Quick Start Projects

Orientation

In July of 1970 the Department of Environmental Resources contracted with Carson Engineers to execute a total watershed study for Cowanshannock Creek to be coupled with a "quick start" project aimed specifically at developing an abatement plan for the mine complex designated Yatesboro 4 and 5. An addendum to the contract in September, 1971, was designed to include a quick start project for developing an abatement plan for the mine complex designated Yatesboro 1, 2, 3, and Margaret 6 and 8. This section of the report presents the nature and results of the quick start projects, along with conclusions and recommendations for a program of direct and immediate action to abate discharge from these sources.

Specifically, our contract objectives called for: (1) a detailed analysis of the physical and chemical conditions of three known discharge points, (2) an extended investigation of other possible points of discharge, (3) the development of recommendations for abatement, (4) preparation of plans and technical specifications necessary for core borings and other detailed investigations, (5) preparation of plans and technical specifications necessary for plugging flows at three known bore holes, (6) design of a monitoring program that would evaluate the effectiveness of abatement action. Results for items 1, 2, 3, and 6 constitute the substance of this report.

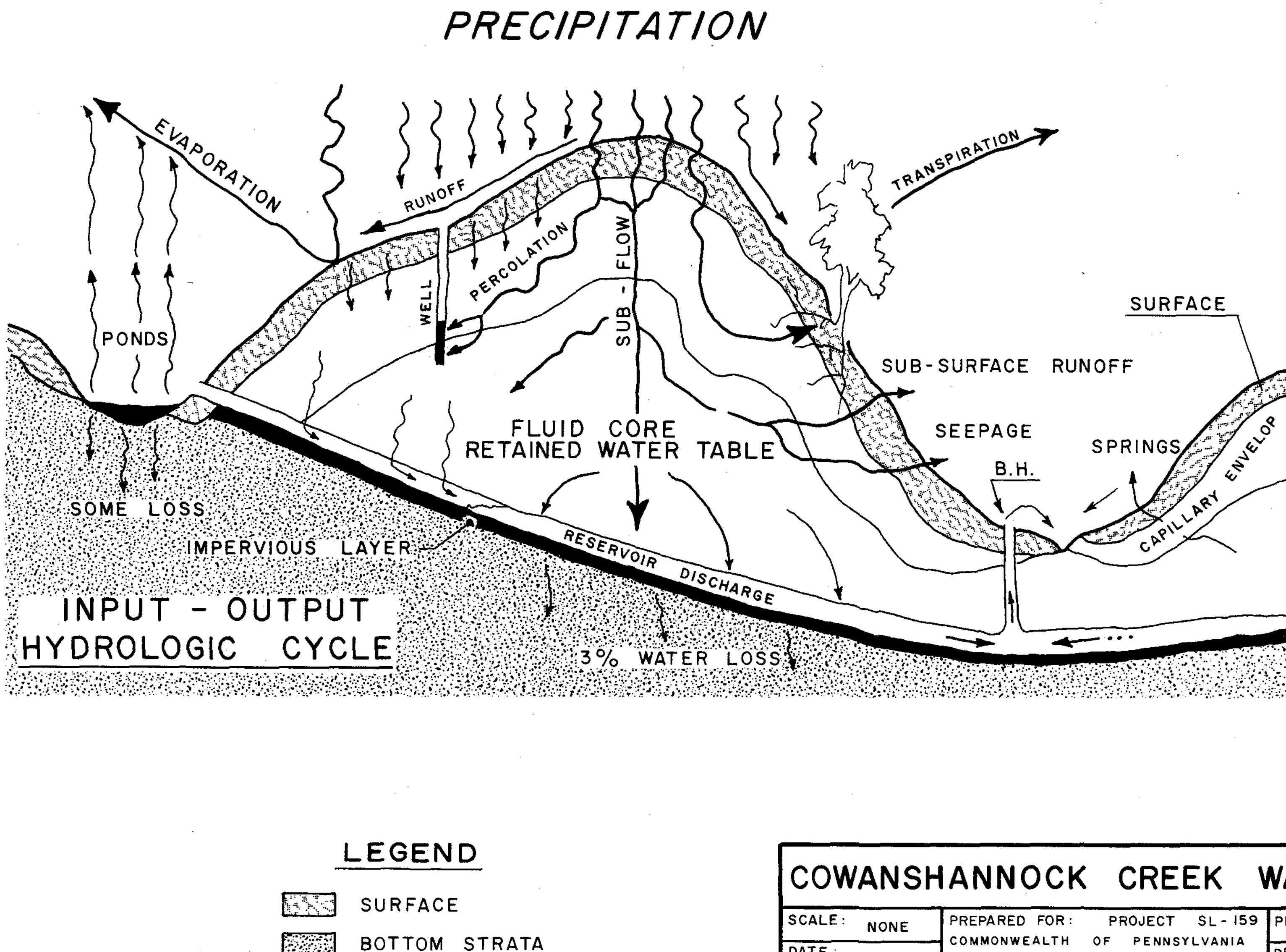
Problem

In brief, the Quick Start problem associated with both mine complexes has been to investigate the conditions of drainage of these mines so as to be able to determine from among alternative methods of abatement the one most feasible for reducing to within acceptable limits the quantity of pollutants flowing into the Cowanshannock. The matter was complicated, however, by the fact that it was not clear exactly which conditions were relevant (if any), nor was it clear what would stand as "acceptable" tolerance limits. Furthermore, it was by no means transparent what ultimate effects would result from a given course of action relative to drainage abatement. Thus, the problem had to receive further and more precise formulation in terms of explicit theory regarding each facet constituting its overall nature. Only in that way have we been able to justify the gathering of certain facts to the exclusion of others, and only on such a basis could meaningful conclusions be drawn with respect to the outcome of each course of action open to us in developing an abatement program.

Geologic Factors

The geological aspects of the problem faced in applying abatement technology to a given mine, or mine complex, is not a problem of general geology. We may draw upon the latter, but nonetheless, we need a special geological theory in order to adequately formulate and solve such a problem. Consequently, we shall introduce what may be called "Subterranean Reservoir Theory" (See Illustration on Plate 15).

Central to the approach is the concept of a subterranean reservoir, generalized to have arbitrary shape, elevation, and volume. Such a reservoir is at once a body of reservoir waters and a reservoir region containing them. It is convenient to visualize the reservoir waters as consisting of a fluid core and its attendant capillary envelop. The latter includes all waters



COWANSHANNOCK CREEK WATERSHED		
SCALE: NONE DATE: 4-20-72	PREPARED FOR: PROJECT SL-159 COMMONWEALTH OF PENNSYLVANIA DEPT. OF ENVIRONMENTAL RESOURCES	PREPARED BY: R.F.C. DRAWN BY: S.H.V.
"SUBTERRANEAN RESERVOIR THEORY"		
SUBMITTED BY: CARSON ENGINEERS		DRAWING NO. PLATE 15

bearing upon the fluid core but which are partially suspended in the saturation zones of strata forming the reservoir region. These waters are often referred to as gravitational waters since they respond to gravitational attraction although under the influence of other forces as well. The water table is a prime example.

Since the reservoir region consists of a reservoir cavity, and adjacent saturated strata, it is evident that the fluid core will comprise all free flowing waters within the reservoir cavity and its connected, outlets such as fissures and seepage channels. Clearly, any change worked upon the equilibrium of such a system and abatement is just such a change-will present the possibility of change in any or all of these factors.

Two questions arise: (1) How can desired change be best effected and maintained, and (2) How is surveillance and control of undesirable side effects to be executed? The effort to answer these questions in terms of the concept of an underground reservoir results in exactly the sort of more precise formulation of the geological aspect of our problem which was originally sought.

Thus, (a), regarding the reservoir cavity, we must determine the following:

(1) Its size.

(2) Its attitude (total flooding is generally feasible only in the down-dip mine).

(3) Whether deposits, the recovery of which could be economically viable, still remain.

(4) The character of the top and bottom adjacent strata:

- (a) Relative to permeability.
- (b) Pyrite deposits.
- (c) Strength.

(5) Strata along the course of cavity openings to be closed or sealed.

(6) The limits of the critical zone within which unknown outlets or weaknesses could possibly exist.

For either partial or total drainage abatement those factors mentioned above must be determined, and doing so is a matter of special geological investigations-not general geology.

Regarding (b), the saturated zone of the reservoir region, we require:

(1) Approximate location of the water table.

(2) The existence, actual or potential, of significant ground water channels.

(3) The water purification capacity of strata in the saturated zone.

(4) Thickness and strength of overburden.

In connection with (c), the fluid core, it is necessary to know:

(1) The location of all present discharge points.

(2) Present volume of water.

(3) Present water level.

(4) Present pressure and flow rate at discharge points.

Finally, in regards to (d); the capillary envelop, it would be helpful to know:

(1) Approximate magnitude of capillary forces operating contrary to gravitational pull.

(2) The rate of flow of capillary waters into the reservoir cavity and fluctuations thereof.

For a variety of practical reasons, we cannot expect complete and perfectly accurate facts in all of the above matters; but because these are the relevant factors, they serve to guide field. investigations and, moreover, a final decision as to abatement procedure will be only as reliable as these facts are available and accurate.

Hydrologic Factors

Interwoven with the geology of drainage abatement, there are a number of crucial hydrological considerations. We shall develop these in terms of an "input-output, theory" of local hydrology, the aim of which is complementation of the previously developed geological theory of subterranean reservoirs.

Conceptually, we can posit an input-output system on each of two levels relative to an underground reservoir. In the first level, the input precipitation, is analyzed into its major output components each of which can be quantitized as a percentage of the total input. These proportions will be different for rain than they are for snow; and again, they will. differ for intense rain over and against gentle rain. The main cases are presented in Table 10 with estimates which are oriented to the Yatesboro area.

TABLE 13

Input Precipitation

Output	Annual Inches	Ave. %	Intense Rain %	Gentle Rain %	Snow %
Evaporation	5	14	4	30	25
Transpiration	5	14	3	15	17
Surface Storage	4	10	18	10	10
Surface Runoff	15	40	55	20	30
Subsurface Flow	8	22	20	25	18
Total	37	100	100	100	100

In the second level, subsurface flow may be viewed as an input itself, having the following component output.

TABLE 14

Subsurface Flow

Output	% of Total Flow
Subsurface Runoff	40
Capillary envelop (Water table)	24
Fluid Core (Reservoir cavity)	30
Reservoir discharge	6

The total volume of the parts of the underground water (fluid core and capillary envelop) will, of course, fluctuate with fluctuation in the subsurface flow. This latter will show seasonal variation, and additionally, it will respond to storm activity. Indeed heavy and/or prolonged precipitation may produce sudden and significant increases in discharge flow rates and pollution content (acid slugging).

Over the long run, these input-output systems achieve a normal equilibrium. Abatement measures will disrupt equilibrium; however, in time a new equilibrium will be established.

Surface Relations

In the previous two sections our aim was to develop special theories capable of indicating exactly which geological and hydrological facts should be considered in dealing with the problem of drainage abatement for the Yatesboro 4 and 5 and Yatesboro 1, 2, 3, and Margaret 6 and 8 complexes. Such theories, and the facts which they embody, form a reasoned framework for later evaluation of various methods of abatement, as well as, providing a justification for the selection of one of these methods for actual application. Also, by supplying the basis for prediction, such theories provide a number of measures of the success of the program which is selected.

More yet is required however. These geophysical factors must be meaningfully related to various socio-economic features of the affected region. Thus, in the present section a "surface relations theory" is introduced, and following that, in the next section we take up criteria. These two "tie things together" in a way that provides full and precise specification of the problem of the abandoned Yatesboro and Margaret complexes.

Changes in the environment, such as those anticipated by a program of pollution abatement, will have their major impact so far as the human population goes, in social and economic conditions. Relative to animal and plant life, the major impact would be ecological. These are inter-related sets of conditions, and for precisely that reason it is desirable to conceive all surface relations in terms of land use patterns and potentials for the area.

Surface relations theory then establishes a number of important implications regarding the possible effects of changes in the geophysical life-support systems as these relate to land use. Water and substructural support are the main systems. The latter has importance mainly for the human population, but the former applies to animals and plants as well.

Geological change that alters substructural support could extend to residential, commercial or industrial buildings, to transportation routes, agricultural activity, water, gas, oil or power transmission lines, to sewage systems, or to natural or man-made water bodies. Such zones are so designated because they represent locations at which one or more land uses may be jeopardized as the result of some geological condition which an abatement program could conceivably aggrevate-e.g. the relative thinness of overburden with respect to the height of mined coal channels underneath. It is especially for buildings that such conditions could become serious. In the Yatesboro area approximately 30% to 35% of the zone of moderate to high density building construction has been undermined. Conversely, about 6% of the total mined area has moderate to high density above it.

Hydrological change induced by abatement can be expected to influence both the quality and quantity of various natural water supplies, as well as possibly working direct effects upon the usability of land for certain purposes. The schematic plans on Plate 19 and 24 show the distribution of land use for each of the three major ecological communities (human, animal, and plant).

Since the explicit aim of abatement is the improvement of water quality, there should be no direct deterioration of overall water quality for the area. Nevertheless, it is possible that water quality in certain places could be adversely affected by abatement. For example, a spring or well could be harmed by polluted underground waters forced from their normal course by abatement measure. On the other hand, improvement of water quality will eventually change patterns of land use all across the ecological range. Thus, significant improvement in stream quality might, for example, induce the Pennsylvania Fish Commission to reconsider a 1968 decision to drop the 1967 proposal to stock the Cowanshannock with game fish. This would no doubt enhance aspects of the social economy of the entire region, and hence, bring about significant changes in land use patterns.

However, for immediate purposes the more urgent question is that of water supply. Is abatement going to "dry up" water supply currently in use despite their polluted condition? Or conversely, could abatement lead to significant flooding or "swamping" in areas currently under dry land use?

In this connection, three things appear to be important:

(1) Current supplies (flows) that will cease with abatement.

(2) Locations where new flows could possibly emerge.

(3) Alteration in pool level of various surface and subsurface water bodies (swamps, ponds, wells, streams, or even the water table itself).

In the case of Yatesboro 4 and 5 there are several places where currently utilized water supply could be cut off by abatement. These are indicated on Plate 17; the present use of such water is primarily that of drinking water for livestock.

Locations where new flows could possibly start comprise:

(1) Natural egresses, the discovery of which would be a major task of any abatement monitoring program.

(2) The totality of existing mine openings.

In our investigations all of the latter have been catalogued and many of them actually located in the field (See Table on Plate 17 and 21). It is to be noted that not all mine openings (either natural or artificial) need be closely monitored since a preliminary critical zone has been defined by the thickness of overburden and to be further defined by elevation contours when the results of calculations based on pressure measurements at key openings has been initiated. In a similar way each point of potential discharge has been examined to determine the most likely drainage channels were a flow to develop following initial abatement steps.

Alteration in the pool level of ponds, swamps, etc., are possible in a number of places. These have been charted and analyzed for their likely influence on current land use (See detail No. 2, Plate 19 and 24). To the extent that such inundation occurs, additional water quality investigation will become necessary.

Criteria

In stating the Quick Start problem of the mine complexes, it was asserted that ultimately, pollution was to be brought to within "acceptable limits." Thus, it is necessary to provide some account of this crucial phrase.

No doubt it could be argued that the present conditions are "acceptable" since the area isn't altogether desolate ecologically, nor is it classed as an economic waste land although it is in an economically depressed area. But such an attitude fails to take into account a kind of loss that is progressively becoming more and more intolerable, namely, the extensive "opportunity loss" which is adding to the general depression of the quality of life itself.

In 1967 the Pennsylvania Fish Commission had considered the Cowanshannock as a potential cold water fishery. Stocking the creek and its feeder streams with abundant game fish could eventually enhance the entire watershed as a recreational area. But this potential was lost when in 1968 further tests showed intolerable quantities of pollutants in these waters. Recent tests made by the Department of Environmental Resources in October, 1971, show some improvement in water quality. Nevertheless, the fact remains that pollution still remains and loss was suffered from lack of a program of pollution control.

This is just one case in which loss has resulted from the lack of standards and necessary control of coal mine drainage. The high sulfate content, for example, in the waters of the Yatesboro region adds also to economic detriment. The quality of drinking water is reported low, and the cost for producing drinkable water is made higher by the need for more elaborate purification methods. In a similar way the lack of water quality criteria and a program to insure that they are met, has all too often dampened the interest of industry and new investments.

The Yatesboro--Rural Valley--Meredith populous hasn't the benefit of an advanced municipal water supply facility. Drinking water is substandard and comes from independently operated purification stations, or is drawn from wells that show signs of drainage pollution.

Value derives from land use; and the productive use of land depends upon an abundant supply of quality water. Of course, not every use has standards that are equally stringent with the highest, nevertheless, each category of use (domestic, wildlife, industrial, etc.) will have certain requirements that simply must be satisfied. In Plate 16 there are presented a number of primary categories with those water quality parameters that govern each. The representation in this Plate shows the existing level of each possible water pollutant (pH, sulfates, iron, etc.) as a heavy horizontal line. The shaded areas in the figure represent the general range of tolerance for each category. Look at pH values in the area of the quick start projects. The range of tolerance for domestic, wildlife, cold fish and warm fish is higher than the general pH values as indicated by the heavy dark line. This represents a pollution source for these categories because pH readings lower than an accepted standard indicates an acidic condition. For the same parameter (pH), the categories of industrial and coarse fish have a range of tolerance that falls within the general pH values. Thus, for these two categories the pH of the water is not considered as critical. For a second example, look at sulfates in the same figure. For sulfates, the range of tolerance for all categories are below the existing level for this parameter, (heavy horizontal line) and are, thus, considered a polluter for all categories.

Discussion

From our development of the Quick Start problem in terms of its major components, the theory and pertinent facts surrounding each, we are now able to draw a set of conclusions on the basis

WATER QUALITY CRITERIA

D - DOMESTIC I - INDUSTRIAL R - WARM FISH
W - WILDLIFE C - COLD FISH U - COARSE FISH
●—● EXISTING LEVEL OF PARAMETERS FOR THE YATESBORO AREA

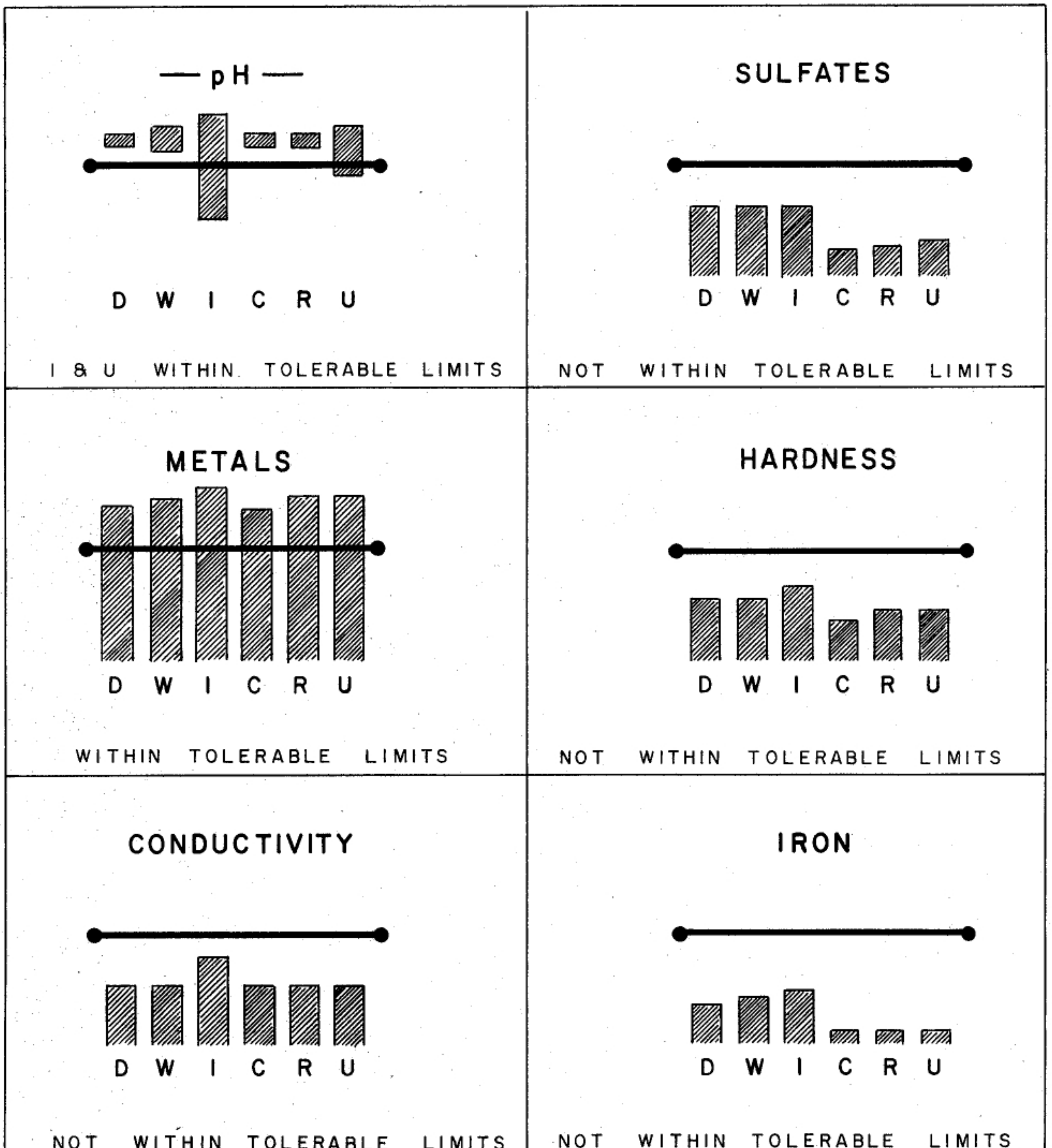


PLATE 16

of which recommendations for action can be forwarded. Essentially, these conclusions fall into two classes: (1) Those regarding the applicability of various methods for dealing with the problem of the quick start mine complexes, and (2) those dealing with contingent aspects of the course of action selected, e.g. the monitoring program, etc. is all of which we have summed up under the heading "maintenance."

Once these conclusions are drawn together, recommendations for action can be made with a fair degree of confidence that the Quick Start solutions will prove efficacious.

Methods Feasibility

A wide variety of methods for dealing with pollution resulting from coal mine drainage was surveyed, this review was carried out with specific reference to the theoretical and factual context of the Yatesboro and Margaret complexes. The results of this research are summarized in this section.

To begin with, we found it convenient to divide pollution con trol methods into two broad classes: those that focus on the treatment of polluted waters, and those that aim to accomplish abatement of these waters. The idea of abatement can be applied either to control of the waters themselves, i.e. discharqe abatement, or to the control of the process of pollutant formation, i.e. reaction abatement.

The nature of the Quick Start Project has recognized the way in which the Yatesboro and Margaret complexes fits with other mines in the same region and how these mines assumed a contributory role in the overall problem of coal mine drainage pollution in the Cowanshannock Watershed. Treatment of at least a portion of the mine water effluent can be considered in light of the marginal quality of drinking water now available in the populated project area. A demonstration project aimed at the production of potable water is within the realm of existing technology. Capital costs would vary depending upon the volume processed. A minimal capital cost for a demonstration project would be approximately one hundred and fifty thousand dollars ($150,000.00) and processing and maintenance costs would presently be twenty to thirty cents ($.20-$.30) per thousand gallons. Consumptive rates for Rural Valley Borough alone would be about 100,000 gpd based upon a population of 1000 persons consuming 100 gal/person/day. This means a daily cost of as much as thirty dollars ($30.00) or about eleven thousand dollars ($11,000.00) per year for processing and plant maintenance. A new distribution system and pumping is not included in the above analysis.

The Yatesboro 4 & 5 complex is currently discharging about 2.1 million gallons per day. Yatesboro 1, 2, & 3 and Margaret 8 is discharging about 3.2 million gallons per day. A total for both mines runs 5.3 million gallons per day. The cost of processing and treatment of this volume of water at twenty cents per thousand gallons ($.20), which is in the area of minimal costs, would be one thousand and sixty dollars per day ($1,060.00) or about $386,900.00 per year excluding capital costs. In view of the idea that existing and potential flowing sources would necessarily be sealed in order to have a one source effluent for each complex (or one effluent if the two complexes were joined) and thus one, or a maximum of two, treatment facilities, we are able to conclude that the question of treatment of waters from the mine complexes is strategically inappropriate at this time because of cost.

Thus, we may concentrate our attention on abatement techniques. Among the techniques of reaction abatement are included the following: Air sealing, surface diversion of influent waters, the use of plastics and/or foams to cut off the major reactants of the pollution forming processes, and the use of inert gases to void the entire mine cavity of an environment capable of supporting the pollution reactions.

Numerous factors associated with the Yatesboro complex makes this approach, generally, an unpromising one. Foremost among the factors militating against reaction abatement methods is the size of the mine complexes. As noted in the mine description, Yatesboro 4 and 5 alone cover 7200 acres and the Yatesboro 1, 2, 3, and Margaret 6 and 8 covers 4300 acres. Few mines larger than a mere 100 acres have been previously dealt with successfully by reaction abatement means.

Furthermore, a variety of conditions at Yatesboro 4 and 5 raise other reasons against the different types of reaction abatement methods. For example, air sealing techniques have not been proven feasible especially for mines with moderate overburden thickness, of which these complexes are an instance, because of a tendency for the mine to "breathe" (and thus replenish the air supply). with changes in atmospheric pressure. Or again, the diversion ditch and surface water impoundment method wouldn't be feasible for a mine complex which is spread over so large an area, and which has as many openings as these complexes do. Some 55 openings are presently recorded for the Yetesboro 4 and 5 complex and 74 openings have been recorded for the Yatesboro 1, 2_1 3, and Margaret 6 and 8 complex.

Foams, plastic shields, and inert gas atmospheres are all techniques of dubious utility even for small mines. For the sprawling complex at Yatesboro and Margaret, such admittedly novel ideas can have no practical overall application. One qualification is in order however: At a later stage in abatement, when perhaps only very localized problems of residual pollution remain (for example, as the result of air pockets intrapped by flooding), it may well prove to be a useful supplement to whatever general approach is adopted to employ a "pinpoint" use of such techniques.

It appears then, that the general solution to the Quick Start problems will have to proceed by way of <u>discharge abatement</u> rather than by reaction abatement.

In a negative sense, discharge abatement can be partially accomplished by dilution. That is, if harmful discharges are satisfactorily diluted with respect to offending pollutants, than it is just as if the discharge itself had been stopped. Indeed, this has the further advantage that water sources dependent on these discharges would not be suddenly shut off, or reduced to useless trickles.

However, use of this method requires large quantities of good water from other sources in order to accomplish the desired dilutions. And since the total present discharges issuing from both complexes measure in the neighborhood of 5.3 million gallons per day, for a conservative 1.9 billion gallons per year, it appears altogether hopeless to seek such a solution.

But again, it is worth keeping in mind the idea, for should drastic reduction of water supply in certain areas result from a program of direct discharge abatement, then a modified application of the technique might be worth while. It is conceivable that certain "polluted" waters could be used to dilute other "polluted waters" if the former involved pollutants not seriously detrimental to a particular land use, while the latter contained other pollutants, the deleterious effects of which were regarded as intolerable for the given intended use. Such a procedure more properly termed "differential dilutions" may well prove useful. In fact, the process of differential dilution can be observed in the Yatesboro area where mine water is now diluting domestic sewage.

In general, it becomes apparent that conditions at Yatesboro 4 and 5 and Yatesboro 1, 2, 3, and Margaret 6 and 8 call for direct discharge abatement via water tight seals of mine openings, and the subsequent flooding of at least part of the mine cavity. It should be noted, too, that such an approach is very likely, as a side-effect, to produce a certain amount of reaction abatement as well, since flooding, if complete, can significantly reduce the amount of oxygen available for adverse reactions.

Hydraulic sealing of mine openings is a means of helping abate mine acid flow either by complete inundation by flooding or by partial inundation by partial flooding. Complete flooding of the mine cavity results in the elimination of a major portion of the oxygen necessary for the chemical conversion of naturally existing pyrites to sulfuric acid, iron, and sulfates. Partial flooding allows the elimination of part of the gaseous atmosphere, including some oxygen and the attendant deleterious chemical reaction, via its replacement with water. Abatement thru the use of partial inundation is advanced here on the theory that the undesirable elements of acid mine drainage (sulfuric acid, iron, and sulfates) formed will settle to near the lowest elevation of the underground reservoir. Thus, mine water effluent, using the partial flooding method, is directed to flow at its highest elevation in order to draw water from the top of the reservoir pool.

This should be done with a minimum of short circuiting of the flow within the reservoir.

The decision to completely inundate the mine cavity or to partially inundate the cavity is a decision based principally upon the geology, hydrology, and surface relations of the area.

As the water level in the mine rises, it is anticipated that the water table at, or near, the mine location will change. This could mean, especially in the areas of concern outlined as areas of 100 feet overburden or less on Plates 18 and 23, that well water could be affected. Thus, a rise in water table elevation could cause adverse conditions such as water seepage into basements or the pollution of existing wells.

Blow-outs of hydraulic seals generally depends upon three parameters: the level of water contained, the strength and condition (geology) of rock supporting the seal, and upon-the strength and condition of the seal itself. The general geology within the quick start areas indicate that the rock strata, although in a geologic unconformity, will support hydraulic seals; however, a closer investigation via a core drilling program will be necessary to determine the strength and type of rock at each seal in order to design a proper seal for the anticipated head of water.

Blow-outs could occur at areas other than where seals are constructed. These areas would be expected where the least overburden occurs and where coal mine workings are close to the ground surface. These areas are defined in Plates 18 and 23 as areas of low overburden. In the case of both of the proposed quick start projects in this report, it is this parameter, minimal overburden, that limits the maximum allowable water elevation in the mine cavities. More precise information on the nature of the geology in these areas will be required via a rock core drilling program in order to better ascertain the shear value of the overlying strata, porosity, fissures, and depth to the mine cavity. This investigation is very critical to the development of an abatement program for these deep mine complexes. Extensive investigative drilling beyond the preliminary investigative drilling outlined in the cost summary of this report its likely.

The possibility of additional mine subsidence is a factor that must be considered, especially in the critical zones outlined. Normally, one can expect an increase in hydrostatic pressure that results from an increase in mine water elevation to have a buoyant effect on the roof of the mine complex and thus help to prevent subsidence to some degree. There is, however, the adverse possibility that the added head could cause water movement through cracks and fissures surrounding the mine tunnels and perhaps weaken the overburden to the point of collapse. Critical areas where subsidence could occur were analyzed by use of existing mine and topographical maps. This type of analysis must in turn be followed by a more detailed physical analysis of areas of concern via monitoring or an in-depth study of the area geology.

The possibility of flooding adjacent active mine workings was considered, especially in the area of the active Margaret 7 mine it was determined that the construction phase of an abatement program should not begin at Margaret 8 until active Margaret 7 is abandoned. Recommendations made here concerning sealing and flooding other abandoned mine workings will not affect the active Margaret 7 mine workings via the possibility of flooding.

Strip mine activities in the quick start project environs were found to represent areas of additional geologic investigation. A drilling program and analysis is recommended where it is evidenced that a strip mine encroaches on or is close to deep mine cavities to be flooded. However, most strip mine activities in the environs are of secondary concern. Where some of the strip mines do encroach the deep mine complex, the encroachment is at an elevation higher than the proposed final expected mine water elevation. Though seals at these points of encroachment may be required to prevent a flow of water into the mines, they are considered as secondary importance at this time.

A change in the water reservoir via an increase in water elevation is expected to cause some change in the water table in adjacent watersheds, especially where the deep mine complexes encroach. The amount of change is unknown except that a small increase in water table elevation is expected. A portion of the Pine Creek watershed is in the critical low overburden area and should be monitored closely.

Existing flows from mine openings are proposed to be cut off. This will likely work to some detriment of local inhabitants in the

Yatesboro-NuMine area where the effects of differential dilution from the existing flow at 4BH14 helps in the abatement of domestic sewage. A deep mine flow at 4BH15 is presently being used on the Wilson farm as a source of supply for livestock watering. This source would be completely or at least partially cut off as sealing is completed.

Within the areas of critical concern (areas of 100 feet overburden or less) there are geologic, hydrologic, and physical conditions of the deep mine complexes that cannot be determined without a very extensive investigative and construction program. This report proposes the use of a nominal investigative, construction, and monitoring program with the use of valved seals as a safety measure. However, a more positive approach to sealing the mine complexes can be taken by thoroughly investigating all possible areas of concern via geologic and hydrologic investigations. This procedure of extensive investigation may be considered as an alternate to the more moderate method proposed.

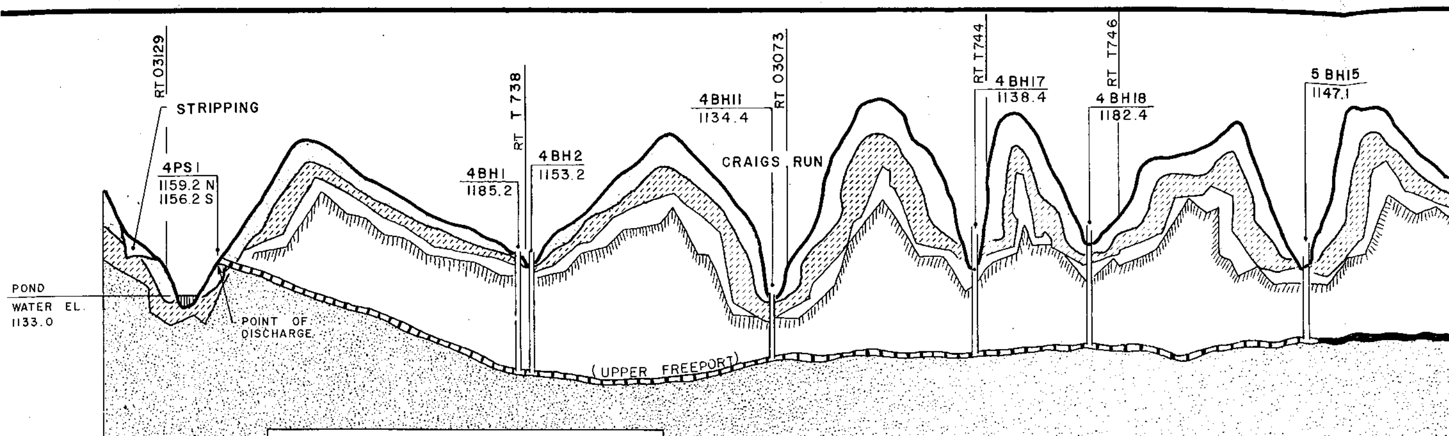
Maintenance

The term "maintenance" is pointedly being used here in a broader than usual sense. Because the nature of the mine sealing program affects not only the mine itself, but the geology and hydrology of the surrounding region as well--not to mention the indirect effects worked on ecology and human activity in the area--because of all this, maintenance of such a program involves necessarily considerably more than just the ordinary maintenance of the seals constructed.

We may say, therefore, that maintenance of such a program means:

1. Periodic investigation of seals, valves and other contracted structures.
2. Provision for contingencies including remedial action (construction, if necessary) where side-effects require it.
3. A monitoring program based on a good theoretical understanding of the conditions of the mine, and the nature of the abatement operation and its predictions.
4. Measures capable of checking critical predictions regarding success or failure of the goals of the program as well as anticipating side-effects.

Given a phased program for abatement, maintenance efficiency will be enhanced in all of the above facets. Changes and/or improvements in type or design are thus possible with a minimum of loss. Remedial maintenance can be made part of the monitoring program also. The design of the monitoring program, therefore, is a critical part of the overall proposal.



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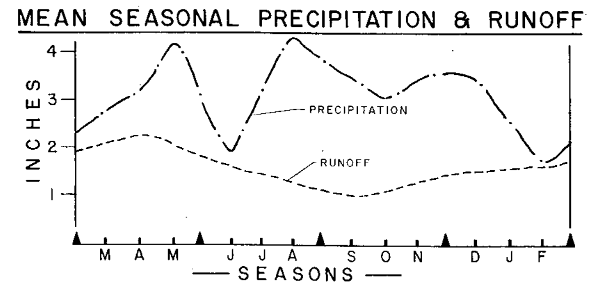
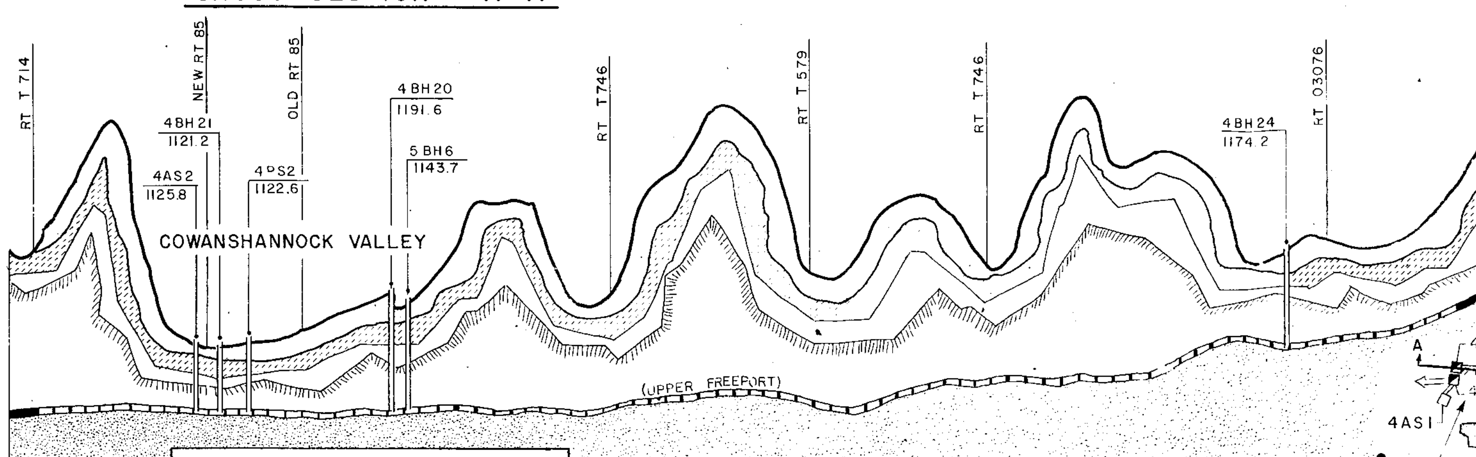


NOTES:

1. BORE HOLE & MINE OPENING ELEVATIONS ESTABLISHED BY FIELD MEASUREMENT.
2. WATER TABLE ELEVATIONS WERE INTERPOLATED FROM ELEVATIONS OBTAINED AT SCATTERED WELLS THROUGHOUT THE AREA. (DRAWDOWN NOT ESTABLISHED)
3. STRATIGRAPHY WAS DERIVED FROM VARIOUS SOURCES OF OLD CORE BORING RECORDS.
4. WATER LEVEL IN THE MINE IS ONLY APPROXIMATE.



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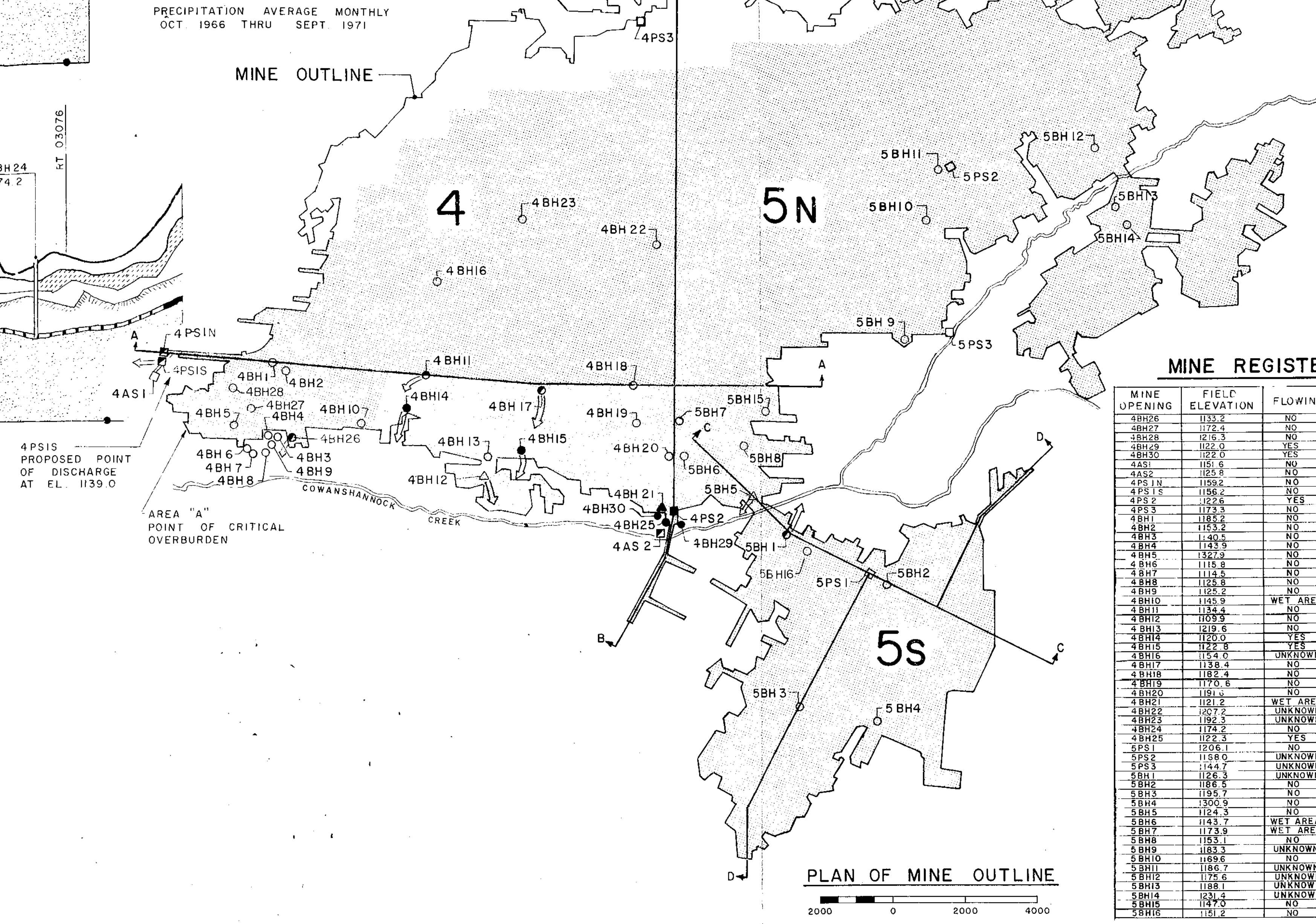
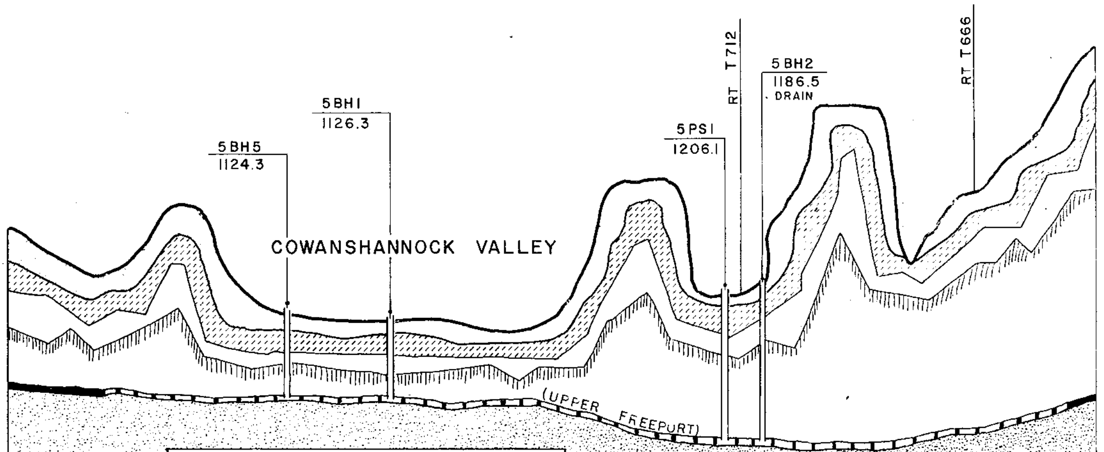


MINE REGISTER

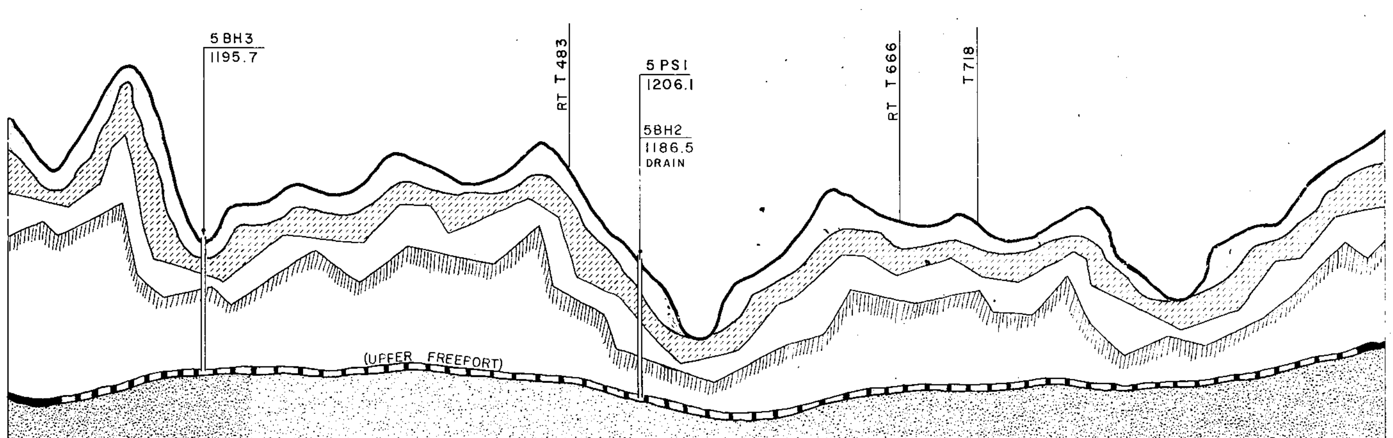
MINE OPENING	FIELD ELEVATION	FLOWING	CONDITION
4BH26	1133.2	NO	COVERED
4BH27	1172.4	NO	COVERED
4BH28	1216.3	NO	OPEN
4BH29	1122.0	YES	OPEN
4BH30	1122.0	YES	OPEN
4AS1	1151.6	NO	COVERED
4AS2	1125.8	NO	COVERED
4PS1N	1159.2	NO	COVERED
4PS1S	1156.2	NO	COVERED
4PS2	1122.6	YES	P/OPEN
4PS3	1173.3	NO	N/LOC.
4BH1	1185.2	NO	FILLED
4BH2	1153.2	NO	FILLED
4BH3	1140.5	NO	WELL
4BH4	1143.9	NO	WELL
4BH5	1327.9	NO	COVERED
4BH6	1115.8	NO	WELL
4BH7	1114.5	NO	WELL
4BH8	1125.8	NO	WELL
4BH9	1125.2	NO	WELL
4BH10	1145.9	WET AREA	FILLED
4BH11	1134.4	NO	OPEN
4BH12	1109.9	NO	DRAIN
4BH13	1219.6	NO	OPEN
4BH14	1120.0	YES	DRAIN
4BH15	1122.8	YES	DRAIN
4BH16	1154.0	UNKNOWN	N/LOC.
4BH17	1138.4	NO	FILLED
4BH18	1182.4	NO	FILLED
4BH19	1170.6	NO	COVERED
4BH20	1191.6	NO	P/FILLED
4BH21	1121.2	WET AREA	FILLED
4BH22	1207.2	UNKNOWN	N/LOC.
4BH23	1192.3	UNKNOWN	N/LOC.
4BH24	1174.2	NO	OPEN
4BH25	1122.3	YES	P/OPEN
5PS1	1206.1	NO	FILLED
5PS2	1168.0	UNKNOWN	N/LOC.
5PS3	1144.7	UNKNOWN	N/LOC.
5BH1	1126.3	UNKNOWN	DRAIN
5BH2	1186.5	NO	COVERED
5BH3	1195.7	NO	FILLED
5BH4	1300.9	NO	OPEN
5BH5	1124.3	NO	DRAIN
5BH6	1143.7	WET AREA	DRAIN
5BH7	1173.9	WET AREA	DRAIN
5BH8	1153.1	NO	OPEN
5BH9	1183.3	UNKNOWN	N/LOC.
5BH10	1169.6	NO	OPEN
5BH11	1186.7	UNKNOWN	N/LOC.
5BH12	1175.6	UNKNOWN	N/LOC.
5BH13	1188.1	UNKNOWN	N/LOC.
5BH14	1231.4	UNKNOWN	N/LOC.
5BH15	1147.0	NO	FILLED
5BH16	1151.2	NO	COVERED

NOTES:

1. N/EST. - NOT ESTABLISHED AT THIS TIME
2. P/OPEN - PARTIALLY OPEN
3. N/LOC. - NOT LOCATED AT THIS TIME
4. P/FILLED - PARTIALLY FILLED
5. BH - BORE HOLE
6. PS - PORTAL SHAFT
7. AS - AIR SHAFT



CROSS SECTION C - C



CROSS SECTION D - D

LEGEND

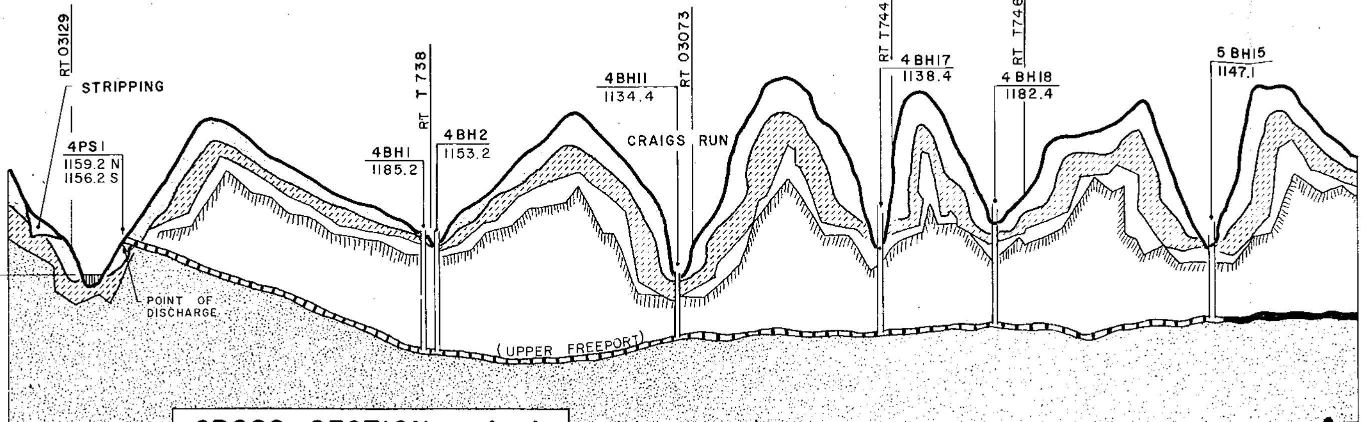
- SURFACE
- ZONE OF WEATHERED JOINTS
- WATER TABLE
- MINED COAL SEAM NOT PILLARED
- BOTTOM STRATA
- UNMINED COAL
- PROBABLE PATH OF DISCHARGE
- PS, AS ● BH NOW FLOWING
- OPENINGS WITH POTENTIAL FLOW
- BH WHICH COULD BE FLOWING BY UNDERGROUND DRAIN
- OPENINGS WHICH SHOULD BE FLOWING BUT ARE DEBRIS FILLED
- OPENINGS WHICH HAVE NO POTENTIAL FLOW
- APPROXIMATE AREA OF MINE NOW FLOODED

COWANSHANNOCK CREEK WATERSHED

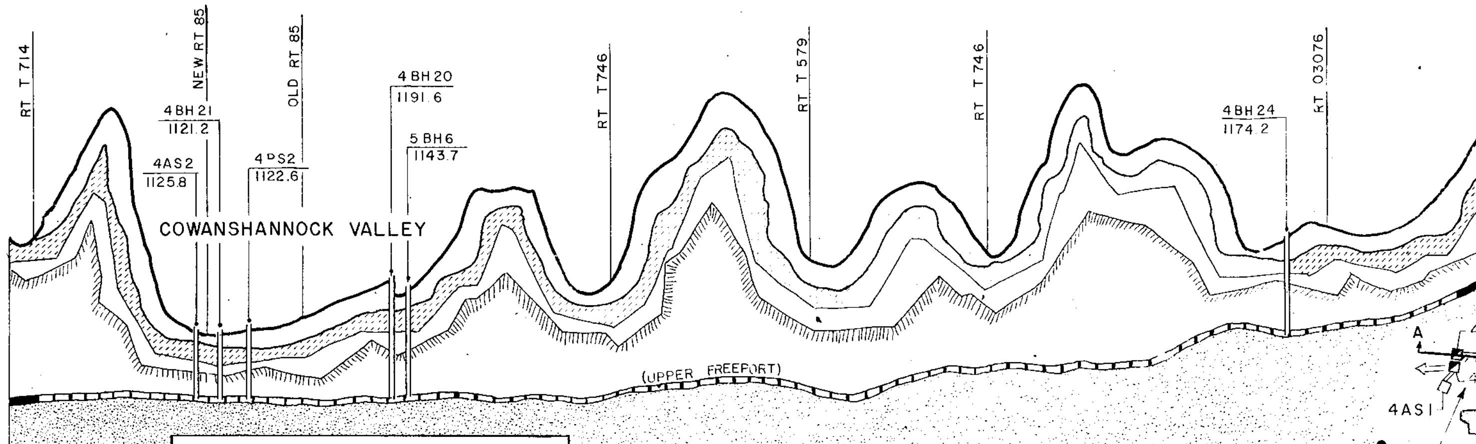
SCALE: AS SHOWN	PREPARED FOR: PROJECT SL - 159 COMMONWEALTH OF PENNSYLVANIA DEPT. OF ENVIRONMENTAL RESOURCES	PREPARED BY: R.F.C.
DATE: 4-20-72		DRAWN BY: S.V.S.

QUICK START STUDY NO. 1
HYDROLOGY - YATESBORO 4 & 5

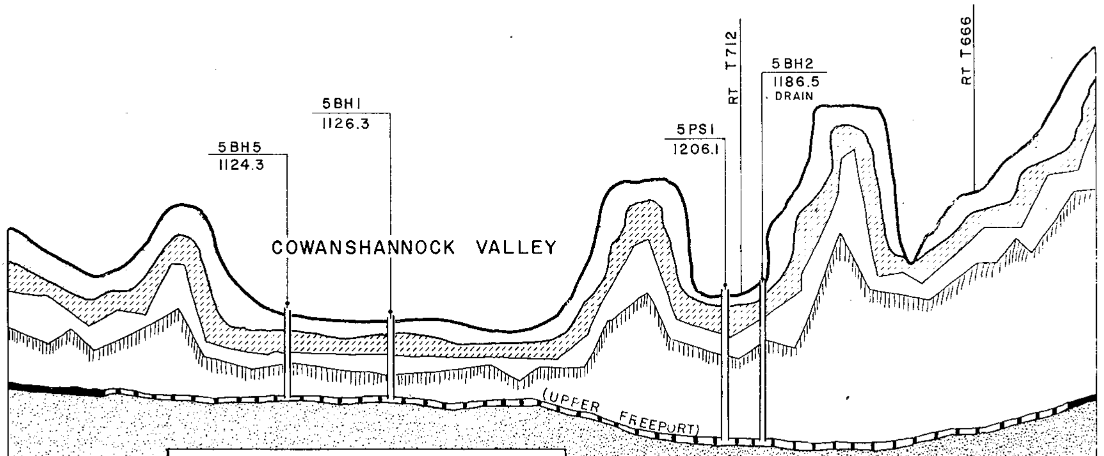
SUBMITTED BY: CARSON ENGINEERS	DRAWING NO. PLATE 17



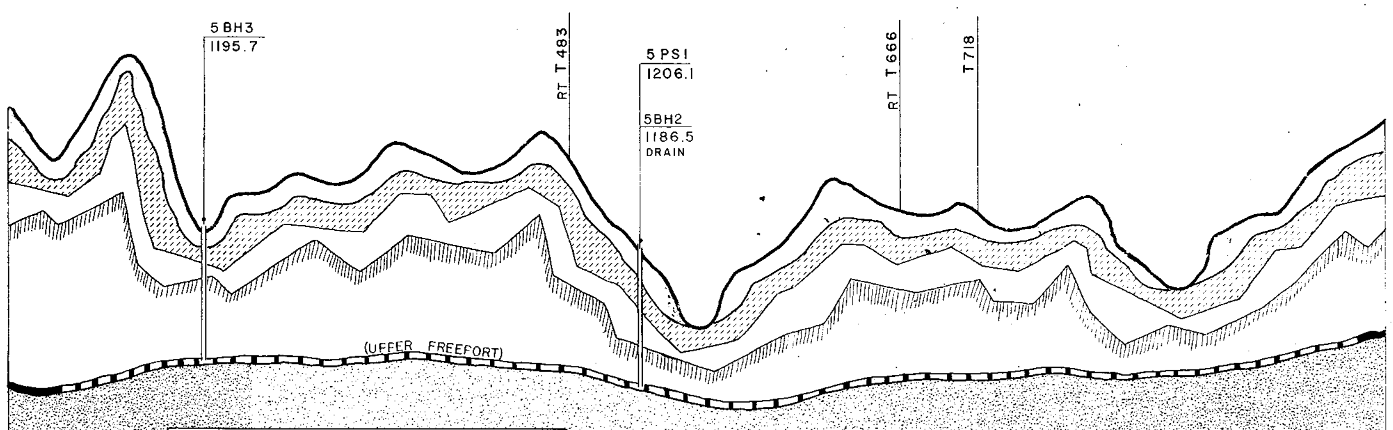
CROSS SECTION A-A



CROSS SECTION B-B

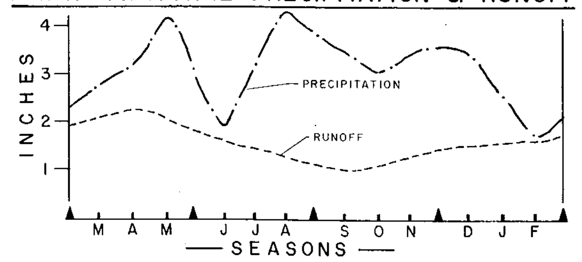


CROSS SECTION C-C

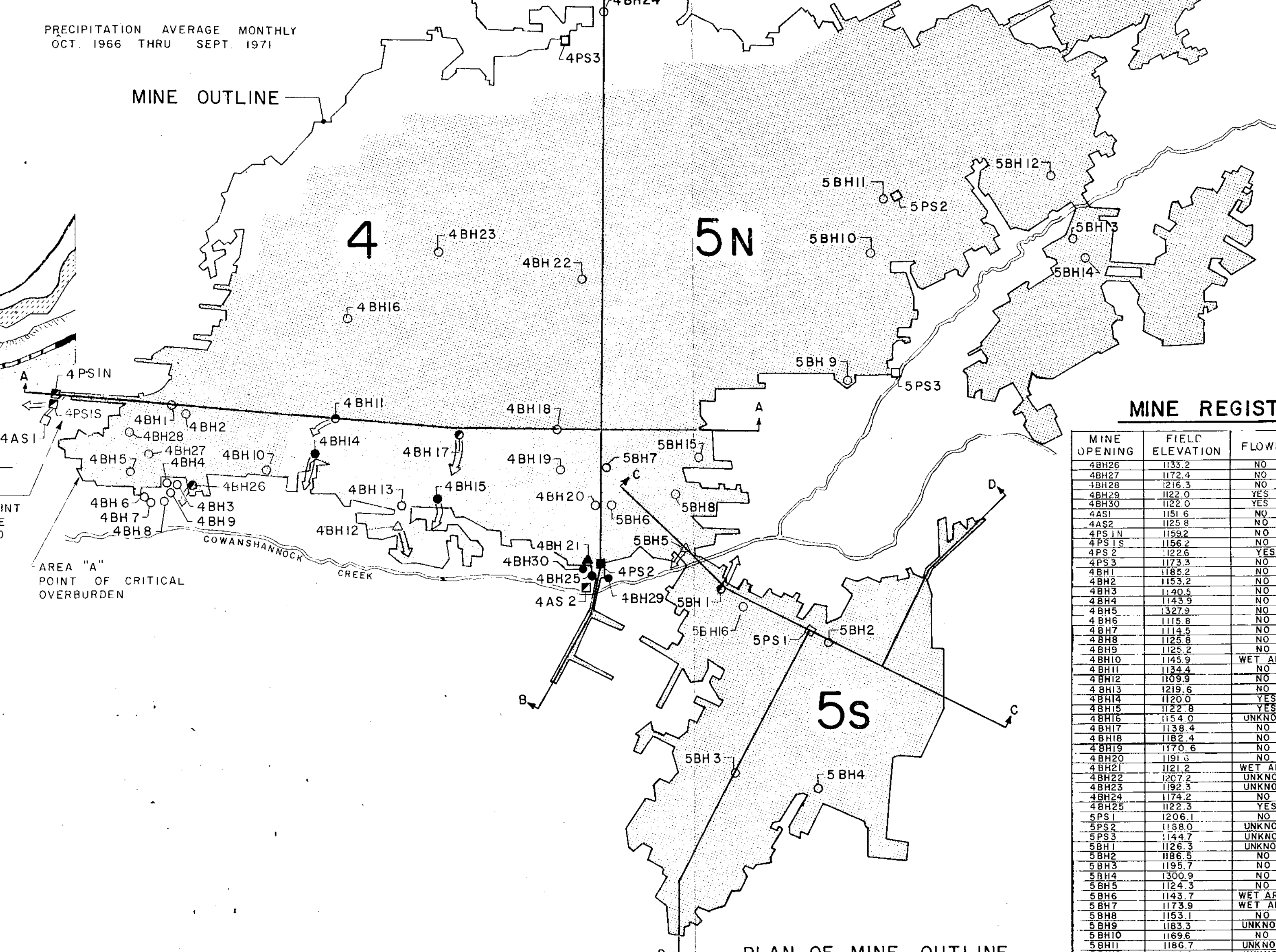


CROSS SECTION D-D

MEAN SEASONAL PRECIPITATION & RUNOFF



PRECIPITATION AVERAGE MONTHLY OCT. 1966 THRU SEPT. 1971



PLAN OF MINE OUTLINE

2000 0 2000 4000

NOTES:

1. BORE HOLE & MINE OPENING ELEVATIONS ESTABLISHED BY FIELD MEASUREMENT.
2. WATER TABLE ELEVATIONS WERE INTERPOLATED FROM ELEVATIONS OBTAINED AT SCATTERED WELLS THROUGHOUT THE AREA. (DRAWDOWN NOT ESTABLISHED)
3. STRATIGRAPHY WAS DERIVED FROM VARIOUS SOURCES OF OLD CORE BORING RECORDS.
4. WATER LEVEL IN THE MINE IS ONLY APPROXIMATE.

LEGEND

- SURFACE
- ZONE OF WEATHERED JOINTS
- WATER TABLE
- MINED COAL SEAM NOT PILLARED
- BOTTOM STRATA
- UNMINED COAL
- PROBABLE PATH OF DISCHARGE
- ■ PS, AS ● BH NOW FLOWING
- OPENINGS WITH POTENTIAL FLOW
- △ BH WHICH COULD BE FLOWING BY UNDERGROUND DRAIN
- ▲ OPENINGS WHICH SHOULD BE FLOWING BUT ARE DEBRIS FILLED
- □ ○ OPENINGS WHICH HAVE NO POTENTIAL FLOW
- APPROXIMATE AREA OF MINE NOW FLOODED

MINE REGISTER

MINE OPENING	FIELD ELEVATION	FLOWING	CONDITION
4BH26	1133.2	NO	COVERED
4BH27	1172.4	NO	COVERED
4BH28	1216.3	NO	OPEN
4BH29	1122.0	YES	OPEN
4BH30	1122.0	YES	OPEN
4AS1	1151.6	NO	COVERED
4AS2	1125.8	NO	COVERED
4PS1N	1159.2	NO	COVERED
4PS1S	1156.2	NO	COVERED
4PS2	1122.6	YES	P/OPEN
4PS3	1173.3	NO	N/LOC.
4BH1	1185.2	NO	FILLED
4BH2	1153.2	NO	FILLED
4BH3	1140.5	NO	WELL
4BH4	1143.9	NO	WELL
4BH5	1327.9	NO	COVERED
4BH6	1115.8	NO	WELL
4BH7	1114.5	NO	WELL
4BH8	1125.8	NO	WELL
4BH9	1125.2	NO	WELL
4BH10	1145.9	WET AREA	FILLED
4BH11	1134.4	NO	OPEN
4BH12	1109.9	NO	DRAIN
4BH13	1219.6	NO	OPEN
4BH14	1120.0	YES	DRAIN
4BH15	1122.8	YES	DRAIN
4BH16	1154.0	UNKNOWN	N/LOC.
4BH17	1138.4	NO	FILLED
4BH18	1182.4	NO	FILLED
4BH19	1170.6	NO	COVERED
4BH20	1191.6	NO	P/FILLED
4BH21	1121.2	WET AREA	FILLED
4BH22	1207.2	UNKNOWN	N/LOC.
4BH23	1192.3	UNKNOWN	N/LOC.
4BH24	1174.2	NO	OPEN
4BH25	1122.3	YES	P/OPEN
5PS1	1206.1	NO	FILLED
5PS2	1188.0	UNKNOWN	N/LOC.
5PS3	1144.7	UNKNOWN	N/LOC.
5BH1	1126.3	UNKNOWN	DRAIN
5BH2	1186.5	NO	COVERED
5BH3	1195.7	NO	FILLED
5BH4	1300.9	NO	OPEN
5BH5	1124.3	NO	DRAIN
5BH6	1143.7	WET AREA	DRAIN
5BH7	1173.9	WET AREA	DRAIN
5BH8	1153.1	NO	OPEN
5BH9	1183.3	UNKNOWN	N/LOC.
5BH10	1169.6	NO	OPEN
5BH11	1186.7	UNKNOWN	N/LOC.
5BH12	1175.6	UNKNOWN	N/LOC.
5BH13	1188.1	UNKNOWN	N/LOC.
5BH14	1231.4	UNKNOWN	N/LOC.
5BH15	1147.0	NO	FILLED
5BH16	1151.2	NO	COVERED

NOTES:

1. N/EST. - NOT ESTABLISHED AT THIS TIME
2. P/OPEN - PARTIALLY OPEN
3. N/LOC. - NOT LOCATED AT THIS TIME
4. P/FILLED - PARTIALLY FILLED
5. BH - BORE HOLE
6. PS - PORTAL SHAFT
7. AS - AIR SHAFT

COWANSHANNOCK CREEK WATERSHED

SCALE: AS SHOWN	PREPARED FOR: PROJECT SL-159 COMMONWEALTH OF PENNSYLVANIA DEPT. OF ENVIRONMENTAL RESOURCES	PREPARED BY: R.F.C.
DATE: 4-20-72		DRAWN BY: S.V.S.

QUICK START STUDY NO. 1
HYDROLOGY - YATESBORO 4 & 5

SUBMITTED BY: CARSON ENGINEERS

DRAWING NO. PLATE 17

During this period, mining was performed on the down-dip within the Upper Freeport coal seam by a modified room-and-pillar system. Coal was undercut, drilled, and blasted and then loaded onto conveyors which emptied into waiting mine cars. Upon completion of a room, the pillars were removed for about 15% of the mined area. In spite of this action, it has been noted that only one discernible shallow surface subsidence has occurred. During mining operation, several in-mine seals were constructed in order to control the flow of percolating ground waters.

Abandonment procedure consisted of backfilling the main portal and air shafts, in addition to debris plugging of randomly selected bore holes. Approximately 14% of the coal seam has been left unmined. Currently, a pair of bore holes (4BH14 and 4BH15) and backfilled mine shaft (4PS2) are continuously issuing gravity discharges of polluted effluent at the combined average rate of about 2.1 million gallons per day. Resulting pollutants from these discharges are:

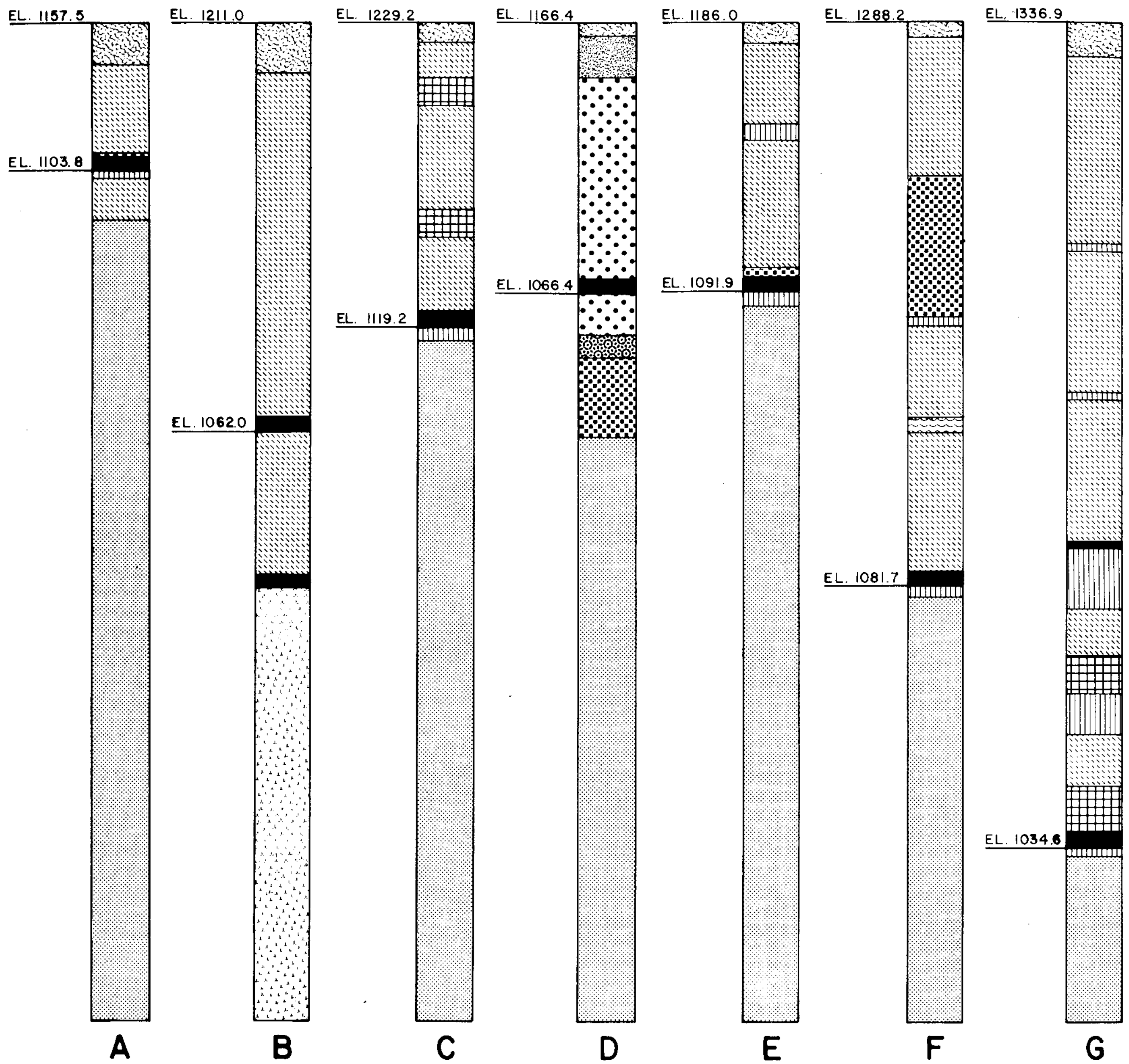
Acidity	0.8 ppm	14#/d	2.6 T/yr.
Iron	13.4 ppm	240#/d	44 T/yr.
Sulfates	366 ppm	6567#/d	1198 T/yr.
Hardness	180 ppm	3230#/d	589 T/yr.

Total volume of the complex is in the neighborhood of 1.49 billion cubic feet. At an average depth of 200', the entire complex has exploited the Upper Freeport coal, and is in this area, therefore, a down-dip operation. There are few deviations from a uniform 3% downgrade from the north, east, and west fringes toward the south fringes of the exploited seam. The predicted advance of the water level in the mine, if the reservoir cavity is filled, is shown by the sketch on Plate 18.

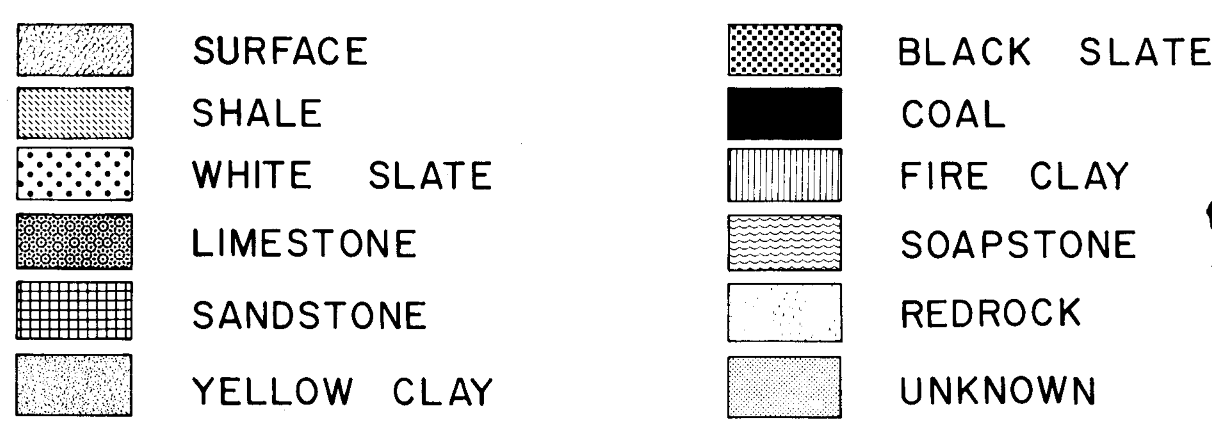
Reports from R&P Coal Company indicate that less than 14% of mineable coal remain in the seam in this area; moreover, it appears not feasible to remove any of this. Hence, total flooding would in no way create an economic disadvantage.

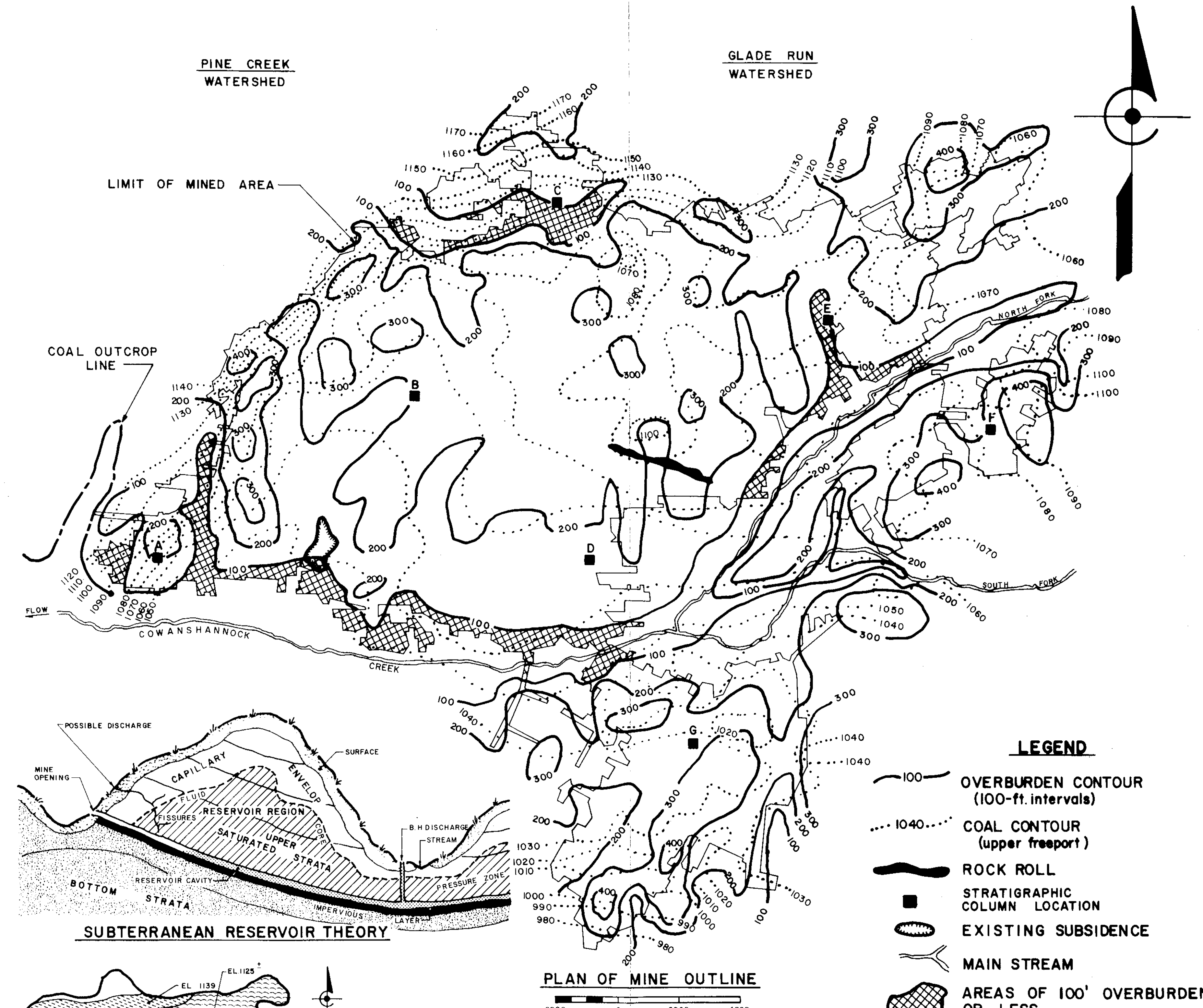
STRATIGRAPHIC COLUMNS

VERTICAL SCALE 30 0 30 60



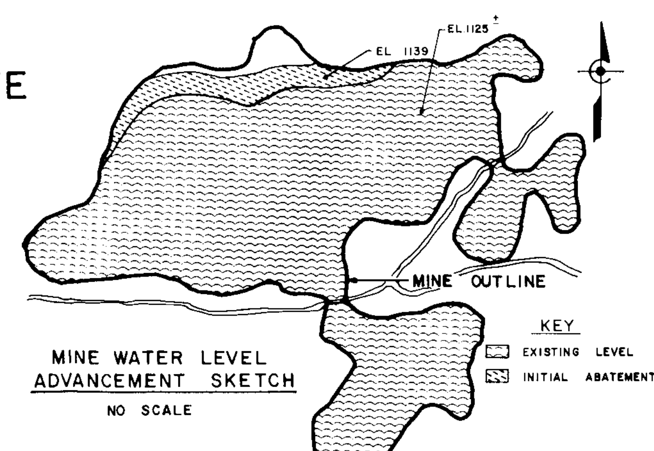
STRATIGRAPHIC KEY





SUBTERRANEAN RESERVOIR THEORY

PLAN OF MINE OUTLINE



MINE WATER LEVEL ADVANCEMENT SKETCH

NO SCALE

NOTES:

1. OVERBURDEN CONTOURS WERE INTERPRETED BY THE DIFFERENCE BETWEEN MINE FLOOR ELEVATIONS AND U.S.G.S. TOPOGRAPHY 20' INTERVAL — 1" = 2000' - RURAL VALLEY 1905
2. COAL CONTOURS REPRESENT THE BOTTOM OF THE MINED UPPER FREEPORT SEAM ELEVATIONS HAVE BEEN CORRECTED TO CORRESPOND TO U.S.G.S. ELEVATIONS.
3. INFORMATION FOR THE STRATIGRAPHIC COLUMNS WAS COMPILED FROM OLD CORE BORING RECORDS OF THE R & P COAL CO., PHILLIPS PETROLEUM & GAS CO. AND THE PEOPLES NATURAL GAS CO.
4. THE AVERAGE THICKNESS OF THE MINED SEAM IS APPROXIMATELY 4'-0 FEET

COWANSHANNOCK CREEK WATERSHED		
SCALE: AS SHOWN DATE: 4-20-72	PREPARED FOR: PROJECT SL-159 COMMONWEALTH OF PENNSYLVANIA DEPT. OF ENVIRONMENTAL RESOURCES	PREPARED BY: R.F.C. DRAWN BY: S.V.S
QUICK START STUDY NO. 1 GEOLOGY - YATESBORO 4 & 5		
SUBMITTED BY: CARSON ENGINEERS		DRAWING NO. PLATE 18

The strata immediately above and below the coal seam are the Conemaugh Formation and the Allegheny Formation strata respectively. The permeability of these strata can be described as moderate to high. Furthermore, seasonal variations in precipitation would likely have some effect.

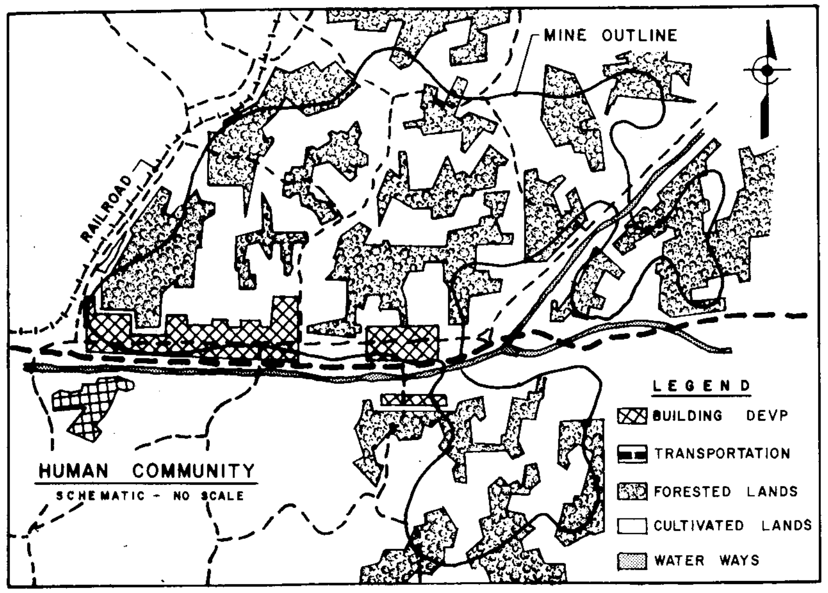
Pyrite oxidation was evidenced by strong acid discharges during the active mining period, however, recent investigation shows that the acid contribution has reduced considerably. Strata adjacent to the Upper Freeport are generally analyzed to have minimum pyrite inclusions. Upon flooding, we could expect discharge points in the elevation range, 1120 to 1140, to be the least acid.

The stratum directly above Upper Freeport Coal consist primarily of various weak shales and, in most areas, appears sufficiently thick to support the existing overburden. However, there is evidence of a subsidence in one area and in some other areas shallow overburdens make additional subsidence possible.

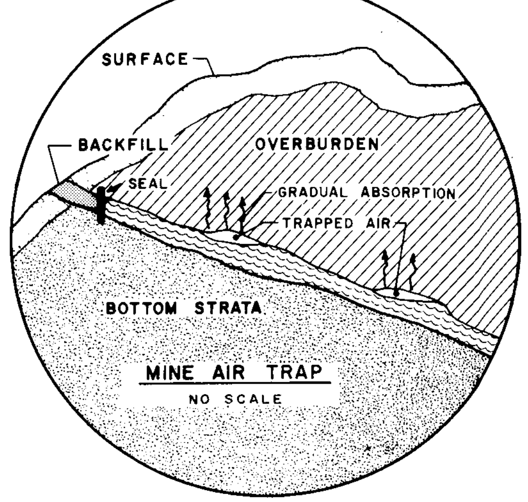
The existing discharge points for Yatesboro 4 and 5 have been recorded and carefully investigated in the field. In our recom mendations we indicate where core borings appear to be necessary. At present, opening No's. 4A51, 4AS2, 4PS1-N, 4PS1-S, 4BH1, 4BH2, 4BH5, 4BH10, 4BH17, 4BH18, 4BH19, 4BH20, 4BH21, 5PS1, 5BH2, 5BH3, and 5BH15 are filled with debris which has halted discharge. How ever, a swampy condition exists at 4BH10 and 4BH21. Gen eralized stratigraphic data indicate conditions that would favor a debris type of bore hole seal for many of the openings. For openings No. 4BH14, and 4BH15, a concrete seal with valve would be prefer able.

Water table data for the saturated zone over Yate sboro 4 and 5 is shown on Plate 17, including a graph regarding seasonal fluctuation. Also, that Plate indicates for each actual or poten tial point of discharge, its probable channel of flow.

Geologic information on the strata through which most sub surface ground waters would pass, indicate a fair purification capacity in the immediate neighborhood of the coal vein. However,



DETAIL #5



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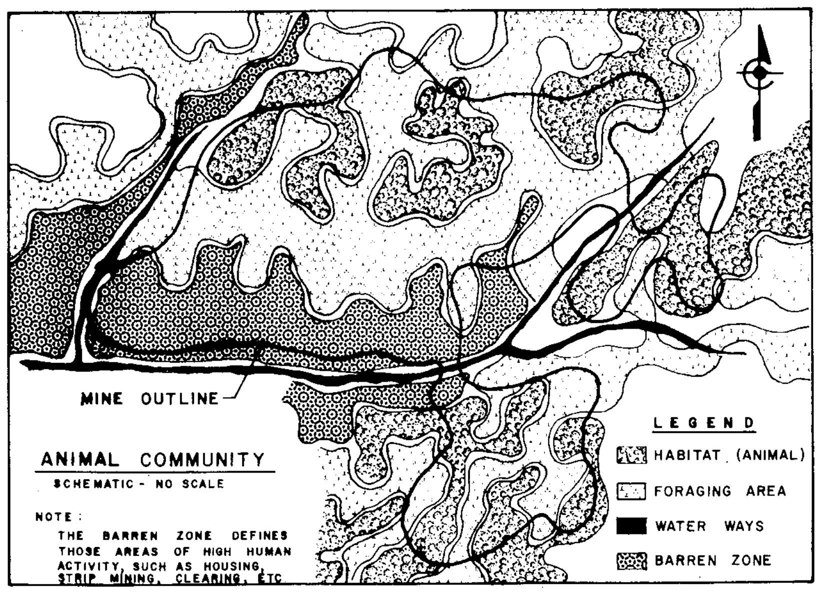

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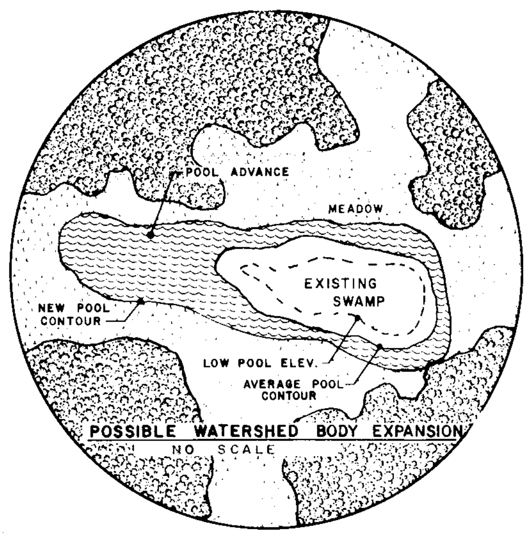
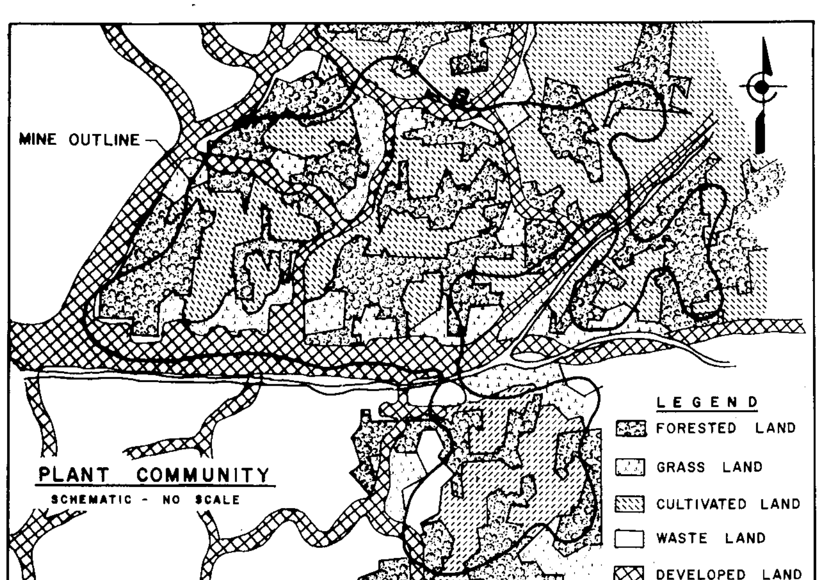


DETAIL #2



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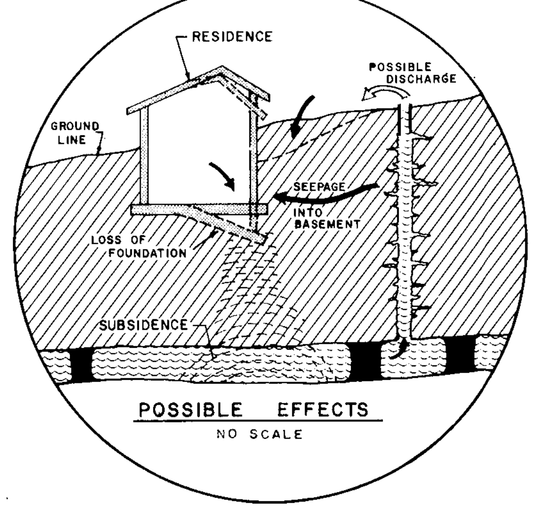

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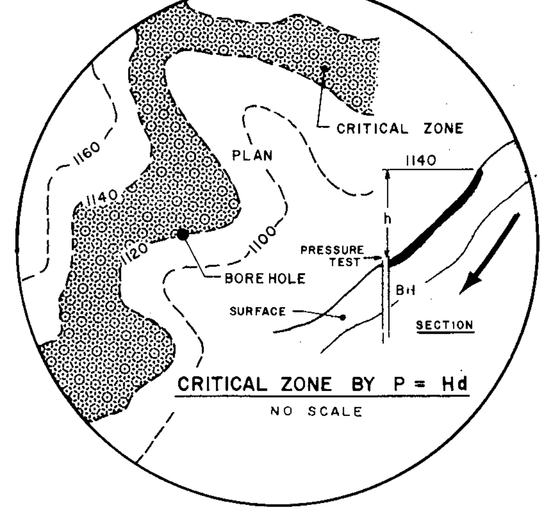

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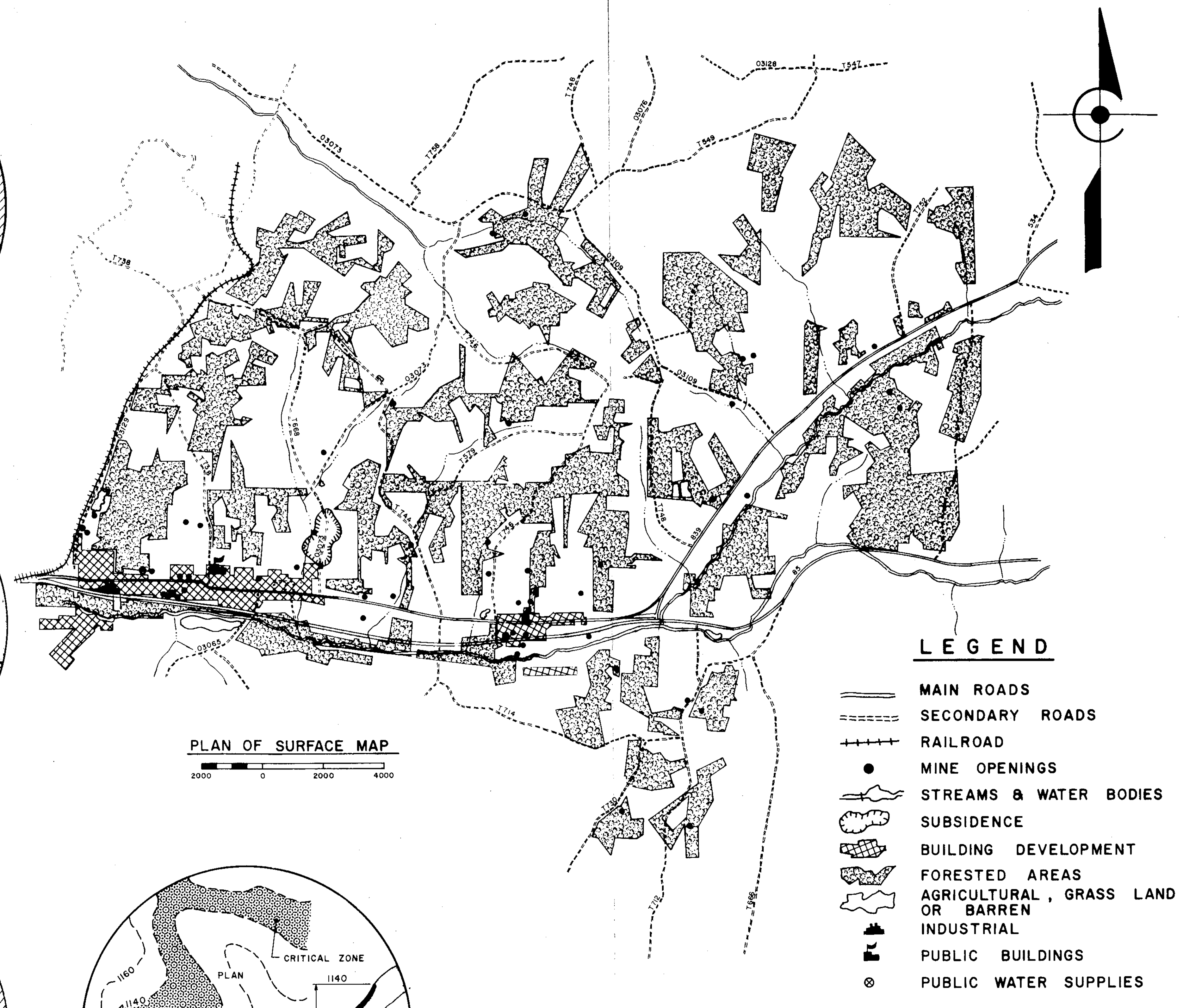


SOME POSSIBLE EFFECTS FROM ABATEMENT

1. WATER TABLE MAY RISE
2. SPRINGS AND SEEPAGE RATES MAY INCREASE SLIGHTLY
3. NEW GRAVITY DISCHARGES MAY DEVELOP
4. WELLS MAY RISE.
5. POOL AREAS MAY INCREASE
6. DILUTION OF POLLUTION COULD OCCUR
7. DILUTION OF DOMESTIC POLLUTION COULD DECREASE

COWANSHANNOCK CREEK WATERSHED

SCALE: AS SHOWN	PREPARED FOR: PROJECT SL-159 COMMONWEALTH OF PENNSYLVANIA DEPT. OF ENVIRONMENTAL RESOURCES	PREPARED BY: R.F.C.
DATE: 4-20-72		DRAWN BY: S.V.S

QUICK START STUDY NO. 1
SURFACE RELATIONS - YATESBORO 4 & 5

SUBMITTED BY: CARSON ENGINEERS	DRAWING NO. PLATE 19

if additional flooding of the mine is effected, the return of the water table nearer to its original level would be expected to improve the water quality in wells and natural outflows.

Thickness of the overburden varies from approximately 20 feet to 300 feet with about 80% being in excess of 150 feet. Moreover, reference to typical stratigraphic data (Plate 18) as well as old core boring results have shown slate and shale of considerable thickness and intermediate strength to exist above the mine vein in most areas. This presents a favorable picture as far as reduced likelihood of subsidence goes. This likelihood is slight and where it does exist the analysis allows us to make a close pinpointing of those places where the greatest concern would exist.

All points of discharge are presently recorded and important parameters noted. Present estimates, based on fairly reliable measures, indicate some 8,500,000,000 to 10,000,000,000 gallons of water already in the mine. This represents about 80% to 90% of the total mine cavity volume. Pressure readings would be desirable at 4BH14 and 4BH15 to be able to calculate the static head which would reveal a more accurate water level elevation.

The theory we are forwarding here postulates equal distribution of pressure throughout the subterranean reservoir. This pressure is based on the standard formula $p=Hd$. The head elevation is thought of as marking the elevation of the top of the capillary envelop, hence, roughly approximating the highest elevation of the water table for a mine completely sealed and flooded. This has key application in drawing several conclusions upon which some recommendations are based.

As far as the magnitude of capillary forces operating contrary to gravity are concerned, no measure is presently available. Therefore, for a completely sealed and flooded mine the capillary envelop would be treated as if its influence were the same as an equal volume of unimpeded water. Further investigation accompanying the first phase of the abatement program will give a basis for better evaluation of this factor; meanwhile, a safety margin is employed in determining the area of concern in our monitoring program. It is expected that close monitoring

of pressure and flooding following initial abatement will provide information regarding the fluctuation flow of capillary waters.
It will be utilized in later review of the program and its improvements.

Conclusion - Yatesboro 4 & 5 Mine

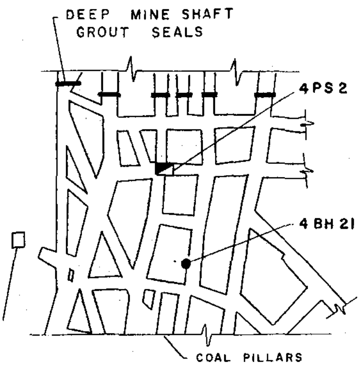
The particular characteristics of the Yatesboro complex, as well as the broader geologic and hydrologic factors involved, lends itself to the application of seal-flood technology. Systematic sealing of discharge points will allow close control of possible side effects, as well as, permitting better evaluation of particular types of seals. Such an approach maximizes the opportunity for continued scientific investigation of the theoretical aspects of the problem. It is probable that 100% flooding of the mine will not be possible because of low overburden in the southwest area of the Number 4 mine without the expense of additional sealing. Overburden in this area (Shown as area 4A on Plate 20) is approximately 20 feet and it is expected that the maximum safe head allowed in this area to be 40 feet. This allowable head would dictate a maximum water elevation of 1140.

The important requirement here, of course, is development of a carefully designed monitoring system to accompany the abatement program. As for the extent of abatement to be achieved, currently the mine has uncontrolled flooding to about 80% to 90% of its capacity. A sealing program would allow this percentage to be increased under control up to approximately 95%. Of course, it is possible even at maximum (100%) flooding, water quality standards may not be met if water quality parameters other than those for this report are considered, or because of the natural high iron content of the local sandstone; in which case other methods, including treatment, might be needed.

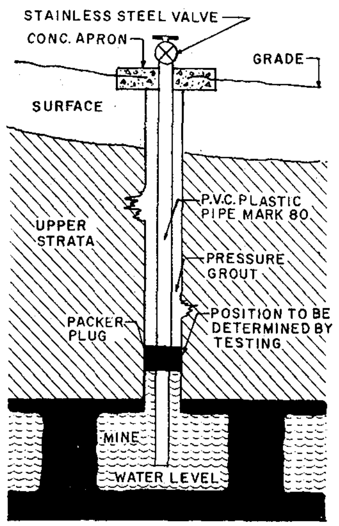
One of the effects to be achieved by eventually attaining 95% flooding of the mine is the raising of the water table. If the water table can be forced into higher zones, particularly where it appears that some purifying strata exist, such flows might well be of more acceptable water quality as the result of natural purification.

On the other hand, it seems certain that because of the huge volume of water involved in partial flooding of Yatesboro 4 and 5 it would be desirable to have some immediate controls in addition to that afforded by phasing the program of abatement. Thus, the use of valve-type seals on at least some strategically selected openings is definitely called for.

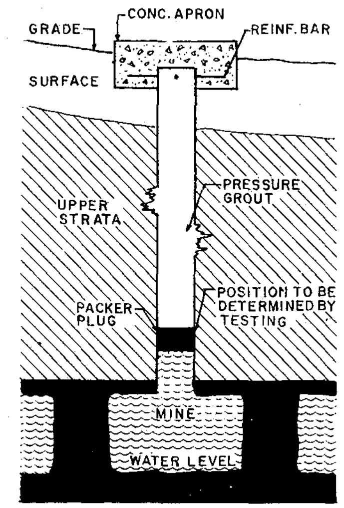
Observe further that the use of underground impermeable barriers may be required in order to deal with certain special conditions that could conceivably develop--especially in connection with wells and springs, or even building foundations located too close to seepage routes or areas in which abatement stimulates significant shifts in water table elevation. Here, it is most important that careful monitoring be initiated so that controls can be exercised sufficiently early for remedial action to be taken.



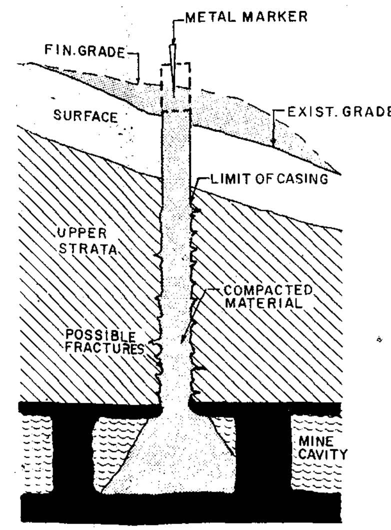
PLAN DETAIL NO. 1



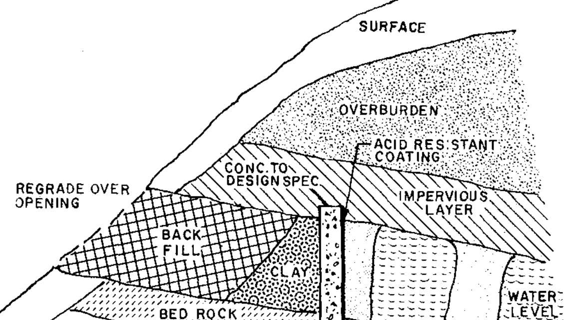
TYPICAL VALVE / B H



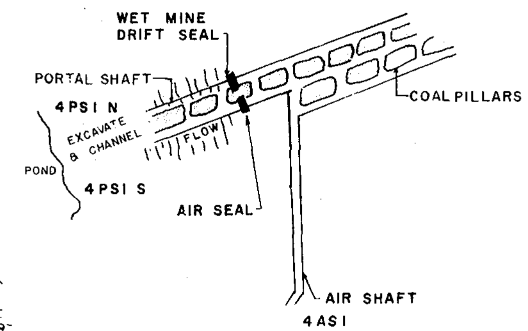
TYPICAL NON VALVE / B H



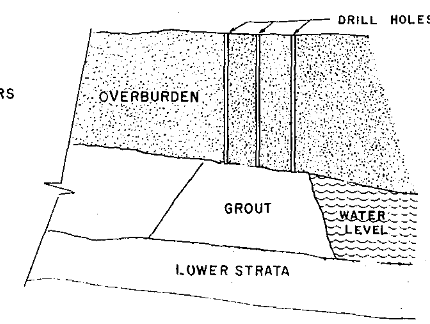
TYPICAL DEBRIS / B H



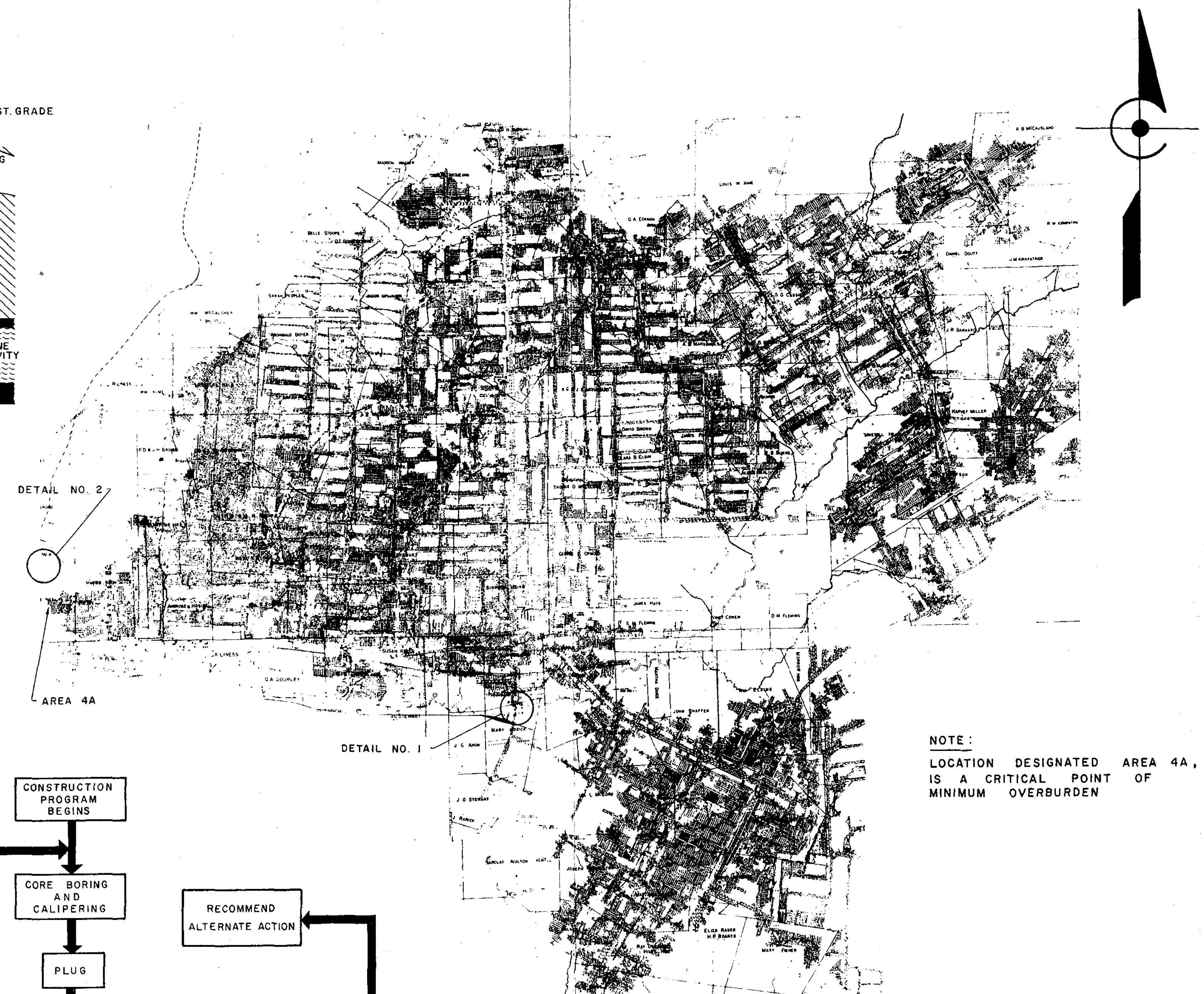
TYPICAL WET MINE DRIFT SEAL



PLAN DETAIL NO. 2



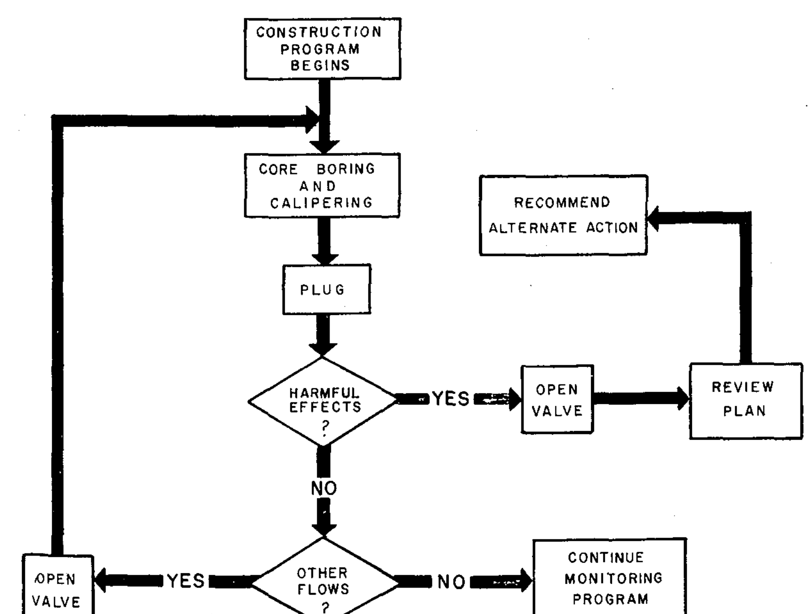
DEEP MINE SHAFT GROUT SEAL



NOTE:
LOCATION DESIGNATED AREA 4A, IS A CRITICAL POINT OF MINIMUM OVERBURDEN

PLAN OF MINE WORKINGS

MINE ABATEMENT REGISTER									
MINE OPENING	LOCATION PROPERTY OF	EXPLOR-ATION	RECOMMENDED ACTION	* ESTIMATED INVESTIGATION COST	MINE OPENING	LOCATION PROPERTY OF	EXPLOR-ATION	RECOMMENDED ACTION	* ESTIMATED INVESTIGATION COST
4AS 1	R & P COAL CO	—	MONITOR	—	4 BH 23	J A WILSON	—	MONITOR	
4AS 2	R & P COAL CO	—	MONITOR	—	4 BH 24	MELISSA STURGEON	—	MONITOR	
4PS 1 N/S	R & P COAL CO	DRILL	EXCAVATION FOR AIR SEAL	3,100	4 BH 25	PA DEPT OF HWY R/W	—	MONITOR	—
4PS 2	R & P COAL CO	DRILL	GROUT SEAL	7,200	4 BH 26	GRORGE INFANTANO	—	NO FLOW / POSSIBLE NON VALVE	
4PS 3	J.O. POSTELWAITE	--	MONITOR		4 BH 27	MAGGIE KROH	—	MONITOR	
4BH 1	MAGGIE KROH	—	MONITOR	—	4 BH 28	MAGGIE KROH	—	MONITOR	—
4BH 2	R & P COAL CO	—	MONITOR	—	4 BH 29	R.& P. COAL CO.	—	MONITOR	
4BH 3	J.O. POSTELWAITE	—	MONITOR	—	4 BH 30	R.& P. COAL CO		VALVE / BH	
4BH 4	MAGGIE KROH	—	MONITOR	—	5 PS 1	JOHN SHAFER	—	MONITOR	
4BH 5	MAGGIE KROH	—	MONITOR	--	5 PS 2	MATTHEW RANKIN	—	MONITOR	
4BH 6	MAGGIE KROH	—	MONITOR	—	5 PS 3	RM & KM NEAL	—	MONITOR	—
4BH 7	MAGGIE KROH	—	MONITOR	—	5 BH 1	M A SMELTZER EARL STOCKDILL	—	NO FLOW / POSSIBLE NON VALVE	—
4BH 8	MAGGIE KROH	—	MONITOR	—	5 BH 2	JOHN SHAFER	—	MONITOR	—
4BH 9	MAGGIE KROH	—	MONITOR	—	5 BH 3	MATTHEW RANKIN	—	MONITOR	
4BH 10	D J Mc LACHLAN G L STEWART	—	FILLED NOW / POSSIBLE NON VALVE	—	5 BH 4	JOHN YAROS	—	NO FLOW / POSSIBLE NON VALVE	—
4BH 11	MARGARET FOSTER	—	NO FLOW / POSSIBLE NON VALVE	—	5 BH 5	M A SMELTZER	—	NO FLOW / POSSIBLE NON VALVE	—
4BH 12	RALPH WILSON	—	NO FLOW / POSSIBLE NON VALVE	—	5 BH 6	DWIGHT BREWER R C HAYES	—	MONITOR	—
4BH 13	MAGGIE KROH	—	MONITOR	—	5 BH 7	D S SIMPSON HRS.	—	MONITOR	
4BH 14	SCOTT MOORE D J Mc LACHLAN	DRILL	VALVE / BH	3,900	5 BH 8	M A SMELTZER	—	MONITOR	
4BH 15	RALPH WILSON	DRILL	2 VALVE / BH	4,100	5 BH 9	ROBERT NEAL	—	MONITOR	
4BH 16	CASPER HALL JAMES BROWN	—	MONITOR		5 BH 10	S S BURNS	—	MONITOR	
4BH 17	R & P COAL CO	—	NO FLOW / POSSIBLE NON VALVE		5 BH 11	MATTHEW RANKIN	—	MONITOR	
4BH 18	D. S, SIMPSON HRS.	—	MONITOR	—	5 BH 12	R S & N MOORE	—	MONITOR	—
4BH 19	D.S. SIMPSON HRS.	—	MONITOR	—	5 BH 14	HARVEY MILLER	—	MONITOR	
4BH 20	D.S. SIMPSON HRS.	—	MONITOR		5 BH 15	M A SMELTZER	—	MONITOR	
4BH 21	R & P COAL CO	—	MONITOR	—	5 BH 16	EARL STOCKDILL	—	MONITOR	
4BH 22	BELLE J STEWART	—	MONITOR		AREA 4A	R.& P. COAL CO.	DRILL	POSSIBLE CURTAIN WALL	3,300



FLOW DIAGRAM FOR ABATEMENT CONTROL

* ESTIMATED INVESTIGATION COSTS IS FOR KNOWN SOURCES OF FLOW ONLY

COWANSHANNOCK CREEK WATERSHED

SCALE: AS SHOWN
DATE: 4-20-72
PREPARED FOR: PROJECT SL-159 COMMONWEALTH OF PENNSYLVANIA DEPT. OF ENVIRONMENTAL RESOURCES
PREPARED BY: R.F.C.
DRAWN BY: S.V.S

QUICK START STUDY NO. 1
ABATEMENT PROGRAM - YATESBORO 4 & 5

SUBMITTED BY: CARSON ENGINEERS
DRAWING NO. PLATE 20

Recommendations

Program

Results of research lead us to submit the following 3-part version of an abatement program for the Yatesboro 4 and 5 complex. We recommend:

1. A phased plan of direct discharge abatement (See Plate 20).

Phase I (upon approval of this report)

a) Core borings, pressure testing, and piezometer installation at mine openings No. 4PS2, 4BH14, 4BH15, and Area "4A".

b) Location boring at 4PS1-S, Area 4A, and in the area of mine portal shaft No. 4PS2.

c) Clean and caliper 4BH14 and 4BH15.

d) Core Boring at 4PS1-S.

Phase II

a) Grout seal mine tunnel at 4PS2.

b) Valve-type seal of bore holes No. 4BH14 and 4BH15. c) Excavate entrance at 4PS1-S to El. 1139 and prepare a channel for water flow to the existing reservoir.

Phase III

a) Three-month "quarantine" as water rises to elevation 1139.

b) Careful monitoring in affect.

Phase IV

a) Additional core borings and analysis (where needed). b) Sealing of other openings until flow ceases at all openings except 4PS1-S.

Phase V

a) Continue monitoring program at least one year after sealing is completed.

b) Water quality testing to continue.

2. A comprehensive monitoring program (see Plate 20) which will include:

   a) Continuation of the water testing program on monthly basis for a nominal 2 years or a 1 year minimum.

   b) Checking of seals and other installations.

   c) Measurements to include pressure and flow at seal points.

   d) Weekly investigation of the critical zone for new flows.

3. A contingency plan.

   a) Establish some contacts with residents in or near critical zone, in case of emergency.

Procedural detail needed for carrying out this program and the sequence of these details are outlined in the next section.

Procedure

Initiation of the plan which was recommended in the foregoing section depends upon execution of the following procedural steps:

1. Early approval of the general program outlined in this report. Consultation needed for clarification and/or revision should be requested as soon as possible.
2. Core borings and field investigation for those mine openings specified in Phase T, a and b above, should proceed as soon as possible. Real estate permits will be required for this work.
3. Further water quality testing to commence before construction begins.

4. Construction
5. Monitoring

Costs

Phase I	Investigation of Flowing Sources (Subsurface Investigation, etc.)	$ 9,700.00
	Contract Preparation	$ 4,400.00
	Supervision & Administration	5,700.00
	Analysis of Results	1,800.00
	Total Phase I.	$ 21,600.00
Phase II	Grout Mine Tunnel @ 4PS2	$ 34,300.00
	Valve Seal 4BH14 & 4BH15	22,320.00
	Channel Construction 4PS1S	24,300.00
	Sub-Total (Construction)	$ 80,920.00
	Plans & Specifications	$ 5,300.00
	Topo Survey & Stakeout	2,400.00
	Inspection	5,100.00
	Total Phase II	$ 93,720.00
Phase III	Monitoring	$ 8,000.00
	Total Phase III.	$ 8,000.00
Phase IV	Investigation of Potential Flowing Sources (Subsurface Investigation, etc.) As Required	$ 16,000.00
	Plug Bore Holes (7 Estimated) @ $5,000	$ 35,000.00
	Sub-Total (Investigation & Construction)	$ 51,000.00
	Plans & Specifications	$ 3,200.00
	Topo Survey & Stakeout	2,800.00
	Inspection	1,680.00
	Possible Grout Seal in Area 4A Including Engineering (650 Feet)	100,000.00
	Total Phase IV	$158,680.00

Phase V	Monitoring & Water Samples For One Year	$ 10,000.00
	Total Phase V	$ 10,000.00

Summary

Phase I	$ 21,600.00
Phase II	93,720.00
Phase III	8,000.00
Phase IV	158,680.00
Phase V	10,000.00
Grand Total	$292,000.00

The cost estimate for Phase IV is given only as a guide based upon potential flows. The true cost of Phase IV is dependent on the results of Phase I, II, III, and initial work in

Phase IV.

Right-of-way purchases are not included in the above costs.

Quick Start Study No. II

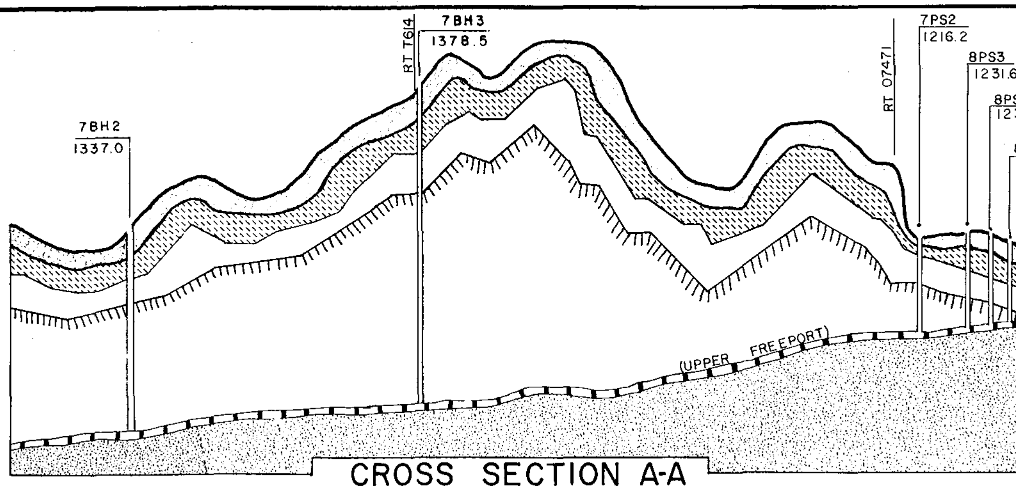
Yatesboro 1, 2$_7$ 3, and Margaret 6 & 8 Mines

Description of Mine

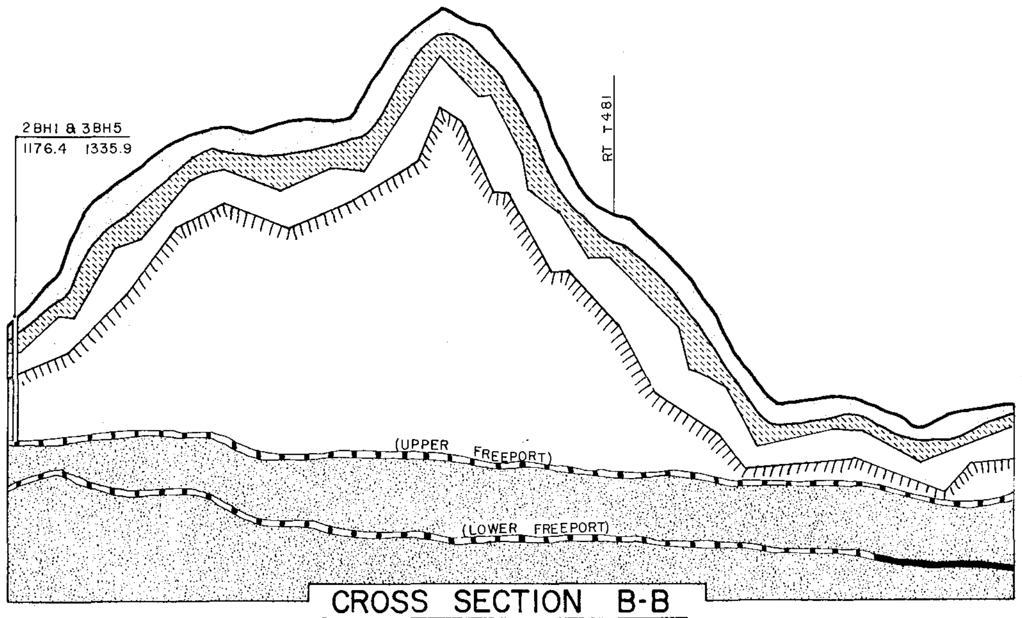
The Yatesboro 1, 2, 3, and Margaret 6 & 8 mine complex comprises some 4300 acres of undermined terrain in the eastern part of the Cowanshannock Creek Watershed. The entire complex lies south of Cowanshannock Creek. Approximately 90% of the total abandoned mine complex falls within the watershed area, while 10% falls into the Cherry Run and Plum Creek watershed on the south. It is estimated that the total complex, were it totally flooded, would have an underground volume of some 6.3 billion gallons.

This mine complex is bounded on the north and east by the abandoned workings of the R&P Coal Company's Yatesboro 4 and 5 mines, however, there is no physical connection between these two mines (Plate 3). Margaret No. 7 mine is located south of Margaret 6 and 8. Margaret 7 is an active mine and is connected to Margaret 6 mine which is used as an air return for the active workings. Therefore, for the purposes of this report, Margaret 6 mine will be treated as an active mine. The life of Margaret 7 is expected to be approximately four to five years according to the R&P Coal Company. Upon abandonment of this active mine, the mines (Margaret 6 & 7) will be flooded. It is then expected that the overflow from the flooding will enter the Cowanshannock Watershed via egress thru the abandoned Yatesboro 1, 2, and 3 workings and Margaret No. 9 mine (the connection between Yatesboro 3 and Margaret 6) shown on Plate 28 in the appendix.

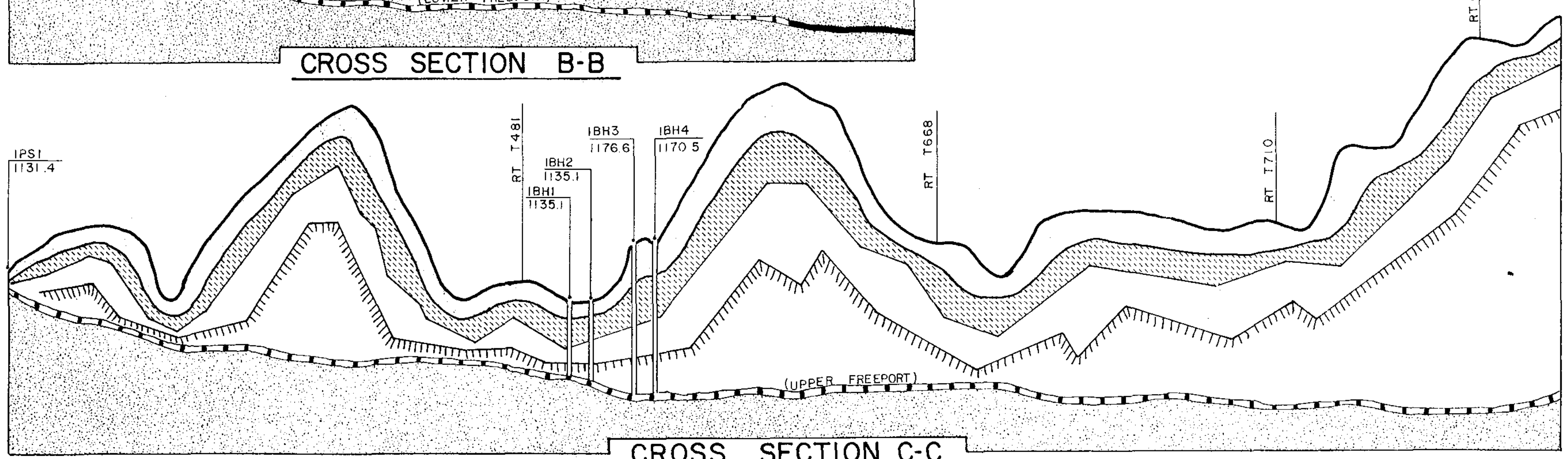
Topography above the mines is characterized by steeply rising hills separated by shallow straight valleys and leading downward to the wide flat flood plain valley of Cowanshannock Creek. The thickness of overburden covering the larger portion of the mine averages 200 feet, ranging up to a maximum of 400 feet on the hilltops. Approximately 8% to 10% of the mine falls within the critical range where the overburden is 100 feet or less.



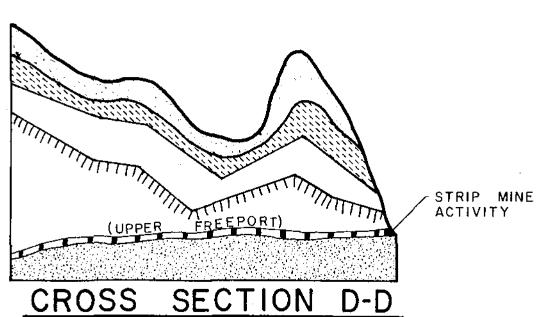
CROSS SECTION A-A



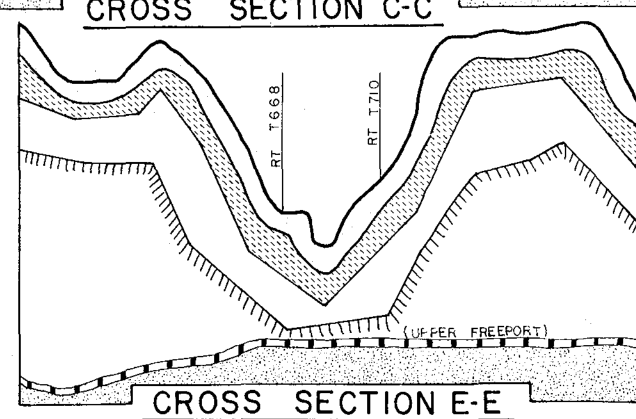
CROSS SECTION B-B



CROSS SECTION C-C

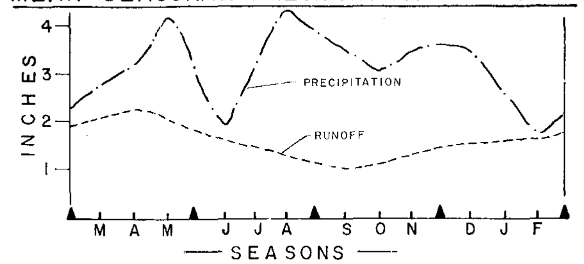


CROSS SECTION D-D

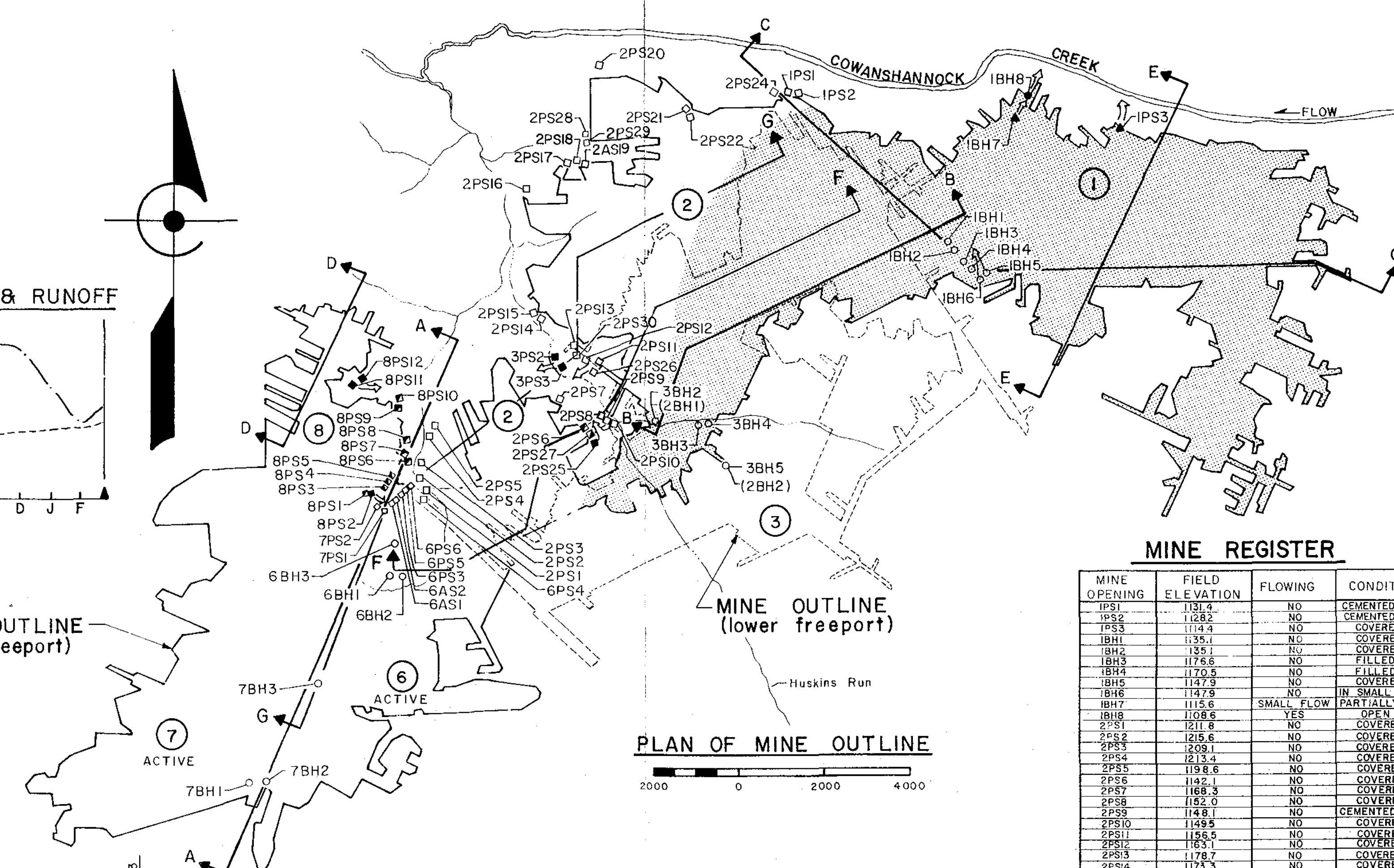


CROSS SECTION E-E

MEAN SEASONAL PRECIPITATION & RUNOFF



PRECIPITATION AVERAGE MONTHLY
OCT 1966 THRU SEPT 1971



PLAN OF MINE OUTLINE

NOTES:

1. BORE HOLE AND MINE OPENING ELEVATIONS ESTABLISHED BY FIELD MEASUREMENT.
2. WATER TABLE ELEVATIONS WERE INTERPOLATED FROM ELEVATIONS OBTAINED AT SCATTERED WELLS THROUGHOUT THE AREA. (DRAWDOWN NOT ESTABLISHED)
3. STRATIGRAPHY WAS DERIVED FROM VARIOUS SOURCES OF OLD CORE BORING RECORDS.
4. WATER LEVEL IN THE MINE IS ONLY APPROXIMATE.
5. MINE Nº 3 LOCATED IN LOWER FREEPORT COAL IS FLOODED.

MINE REGISTER

MINE OPENING	FIELD ELEVATION	FLOWING	CONDITION
1PS1	1131.4	NO	CEMENTED SHUT
1PS2	1128.2	NO	CEMENTED SHUT
1PS3	1114.4	NO	COVERED
1BH1	1135.1	NO	COVERED
1BH2	1135.1	NO	COVERED
1BH3	1176.6	NO	FILLED
1BH4	1170.5	NO	FILLED
1BH5	1147.9	NO	COVERED
1BH6	1147.9	NO	IN SMALL LAKE
1BH7	1115.6	SMALL FLOW	PARTIALLY OPEN
1BH8	1108.6	YES	OPEN
2PS1	1211.8	NO	COVERED
2PS2	1215.6	NO	COVERED
2PS3	1209.1	NO	COVERED
2PS4	1213.4	NO	COVERED
2PS5	1198.6	NO	COVERED
2PS6	1142.1	NO	COVERED
2PS7	1168.3	NO	COVERED
2PS8	1152.0	NO	COVERED
2PS9	1148.1	NO	CEMENTED SHUT
2PS10	1149.5	NO	COVERED
2PS11	1156.5	NO	COVERED
2PS12	1163.1	NO	COVERED
2PS13	1178.7	NO	COVERED
2PS14	1173.3	NO	COVERED
2PS15	1169.7	NO	COVERED
2PS16	1222.4	NO	COVERED
2PS17	1176.5	NO	COVERED
2PS18	1191.2	NO	COVERED
2AS19	1199.6	NO	COVERED
2PS20	1135.0	NO	COVERED
2PS21	1166.2	NO	COVERED
2PS22	1166.5	NO	SEALED SHUT
2PS24	1140.1	NO	CEMENTED SHUT
2PS25	1144.3	YES	OPEN
2PS26	1157.6	NO	COVERED
2PS27	1141.4	NO	COVERED
2PS28	1203.2	NO	OPEN
2PS29	1197.2	NO	COVERED
2PS30	1169.1	NO	COVERED
2BH1	1176.4	NO	FILLED
2BH2	1335.9	NO	NOT LOCATED
3PS2	1125.7	YES	COVERED
3PS3	1121.0	YES	COVERED
3BH2	1176.4	NO	FILLED
3BH3	1189.5	NO	OPEN
3BH4	1190.0	NO	OPEN
3BH5	1335.9	NO	NOT LOCATED
6AS1	1213.8	NO	STEEL DOORS SHUT
6AS2	1212.7	NO	OPEN
6PS3	1213.2	NO	CEMENTED SHUT
6PS4	N/EST.	UNKNOWN	NOT LOCATED
6PS5	1213.3	NO	CEMENTED SHUT
6PS6	1211.7	NO	CEMENTED SHUT
6BH1	1315.1	FLOW INTO MINE	OPEN
6BH2	1296.7	FLOW INTO MINE	OPEN
6BH3	1289.8	FLOW INTO MINE	OPEN
7PS1	1214.5	NO	ACTIVE
7PS2	1216.2	NO	OPEN
7BH1	1267.6	NO	AT HORIZONTAL PIPE
7BH2	1337.0	NO	OPEN
7BH3	1378.5	NO	OPEN
8PS1	1229.9	NO	COVERED
8PS2	1228.5	SMALL FLOW	COVERED
8PS3	1231.6	NO	COVERED
8PS4	1234.4	NO	COVERED
8PS5	1225.2	NO	COVERED
8PS6	N/EST	SEEPAGE	NOT LOCATED
8PS7	N/EST	SEEPAGE	NOT LOCATED
8PS8	N/EST	SEEPAGE	NOT LOCATED
8PS9	N/EST	SEEPAGE	NOT LOCATED
8PS10	N/EST	SEEPAGE	NOT LOCATED
8PS11	1258.3	YES	OPEN
8PS12	1258.5	SMALL FLOW	COVERED

NOTES:

1. N/EST. - NOT ESTABLISHED AT THIS TIME.
2. BH - BORE HOLE
3. PS - PORTAL SHAFT
4. AS - AIR SHAFT

LEGEND

- SURFACE
- ZONE OF WEATHERED JOINTS
- WATER TABLE
- MINED COAL SEAM NOT PILLARED
- BOTTOM STRATA
- UNMINED COAL
- PROBABLE PATH OF DISCHARGE
- ■ PS, AS ● BH NOW FLOWING
- OPENINGS WITH POTENTIAL FLOW
- ▲ OPENINGS WHICH SHOULD BE FLOWING BUT ARE DEBRIS FILLED
- □ ○ OPENINGS WHICH HAVE NO POTENTIAL FLOW
- APPROXIMATE AREA OF MINE NOW FLOODED
- (1) MINE NO. DESIGNATION

COWANSHANNOCK CREEK WATERSHED

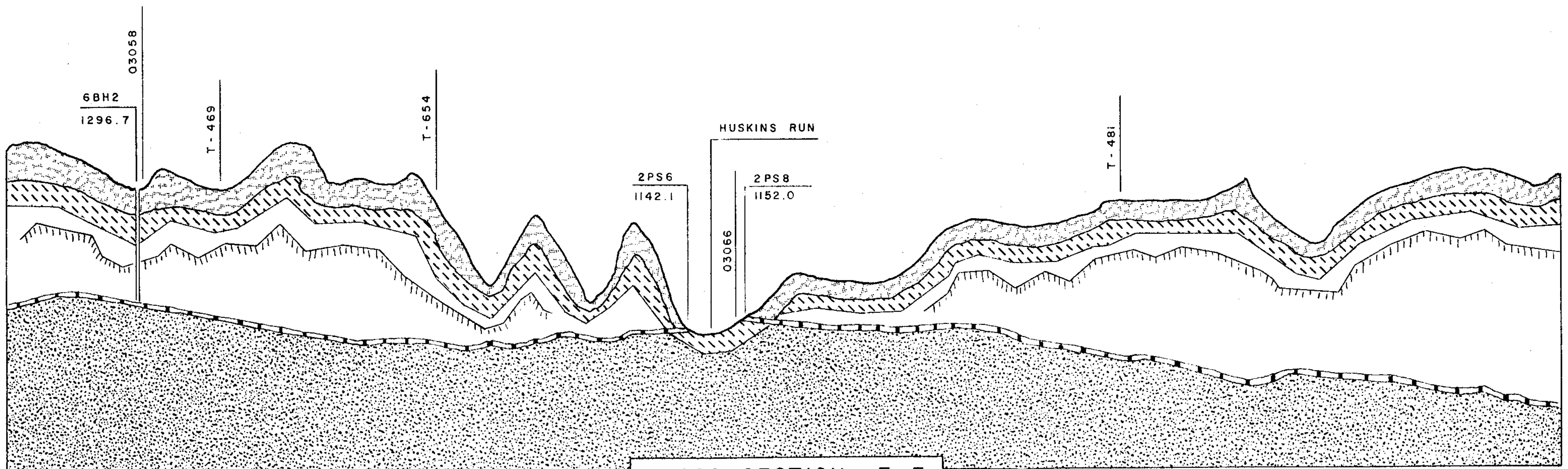
SCALE: AS SHOWN	PREPARED FOR: PROJECT SL-159 COMMONWEALTH OF PENNSYLVANIA DEPT. OF ENVIRONMENTAL RESOURCES	PREPARED BY: R.F.C.
DATE: 4-20-72		DRAWN BY: J.M.H.

QUICK START STUDY NO. 2

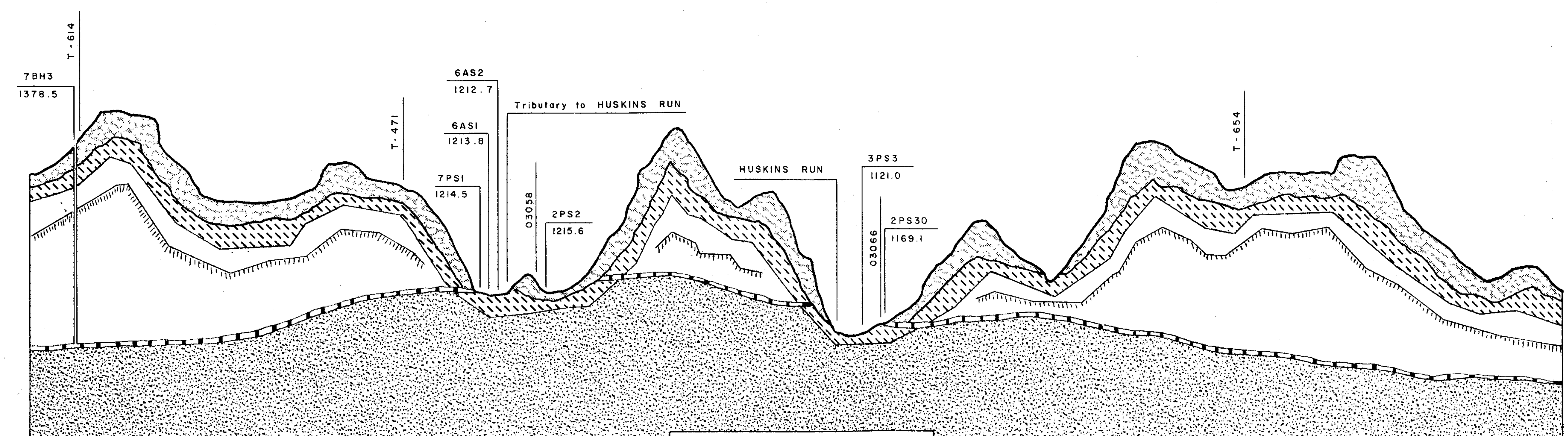
HYDROLOGY - YATESBORO 1, 2 & 3 MARGARET 688

SUBMITTED BY: CARSON ENGINEERS

DRAWING NO. PLATE 21



CROSS SECTION F-F



CROSS SECTION G-G

Note :

Bore Hole Elevations , Mine Opening Elevations and Locations of Cross Sections are shown on Plate 21

LEGEND

- SURFACE
- ZONE OF WEATHERED JOINTS
- WATER TABLE
- MINED COAL SEAM NOT PILLARED
- BOTTOM STRATA
- UNMINED COAL

COWANSHANNOCK CREEK WATERSHED		
SCALE: N.T.S	PREPARED FOR: PROJECT SL-159 COMMONWEALTH OF PENNSYLVANIA	PREPARED BY: R.F.C.
DATE: 10-11-72	DEPT. OF ENVIRONMENTAL RESOURCES	DRAWN BY: S.H.V.
QUICK START STUDY NO. 2		
HYDROLOGY - YATESBORO 1,2 & 3 MARGARET 6&8		
SUBMITTED BY:	CARSON ENGINEERS	DRAWING NO. PLATE 22

The down-dip concave character of this particular vein of the Upper and Lower Freeport coal formations is evidenced by the mine cross-sections on Plates 21 and 22. Coal outcrops of the complex are found along both sides of the Huskins Run sub-watershed.

Operated by the R&P Coal Company in the early 1900's, the Yatesboro 1, 2, and 3 mines were in continuous production until the late 1950's. During this period, mining was performed on the down-dip by a modified room-and-pillar system. Coal was undercut, drilled, and blasted and then loaded onto conveyors which emptied into waiting mine cars. Upon completion of a room, the pillars were removed for about 15% of the mined area. In spite of this action, it has been noted that no discernible shallow surface subsidence has occurred. During mining operations in-mine seals were constructed in order to control the flow of percolating ground waters.

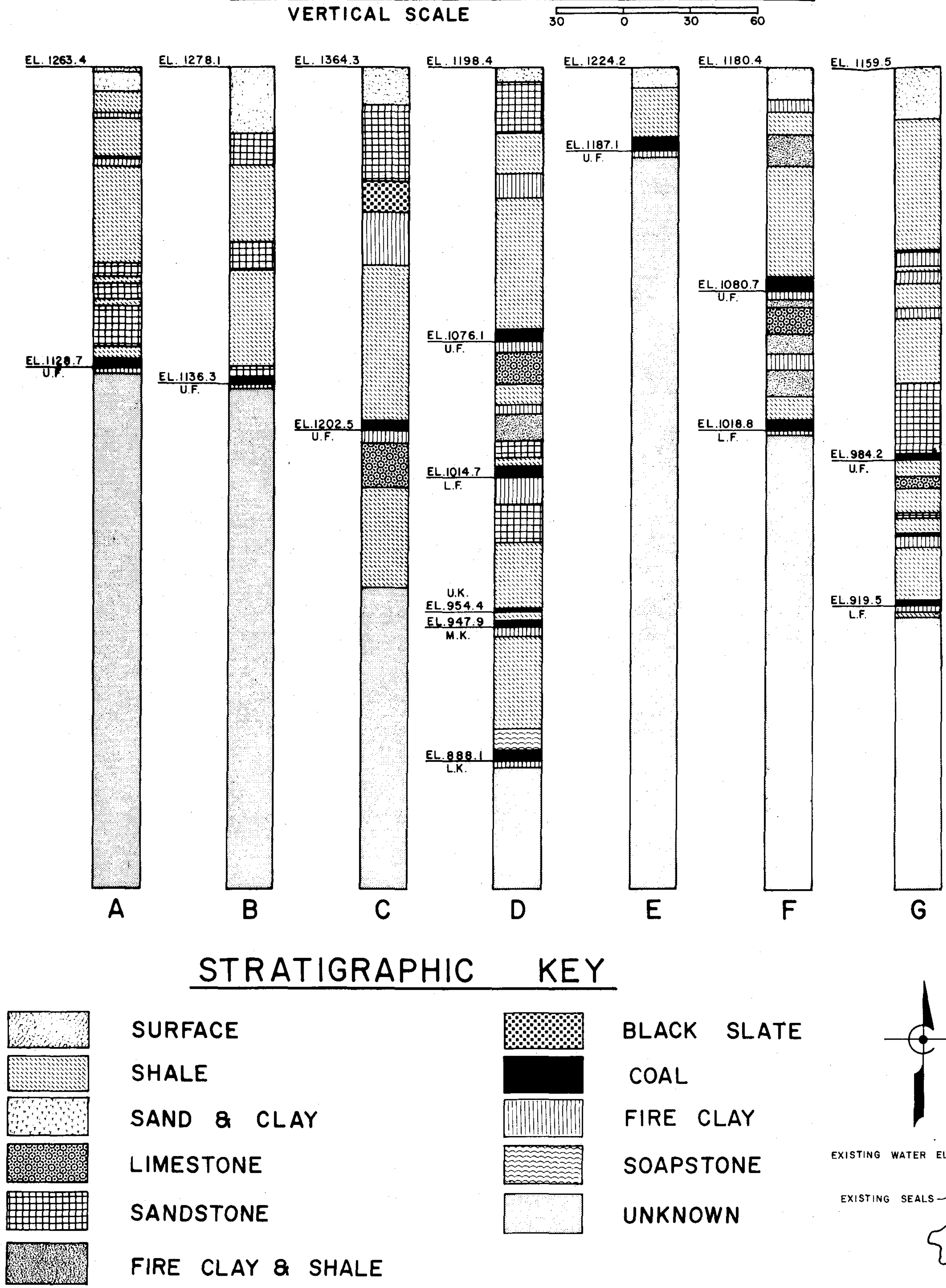
Abandonment procedure consisted of backfilling or sealing the main portal and bore holes. Approximately 5% of the coal seam has been left unmined in the area north of the complex running along and adjacent to Cowanshannock Creek. Mining activity is continuing in the southern section of the complex in active Margaret No. 7. Currently one bore hole is continuously issuing a gravity discharge from Yatesboro 1 (1BH8) with intermittent discharges from bore hole 1BH7 and seepage at portal shaft 1PS3 where flows could not be measured. The average rate of flow from 1BH8 and 1BH7 at Yatesboro 1 is about 940,000 gallons per day. Pollutants from this discharge are:

Acidity	228 ppm	272#/d	49.6 T/yr
Iron	31 ppm	29#/d	5.3 T/yr
Sulfates	635 ppm	568#/d	104 T/yr
Hardness	336 ppm	269#/d	49 T/yr

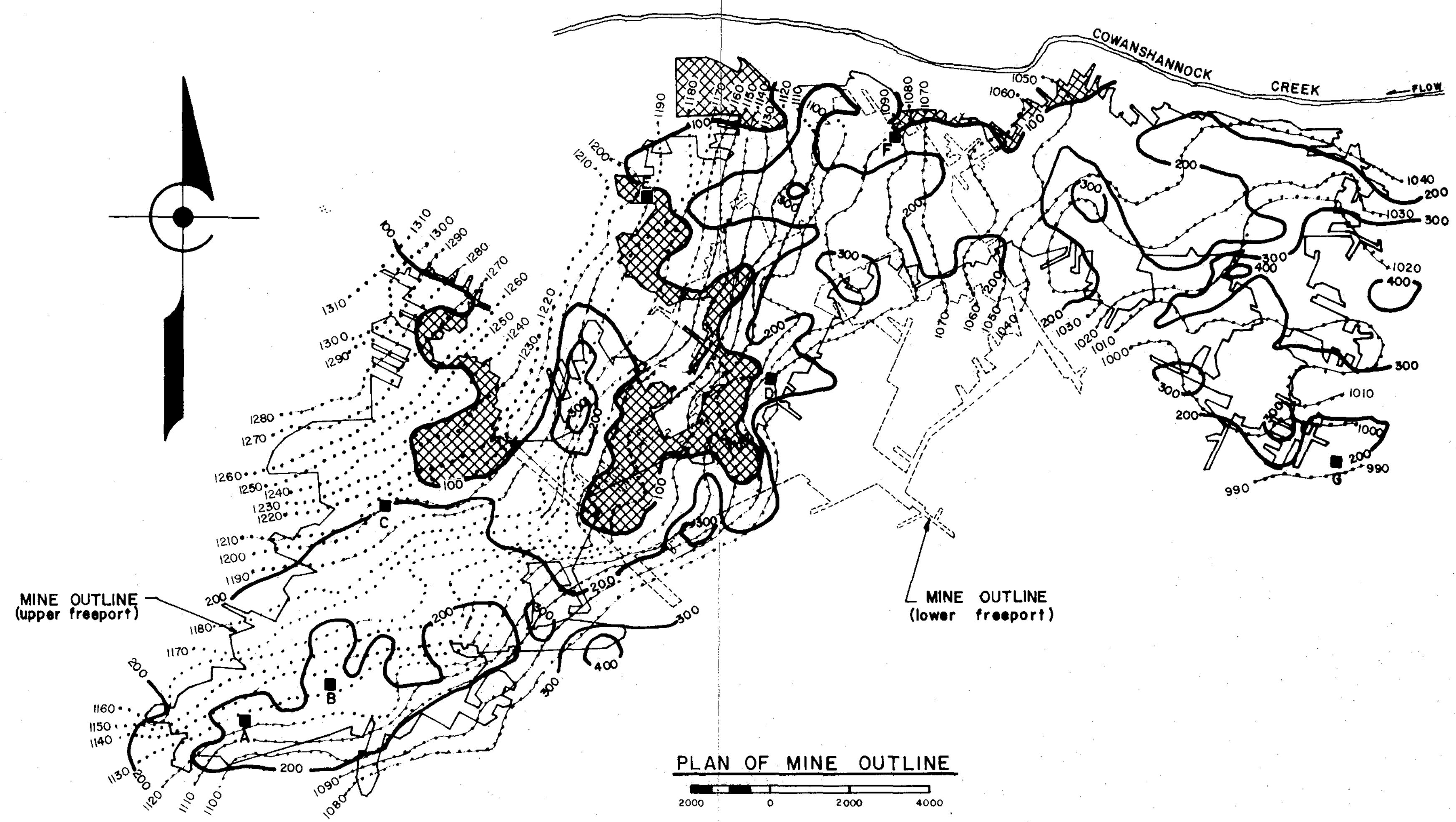
One shaft in Yatesboro 2 issues a continuous gravity discharge at 2PS25 of about 102,000 gallons per day. Pollutants from this discharge are:

Acidity	10.1 ppm	80.3#/d	14.6 T/yr
Iron	1.6 ppm	12.4#/d	2.26 T/yr
Sulfates	300 ppm	2368 #/d	432 T/yr
Hardness	240 ppm	1893 #/d	345 T/yr

STRATIGRAPHIC COLUMNS



STRATIGRAPHIC KEY



PLAN OF MINE OUTLINE

NOTES:

1. OVERBURDEN CONTOURS WERE INTERPRETED BY THE DIFFERENCE BETWEEN MINE FLOOR ELEVATIONS AND U.S.G.S. TOPOGRAPHY 20' INTERVAL - 1" = 2000'

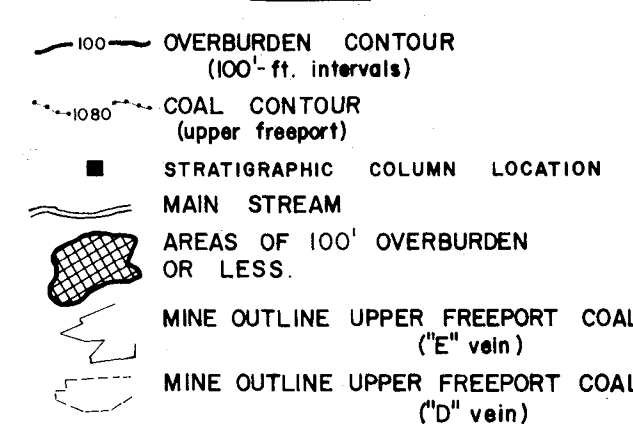
2. COAL CONTOURS REPRESENT THE BOTTOM OF THE MINED UPPER FREEPORT SEAM. ELEVATIONS HAVE BEEN CORRECTED TO CORRESPOND TO U.S.G.S. ELEVATIONS.

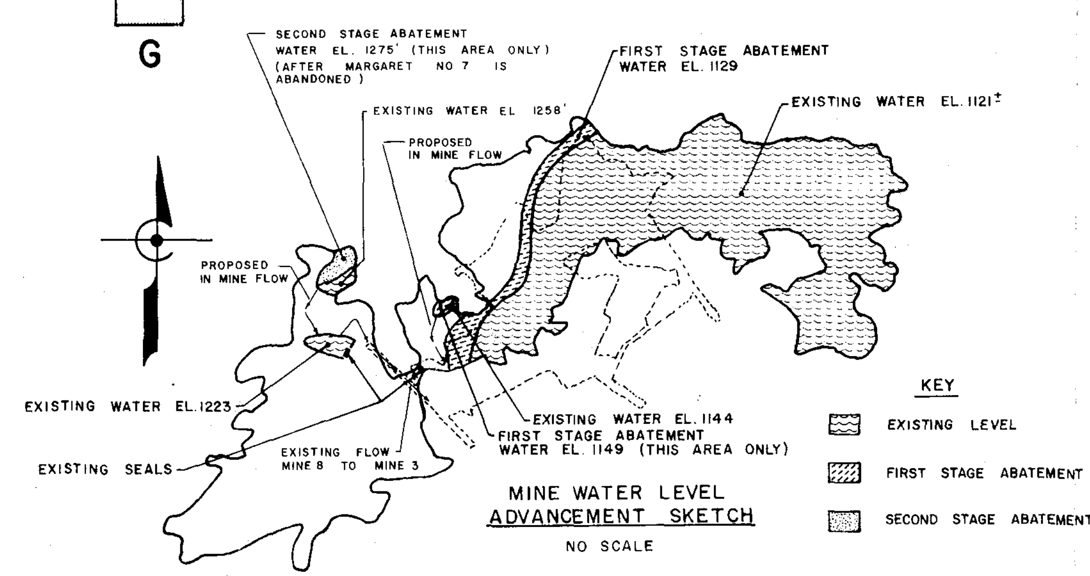
3. INFORMATION FOR THE STRATIGRAPHIC COLUMNS WAS COMPILED FROM OLD CORE BORING RECORDS OF THE R & P COAL CO., PHILLIPS PETROLEUM & GAS CO AND THE PEOPLES NATURAL GAS CO.

4. THE AVERAGE THICKNESS OF THE UPPER FREEPORT SEAM IS APPROXIMATELY 4'-6"

5. THE AVERAGE THICKNESS OF THE LOWER FREEPORT SEAM IS APPROXIMATELY 4'-0"

LEGEND





MINE WATER LEVEL ADVANCEMENT SKETCH

NO SCALE

COWANSHANNOCK CREEK WATERSHED		
SCALE: AS SHOWN	PREPARED FOR: PROJECT SL-159 COMMONWEALTH OF PENNSYLVANIA	PREPARED BY: R.F.C.
DATE: 4-20-72	DEPT. OF ENVIRONMENTAL RESOURCES	DRAWN BY: J.M.H.
QUICK START STUDY NO. 2 GEOLOGY - YATESBORO 1,2 & 3 - MARGARET 6 & 8		
SUBMITTED BY: CARSON ENGINEERS		DRAWING NO. PLATE 23

One continuous gravity discharge is found at Yatesboro 3 at shaft 3PS3 along with an intermittent discharge at shaft 3PS2 with a combined average discharge of approximately 2,000,000 gallons per day. Pollutants from this discharge are:

Acidity	0.0	ppm	0.1	#/d	0.0	T/yr
Iron	2.5	ppm	42.5	#/d	7.8	T/yr
Sulfates	307	ppm	5200	#/d	949	T/yr
Hardness	238	ppm	4028	#/d	735	T/yr

Margaret 8 has two continuous gravity flows at shafts 8PS2 and 8PS11 plus intermittent and seepage flows at several openings. The combined flow of 8PS1, 8PS2, and 8PS11 is about 120,000 gallons per day. Pollutants from these discharges are:

Acidity	29	ppm	29	#/d	5.3	T/yr
Iron	5.7	ppm	5.7	#/d	1.0	T/yr
Sulfates	136	ppm	136	#/d	25	T/yr
Hardness	134	ppm	134	#/d	24	T/yr

Combined discharge for Yatesboro 1, 2, and 3, and Margaret 8 averages approximately 3,160,000 gallons per day with a total average pollution load of:

Acidity	14	ppm	381	#/d	70	T/yr
Iron	3.4	ppm	90	#/d	16	T/yr
Sulfates	467	ppm	12322	#/d	2249	T/yr
Hardness	240	ppm	6324	#/d	1154	T/yr

Water from Margaret 6 drains to active Margaret 7 mine. However, part of the drainage from Margaret 8 mine passes across Margaret 6 and 7 near the entrance at 6AS1 and 7PS1 and eventually finds its way to Yatesboro 3 via the Margaret 9 mine. Water is then discharged at 1BH8 at Yatesboro 1 or 1PS3 at Yatesboro 3.

At an average depth of 200', the Yatesboro 1 and 2 and Margaret 6 and 8 complex has exploited the Upper Freeport coal whereas Yatesboro 3 has exploited the Lower Freeport coal where mining has been primarily a down dip operation. There are few deviations from a uniform 3% downgrade from the north, east, and west fringes toward south fringes of the exploited seam. The predicted advance of the water level in the mine if the reservoir cavities are filled to safe capacity is shown by the sketch on Plate 23.

Reports from R&P Coal Company indicate that less than 15% of mineable coal remain in the seam in this area; moreover, it appears not feasible to remove any of this. Hence, total flooding would in no way create an economic disadvantage.

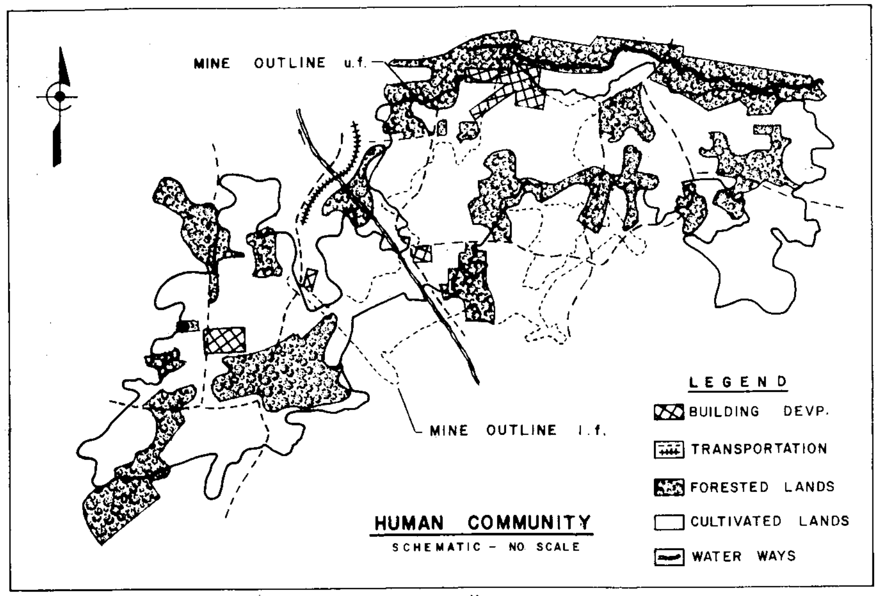
The strata immediately above and below the Upper Freeport coal seam are the Conemaugh Formation and the Allegheny Formation strata respectively. The permeability of these strata can be described as moderate to high. Furthermore, seasonal variations in precipitation would likely have some effect.

Pyrite oxidation was evidenced by strong acid discharges during the active mining period; however, recent investigation of the long abandoned mine complexes shows that the acid contribution has reduced considerably. Strata adjacent to the Upper Freeport are generally analyzed to have minimum pyrite inclusions. Upon flooding, we could expect discharge points in the elevation range 1120 to 1140 to be the least acid.

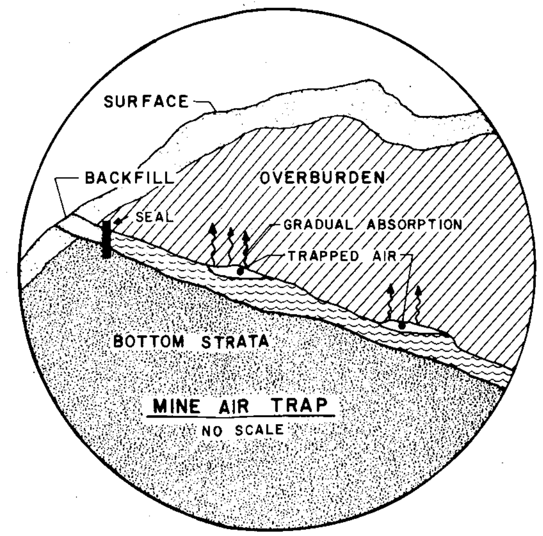
The stratum directly above Upper Freeport Coal consists primarily of various weak shales, and, in most areas, appears sufficiently thick to support the existing overburden. However, most evidence indicates that a geologic unconformity exists along the lower strata of the Conemaugh Formation (Mahoning sandstone) in this area.

Thickness of the overburden varies from approximately 20 feet to 300 feet with about 70% being in excess of 150 feet. Moreover, reference to typical stratigraphic data (Plate 23) as well as old core boring results have shown slate and shale of considerable thickness and intermediate strength to exist above the mine vein in most areas. This presents a favorable picture as far as reduced likelihood of subsidence goes. This likelihood is slight, and, where it does exist, the analysis allows us to make a close pinpointing of those places where the greatest concern would exist.

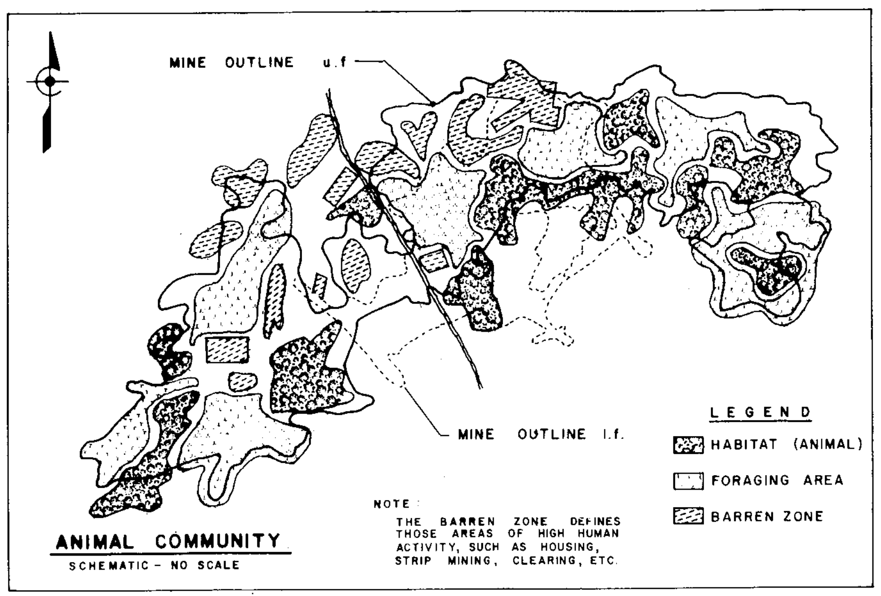
The existing discharge points for Yatesboro 1, 2, 3, and Margaret 6 and 8 have been recorded and carefully investigated in the field (see Plate 21). In our recommendations we indicate where core borings appear to be necessary. Water table data for the saturated zone over Yatesboro 4 and 5 is also shown on Plate 21, including a graph regarding seasonal fluctuation. Also, that plate indicates for each actual or potential point of discharge its probable channel of flow.



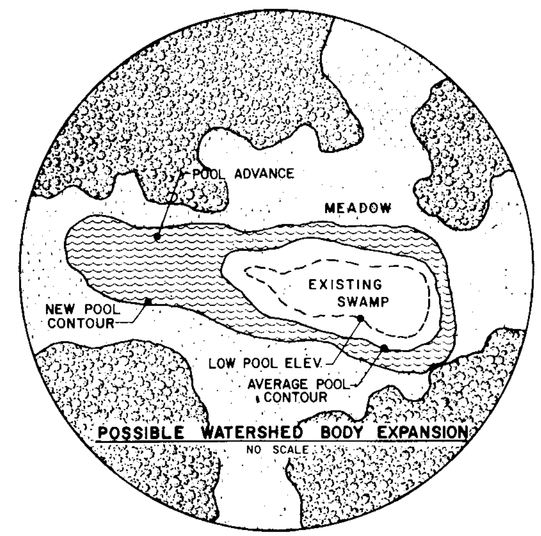
DETAIL #5



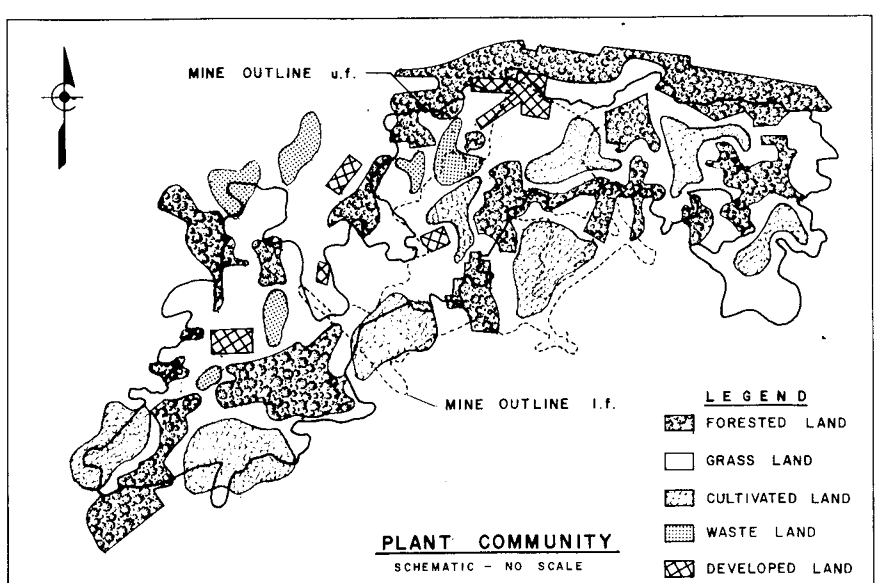
DETAIL #1



DETAIL #6



DETAIL #2



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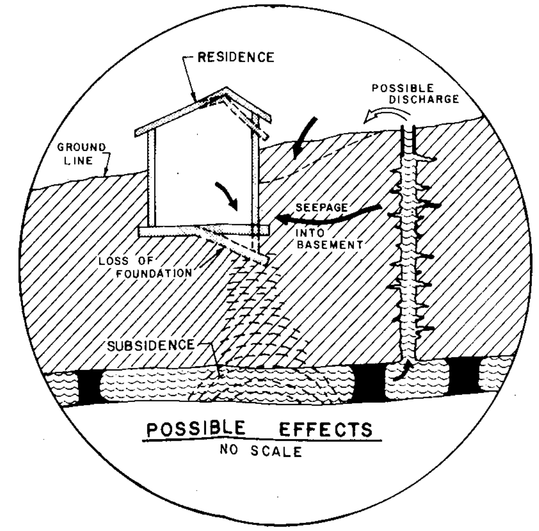
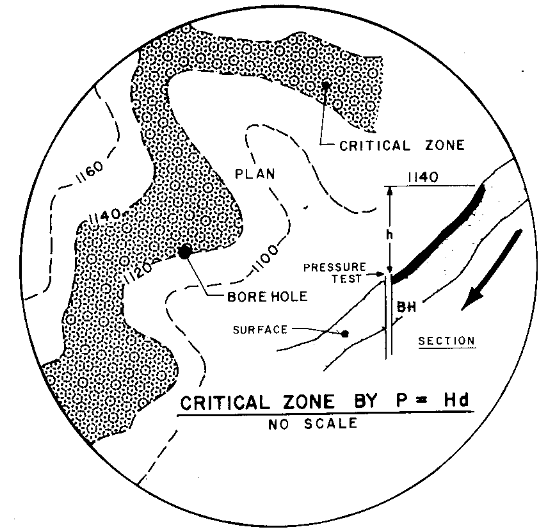
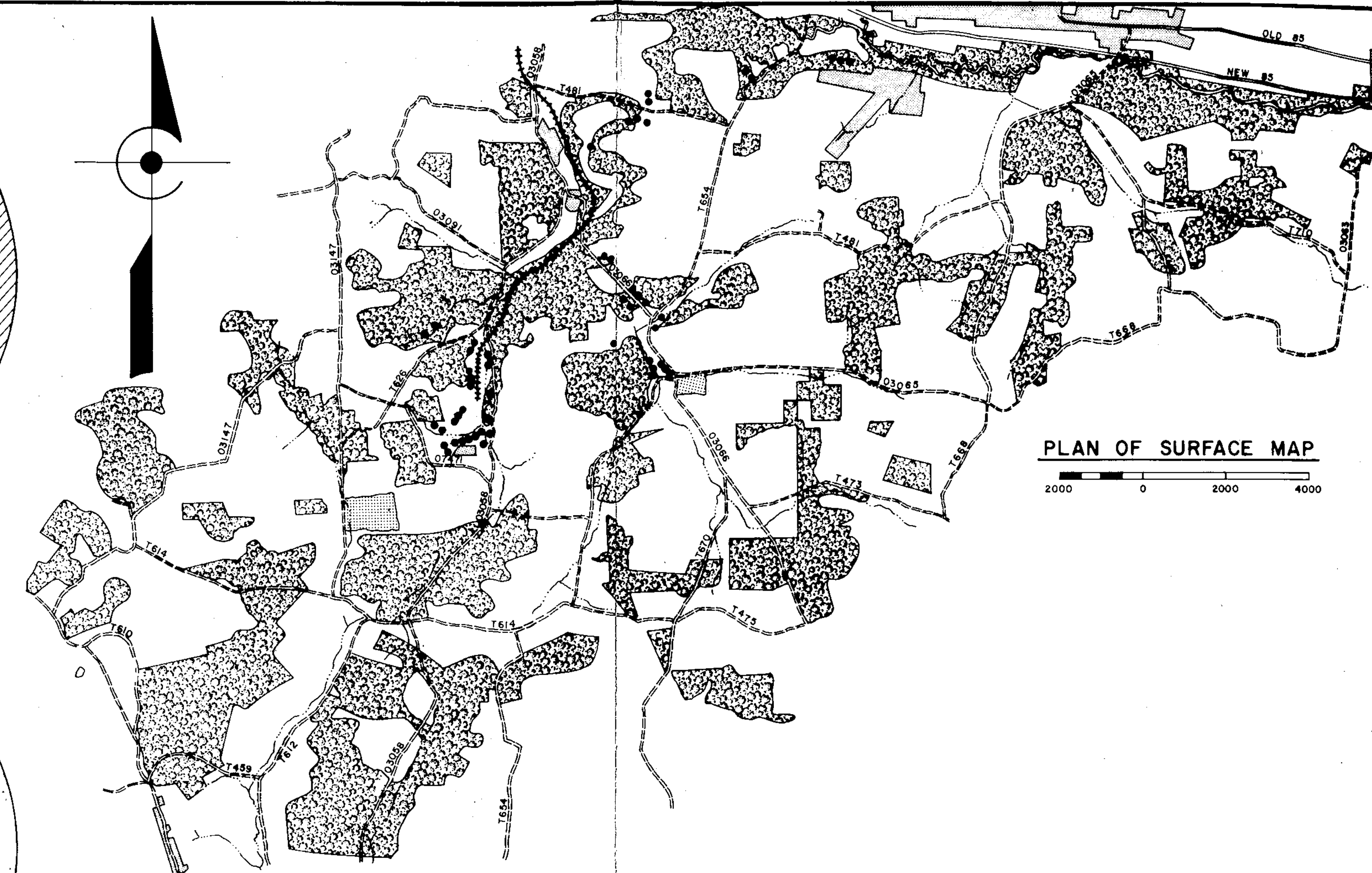


DETAIL #3



DETAIL #4



SOME POSSIBLE EFFECTS FROM ABATEMENT

1. WATER TABLE MAY RISE.
2. SPRINGS AND SEEPAGE RATES MAY INCREASE SLIGHTLY.
3. NEW GRAVITY DISCHARGES MAY DEVELOP.
4. WELLS MAY RISE.
5. POOL AREAS MAY INCREASE.
6. DILUTION OF POLLUTION COULD OCCUR.
7. DILUTION OF DOMESTIC POLLUTION COULD DECREASE.

LEGEND

- MAIN ROADS
- SECONDARY ROADS
- RAILROAD
- MINE OPENINGS
- STREAMS & WATER BODIES
- BUILDING DEVELOPMENT
- FORESTED AREAS
- AGRICULTURAL, GRASS LAND OR BARREN

COWANSHANNOCK CREEK WATERSHED

SCALE: AS SHOWN	PREPARED FOR: PROJECT SL-159 COMMONWEALTH OF PENNSYLVANIA DEPT. OF ENVIRONMENTAL RESOURCES	PREPARED BY: R.F.C.
DATE: 4-20-72		DRAWN BY: J.M.H.

QUICK START STUDY NO. 2
SURFACE RELATIONS - YATESBORO MINES 1, 2 & 3 MARGARET MINES 6 & 8

SUBMITTED BY: CARSON ENGINEERS	DRAWING NO. PLATE 24

Geologic information on the strata through which most subsurface ground waters would pass indicate a fair purification capacity in the immediate neighborhood of the coal vein. However, if additional flooding of the mine is effected, the return of the water table nearer to its original level would be expected to improve the water quality in wells and natural outflows.

Present estimates indicate some 4,000,000,000 to 5,000,000,000 gallons of water already in the mine. This represents about 65% to 75% of the total mine cavity volume. Pressure readings would be desirable at 1BH8 and 1BH7 to be able to calculate the static head which would reveal a more accurate water level elevation. The theory we are forwarding here postulates equal distribution of pressure throughout the subterranean reservoir. This pressure is based on the standard formula $p=Hd$. The head elevation is thought of as marking the elevation near the top of the capillary envelop, hence, roughly approximating the highest elevation of the water table for a mine completely sealed and flooded. This has key application in drawing several conclusions upon which some recommendations are based.

As far as the magnitude of capillary forces operating contrary to gravity are concerned, no measure is presently available. Therefore, for a completely sealed and flooded mine the capillary envelop would be treated as if its influence were the same as an equal volume of unimpeded water. Further investigation accompanying the first phase of the abatement program will give a basis for better evaluation of this factor; meanwhile, a safety margin is employed in determining the area of concern in our monitoring program. It is expected that close monitoring of pressure and flooding following initial abatement will provide information regarding the fluctuation flow of capillary waters. It will be utilized in later review of the program and its improvements.

Conclusion - Yatesboro 1, 2, 3, and Margaret 6 and 8

The particular characteristics of this complex, as well as the broader geologic and hydrologic factors involved, lends itself to the application of seal-flood technology. Systematic sealing of discharge points will allow close control of possible side effects, as well as permitting better evaluation of particular types of seals. Such an approach maximizes the opportunity for continued scientific investigation of the theoretical aspects of the problem. It is probable that 100% flooding of the mine will not be possible because of low overburden in the northern area of the Yatesboro 1 mine and the restrictions of overburden and updip nature of the Margaret 8 mine without the expense of additional extensive sealing. Overburden in Yatesboro 1 (shown as area 1A on Plate 25) is approximately 20 feet and it is expected that the maximum safe head allowed in this area to be 40 feet. This allowable head would dictate a maximum water elevation of 1140 in this area of the mine. Other areas considered critical because of minimal cover are shown as areas 8A, 8B, and 8C.

Water elevation in part of Yatesboro 2 will rise after 2PS25, 2PS27, and 2PS6 are sealed and the water will find its way to 1BH8 or 3PS3 or other selected points if the shaft connecting this section of the Yatesboro 2 mine has not been sealed. The seal at 2PS25 should be valved and monitored via piezometer readings in order to determine if the water is finding an egress. Similarly the water elevation in the northern section of Margaret 8 will rise and allow an overflow through mine 8 to, discharge into Margaret 3 mine when 8PS11 and 8PS12 are sealed. However, coal in the Margaret 8 area has been worked close to the outcrop and strip mine activity in the same area has resulted in a minimal barrier between the deep mine workings and the ground line. A water head of approximately 17 feet will result in order to obtain an overflow in Margaret 8, and considerable investigation in order to determine the extent of workings near the outcrops will be necessary along with a well designed monitoring program. Investigation of mine 8 can begin immediately however, construction on seals should not commence until Margaret 7 is abandoned because of the possibility of water damming in the area of mine 7 as a result of abatement activities.

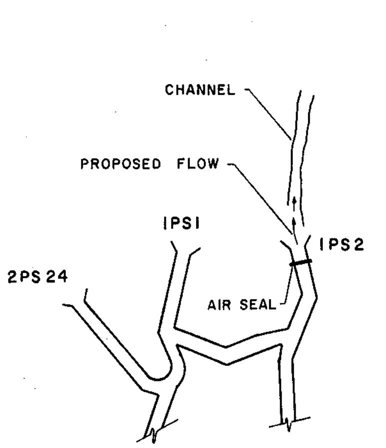
The water elevation in Yatesboro 1 and 2 can be raised enough to flow at shaft 1PS2 by sealing bore holes 1BH7 and 1BH8 and shafts 3PS2 and 3PS3. Portal shaft 1PS3 should be investigated and pressure gages installed for monitoring purposes if flow commences in this area.

The important requirement here, of course, is development of a close and carefully designed monitoring system to accompany the abatement program. As for the extent of abatement to be achieved, currently the mine has uncontrolled flooding to about 65% to 75% of its capacity. A sealing program would allow this percentage to be increased <u>under control</u> up to approximately 68% to 78%. Of course, it is possible even at maximum (100%) flooding, water quality standards may not be met if water quality parameters other than those used for this report are considered, or because of the natural high iron content of the local sandstone; in which case other methods, including treatment, might be needed.

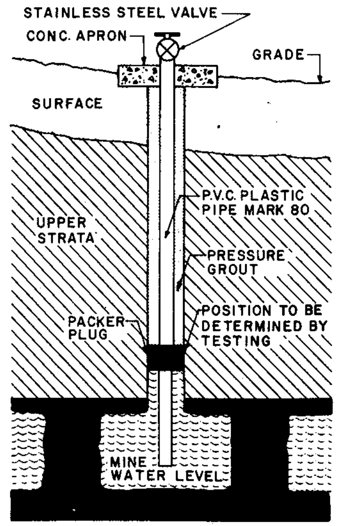
One of the effects to be achieved by eventually attaining 68% to 78% flooding of the mine is the raising of the water table. If the water table can be forced into higher zones, particularly where it appears that some purifying strata exist then, such flows might well be of much more acceptable water quality as the result of natural purification.

On the other hand, it seems certain that because of the huge volume of water involved in partial flooding of Yatesboro 1, 2, 3, and Margaret 6 and 8 it would be desirable to have some immediate controls, thus, the use of valve-type seals on at least some strategically selected openings is definitely called for.

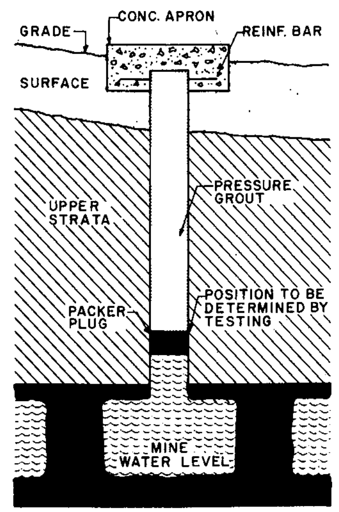
Observe further that the use of underground impermeable barriers may be required in order to deal with certain special conditions that could conceivably develop--especially in connection with wells and springs, or even building foundations located too Close to seepage routes or areas in which abatement stimulates significant shifts in water table elevation. Here, it is most important that careful monitoring be initiated so that controls can be exercised sufficiently early for remedial action to be taken.



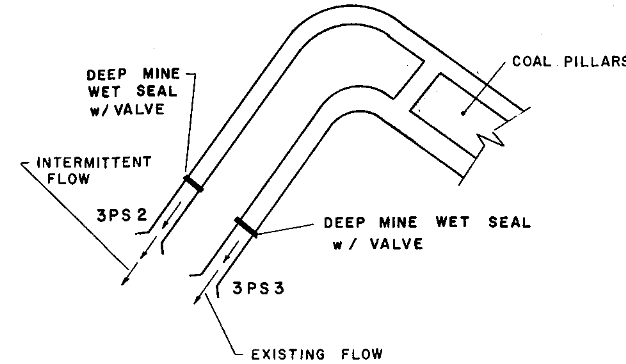
DETAIL NO. 1



TYPICAL VALVE / BH



TYPICAL NON VALVE / BH



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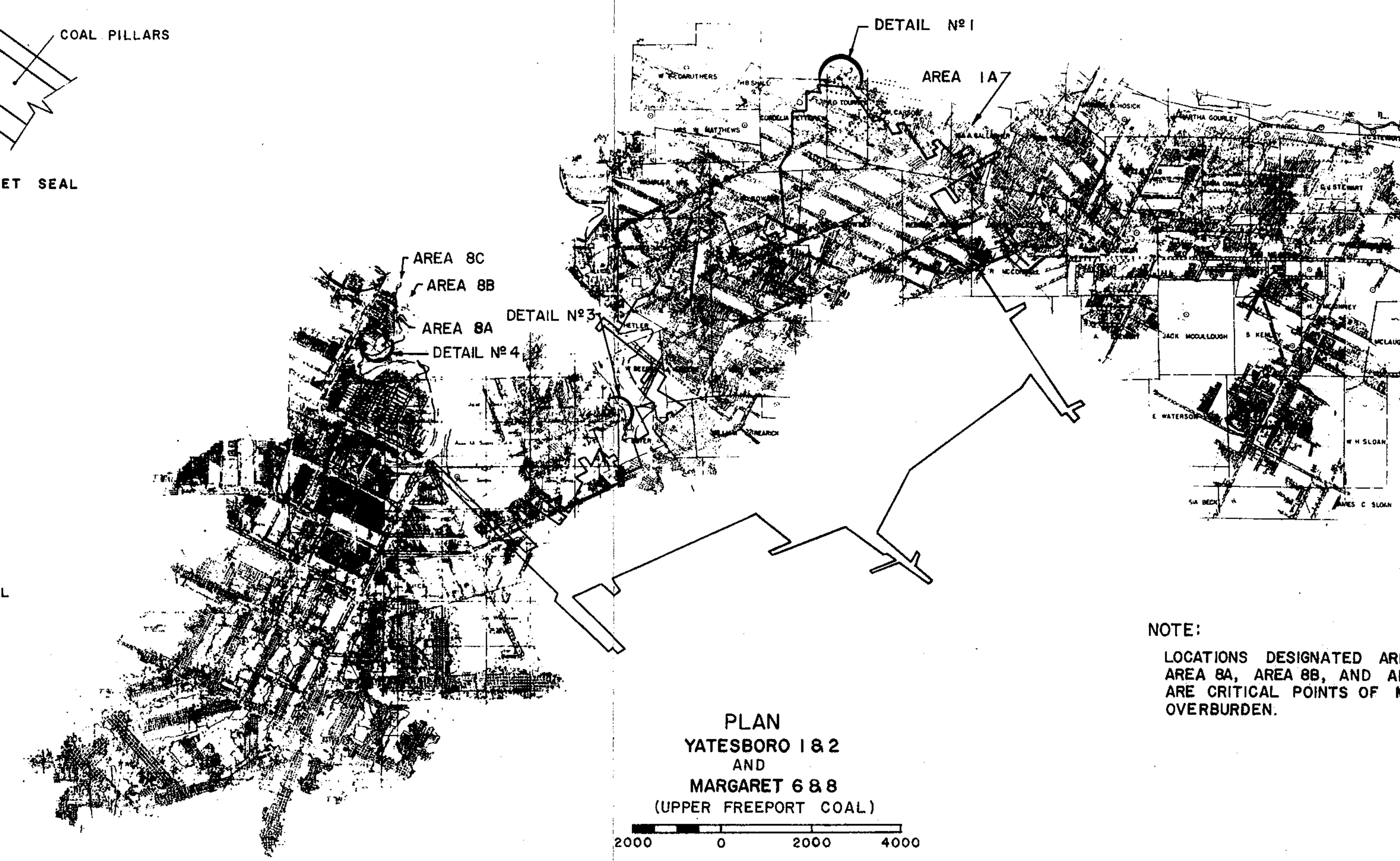
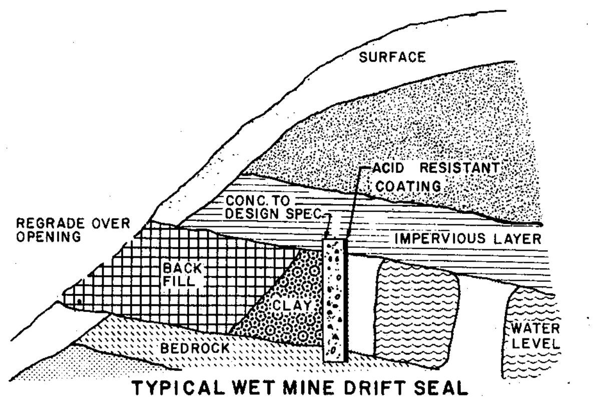
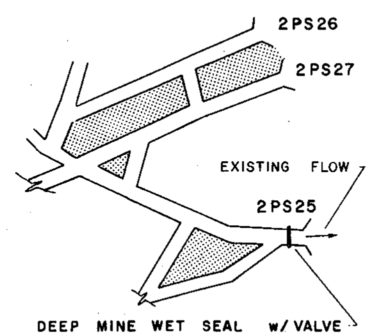


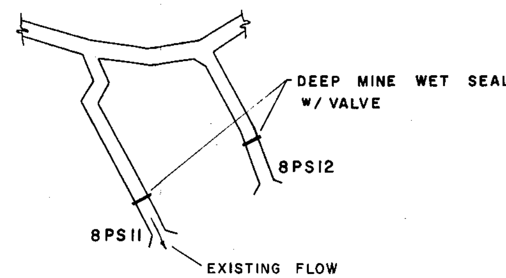
NOTE:
LOCATIONS DESIGNATED AREA 1A, AREA 8A, AREA 8B, AND AREA 8C ARE CRITICAL POINTS OF MINIMUM OVERBURDEN.



TYPICAL WET MINE DRIFT SEAL



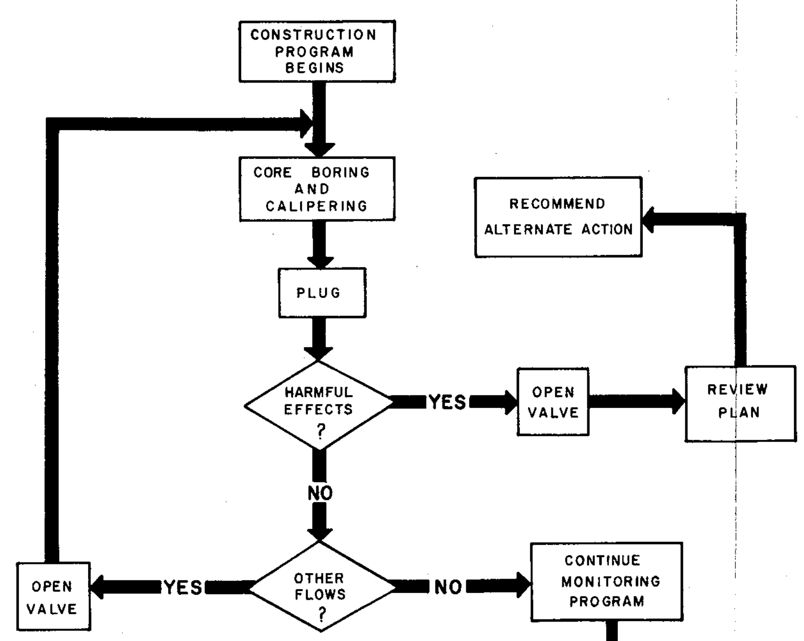
DETAIL NO. 3



DETAIL NO. 4

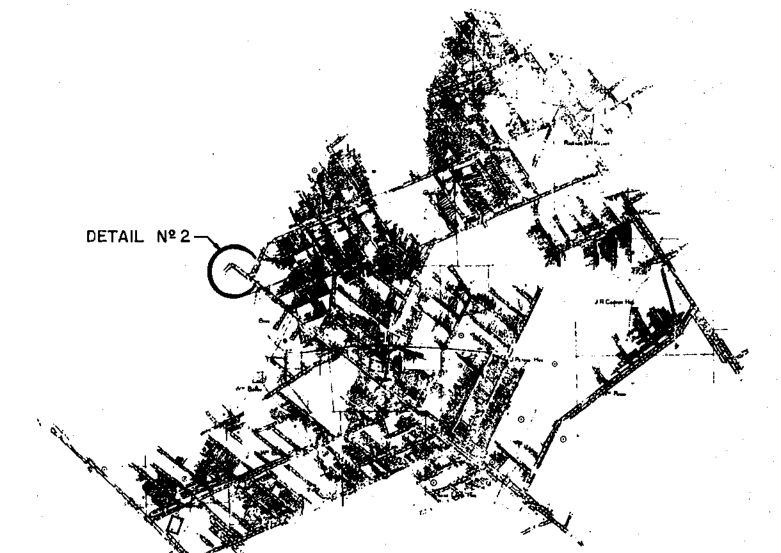
MINE ABATEMENT REGISTER

MINE OPENING	LOCATION PROPERTY OF	EXPLOR-ATION	RECOMMENDED ACTION	* ESTIMATED INVESTIGATION COST	MINE OPENING	LOCATION PROPERTY OF	EXPLOR-ATION	RECOMMENDED ACTION	* ESTIMATED INVESTIGATION COST
1PS1	R. & P. COAL CO.	—	MONITOR	—	2PS28	EARNEST D. SMITH & HARL BOWSER	—	MONITOR	—
1PS2	R. & P. COAL CO.	DRILL	AIR SEAL	$1,840	2PS29	EARNEST D. SMITH & HARL BOWSER	—	MONITOR	—
1PS3	R. & P. COAL CO.	—	NO FLOW / POSSIBLE SEAL	—	2PS30	R. & P. COAL CO.	—	MONITOR	—
1BH1	ROY E. JONES	—	MONITOR	—	2BH1	WILLIAM REARICK	—	MONITOR	—
1BH2	ROY E. JONES	—	MONITOR	—	2BH2	WILLIAM REARICK	—	MONITOR	—
1BH3	DEAN E. WALKER	—	MONITOR	—	3PS2	R. & P. COAL CO.	DRILL	SEAL WITH VALVE	$4,440
1BH4	DEAN E. WALKER	—	MONITOR	—	3PS3	R. & P. COAL CO.	DRILL	SEAL WITH VALVE	$4,350
1BH5	DEAN E. WALKER	—	MONITOR	—	3BH2	WILLIAM REARICK	—	MONITOR	—
1BH6	DEAN E. WALKER	—	MONITOR	—	3BH3	WILLIAM REARICK	—	MONITOR	—
1BH7	ETHEL MILLER	DRILL	VALVE / BH	$2,600	3BH4	WILLIAM REARICK	—	MONITOR	—
1BH8	L. D. COCHRAN	DRILL	VALVE / BH	$2,440	3BH5	WILLIAM REARICK	—	MONITOR	—
2PS1	HENRY SOWERS	—	MONITOR	—	AREA 1A	ISA A. GALLAGHER	DRILL	POSSIBLE CURTAIN WALL	$2,170
2PS2	ANN M. SOWERS	—	MONITOR	—					
2PS3	ANN M. SOWERS	—	MONITOR	—					
2PS4	JACOB BOYER	—	MONITOR	—	6PS4	R. & P. COAL CO.	—	MONITOR	—
2PS5	JACOB BOYER	—	MONITOR	—	6PS5	R. & P. COAL CO.	—	MONITOR	—
2PS6	R. & P. COAL CO.	—	MONITOR	—	6PS6	R. & P. COAL CO.	—	MONITOR	—
2PS7	EVERETT BARKER	—	MONITOR	—	6BH1	R. & P. COAL CO.	—	MONITOR	—
2PS8	R. & P. COAL CO.	—	MONITOR	—	6BH2	R. & P. COAL CO.	—	MONITOR	—
2PS9	R. & P. COAL CO.	—	MONITOR	—	6BH3	R. & P. COAL CO.	—	MONITOR	—
2PS10	R. & P. COAL CO.	—	MONITOR	—					
2PS11	R. & P. COAL CO.	—	MONITOR	—					
2PS12	R. & P. COAL CO.	—	MONITOR	—	AREA 8A	R. & P. COAL CO.	DRILL	POSSIBLE CURTAIN WALL	$6,950
2PS13	R. & P. COAL CO.	—	MONITOR	—	AREA 8B	R. & P. COAL CO.	DRILL	POSSIBLE CURTAIN WALL	$6,950
2PS14	R. & P. COAL CO.	—	MONITOR	—	AREA 8C	LEWIS W. SMITH	DRILL	POSSIBLE CURTAIN WALL	$4,950
2PS15	SEITS HR'S	—	MONITOR	—	8PS1	R. & P. COAL CO.	—	NO FLOW / POSSIBLE SEAL	—
2PS16	W. LAUSTER	—	MONITOR	—	8PS2	R. & P. COAL CO.	DRILL	WET MINE DRIFT SEAL	$2,000
2PS17	W. LAUSTER	—	MONITOR	—	8PS3	R. & P. COAL CO.	—	NO FLOW / POSSIBLE SEAL	—
2PS18	W. LAUSTER	—	MONITOR	—	8PS4	R. & P. COAL CO.	—	NO FLOW / POSSIBLE SEAL	—
2AS19	W. LAUSTER	—	MONITOR	—	8PS5	R. & P. COAL CO.	—	NO FLOW / POSSIBLE SEAL	—
2PS20	SAM HINES	—	MONITOR	—	8PS6	R. & P. COAL CO.	—	NO FLOW / POSSIBLE SEAL	—
2PS21	R. & P. COAL CO.	—	MONITOR	—	8PS7	R. & P. COAL CO.	—	NO FLOW / POSSIBLE SEAL	—
2PS22	R. & P. COAL CO.	—	MONITOR	—	8PS8	R. & P. COAL CO.	—	NO FLOW / POSSIBLE SEAL	—
2PS24	R. & P. COAL CO.	—	MONITOR	—	8PS9	R. & P. COAL CO.	—	NO FLOW / POSSIBLE SEAL	—
2PS25	R. & P. COAL CO.	DRILL	SEAL WITH VALVE	$2,810	8PS10	R. & P. COAL CO.	—	NO FLOW / POSSIBLE SEAL	—
2PS26	R. & P. COAL CO.	—	MONITOR	—	8PS11	RALPH C. STUBRICK	DRILL	SEAL WITH VALVE	$2,050
2PS27	R. & P. COAL CO.	—	NO FLOW / POSSIBLE SEAL	—	8PS12	RALPH C. STUBRICK	DRILL	SEAL WITH VALVE	$2,050



FLOW DIAGRAM FOR ABATEMENT CONTROL

* ESTIMATED INVESTIGATION COSTS IS FOR KNOWN SOURCES OF FLOW ONLY



PLAN
YATESBORO 3
(LOWER FREEPORT COAL)

COWANSHANNOCK CREEK WATERSHED

SCALE: AS SHOWN	PREPARED FOR: PROJECT SL-159 COMMONWEALTH OF PENNSYLVANIA DEPT. OF ENVIRONMENTAL RESOURCES	PREPARED BY: R.F.C.
DATE: 4-20-72		DRAWN BY: J.M.H.

QUICK START STUDY NO. 2
ABATEMENT PROGRAM – YATESBORO MINES 1, 2 & 3 MARGARET MINES 6 & 8

SUBMITTED BY: CARSON ENGINEERS

DRAWING NO. PLATE 25

Recommendations

Program

Results of research lead us to submit the following 3-part version of an abatement program for the Yatesboro 1, 2, 3, and Margaret 6 & 8. We recommend:

1. A phased plan of direct discharge abatement (See Plate 25).

Phase I (upon approval of this report)

a) Core borings, pressure testing, and piezometer installations at 1PS3, 1BH7, 1BH8, and Area lA.

b) Core boring and pressure test at 2PS25, 3PS2, 3PS3, 8PS11, 8PS12, 8PS2, Area 8A, Area 8B, and Area 8C.

c) Location borings at 3PS2, 3PS3, Area lA, Area 8A, Area 8B, and Area 8C.

d) Clean and caliper 1BH8 and 1BH7. e) Core Boring at 1PS2.

Phase II

a) Seal mine tunnel at 1PS2, 2PS25, 3PS2, 3PS3.

b) Seal mine tunnel at 8PS11 and 8PS12 after active mining is completed at Margaret 7.

c) Valve-type seal of bore holes No. 1BH7 and 1BH8.

d) Channel Construction at 1PS2.

e) Install Piezometers at 2PS25, 3PS2, 3PS3, 8PS11 and 8PS12.

Phase III

a) Three-month "quarantine" as water elevation rises.

b) Careful monitoring in affect.

Phase IV

a) Additional core borings and analysis (where needed).

b) Sealing of other openings until flow ceases at all openings except 1PS2.

Phase V

(a) Continue monitoring program at least one year after sealing is completed.

(b) Water quality testing to continue.

2. A comprehensive monitoring program (see Plate 25) which will include:

   (a) Continuation of the water testing program on monthly basis for a nominal 2 years or 1 year minimum.

   (b) Checking of seals and other installations.

   (c) Measurements to include pressure and flow at seal points.

   (d) Weekly investigation of the critical zone for new flows.

3. A contingency plan.

   (a) Establish some contacts with residents in or near critical zone, in case of emergency.

Procedural detail needed for carrying out this program and the sequence of these details are outlined in the next section.

Procedure

Initiation of the plan which was recommended in the foregoing, section depends upon execution of the following procedural steps:

1. Early approval of the general program outlined in this report. Consultation needed for clarification and/or revision should be requested as soon as possible.
2. Coreborings and field investigation for those mine openings specified in Phase I should proceed as soon as possible. Real estate permits will be required for this work.
3. Water quality testing to continue during construction.
4. Construction
5. Monitoring

Costs

Phase I	Investigation of Flowing Sources (Subsurface Investigation, etc.)	$ 27,100.00
	Contract Preparation	5,200.00
	Supervision & Administration	10,000.00
	Analysis of Results	3,600.00
	Total Phase I.	$ 45,900.00
Phase II	Yatesboro 1, 2, & 3 Mines	
	Seal 1PS2 (Includes Nominal Grouting)	$ 14,000.00
	Seal 2PS25 (Includes Nominal Grouting)	14,000.00
	Seal 3PS2 (Includes Nominal Grouting)	14,000.00
	Seal 3PS3 (Includes Nominal Grouting)	14,000.00
	Valve Seal 1BH7 & 1BH8	24,000.00
	Channel at 1PS2	12,800.00
	Sub-Total (Construction Yatesboro 1, 2, & 3)	$ 92,800.00
	Plans & Specifications	6,100.00
	Topo Survey & Stakeout	8,300.00
	Inspection	9,000.00
	Total Construction & Engineering Yatesboro 1, 2, & 3	$116,200.00
	Margaret 8 Mine	
	Seal 8PS11 (Includes Nominal Grouting)	$ 14,000.00
	Seal 8PS12 (Includes Nominal Grouting)	14,000.00
	Sub-Total (Construction Margaret 8)	$ 28,000.00
	Plans & Specifications	1,800.00
	Topo Survey & Stakeout	1,800.00
	Inspection	2,800.00
	Total Construction & Engineering Margaret 8	$ 34,400.00
	Total Phase II	$150,600.00
Phase III	Monitoring	$ 12,000.00
	Total Phase III.	$ 12,000.00

Phase IV	Investigation of Potential Flowing Sources (Subsurface Investigation, etc.) As Required	
	Yatesboro 1, 2, 3	$ 15,000.00
	Margaret 8	10,000.00
	Yatesboro 1, 2, & 3	
	Seal 3 Mine Shafts	$ 67,500.00
	Possible Grout Seal in Area 2A (250 feet)	40,000.00
	Margaret 8	
	Seal 9 Mine Shafts	96,000.00
	Possible Grout Seal in Areas 8A, 8B, and 8C (1,000 Feet)	169,000.00
	Sub-Total (Investigation & Construction)	$397,500.00
	Engineering	$ 25,900.00
	Topo Survey & Stakeout	16,000.00
	Inspection	16,000.00
	Total Phase IV.	$455,500.00
Phase V	Monitoring & Water Samples for One Year	$ 16,000.00
	Total Phase V	$ 16,000.00

Summary

Phase I	$ 45,900.00
Phase II	150,600.00
Phase III	12,000.00
Phase IV	455,500.00
Phase V	16,000.00
Grand Total	$680,000.00

The cost estimate for Phase IV is given only as a guide based upon potential flows. The true cost of Phase IV is dependent on the results of Phase I, II, III, and initial work in Phase IV.

Right-of-way purchases are not included in the above costs.