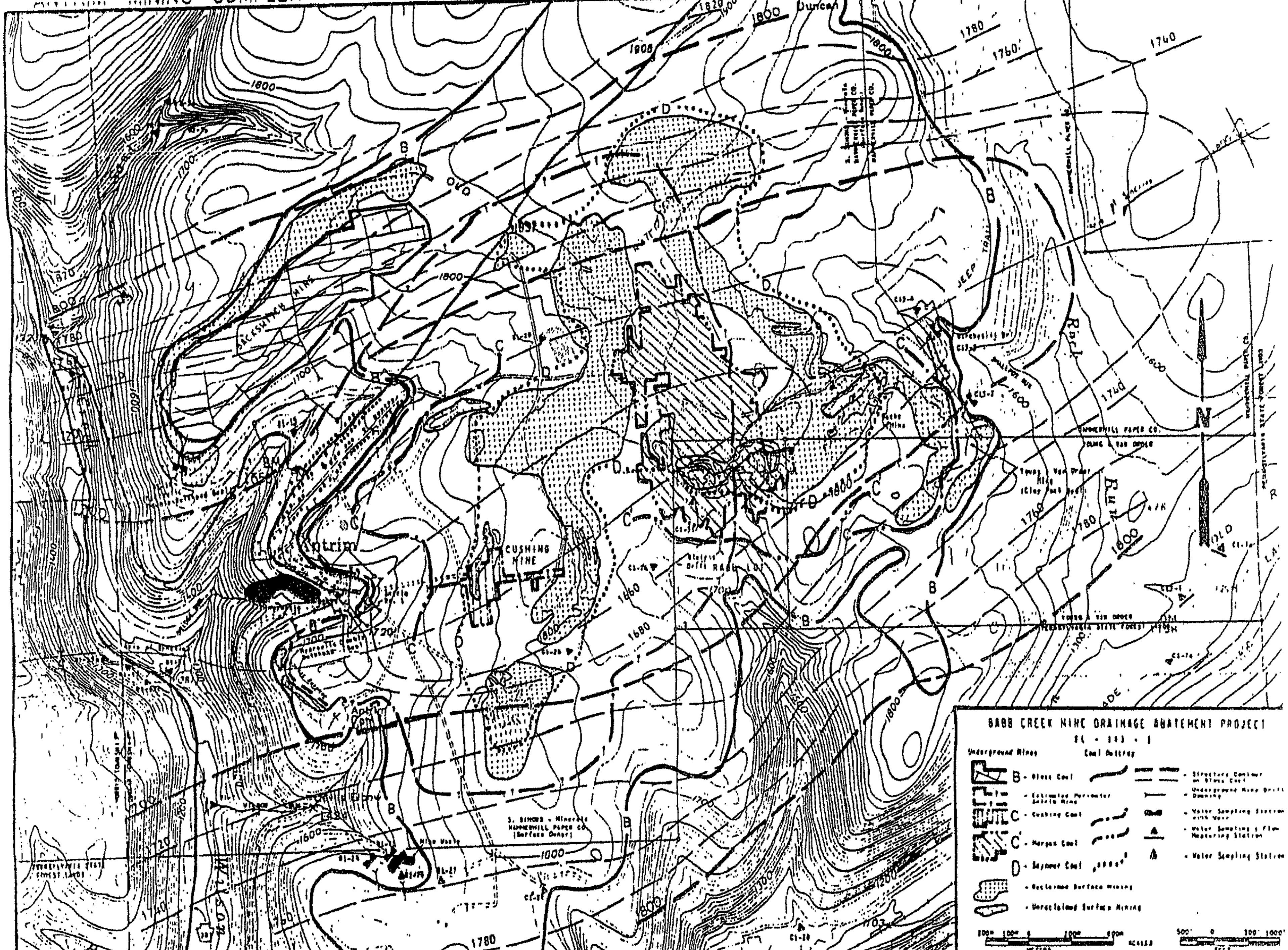
Arnot Mining Complex (from Kantz, 1976).



Klondike Mining Complex (from Kantz, 1976).

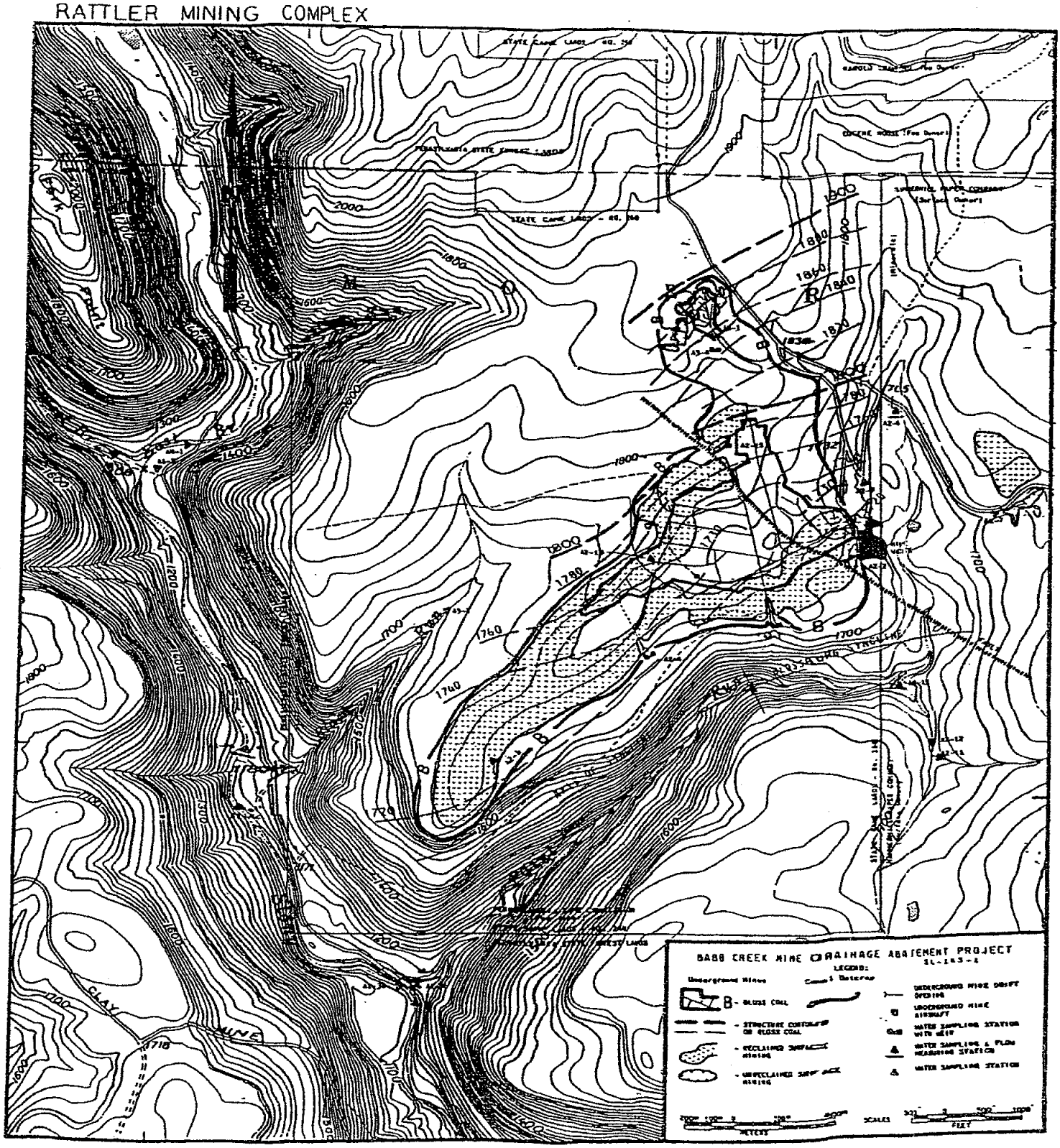


Bear Run Mining Complex (from Kantz, 1976).



BABB CREEK MINE DRAINAGE ABATEMENT PROJECT
SL - 193 - 1
Underground Mines
Coal Outcrop
B - Bloss Coal
- Structure Contour on Bloss Coal
- Estimated Perimeter Antrim Mine
- Underground Mine Drift Opening
C - Cushing Coal
- Water Sampling Station with Weir
C' - Morgan Coal
- Water Sampling & Flow Measuring Station
- Water Sampling Station
D - Seymour Coal
- Reclaimed Surface Mining
- Unreclaimed Surface Mining
METERS
SCALES
FEET
CUSHING MINE
Antrim
Duncan
JEEP TRAIL
HAMMERMILL PAPER CO.

Anna S Mining Complex (from Kantz, 1976).



Rattler Mining Complex (from Kantz, 1976).