UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

GENERAL

State Virginia County Augusta - ¼ - ¼ Sec - T - R - Watershed Upper North River

Subwatershed Little River Fund class FP (FP 2, WP 1, etc.) Site number 77 Site group 1 Structure class C

Investigated by Mack, T., Geologist (signature and title), Equipment used Case backhoe, coradrill Sprague & Henwood (Type, size, make, model, etc.) Date 8-10-63

SITE DATA

Drainage area size 16.01 sq. mi. 10,240 acres Type of structure Earth Fill Purpose Flood Prevention

Direction of valley trend (downstream) South Maximum height of fill 93.0 feet, Length of fill 685 feet.

Estimated volume of compacted fill required 557,105 yards

STORAGE ALLOCATION

	Volume (ac. ft.)	Surface Area (acres)	Depth at Dam (feet)
Sediment	161	15.6	16.0
Floodwater	2550	77.0	82.0

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Ridge & Valley Topography Mountainous Attitude of beds Dip 27° 0' Strike N16°30'E

Steepness of abutments Left 36 percent Right 82 percent Width of floodplain at centerline of dam 335 feet

General geology of site Site #77 is located in Augusta County in the George Washington National Forest. The bedrock present is part of the Price-Pocono formation which is the lowest formation of the Mississippian system present in Virginia. Approximately 500 feet of Price-Pocono formation lie below the rocks that occur at the centerline of the dam and the unconformity at the base of the Mississippian system. Below this unconformity is the Hampshire formation which is of upper Devonian age.

The lithology of the underlying bedrock present under the foundation of the dam is an alternation of sandstone, orthoquartzite, black shale, dark gray siltstone, silty anthracite coal and gray green shale. As can be observed from the stratigraphic section of the bedrock under the centerline of the dam, the lithologic sequence follows approximately the typical Appalachian or Piedmont type cyclothems.

The dam site is on the western limb of a syncline that has the Price-Pocono formation as uppermost central member. The structure is a parallel class of fold. This accounts for the low angle of dip that occurs in Price-Pocono formation upstream from the dam site and the steeper dips that occur to the east downstream. At the centerline of the dam the attitude of the beds is N16°30'E and 27°E. In the area of the foundation,

however, the strike ranges from N 12° E to N 31° E. This is due in part to the gentle secondary folds that strike at approximately right angles to the strike of the primary fold. It is also due in part to the cross bedding in the sandstone which is as extensive as any present in the folded Appalachians. The cross bedding is produced by typical scour and fill sedimentation. The greatest difference in the dip of scour to that of the fill is 32° - approximate strike of the scour channels is N 80° E. At the centerline of the dam the channel of Little River crosses the strike of the rock at a 39° angle.

A well-developed joint pattern is present in the strata. In the sandstone and orthoquartzite the joint sets have a mean strike of N 15° E and N 75° W. That the joint set angle is 90° clearly shows the competence of the rock. Less competent rocks such as the siltstone and coal have been shattered in the joint planes. In these rocks the angles of joint sets are less than 90°. In the coal and siltstone the joint sets show slight or no recementation. In the sandstone and quartzite there has been moderate to strong recementation due to the slight solution of quartz under the static pressure of the overlying rock. The presence of cliffs in both abutments shows the extent to which the recementation of joint sets in the sandstone and quartzite has proceeded.

Upstream from the dam site Little River flows in a strongly entrenched dendritic pattern. Downstream there is the development of a trellis drainage pattern. The stream is degrading. This degrading action is so strong that a large percentage of fines have been flushed out from the present alluvium in the narrow stream valley.

Approximately 60 percent of the subrounded boulders and cobbles in this stream alluvium are red sandstone from the Hampshire formation. As the silt and sand in the alluvial fines have the typical indian red color of the Hampshire formation, it can be assumed that this sediment is from the Hampshire formation. The top of this formation occurs two and one-half miles upstream from the centerline of the dam. Most of the remaining percentage of boulders and cobbles are light gray sandstone and quartzite from the Price-Pocono formation. There also occurs less than one percent of subangular to subrounded cobbles of dike rock. The majority of these are from a basic dike that occurs approximately 4 miles upstream. The cobbles are green porphyritic lamprophyre with fibers of white plagioclase feldspar forming the porphyries. Also present are a few cobbles of acid dike rock. This light gray felsitic porphyry has hornblende laths as the porphyries. The cobbles are from a large acid dike that occurs on Shenandoah Mountain near the Virginia state line.

No faults were observed near the dam foundation. However, a thrust fault that strikes along the eastern crest of narrow ridge mountain was noted in a road cut. This thrust passes within three quarters of a mile east of the dam site. Also the North Mountain fault that thrusts Cambrian rocks over Devonian rocks occurs two and two-fifth miles east of the dam site. The influence of these thrusts is present in the tight compression ~~point~~ joint pattern occuring at the dam location.

The effect of some post-Schooley peneplanation is noticeable. The benches on the mountain slopes that occur at approximately 2,000 feet elevation are

tentatively correlated to the Harrisburg peneplane. Lower benches that occur at approximately 1,800 feet are tentatively correlated to the Somerville peneplane. The emergency spillway occurs on one of these latter benches. The fact that a high terrace soil such as the Waynesboro series occurs on Somerville peneplanation shows that this bench was formed at the start of the glacial epoch.

Methods and Procedures:

1. Seismic surveys were taken at several test pit locations in the borrow area. The base plate was placed near the test pit and the geophone extended in a line away from the test pit. This was to determine the depth of the non-rippable sandstone below rippable material such as the Allen soil or the siltstone. Also the rippability of the materials present can be determined by the velocity of the seismic wave through this material. In determining whether a material is rippable the Rippability Chart for the D-9 compiled by the Caterpillar Tractor Company is taken as the standard. To estimate the degree of rippability reference can be made to this chart. Within reasonable limits correlation was obtained between observed horizons in the test pits and the change in the seismic velocity at these points. The largest discrepancy observed was approximately two feet. However, the depths of horizons could vary this amount within twenty or thirty feet from the test pit. A seismic survey taken along the centerline of the emergency spillway showed a discrepancy of three-tenths of a foot in the depth of the non-rippable sandstone as checked by drill holes along this centerline. In the flood plain, however, no valid seismic information could be obtained. This is because seismic velocity is directly related to the density. Thus a tightly packed boulder bed could approximate the density of sandstone. A seismic survey taken in the flood plain showed a ten foot discrepancy to sandstone bedrock as determined by a drill hole.

2. Pressure tests were made up to maxiumum pressure and then made back to minimum pressure. This determines whether the fractures are subject to flushing out or sealing under applied water pressure.

3. Soils that are to be used as construction material are classified according to the standard agricultural classification of soils by series names. Horizons of these series are correlated to the samples both in the correlation chart and in the cross sections. Standard descriptions of the series named are included in the report.

4. Cross sections and geologic maps show the location of the strata in the foundation and the emergency spillway. Descriptive geometry plats are shown for the foundation area to show the theoretical location of beds. Actual location of these beds shows reasonable correlation.

5. Statements made on Form SCS-376-c are to be considered as suggestions and not as recommendations. Terseness of technical writing may make these statements appear to be recommendations.

Centerline of the Dam:

The centerline of the dam is along steep abutments and a flat alluvial area. The alluvial flood plain is almost equally divided between a low terrace deposit and the wide stream channel of a braided stream. The low terrace is below the left abutment. The braided stream is below the right abutment. The sedimentary

materials underlying each of these topographic features are similar. This consists of boulders, cobbles and gravels with sand and silt completely filling the interstices. The material larger than sand size forms approximately 70 percent of the flood plain sediments. This material is subrounded red and gray sandstone and subrounded gray quartzite particles. The sand and silt are colored a dark red. This color is often referred to by geologists as indian red. The depth of the stream alluvium in the low terrace ranges from 13 to 17 feet. In the braided stream the depth ranges from 7 to 10 feet. The rockline in the flood plain is level. It has a range in elevation of less than 1 foot in over 225 feet on the centerline of the dam.

Sandstone and orthoquartzite are the predominant rocks that underlie the centerline of the dam. The other rocks present are carbonaceous shale and siltstone and anthracite coal. A stratum of anthracite coal crosses the centerline of the dam in two places. It crosses on the right abutment and in the flood plain below this abutment as shown by DH 3 this layer is fractured in the flood plain area. Here it is also fairly pure coal. On the right abutment this layer is less fractured and is also impure coal. At DH 1 at the top of the right abutment this layer has become sufficiently impure to be classed as a carbonaceous shale. Generally, the rocks on the right abutment show a slight facies change to sandstone or littoral sedimentary environment.

On the right abutment there is a void nine-tenths of a foot thick that outcrops at station 12+65. Above this void the rock is highly fractured. DH2 which drilled into this fractured and weathered area had to have casing to below the void area. A permeability test on the void area in DH 2 shows a water loss of 4.2 gpm. The fact that this void and the highly fractured and weathered zone above it do not extend into the abutment with the strike of the beds is shown by the relatively low water loss under pressure in DH 1 from a depth of 35 to 45 feet. This void area and the fractured and weathered zone above it are caused by the intersection of the zone of weathering, a joint plane and the strata of interbedded siltstone and sandstone. This joint plane intersects DH 1 at 27 to 33 feet depth and DH 5 at approximately 23 foot depth. Low water loss under pressure testing was obtained in other depth locations in the right abutment.

The flood plain has several fracture zones present. The black carbonaceous shale that occurs at the base of the left abutment is fractured. Indicative of this is the moderately high water loss in this zone under water pressure testing of DH 4.

The centerline of the left abutment had little water loss under pressure testing. The exception to this is the zone from 5.0 to 15.0 feet in DH 6. Here a joint plane occurs.

The lithology along the centerline of the dam is given in the cross section. As the beds are not overturned the stratigraphic section can be read downward.

Emergency Spillway:

The emergency spillway is located in the left abutment. It occurs on a bench that is underlain by hard sandstone with one or more thin seams of shale interbedded within the sandstone. The downstream slope from this bench is underlain by a brown and gray rippable siltstone. The rockline underlying the floor of the central

section of the emergency spillway is fairly regular. This causes the soils to be deep on the left side of the emergency spillway.

Three soils series are present in the emergency spillway area. The Muskingum series occurs on the right side. It is an acid shallow residual soil weathered from sandstone, siltstone and shale. Over the sandstone this soil is extremely shallow, ranging from two to three feet in depth. It is only slightly deeper over the siltstone. This siltstone, however, is rippable. The central portion of the bench and some of both upstream and downstream slopes are overlain by Waynesboro soil. This soil is formed by the weathering of an old high terrace deposit. It contains weathered and unweathered subrounded boulders and cobbles of red sandstone. This terrace deposit is deepest on the upstream edge of the bench and on the upstream slope adjacent to this bench. It becomes thinner downstream.

The alluvial material blends into colluvial material on the left side of the emergency spillway. The alluvial material is sandier and less clayey than the colluvial Allen series material. The colluvial material contains unweathered angular to subangular cobbles of gray Price-Pocono sandstone. The old alluvium contains red subrounded cobbles of Hampshire sandstone. The Allen series material is relatively deep. This shows the strong action of former colluvialization. A fossil soil with clay oolites is present at depth in the colluvial material.

The Muskingum series material is covered by sample DS 253-1. As this light yellow brown fine sandy silt covers both the Allen and Waynesboro "B" horizons, the top layers of these latter soils are also covered by this sample. The Waynesboro series material below this layer is covered by sample DS 256-1. The Allen series material below this layer is covered by sample DS 280-1. Each of these soils has a "c" layer that is complex. Also these soils intersperse together. Thus assigning only one sample to each of these sequence of soil materials is a generalization.

Principal Spillway:

Two tentative principal spillway locations were investigated. The first of these investigated is normal to 1550 on the centerline of the dam. This proposed location lies mainly in the braided stream bed. Only the riser location is on the low terrace. Along this proposed location the rockline will be close to the cradle. The top of the rock lies approximately one-half foot below the riser. Rock lies approximately three and one-half feet below the bottom of the pipe on the centerline of the dam. Also rock lies approximately five feet below the bottom of the pipe at the bent location. The bedrock present consists of sandstone orthoquartzite, siltstone and anthracite coal. The more competent sandstone and orthoquartzite comprise the majority of the rock. Six strata of siltstone and shale cross this proposed principal spillway foundation. One stratum of anthracite coal is present. Locations of these rock types can be seen in the cross section. The rockline under this proposed location appears even. The reason that this natural location was abandoned is that it will discharge in a line with a cabin owned by Mr. Kirkle in Staunton. It was thought that the outflow from this proposed spillway will wash out this cabin which is located on the edge of the left side of the braided streambank.

Because of this condition involving a privately-owned cabin a second proposed principal spillway was investigated. This location is on the low terrace. The depth of the clastic stream alluvium here under the proposed riser location is 19 feet. The depth of clastic overburden under the centerline of the dam is 14 feet. As the pipe will be placed approximately over an old stream channel, the rockline along this foundation is regular. The only irregularity is a gentle depression that occurs between the centerline of the dam and the bent. The same rock types that occur under the other proposed principal spillway occur here. But as the centerline of the dam intersects the strike of the rock at an acute angle, the strata occur further downstream. The bent is located on the right edge of the stream channel. The centerline of this proposed principal spillway intersects the stream at a 20° angle. The riser of this proposed pipe will be approximately four feet above competent rock, the centerline of the dam will be approximately four feet above competent rock, and the bent will be approximately two feet above competent rock. A fracture zone that carries artesian water occurs on the centerline at Station 3+00. Other fracture zones are present downstream.

Foundation:

The foundation of the dam will rest on a low terrace, a braided stream bed and steep abutments. The low terrace has a thin layer of soil over subrounded red cobbles, boulders and gravels. This thin soil supports a heavy forest. The layer of clastic material ranges from 11 to 19 feet in thickness. The clastic material in the stream bed ranges in depth from five to eleven feet.

A steep cliff occurs in the foundation area on the left abutment upstream from the centerline of the dam. This cliff is held up by highly compact sandstone and orthoquartzite. A layer of carbonaceous shale forms a narrow ledge on this cliff. Downstream on the left abutment from this cliff the slope is less steep. Downstream from the centerline of this abutment there are few rock outcrops. But hand auger borings show that the rockline is close to the surface here. On the downstream toe on this abutment a rock outcrop occurs as a road cut.

The right abutment contains several large rock outcrops. Three vertical cliffs occur. One is upstream from the dam centerline at the base of the abutment. One extends downstream from the upstream toe of the dam midway down the abutment. The third is located at the top of the dam along the centerline of the dam. A fractured area occurs from five to twenty-five feet below DH 2. A small colluvial terrace is present on the upstream toe of the dam on the right abutment. This terrace extends into the foundation area. The top of this colluvial terrace is thirty feet above the flood plain. DH 45 was drilled into the downstream portion of this bench. Here there is present nine feet of colluvial soil that contains angular cobbles of sandstone. Downstream from this terrace is a talus slope of angular sandstone boulders.

An old stream channel occurs below the present flood plain alluvium. This former channel appears on the top-of-rock contour map. The bed of this old channel approximates the centerline of the proposed principal spillway normal to 13+80 on the centerline of the dam. It underlies the low terrace on the right side of the flood plain. The modern stream flows on the left side of the flood plain.

The rock types previously described are present in the foundation area. The sandstone and quartzite are the more competent rock. The coal and siltstone are the less competent. A strong flow of artesian water is present at Station 3+00 on the centerline of the pipe normal to Station 13+80 on the centerline of the dam. This is along a joint plane that strikes into the adjacent right abutment. As taken from the cross section of the centerline of the dam the approximate attitude of this joint plane is N 74° E, 66° E. The dip of the joint plane as taken in a road cut on the right abutment is 70° E. Three other joint planes were found in the foundation area. Others may be present.

A light duty gravel road crosses the foundation area. A concrete slab bridge is present. This bridge contains 95± cubic yards of concrete. The concrete slab has been poured on the cobbles and boulders in the stream bed. These particles have been incorporated into the concrete. The bridge appears not to be anchored to bedrock. It is held in place by gravity. An orthographic projection of the surface of this structure is given.

Borrow Area:

Three borrow areas were investigated. One borrow area is in the clastic material that lies in the flood plain. The other two borrow areas are on the hill slopes that occur on each side of this flood plain. The flood plain borrow area lies below the waterline in the permanent pool area. Two land forms are present. One is the braided stream, the other is a low terrace. The alluvium appears generally homogeneous between these two areas. This material in the stream bed consists of sand, silty (45%), cobbles (50%), and boulders (5%) as taken at TP-109. The material on the low terrace consists of sand, silty (56%), cobbles (38%), and boulders (6%) as taken at TP-101. The boulders and cobbles are predominantly (75%) red sandstone from the Hampshire formation. Of minor importance is gray Price-Pocono sandstone and quartzite. Little or no clay is present. A layer of large boulders (GP) generally covers the bedrock present.

The largest borrow area is located on the right side of the dam between two ridges that strike downstream with Little River. The pedology of this area is simple. Muskingum is the only residual series that occurs. Two colluvial soils occur. These are the Leadvale and Allen series. The Leadvale is a recent colluvial soil whereas the Allen is an old colluvial soil. The Muskingum series is shallow. It ranges from two to four feet in depth. This material is a pale brown fine sandy silt. The Muskingum series overlies hard sandstone, carbonaceous shale and siltstone and some impure anthracite coal. It occurs on the steeper slopes. The Allen series is generally composed of two layers. The upper of these is the same as the Muskingum series. Below this is a mottled yellow red and red clayey silt. In this borrow area the Allen series occupies the lower and less steep slopes at the base of the two ridges present. It ranges from eight to thirteen feet in depth. Generally, it overlies sandstone. The Leadvale series occurs in two places in this borrow area. One is in the far southwestern corner of the area covered by the topographic survey in a flat talus fan. The colluvial soil is mixed with flaggy sandstone talus boulders to the extent that it cannot be dug with a backhoe. Rippability is doubtful. The Other area of Leadvale soil is in a draw between the two ridges in the approximate center of the borrow area. Here this soil is mixed with few talus boulders. However, it can easily be dug with a backhoe to a depth ranging from five to eight feet.

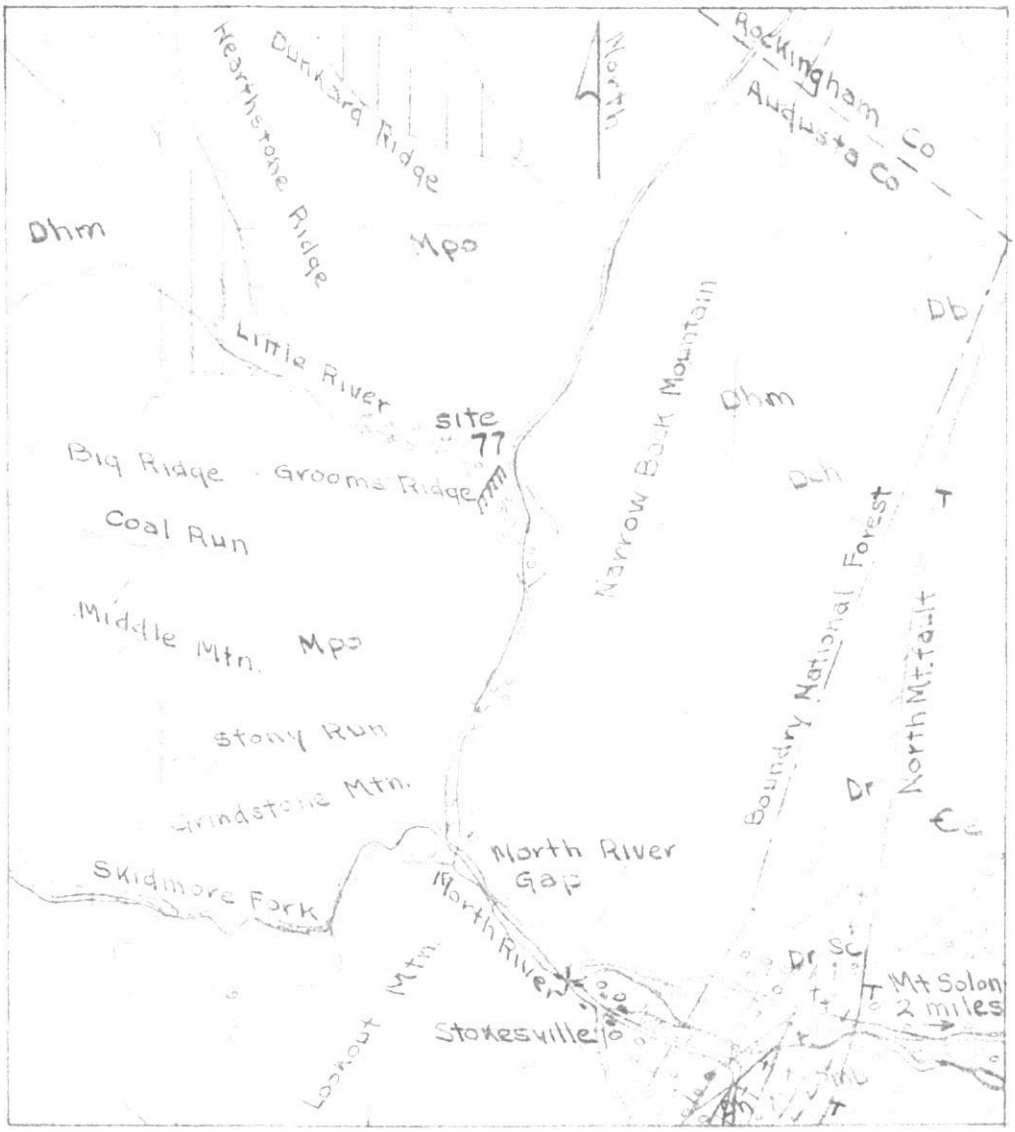
Backhoe refusal was effected by a tightly packed talus deposit of large boulders. The Leadvale soil here is a silty clay or a clayey sand. As a spring occurs in in the draw, the soil is moist to wet. Weathered and unweathered carbonaceous shale, siltstone and impure coal occur in this borrow area. Its easy rippability is shown by its low seismic velocities.

The third borrow area is located on the ridge that forms the left abutment. It borders the left slope of the emergency spillway. Only two soils are present. These are the shallow residual Muskingum series and the deeper colluvial Allen series. The Muskingum and Allen soils here are respectively similar to these series in the borrow area on the right abutment. Carbonaceous shale, siltstone and impure anthracite coal also occur in this borrow area on the left abutment.

As the borrow areas containing residual and colluvial soils cover a large area, several samples of each soil type were submitted for analysis. This was to cover this area with a proctor analysis for construction control. A list and classification of these samples is included.

Scale 0 ½ 1 2

scale 1 inch equals approximately one mile



Pocono sandstone and shale	Mpo	Helderberg limy shale	Dh
Hampshire red shale and sandstone	Dhm	Clinch sandstone and quartzite	Sc
Chemung shale and sandstone	Dch	Martinsburg shale	Omb
Brallier shale	Db	Elbrook limestone and dolomite	Cc
Romney shale	Dr	Recent overlay boulders, cobbles & gravels	

GEOLOGIC MAP* OF AREA SURROUNDING SITE NO.77, UPPER NORTH RIVER W/S, AUGUSTA CO., VIRGINIA

Butts, Charles, 1933, Geologic Map of the Appalachian Valley, Virginia: Va. Geol. Survey Bulletin 52 pt. 3