

# REHABILITATION ASSESSMENT REPORT

## Brush Creek Watershed Site 9

Mercer County, West Virginia



**Project Sponsors:** Southern Conservation District  
Mercer County Commission  
Brush Creek Watershed Improvement District  
Green Valley-Glenwood Public Service District  
Cities of Princeton and Bluefield  
West Virginia Department of Highways  
West Virginia State Conservation Committee

**National Inventory of Dams (NID) ID: WV 05507**

**Total Failure Index: 198**

**Population at Risk: 1618**

**Total Risk Index: 12815**

**Hazard Classification: High**

**March 2011**

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MERCER COUNTY COMMISSION  
BRUSH CREEK WATERSHED IMPROVEMENT DISTRICT  
GREEN VALLEY-GLENWOOD PUBLIC SERVICE DISTRICT  
CITY OF PRINCETON  
CITY OF BLUEFIELD  
WEST VIRGINIA DEPARTMENT OF HIGHWAYS  
WEST VIRGINIA STATE CONSERVATION COMMITTEE

March 2011

Prepared for

WEST VIRGINIA NRCS  
MORGANTOWN, WEST VIRGINIA

Prepared by

GANNETT FLEMING, INC.  
HARRISBURG PENNSYLVANIA



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#### Table of Contents

	<u>Page</u>
1. Introduction and Purpose .....	1
2. Project Setting and History .....	1
3. Site Inspection Summary and Operation and Maintenance .....	2
4. Hydrologic and Hydraulic Analyses .....	6
5. Spillway Integrity Analyses .....	7
6. Breach Inundation Mapping and Hazard Classification Summary .....	9
7. Review of Available Geotechnical Information .....	12
8. Failure and Risk Indexes .....	13
9. Discussion of Potential Rehabilitation Alternatives .....	13
10. Cost Estimates for Rehabilitation Alternatives .....	14
11. Conclusions and Recommendations .....	14

#### Exhibits

Exhibit 1	Project Map for the Brush Creek Watershed
Exhibit 2	Limits of the Maximum Pool Elevation and the Downstream Inundation Limits on Orthophoto Base Map
Exhibit 3	Limits of the Maximum Pool Elevation and the Downstream Inundation Limits on USGS 7.5 Minute Quadrangle Base Map

#### Appendices

Appendix A	Selected As-Built Drawings
Appendix B	Site Inspection Checklist and Photographs
Appendix C	SITES Output
Appendix D	Evaluation of Potential Rehabilitation Projects-Priority Ranking Spreadsheet



## **1. Introduction and Purpose**

The purpose of this report is to provide the West Virginia Natural Resources Conservation Service (NRCS) an assessment of Brush Creek Site 9, as authorized by contract dated May 24, 2010 for 41 Dam Assessments for various watersheds in West Virginia (Award No. AG-3D47-D-10-0008). The report provides a description of the dam, an assessment of the current conditions and status of operation and maintenance, and the scope of potential rehabilitation alternatives. In addition to assessing the overall integrity of the structure, available design information was reviewed to determine whether the structure meets current NRCS design criteria. This information is provided to assist the NRCS and local sponsor(s) in determining future actions concerning potential rehabilitation of the dam to extend the service life of the dam and meet current safety criteria.

The Watershed Protection and Flood Protection Act (Section 14 of PL-83-566, as amended) authorizes funding and technical assistance to rehabilitate aging flood control dams originally built with assistance of the USDA Watershed Programs. Sponsors of these dams may apply for assistance to extend the project service life and ensure that the facility meets applicable safety and performance standards. If the project is eligible for rehabilitation assistance, the NRCS may provide funding for 65 percent of the total rehabilitation project costs; the project sponsors are responsible for the remaining 35 percent. Technical assistance by NRCS for planning and design of the rehabilitation project is provided at no cost to project sponsors.

## **2. Project Setting and History**

The original Brush Creek Watershed Work Plan Agreement was signed on March 16, 1960. The Brush Creek Watershed was planned and constructed in accordance with provisions of PL-566, approved August 4, 1954. The project Work Plan was supplemented seven times: Supplemental Work Plan Agreement No. 1 signed September 10, 1963; Supplemental Work Plan Agreement No. 2 signed January 29, 1965; Supplemental Work Plan Agreement No. 3 signed June 22, 1967; Supplemental Work Plan Agreement No. 4 signed November 4, 1968; Supplemental Work Plan Agreement No. 5 signed August 13, 1969; Supplemental Work Plan Agreement No. 6 signed March 29, 1973; and Supplemental Work Plan Agreement No. 7 signed October 8, 1981. Local organizations sponsoring the project include the Southern Conservation District, the Mercer County Commission, Brush Creek Watershed Improvement District, Green Valley-Glenwood Public Service District, Princeton City, Bluefield City, the West Virginia State Conservation Committee, and the West Virginia Department of Highways.

The purpose of the plan for the Brush Creek Watershed was to outline land treatment and structural measures necessary to achieve the maximum practical erosion control and alleviate flood damage. Installation of planned structural measures were to assist in providing floodwater protection to dwellings, roads, fields, crops, and businesses, to permit more intensive land use by reducing damage to land in the flood regions, and also to make uplands more attractive and productive. A total of 10 floodwater retarding dams were constructed on tributaries within the Brush Creek Watershed.



Brush Creek Site 9 is located on the South Fork of Brush Creek in Mercer County approximately 3 miles from Bluefield, WV. The location of Brush Creek Site 9 is shown on the Project Map for the Brush Creek Watershed presented on Exhibit 1. An aerial photo and USGS quadrangle of Brush Creek Site 9 are presented on Figures 1 and 2, respectively.

Engineering design data and other reference data were collected and reviewed. The following is a list of data sources reviewed for this assessment report.

1. Original Work Plan and Subsequent Supplements (3/1960, 9/1963, 1/1965, 6/1967, 11/1968, 8/1969, 3/1973, 10/1981)
2. As-Built Drawings (1964)
3. Design Report Sections (Geology, Soil Mechanics, Hydraulic Design) (1963)
4. Inspection Records (2008, 2009, 2010)
5. O&M Agreement (08/1966)
6. Failure and Risk Index Spreadsheet (2011)
7. Brush Creek Watershed Map (1980)
8. Emergency Action Plan (09/22/2009)

Brush Creek Site 9 is a dual purpose flood control dam designed by the SCS (now NRCS), Morgantown, West Virginia. The dam and its appurtenances consist of a 545-foot long, zoned earthfill embankment with a maximum height of 41 feet above the invert of the principal spillway. The dam has two spillways; a two-stage principal spillway and an open channel vegetated auxiliary spillway. The auxiliary spillway crest is approximately 7.8 feet below the top of the dam. Both spillways are uncontrolled. All inflow is discharged through the principal spillway until the pool level reaches the level of the auxiliary spillway crest. A drawdown gate was provided to lower or drain the reservoir. The principal spillway conduit consists of a 24-inch diameter reinforced concrete, steel cylinder type pre-stressed pressure pipe conforming to AWWA-C301 standards. The principal spillway conduit was constructed with a concrete cradle with reinforced concrete anti-seep collars.

A summary of specific design data is presented in Table 1. Selected as-built drawings are presented in Appendix A.

### **3. Site Inspection Summary and Operation and Maintenance**

Paul Schweiger, P.E.; Gregory Richards, E.I.T.; and E.J. Barben, E.I.T. of Gannett Fleming, Inc. conducted a site inspection of Brush Creek Site 9 on October 18-19, 2010. The WV-ENG-105, Formal Dam Inspection Checklist was used to record findings and is presented in Appendix B. General photographs of the dam site (Photos 1-6) and photographs of deficiencies (Photos 7-16) noted during the site inspection are also presented in Appendix B. Additional photos taken during the field review are furnished in the Supporting Data Folder on a CD. With the exception of several ongoing maintenance items noted below, the dam was found to be in good condition

There are bare earth trails and areas of significant wave erosion and sloughing on the upstream slope of the embankment. The grass cover on the downstream slope of the dam embankment appears to be adequate.



Figure 1. Aerial Photo of Brush Creek Site 9

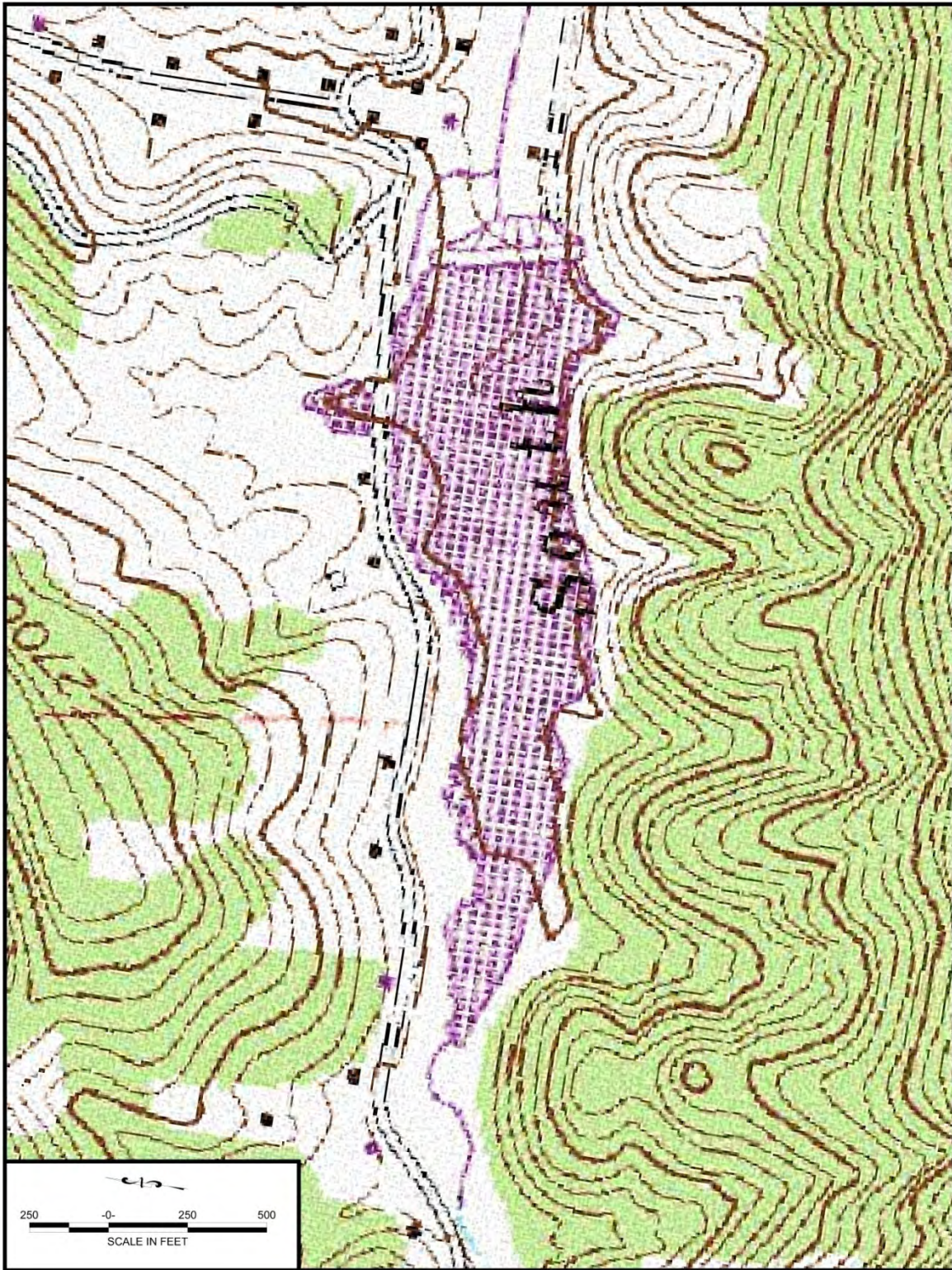


Figure 2. USGS Quadrangle of Brush Creek Site 9



**Table 1**  
**As-Built Design Data for Brush Creek Site 9**

Description	Value
<b>General Data</b>	
Year Designed	1963
Year Constructed	1964
Purpose	Flood Control, Water Supply
Original Hazard Classification	High (Class C)
Current Hazard Classification	High (Class C)
Design Life	50 years (2014)
Design Drainage Area	592 Acres (0.93 Mi <sup>2</sup> )
Dam Height (Along Centerline)	36 Feet
Maximum Dam Height	41 Feet
Embankment Length	545 Feet
Embankment Top Width	14 Feet
Embankment Upstream Slope	3H:1V
Embankment Downstream Slope	2.5H:1V
<b>Critical Elevations (MSL)</b>	
Top of Dam	2513.5 Feet
Auxiliary Spillway Crest	2505.6 Feet
PSW Weir	2503.4 Feet
Normal Pool (Water Supply Pool)	2500.0 Feet
PSW Conduit Outfall Invert	2472.34 Feet
PSW Outlet Channel Invert	2472.34 Feet
<b>Storage Capacities</b>	
Sediment Storage (50-Year Submerged & Aerated Sediment)	17.53 Acre-Feet
Normal Pool (Water Supply Pool)	253.5 Acre-Feet
Auxiliary Spillway Crest	436.3 Acre-Feet
Top of Dam	777.8 Acre-Feet
<b>Pool Surface Areas</b>	
Normal Pool	27.7 Acres
Auxiliary Spillway Crest	36.6 Acres
<b>Other Features</b>	
Principal Spillway Orifice Size	16 Inch Dia.
Principal Spillway Conduit Diameter	24 Inches
Principal Spillway Conduit Length	220.38 Feet
Principal Spillway Weir Crest Length	12-Feet (Total)
Auxiliary Spillway Width	70 Feet



There is significant wave erosion on the entrance slope of the auxiliary spillway. A bare, unvegetated area was observed on the outslope of the spillway. There are also a few minor obstructions (trash cans, fence posts, etc.) within the auxiliary spillway channel.

The CMP drains located on either side of the principal spillway outlet conduit were both flowing at greater than ½ gpm. Wet areas were observed below the toe of the dam on both the left and right sides of the stilling basin, possibly due to poor drainage. Otherwise, no signs of embankment instability or seepage were observed.

The concrete principal spillway riser structure and stilling basin appear to be in good condition and operating as designed. No external evidence of cracking or deterioration was observed. Metal parts on the lower portion of the riser are showing signs of corrosion and need to be painted. The bottom rungs of the ladder are missing. Sediment and vegetation are clogging the outlet channel downstream of the stilling basin causing a backwater that extends over the endsill and nearly submerges the conduit.

Items inaccessible for inspection include the submerged exterior of the riser structure, interior of the riser structure, sluice gate, interior of the principal spillway conduit and the interior of the CMP drain pipes.

In addition to the site inspection, video inspections of the principal spillway conduit and the drawdown gate as provided by the NRCS were reviewed. The ROVVER inspection of the principal spillway conduit was performed on September 10, 2002 and revealed concrete deterioration in the conduit and inside the principal spillway intake structure, debris inside the intake structure, and some joint separation between the intake structure and the first section of the principal spillway conduit. The underwater inspection of the drawdown gate and gate stem was also performed on September 10, 2002. The inspection video revealed no significant deficiencies.

Items of deferred maintenance include repairing and armoring areas damaged by wave erosion, seeding bare areas, painting corroded metal on the riser structure, repairing the ladder, removal of obstructions within the auxiliary spillway, and clearing sediment and vegetation from the outlet channel. Wet areas on both sides of the stilling basin should also be monitored.

It should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is also important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Continued care and inspection are necessary to detect unsafe conditions.

#### **4. Hydrologic and Hydraulic Analyses**

Hydraulic analyses were conducted to determine whether the dam meets NRCS and WVDEP current criteria. NRCS design precipitation and other hydrologic parameters have become more stringent since the dam was designed in the 1960s. As part of this assessment, updated hydrologic and hydraulic analyses using the NRCS SITES model were performed to



determine the required auxiliary spillway crest and top of dam elevations. Structure geometry and reservoir storage inputs as well as watershed hydrologic characteristics for the model were obtained from as-built drawings and other design documents provided by the West Virginia NRCS. The SITES analyses involved evaluation of the top of dam elevation for both the short duration (6-hour) storm and the long duration (24-hour) storm in accordance with procedures outlined in the latest version (July 2005) of TR-60. The elevation of the auxiliary spillway crest was also evaluated for the 100-year event. The SITES output for as-built, Class C (*high hazard*) criteria for the 6-hour and 24-hour duration storms and the auxiliary spillway crest elevation are presented in Appendix C. A side-by-side comparison of key SITES model input and output for the different scenarios analyzed is presented in Table 2.

**Table 2**  
**Side-By-Side Comparison of Key SITES Model Input and Output**

Parameter	Original Class C 1963 Design	100-Year ASW Crest	6-hr Class C Top of Dam	24-hr Class C Top of Dam
<b>Key Input Data</b>				
Watershed Area	592 Acres	592 Acres	592 Acres	592 Acres
Weighted Curve Number	80.0	80.0	80.0	80.0
Time of Concentration, T <sub>c</sub>	1.58 Hours	1.58 Hours	1.58 Hours	1.58 Hours
100-Year Rainfall (P-100)	- Inches	4.84 Inches	3.66 Inches	4.84 Inches
Freeboard Rainfall (P-FB)	29.38 Inches	-	28.7 Inches	37.0 Inches
<b>Key Output Data</b>				
ASW Crest Elevation	2505.6 Feet	<b>2505.85 Feet</b>	2505.6 Feet	2505.6 Feet
Top of Dam Elevation	2513.5 Feet	-	2512.90 Feet	2511.70 Feet
<b>Freeboard</b>	-	-	<b>0.60 Feet</b>	<b>1.80 Feet</b>

The following can be concluded based on the analysis results summarized in Table 2:

1. The Auxiliary Spillway crest is 0.25 feet lower than required using the 100-year flood activation criteria.
2. For a Class C (*high hazard*) structure, the dam would not be overtopped and would have 0.60 feet of freeboard to pass the 6-hr Freeboard Hydrograph.

## 5. Spillway Integrity Analyses

Preliminary auxiliary spillway integrity analyses were also performed as part of this assessment using the SITES program. Very little subsurface information is available from which to develop a representative geologic profile of the most erodible section through the auxiliary spillway. The assumed geologic profile of the auxiliary spillway was developed using as-built drawings, geology and soils design reports, and supplemental reports from the United States Geological Survey and the West Virginia Geological and Economic Survey.



The geology of the auxiliary spillway for the SITES integrity analysis was assumed to consist of claystone from the crest of the spillway down to the valley floor. The exit slope of the auxiliary spillway also consists of a layer of sandstone and shale. The assumed material properties for the preliminary assessment of the spillway integrity are presented in Table 3. A schematic profile of the auxiliary spillway obtained from the SITES output is presented on Figure 3.

**Table 3**  
**Assumed Parameters for Auxiliary Spillway Integrity Analysis**

Material Description	Assumed ASW Material Erosion Parameters				
	Dry Density (lbs/ft <sup>3</sup> )	Headcut Index (K <sub>h</sub> )	Percent Clay	Plasticity Index	D <sub>75</sub> / Rep. Dia.(in)
Soil	100	0.28	16	8	0.002
Claystone	130	5	0	0	4
Sandstone	133	14	0	0	7
Shale	121	10	0	0	10

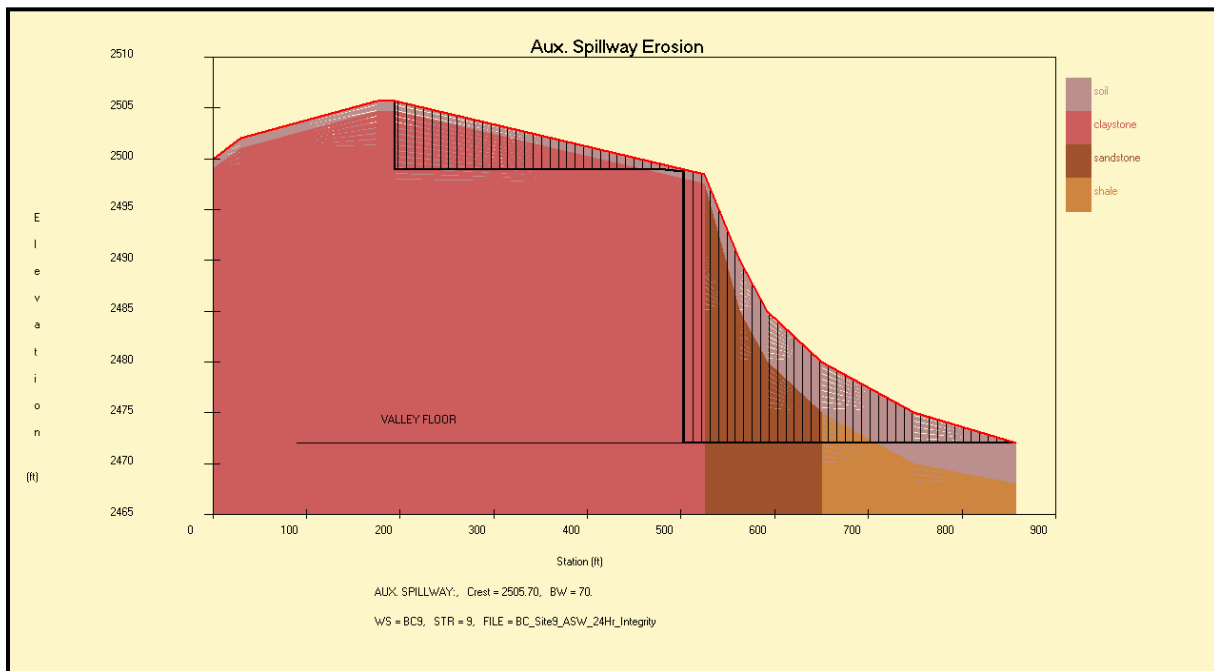


Figure 3. Plot of Auxiliary Spillway Profile and Extent of Erosion from Integrity Analysis for 24-hour Class C Freeboard Hydrograph (PMF) Obtained from SITES Model Output



The SITES auxiliary spillway analysis shows that the auxiliary spillway crest experiences significant damage, including a shallow headcut that extends up to the control section of the spillway, during passage of the 24-hour FBH. A similar extent of damage will occur during the 6-hour duration event.

Photos 9 and 14 in Appendix B show features observed during the site visit including wave erosion of the entrance slope of the spillway and an unvegetated area in the spillway that can also accelerate erosion of the spillway. These features have not been incorporated in the SITES auxiliary spillway analysis but should be considered in evaluating the overall integrity of the spillway. The SITES output for both the 6-hour and 24-hour storms for as-built, Class C criteria are presented in Appendix C. The electronic input files for the SITES model are furnished in the Supporting Data Folder on a CD.

## **6. Breach Inundation Mapping and Hazard Classification Summary**

A dam breach hydraulic analysis was performed using the U.S. Army Corps of Engineers' HEC-RAS computer model in order to determine the downstream inundation limits of the flood wave created by a sudden breach of the dam. A field assessment of downstream structures located within the path of the flood wave was also made to verify the current hazard classification. The hazard classification evaluation consisted of evaluating the downstream area within the breach inundation zone. The dam was then classified according to West Virginia State Dam Safety definitions and NRCS definitions in NEM, Part 520, Subpart C – Dams.

The inflow hydrograph and reservoir stage-storage relationship, and other inputs used to describe the dam in the HEC-RAS model were obtained from the 6-hour FBH SITES output and as-built drawings. The dam breach parameters, including the time to breach, breach bottom width and side slopes were determined by trial and error until the peak breach discharge criteria specified in TR-60 was satisfied. The minimum and maximum peak breach discharges using TR-60 criteria were computed to be 34,444 cfs and 62,250 cfs, respectively. Assuming a complete breach of the dam occurs within 30 minutes, a peak breach discharge of approximately 36,500 cfs was computed using the HEC-RAS model. The height of the breach flood wave at the dam site, from the top of the dam to the valley floor would be approximately 41 feet.

The HEC-RAS dam breach analysis and downstream unsteady flow modeling of the flood wave was performed using a three (3) meter Digital Elevation Model (DEM) and SAMB Orthophotos to obtain the cross sections and Manning's "n" values necessary for modeling the channel and flood plain.

The extent of the breach analysis was greater than that shown on the existing inundation map included in the Emergency Evacuation Plan for this structure. The breach analysis was based upon the FBH storm for a Class C dam with assumed failure occurring at the top of dam elevation. The FBH storm was only assumed to occur in the watershed upstream of the dam with normal base flow of approximately 50 cfs occurring downstream of the dam. Flood elevations were tracked downstream until they came largely within the stream bank or when the flow rate was less than 10 percent of the peak breach flow rate at the dam.



For Brush Creek Site 9, the inundation mapping was extended to the city of Princeton, approximately 9 miles downstream of the dam, until the flood wave was largely within the banks of Brush Creek. According to the HEC-RAS dam breach model, the peak flow rate of the breach flow or flood wave at Princeton is approximately 2,500 cfs or 7 percent of the peak breach flow at the dam. The resulting inundation limits in the vicinity of Princeton were compared with the inundation limits shown on the existing detailed FEMA Flood Insurance maps for the same area for the 100-year and 500-year flood events. Near the upstream corporate limits of Princeton, the peak 100-year and 500-year FEMA flood flows were estimated to be 2,030 cfs and 3,930 cfs, respectively. The peak FEMA 100 and 500-year flood elevations near the upstream corporate limit of Princeton were reported to be 2,395 feet and 2,398 feet, respectively. The peak dam breach flood elevation at the same location was computed to be 2,397.5 feet. A side by side comparison of the dam breach inundation mapping and the FEMA Flood Insurance mapping near the upstream limit of Princeton is presented in Figure 4.

Homes, businesses, road crossings, bridges, farms and commercial buildings, utilities and other structures located within the dam breach inundation limits were identified and photographed. All photographs were tagged electronically with their date, time, longitude and latitude using GPS. This information was used to create a GIS database to help quantify the flood impacts and persons at risk.

The limits of the maximum pool elevation and the downstream inundation were plotted in AutoCAD on both an orthophoto base map and a USGS Quadrangle base map, and are presented on Exhibits 2 and 3, respectively. The locations of all cross sections used in the HEC-RAS model are also shown Exhibits 2 and 3. All associated HEC-RAS, AutoCAD, and other supporting computer files are furnished in the Supporting Data Folder on a CD. A GIS database containing the downstream inundation limits and the photographs of all inundated features within the downstream inundation limits is also provided on a CD.

According to West Virginia State Dam Safety definitions and NRCS definitions in NEM, Part 520, Subpart C – Dams, *high hazard* dams (Class 1 or Class C) are those dams located where failure may cause loss of human life or serious damage to homes, commercial or industrial buildings, main highways or railroads, or important public utilities. This classification must be used if failure may result in the loss of human life. Existing and future downstream development including controls for future development must be considered when classifying the dam.

Brush Creek Site 9 was designed in 1963 as a *high hazard* (Class C) structure. Based on the inundation mapping presented on Exhibits 2 and 3, and the downstream reconnaissance of the area within the inundation zone, this classification is found to be appropriate. Sudden failure of Brush Creek Site 9 during the FBH event impacts considerable downstream dwellings, road crossings/bridges, commercial buildings and other structures, and meets both the loss of life and property damage criteria for a high hazard dam.

Three dwellings were identified within the downstream inundation zone that are less than 600 feet from the toe of the dam. Many other dwellings, including 42 mobile homes located





It should be noted that according to the HEC-RAS model results, it will take about 8.5 hours for a flood wave created by a sudden failure of Brush Creek Site 9 to reach its peak flood level at Princeton. There is, therefore, a moderate amount of warning time available which can increase the probability of survival for persons at risk that are located in the furthest downstream reaches of the inundation area.

## **7. Review of Available Geotechnical Information**

Available geotechnical information was reviewed with respect to items that are considered in the “*Evaluation of Potential Rehabilitation Projects-Priority Ranking Spreadsheet*”. This information included the Geology and Soils Reports (1963) as well as the as-built drawings (1964).

The 1960’s time period for design and construction predates the full development of several current NRCS design criteria. Two important design criteria include drain/filter compatibility and seepage control for principal spillway conduits. The manuals that define these two design methodologies, Gradation Design of Sand and Gravel Filters and Filter Diaphragms, were first published in 1994 and 2007, respectively. The compatibility of adjacent embankment zones is another design criterion that has developed since the 1960’s and has become an essential step in the design process for earthen dams.

The existing embankment drain consists of a single, broadly graded aggregate with both sand and gravel sized particles. Current criteria would require the drain to have at least two components. The finer component (typically a sand) would be compatible with a range of embankment and foundation soils while the coarser component (typically a gravel) would have a higher permeability designed to adequately collect and convey seepage. Two additional gradation characteristics of the existing drain that do not meet current criteria are a maximum particle size of three inches which is too large to prevent segregation and a coefficient of uniformity of 17, which exceeds the recommended maximum of 6 to prevent gap-graded filters. A filter compatibility analysis that would evaluate all the current design parameters is not possible without an additional subsurface investigation that would define the range of gradation and plasticity characteristics of the embankment and foundation soils. The design reports only contain recommendations for borrow areas and do not contain test results completed on fill placed during construction.

The drain configuration at the embankment toe that surrounds the principal spillway conduit and outlets to the stilling basin is similar, but does not meet all current criteria for filter diaphragms. Current criteria require the minimum horizontal and vertical upward dimensions to be three times the conduit diameter. The as-built drawings show that the minimum horizontal dimension is met, however the vertical dimension is less than three times the conduit diameter. Another similarity is the use of two 8-inch diameter corrugated metal drainage pipes to convey seepage from the filter to the stilling basin. The use of corrugated metal pipes, which have been found to be susceptible to corrosion, is not recommended and the integrity of this pipe should be investigated by video inspection.

Another geotechnical design issue that can only be evaluated with an additional subsurface investigation is the compatibility between the embankment zones. The as-built plans



show two distinct zones, a clay core and a shell consisting of emergency spillway cut material without an intermediate transition zone. Transition zones are typically required by current designs.

A slope stability analysis was performed as part of the original design. Shear strength parameters were based on laboratory testing of borrow area and auxiliary spillway excavation materials. The stability analysis neglects the presence of the filter/drain trench and utilizes a phreatic surface that exits the embankment on the downstream slope above the toe. This is a conservative design approach which assumes that the drain may become clogged or non-functional. Seepage analyses were not contained in the design files available. The dam has no instrumentation to monitor phreatic levels, seepage discharge, or surface movement.

Review comments related to the geotechnical factors in the “*Evaluation of Potential Rehabilitation Projects-Priority Ranking Spreadsheet*” are presented in Appendix D. Also included in the appendix is a copy of the spreadsheet as completed by the WV NRCS.

## **8. Failure and Risk Indexes**

The structure’s risk of failure and the consequences of failure were evaluated by the WV NRCS by completing the “Evaluation of Potential Rehabilitation Projects-Priority Ranking Spreadsheet” (Exhibit 508.1 of the NRCS-National Watershed Manual) to determine whether the dam qualifies for rehabilitation as per Section 508 Subpart E of the National Watershed Manual. Based on the completed spreadsheet, the total failure index computed by the NRCS for Brush Creek Site 9 is 198, with a total risk index of 12,815. A copy of the spreadsheet completed by the WV NRCS is included in Appendix D.

## **9. Discussion of Potential Rehabilitation Alternatives**

Assuming the dam must satisfy Class C (*high hazard*) design criteria, the only identified deficiency is the early activation of the auxiliary spillway. The preliminary SITES integrity analysis determined that the auxiliary spillway would experience a significant but acceptable amount of damage during passage of the Freeboard Hydrograph. Therefore, armoring of the spillway will not be required.

It is noted that the dam assessment and spillway integrity analysis were performed using limited information about the subsurface properties of the dam embankment and auxiliary spillway profile. Some design features within the embankment, particularly drain/filter compatibility, seepage control, and compatibility between adjacent embankment zones as discussed in Section 7 of this report, do not meet current NRCS design criteria. Full evaluation for compliance to current criteria cannot be confirmed without a subsurface investigation and subsequent analyses and are not included herein as deficiencies requiring rehabilitation.

The only modification modeled with the SITES program was raising the auxiliary spillway. By raising the auxiliary spillway crest by 0.25 feet, the existing top of dam elevation is still sufficient to pass the Freeboard Hydrograph. Therefore, only the auxiliary spillway would need to be modified. Due to the relatively small amount that the auxiliary spillway needs to be raised, the necessity of this rehabilitation alternative may be debated. Updated survey



information should be obtained and detailed hydrologic and hydraulic analyses should be performed prior to the rehabilitation of the auxiliary spillway.

## 10. Cost Estimates for Rehabilitation Alternatives

Based on preliminary information, a planning level cost estimate was prepared for the alternative described in Section 9 and is presented in Table 4. Decommissioning or breaching the dam was also included as an alternative in Table 4. The cost estimates presented in Table 4 are based on approximate quantities and construction prices from similar projects. As noted in Section 9, additional data and analysis is required to verify the need for raising the auxiliary spillway. This estimate also assumes that the auxiliary spillway will not need to be armored to prevent spillway breaching and that major expenditures to address potential embankment deficiencies are not required.

**Table 4**  
**Planning-Level Cost Estimates for Modifications to Bring**  
**Brush Creek Site 9 into Compliance with NRCS Class C Design Criteria\***

Alternative	Alternative Description	Estimated Total Project Cost
1	Raise ASW	\$70,000
2	Decommission/Breach Dam	\$590,000

\* *Some design features within the embankment may not meet current NRCS design criteria. Compliance of these features cannot be confirmed without further analysis and are not included herein as deficiencies requiring rehabilitation.*

## 11. Conclusions and Recommendations

**11.1 Operations and Maintenance.** Brush Creek Site 9 was observed to be in good condition with several maintenance deficiencies that need to be addressed. These include repairing and armoring areas damaged by wave erosion, seeding bare areas, painting corroded metal on the riser structure, repairing the ladder, removal of obstructions within the auxiliary spillway, and clearing sediment and vegetation from the outlet channel. Wet areas on both sides of the stilling basin should also be monitored.

**11.2 Additional Studies.** Subsurface investigations to more accurately quantify conditions within the embankment, foundation, and auxiliary spillway are recommended. This information is important to confirm that the embankment meets current design criteria and to more accurately evaluate the integrity of the auxiliary spillway. Embankment slope stability should be evaluated based on the results of the subsurface investigations. Items not readily accessible for inspection such as the inside of the principal spillway conduit, riser structure, and embankment drains, and the submerged exterior of the riser and sluice gate should also be assessed.



- 11.3 Hazard Classification.** Based on the inundation mapping prepared as part of this study and the downstream reconnaissance of the area within the inundation zone, the classification of Brush Creek Site 9 as a high hazard structure is found to be appropriate. Sudden failure of Brush Creek Site 9 during the FBH event impacts considerable downstream dwellings, road crossings/bridges, commercial buildings and other structures, and meets both the loss of life and property damage criteria for a high hazard dam.
- 11.4 Design Deficiencies.** Brush Creek Site 9 does not meet current NRCS design criteria for a Class C (*high hazard*) structure. The only identified design deficiency is the early activation of the auxiliary spillway. Due to the relatively small amount that the auxiliary spillway needs to be raised, the necessity of this rehabilitation alternative may be debated. It is recommended that updated survey information be obtained and detailed hydrologic and hydraulic analyses be performed prior to the rehabilitation of the auxiliary spillway. Other deficiencies may exist related to geotechnical issues with the embankment or features that were not inspected.
- 11.5 Failure and Risk Indexes and Priority Ranking of Rehabilitation Project.** The total failure index for Brush Creek Site 9 as indicated in the spreadsheet prepared by the WV NRCS is 198, with a total risk index of 12,815.
- 11.6 Rehabilitation Project.** According to preliminary assessment analyses, only minor modifications to Brush Creek Site 9 are needed to bring the dam into compliance with current NRCS high hazard dam design criteria, for the known deficiencies. Additional data and analysis is required to verify the need for raising the auxiliary spillway. A planning level total project cost to make structural modifications to the dam to meet current NRCS design criteria without compromising current flood control benefits is estimated at \$70,000. This estimate assumes that the auxiliary spillway will not need to be armored to prevent spillway breaching and that major expenditures to address potential embankment deficiencies are not required, as discussed in Section 9 and Section 11.2.

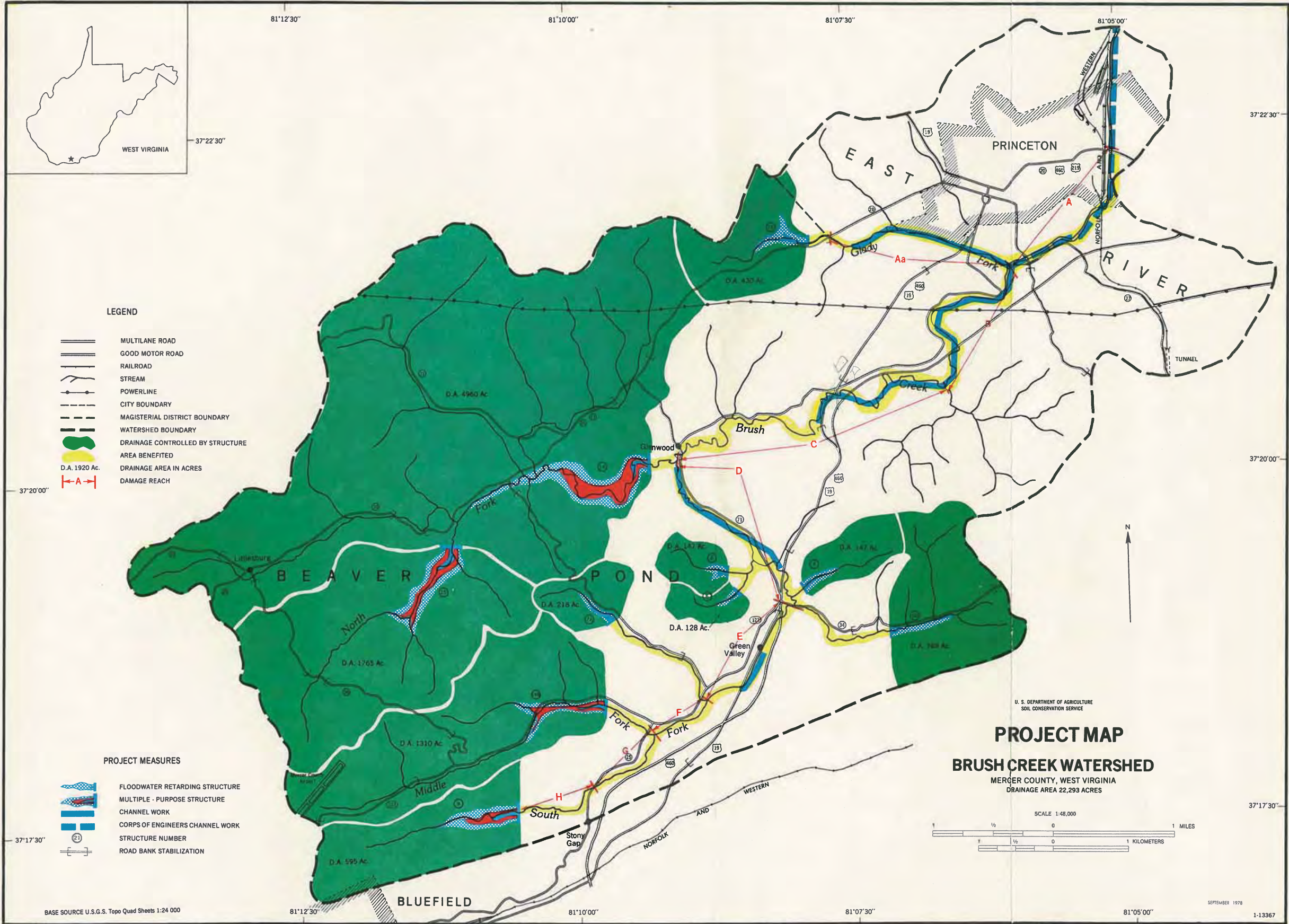


EXHIBIT 1

W:\2010\10\22\2010 WV NRCS 2010 Contract\05 Wooding\41 Dam Assessment\41 - CADD\Brush Creek Site 9\Brush Creek Site 9 Inundation Map.dwg  
Plot Date: 11/17/2010 11:22 AM Plotted By: Miller, Brian S.



**BRUSH CREEK  
SITE 9 DAM**

**GLENWOOD**

**MAPLE ACRE**

**GREEN VALLEY**

**DAM BREACH INUNDATION MAP**

**BRUSH CREEK SITE 9  
NIDID: WV 05507  
MERCER COUNTY, WEST VIRGINIA**



**LEGEND**

- HEC-RAS CROSS SECTIONS
- INUNDATION AREA
- FLOOD POOL



PREPARED BY:  
**Gannett Fleming**  
207 SENATE AVENUE, CAMP HILL, PA. 17011

**EXHIBIT  
2  
NOV. 2010**

W:\250\active\_jobs\02299 - WV NRCS 2010 Contract\02 Wooding\1 Dam Assessments\1 - CAD\Brush Creek Site 9 Inundation Map.dwg  
Plot Date: 11/17/2010 11:23 AM Plotted By: Miller, Brian S.



**BRUSH CREEK  
SITE 9 DAM**

**DAM BREACH INUNDATION MAP**

BRUSH CREEK SITE 9  
NIDID: WV 05507  
MERCER COUNTY, WEST VIRGINIA



**LEGEND**

- HEC-RAS CROSS SECTIONS
- INUNDATION AREA
- FLOOD POOL



PREPARED BY:  
**Gannett Fleming**  
207 SENATE AVENUE, CAMP HILL, PA. 17011

EXHIBIT  
**3**  
NOV. 2010



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Appendix A  
Selected As-Built Drawings

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# BRUSH CREEK WATERSHED PROJECT

## BRUSH CREEK NO.9 MULTIPLE - PURPOSE DAM

WATER SUPPLY FOR  
THE GREEN VALLEY - MAPLE ACRES AND GLENWOOD ACRES  
AND FLOOD PREVENTION

DRAINAGE AREA	592	Acres
TOTAL STORAGE TO EMERGENCY SPILLWAY CREST	436.7	Acre Ft.
FLOODWATER RETARDING STORAGE	177.9	Acre Ft.
WATER SUPPLY STORAGE	241.2	Acre Ft.
SEDIMENT STORAGE	17.5	Acre Ft.
WATER SURFACE AREA TO NORMAL POOL	27.7	Acres
HEIGHT OF DAM	36	Feet
VOLUME OF FILL	<del>52,000</del> 55,234	Cubic Yards

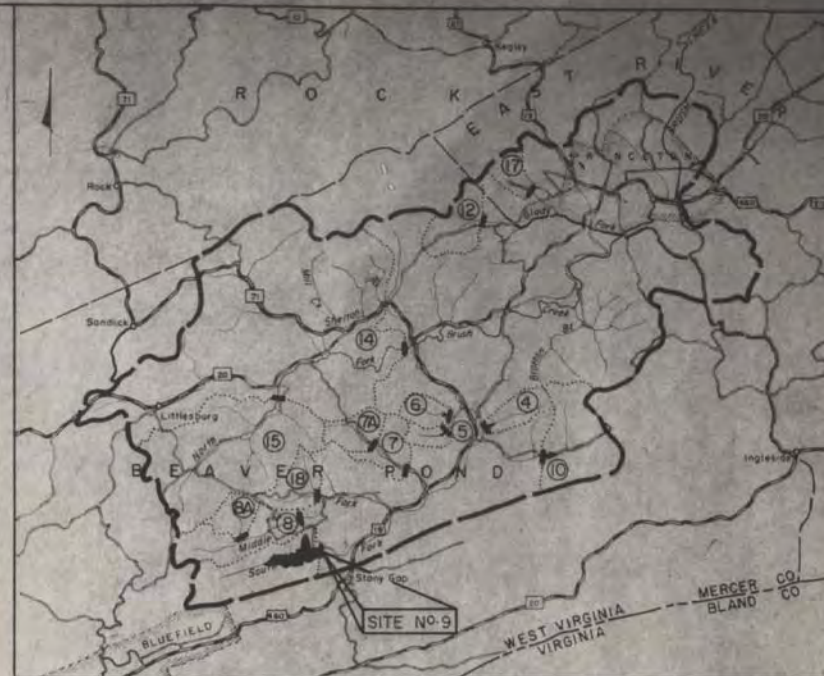
BUILT UNDER THE WATERSHED PROTECTION AND  
FLOOD PREVENTION ACT

by  
SOUTHERN SOIL CONSERVATION DISTRICT,  
BRUSH CREEK WATERSHED IMPROVEMENT DISTRICT  
GREEN VALLEY - GLENWOOD PUBLIC SERVICE DISTRICT  
with the assistance of  
SOIL CONSERVATION SERVICE  
of the  
U.S. DEPARTMENT OF AGRICULTURE

# 1967 "AS BUILT"

INDEX

SHEET 1 - COVER SHEET	SHEET 9 - LOGS OF TEST PITS
SHEET 2 - PLAN OF DAMSITE AND STORAGE AREAS	SHEET 10 - LOGS OF DRILL HOLES
SHEET 3 - PLAN OF STORAGE AND BORROW AREAS	SHEET 11 - PLAN-PROFILE OF PRINCIPAL SPILLWAY
SHEET 4 - PLAN OF STORAGE AND BORROW AREAS	SHEET 12 - RISER-STRUCTURAL DETAILS
SHEET 5 - PLAN OF STORAGE AND BORROW AREAS	SHEET 13 - RISER-WATER SUPPLY PIPE
SHEET 6 - PLAN OF STORAGE AND BORROW AREAS	SHEET 14 - RISER-CRADLE AND COLLAR DETAILS
SHEET 7 - PROFILES	SHEET 15 - TRASH RACK AND MISC. DETAILS
SHEET 8 - SEEPAGE DRAIN DETAILS	SHEET 16 - IMPACT BASIN DETAILS



LOCATION MAP  
SCALE = 1:62500

Time to drain

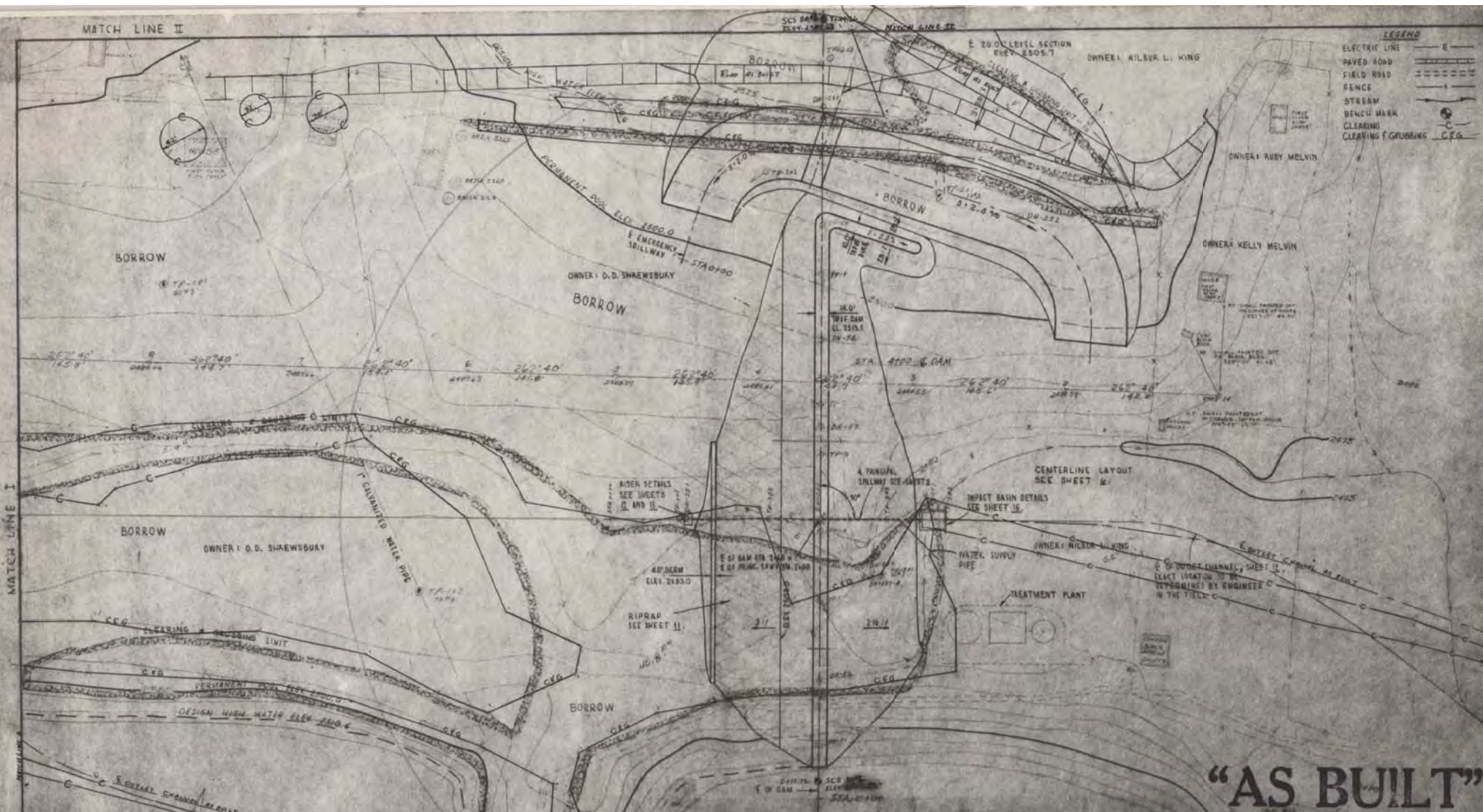
Full - 2500 Ft	68 hr
2495 "	42 hr
2490 "	21 hr
2485 "	9 hr
2480 "	3 hr

# "AS BUILT"

BRUSH CREEK WATERSHED PROJECT  
MULTIPLE PURPOSE DAM NO. 9  
BLUEFIELD, MERCER CO., WEST VIRGINIA  
COVER SHEET

U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

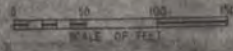
Designed by KESSEL	Checked by Harold M. Rhoads
Drawn by M. WROBLICH	State Conservation Engineer STATE CONSERVATION ENGINEER
Sheet No. 1	Drawing No. WV-466-P
S. C. Rossier 4/4/67	



**LEGEND**

- ELECTRIC LINE
- PAVED ROAD
- FIELD ROAD
- FENCE
- STREAM
- BENCH MARK
- CLEARING
- CLEARING & GRUBBING

**"AS BUILT"**



**GENERAL NOTES:**

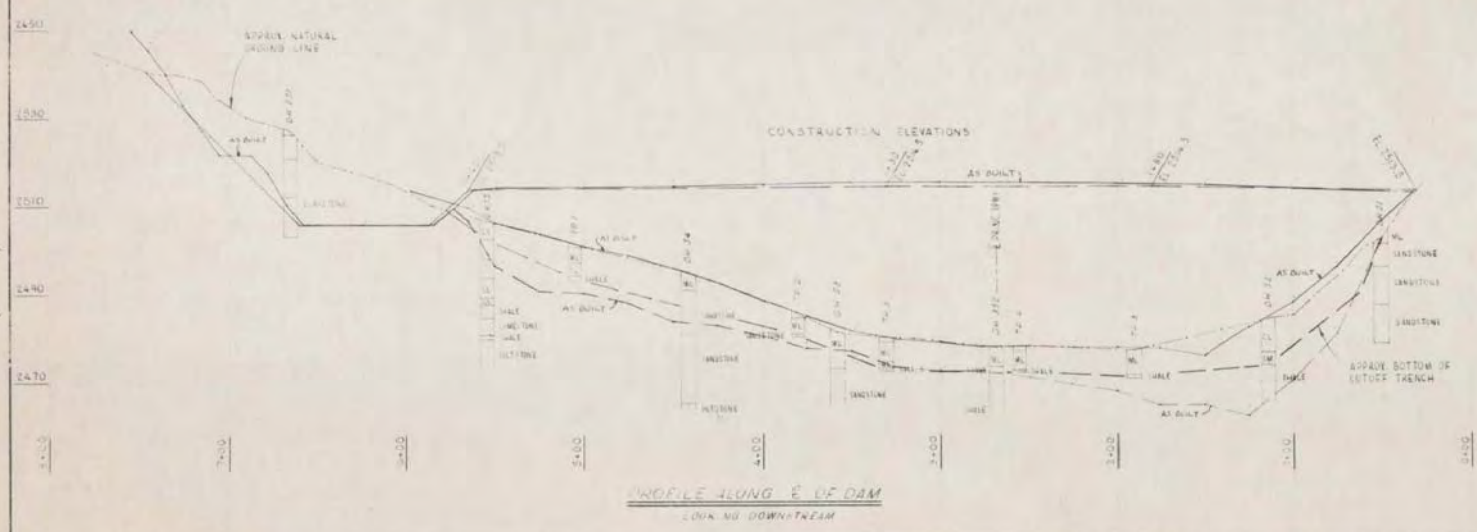
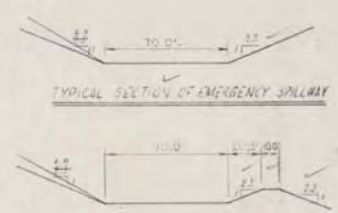
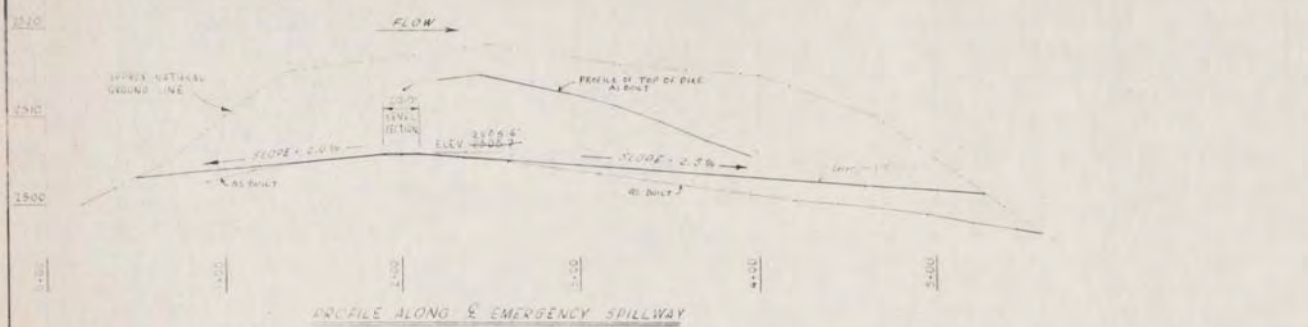
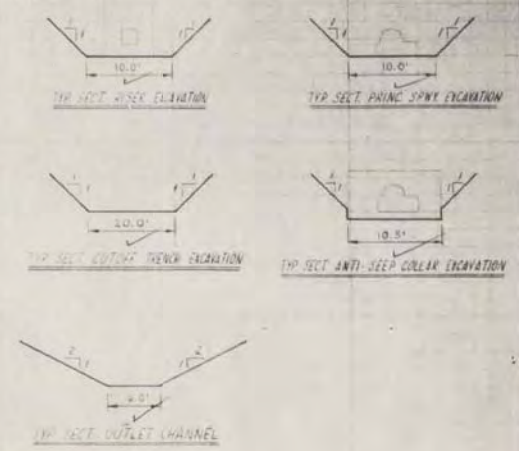
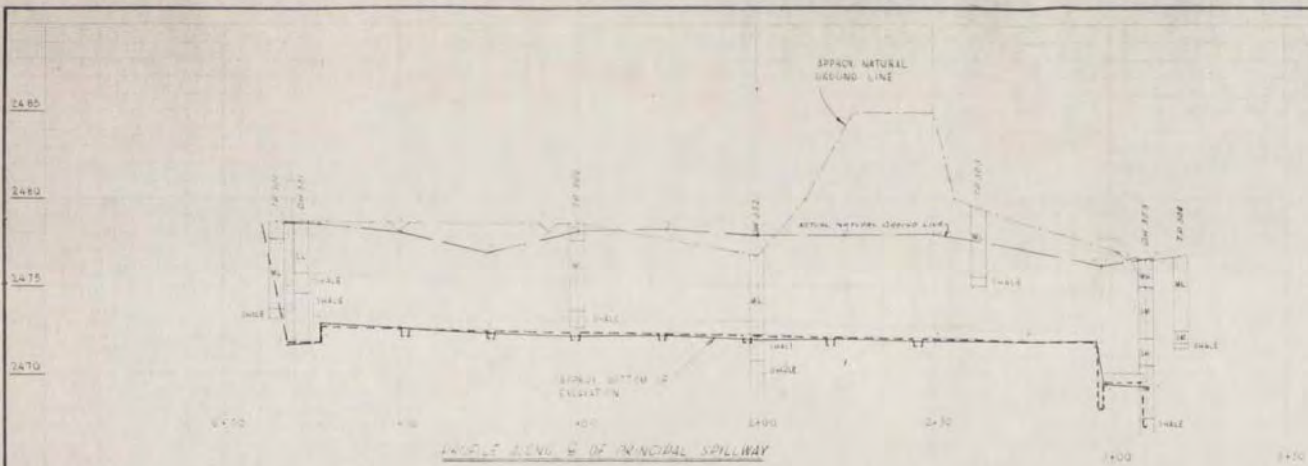
1. ALL QUANTITIES FOR ALL CLASSES TO BE CONTACTED WITH A 100 TON TRAMPING ROLLER MINIMUM DIAMETER 60".
2. ONLY BRACK TOPSOIL WILL BE HARROWED & STOCKPILED. IT WILL COME FROM UNDER THE EMBANKMENT & THOSE BORROW AREAS DESIGNATED BY THE ENGINEER. ALL OTHER SURFACE SOIL STRIPPED FROM SLOPES OR ELEVATED AREAS THAT IS NOT SUITABLE FOR PLANTING IN THE DAM SHALL BE DISPOSED OF IN ACCORDANCE WITH RESOLUTION # 1-10 OF THE EXECUTION PLAN, & NO PERMIT MADE THEREFOR.
3. TOPSOIL, SEEDING & FERTILIZERS IN STRIPPING OPERATIONS SHALL BE SPREAD ON DAM, EMERGENCY SPILLWAY & OTHER AREAS AS DIRECTED BY THE ENGINEER.
4. ALL FENCES IN WORK AREA WILL BE REMOVED & MAINTAINED.
5. ALL BUILDINGS & UTILITY LINES TO BE REMOVED BY OTHERS.
6. EARS WILL BE RELOCATED BY OTHERS, NOTWITHSTANDING THE CONSTRUCTION OF THE DAM WILL BE MAINTAINED IN SUCH POSITION THAT TRAFFIC WILL BE UNHINDERED THROUGH THE ENTIRE CONTRACT.
7. BORROW FROM STREAM THAN THE PERMANENT POOL WILL BE LEFT IN SUCH WAY THROUGH THAT NORMAL FLOODFLOW WILL BE CONFINED TO A DEFINITE CHANNEL.
8. AREAS BELOW PERMANENT POOL ELEVATION WHICH ARE USED FOR BORROW ARE TO BE RECLAIMED AND HARROWED AND AREAS NOT USED FOR BORROW WILL BE CLEARER ONLY.

**NOTE:**

1. ALL LAND RIGHT INSTRUMENTS ARE TO BE HELD BY THE GREEN VALLEY-CLERKWOOD PUBLIC SERVICE DISTRICT.
2. SEE SHEET 6 FOR LAYOUT OF DAM AND SPILLWAYS.
3. TOE OF SLOPES ARE TO BE LOCATED BY GROUND STAKING FROM ELEV. 2513.5

**BRUSH CREEK WATERSHED PROJECT  
MULTIPLE PURPOSE DAM NO. 9  
BLUEFIELD, MERCER CO., WEST VIRGINIA  
PLAN OF DAMSITE & STORAGE AREAS  
U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE**

Designed by	Checked by
KESSEL	6-51
Drawn by	Scale
C. DAVIS	1" = 40.50'
Project No.	Sheet No.
1-244-1095	4-22-39
Project Name	Date
	10/63
	11
	WV-456-P

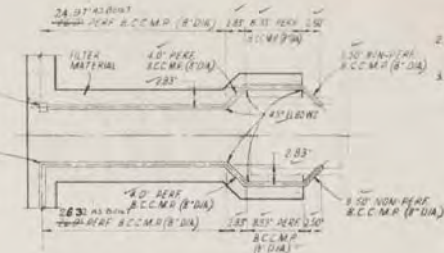
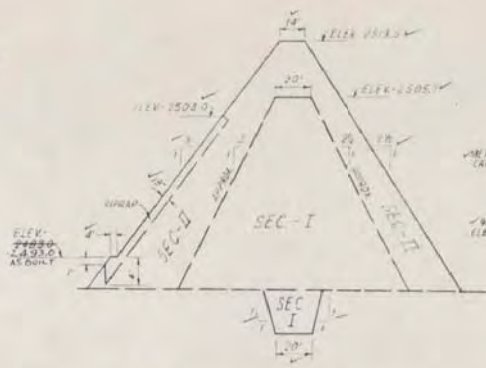
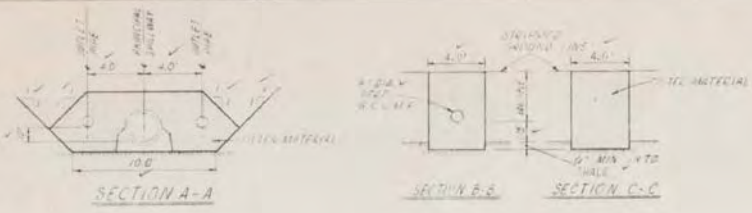


**"AS BUILT"**

BRUSH CREEK WATERSHED PROJECT  
 MULTIPLE PURPOSE DAM NO 9  
 BLUEFIELD, MERCER CO, WEST VIRGINIA  
 PROFILES

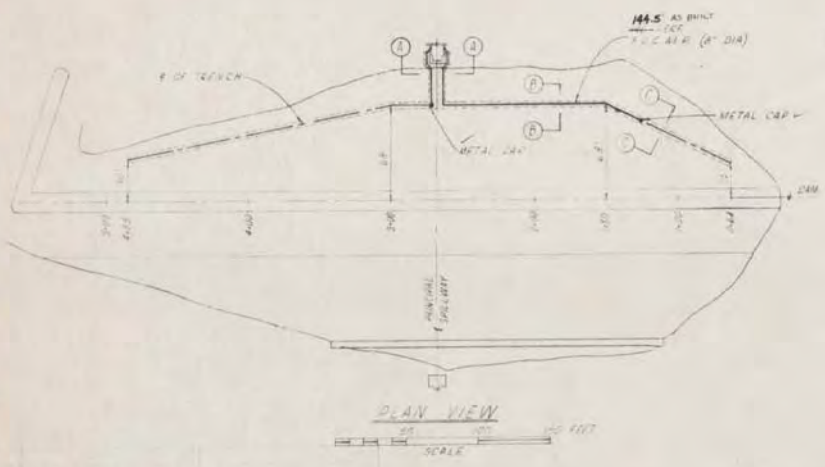
U. S. DEPARTMENT OF AGRICULTURE  
 SOIL CONSERVATION SERVICE

DESIGNED BY KESSEL	DATE JULY 19	APPROVED BY S. C. ROSSER	DATE 9/63
SHEET NO. 7		PROJECT NO. WV-466-P	



**NOTES:**

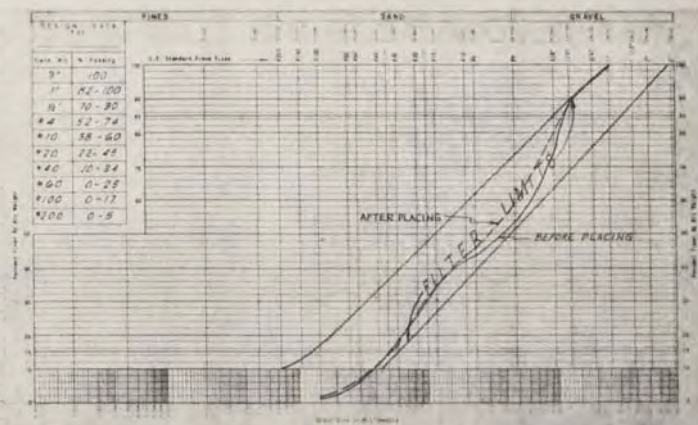
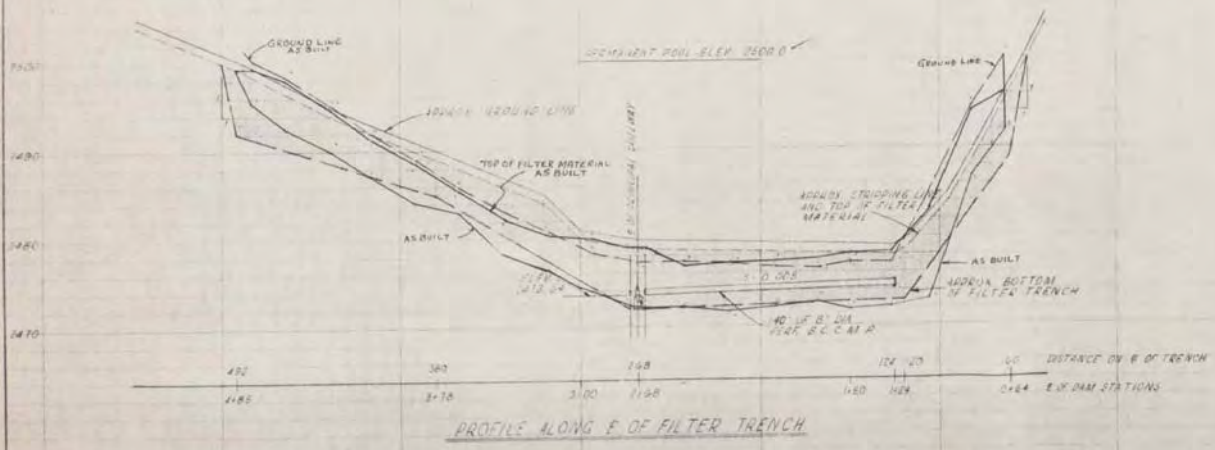
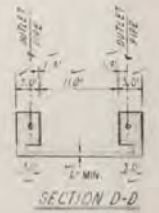
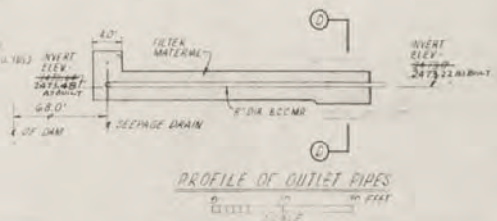
1. THE SEEPAGE DRAIN PIPES BEING A NON-REF. SHALL BE 8" DIA. ANNUAR OR SPIRAL IN GAGE SITUATIONS COATED CORRUGATED METAL PIPE WITH STD. COUPLING BANDS.
2. ALL PEAK PIPE SHALL BE LAID WITH 3/4" DIA. REINFORCATIONS ON LOWER SIDE.
3. ALL SEEPAGE DRAIN PIPES SHALL BE SURROUNDED BY A MIN. OF 1.0' OF FILTER MATERIAL.



**SECTION I**  
COMPACTED FILL CLASS 70-1 CLAY (C) REPRESENTED BY THE LOG. UP TO 101 FROM 2' TO 5' AND TO 102 FROM 5' TO 21' (APPROX. 34,000 C.F.T.S.)

**SECTION II**  
COMPACTED FILL LEAS C' (CLAY) MATERIAL (C) TO THE 101' ELEVATION. (APPROX. 18,000 C.F.T.S.)

**TYPICAL SECTION OF DAM**  
1/2" TO SCALE

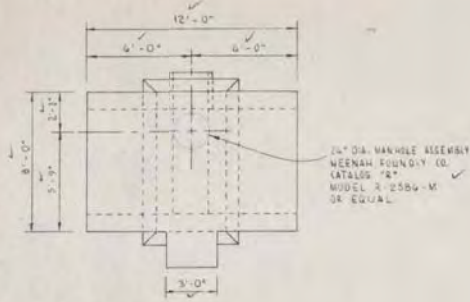


# "AS BUILT"

BRUSH CREEK WATERSHED PROJECT  
MULTIPLE PURPOSE DAM NO 9  
BLUEFIELD, MERCER CO., WEST VIRGINIA  
SEEPAGE DRAIN DETAILS  
U. S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

Drawn by <b>S. G. K. ...</b>	Checked by <b>FORD, ...</b>	Approved by <b>...</b>
Date <b>...</b>	Scale <b>...</b>	Sheet No. <b>...</b>
Project No. <b>...</b>		Project Name <b>...</b>

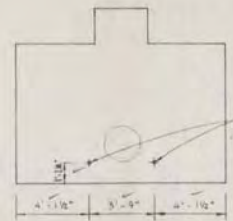




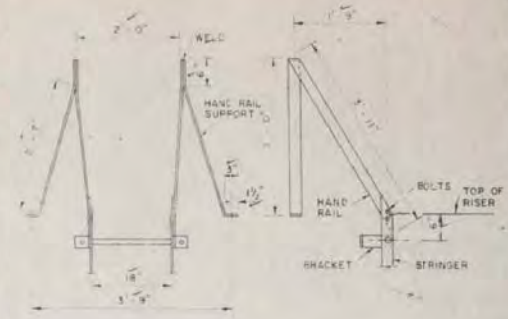
PLAN

**SLUICE GATE NOTES**

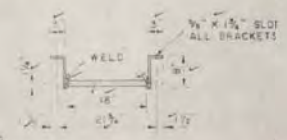
1. 18" SQUARE SLUICE GATE RODNEY HUNT 240 STAGES OR APPROVED EQUAL.
2. FLAT FRAME
3. 1" TYPE WALL THIMBLE 20" LONG
4. HEATING HEAD = 33 FT.
5. UNSEATING HEAD = 0
6. OPERATING HEAD = 33 FT.
7. RISING STEM THREADED PORTION BRONZE
8. STEM STEM GUIDES & LIFTING DEVICE SIZED & SPACED ACCORDING TO MANUFACTURER'S RECOMMENDATIONS.



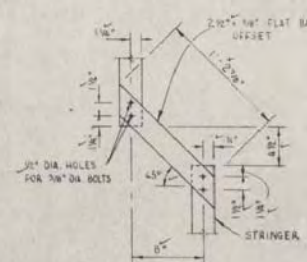
PLAN OF TOP SLAB  
SHOWING ANCHOR BOLT PLACEMENT



DETAIL I



DETAIL II

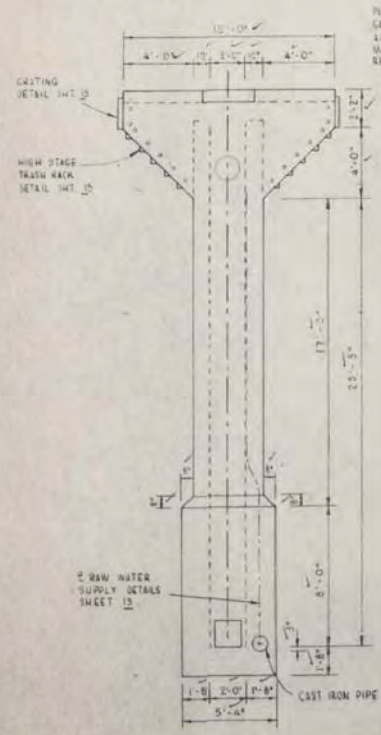


DETAIL III

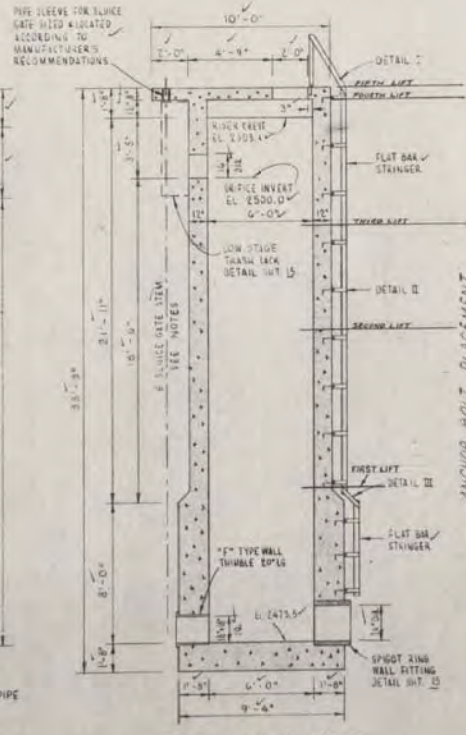


STRINGER SPLICE

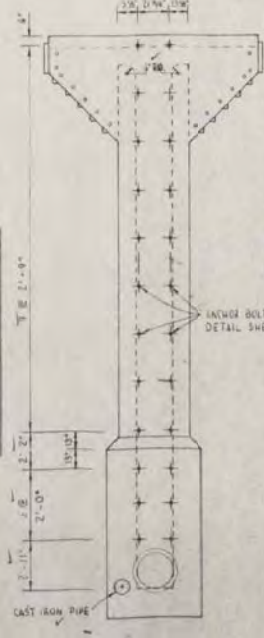
LADDER DETAILS  
NOT TO SCALE



UPSTREAM ELEV.



SECTION ALONG CENTERLINE



DOWNSTREAM ELEV.

**BILL OF MATERIAL FOR LADDER**

ITEM	SIZE	LENGTH	QUAN.
FLAT BAR HAND RAIL	2 1/2" x 3/4"	3'-11"	2
FLAT BAR HAND RAIL SUPPORT	2 1/2" x 3/4"	3'-4"	2
BOLTS NUTS & WASHERS	3/4" DIA.	2 1/2"	11
BRACKETS	2 1/2" x 3/4"	3" x 8"	24
PIPE RUNGS	1" DIA.	1'-6"	22
ANCHOR BOLTS	3/4" DIA.	2" x 8"	26
FLAT BAR STRINGER	2 1/2" x 3/4"	22'-11"	2
FLAT BAR STRINGER	2 1/2" x 3/4"	5'-0"	2
STRINGER OFFSET	2 1/2" x 3/4"	1'-1"	2

**"AS BUILT"**

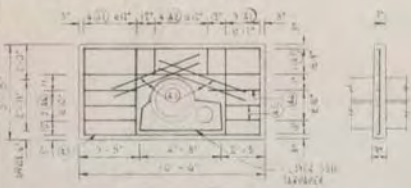
BRUSH CREEK WATERSHED PROJECT  
MULTIPLE PURPOSE DAM NO. 9  
BLUEFIELD, MERCER CO., WEST VIRGINIA  
RISER STRUCTURAL DETAILS

U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

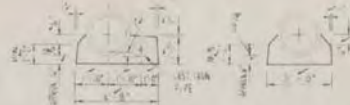
Designed by: *W. L. ...* Date: *JULY 45*  
 Checked by: *H.T. BROWNING JR.*  
 Title: *...*  
 Project: *...*  
 No. *12* of *16* sheets  
 Drawing No. **WV-466-P**



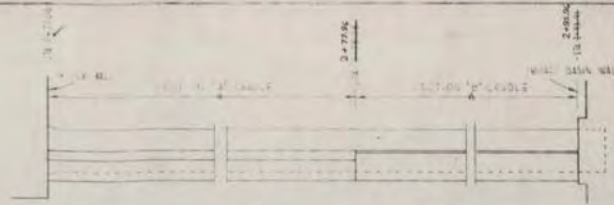
RECOMMENDED JOINT COLLAR FOR THIS SLAB SHALL BE WITH 2" x 4" x 1/4" IN B.W.A. PLACED BETWEEN SIDES OF COLLAR, ONE A COLLAR.



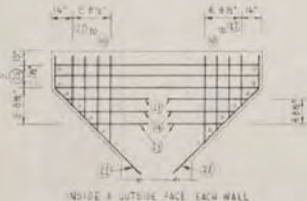
DETAILS REIN. CONC. ANTI-SHEAR COLLAR 7-1529



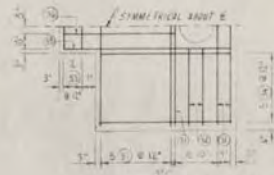
SECTION 'A' CRADLE SECTION 'B' CRADLE



DETAILS CONCRETE CRADLE



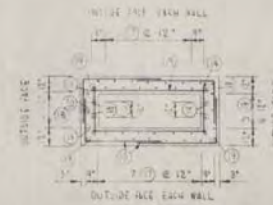
STEEL DETAILS TOP SLAB SUPPORT



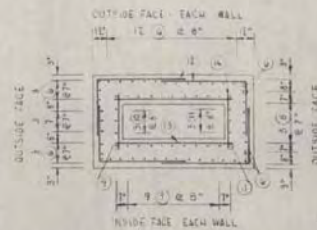
STEEL DETAILS TOP SLAB



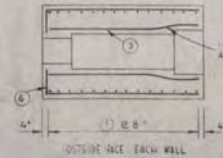
MIDDLE STEEL



SECTION FF



SECTION EE



SECTION DD

AS BUILT NOTE  
ALL REIN. STEEL WAS PLACED EXACTLY AS SHOWN ON PLANS

STEEL SCHEDULE									
NO.	LOCATION	QUANTITY	UNIT	WEIGHT	CLASS	TYPE	DIAM.	LENGTH	TOTAL WEIGHT
1	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
2	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
3	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
4	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
5	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
6	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
7	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
8	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
9	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
10	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
11	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
12	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
13	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
14	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
15	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
16	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
17	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
18	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
19	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
20	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
21	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
22	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
23	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
24	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
25	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
26	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
27	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
28	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
29	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
30	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
31	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
32	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
33	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
34	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
35	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
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38	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
39	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
40	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
41	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
42	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
43	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
44	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
45	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
46	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
47	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
48	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
49	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
50	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
51	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
52	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
53	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
54	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
55	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
56	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
57	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
58	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
59	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
60	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
61	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
62	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
63	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
64	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
65	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
66	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
67	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
68	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
69	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
70	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
71	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
72	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
73	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
74	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
75	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
76	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
77	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
78	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
79	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
80	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
81	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
82	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
83	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
84	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
85	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
86	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
87	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
88	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
89	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
90	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
91	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
92	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
93	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
94	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
95	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
96	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
97	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
98	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
99	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0
100	WALL	10	LB	10.0	1	A	1/2"	10.0	10.0

NOTE: STEEL SCHEDULE INCLUDES EXTRA BARS IF KIDDER IS LENGTHENED TO MARK 1 TO MARK 3.  
STEEL QUAN - THIS SHOWN ONLY - CONCRETE QUAN.

TOTAL QUANTITIES FOR PROJECT			
STEEL QUAN	CONCRETE QUAN		
NO. BARS 10398	UNIT 684.6	LB	CLASS 'B' TYPE I, 570 40 W8
NO. BARS 33367	UNIT 918.7	LB	CLASS 'B' TYPE II, 570 40 W8
TOTAL	16035	LB	CLASS 'B' TYPE II, 570 40 W8

- GENERAL NOTES:
- ALL CONCRETE SHALL BE CLASS 'B' & UP OF THE TYPE NOTED.
  - PORTLAND CEMENT TYPE IA OR TYPE I WITH AN ENTRAINING ADMIXTURE SHALL BE USED.
  - ALL REIN. STEEL TO BE LAPPED 3 DIA. OF 30 BAR DIA.
  - ALL REIN. STEEL PLACED IN CONCRETE Poured AGAINST THE GROUND SHALL HAVE 2 DIA. OF 3" CLEAR COVER. WHEAR FORMS ARE USED BARS SHALL HAVE A MIN. OF 1" CLEAR COVER.
  - ALL EXPOSED EDGES OF CONCRETE TO HAVE A 3/4" CHAMFER UNLESS OTHERWISE NOTED.

**"AS BUILT"**  
SCALE

BRUSH CREEK WATERSHED PROJECT  
MULTIPLE PURPOSE DAM NO. 9  
BLUEFIELD, MERCER CO, WEST VIRGINIA  
RISER-CRADLE & COLLAR DETAILS  
U.S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

Drawn by H.L. BROWNING, JR.	Checked by A.R. 93
Date 1-16	Project WV-466 -P



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Appendix B  
Site Inspection Checklist and Photos

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**WATERSHED** Brush Creek  
**COUNTY** Mercer  
**OWNER** \_\_\_\_\_  
**ADDRESS** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**SITE NUMBER** 9  
**NID #** 05507      **HAZARD CLASS** C  
**PURPOSE OF DAM** Flood Control, Water Supply  
**INSPECTION DATE** 10/18/10; 10/19/10  
**WEATHER** Sunny, 55° F; Sunny, 65° F

ITEM	Y	N	N/A	REMARKS
<b>1. General Conditions</b>				
a. Alterations to dam?		X		
b. Grass cover adequate?		X		Unvegetated, eroded areas due to wave erosion
c. Settlements, misalignments or cracks?		X		
d. Vehicle ruts or animal trails?	X			Trail near pool level.
e. Fencing adequate?			X	
f. Recent high water marks?		X		elevation
g. Development in flood pool?		X		
h. Development in downstream floodplain?	X			Town of Maple View, WV immediately downstream of dam.
i. Development in upstream watershed?	X			Residential development
<b>2. Upstream Slope</b>				
a. Erosion?	X			Bare earth trails and areas of wave erosion near pool level. Significant sloughing occurring due to wave erosion.
b. Trees?		X		Woody vegetation growing within riprap was recently cut; stumps of woody vegetation remain.
c. Rodent holes?		X		
d. Cracks, settlements or bulges?		X		
e. Adequate and sound riprap?		X		Area near pool level could be armored.
<b>3. Downstream Slope</b>				
a. Erosion?		X		
b. Trees?		X		
c. Rodent holes?		X		
d. Cracks, settlements, & bulges?		X		
e. Drains or wells flowing?	X			estimated gpm Both drains flowing at greater than 1/2 gpm.
f. Seepage or boils?	X			estimated gpm Wet areas observed below toe on both left and right sides of stilling basin.
<b>4. Intake Structure</b> concrete <input checked="" type="checkbox"/> metal				water surface elevation
a. Spalling, cracking, & scaling?				None observed. Interior not accessed.
b. Exposed reinforcement?				None observed. Interior not accessed.
c. Corrosion present?	X			Corrosion of ladder and trash racks on lower portion of riser structure.
d. Manhole cover?	X			
e. Leakage?				estimated gpm None observed. Interior not accessed.
f. Trash rack adequate?	X			
g. Inlet obstructed?		X		
h. Drawdown operative? closed ___ open ___				Not accessed. Unknown.
i. Ladder intact?		X		Missing bottom rungs.
j. Pedestal securely fastened?				Not accessed. Unknown.
k. Floodgates operational?				Not accessed. Unknown.
l. Stem bent?				Visible portion not bent.
m. Stem guides operational?				Not accessed. Unknown.
n. Stem handwheel present?	X			
o. Do metal parts require painting?	X			Lower portion only.
<b>5. Abutment Contacts</b>				
a. Erosion, cracks, or slides?		X		
b. Seepage?		X		
c. Gutters intact?	X			
<b>6. Auxiliary Spillway</b>				
a. Obstructions?	X			Minor obstructions (trash cans, fence posts)
b. Erosion?	X			Bare area on outslope of spillway; wave erosion on entrance slope.
c. Rodent holes?		X		
d. Low areas?		X		
e. Slips?		X		

ITEM	Y	N	N/A	REMARKS
<b>7. Conduit &amp; Outlet</b> concrete <input checked="" type="checkbox"/> metal				tailwater elevation/flow
a. Spalling, cracking, & scaling?				None observed. See Note 1.
b. Exposed reinforcement?				None observed. See Note 1.
c. Joints displaced or offset?				None observed. See Note 1.
d. Joint material lost?				None observed. See Note 1.
e. Leakage?				None observed. See Note 1.
f. Earth erosion?				None observed. See Note 1.
g. Conduit misaligned?				Not observed. See Note 1.
h. Outlet channel obstructed?		<input checked="" type="checkbox"/>		Sediment and vegetation clogging outlet channel; backwater extends over endsill and nearly
<b>8. Stilling Basin</b> <input checked="" type="checkbox"/> Plunge Pool				submerges the invert of the outlet conduit.
a. Spalling, cracking, & scaling?		<input checked="" type="checkbox"/>		
b. Exposed reinforcement?		<input checked="" type="checkbox"/>		
c. Joints displaced or offset?		<input checked="" type="checkbox"/>		
d. Joint material lost?		<input checked="" type="checkbox"/>		
e. Joints leak?		<input checked="" type="checkbox"/>		
f. Rock adequate?			<input checked="" type="checkbox"/>	
g. Dissipater deteriorating?		<input checked="" type="checkbox"/>		
h. Dissipater clean of debris?		<input checked="" type="checkbox"/>		
i. Toe drains visible?		<input checked="" type="checkbox"/>		
j. Toe drains flowing?		<input checked="" type="checkbox"/>		Both drains flowing at greater than 1/2 gpm.
k. Toe drain animal guards in place?		<input checked="" type="checkbox"/>		
<b>9. Reservoir</b>				
a. Buildings in floodpool?		<input checked="" type="checkbox"/>		
b. Slides or erosion on banks?		<input checked="" type="checkbox"/>		
c. Debris?		<input checked="" type="checkbox"/>		
d. Unsecured boats/docks?		<input checked="" type="checkbox"/>		
e. Sediment deposits?		<input checked="" type="checkbox"/>		
<b>10. Instruments</b>				
a. Structure instrumented?		<input checked="" type="checkbox"/>		
b. Monitoring performed?			<input checked="" type="checkbox"/>	
<b>11. Development</b>				
a. New development upstream of dam?		<input checked="" type="checkbox"/>		
b. New development downstream of dam?		<input checked="" type="checkbox"/>		Since dam was constructed.
c. EAP plan and mapping adequate?				To be determined by others.
<b>12. Hazard Classification Correct?</b>	<input checked="" type="checkbox"/>			

- REMARKS:**
- Bare earth trails, areas of wave erosion, and sloughing was observed near pool level on the upstream slope.
  - Wet areas were observed below the toe on both the left and right sides of the stilling basin.
  - Corrosion of ladder and trash racks occurring on the lower portion of the riser structure.
  - Ladder on the riser structure is missing bottom rungs.
  - Minor obstructions were observed within the auxiliary spillway (trash cans, fence posts).
  - There is a bare area on the outslope and wave erosion on entrance slope of the auxiliary spillway.
  - Sediment and vegetation are clogging outlet channel; backwater extends over endsill and nearly submerges the invert of the outlet conduit.
  - Woody vegetation growing within riprap on upstream slope was recently cut; stumps of woody vegetation remain.

Note 1: The conduit and outlet were inspected from the downstream end. A comprehensive inspection of the conduit has not been performed as part of this inspection.

ENGINEER Paul Schweiger

DATE 12/27/2010

SIGNATURE Paul Schweiger  
Engineer

PROFESSIONAL ENGINEER SEAL

## GENERAL



1. General overview of dam from left side of auxiliary spillway.



2. Principal spillway riser structure.

**GENERAL**



3. Upstream embankment slope.



4. Downstream embankment slope.

GENERAL



5. Stilling basin.



6. Outlet conduit.

**OBSERVED DEFICIENCIES**



7. Wet areas on both left and right side of stilling basin.



8. Backwater from outlet channel submerging the endsill and conduit outlet invert.

## OBSERVED DEFICIENCIES



9. Erosion of entrance slope of the auxiliary spillway.



10. Bottom rungs missing on riser structure ladder.

**OBSERVED DEFICIENCIES**



11. Bare earth trail, wave erosion, and sloughs near pool level on upstream slope.



12. Bare earth trail, wave erosion, and sloughs near pool level on upstream slope.

## OBSERVED DEFICIENCIES



13. Woody vegetation growing within riprap on upstream slope was recently cut; stumps of woody vegetation remain.



14. Unvegetated area on outslope of auxiliary spillway.

**OBSERVED DEFICIENCIES**



15. Left CMP drain.



16. Right CMP drain.



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Appendix C  
SITES Output

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## SITES Output

Brush Creek Site 9 – ASW Crest Criteria

---

# Brush Creek Site 9 – ASW Crest Criteria

```

1*****
SITES XEQ 02/11/2011  WATER RESOURCE SITE ANALYSIS COMPUTER PROGRAM
      VER 2005.1.04      (USER MANUAL - DATED DECEMBER 2005)
      TIME 07:51:26
  
```

\*\*\*\*\* 80-80 LIST OF INPUT DATA \*\*\*\*\*

```

SITES      01/01/2005BC9      Brush Creek Site 9      0.925      A1
SAVMOV     0      101
SAVMOV     101  1
STRUCTURE  9
           2478
           2480
           2485
           2490
           2495
           2500
           2505
           2510
           2515
           2530
           0
           1
           18
           60
           136
           253.5
           412.5
           610.5
           849.5
           1600

ENDTABLE
WSDATA     2C  9      80      0.925      1.58      7.5
BASEFLOW   1.12
PDIRECT    1.42      4.84      7.68
POOLDATA   ELEV      2500
PSINLET    ELEV      0.75      12      2503.4      1.18      1.18      TC
PSDATA     1      220      24      0.013      2473.5
GRAPHICS   I
GO,DESIGN  LN
SAVMOV     2      101  1      9
ENDJOB
  
```

\*\*\*\*\*

```

1SITES -----
XEQ 02/11/2011      Brush Creek Site 9      WSID= BC9
VER 2005.1.04      SUBW= 9
TIME 07:51:26      SITE = 9      PASS= 1      PART= 1
  
```

\*\*\*\*\* BASIC DATA \*\*\*\*\*

```

HUMID- SUBHUMID CLIMATE AREA      DESIGN CLASS  C

STORM DISTRIBUTION PSH..10 DAY NRCS DESIGN STORM (CHAPTER 21, NEH4 & TR-60).
  
```

STORM DISTRIBUTION USED FOR AUXILIARY SPILLWAY IS;  
NRCS DESIGN STORM RAINFALL DISTRIBUTION (CHAPTER 21, NEH4 & TR-60).

PRECIP. - P-PS,1-DAY	P-PS,10-DAY	Q-SD	Q-FB	
4.84	7.68	0.00	0.00	
WSDATA - CN	DA-SM	TC/L	-/H	QRF
80.00	0.93	1.58	0.00	7.50
SITEDATA- PERM POOL	CREST PS	FP SED	VALLEY FL	378?
0.00	2500.00	2500.00	0.00	NO
BASEFLOW	INITIAL EL	EXTRA VOL	SITE TYPE	
1.12	0.00	0.00	DESIGN	
PSDATA - NO. COND	COND L	DIA/W	-/H	
1.00	220.00	24.00	0.00	
PS N	KE	WEIR L	TW EL	
0.013	0.75	12.00	2473.50	

## Brush Creek Site 9 – ASW Crest Criteria

	2ND STG	ORF H	ORF L	START AUX.	
	2503.40	1.18	1.18	0.00	
ASCRESTS -	AUX.1	AUX.2	AUX.3	AUX.4	AUX.5
	0.00	0.00	0.00	0.00	0.00
AUX.DATA -	REF.NO.	RETARD. Ci	TIE STATION	INLET LENGTH	
	0	0.00	0.00	0	
AUX.DATA -	INLET N	SIDE SLOPE	EXIT N	EXIT SLOPE	ACTUAL AUX?
	0.000	0.00	0.000	0.000	NO
BTM WIDTH -	BW1	BW2	BW3	BW4	BW5
	0.00	0.00	0.00	0.00	0.00

1SITES -----

XEQ 02/11/2011	Brush Creek Site 9	WSID= BC9
VER 2005.1.04		SUBW= 9
TIME 07:51:26	SITE = 9	PASS= 1 PART= 2

CREST PS	2500.00 FT	253.5 ACFT	0.00 AC	0.0 CFS
SED ACCUM	2500.00 FT	253.5 ACFT	0.00 AC	0.0 CFS
BASEFLOW	2500.43 FT	267.1 ACFT	0.00 AC	1.0 CFS
2ND STAGE	2503.40 FT	361.6 ACFT	0.00 AC	11.2 CFS
START ELEV	2500.43 FT	267.1 ACFT	0.00 AC	1.0 CFS

NRCS-PSH RAINFALL	1-DAY =	4.84 IN	10-DAY =	7.68 IN	DA =	0.93 SM
RUNOFF	1-DAY =	2.75 IN	10-DAY =	3.64 IN		
CLIMATIC INDEX = 1.42		CN 10-DAY = 65.	CN 1-DAY = 80.			
QRF =	6.94 CFS	2501.67 FEET,	GIVEN VALUE.			
PEAK =	748.9 CFS, AT 120.5 HRS.					

ROUTED RESULT - HYD TYPE	EMAX	VOL-MAX	AMAX	QMAX
NRCS-PSH	2504.42 FT	394.1 ACFT	0.00 AC	52.1 CFS

PS STORAGE 140.6 ACFT, BETWEEN AUX. CREST AND SED. ACCUM ELEVATIONS.

DRAWDOWN (DDT) TEST	2501.67 FT	306.7 ACFT	6.94 CFS
CONTROL IS 1.000 BASEFLOW OR QRF			

TIME LIMIT REACHED = 10.00 DAYS. FLOW WAS 8.04 CFS, ELEV = 2502.07  
(ELEVATION TO START ROUTING SDH AND/OR FBH HAS BEEN RAISED.)

TIME TO DDT TEST DISCHARGE IS 28.92 DAYS - DRAWDOWN STOPPED.

\*\*\*\*\* NOTE - CREST OF AUX. RAISED TO HOLD 52.14 ACFT NOT EVACUATED IN  
DRAWDOWN TIME LIMIT. TOTAL STORAGE REQUIRED = 446.23 ACFT,  
NEW ELEVATION OF AUXILIARY SPILLWAY CREST = 2505.85 FT.

\*\*\*\*\*  
RATING TABLE DEVELOPED, SITE = 9 :  
WITH PS DEVELOPED BY PROGRAM AND NO AUX. DATA GIVEN.

RATING TABLE NUMBER	1				
ELEV.	Q-TOTAL	Q-PS	Q-AUX.	VOLUME	AREA
FEET	CFS	CFS	CFS	AC-FT	ACRE
1	2500.00	0.00	0.00	253.50	0.00

## Brush Creek Site 9 – ASW Crest Criteria

2	2500.23	0.40	0.40	0.00	260.78	0.00
3	2500.46	1.13	1.13	0.00	268.06	0.00
TRANSITION TO ORIFICE FLOW, ELEV = 2500.69 FT						
4	2500.69	2.08	2.08	0.00	275.35	0.00
5	2501.59	6.71	6.71	0.00	304.11	0.00
6	2502.50	9.25	9.25	0.00	332.87	0.00
7	2503.40	11.23	11.23	0.00	361.62	0.00
8	2503.82	22.22	22.22	0.00	375.02	0.00
9	2504.24	41.59	41.59	0.00	388.42	0.00
FULL CONDUIT FLOW, ELEV = 2504.66 FT						
10	2504.66	66.40	66.40	0.00	401.82	0.00
11	2513.11	74.92	74.92	0.00	759.13	0.00
12	2521.55	82.53	82.53	0.00	1177.45	0.00
13	2530.00	89.48	89.48	0.00	1600.00	0.00

```

1SITES -----
XEQ 02/11/2011           Brush Creek Site 9           WSID= BC9
VER 2005.1.04           SUBW= 9
TIME 07:51:26           SITE = 9           PASS= 1           PART= 3
  
```

```

AUX. CREST      2505.85 FT      446.2 ACFT      0.00 AC      67.5 CFS

  PS STORAGE    192.7 ACFT, BETWEEN AUX. CREST AND SED. ACCUM ELEVATIONS.

START ELEV      2502.07 FT      319.2 ACFT      0.00 AC      8.0 CFS

ELEVATION OF LOW POINT IS ZERO. NO CRITERIA CHECK MADE FOR
STRUCTURE CLASSIFICATION.
  
```

```

***** MESSAGE - NO INPUT DATA GIVEN FOR AUXILIARY SPILLWAY CREST AND/OR
                  BOTTOM WIDTH. NO AUXILIARY SPILLWAY ROUTINGS PERFORMED.
  
```

```

-----
Inflow Hyd 1 PSH-Peak =          52.08 CFS at 123.30 hrs., Location Point
HYDOUT 1 9
  
```

```

1SITES....JOB NO. 1 COMPLETE.
-----
  
```

```

BC9           Brush Creek Site 9

0 SUBWATERSHED(S) ANALYZED.

1 STRUCTURE(S) ANALYZED.

1 HYDROGRAPHS ROUTED AT LOWEST SITE.

0 TRIALS TO OBTAIN BOTTOM WIDTH FOR SPECIFIED STRESS OR VELOCITY.
  
```

```

*****
  
```





---

## SITES Output

Brush Creek Site 9 – Top of Dam (6-hr)

---







## Brush Creek Site 9 – Top of Dam (6-hr)

	STA (ft)	STA (ft)	CURVE (%)	CURVE INDEX@	COVER FACTOR	CODE	DEPTH (ft)	LOCATION *
1	-180.	-125.	-8.2	0.035	**	**	**	INLET
2	-125.	-10.	-1.0	0.035	**	**	**	INLET
3	-10.	10.	0.0	0.035	**	**	**	CREST
4	10.	315.	1.9	0.035	0.50	1	1.0	EXIT !

@ The program interprets retardance curve index entries of less than 1 as Manning's n values.

\* Upper case indicates a reach of constructed spillway channel.

\*\* The program does not use vegetal cover factor, maintenance code, and rooting depth for inlet and crest reaches in computations.

! Reach 4 used in computing exit channel velocities.

\*\*\*\*\*

ROUTED RESULTS	BTM WIDTH FT	MAX ELEV FT	VOL-MAX ACFT	AREA-MAX AC	AUX.-HP FT	VOL-AUX. ACFT
NRCS-SDH	70.0	2508.09	534.9	0.0	2.39	94.7

PEAK - CFS                      Q-PS                      Q-AUX.                      Q-TOT.  
DISCHARGE =                      70.0                      645.0                      715.0

	CRITICAL DEPTH FT	CRITICAL VELOCITY FT/SEC	CRITICAL SLOPE-Sc FT/FT	25% OF Q Sc FT/FT
AUXILIARY SPILLWAY ---	1.36	6.47	0.017	0.022

AUXILIARY SPILLWAY DURATION FLOW =                      8.9 HOURS

EXIT CHANNEL FLOW SUPERCRITICAL: MAX VELOCITY=    6.7 FT/SEC  
EXIT SLOPE = 0.019 FT/FT  
FLOW DEPTH = 1.3 FT

\*\*\*\*\*

EROSIONALLY EFFECTIVE STRESS FOR STABILITY ANALYSIS OF AUX. EXIT CHANNEL  
(Refer to Ag. Handbook 667, Chapt. 3, for allowable stresses.)

Aux. Spillway Discharge =    645. cfs;    Bottom Width =    70. ft

REACH NO.	FROM STA	TO STA	SLOPE %	MANNING'S n	VELOCITY ft/s	TOTAL STRESS lb/ft^2	EFFECTIVE STRESS lb/ft^2
4	10.	315.	1.87	0.035	6.72	1.53	0.190

\*\*\*\*\*

ROUTED RESULTS	BTM WIDTH FT	MAX ELEV FT	VOL-MAX ACFT	AREA-MAX AC	AUX.-HP FT	VOL-AUX. ACFT
NRCS-FBH	70.0	2512.90	749.3	0.0	7.20	309.1

PEAK - CFS                      Q-PS                      Q-AUX.                      Q-TOT.  
DISCHARGE =                      75.                      4301.                      4375.

	CRITICAL DEPTH FT	CRITICAL VELOCITY FT/SEC	CRITICAL SLOPE-Sc FT/FT	25% OF Q Sc FT/FT
AUXILIARY SPILLWAY ---	4.62	11.42	0.011	0.015

AUXILIARY SPILLWAY DURATION FLOW =                      10.8 HOURS  
ATTACK, OE/B =                      15.6 ACFT/FT

EXIT CHANNEL FLOW SUPERCRITICAL: MAX VELOCITY=    13.4 FT/SEC  
EXIT SLOPE = 0.019 FT/FT  
FLOW DEPTH = 4.0 FT

Inflow Hyd 1 SDH-Peak =                      714.97 CFS    at    5.18 hrs.,    Location Point

Inflow Hyd 1 FBH-Peak =                      4375.41 CFS    at    3.96 hrs.,    Location Point  
HYDOUT    1                      9

1SITES....JOB NO. 1 COMPLETE.





---

## SITES Output

Brush Creek Site 9 – Top of Dam (24-hr)

---

# Brush Creek Site 9 – Top of Dam (24-hr)

```

1*****
SITES XEQ 02/11/2011  WATER RESOURCE SITE ANALYSIS COMPUTER PROGRAM
VER 2005.1.04          (USER MANUAL - DATED DECEMBER 2005)
TIME 07:53:05
  
```

\*\*\*\*\* 80-80 LIST OF INPUT DATA \*\*\*\*\*

```

SITES      01/01/2005BC9      Brush Creek Site 9      0.925      C2
SAVMOV     0      101
SAVMOV     101  1
STRUCTURE  9

          2478      0
          2480      1
          2485      18
          2490      60
          2495      136
          2500      253.5
          2505      412.5
          2510      610.5
          2515      849.5
          2530      1600

ENDTABLE
WSDATA     2C  9      80      0.925      1.58
BASEFLOW
RAINTABLE  9
          0      0.008      0.0162      0.0246      0.0333
          0.0425      0.0524      0.063      0.0743      0.0863
          0.099      0.1124      0.1265      0.142      0.1595
          0.18      0.205      0.255      0.345      0.437
          0.53      0.603      0.633      0.66      0.684
          0.705      0.724      0.742      0.759      0.775
          0.79      0.8043      0.818      0.8312      0.8439
          0.8561      0.8678      0.879      0.8898      0.9002
          0.9103      0.9201      0.9297      0.9391      0.9483
          0.9573      0.9661      0.9747      0.9832      0.9916
          1

ENDTABLE
PDIRECT
POOLDATA   ELEV      2500      2500      2500      2478      2472      TC
PSINLET     ELEV      0.75      12      2503.4      1.18      1.18
PSDATA     1      220      24      0.013      2473.5
ASSPRFL    41
          -180      2500      -125      2504.5      -10      2505.7
          10      2505.7      315      2500

ENDTABLE
ASSURFACE  41      315      0.1
          -180      -125      0.035      0.5      1      1
          -125      -10      0.035      0.5      1      1
          -10      10      0.035      0.5      1      1
          10      315      0.035      0.5      1      1

ENDTABLE
ASDATA     41      2.5      2
BTMWIDTH   FEET      70
GRAPHICS   I
GO,DESIGN  HL      9      24      2502.07
SAVMOV     2      101  1      9
ENDJOB
  
```

\*\*\*\*\*

\*\*\*\*\* MESSAGE - AUXILIARY SPILLWAY CREST ELEVATION IS SET TO 2505.70  
FROM THE ASSPRFL RECORDS.

```

1SITES -----
XEQ 02/11/2011      Brush Creek Site 9      WSID= BC9
VER 2005.1.04          SUBW= 9
  
```



## Brush Creek Site 9 – Top of Dam (24-hr)

	ELEV. FEET	Q-TOTAL CFS	Q-PS CFS	Q-AUX. CFS	VOLUME AC-FT	AREA ACRE
1	2500.00	0.00	0.00	0.00	253.50	0.00
2	2500.23	0.40	0.40	0.00	260.78	0.00
3	2500.46	1.13	1.13	0.00	268.06	0.00
TRANSITION TO ORIFICE FLOW, ELEV = 2500.69 FT						
4	2500.69	2.08	2.08	0.00	275.35	0.00
5	2501.59	6.71	6.71	0.00	304.11	0.00
6	2502.50	9.25	9.25	0.00	332.87	0.00
7	2503.40	11.23	11.23	0.00	361.62	0.00
8	2503.82	22.22	22.22	0.00	375.02	0.00
9	2504.24	41.59	41.59	0.00	388.42	0.00
FULL CONDUIT FLOW, ELEV = 2504.66 FT						
10	2504.66	66.40	66.40	0.00	401.82	0.00
11	2513.11	74.92	74.92	0.00	759.13	0.00
12	2521.55	82.53	82.53	0.00	1177.45	0.00
13	2530.00	89.48	89.48	0.00	1600.00	0.00

```

1SITES -----
XEQ 02/11/2011           Brush Creek Site 9           WSID= BC9
VER 2005.1.04           SUBW= 9
TIME 07:53:05           SITE = 9           PASS= 1           PART= 3
  
```

```

AUX. CREST      2505.70 FT      440.2 ACFT      0.00 AC      67.3 CFS
  PS STORAGE    186.7 ACFT, BETWEEN AUX. CREST AND SED. ACCUM ELEVATIONS.
START ELEV      2502.07 FT      319.3 ACFT      0.00 AC      8.1 CFS
EFFECTIVE HEIGHT(H)= 27.7 FEET, PRODUCT= 12194. (H * STORAGE AT CREST AUX.).
INPUT DESIGN CLASS = C
NRCS-SDH        D= 24.00 HR      P= 13.20 IN      Q= 10.61 IN      DA= 0.93 SM
                 TC= 1.58 HR      CN= 80.00        VOL= 525.8 ACFT
  PEAK =        1207.4 CFS, AT 10.3 HRS.
NRCS-FBH        D= 24.00 HR      P= 37.00 IN      Q= 34.16 IN      DA= 0.93 SM
                 TC= 1.58 HR      CN= 80.00        VOL= 1687.7 ACFT
  PEAK =        3746.1 CFS, AT 10.2 HRS.
  
```

```

*****
RATING TABLE DEVELOPED, SITE = 9 :
BY PROGRAM FOR PS AND AUX. SPILLWAYS
AUX. RATING USED WSPVRT METHOD.
  
```

RATING TABLE NUMBER 2

	ELEV. FEET	Q-TOTAL CFS	Q-PS CFS	Q-AUX. CFS	VOLUME AC-FT	AREA ACRE
1	2500.00	0.00	0.00	0.00	253.50	0.00
2	2500.23	0.40	0.40	0.00	260.78	0.00
3	2500.46	1.13	1.13	0.00	268.06	0.00
TRANSITION TO ORIFICE FLOW, ELEV = 2500.69 FT						
4	2500.69	2.08	2.08	0.00	275.35	0.00
5	2501.59	6.71	6.71	0.00	304.11	0.00
6	2502.50	9.25	9.25	0.00	332.87	0.00
7	2503.40	11.23	11.23	0.00	361.62	0.00
8	2503.82	22.22	22.22	0.00	375.02	0.00
9	2504.24	41.59	41.59	0.00	388.42	0.00
FULL CONDUIT FLOW, ELEV = 2504.66 FT						
10	2504.66	66.40	66.40	0.00	401.82	0.00
11	2505.01	66.83	66.83	0.00	412.87	0.00
12	2505.35	67.19	67.19	0.00	426.54	0.00
13	2505.70	67.55	67.55	0.00	440.21	0.00



# Brush Creek Site 9 – Top of Dam (24-hr)

ATTACK, OE/B = 20.3 ACFT/FT

EXIT CHANNEL FLOW SUPERCRITICAL: MAX VELOCITY= 12.1 FT/SEC  
 EXIT SLOPE = 0.019 FT/FT  
 FLOW DEPTH = 3.4 FT

Inflow Hyd 1 SDH-Peak = 638.52 CFS at 11.56 hrs., Location Point  
 Inflow Hyd 1 FBH-Peak = 3306.57 CFS at 10.70 hrs., Location Point  
 HYDOUT 1 9

1SITES....JOB NO. 1 COMPLETE.

-----  
 BC9 Brush Creek Site 9  
 0 SUBWATERSHED(S) ANALYZED.  
 1 STRUCTURE(S) ANALYZED.  
 2 HYDROGRAPHS ROUTED AT LOWEST SITE.  
 0 TRIALS TO OBTAIN BOTTOM WIDTH FOR SPECIFIED STRESS OR VELOCITY.  
 \*\*\*\*\*

SITES....COMPUTATIONS COMPLETE

1 SUMMARY TABLE 1 SITES VERSION 2005.1.04  
 ----- DATED 01/01/2005

WATERSHED ID									RUN DATE	RUN TIME
-----									-----	-----
BC9									02/11/2011	07:53:05
>>>	SITE	SUBWS	SUBWS DA	CURVE	TC	TOTAL DA	TYPE	STRUC	<<<	
	ID	ID	(SQ MI)	NO.	(HRS)	(SQ MI)	DESIGN	CLASS		
	-----	-----	-----	-----	-----	-----	-----	-----		
	9	9	0.93	80.	1.58	0.93	TR60	C		
PASS	DIA./	AUX.CREST	BTM.	MAX.	MAX.	EMB.	INTEGR.*	EXIT*	TYPE	
NO.	WIDTH	ELEV	WIDTH	HP	ELEV	VOL.	DIST.	VEL.	HYD	
	(IN/FT)	(FT)	(FT)	(FT)	(FT)	(CY)	(FT)	(FT/SEC)		
	-----	-----	-----	-----	-----	-----	-----	-----		
1	24.0	2505.7	70.0	6.0	2511.7	0.	0.	12.1	NRCS-FBH	

\* INTEGRITY DIST. AND EXIT VEL. VALUES ARE BASED ON THE ROUTED HYDROGRAPH SHOWN UNDER TYPE HYD.

## Brush Creek Site 9 – Top of Dam (24-hr)

SITES.....SUMMARY TABLE 1 COMPLETED.

NRCS SITES VERSION 2005.1.04 ,01/01/2005  
BC9 FILES

INPUT = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES  
Model\BrC9\BC\_Site9\_Estimating\_TOD\_Crest\_24Hr.D2C  
OUTPUT = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES  
Model\BrC9\BC\_Site9\_Estimating\_TOD\_Crest\_24Hr.OUT  
DATED 02/11/2011 07:53:05

GRAPHICS FILES GENERATED

OPTION "L" = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES  
Model\BrC9\BC\_Site9\_Estimating\_TOD\_Crest\_24Hr.DRG DATED 02/11/2011 07:53:05

OPTION "P" = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES  
Model\BrC9\BC\_Site9\_Estimating\_TOD\_Crest\_24Hr.DHY DATED 02/11/2011 07:53:05

OPTION "E" = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES  
Model\BrC9\BC\_Site9\_Estimating\_TOD\_Crest\_24Hr.DEM DATED 02/11/2011 07:53:05



---

## SITES Output

Brush Creek Site 9 – ASW Integrity (6-hr)

---

# Brush Creek Site 9 – ASW Integrity (6-hr)

```

1*****
SITES XEQ 02/11/2011  WATER RESOURCE SITE ANALYSIS COMPUTER PROGRAM
VER 2005.1.04          (USER MANUAL - DATED DECEMBER 2005)
TIME 07:49:15
  
```

\*\*\*\*\* 80-80 LIST OF INPUT DATA \*\*\*\*\*

```

SITES      01/01/2005BC9      Brush Creek Site 9      0.925      C2
SAVMOV     0      101
SAVMOV     101  1
STRUCTURE  9

                2478                0
                2480                1
                2485                18
                2490                60
                2495                136
                2500                253.5
                2505                412.5
                2510                610.5
                2515                849.5
                2530                1600

ENDTABLE
WSDATA     2C  9      80      0.925      1.58
BASEFLOW   1.12
PDIRECT
POOLDATA   ELEV      2500      2500      2500      2478      2472      TC
PSINLET    ELEV      0.75      12      2503.4      1.18      1.18
PSDATA     1      220      24      0.013      2473.5
ASSURFACE  41      525      0.1
            0      525      0.035      0.5      1      1
            525      857.8      0.035      0.5      1      1

ENDTABLE
ASDATA     41                2.5                1
BTMWIDTH   FEET      70
ASMATERIAL
            1      8      0.002      16      100      0.28
            2      0      4      0      130      5
            3      0      7      0      133      14
            4      0      10      0      121      10

ENDTABLE
ASCOORD    1      Soil      Y
            0      2500      30      2502      175      2505.7
            195      2505.7      525      2498.5      562.5      2490
            591.6      2485      649.9      2480      748.3      2475.00
            857.8      2472

ENDTABLE
ASCOORD    2      Claystone
            0      2499      30      2501      175      2504.7
            195      2504.7      525      2497.5      525.01      2470

ENDTABLE
ASCOORD    3      Sandstone
            525.01      2497.48      562.5      2485      591.6      2480
            649.9      2475      649.91      2470

ENDTABLE
ASCOORD    4      Shale
            649.91      2474.99      748.3      2470      857.80      2468

ENDTABLE
GRAPHICS   I
GO,DESIGN  L                6                2502.07
SAVMOV     2      101  1                9
ENDJOB
  
```

\*\*\*\*\*

\*\*\*\*\* MESSAGE - DEFAULT TOPSOIL FILL MATERIAL PARAMETERS USED.

\*\*\*\*\* MESSAGE - AUXILIARY SPILLWAY CREST ELEVATION IS SET TO 2505.70

# Brush Creek Site 9 – ASW Integrity (6-hr)

FROM THE ASCOORD RECORDS.

```

1SITES -----
XEQ 02/11/2011           Brush Creek Site 9           WSID= BC9
VER 2005.1.04           SUBW= 9
TIME 07:49:15           SITE = 9           PASS= 1           PART= 1
    
```

```

***** MATERIAL PROPERTIES *****
          DRY
MATERIAL  PI  DENSITY  Kh  PERCENT  DETACH.  REP.
          lbs/CuFt  CLAY  RATE  DIAMETER
          (Ft/H)/(lb/SqFt) inches
Soil      8.   100.    0.28  16.0    --      0.00200
Claystone 0.   130.    5.00   0.0    --      4.00000
Sandstone 0.   133.   14.00   0.0    --      7.00000
Shale     0.   121.   10.00   0.0    --     10.00000
TS_FILL   0.   100.    0.05   0.0    --      0.05000
GEN_FILL  8.   100.    0.28  16.0    --      0.00200
    
```

```

***** BASIC DATA *****
HUMID- SUBHUMID CLIMATE AREA           DESIGN CLASS C
    
```

STORM DISTRIBUTION USED FOR AUXILIARY SPILLWAY IS;  
 NRCS DESIGN STORM RAINFALL DISTRIBUTION (CHAPTER 21, NEH4 & TR-60).

PRECIP. - Q-PS,1-DAY	Q-PS,10-DAY	P-SD	P-FB	
0.00	0.00	10.20	28.70	
WSDATA - CN	DA-SM	TC/L	-/H	QRF
80.00	0.93	1.58	0.00	0.00
SITEDATA- PERM POOL	CREST PS	FP SED	VALLEY FL	378?
2500.00	2500.00	2500.00	2472.00	NO
BASEFLOW	INITIAL EL	EXTRA VOL	SITE TYPE	
1.12	0.00	0.00	DESIGN	
PSDATA - NO. COND	COND L	DIA/W	-/H	
1.00	220.00	24.00	0.00	
PS N	KE	WEIR L	TW EL	
0.013	0.75	12.00	2473.50	
2ND STG	ORF H	ORF L	START AUX.	
2503.40	1.18	1.18	2502.07	
ASCRESTS - AUX.1	AUX.2	AUX.3	AUX.4	AUX.5
2505.70	0.00	0.00	0.00	0.00
AUX.DATA - REF.NO.	RETARD. Ci	TIE STATION	INLET LENGTH	
41	0.00	195.00	0	
AUX.DATA - INLET N	SIDE SLOPE	EXIT N	EXIT SLOPE	ACTUAL AUX?
0.035	2.50	0.035	0.022	YES
BTM WIDTH - BW1	BW2	BW3	BW4	BW5
ft 70.00	0.00	0.00	0.00	0.00

AUXILIARY SPILLWAY RATING DEVELOPED USING WSPVRT.

```

1SITES -----
XEQ 02/11/2011           Brush Creek Site 9           WSID= BC9
VER 2005.1.04           SUBW= 9
TIME 07:49:15           SITE = 9           PASS= 1           PART= 2
    
```

```

PERM POOL      2500.00 FT      253.5 ACFT      0.00 AC      0.0 CFS
    
```



## Brush Creek Site 9 – ASW Integrity (6-hr)

RATING TABLE NUMBER 2

	ELEV. FEET	Q-TOTAL CFS	Q-PS CFS	Q-AUX. CFS	VOLUME AC-FT	AREA ACRE
1	2500.00	0.00	0.00	0.00	253.50	0.00
2	2500.23	0.40	0.40	0.00	260.78	0.00
3	2500.46	1.13	1.13	0.00	268.06	0.00
TRANSITION TO ORIFICE FLOW, ELEV = 2500.69 FT						
4	2500.69	2.08	2.08	0.00	275.35	0.00
5	2501.59	6.71	6.71	0.00	304.11	0.00
6	2502.50	9.25	9.25	0.00	332.87	0.00
7	2503.40	11.23	11.23	0.00	361.62	0.00
8	2503.82	22.22	22.22	0.00	375.02	0.00
9	2504.24	41.59	41.59	0.00	388.42	0.00
FULL CONDUIT FLOW, ELEV = 2504.66 FT						
10	2504.66	66.40	66.40	0.00	401.82	0.00
11	2505.01	66.83	66.83	0.00	412.87	0.00
12	2505.35	67.19	67.19	0.00	426.54	0.00
13	2505.70	67.55	67.55	0.00	440.21	0.00
14	2506.92	296.91	68.82	228.10	488.34	0.00
15	2508.13	776.85	70.06	706.79	536.44	0.00
16	2510.32	2157.07	72.24	2084.84	625.65	0.00
17	2512.99	4580.30	74.81	4505.49	753.42	0.00
18	2517.85	11445.97	79.28	11366.69	992.10	0.00
19	2523.93	23437.23	84.54	23352.69	1296.05	0.00
20	2530.00	39874.68	89.48	39785.19	1600.00	0.00

\*\*\*\*\*

### SUMMARY OF AUXILIARY SPILLWAY SURFACE CONDITIONS USED IN COMPUTATIONS BY REACH

REACH	FROM STA (ft)	TO STA (ft)	SLOPE (%)	RETARDANCE CURVE INDEX@	VEGETAL COVER FACTOR	MAINT. CODE +	ROOTING DEPTH (ft)	REACH LOCATION *
1	0.	30.	-6.7	0.035	**	**	**	INLET
2	30.	175.	-2.6	0.035	**	**	**	INLET
3	175.	195.	0.0	0.035	**	**	**	CREST
4	195.	525.	2.2	0.035	0.50	1	1.0	EXIT !
5	525.	562.	22.7	0.035	0.50	1	1.0	exit
6	562.	592.	17.2	0.035	0.50	1	1.0	exit
7	592.	650.	8.6	0.035	0.50	1	1.0	exit
8	650.	748.	5.1	0.035	0.50	1	1.0	exit
9	748.	858.	2.7	0.035	0.50	1	1.0	exit

- @ The program interprets retardance curve index entries of less than 1 as Manning's n values.
- + The minimum maintenance code value of 2 is used in INTEGRITY computations (the program changes values of 1 to 2 during computation).
- \* Upper case indicates a reach of constructed spillway channel.
- \*\* The program does not use vegetal cover factor, maintenance code, and rooting depth for inlet and crest reaches in computations.
- ! Reach 4 used in computing exit channel velocities.

ROUTED RESULTS	BTM WIDTH FT	MAX ELEV FT	VOL-MAX ACFT	AREA-MAX AC	AUX.-HP FT	VOL-AUX. ACFT
NRCS-SDH	70.0	2508.02	532.1	0.0	2.32	91.9

PEAK - CFS DISCHARGE =	Q-PS 69.9	Q-AUX. 664.0	Q-TOT. 733.9
	CRITICAL DEPTH FT	CRITICAL VELOCITY FT/SEC	CRITICAL SLOPE-Sc FT/FT
AUXILIARY SPILLWAY ---	1.38	6.53	0.016
			25% OF Q Sc FT/FT
			0.022

AUXILIARY SPILLWAY DURATION FLOW = 8.6 HOURS

EXIT CHANNEL FLOW SUPERCRITICAL: MAX VELOCITY= 7.1 FT/SEC  
EXIT SLOPE = 0.022 FT/FT

## Brush Creek Site 9 – ASW Integrity (6-hr)

FLOW DEPTH = 1.3 FT

\*\*\*\*\*

EROSIONALLY EFFECTIVE STRESS FOR STABILITY ANALYSIS OF AUX. EXIT CHANNEL  
(Refer to Ag. Handbook 667, Chapt. 3, for allowable stresses.)

Aux. Spillway Discharge = 664. cfs; Bottom Width = 70. ft

REACH NO.	FROM STA	TO STA	SLOPE %	MANNING'S n	VELOCITY ft/s	TOTAL STRESS lb/ft^2	EFFECTIVE STRESS lb/ft^2
4	195.	525.	2.18	0.035	7.13	1.73	0.215

\*\*\*\*\*

ROUTED RESULTS	BTM WIDTH FT	MAX ELEV FT	VOL-MAX ACFT	AREA-MAX AC	AUX.-HP FT	VOL-AUX. ACFT
NRCS-FBH	70.0	2512.80	744.4	0.0	7.10	304.2

PEAK - CFS DISCHARGE =	Q-PS = 75.	Q-AUX. = 4335.	Q-TOT. = 4409.
------------------------	------------	----------------	----------------

AUXILIARY SPILLWAY ---	CRITICAL DEPTH FT	CRITICAL VELOCITY FT/SEC	CRITICAL SLOPE-Sc FT/FT	25% OF Q Sc FT/FT
	4.64	11.44	0.011	0.015

INTEGRITY ANALYSIS - REACH SURFACE PERFORMANCE SUMMARY

(The auxiliary spillway began flow at time = 2.5 hours  
and peaked at time = 4.0 hours.)

REACH 4: FROM STATION 195. TO 525. ON 2.2% SLOPE.  
Vegetal cover failed and concentrated flow developed  
at time = 5.9 hours.

REACH 5: FROM STATION 525. TO 562. ON 22.7% SLOPE.  
Vegetal cover failed and concentrated flow developed  
at time = 3.1 hours.

REACH 6: FROM STATION 562. TO 592. ON 17.2% SLOPE.  
Vegetal cover failed and concentrated flow developed  
at time = 3.1 hours.

REACH 7: FROM STATION 592. TO 650. ON 8.6% SLOPE.  
Vegetal cover failed and concentrated flow developed  
at time = 3.2 hours.

REACH 8: FROM STATION 650. TO 748. ON 5.1% SLOPE.  
Vegetal cover failed and concentrated flow developed  
at time = 3.7 hours.

REACH 9: FROM STATION 748. TO 858. ON 2.7% SLOPE.  
Vegetal cover failed and concentrated flow developed  
at time = 4.5 hours.

INTEGRITY ANALYSIS - HEADCUT EROSION DAMAGE SUMMARY

The most upstream headcut began at station 195.  
and progressed upstream to station 195.  
The final height of the headcut was 4.5 ft.

The headcut having the maximum final overfall height began  
at station 525. and progressed upstream to station 501.  
The final height of the headcut was 27.0 ft.



## Brush Creek Site 9 – ASW Integrity (6-hr)

SITES.....SUMMARY TABLE 1 COMPLETED.

NRCS SITES VERSION 2005.1.04 ,01/01/2005  
BC9 FILES

INPUT = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES Model\BrC9\BC\_Site9\_ASW\_6Hr\_Integrity.D2C  
OUTPUT = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES Model\BrC9\BC\_Site9\_ASW\_6Hr\_Integrity.OUT  
DATED 02/11/2011 07:49:15

### GRAPHICS FILES GENERATED

OPTION "L" = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES Model\BrC9\BC\_Site9\_ASW\_6Hr\_Integrity.DRG DATED  
02/11/2011 07:49:15

OPTION "P" = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES Model\BrC9\BC\_Site9\_ASW\_6Hr\_Integrity.DHY DATED  
02/11/2011 07:49:15

OPTION "E" = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES Model\BrC9\BC\_Site9\_ASW\_6Hr\_Integrity.DEM DATED  
02/11/2011 07:49:15

AUX.GRAPHICS = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES Model\BrC9\BC\_Site9\_ASW\_6Hr\_Integrity.DG\* DATED  
02/11/2011 07:49:15



---

## SITES Output

Brush Creek Site 9 - ASW Integrity (24-hr)

---

# Brush Creek Site 9 – ASW Integrity (24-hr)

```

1*****
SITES XEQ 02/11/2011  WATER RESOURCE SITE ANALYSIS COMPUTER PROGRAM
VER 2005.1.04          (USER MANUAL - DATED DECEMBER 2005)
TIME 07:50:58
  
```

\*\*\*\*\* 80-80 LIST OF INPUT DATA \*\*\*\*\*

```

SITES      01/01/2005BC9      Brush Creek Site 9      0.925      C2
SAVMOV     0      101
SAVMOV     101  1
STRUCTURE  9

                2478                0
                2480                1
                2485                18
                2490                60
                2495                136
                2500                253.5
                2505                412.5
                2510                610.5
                2515                849.5
                2530                1600

ENDTABLE
WSDATA     2C  9      80      0.925      1.58
BASEFLOW
RAINTABLE  9
                0      0.008      0.0162      0.0246      0.0333
                0.0425      0.0524      0.063      0.0743      0.0863
                0.099      0.1124      0.1265      0.142      0.1595
                0.18      0.205      0.255      0.345      0.437
                0.53      0.603      0.633      0.66      0.684
                0.705      0.724      0.742      0.759      0.775
                0.79      0.8043      0.818      0.8312      0.8439
                0.8561      0.8678      0.879      0.8898      0.9002
                0.9103      0.9201      0.9297      0.9391      0.9483
                0.9573      0.9661      0.9747      0.9832      0.9916
                1

ENDTABLE
PDIRECT
POOLDATA   ELEV      2500      2500      2500      2478      2472      TC
PSINLET    ELEV      0.75      12      2503.4      1.18      1.18
PSDATA     1      220      24      0.013      2473.5
ASSURFACE  41      315      0.1
                0      525      0.035      0.5      1      1
                525      857.8      0.035      0.5      1      1

ENDTABLE
ASDATA     41
BTMWIDTH   FEET      70
ASMATERIAL
                1      8      0.002      16      100      0.28
                2      0      4      0      130      5
                3      0      7      0      133      14
                4      0      10      0      121      10

ENDTABLE
ASCOORD    1      Soil      Y
                0      2500      30      2502      175      2505.7
                195      2505.7      525      2498.5      562.5      2490
                591.6      2485      649.9      2480      748.3      2475.00
                857.8      2472

ENDTABLE
ASCOORD    2      Claystone
                0      2499      30      2501      175      2504.7
                195      2504.7      525      2497.5      525.01      2470

ENDTABLE
ASCOORD    3      Sandstone
                525.01      2497.48      562.5      2485      591.6      2480
                649.9      2475      649.91      2470

ENDTABLE
  
```

## Brush Creek Site 9 – ASW Integrity (24-hr)

```

ASCOORD      4      Shale
              649.91  2474.99  748.3   2470    857.80  2468
ENDTABLE
GRAPHICS     I
GO,DESIGN L          9      24
SAVMOV      2      101  1          9
ENDJOB
  
```

\*\*\*\*\*

\*\*\*\*\* MESSAGE - DEFAULT TOPSOIL FILL MATERIAL PARAMETERS USED.

\*\*\*\*\* MESSAGE - AUXILIARY SPILLWAY CREST ELEVATION IS SET TO 2505.70  
FROM THE ASCOORD RECORDS.

```

1SITES -----
XEQ 02/11/2011          Brush Creek Site 9          WSID= BC9
VER 2005.1.04          SUBW= 9
TIME 07:50:58          SITE = 9          PASS= 1          PART= 1
  
```

```

***** MATERIAL PROPERTIES *****
          DRY          PERCENT          DETACH.          REP.
MATERIAL  PI  DENSITY  Kh          CLAY          RATE          DIAMETER
          lbs/CuFt          (Ft/H)/(lb/SqFt)  inches
Soil      8.   100.   0.28    16.0          --          0.00200
Claystone 0.   130.   5.00     0.0          --          4.00000
Sandstone 0.   133.  14.00     0.0          --          7.00000
Shale     0.   121.  10.00     0.0          --          10.00000
TS_FILL   0.   100.   0.05     0.0          --          0.05000
GEN_FILL  8.   100.   0.28    16.0          --          0.00200
  
```

```

***** BASIC DATA *****
HUMID- SUBHUMID CLIMATE AREA          DESIGN CLASS C
  
```

STORM DISTRIBUTION AUX. -

```

PRECIP. - Q-PS,1-DAY  Q-PS,10-DAY  P-SD          P-FB
              0.00          0.00          13.20          37.00

WSDATA -      CN          DA-SM          TC/L          -/H          QRF
              80.00          0.93          1.58          0.00          0.00

SITEDATA- PERM POOL  CREST PS          FP SED          VALLEY FL          378?
              2500.00          2500.00          2500.00          2472.00          NO

          BASEFLOW  INITIAL EL          EXTRA VOL          SITE TYPE
              1.12          0.00          0.00          DESIGN

PSDATA - NO. COND          COND L          DIA/W          -/H
              1.00          220.00          24.00          0.00

          PS N          KE          WEIR L          TW EL
              0.013          0.75          12.00          2473.50

          2ND STG          ORF H          ORF L          START AUX.
              2503.40          1.18          1.18          2502.07

ASCRESTS - AUX.1          AUX.2          AUX.3          AUX.4          AUX.5
              2505.70          0.00          0.00          0.00          0.00

AUX.DATA - REF.NO.  RETARD. Ci  TIE STATION  INLET LENGTH
              41          0.00          195.00          0

AUX.DATA - INLET N  SIDE SLOPE  EXIT N          EXIT SLOPE  ACTUAL AUX?
              0.035          2.50          0.035          0.022          YES

BTM WIDTH - BW1          BW2          BW3          BW4          BW5
  
```



# Brush Creek Site 9 – ASW Integrity (24-hr)

NRCS-FBH      D= 24.00 HR      P= 37.00 IN      Q= 34.16 IN      DA= 0.93 SM  
 TC= 1.58 HR      CN= 80.00      VOL= 1687.7 ACFT

PEAK = 3746.1 CFS, AT 10.2 HRS.

\*\*\*\*\*  
 RATING TABLE DEVELOPED, SITE = 9 :  
 BY PROGRAM FOR PS AND AUX. SPILLWAYS  
 AUX. RATING USED WSPVRT METHOD.

RATING TABLE NUMBER 2

	ELEV. FEET	Q-TOTAL CFS	Q-PS CFS	Q-AUX. CFS	VOLUME AC-FT	AREA ACRE
1	2500.00	0.00	0.00	0.00	253.50	0.00
2	2500.23	0.40	0.40	0.00	260.78	0.00
3	2500.46	1.13	1.13	0.00	268.06	0.00
TRANSITION TO ORIFICE FLOW, ELEV = 2500.69 FT						
4	2500.69	2.08	2.08	0.00	275.35	0.00
5	2501.59	6.71	6.71	0.00	304.11	0.00
6	2502.50	9.25	9.25	0.00	332.87	0.00
7	2503.40	11.23	11.23	0.00	361.62	0.00
8	2503.82	22.22	22.22	0.00	375.02	0.00
9	2504.24	41.59	41.59	0.00	388.42	0.00
FULL CONDUIT FLOW, ELEV = 2504.66 FT						
10	2504.66	66.40	66.40	0.00	401.82	0.00
11	2505.01	66.83	66.83	0.00	412.87	0.00
12	2505.35	67.19	67.19	0.00	426.54	0.00
13	2505.70	67.55	67.55	0.00	440.21	0.00
14	2506.92	296.91	68.82	228.10	488.34	0.00
15	2508.13	776.85	70.06	706.79	536.44	0.00
16	2510.32	2157.07	72.24	2084.84	625.65	0.00
17	2512.99	4580.30	74.81	4505.49	753.42	0.00
18	2517.85	11445.97	79.28	11366.69	992.10	0.00
19	2523.93	23437.23	84.54	23352.69	1296.05	0.00
20	2530.00	39874.68	89.48	39785.19	1600.00	0.00

SUMMARY OF AUXILIARY SPILLWAY SURFACE CONDITIONS USED IN COMPUTATIONS BY REACH

REACH	FROM STA (ft)	TO STA (ft)	SLOPE (%)	RETARDANCE CURVE INDEX@	VEGETAL COVER FACTOR	MAINT. CODE +	ROOTING DEPTH (ft)	REACH LOCATION *
1	0.	30.	-6.7	0.035	**	**	**	INLET
2	30.	175.	-2.6	0.035	**	**	**	INLET
3	175.	195.	0.0	0.035	**	**	**	CREST
4	195.	525.	2.2	0.035	0.50	1	1.0	EXIT !
5	525.	562.	22.7	0.035	0.50	1	1.0	exit
6	562.	592.	17.2	0.035	0.50	1	1.0	exit
7	592.	650.	8.6	0.035	0.50	1	1.0	exit
8	650.	748.	5.1	0.035	0.50	1	1.0	exit
9	748.	858.	2.7	0.035	0.50	1	1.0	exit

@ The program interprets retardance curve index entries of less than 1 as Manning's n values.  
 + The minimum maintenance code value of 2 is used in INTEGRITY computations (the program changes values of 1 to 2 during computation).  
 \* Upper case indicates a reach of constructed spillway channel.  
 \*\* The program does not use vegetal cover factor, maintenance code, and rooting depth for inlet and crest reaches in computations.  
 ! Reach 4 used in computing exit channel velocities.  
 \*\*\*\*\*

ROUTED RESULTS	BTM WIDTH FT	MAX ELEV FT	VOL-MAX ACFT	AREA-MAX AC	AUX.-HP FT	VOL-AUX. ACFT
NRCS-SDH	70.0	2507.82	524.4	0.0	2.12	84.2

## Brush Creek Site 9 – ASW Integrity (24-hr)

PEAK - CFS            Q-PS            Q-AUX.            Q-TOT.  
DISCHARGE =            69.7            586.6            656.4

	CRITICAL DEPTH	CRITICAL VELOCITY	CRITICAL SLOPE-Sc	25% OF Q Sc
AUXILIARY	FT	FT/SEC	FT/FT	FT/FT
SPILLWAY ---	1.28	6.28	0.017	0.023

AUXILIARY SPILLWAY DURATION FLOW =            17.6 HOURS

EXIT CHANNEL FLOW SUPERCRITICAL: MAX VELOCITY=    6.8 FT/SEC  
EXIT SLOPE = 0.022 FT/FT  
FLOW DEPTH = 1.2 FT

\*\*\*\*\*

EROSIONALLY EFFECTIVE STRESS FOR STABILITY ANALYSIS OF AUX. EXIT CHANNEL  
(Refer to Ag. Handbook 667, Chapt. 3, for allowable stresses.)

Aux. Spillway Discharge =            587. cfs;    Bottom Width =            70. ft

REACH NO.	FROM STA	TO STA	SLOPE %	MANNING`S n	VELOCITY ft/s	TOTAL STRESS lb/ft^2	EFFECTIVE STRESS lb/ft^2
4	195.	525.	2.18	0.035	6.80	1.61	0.200

\*\*\*\*\*

ROUTED RESULTS NRCS-FBH	BTM WIDTH FT	MAX ELEV FT	VOL-MAX ACFT	AREA-MAX AC	AUX.-HP FT	VOL-AUX. ACFT
	70.0	2511.60	686.9	0.0	5.90	246.6

PEAK - CFS            Q-PS            Q-AUX.            Q-TOT.  
DISCHARGE =            73.            3244.            3318.

	CRITICAL DEPTH	CRITICAL VELOCITY	CRITICAL SLOPE-Sc	25% OF Q Sc
AUXILIARY	FT	FT/SEC	FT/FT	FT/FT
SPILLWAY ---	3.87	10.54	0.012	0.016

INTEGRITY ANALYSIS - REACH SURFACE PERFORMANCE SUMMARY

(The auxiliary spillway began flow at time =    6.9 hours  
and peaked at time =    10.7 hours.)

REACH 4: FROM STATION    195. TO    525. ON    2.2% SLOPE.  
Vegetal cover failed and concentrated flow developed  
at time =    11.9 hours.

REACH 5: FROM STATION    525. TO    562. ON    22.7% SLOPE.  
Vegetal cover failed and concentrated flow developed  
at time =    9.2 hours.

REACH 6: FROM STATION    562. TO    592. ON    17.2% SLOPE.  
Vegetal cover failed and concentrated flow developed  
at time =    9.2 hours.

REACH 7: FROM STATION    592. TO    650. ON    8.6% SLOPE.  
Vegetal cover failed and concentrated flow developed  
at time =    9.4 hours.

REACH 8: FROM STATION    650. TO    748. ON    5.1% SLOPE.  
Vegetal cover failed and concentrated flow developed  
at time =    10.0 hours.

REACH 9: FROM STATION    748. TO    858. ON    2.7% SLOPE.  
Vegetal cover failed and concentrated flow developed  
at time =    10.5 hours.

# Brush Creek Site 9 – ASW Integrity (24-hr)

INTEGRITY ANALYSIS - HEADCUT EROSION DAMAGE SUMMARY

The most upstream headcut began at station 195.  
 and progressed upstream to station 195.  
 The final height of the headcut was 6.8 ft.

The headcut having the maximum final overfall height began  
 at station 525. and progressed upstream to station 503.  
 The final height of the headcut was 27.0 ft.

	DURATION	ATTACK	DIST. FROM MOST U/S
	FLOW	OE/B	HEADCUT TO U/S EDGE
AUXILIARY	HRS	ACFT/FT	AUX. CREST, FT
SPILLWAY ---	22.6	20.4	20.

EXIT CHANNEL FLOW SUPERCRITICAL: MAX VELOCITY= 12.8 FT/SEC  
 EXIT SLOPE = 0.022 FT/FT  
 FLOW DEPTH = 3.3 FT

Inflow Hyd 1 SDH-Peak = 656.37 CFS at 11.56 hrs., Location Point  
 Inflow Hyd 1 FBH-Peak = 3317.79 CFS at 10.70 hrs., Location Point  
 HYDOUT 1 9

1SITES....JOB NO. 1 COMPLETE.

-----  
 BC9 Brush Creek Site 9

- 0 SUBWATERSHED(S) ANALYZED.
- 1 STRUCTURE(S) ANALYZED.
- 2 HYDROGRAPHS ROUTED AT LOWEST SITE.
- 0 TRIALS TO OBTAIN BOTTOM WIDTH FOR SPECIFIED STRESS OR VELOCITY.

\*\*\*\*\*

SITES.....COMPUTATIONS COMPLETE

1 SUMMARY TABLE 1 SITES VERSION 2005.1.04  
 ----- DATED 01/01/2005

WATERSHED ID	RUN DATE			RUN TIME					
-----	-----			-----					
BC9	02/11/2011			07:50:58					
>>>	SITE ID	SUBWS ID	SUBWS DA (SQ MI)	CURVE NO.	TC (HRS)	TOTAL DA (SQ MI)	TYPE DESIGN	STRUC CLASS	<<<
	-----	-----	-----	-----	-----	-----	-----	-----	-----
	9	9	0.93	80.	1.58	0.93	TR60	C	
PASS NO.	DIA./ WIDTH (IN/FT)	AUX.CREST ELEV (FT)	BTM. WIDTH (FT)	MAX. HP (FT)	MAX. ELEV (FT)	EMB. VOL. (CY)	INTEGR.* DIST. (FT)	EXIT* VEL. (FT/SEC)	TYPE HYD
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1	24.0	2505.7	70.0	5.9	2511.6	0.	20.	12.8	NRCS-FBH

\* INTEGRITY DIST. AND EXIT VEL. VALUES ARE BASED ON THE ROUTED HYDROGRAPH SHOWN UNDER TYPE HYD.

## Brush Creek Site 9 – ASW Integrity (24-hr)

SITES.....SUMMARY TABLE 1 COMPLETED.

NRCS SITES VERSION 2005.1.04 ,01/01/2005  
BC9 FILES

INPUT = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES Model\BrC9\BC\_Site9\_ASW\_24Hr\_Integrity.D2C  
OUTPUT = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES Model\BrC9\BC\_Site9\_ASW\_24Hr\_Integrity.OUT  
DATED 02/11/2011 07:50:58

### GRAPHICS FILES GENERATED

OPTION "L" = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES Model\BrC9\BC\_Site9\_ASW\_24Hr\_Integrity.DRG DATED  
02/11/2011 07:50:58

OPTION "P" = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES Model\BrC9\BC\_Site9\_ASW\_24Hr\_Integrity.DHY DATED  
02/11/2011 07:50:58

OPTION "E" = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES Model\BrC9\BC\_Site9\_ASW\_24Hr\_Integrity.DEM DATED  
02/11/2011 07:50:58

AUX.GRAPHICS = W:\426\Active Jobs\52299 - WV NRCS 2010 Contract\05 Working\41 Dam  
Assessments\Brush Creek Site 9\BC9 SITES Model\BrC9\BC\_Site9\_ASW\_24Hr\_Integrity.DG\* DATED  
02/11/2011 07:50:58



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Appendix D  
Evaluation of Potential Rehabilitation  
Projects-Priority Ranking Spreadsheet

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**EVALUATION OF POTENTIAL REHABILITATION PROJECTS**

<b>STATE</b>	WV	<b>DAM</b>	Brush Creek Site 9	<b>BY</b>	TAR	<b>DATE</b>	01/20/11
<b>YEAR BUILT</b>	1964	<b>DESIGN HAZARD CLASS</b>	C	<b>DRAINAGE AREA</b>	0.93	mi2	
<b>WORK PLAN DATE</b>	1959	<b>CURRENT HAZARD CLASS</b>	C	<b>DAM HEIGHT</b>	41	ft	

sht 1 of 5 CONSEQUENCES OF DAM FAILURE ver 100101

**POTENTIAL DAM FAILURE:**

Total Failure Index 198 A

**POTENTIAL LOSS OF LIFE:**

Maximum Population-at-Risk [PAR] (number) 1618 B

Total Risk Index 12815 C

**POTENTIAL LOSS OF PROPERTY:**

Identify major community affected by breach and rate impact as High (H), Medium (M), Low (L) or None(blank)

Community Green Valley (H,M,L,-) H D

Number of homes, businesses, major buildings (number) 647 E

**POTENTIAL LIFELINE DISRUPTION:**

Water supply, identify community disrupted by dam failure, and estimate number/amount

Municipal sole source \_\_\_\_\_ Users (number)  F

Supplemental source \_\_\_\_\_ Users (number)  G

Irrigation water \_\_\_\_\_ Storage (Ac-Ft)  H

**POTENTIAL INFRASTRUCTURE DISRUPTION:**

Transportation system crossings, identify major crossing rendered unusable by dam failure, and estimate number

Major/Interstate U.S. Routes 19 and 460 Roads (number) 2 I

Secondary/County WV Rte 123, Co Rtes 25/3,25,25/7,25/8,25/9,17/1,19/ Roads (number) 20 J

**POTENTIAL ADVERSE IMPACTS ON THE ENVIRONMENT:**

Describe impacts and rate each as High (H), Medium (M), Low (L), or None (blank)

Threatened & endangered species \_\_\_\_\_ (H,M,L,-) L K

Sensitive riparian areas \_\_\_\_\_ (H,M,L,-) L L

Contaminated reservoir sediment \_\_\_\_\_ (H,M,L,-) L M

Wetland and wildlife habitat \_\_\_\_\_ (H,M,L,-) L N

Other \_\_\_\_\_ (H,M,L,-)  O

**POTENTIAL ADVERSE SOCIAL IMPACTS:**

Describe impacts and rate each as High (H), Medium (M), Low (L) or None(blank)

Known cultural resources \_\_\_\_\_ (H,M,L,-) L P

Historic preservation issues \_\_\_\_\_ (H,M,L,-)  Q

Socially disadvantaged community \_\_\_\_\_ (H,M,L,-) M R

**POTENTIAL ADVERSE ECONOMIC IMPACTS:**

Average annual benefits attributed to this dam, updated workplan value ( \$ ) 20,714 S

Changes in benefits since workplan; Increase(I), No change(NC), Decrease(D) (I,NC,D) I T

Low income families impacted (number) 267 U

**INPUT BY STATE DAM SAFETY AGENCY:**

State dam safety order issued for repair, modification, removal issued, Yes(Y), No(N) ( Y,N )  V

State Dam Safety Agency Priority, High(H), Medium(M), Low(L), None(blank) (H,M,L,-)  W

**OTHER CONSIDERATIONS:**

Identify any other considerations and rate as High(H), Medium(M), Low(L) or None(blank)

\_\_\_\_\_ (H,M,L,-)  X

\_\_\_\_\_ (H,M,L,-)  Y

**EVALUATION OF POTENTIAL REHABILITATION PROJECTS**

<b>STATE</b>	WV	<b>DAM</b>	Brush Creek Site 9	<b>BY</b>	TAR	<b>DATE</b>	01/20/11
sht 2 of 5	<b>FAILURE &amp; RISK INDEXES</b>						ver 102201

Adopted from Bureau of Reclamation "Risk Based Profile System"

see: <http://www.usbr.gov/dsis/risk/rbpsdocumentation.pdf>

**LIFE LOSS:**

Population-at-Risk [PAR], see NRCS dams inventory definition (number of people)

Estimate PAR for static loading failure, typically assume water at top of dam	1618	A
Estimate PAR for hydrologic loading failure, typically assume water at top of dam	1618	B
Estimate PAR for seismic loading failure, typically assume water at ES crest (sunny day failure)	1618	C

Fatality Rates [FR] from dam breach

Adopted from BuRec "A Procedure for Estimating Loss of Life Caused by Dam Failure" DSO-99-06

see: [http://www.usbr.gov/research/dam\\_safety/documents/dso-99-06.pdf](http://www.usbr.gov/research/dam_safety/documents/dso-99-06.pdf)

Flood Severity/Lethality [DV] is the average depth [D] times velocity [V] across flood plain (ft2/sec)

$$DV = (\text{breach discharge} - \text{bank full discharge}) / \text{breach floodplain width}$$

Warning Time [T] between failure warning and flood wave at population (minutes)

Flood Severity Understanding [U] of the warning issuer of the likely flooding magnitude

scenario	breach discharge	bankfull discharge	breach width	DV	warning time	under-standing
	(cfs)	(cfs)	(ft)	(ft2/sec)	(minutes)	(N/A or Vague)
Static	40976	78	534	77	8	Vague
Hydrologic	62251	78	573	109	7	Vague
Seismic	40976	78	534	77	8	Vague

For DV>50	T=0	U=N/A (no warning)	FR=0.15
For DV>50	T<60	U=vague	FR=0.04
For DV>50	T>60	U=vague	FR=0.03
For DV<50	T=0	U=N/A (no warning)	FR=0.01
For DV<50	T<60	U=vague	FR=0.007
For DV<50	T>60	U=vague	FR=0.0003

Estimate FR for static loading failure scenario	0.04	D
Estimate FR for hydrologic loading failure scenario	0.04	E
Estimate FR for seismic loading failure scenario	0.04	F

Scenario	Load Factor	Response Factor	Failure Index	Fatality Rate	PAR	Risk Index
Static	1	31	31	0.04	1618	2006
Hydrologic	*	*	159	0.04	1618	10290
Seismic	0.15	53	8	0.04	1618	518
<b>TOTAL=</b>			198	<b>TOTAL=</b>		12815

EVALUATION OF POTENTIAL REHABILITATION PROJECTS								
STATE	WV	DAM	Brush Creek Site 9	BY	TAR	DATE	01/20/11	
sht 3 of 5		<b>STATIC FAILURE INDEX</b>					ver 100101	
<b>PRINCIPAL SPILLWAY SYSTEM</b> (60 points max):						(total points)	20	A
Downstream filter or filter zone around conduit (yes=0 or no=10)							0	B
Conduit trench deep (>2d) and narrow (<3d) and steep sideslope (<2:1) (no=0 or yes=10)							0	C
Principal spillway system (inlet, pipe, or outlet) in deteriorated condition (no=0 or yes=10)							0	D
Conduit has seepage cutoff collars or other compaction adverse features (no=0 or yes=10)							10	E
Conduit contains open joints, open cracks, steady seepage (no=0 or yes=10)							10	F
Conduit founded on competent bedrock (yes=0 or no=10)							0	G
Reservoir control gate located at outlet of conduit (no=0 or yes=10)							0	H
<b>RESERVOIR FILLING HISTORY</b> (75 points max):						(total points)	5	I
Reservoir has filled to x% of effective height (earth spillway crest minus original streambed)							96	J
(<50%=75 or 51-75%=50 or 76-90%=25 or 91-95%=10 or 96-100%=5 or >100%=0)							5	K
<b>SEEPAGE AND DEFORMATION</b> (85 points max):						(total points)		L
Seepage carrying fines, or seepage increases with reservoir elevation increases, or sinkholes/jugholes exist in embankment (no=0 or yes=80)							0	M
Large amounts of seepage (no=0 or yes=6)							0	N
Visible and significant slope movement or sloughing (no=0 or yes=6)							0	O
Longitudinal or transverse embankment cracking greater than one foot in depth (no=0 or yes=6)							0	P
Sinkholes/depressions within two times effective height of the dam, either face (no=0 or yes=6)							0	Q
Poor top of dam condition, eroded, trees, rodent holes, settlement (no=0 or yes=6)							0	R
Abnormally wet areas at downstream toe/groin of embankment (no=0 or yes=6)							0	S
Inadequate slope protection against erosion by rainfall or waves (no=0 or yes=6)							0	T
<b>FOUNDATION GEOLOGY</b> (41 points max):						(total points)		U
Highly fractures rock under core (no=0 or treated=3 or untreated=30)							0	V
Karst terrain and soluble rock (gypsum or limestone) (no=0 or treated=3 or untreated=30)							0	W
Collapsible soils (no=0 or treated=3 or untreated=30)							0	X
Significant stress relief fractures in abutments (no=0 or treated=3 or untreated=30)							0	Y
History of underground mining under embankment area (no=0 or treated=3 or untreated=30)							0	Z
Coarse grained and highly permeable soils (no=0 or yes=3)							0	AA
Presence of weak layers/conditions diminishing embankment stability (no=0 or yes=3)							0	AB
Erodible soils (sandy/silty materials) or weakly cemented rock (no=0 or yes=3)							0	AC
Reservoir area prone to landslides that could cause overtopping (no=0 or yes=3)							0	AD
<b>EMBANKMENT DESIGN AND CONSTRUCTION</b> (24 points max):						(total points)		AE
Filters for core or foundation or incompatibility between zones (no=3 or yes=0)							0	AF
Embankment or foundation drainage system (yes=0 or no=4)							0	AG
Erodible core material (sands, silts, dispersive clays) (no=0 or yes=4)							0	AH
Incomplete or no foundation cutoff of shallow permeable layers (no=0 or yes=4)							0	AI
Poorly placed earthfill, inadequate density (no=0 or yes=4)							0	AJ
Gate features to drain reservoir (yes=0 or no=4)							0	AK
<b>EMBANKMENT MONITORING</b> (15 points max):						(total points)	6	AL
Instruments (except surficial survey points) installed at dam (yes=0 or no=3)							3	AM
Installed instruments routinely read and evaluated (yes=0 or no=3)							3	AN
Visual inspection of dam by engineer less often than yearly (no=0 or yes=3)							0	AO
Good physical/visual access to downstream groin/toe for inspection (yes=0 or no=3)							0	AP
<b>STATIC FAILURE INDEX:</b> A+I+L+U+AE+AL							31	AQ

EVALUATION OF POTENTIAL REHABILITATION PROJECTS								
STATE	WV	DAM	Brush Creek Site 9	BY	TAR	DATE	01/20/11	
sht 4 of 5		HYDROLOGIC FAILURE INDEX					ver 100101	
<b>HYDROLOGIC LOADING:</b>								
Total Spillway Capacity (PS&ES) for 6hr storm [Pfb], Work Plan Tbl 3 (rainfall inches)						10.12	A	
Obtained from Work Plan Tbl 3, or dams inventory data, or computer routings								
100 year, 6hr rainfall [P100] (inches)						3.66	B	
Probable Maximum Precipitation [PMP] (inches)						28.5	C	
if Pfb < P100 = 3.66 enter 40								
if Pfb = P100+0.2(PMP-P100) = 8.628 enter 25								
if Pfb = P100+0.4(PMP-P100) = 13.6 enter 15								
if Pfb = P100+0.6(PMP-P100) = 18.56 enter 7								
if Pfb = P100+0.8(PMP-P100) = 23.53 enter 3								
if Pfb = PMP = 28.5 enter 1								
Enter interpolated value						22	D	
<b>HYDROLOGIC UNCERTAINTY:</b>								
Drainage Area [DA] (square miles)						0.93	E	
DA<10 enter 1.5 ; 10<DA<20 enter 1.4 ; 20<DA<50 enter 1.3 ; DA=>50 enter 1.2						1.5	F	
<b>PIPE SPILLWAY PLUGGING:</b>								
Pipe Diameter [D] (inches)						24	G	
D<12 enter 1.1; 12<=D<24 enter 1.0; 24<=D enter 0.9						0.9	H	
Riser & trash rack type:								
Non-standardized inlet enter 1.1, Open Top riser enter 1.0; Covered or Baffle Top enter 0.9						1.1	I	
<b>EARTH SPILLWAY FLOW:</b>								
Earth spillway flow depth [Des] from top of dam to spillway crest (feet)(10' max)						7.5	J	
<b>DAM EROSION RESISTANCE:</b>								
Non-plastic (PI<10) fill enter 2.0 ; Plastic core enter 1.7 ; Overtopping armoring enter 0.8						2	K	
Vegetal Cover Factor [Cf], see SITES or AH667						0.7	L	
<a href="http://www.pswcrl.ars.usda.gov/ah667/ah667.htm">http://www.pswcrl.ars.usda.gov/ah667/ah667.htm</a>								
Cf <0.4 enter 1.1; Cf < 0.7 enter 1.0; Cf<1.0 enter 0.9; larger Cf enter 0.8						0.9	M	
<b>EARTH SPILLWAY EROSION RESISTANCE:</b>								
Low, can be excavated with hand tools, enter 2.0								
PI>10 and SPT blows<8, PI<10 and SPT blows>8, Kh<0.10, seismic velocity<2000fps								
Moderate, can be excavated with construction equipment, easy ripping, enter 1.2								
PI>10 and SPT blows>8, PI<10 and SPT blows>30, Kh<10, seismic velocity<7000fps								
High, very hard ripping, requires drilling and blasting, enter 0.2								
moderately hard rock, Kh>10, seismic velocity>7000fps						2	N	
Vegetal Cover Factor [Cf], see SITES or AH667						0.7	O	
Cf <0.4 enter 1.1; Cf < 0.7 enter 1.0; Cf<1.0 enter 0.9; larger Cf enter 0.8						0.9	P	
<b>HYDROLOGIC FAILURE INDEX:</b>								
dam overtopping breach: (2)(D)(F)(H)(I)(K)(M)						118	Q	
earth spillway breach: (D+5J)(F)(H)(I)(N)(P)						159	R	
larger of (2)(D)(F)(H)(I)(K)(M) or (D+5J)(F)(H)(I)(N)(P) but less than 300						159	S	

**EVALUATION OF POTENTIAL REHABILITATION PROJECTS**

<b>STATE</b>	<b>WV</b>	<b>DAM</b>	Brush Creek Site 9	<b>BY</b>	TAR	<b>DATE</b>	01/20/11
sht 5 of 5	<b>SEISMIC FAILURE INDEX</b>						ver 102201

**SEISMIC LOADING:**

Latitude (degrees.decimal)	<input type="text" value="37.294"/>	A
Longitude (degrees.decimal)	<input type="text" value="-81.18"/>	B
See "http://eqint.cr.usgs.gov/eq/html/lookup.shtml"		
PGA [peak ground acceleration] for 2% chance in 50 years, see NEHRP maps (%g) if PGA is less than 10% g, enter 0 if PGA is between 10% g and 19% g, enter 0.15 if PGA is between 20% g and 39% g, enter 0.30 if PGA is between 40% g and 59% g, enter 0.65 if PGA is greater than 60% g, enter 1.0	<input type="text" value="15.04"/>	C
	<input type="text" value="0.15"/>	D

**FOUNDATION LIQUEFACTION:**

Select only one of the following foundation conditions which best represents the site

Loose alluvium, lacustrine, loess materials (no=0 or yes=10)	<input type="text" value="0"/>	E
Bedrock, glacial till, highly clayey materials (no=0 or yes=5)	<input type="text" value="5"/>	F

**EMBANKMENT FREEBOARD FOR FOUNDATION LIQUEFACTION:**

Dam height for seismic event is the height from top of dam to downstream channel bottom (ft)	<input type="text" value="41"/>	G
Freeboard for seismic event is the depth from top of dam to assumed pool surface (ft)	<input type="text" value="7.5"/>	H
Freeboard percent of dam height (%) if Freeboard is less than 25% of dam height, enter 10 if Freeboard is 25% to 50% of dam height, enter 5 if Freeboard is more than 50% of dam height, enter 1	<input type="text" value="18"/>	I
	<input type="text" value="10"/>	J

**EMBANKMENT FREEBOARD FOR EMBANKMENT CRACKING:**

Freeboard is less than or equal to 15 feet (no=0 or yes=1)	<input type="text" value="1"/>	K
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**EMBANKMENT CRACKING:**

Embankment contains self-healing filter zones (no=4 or yes=0)	<input type="text" value="4"/>	L
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**SEISMIC FAILURE INDEX:**

(D) ( (E)(J) + (F)(K+1)(L+1) ) but less than 100	<input type="text" value="8"/>	M
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Digitally signed by Angela D. Greene, PE  
Date: 2011.03.21 09:33:50 -04'00'

\_\_\_\_\_  
**State Conservation Engineer's Signature**  
concurring with technical content of sheets 2 thru 5

**Brush Creek 9**  
**Review Comments Related to Geotechnical Factors in the**  
***“Evaluation of Potential Rehabilitation Projects-Priority Ranking Spreadsheet”***

<b>Failure Index</b>	<b>Line</b>	<b>Comment</b>
Static	B	As-built drawings show single aggregate filter materials placed around conduit. Current filter diaphragm criteria met in horizontal direction.
Static	C	As-built drawings show PSW excavation slopes of 1H:1V, a 10 ft bottom width and an approximate depth of 5 feet for a 24-inch conduit.
Static	E	As-built drawings show that 7 anti-seep collars were constructed along the PSW.
Static	G	As-built drawings show conduit on rock.
Static	M, N	Both drains flowing at greater than ½ gpm during inspection on 10/18/10. Wet areas observed beyond toe on both left and right sides of stilling basin.
Static	O,P,Q	No sloughs, cracks or sinkholes/depressions observed.
Static	R	Embankment in good condition
Static	S	Wet areas observed beyond toe on both left and right sides of stilling basin.
Static	T	Wave erosion observed on upstream slope and at entrance to auxiliary spillway. No observed erosion on downstream slope.
Static	V	As-built drawings show cutoff trench excavated to rock. No foundation grouting completed during construction.
Static	W	No karst geology or soluble rock mapped on West Virginia Geologic Survey publications.
Static	X	No collapsible soils identified in the design reports.
Static	Y	No stress relief fractures identified in the design reports.
Static	Z	No underground mining under embankment described in the design reports.
Static	AA	Soil thickness is approximately 5 feet. Testing in the Soils Report shows an average PI of 9, which suggests that the foundation contains sufficient clay to produce reasonably low permeability.
Static	AB	No weak layers/conditions identified in the design reports.
Static	AC	No erodible soils or weakly cemented rock identified in the design reports.
Static	AD	Susceptibility of reservoir area to landslides that could overtop dam was not accessed in the design files.
Static	AF	As-built drawings indicate two embankment zones, clay core and outer shell. No transition zone is identified. Calculations for the compatibility of filters/embankment zones were not included in the design files.
Static	AG	As-built drawings show a seepage drain system.
Static	AH	No erodible core materials identified in the design reports.
Static	AI	As-built drawings show cutoff trench excavated to rock.
Static	AJ	As-built drawings indicate class B-1 compaction for clay core, class C compaction for shell, however no construction quality control testing results are available.
Static	AM	Dam does not have any instrumentation.
Hydrologic	N	Claystone, average sandstone and average shale SITES parameters were used.
Seismic	E, F	Liquefaction was not evaluated in the design documents reviewed.
Seismic	L	As-built drawings do not indicate transitions between embankment zones.