CALVERT CLIFFS UNIT 3

STORMWATER MANAGEMENT PLAN

Document No: 25470-000-30G-K03G-00001

Revision 003

BECHTEL POWER CORPORATION

August 2010

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NUCLEAR ENERGY

October 1, 2010

UN#10-242

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Non-Tidal Wetlands and Waterways Division
Maryland Department of the Environment
Water Management Administration
1800 Washington Boulevard
Baltimore, Maryland 21230

Subject: Response to Maryland Department of the Environment (MDE) Comments
Nontidal Wetlands Permit # 08-NT-0191
Calvert Cliffs Nuclear Power Plant Unit 3
Calvert County, Maryland

Attached is a response to MDE's 11 January 2010, comment letter along with two (2) sets of revised site development and stormwater management plans to address the majority of these comments. In addition to these submitted plans and responses, more information will be provided with the submittal of the Draft Final Phase II Nontidal Wetland and Stream Mitigation Plan, anticipated for October 2010.

Please note that the enclosed documents are for agency use as required to process the Joint Permit Application.

If you have any questions concerning the attached document, please call Mr. Dimitri Lutchenkov at (410) 470-5524.

Sincerely,

Greg Gibson

Enclosure – Response to MDE Comments (January 11, 2010), Nontidal Wetlands Permit # 08-NT-0191, Calvert Cliffs Nuclear Power Plant, Unit 3, 9 September 2010

cc: Mohammad Ebrahimi – Maryland Department of the Environment (w/o enclosure)
Woody Francis – US Army Corps of Engineers (w/o enclosure)
Susan Gray – Power Plant Research Program
Cheryl Kerr – Maryland Department of the Environment (w/o enclosure)
Laura Quinn – NRC Project Manager, Environmental Projects Branch 2

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Table of Contents

List of Figures

List of Drawings

25470-000-C2-0000-00001	Site Plan
25470-000-C2-0000-00002	Plot Plan
25470-000-C2-0010-00001	Pre-Development Plan
25470-000-C2-0010-00002	Post-Development Plan
25470-000-CG-0000-00001	Rough Grade Key Plan
25470-000-CG-0100-00001 through 00016	Rough Grade Plan
25470-000-CS-0100-00001 through 00013	Finish Grade Plan
25470-000-C0-0001-00001	Civil/Site Cover Sheet
25470-000-C0-0000-00001 through 00010	Civil Standards Notes, Sections and Details
25470-000-CG-0190-00001	Typical Road Cross Sections
25470-000-CE-0000-00001	Soil Erosion and Sediment Control Key Plan
25470-000-CE-0100-00001 through 00016	Soil Erosion and Sediment Control Plan
25470-000-C2-0000-00003	Clearing and Grubbing Plan Sheet 1
25470-000-C2-0000-00004	Clearing and Grubbing Plan Sheet 2
25470-000-CD-0190-00001 through 00003	Storm Water Drainage Catch Basin & Manhole Schedule
25470-000-CD-0190-00004 through 00005	Construction Access Road Culvert Pipe Profiles

List of Attachments

1.	Calvert Cliffs Unit 3 Site Development Pre-JPA Phasing Plan	2 Pages
2.	Calvert Cliffs Unit 3 Site Development Post-JPA Phasing Plan	11 Pages
3.	Layout of Stormwater Management Facilities	1 Page
4.	Flow Summary for Culverts	1 Page

1.0 INTRODUCTION

This document describes the plan for the stormwater management and the erosion and sedimentation control which is necessary during construction and operation phases in connection with the Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 Project.

In developing the plan, applicable regulations and design criteria governing Maryland's stormwater management program, Code of Maryland Regulations (COMAR) 26.17.02, Calvert County Public Code, and the U.S. Natural Resources Conservation Service were utilized. The following report gives a short description of the project and the methods to be utilized for stormwater management.

The practices presented in this plan are based on proven construction techniques and activities that will be applicable to the project. As construction progresses, site specific conditions may arise which may warrant changes. These changes will be made using the same criteria used in the preparation of this plan for the erosion and sedimentation control. It should be noted that all of the work activities discussed in this plan will not occur simultaneously. The work, as well as the appropriate control measures, will be in accordance with the Sequence of Construction shown on the Soil Erosion & Sediment Control Plans.

2.0 THE PROJECT

The Calvert Cliffs Nuclear Power Plant (CCNPP) site is located near the town of Lusby in Calvert County, Maryland between the Chesapeake Bay and the Patuxent River. The CCNPP Unit 3 project consists of the addition of one (1) 1600 megawatt (MW) power plant located to the south of existing CCNPP Units 1 & 2. The approximate location of Unit 3 is shown in Figure 1

BASED ON USGS 7.5 MINUTE SERIES
TOPOGRAPHIC MAP, COVE POINT
QUADRANGLE, 1987

0 600 1,200 2,400 3,600 4,800 Feet

Figure 1: CCNPP Site Area Topography, Drainage & Unit 3 Boundary

3.0 SITE DRAINAGE CONDITION

The CCNPP site covers an approximate area of 2,070 acres. Approximately 80 percent of the total 2,070 acres area is drained through the St. Leonard Creek drainage basin of the Patuxent River watershed as shown in Figure 2. The remaining 20 percent drains through the Maryland Western Shore watershed discharging northeastward and directly into the Chesapeake Bay via two unnamed creeks labeled Branch 1 and Branch 2 (Figure 2).

Runoff from the CCNPP Unit 3 site that lies within the St. Leonard Creek watershed mainly drains through Johns Creek, a tributary to St. Leonard Creek. The tributaries located upstream of Maryland Route 2-4 that contribute to Johns Creek are the Goldstein Branch, Laveel Branch, and two unnamed branches (Branches 3 and 4), as shown in Figure 2.

The CCNPP Unit 3 power block will be located in the Maryland Western Shore watershed as shown in Figure 2. The cooling tower and switchyard will be located in the St. Leonard Creek watershed. Site grading for CCNPP Unit 3 will affect the headwaters of the unnamed creek, Branch 1, in the Maryland Western Shore watershed. In the St. Leonard Creek watershed, the unnamed creek, Branch 3, will be affected by the switchyard. Post-construction drainage from the CCNPP Unit 3 power block area will be directed toward the Chesapeake Bay, while drainage from the cooling tower and switchyard areas will be directed to Johns Creek.

Wetlands near the CCNPP site consist of headwater streams with narrow floodplains and associated riparian forest in the St. Leonard Creek watershed, and minor Chesapeake Bay tributary streams and associated impoundments. Impoundments within the site include the Lake Davies stormwater impoundment, sequential perennial water bodies that drain the dredged spoil disposal area, and the Camp Conoy fishing pond, which is located at the headwaters of Branch 1 (Figure 2). Runoff from Lake Davies discharges westward to Goldstein Branch, which then discharges to Johns Creek. The sequential ponds discharge directly to Johns Creek upstream of Goldstein Branch. Both the Camp Conoy fishing pond and Lake Davies are man-made impoundments.

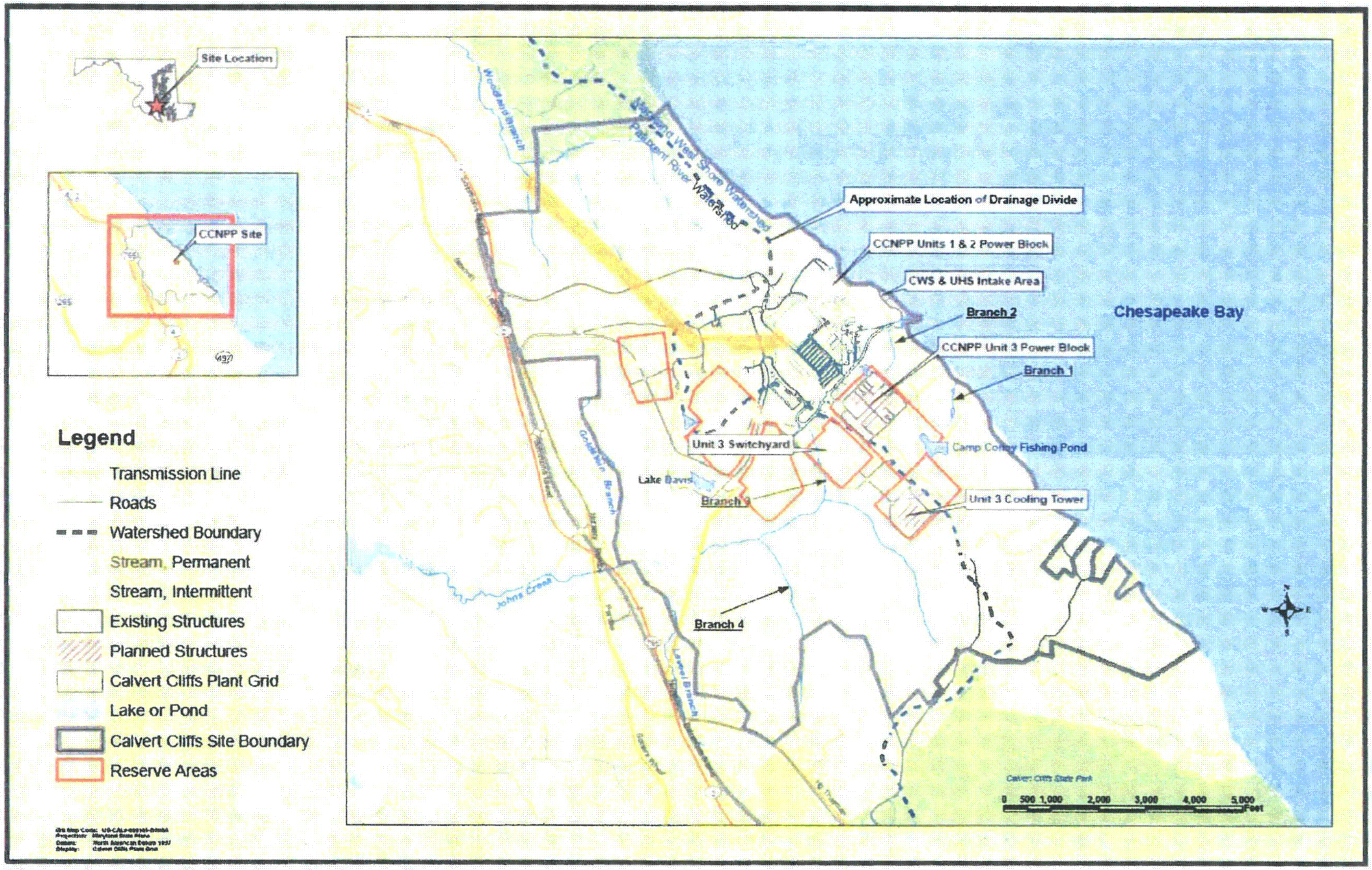

Figure 2: CCNPP Site Area Drainage System

The Camp Conoy pond will be re-graded to create a laydown area for the construction of CCNPP Unit 3. The US Fish and Wildlife Service (Reference 3) has designated the water bodies within the CCNPP Unit 3 site as palustrine wetlands. Camp Conoy pond and Lake Davies are further sub-classified as unconsolidated bottom permanently flooded wetland and emergent semi-permanently flooded wetland, respectively. Wetlands along the streams and creeks are mostly classified as forested or scrub-shrub wetlands that are seasonally or temporarily flooded. A similar classification is also used in the CCNPP site draft wetland delineation report (Reference 4). No designated floodplains occur on the site except along the Chesapeake Bay shoreline (Reference 5).

4.0 VICINITY MAP

The site is located on the western shore of the Chesapeake Bay in Calvert County, MD near Maryland Route 2-4, approximately 110 mi north of the Chesapeake Bay entrance. Communities located nearby the site include the following: Calvert Beach and Long Beach, approximately 3 mi to the northwest; Cove Point, approximately 4.5 mi to the southeast; Chesapeake Ranch Estates, approximately 6 mi to the south-southwest; the Patuxent Naval Air Test Center (NATC), approximately 10 mi to the south; and Prince Frederick, approximately 10.5 mi to the northwest. The metropolitan centers closest to the site are: Annapolis, MD, approximately 40 mi to the north; Washington, DC, approximately 45 mi to the northwest; Baltimore, MD, approximately 60 mi to the north; Richmond, VA, approximately 80 mi to the southwest; and Norfolk, VA, approximately 110 mi to the south.

5.0 SITE SOIL

The soils within the project area include Sassafras loamy fine sand, sloping 2 to 15 percent, Rumford loamy sand with 10–15 percent slope, Rumford-Evesboro gravelly loamy sands with 6-20 percent slope, Evesboro loamy sand with 0–12 percent slope, Butlerdown silt loam with 2-5 percent slope and very little eroded land with steep slope (Reference 1). The distribution of soil type within the project area is shown on Drawing 25470-000-C2-0010-00001 The soil types of the area fall predominantly into hydrological soil group Type B with small areas of Type A, Type C and Type D soils (Reference 1, Reference 8).

6.0 CIVIL PLANNING AND DESIGN SYNOPSIS

The proposed limits of disturbance for the proposed project area are approximately 408 acres that include additional temporary acreage for construction activities. Drawing 25470-000-C2-0010-00002 shows the extent of post development drainage boundaries including the proposed disturbed areas, existing laydown area that will be used during construction, and the drainage areas contributing to the proposed culverts along the new access road. Presently, the area within the project boundary for the proposed CCNPP Unit 3 includes light to dense forests. Careful phasing and sequencing for erosion and sediment control, as well as stormwater management, will be required to minimize impacts from erosion and sedimentation while providing environmental protection and maintaining water quality standards.

The phasing plan will be established with four (4) phases of construction sequence:

- Installation of perimeter erosion and sediment controls
- Clearing and grubbing activities
- Grading and temporary vegetation
- Final establishment of stormwater management and permanent vegetation

6.1 Erosion and Sediment Control

6.1.1 Approach

Erosion and Sediment Control for the proposed project will be designed in accordance with the Calvert County Erosion and Sediment Control Ordinance and 1994 Maryland Standards and Specifications for Soil Erosion and Sediment Control. Installation of initial, intermediate, and final Erosion and Sedimentation Controls will be planned and implemented in accordance with Culvert County and MDE Best Management Practices (BMPs).

6.1.2 Sequence

Initial Erosion and Sediment Control

Controls will be installed prior to commencement of construction to minimize erosion and prevent sediment runoff due to construction activities. Initial controls will include, but not limited to the following:

- demarcation of limits
- perimeter protection fencing and controls including earth berms
- stabilized construction entrance at each point of entry or exit from the proposed site
- sediment traps/basins

Intermediate Erosion and Sediment Control

Upon satisfactory implementation of initial erosion and sediment control measures, the contractor will proceed with clearing and grubbing operations. The contractor will construct intermediate controls such as sediment ponds, diversion dikes, and stone check dams if necessary to control erosion and stormwater runoff. Upon completion, the contractor will begin the grading and construction phase. During this phase of construction, intermediate erosion control will be implemented as disturbances occur. Erosion control devices will need to be implemented or altered as the drainage patterns for stormwater are constructed. All disturbed areas, left exposed for a period of 14 days (7 days for steep slopes), will be mulched or have a temporary application of grass seeding. Sediment and erosion control measures will be checked and the contractor will inspect and maintain control measures daily.

Intermediate erosion and sediment controls may include, but are not limited to the following:

- Inlet sediment protection for existing storm structures and/or swales
- Stone check dams in existing and constructed swales
- Temporary sediment ponds and/or barriers

- Sediment traps
- Filter bags (as needed)
- Super Silt fencing
- Riprap aprons
- Gabion outlet structures
- Stabilized construction entrances
- Diversion dikes
- Mulching and temporary stabilization measures
- Dust control
- Dewatering sumps
- Other erosion and sediment controls as application of Flocculent Chemicals to reduce turbidity, if necessary.

Permanent Sediment and Erosion Control

The sequence of activities during the final phase of construction is as follows:

- Final grading (rough & finish)
- Stormwater management system and basins
- Installation of gravel sub-base for roads and parking areas
- Miscellaneous construction (pads, buildings, equipment, pavement, structures, etc.)

Permanent sediment and erosion control activities will include, but are not limited to the following:

- Installation of stormwater management systems, including basins and trenches which will work as sediment basins, during the rough grading phase
- Construction road stabilization during construction activities for gravel sub-base
- Application of rolled erosion control product (RECP) on steep slopes during final grading
- Permanent stabilization (grass seeding of final grades/open pervious areas)

- Removal of temporary erosion and sediment control measures when construction activities have been completed and permanent stabilization of the contributing drainage area has been established
- Other erosion and sediment controls as deemed appropriate

Unless otherwise stated, all erosion and sediment control measures will be planned, conducted, and maintained according to the Calvert County Soil Conservation District Standards and Specifications.

6.1.3 Management Strategy

The following six activities (as detailed in the Site Development Phasing Plan, Attachment 1) will constitute the erosion and sediment control strategy for this plan:

- Developing a construction schedule designed to minimize soil disturbance
- Limiting construction traffic to access roads and areas to be graded, and restricting entry and exit to the designated construction entrances (unless absolutely necessary, traffic will be prohibited from entering the runoff drainage course)
- Ensuring that equipment will be kept away from wetland areas, and prohibiting washing of tools in any body of water
- Implementing protective measures to prevent transport of sediment out of limits of disturbance (LOD), into any stream, wetland or drainage course
- Ensuring that excavated material will be stockpiled in an area protected from washout by proper controls such as silt fences and earth dikes, and assuring that laydown areas will be stabilized.
- Making sure that installed BMPs are regularly cleaned and repaired as necessary to maintain performance.

6.1.4 Vegetation Control Practice

- Mulching: Plant residue (wood chips) from the clearing and grubbing operation shall be utilized for disturbed area stabilization where practical. Due to time constraints and/or construction sequencing, it may be impractical to stabilize an area with vegetation. Mulching will reduce runoff and erosion, conserve moisture, prevent soil compaction and crusting, and modify soil temperature. Straw may be utilized at contractor's discretion in lieu of wood chips.

- Temporary Seeding: The sediment basin embankment, perimeter dikes, topsoil stockpile, and areas to be rough graded during the initial phase of construction shall be seeded and mulched per accepted standards. Conventional or hydraulic seeding equipment may be utilized in accordance with local jurisdictional codes.
- Jute Mesh: Jute mesh or other synthetic erosion control material will be used to aid in establishing grass growth. During construction, it may be applied in roadside ditches if deemed necessary.

6.1.5 Structural Practices and Controls

- Diversion Dikes/ Perimeter Dikes - Earthen perimeter dikes will be constructed to prevent the sediment laden stormwater runoff from reaching undisturbed areas and adjacent water bodies. Drawings 25470-000-CE-0100-00001 through 00016 show the locations of the perimeter dikes. The details of the dikes are given in Drawing 25470-000-C0-0000-00002. In addition, clean water diversion dikes will be placed to prevent runoff from undisturbed areas from reaching or impacting construction areas. Considerations will be given to construction sequence, construction season, local topography and the final erosion and runoff control scheme.
- Swales - Swales will be formed as needed to direct the runoff to the sediment traps, basins, or to the natural drainage. These swales will be excavated, graded and stabilized by gravel, sodding, seeding and mulch, or other synthetic material as required, according to the site and soil conditions. The cross section of the swales shall be designed to carry the runoff from each contributing area at a safe, non-eroding velocity.
- Temporary Construction Entrance - One of the first activities in the construction sequence will be the establishment of a construction entrance. At the intersection of the existing roads, temporary paved aprons will be installed. In periods of wet weather, wheels and tires will be washed as required to minimize transport of

soils onto public roads. Construction laydown and storage will be accessed through the same entrance. The detail of the construction entrance is shown on Drawing 25470-000-C0-0000-00002.

- Riprap Aprons - A riprap apron will be placed at the outlets of all pipes and culverts. The riprap apron will permit spreading of the discharge from the pipes and culverts to a larger area to slow the velocity of the discharge to a non-eroding velocity. The dimensions of the riprap apron and stone sizes are shown on the Rough Grade drawings. Details of the aprons are shown on Drawing 25470-000-C0-0000-00008.
- Super Silt Fence – Perimeter silt fence will be installed prior to the disturbance of the area. These will be placed on the contour to the extent possible. Silt fences will also be used at wetlands and 25 ft each side of wetlands. The details of the silt fence are shown on Drawings 25470-000-C0-0000-00002 and 00004.
- Sediment Traps/Basins – Sedimentation basins will be constructed, where necessary, to control the transport of sediment and the release of stormwater away from the construction area. The locations and design parameters of the sediment basins and traps are shown on Drawings 25470-000-CE-0100-00001 through 00016. The sediment basins/traps for the approximately 408 acres site are designed for two stages: 1) for the existing topographic condition (for the initial stages of construction while grading is established), and 2) for the proposed grading condition. For the existing condition, the site will be surrounded by earth dikes at strategic locations to create many of these temporary basins/traps, and also to divert the sediment laden flows towards them. For the proposed grading condition, the permanent stormwater basin will serve as sediment basins till the end of the construction activity. Each permanent basin will be excavated to its full post development dimensions and the permanent riser and outfall structures will be installed to provide sediment settling zone by the appropriate configuration of the outfall riser. Each basin will have an outlet that permits draining of water at a slow rate during a storm. These basins/traps will remain in operation during construction and will be cleaned periodically to maintain their function. Upon completion of construction, the basins will either be converted to

permanent basins if required, or be filled and the area shall be re-graded and stabilized. The details of the sediment trap and basin outlets are shown on Drawings 25470-000-C0-0000-00003 and 00005. The sizing of all these sediment basins and traps are performed in Reference 11.

- Dewatering During Construction – During construction, it may be necessary to remove water from inside the work area. Water will be pumped out of the excavation using a filtering sump and diverted through filter bags into a sediment trap or basin.
- Dust Control During Construction – Dust will be controlled by either temporary seeding or with dust suppression spray.
- Construction Laydown – Construction laydown areas will be established as shown on Drawings 25470-000-CG-0100-00003 through 00009. Construction parking areas will also be used as laydown areas when not in use for parking. These areas will be stabilized with a layer of gravel placed on a compacted sub-base.
- Permanent Stabilization – All areas disturbed by construction will be stabilized with vegetation, gravel or paving immediately following finish grading. Finish grading will include conversion of the temporary sediment basins to the planned permanent stormwater management system/basins (Permanent seeding shall be accomplished during the first planting season after the final grading). All vegetated areas will be re-established and stabilized with permanent seed mixture.

6.2 Stormwater Management

6.2.1 Introduction

An integrated system of stormwater management facilities are proposed to handle runoff from the developed areas in the drainage basins in which the project is proposed. A stormwater management study has been conducted to confirm sizes of different elements of the stormwater system in order to maintain both quality and quantity requirements applicable for the area.

6.2.2 Existing Condition

The proposed CCNPP Unit 3 site currently drains to the Chesapeake Bay, east of the site and to Johns Creek, west of the site. The eastern part of the site, which includes the power block area, drains east to the Chesapeake Bay through two tributaries. The western part of the site, including the cooling tower and the switchyard area, drains west to the Johns Creek. The existing drainage pattern will be maintained to the extent possible during the proposed construction of CCNPP Unit 3.

6.2.3 Stormwater Hydrology

In Maryland, 2000 Maryland Stormwater Design Manual (Reference 12) set the following criteria for sizing the stormwater management basins:

a. The water quality requirement (WQv) is the treatment volume generated from 1 inch rainfall multiplied by the volumetric runoff coefficient and site drainage area (Reference 12). Surface sand filter facilities and stormwater basins are designed to provide WQv. The channel protection storage volume (Cpv) dewatering orifice is set above the water quality volume when WQv is provided in the stormwater basin.

b. The recharge volume (Rev) is calculated based on the average annual recharge rate of the hydrological soil group present in the site (Reference 12). Rev is provided in the sand filter facilities (by exfiltration).

c. The channel protection storage volume (Cpv) is required to protect channels from erosion. This volume is set to be generated from 1-year 24-hour storm event. The drawdown requirement for the channel protection volume is 24 hours. (Reference 12). The outlet orifices are sized to maintain the extended detention drawdown time. This requirement is waived for direct tidal discharges.

d. The over bank flood protection volume (Qp) is provided by setting allowable release rates for given frequency storm events to equal the watershed's pre-developed rates in order to maintain discharge quantity requirement (Reference 12). The stormwater basins are sized to maintain post-development peak discharges at or below pre-development peak discharge rates for the 10-year, 24-hour storm. This requirement is waived for tidal discharges.

e. The spillways for the basins and trenches are sized to pass the 100-year, 24-hour storm without overtopping.

Reference 8 presents the stormwater runoff analysis for the stormwater management basins and ditches for CCNPP Unit 3. The stormwater basins and trenches are sized to have sufficient storage volume to detain the design storm in order to control the post-development runoff to the pre-development rate. Reference 10 presents the analysis for sizing the culverts to maintain adequate conveyance of the stormwater across the site (for design rainfall event 10-year 24-hour). Drawings 25470- 000-CG-0100-00001 through 000016 show the culverts and stormwater basins on the site (the stormwater basins will be used as sediment basins during construction). Drawings 25470- 000-CS-0100-00001 through 00013 show the permanent stormwater facilities. Stormwater management measures as described below will be implemented to promote infiltration, to attenuate the increase in peak discharge and to detain the stormwater runoff from the design storm events before discharging it:

- Use of crushed stone/gravel cover and seeded slopes to promote infiltration outside areas to be paved;
- Riprap swales to slowdown the runoff and to promote infiltration
- Use of riprap aprons at discharge outlets to slow down outflow to non-erodible velocities and encourage sheet flow downstream to prevent erosion

6.2.4 Methodology

- Stormwater management is addressed by following the Calvert County Department of Public Works Stormwater Management Ordinance (Reference 13) and Maryland Stormwater Design Manual (Volumes I & II), dated October 2000 (Reference 12). The discharge hydrographs are developed by using U.S. Department of Agriculture, Soil Conservation Service methodology (Reference 2) for the 1-, 10-, and 100-year design storm events for post-development conditions. The design hydrographs are also generated for 10-year design storm for pre-development condition in order to compare with 10-year post development discharge. The HEC-HMS computer program (Reference 6) is used as the tool to generate the hydrographs.

- Structural stormwater controls such as stormwater basins, stormwater trenches and sand filter trenches will be used to treat stormwater runoff and mitigate the impacts of increased discharge rates, volumes, and velocities. This will be accomplished by design and construction of open channels, energy dissipaters and storm drain pipe systems as applicable. Stormwater collected in the system will be routed to the detention basins before being discharged. Direct surface runoff will occur as sheet flow within the site and along internal roadway surfaces. In addition, culverts will be provided or modified to provide continuity to existing drainage patterns.

- The drainage design incorporates open channel and culvert design calculations to ensure that appropriate flow discharge and velocities are maintained throughout the system. The stormwater management design will incorporate design features to maintain existing water quality conditions. Catch basins may be equipped with sumps and oil/grease traps where deemed necessary to remove potential contaminants.

6.2.5 Stormwater Management System

The proposed stormwater management facilities include an integrated system of stone lined/riprap trenches, surface sand filter trenches, stormwater basins, wetland mitigation and stream restoration. The runoff from the developed area will be collected via the ditches towards the stormwater management basins. Controlled outflow from the basins will be discharged through outlets so that the discharge is at or below pre-development peak discharge rates.

Drawings 25470-000-CS-0100-00001 through 00013 show the post-development drainage facilities. Attachment 3 shows all permanent stormwater facilities.

Four surrounding trenches drain the site area that contains the CCNPP Unit 3 power block and adjacent construction laydown and cooling tower areas as described below:

- Runoff from the power block area is directed towards Trench 1, which is located along the northern, southern, and eastern edges of the power block. The north and south segments of Trench 1 discharge to the eastern segment of Trench 1.
- Runoff from the construction laydown area south of the power block is directed toward the south segment of Trench 1, and the east and south segments of Trench 2.
- The outflow from Trench 1 is directed to two locations: the treated low flow (via sand filter facility 1) will be discharged to the existing stream through Riser 7. The overflow from Trench 1 will be directed only to Forested Wetland through Riser 8. The treated outflows from Trench 2 are also directed to Forested Wetland. The spillway discharges from Forested Wetland is directed to the south towards the existing channel, while the low flow is diverted to the north to feed the forested wetland.
- The construction parking/batch plant area east to the cooling tower will drain to Trench 3. Trench 3 discharges to the east to the existing channel.

- The runoff from the cooling tower area will be discharged to Trench 4 located west of the cooling tower area. The outflow from Trench 4 will be discharged to Johns Creek west of the site.

The runoff from the switch yard area will be diverted to a stormwater basin SWB2 west of the switch yard area. The runoff from construction parking/laydown areas north of switch yard will flow to SWB2 through pipes and swales via sand filter trench 4. Runoff from the parking/laydown area north-west of switch yard will flow to sand filter trench 5 to the south of that area. The outflow from the sand filter will discharge to stormwater basin SWB2. Controlled treated outflow from SWB2 basin will be discharged to John's Creek.

Runoff from the parking/laydown area east of the existing ISFSI facility will be collected in basin SWB3 east of the ISFSI facility. The discharge from basin SWB3 will flow to the existing parking lot drainage system at the predevelopment rate.

The stormwater from the existing ISFSI building area currently drains towards the south. For the post developed condition, this flow will be diverted towards west to Lake Davis area as shown in Attachment 3. A stormwater basin (SWB1) is designed to detain the additional runoff before discharging it to Lake Davies.

All the stormwater detention facilities (stormwater basins and trenches) will be sized to fulfill the requirements according to Reference 12.

The proposed haul road drainage area will be drained directly to the Chesapeake Bay through road side ditches and culverts. The road side ditches are designed with mild slope and check dams to provide detention and recharge of the stormwater and also to provide non-erosive velocities. The configuration of the road side ditches fulfill the grass channel credit criteria, and hence provide the stormwater management for the haul road. The drainage from the intake area will also discharge directly to the Chesapeake Bay.

Reference 8 and Reference 15 details the calculation for sizing the stormwater basins and the outlets. The stormwater detention basins and trenches and their outlets are sized to provide controlled discharges at the outfall locations. The post-development discharges from the developed areas are compared with pre-development discharges for the 10-year 24-hour design storm at 6 locations: power block-north, power block-south, cooling tower, switchyard, parking area east to the existing ISFSI building, and Lake Davis area. Table 1 summarizes the pre- and post-development discharges at those locations (shown as Points of Interests (POIs) on Attachment 3). Table 2 provides the summary of flow and water level for each of the basins and trenches for 10-year 24-hour design storm.

Table 1: Pre- and Post-Development Discharge Summary For 10-year, 24-hour Storm at Outlets (POIs)

POI	Drainage Area	Post Development Peak Discharge (cfs)	Pre-Development Peak Discharge (cfs)
1	PBnorth-post	77.5	119.8
2	PBsouth-post	236.7*	101.0
3	Coolingtower-post	31.3	61.8
4	Switchyard-post	43.9	202.5
5	Parking-post	13.9	22.3
6	Lake Davies-post	12.1	14.8

*Qp waiver requested due to direct tidal discharge. Note that the stormwater from this area will be conveyed to the Chesapeake Bay in a non-erodible velocity.

Table 2: Post Development Basin Discharge Summary for 10-year, 24-hour Storm (Basins and trenches)

Stormwater Basin	Peak Inflow (cfs)	Peak Outflow (cfs)	Peak Water Level (ft)	Top of the Basin (ft)
SWB1	81.6	2.3	95.0	97.0
SWB2	387.0	28.5	86.3	90.0
SWB3	71.6	4.2	71.1	74.0
Ditch1	305.9	222.6	77.6	79.0
Ditch2	53.0	10.5	76.8	79.0
Ditch3	74.0	21.1	90.1	92.0
Ditch4	117.2	21.4	90.1	92.0
Res-1	54.6	33.1	57.6	65.0

The emergency spillways of the stormwater basins/ trenches are sized to pass the 100-year design storm keeping minimum 1 foot of free board. Table 3 provides a summary of the basins/trenches after passing the 100-year storm:

Table 3: Post Development Basin/Trench Discharge Summary for 100 year 24 hour Storm for Basin Full Condition (Basins and Trenches)

Stormwater basin	Peak Inflow (cfs)	Basin Water Level Before Storm (ft)	Peak Water Level (ft)	Top of the Basin (ft)	Peak Outflow (cfs)
SWB1	127.4	95.0	96.0	97.0	58.0
SWB2	573.3	86.0	88.9	90.0	341.4
SWB3	110.6	71.0	72.7	74.0	70.4
Ditch1	466.2	77.0	78.0	79.0	400.6
Ditch2	86.4	76.5	77.6	79.0	56.5
Ditch3	119.5	90.0	91.0	92.0	102.5
Ditch4	177.4	90.0	91.0	92.0	139.1
Res-1	186.1	57.0	60.0	65.0	136.2

The stormwater management facilities (stormwater basins/trenches and sand filters) are sized to fulfill the water quality and groundwater recharge requirement of the proposed development. The required volumes are calculated in Reference 8. The required volumes and the provided locations are summarized in Tables 4 and 5.

Table 4: Water Quality Volume Requirement for Post-development Condition

	Area (ac)	Required WQv (ft^3)	Provided WQv (ft^3)	Location
Powerblock	55	57027	59991	Sand Filter 1
Laydown/parking (east of CT)	15.4	11180	14004	Sand Filter 2
Cooling Tower	21.2	21816	26846	Sand Filter 3
Switch Yard	22.5	16335	114094	SWB2, below EL 80 ft
Switch Yard + North Parking/Laydown	27.5	50076	54269	Sand Filter 4
North-west Parking/Laydown	9.4	27842	32418	Sand Filter 5

Table 5: Recharge Volume Requirement for Post-Development Condition

	Area (ac)	Rev (ft^3)	Provided Rev (ft^3)	Location
Powerblock	55	14827	16878	Sand Filter 1, included in WQv
Laydown/parking (east of CT)	15.4	1246	4104	Sand Filter 2, included in WQv
Cooling Tower	21.2	5273	9450	Sand Filter 3, included in WQv
Switch Yard + North Parking/Laydown	50	16392	17149	Sand Filter 4, included in WQv
North-west Parking/Laydown	9.4	7239	8424	Sand Filter 5, included in WQv

The stormwater basin at the switchyard area (SWB2) will have storage below the CPv draw down orifice to provide quality volumes for the area. The power block area, the construction parking/laydown area to the east of the cooling tower, the cooling tower area, the switchyard area and the construction area at the north and north-west of switchyard area will have sand filter trenches as shown in the finish grade Drawings 25470-000-CS-0100-00001 through 00013 (also shown in Attachment 3). These are sized to meet the water quality and recharge requirements for the respective areas. The quality and recharge volumes for the heavy haul road and also for the construction road in the intake area will be met by grass channel credit. The quality and recharge volume requirements for the impervious Intake Area will be provided by disconnecting the roof top drainage.

Reference 15 describes the stormwater management for the access road, haul road and the Intake Area. The calculation shows that the road side ditches are designed with mild slope (maximum 4%) and check dams to provide detention and recharge of the stormwater and to provide non-erosive velocities (maximum 1 ft/sec) for 1-year 24-hour rainfall event. Also for the access road, the discharge at the ditches are kept below 2 cfs which result in no requirement for channel protection volume. The configuration of the road side ditches fulfill the grass channel credit criteria, and hence provide the stormwater management for the access road and the haul road.

The stormwater runoff from the two spoil areas (Lake Davies spoils area and the spoil area at the northern part of the site) has been analyzed in Reference 16. For the lake Davies spoils area, the storm drain system has been analyzed to safely pass the 10-yr, 24-hr storm to SWB7. The outflow from SWB7 is kept below the pre-development discharge for the same design storm. The principal spillway configuration for SWB7 satisfies the Cpv requirement, and the emergency spillway is sized to pass the 100 year storm with 1 foot of freeboard. For the northern spoil area, sediment traps will be converted to permanent impoundments so that the 10-yr, 24-hr peak discharge is below the pre-development peak discharge at all outfall locations toward the existing streams. The storage capacity in the impoundments satisfies the Cpv requirement for the area.

Reference 10 shows the calculations to size the roadway culverts to be built to ensure proper passage of the flow across the roadways. There are a total of 21 culverts in the site. The culverts are designed to pass the 10-year, 24-hour peak discharge. For the culverts constructed on the natural stream bed, the culverts are depressed by 1 foot to encourage siltation for improved fish passage. The inlet and outlets of the culverts are protected by providing rip-rap aprons as shown in the Rough Grade Drawings 25470-000-CG-0100-00001 through 00016. A summary of culvert flows are given in Attachment 4.

Reference 17 shows the hydraulic analysis of Culvert 5A and 5B. The pre- and post construction water surface elevations at the upstream of the culverts are calculated for 2-, 10-, and 100-year 24-hour design storm. The analysis shows that the construction of the culverts does not impose any potential inundation of the roadway or property at the vicinity of the culverts.

6.3 Critical Area 10% Rule Calculation

In order to reduce the potential for contamination of the Chesapeake Bay area watershed, the Chesapeake Bay Critical Area Commission uses a "10% rule" for the project area that falls within the Critical Area boundary to determine the extent, if any, for which the best management practices must be used to reduce the phosphorus loading caused by the project. The applicant has made the 10% rule calculation in accordance with the Commission's 10% Rule Guidance (Reference 7) and determined that there is no requirement for reducing the phosphorus loading, and hence no such best management practices are needed for this project.

7.0 PROPOSED CONSTRUCTION ACTIVITY

7.1 General Activities

Construction activities for the CCNPP Unit 3 project will disturb an area of approximately 408 acres that includes the disturbed area for parking, construction laydown and temporary facilities. The main plant will consist of the main power block structure, cooling tower, security building, switchyard, collecting ponds, buried utilities, intake structures, desalinized water storage tank, water treatment buildings intake structures and other miscellaneous structures.

Primary construction activities will include:

- Clearing and grubbing
- Excavation for main plant buildings
- Placement of compacted fill on the roadways and parking lot
- Excavation for and installation of underground utilities
- Excavation and placement of both bedding material and compacted backfill for the buried pipes
- Construction of plant structures

- Roadway and parking lot construction
- Final grading, permanent stabilization, and final paving
- Restoration and cleanup

7.2 Earth-Moving Activities

Excavation for plant facilities will require the removal and stockpiling of soils. This material will be stored on site. Sediment traps will be placed to block any sediment discharge from the stock pile area.

7.3 Construction of Buried Utilities

Construction of the underground utilities for the Project area will be conducted using conventional trench excavating techniques. The site will be divided into construction spreads or line segments to minimize the presence of open trenches at any given time. The excavation side slopes will be shored for safety. The excavated materials shall be placed on the high side of the trench for sediment control purposes. Adequate minimum cover over the pipelines will be in accordance with local jurisdictional codes. All disturbed area not covered by roadways will be restored and reseeded after construction.

Excavation of pipeline trenches will result in excess material to be stockpiled on site while stringing and joining operations are in progress. Subsequently, and when accessible, the stockpile material will be reused as the backfill material. Unused material will be used as fill elsewhere on the site or stockpiled on the site.

In general, pipeline construction activities will include the following typical construction methods:

- Grading and surface preparation
- Ditching and stabilizing the underground pipe trench
- Pipe installation and backfilling the underground pipe trench
- Restoration and cleanup

7.3.1 Grading and Surface Preparation

Surface vegetation will be removed and disposed of in an approved manner. Debris will be removed and the area graded in preparation for ditching.

7.3.2 Ditching and Erosion Prevention of Underground Pipe Trench

The ditch centerline will be staked following completion of grading or surface preparation activities. The ditch will be excavated to a depth sufficient to provide a minimum cover for protection from freezing. In areas that have been temporarily filled, the depth will be measured from the original ground surface. The method of excavation depends upon the specific soil conditions encountered. It is expected that a combination of rotary wheel type ditching machines and backhoes will be required. Ditch line breakers will be installed on steep or long slopes to prevent erosion around the pipeline.

7.3.3 Pipe Installation and Backfilling the Underground Pipe Trench

Prior to installation of the pipe, a suitable bedding material will be placed and then the pipe will be installed. Before backfilling begins, a final inspection will be made to ensure that all debris has been removed from the ditch and that the pipe and pipe coating are undamaged. Where bedrock is encountered or where the excavated materials are unacceptable for backfilling around the pipe, suitable material will be brought to the site for use. Sand, gravel, crushed rock, screened soil, or a combination of each, could be used. Breakers shall be installed if necessary, in the ditch over and around the pipe to provide full protection against wash-away in areas that are vulnerable to erosion.

The ditch will be backfilled using soil from the excavated pipeline ditch or, if necessary, imported material. Where applicable, measures will be taken to compensate for settling. Finish grade will be restored to ensure adequate stormwater drainage.

7.3.4 Restoration and Cleanup

When backfilling and resurfacing are complete, excess rock and similar materials will be removed from the right-of-way together with any accumulated construction debris.

Drainage ditches, terraces, roads, and fences will be restored to their former condition. Soil materials will be compacted and stabilized with vegetation. All surplus materials and construction equipment will be removed. Silt fences placed along the excavation, however, will remain in place until the vegetation soil cover is re-established.

7.4 Main Plant Area

During construction, the main plant construction area will be surrounded by a series of swales and diversions designed to direct all overland flow to the appropriate locations (culverts, sediment basins and stormwater basins). Silt fences will also be placed so that overland flow will filter transported sediment.

Construction laydown areas will be stabilized with crushed stone or gravel. Soil stockpile areas will be protected by silt fencing, earth dikes, gabion structures and sediment basin/traps to prevent any off-site transport of sediment. During construction of roadway(s), silt fencing will be placed in strategic locations in order to contain sediments.

8.0 CONSTRUCTION MONITORING AND MAINTENANCE

In general, all erosion and sediment control measures will be checked daily and after each significant rainfall. In particular, the following items will be checked:

- All sediment basins will be cleaned out when the level of sediment buildup reaches 50 percent of wet storage volume.
- The sediment traps will be checked regularly and after every rainfall event for sediment clean out.
- The gravel outlets will be checked regularly for sediment build up which will prevent drainage. If the outlet is clogged with silt, it will be removed and cleaned or replaced.
- All seeded areas will be checked regularly to see that a good stand is maintained. Areas shall be fertilized and reseeded as needed.

- Silt fence and filter bags shall be inspected immediately after each rainfall event. Any required repair shall be made immediately.
- Should the geotextile on any required silt fence or filter bag decompose or become ineffective (prior to its expected useful life), the geotextile shall be replaced promptly.
- Sediment deposits at barriers should be removed after heavy storms. They must be removed when deposits reach the criteria limit as defined by the state and local jurisdictional codes.
- Erosion rills formed on slopes, in swales, or around structures will be repaired and stabilized as soon as practicable after they are discovered.
- Diversion ditches/swales will be maintained at the required depth. Settled sediment material will be removed.
- Any sediment deposits remaining in place after the silt fence or filter barrier is no longer required shall be dressed to conform to the existing grade, prepared, and seeded.

9.0 REFERENCES

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4. Calvert Cliffs Nuclear Power Plant Site, Calvert County, MD, *Draft Wetlands Delineation Report, Proposed UniStar Nuclear Project Plant and Construction Area*, January 2007.
5. UniStar CCNPP Site Layout Team/ Cooling System Expert Working Group. *UniStar Calvert Cliffs Nuclear Power Plant Units 3 and 4. Cooling System*

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7. Maryland Chesapeake and Atlantic Coastal Bays, *Critical Area 10% Rule Guidance Manual,* Fall 2003.
8. Bechtel Calculation No. 25470-000-K0C-7400-00001, Rev 001, Stormwater Basin Sizing.
9. Bechtel Calculation No. 25470-000-K0C-7400-00002, Rev 000, Power Block and Switchyard Areas, Stormwater Drain Sizing.
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11. Bechtel Calculation No. 25470-000-K0C-7400-00004, Rev 001, Sediment Basin Sizing.
12. 2000 Maryland Stormwater Design Manual Volumes I & II, Maryland Department of the Environment, October 2000.
13. Stormwater Management Ordinance, Calvert County Department of Public Works, July 2001.
14. 1994 Maryland Standards and Specifications for Soil Erosion and Sediment Control.
15. Bechtel Calculation No. 25470-000-K0C-7400-00007, Rev 000, Calvert Cliffs Unit 3 Roadway Stormwater Management.
16. Bechtel Calculation No. 25470-000-K0C-7400-00008, Rev 000, Spoils Area Storm Drain Sizing.
17. Bechtel Calculation No. 25470-000-K0C-7400-00009, Rev 000, Hydraulic Analysis of Culvert 5A, 5B Area.

Attachment 1
CALVERT CLIFFS UNIT 3
SITE DEVELOPMENT
PRE-JPA PHASING PLAN

Document # 25470-000-30G-K03G-00001, Rev 003

BACKGROUND:

Site development for the Calvert Cliffs Unit 3 involves disturbance of approximately 408 acres of previously undisturbed lands. This area includes wetlands and streams which flow into John's Creek and the Chesapeake Bay. The areas of disturbance include steep slopes and natural soil which are subject to erosion.

PURPOSE:

This phasing plan describes the sequence of activities necessary to avoid uncontrolled run-off to streams and wetlands surrounding the property during site development. Activities described in this phasing plan include installation of silt fence, berms, sediment traps and basins prior to receipt of a Joint Permit Application (JPA). No work will be done in wetlands, buffers, or in areas that drain directly to wetlands/buffers until JPA is granted. This plan, along with the referenced drawings describe the initial stages of the site development and the methods to be followed to address environmental concerns associated with erosion and sediment control based on best practices and lessons learned from similar sites in the area.

This plan describes a general sequence of activities and does not preclude work from being performed in multiple areas concurrently or working more than one phase at a time provided the necessary protective measure are in place prior to proceeding with subsequent task.

PRE-JPA PHASING PLAN:

Phase 1: Silt Fence/ Orange Safety Fence Installation – (Duration 2 months)

The limit of disturbance (LOD) for the site shall be surveyed and marked as shown on Drawings 25470-000-C2-0000-00003 and 00004.

Contact the Maryland Department of the Environment Water Management Administration (WMA) at 410-537-3762 seven (7) days before commencing any land disturbance activities. A preconstruction meeting with WMA is required prior to proceeding with any land disturbance activities.

Contact "Miss Utility" at 1-800-257-7777 fourteen (14) days before commencing any land disturbance activities to request identification and marking of underground utilities.

The super silt fence/ orange safety fence shall be installed along the LOD, using small equipment, thus, limiting the amount of disturbance to the extent practical, around the spoils area (next to and east of the construction access road), the lay down areas (next to and west of the construction access road) and the forested wetland area (south of the Intake Structure), as shown on Drawings 25470-000-CG-0100-00002, 00003 and 00004.

The super silt fence shall be inspected after each rain event and maintenance performed as necessary.

Phase 2: Erosion & Sediment Control Features – (Duration 2 months)

Following Phase 1, sediment traps and basins shall be installed inside the spoils area, the laydown areas and the forested wetland area as shown on Drawings 25470-000-CE-0100-00002 through 6 and 25470-000-CE-0100-00012, 00013 and 00015.

After the installation of traps, berms shall be constructed. Soil required for the construction of berms, may be obtained from designated traps and from the spoils area if required, to complete the interim erosion and sediment control measures.

Berms should be covered with erosion matting and all disturbed areas should be mulched and seeded on a weekly basis. All erosion and sediment control features should be inspected after each rain fall to insure they are functioning as designed and to repair any areas where erosion is evident. Weekly inspections should also be conducted to verify that seeding has been successful and where necessary re-seed and mulch as required.

Phase 3: Maintenance – (As required)

On-going maintenance of all temporary erosion and sediment control and storm water management features is required during all site prep activities. This maintenance includes inspection and repair of silt fencing, berms and other features.

The steps and features outlined in the Phasing Plan are considered the minimum requirements based on best management practices and lessons learned. Maintenance and inspections activities need to include additional features as deemed necessary based on changes in field conditions, changes in work activities and observations associated with the performance of the features identified in this Plan.

Attachment 2
CALVERT CLIFFS UNIT 3
SITE DEVELOPMENT
POST-JPA PHASING PLAN

BACKGROUND:

Site development for the Calvert Cliffs Unit 3 involves disturbance of approximately 408 acres of previously undisturbed lands. This area includes wetlands and streams which flow into John's Creek and the Chesapeake Bay. The areas of disturbance include steep slopes and natural soil which are subject to erosion.

PURPOSE:

This phasing plan describes the sequence of activities necessary to avoid uncontrolled run-off to streams and wetlands surrounding the property during site development. Activities described in this phasing plan include tree clearing, stripping and rough grading. This plan, along with the referenced drawings describe the overall stages of the site development and the methods to be followed to address environmental concerns associated with erosion and sediment control based on best practices and lessons learned from similar sites in the area.

This plan describes a general sequence of activities and does not preclude work from being performed in multiple areas concurrently or working more than one phase at a time provided the necessary protective measure are in place prior to proceeding with subsequent task.

PHASING PLAN:

Phase 1: Survey – (Duration 2 months)

The limit of disturbance (LOD) for the site shall be surveyed and marked as shown on Drawings 25470-000-C2-0000-00003 and 00004.

Phase 2: Silt Fence/ Orange Safety Fence Installation – (Duration 4 months)

Contact the Maryland Department of the Environment Water Management Administration (WMA) at 410-537-3762 seven (7) days before commencing any land disturbance activities. A preconstruction meeting with WMA is required prior to proceeding with any land disturbance activities.

Contact "Miss Utility" at 1-800-257-7777 fourteen (14) days before commencing any land disturbance activities to request identification and marking of underground utilities.

Super silt fence/ orange safety fence shall be installed along the LOD using small equipment limiting the amount of disturbance to the extent practical.

The super silt fence/ orange safety fence installation shall begin at Nursery Road and proceed along both sides of the proposed construction access road, the spoils area and the lay down areas as shown on Drawings 25470-000-C2-0000-00003 and 00004.

The super silt fence/ orange safety fence shall be inspected after each rain event and maintenance performed as necessary.

Once the construction access road is complete, silt fence/ orange safety fence installation shall proceed around the plant area.

Upon completion of the silt fence/ orange safety fence around the plant area, installation of the silt fence/ orange safety fence shall continue along both sides of the haul road and around the intake area, including the shore line.

Phase 3: Construction Access Road Initial Tree Clearing – (Duration 2 months)

Notify the DNR Forest Service, 48 hours in advance, at (410) 260-8511 for the pre-construction meeting, inspection of retention line (tree protection device), and completion of construction activities and for inspection of the reforestation/afforestation planting sites as it is being installed, if planting is occurring. Tree protection devices consist of super silt fencing around the perimeter of the work area, where super silt fencing is not required; the limits of disturbance should be delineated with orange safety fencing.

Once the silt fence is installed along the construction access road, lay down areas and spoils area, trees along the silt fence line may be cleared to allow access for larger equipment necessary for installation of interim erosion and sediment control features. Tree clearing in this phase includes clearing for sediment traps 1 through 8 and sediment basins 7, 8 and 9 as shown on Drawings 25470-000-CE-0100-00002, 3, 12 and 13 and Drawings 25470-000-CE-0100-00004, 5 and 12 respectively. .

Tree clearing in this Phase, includes an area from the silt fence inward towards the work area. This area is to be limited to approximately 40-feet from the silt fence inward to allow adequate room for subsequent activities.

Trees within this 40-foot area are to be felled inward towards the work area taking care not to drop any trees or debris outside the limits of disturbance. Tree clearing in the area includes grubbing of tree trunks and root mats. Trees and grubbed materials shall be moved into or left in the center of the work area.

Note: Where access to existing site roads is maintained, materials generated from tree clearing and grubbing operations may be removed from the site as the work progresses provided no soil disturbance in unprotected areas is required

Phase 4: Plant Area Initial Tree Clearing – (Duration 3 months)

Notify the DNR Forest Service, 48 hours in advance, at (410) 260-8511 for the pre-construction meeting, inspection of retention line (tree protection device), and completion of construction activities and for inspection of the reforestation/afforestation planting sites as it is being installed, if planting is occurring. Tree protection devices consist of super silt fencing around the perimeter of the work area, where super silt fencing is not required; the limits of disturbance should be delineated with orange safety fencing.

Once the silt fence is installed around the perimeter of the plant area, trees along the silt fence line may be cleared to allow for larger equipment necessary for installation of interim erosion and sediment control features. Trees clearing in this phase includes clearing for sediment basins 1, 2, 3, 4, 5, 6 and 10 as shown on Drawings 25470-000-CE-0100-00007, 8, 9, 10 and 11 and sediment trap 12 as shown on Drawing 25470-000-CE-0100-00009.

Tree clearing in this Phase, includes an area from the silt fence inward towards the work area. This area is to be limited to approximately 40-feet from the silt fence inward to allow for adequate room for subsequent activities.

Trees within this 40-foot area are to be felled inward towards the work area taking care not to drop any trees or debris outside the limits of disturbance. Tree clearing in the area includes grubbing of tree trunks and root mats. Trees and grubbed materials shall be moved to, or left in the center of the work.

Note: Where access to existing site roads is maintained, materials generated from tree clearing and grubbing operations may be removed from the site as the work progresses provided no soil disturbance in unprotected areas is required.

Phase 5: Intake/Haul Road Initial Tree Clearing – (Duration 3 months)

Notify the DNR Forest Service, 48 hours in advance, at (410) 260-8511 for the pre-construction meeting, inspection of retention line (tree protection device), and completion of construction activities and for inspection of the reforestation/afforestation planting sites as it is being installed, if planting is occurring. Tree protection devices consist of super silt fencing around the perimeter of the work area, where super silt fencing is not required; the limits of disturbance should be delineated with orange safety fencing.

Once the silt fence is installed around the perimeter of the haul road and intake area, trees along the silt fence line may be cleared to allow for larger equipment necessary for installation of interim erosion and sediment control features. A tree clearing in this phase includes clearing for sediment traps 8, 9 and 10 as shown on Drawings 25470-000-CE-0100-00014 and 15.

Tree clearing in this Phase, includes an area from the silt fence inward towards the work area. This area is to be limited to approximately 40-feet from the silt fence inward to allow for adequate room for subsequent activities.

Trees within this 40-foot area are to be felled inward towards the work area taking care not to drop any trees or debris outside the limits of disturbance. Tree clearing in the area includes grubbing of tree trunks and root mats. Trees and grubbed materials shall be moved to, or left in the center of the work.

Note: Where access to existing site roads is maintained, materials generated from tree clearing and grubbing operations may be removed from the site as the work progresses provided no soil disturbance in unprotected areas is required.

Phase 6: Construction Access Road E&S Features – (Duration 5 months)

Following Phase 3; berms and traps shall be installed along the construction access road, inside the spoils area and in the laydown areas as shown on Drawings 25470-000-CE-0100-00001 through 6 and 25470-000-CE-0100-00012 and 13.

Soils required for construction of the berms may be obtained from high point along the access road (Sta. 5+00, Sta. 11+50, Sta. 23+00, Sta. 31+00, Sta. 38+00 and Sta. 56+00). If additional soil is required for the construction of berms, it may be obtained from designated traps along the construction access road and from the spoils area if required.

Construction of the berms includes installation of rock outlets. Stone for the rock outlets will need to be imported from off site.

In parallel with construction of the berms and associated rock outlets or gabions, sediment traps should be constructed in these areas as shown on the drawings to complete the interim erosion and sediment control measures.

Berms should be covered with erosion matting and all disturbed areas should be mulched and seeded on a weekly basis,. All erosion and sediment control features should be inspected after each rain fall to insure they are functioning as designed and to repair any areas where erosion is evident. Weekly inspections should also be conducted to verify that seeding has been successful and where necessary re-seed and mulch as required.

In parallel with the installation of temporary erosion and sediment control features, permanent culverts should be installed along the construction access road (Sta. 3+50, Sta. 7+50, Sta. 9+50, Sta. 17+50, Sta. 28+00, Sta. 34+00, Sta. 35+50, Sta. 42+50) to allow clean water from undisturbed areas to pass through the work area. Once culverts are installed, berms along the sides of the culverts may be abandoned and berm should be extended along the perimeter to close in gaps along at the culvert.

Culvert installations should include inlet and outlet protection as shown on the drawings and should be in place prior to the culvert being used for any flow of water.

As an alternative, the first culverts at Sta. 3+50, Sta. 7+50 and Sta. 9+50 may be installed near the end of the construction access road rough grading phase to maintain use of the existing paved roadway as long as possible for the activities shown in the early phases of the work.

Note: Installation of berms should start at low points (including traps and basins) and work outward towards high points to ensure that water from disturbed areas flow towards protected sections.

Phase 7: Plant Area E&S Features – (Duration 5 months)

Following Phase 4; berms basins, traps and ponds shall be installed within the Plant Area as shown on Drawings 25470-000-CE-0100-00006 through 11, 14, 15 and 16.

Soils required for construction of the berms may be obtained from high points within the site (Power Block – Drawing 25470-000-CG-0100-00010, Cooling Tower Blowdown Basin – Drawing 25470-000-CG-0100-00008) and from excavations required for traps, ponds and basins.

Construction of the berms includes installation of rock outlets. Stone for the rock outlets will need to be imported from off site.

Berms should be covered with erosion matting and all disturbed areas should be mulched and seeded on a weekly basis. All erosion and sediment control features should be inspected after each rain fall to insure they are functioning as designed and to repair any areas where erosion is evident. Weekly inspections should also be conducted to verify that seeding has been successful and where necessary re-seed and mulch as required.

Camp Conoy Road must remain open for emergency egress throughout the site development process.

Note: Installation of berms should start at low points (including traps and basins) and work outward towards high points to ensure that water from disturbed areas flow towards protected sections.

Phase 8: Intake/Haul Road E&S Features – (Duration 5 months)

Following Phase 5; berms and traps shall be installed within this area as shown on Drawings 25470-000-CE-0100-00014 and 15.

Soils required for construction of the berms may be obtained from high points within the site (Power Block, Drawing 25470-000-CG-0100-00010) and within excavations required for traps. If additional soil is required, excavation within the intake area may be performed to obtain addition material (Drawing 25470-000-CS-0100-00007).

Construction of the berms includes installation of rock outlets. Stone for the rock outlets will need to be imported from off site.

Berms should be covered with erosion matting and all disturbed areas should be mulched and seeded on a weekly basis. All erosion and sediment control features should be inspected after each rain fall to insure they are functioning as designed and to repair any areas where erosion is evident. Weekly inspections should also be conducted to verify that seeding has been successful and where necessary re-seed and mulch as required.

Note: Installation of berms should start at low points (including traps and basins) and work outward towards high points to ensure that water from disturbed areas flow towards protected sections

Phase 9: Tree Clearing Along the Construction Access Road – (4 months)

Following Phase 6, trees may be cleared along the entire width of the access road and the spoil area. Lumber is to be stockpiled in the spoils area to be subsequently shipped off site once the construction access road rough grading has been completed.

All limbs and undergrowth are to be mulched and may be stockpiled in the spoils area for re-use on site and subsequent shipment off site. Approximately 35 acres of tree clearing are estimated for this Phase and Phase 3 combined.

The entire length of the construction access road (up to Sta. 80+00) shall be grubbed of all root mats and stumps. Root material and stumps are to be stockpiled in the spoils area for subsequent shipment off-site. These materials may be ground up on site prior to being disposed of off-site.

Note: Where access to existing site roads is maintained, materials generated from tree clearing and grubbing operations may be removed from the site as the work progresses provided no soil disturbance in unprotected areas is required.

Phase 10: Tree Clearing - Plant Area – (Duration 5 months)

Following Phase 7, trees may be cleared in the plant area. Lumber is to be stockpiled in the lay down area in the Northwest corner of the plant area (Drawing 25470-000-CG-0100-00007) to be subsequently shipped off site once the access road rough grading has been completed. Approximately 190 acres of clearing are estimated for this Phase combined with Phase 4.

All limbs and undergrowth are to be mulched and stockpiled in the lay down area in the Northwest corner of the plant area for re-use on site and subsequent shipment off site.

The entire plant area shall be grubbed of all root mats and stumps. Root material and stumps are to be ground up and stockpiled in the lay down area in the Northwest corner of the plant area to subsequent shipment off site. These materials may be ground up on site prior to being disposed of off-site

Camp Conoy Road must remain open for emergency egress throughout the entire site development process.

Note: Where access to existing site roads is maintained, materials generated from tree clearing and grubbing operations may be removed from the site as the work progresses provided no soil disturbance in unprotected areas is required.

Phase 11. Tree Clearing - Intake/Haul Road Area – (Duration 4 months)

Following Phase 8, trees may be cleared from the haul road and intake area. Lumber is to be stockpiled in the power block area (Drawing 25470-000-CG-0100-00010) to be subsequently shipped off site once the access road rough grading has been completed. Approximately 15 acres of clearing are estimated for this Phase combined with Phase 5.

All limbs and undergrowth are to be mulched and stockpiled in the power block area for re-use on site and subsequent shipment off site.

The entire intake and haul road area shall be grubbed of all root mats and stumps. Root material and stumps are to be stockpiled in the power block area for subsequent shipment off-site. These materials may be ground up on site prior to being disposed of off-site

Note: Where access to existing site roads is maintained, materials generated from tree clearing and grubbing operations may be removed from the site as the work progresses provided no soil disturbance is required

Phase 12: Construction Access Road Rough Grading – (Duration 6 months)

Following Phase 9, the construction access road (Sta. 0+00 to Sta. 80+00) shall be stripped of organic material. Stripped materials shall be stock piled in the west end of the spoils area for subsequent re-use. The spoil area shall be built up in compacted lifts in a manner to maintain sheet flow off the spoil area and to avoid concentrated, or point discharges. Approximately 115,000 cubic yards of stripped materials are estimated in this Phase.

This phase includes intersecting roads off the construction access road which tie into existing site roads.

Rough grading of the construction access road from Sta. 0+00 to Sta. 80+00 shall be completed as shown on Drawings 25470-000-CG-0100-00001 through 7 and 25470-000-CG-0190-00002 through 5. This work includes all permanent storm water management features (ditches, manholes, catch basins, rip rap, etc.).

The rough grading for the access road includes approximately 300,000 cubic yards of cut and approximately 225,000 cubic yards of fill. For rough grading, rip rap will be the only materials which need to be imported during this Phase.

As the rough grading progresses, sediment traps 2, 4 and 7 shall be pumped out, filled in and abandoned.

Disturbed areas are to be seeded and mulched on a weekly basis, keeping up with the work as it progresses.

Upon completion of the rough grading for the access road, geotextile fabric shall be placed followed by the installation of aggregate subbase materials as shown on Drawing 25470-000-CG-0190-00001.

As an alternative, rough grading of the first 1500-feet of the construction access road may be completed in parallel with later phases in the development in order to maintain access to the existing paved entrance road as long as possible.

Phase 13: Lumber and Mulch Removal – (Duration 4 months)

Upon completion of the construction access road (Phase 12), lumber and mulch generated during the tree clearing operations shall be removed from the site.

Phase 14: Plant Area Rough Grading – (Duration 8 months)

Following Phase 10, the plant area shall be stripped of all organic material. Stripped materials shall be stock piled in the west end of the spoils area for subsequent re-use. The spoil area shall be built up in compacted lifts in a manner to maintain sheet flow off the spoil area and to avoid concentrated, or point discharges. Approximately 380,000 cubic yards for stripped material are estimated for this Phase.

Rough grade of plant area shall be completed as shown on Drawings 25470-000-CG-0100-00006 through 11 and 15. This work includes all permanent storm water management features (ditches, trenches basins, culverts, rip rap, etc.).

Catch basins with inlet protection, manholes and storm drain piping around the perimeter of the plant area should be installed in this Phase to avoid disturbances to the roads, ditches, trenches and ponds. The remaining catch basins, manholes and storm drain pipe are addressed Phase 16 of this plan.

The rough grading for the plant area includes approximately 3,500,000 cubic yards of cut and approximately 3,000,000 cubic yards of fill.

As the rough grading progresses, ponds, traps and basin as shown on Drawings 25470-000-CE-0100-00006 through 11, 15 and 16 should be pumped out, filled in and abandoned, with the concurrence of the Maryland Department of Environment, Water Management Administration (WMA) inspector, and when the areas draining to the facilities have been stabilized.

Disturbed areas along the perimeter of the plant area are to be seeded and mulched on a weekly basis keeping up with the work as it progresses.

Camp Conoy Road must remain open for emergency egress throughout this phase, until alternate access is provide by completing plant roads tying into Camp Conoy Road at Sta. 21+00 as shown on Drawings 25470-000-CG-0100-00009 and 25470-000-CG-0190-00001.

Upon completion of the rough grading in the plant area, roads within the plant area are to be completed with the installation of geotextile fabric and aggregate base material as shown on Drawing 25470-000-CG-0190-00001. After installing roads in the plant areas, lay down areas should be covered with aggregate base material as shown on Drawings 25470-000-CG-0100-00006 & 00007.

Phase 15: Intake/Haul Road Area Rough Grading – (Duration 5 months)

Following Phase 11, the intake and haul road area shall be stripped of all organic material. Stripped materials shall be stock piled in the west end of the spoils area for subsequent re-use. The spoil area shall be built up in compacted lifts in a manner so as to maintain sheet flow off the spoil area and to avoid concentrated, or point discharges. Approximately 35,000 cubic yards for stripped material are estimated for this Phase.

Rough grading of plant area shall be completed as shown on Drawings 25470-000-CG-0100-00010, 14 and 15. This work includes all permanent storm water management features (ditches, catch basins, culverts, rip rap, etc.).

The rough grading for the intake and haul road area includes approximately 240,000 cubic yards of cut.

As the rough grading progresses, sediment traps 9 and 10 as shown on Drawings 25470-000-CE-0100-00014 and 15 should be pumped out, filled in and abandoned.

Disturbed areas along the haul road and in the intake area are to be seeded and mulched on a weekly basis keeping up with the work as it progresses.

Upon completion of the rough grading in the intake and haul road area, the haul road and the barge slip apron are to be completed with the installation of geotextile fabric and aggregate subbase material as shown on Drawing 25470-000-CG-0190-00001.

Phase 16: Storm Drain Pipe Installation – (3 months)

Storm drain piping, manholes and catch basins, not installed during the rough grading phase, within the plant area (outside the power block loop road) shall be installed as shown on Drawing 25470-000-CD-0100-00001. Once installed, standard inlet protection shall be provided around each catch basin as shown on Drawing 25470-000-C0-0000-00003.

Catch basins, manholes and storm water piping with the power block loop road will be installed later in the project and coordinated with the mass excavation and backfill operations.

Storm drain piping, manholes and catch basins, not installed during the rough grading phase, within the switchyard area shall be installed as shown on Drawing 25470-000-CD-0100-00002. Once installed, standard inlet protection shall be provided around each catch basin as shown on Drawing 25470-000-C0-0000-00003.

Phase 17: Removal of Interim Measures and Site Stabilization (3 months)

After two full growing seasons and upon verification of successful germination of grass on disturbed areas, temporary berms and rock outlets should be removed.

Using small equipment, to limit disturbance, berms are leveled out and spoil spread over the area between the silt fencing and the finish grading limits. Rock from the outlets may also be spread over this area. Once the berm material (soil and rock) have been leveled out, the areas shall be seeded and mulched.

Non bio-degradable items such as gabions shall be removed from the area and discarded.

Silt fencing around the perimeter of the site may be removed one growing season after the berms have been removed.

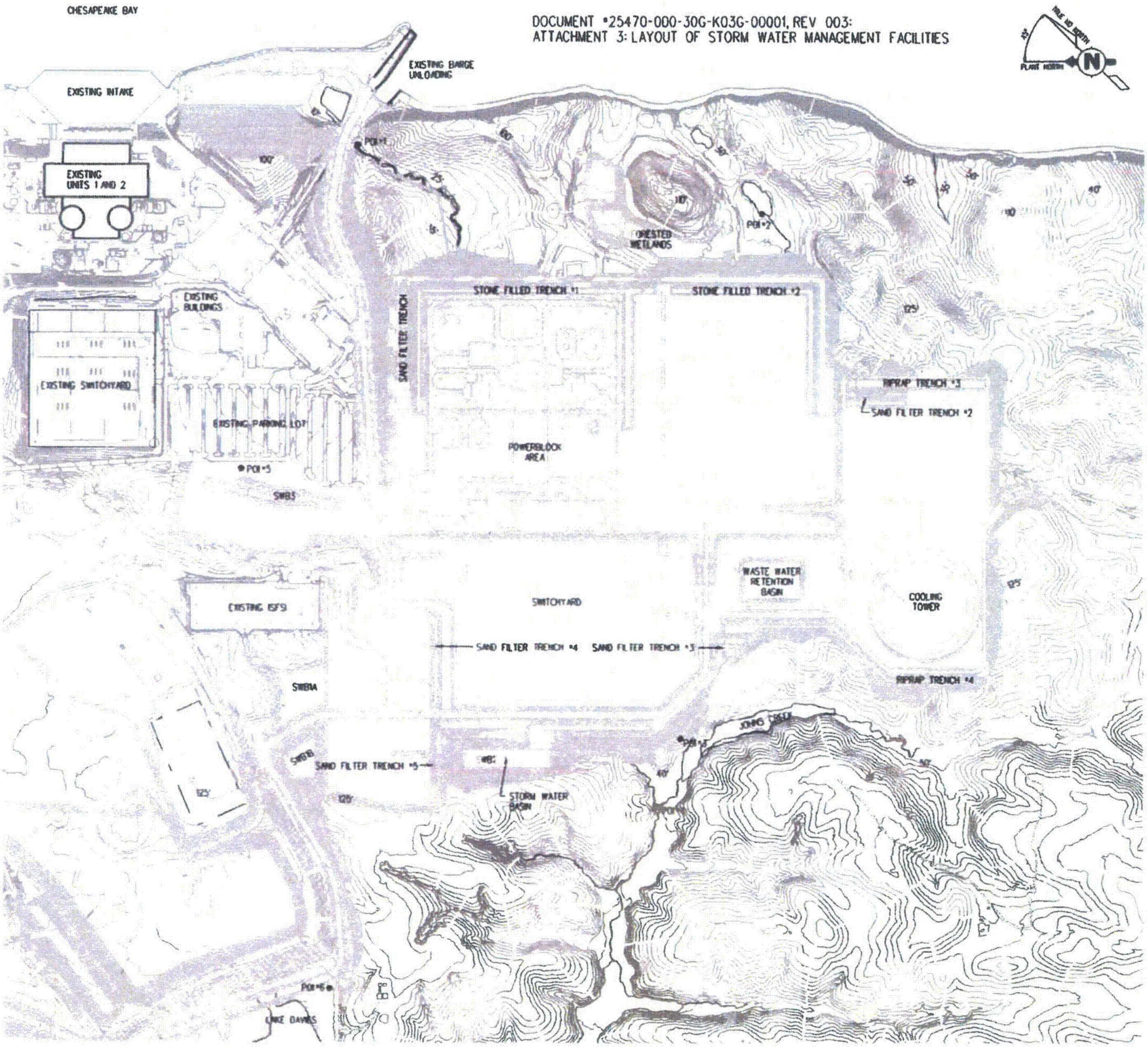
Phase 18. Maintenance – (As required)

On-going maintenance of all temporary and permanent erosion and sediment control and storm water management features is required during all site prep activities. This maintenance includes inspection and repair of silt fencing, berms and other features and re-seeding and mulching as required.

Upon completion of the site prep activities, inspections may be limited to weekly walk downs and inspections after each rain fall. After two growing seasons inspections may be further reduced based on field conditions.

The steps and features outlined in the Phasing Plan are considered the minimum requirements based on best management practices and lessons learned. Maintenance and inspections activities need to include additional features as deemed necessary based on changes in field conditions, changes in work activities and observations associated with the performance of the features identified in this Plan.

DOCUMENT #25470-000-30G-K03G-00001, REV 003:
ATTACHMENT 3: LAYOUT OF STORM WATER MANAGEMENT FACILITIES



Attachment 4
CALVERT CLIFFS UNIT 3
FLOW SUMMARY FOR CULVERTS

Document # 25470-000-30G-K03G-00001, Rev 003

Flow Summary for Culverts

Rough Grading Culvert #	Location	Drainage Area (Ac)	Length, feet	Inlet Inv. Elev., ft	Outlet Inv. Elev, ft	Dia, ft	Peak Q_{10}, cfs	# of Pipe	Q per pipe, cfs	Vel, V, fps
1	17+25 Const Rd	11.89	217.00	103.50	86.57	2.50	39.9	1	39.90	8.13
2	27+95 Const Rd	16.44	175.00	86.00	80.00	2.50	35.4	1	35.40	7.21
3*	34+20 Const Rd	16.16	209.50	79.00	76.00	2.50	40.0	1	40.00	8.15
4	37+20 Const Rd	2.35	98.00	100.50	98.00	1.50	8.9	1	8.90	5.04
5a,5b	42+80 Const Rd	99.26	495.00	80.00	60.00	4.50	265.4	2	132.70	8.34
7	61+80 Const Rd	9.12	100.00	76.00	75.50	2.50	32.2	1	32.20	6.56
6	61+40 Const Rd	4.20	100.00	76.00	75.50	2.00	16.2	1	16.20	5.16
8a,8b	EX Rd 64+50 R	22.64	90.00	77.00	76.00	2.50	62.1	2	31.05	6.33
10	79+00 Const Rd	14.10	141.25	94.00	92.00	3.00	45.6	1	45.60	6.45
9	78+00 Const Rd	4.00	270.00	100.00	95.00	2.00	18.3	1	18.30	5.83
11a,11b,11c	1+90 N	4.80	131.00	95.50	95.00	1.50	33.6	3	11.20	6.34
12	6+05 N	1.92	131.00	94.00	91.00	1.50	11.1	1	11.10	6.28
13	88+40 Const Rd	3.07	84.00	91.00	90.00	2.00	21.3	1	21.30	6.78
14	108+50	3.20	80.00	89.38	89.00	2.00	16.9	1	16.90	5.38
15	112+70	3.20	80.00	89.38	89.00	2.00	16.9	1	16.90	5.38
16	4+50 S	7.49	60.00	86.50	86.00	2.50	37.5	1	37.50	7.64
17	8+30 S	9.58	60.00	86.50	86.00	2.50	41.6	1	41.60	8.47
19a,19b	Laydown 12+25	4.61	155.50	83.00	82.50	2.00	21.10	2	10.55	3.36
20	3+10 Const Rd	1.32	107.00	100.00	97.00	1.50	4.10	1	4.10	2.32
21	7+45 Const Rd	5.38	192.75	92.25	89.50	2.00	19.4	1	19.40	6.18
22	9+55 Const Rd	0.77	123.00	102.00	101.40	1.50	2.5	1	2.50	1.41

Flow Summary for Depressed Culverts

Rough Grading Culvert #	Location	Drainage Area (Ac)	Length, feet	Inlet Inv. Elev., ft	Outlet Inv. Elev, ft	Dia, ft	Peak Q_{10}, cfs	# of Pipe	Q per pipe, cfs	Vel, V, fps
1	17+25 Const Rd	11.89	217.00	103.50	86.57	3.00	39.9	1	39.9	8.0
2	27+95 Const Rd	16.44	175.00	86.00	80.00	3.00	35.4	1	35.4	7.1
3*	34+20 Const Rd	16.16	209.50	79.00	76.00	3.00	40.0	1	40	8.0
5a,5b -2year	42+80 Const Rd	99.26	495.00	80.00	60.00	5.00	124.7	2	62.35	3.7
5a,5b -10year	42+80 Const Rd	99.26	495.00	80.00	60.00	5.00	265.4	2	132.7	7.9
5a,5b -100year	42+80 Const Rd	99.26	495.00	80.00	60.00	5.00	569.2	2	284.6	16.9
7	61+80 Const Rd	9.12	100.00	76.00	75.50	3.00	32.2	1	32.2	6.4
6	61+40 Const Rd	4.20	100.00	76.00	75.50	2.50	16.2	1	16.2	5.3
20	3+10 Const Rd	1.32	107.00	100.00	97.00	2.00	4.1	1	4.1	2.6

CALCULATION COVER SHEET

PROJECT	JOB NUMBER	CALCULATION NUMBER	SHEET
Calvert Cliffs Nuclear Power Plant Unit 3	25470	25470-000-K0C-7400-00003	1 of 16
US EPR Doc No. CCNP3-032-K0C-7400-00003	Rev 001	UNE Doc No. 000005910	Rev 001

SUBJECT	DISCIPLINE
Roadway Culvert Sizing	G&HES

CALCULATION STATUS DESIGNATION	PRELIMINARY	CONFIRMED with PRELIMINARY INFORMATION	CONFIRMED	SUPERSEDED	VOIDED
	☐	☐	☒	☐	☐

COMPUTER PROGRAM/TYPE	SCP	PROGRAM NO.	VERSION/RELEASE	OPERATING SYSTEM
	☒	GE212	3.2.0	Windows XP

NUCLEAR QUALITY CLASSIFICATION	SAFETY-RELATED	AUGMENTED QUALITY	NONSAFETY-RELATED	
	☐	☐	☒	

List of Attachments

1. Location Map and FEMA Flood Plain Map (1sheet)
2. Sub-Basin Drainage Area Map (1 sheet)
3. Calvert Cliffs post-development culvert drainage basin and soil classification (1 sheet)
4. Reference email for soil and land use data source(3 sheets)
5. RCN Calculation Spreadsheet (10 sheets)
6. HEC-HMS Input and Output (12 sheets)
7. Riprap Sizing Graph (1 sheet)
8. Culvert Pipe Sizing Calculation (3 sheets)
9. MDE Comments (3 sheets)
10. List of revised culverts (1 sheet)
11. Point Precipitation Frequency Estimates from NOAA Atlas 14 (3 Sheets)

Computer Program Validation Statement

Computer and software application were verified to be functioning correctly. A problem with a known answer was run, and the results were then compared to the known solution and found to be the same.

HEC-HMS is designed to simulate the precipitation-runoff processes of dendritic watershed systems, including large river basin water supply and flood hydrology, and small urban or natural watershed runoff. It is validated as shown in Calc No. 54921-510-BSAPHH-HEC-HMS-3.2.0, Rev 0.

Revision 000 Description

This calculation is updated from Previous calculation (25237-209-S0C-SS90-00003, Rev001) as the job number has been changed. The updates include minor changes in culvert locations and inverts as per Rev 0 drawings.

Revision 001 Description

The calculation has been revised to incorporate changes in culvert information and to add one new culvert.

Revision 002 Description

The calculation has been revised to incorporate MDE comments (Attachment 9) to depress the culvert inverts on natural streams. In addition, 2 and 100 year storm events are included in the HEC-HMS model.

REV. NO.	REASON FOR REVISION	TOTAL NO. OF SHEETS	LAST SHEET NO.	BY	CHECKED	APPROVED/ ACCEPTED	DATE
002	Issue to Project	55	Att.11 (sh3)	CKT	CMF	YZ/MN for NM	09 Aug. 2010
001	Issue to Project	42	Att.8 (sh2)	TA	CKT	YZ/MN for NM	11/4/09
000	Issue to Project	40	Att.8 (sh2)	TA	CKT	KRB/KRB for NM	5/15/09

RECORD OF REVISIONS

I. Objective

The objective of this calculation is to size the culverts along the proposed entrance road and other road crossings within the new facility for the Calvert Cliffs Unit 3 Nuclear Power Plant located in the Calvert County, Maryland (shown in Attachment 1). The culverts will be required to maintain the existing flow condition and to provide adequate drainage for the proposed storm water system in the region.

The calculation has been revised to incorporate MDE comments (Attachment 9) to depress the culvert inverts on natural streams by 1 ft. The culverts identified for this revision are: rough grade culverts 1, 2, 3, 5A & 5B, 6, 7 and 20 (Attachment 10) which correspond to calculation culverts 3, 4, 5, 7, 8A, 8 and 1, respectively. In addition, 2 and 100 year storm events are included in the HEC-HMS model.

II. Approach

Existing drainage pathways were identified from topographic surveys at the site, augmented by studies of 1:24,000-scale USGS topographic maps, aerial photography, and site visits.
The existing flow condition will be maintained through the culverts along the entrance road. The other culverts within the proposed area will be sized to provide adequate flow of the storm water. The culvert locations are shown in Attachment 2 (details are available on rough grade drawings).

A discharge hydrograph is developed in HEC-HMS (Reference 3) for each of the culverts taking in to account all the upstream drainage areas. The hydrographs are generated for 2, 10 and 100-year 24 hour storms. The culverts are sized to pass the 10-year 24 hour storm without overtopping the roads (Reference 1). Reinforced concrete pipes will be used for the culverts.

III. References

The following references were used for calculation of the culvert hydrology and hydraulics.

1. Stormwater Management Ordinance, Calvert County, Maryland, 2010.
2. National Highway Institute, "Hydraulic Design of Highway Culverts", September 2001
3. HEC-HMS Hydrologic Modeling System, Version 3.2 User's Manual, U.S. Army Corps of Engineers, April 2008
4. Technical Release 55, Urban Hydrology for Small Watersheds, U.S. Department of Agriculture, Soil Conservation Service, June 1986.
5. Munson, B.R., Young, D.F., Okiishi, T.H., "Fundamentals of Fluid Mechanics", 1994
6. Hydraulic Design Criteria, US Army Corps of Engineers, Waterways Experiment Station, March 1974. Graph for riprap sizing.
7. Maryland State Highway Administration, *Standard Specifications for Construction and Materials*, January 2001.
8. Chow, V.T., "Open-Channel Hydraulics", 1981

IV. Basic Data for HEC-HMS Model Development

Runoff hydrographs for the site conditions are developed in HEC-HMS, version 3.2.0. The parameters used for modeling are described in the following subsections.

a. Hyetograph development

Rainfall hyetograph used as input to HEC-HMS was developed using the rainfall depths from Attachment 11. The total rainfall depths for 1-, 2-, 5-, 10-, 25-, 50-, and 100-year events are listed in Table 1.

Table 1 - Design rainfall depths for Calvert County, MD (Attachment 11)

Return Period - years	24-hr total depth, inches
1	2.8
2	3.4
5	4.4
10	5.3
25	6.6
50	7.8
100	9.1

b. HEC-HMS Basin Model Input Parameters

Elements within the HEC-HMS basin model include subbasins, reaches, and junctions. Runoff hydrographs are developed for subbasins and are routed through the channel system along reaches connected by junctions (Reference 3).

This calculation utilized the NRCS Dimensionless Unit Hydrograph Methodology, which requires the following parameters for each subbasin:

- Drainage Area, in square miles
- Runoff Curve Number and Initial Abstractions
- Lag Time, in minutes (Lag = 0.6 x Time of concentration)

Drainage Area

Drainage areas were delineated and measured in MicroStation for each subbasin as shown in Attachments 2 and 3. The areas are presented in Table 2. The subbasin delineations are based on the rough grading plan 25470-000-CG-0100-0001 through 0016, Rev. 001.

Table 2 – Drainage Areas for Culvert Calculations

Sub basin ID	Area (acres)	Area (sq. mi)
CA-10 (1)	14.1	0.02203
CA-10A	4.0	0.00625
CA-9A (2)	1.05	0.00164
CA-7B (3)	68.36	0.10681
CA-7A (4)	30.9	0.04828
CA-5 (5)	16.16	0.02525
CA-4 (6)	16.44	0.02569
CA-3 (7)	11.89	0.01858
CA-2A (9)	0.77	0.00120
CA-2 (10)	5.38	0.00841
CA-1 (11)	1.32	0.00206
CA-9 (12)	8.01	0.01252
CA-8 (13)	4.59	0.00717
CA-8A (14)	4.2	0.00656
CA-6 (15)	2.35	0.00367
CA-11	3.07	0.00480
CA-13a	7.85	0.01230
CA-13b	1.73	0.00270
CA-14	7.49	0.01170
CA-15	3.20	0.00500
CA-16	3.20	0.00500
CA-17	4.80	0.00750
CA-18	1.92	0.00300
CA-21	4.61	0.00720

The peak flow through each of the culverts is the contribution of all the upstream drainage areas. Table 3 summarizes the drainage areas contributing to each of the culverts.

Table 3 – Drainage Areas Contributing to Each Culvert

Culvert #	Contributing Areas	Total Drainage Area	
		Ac	Sq miles
C-1	CA-1 (11)*	1.32	0.0021
C-2	CA-2 (10)*	5.38	0.0084
C-2A	CA-2A (9)*	0.77	0.0012
C-3	CA-3 (7)*	11.89	0.0186
C-4	CA-4 (6)*	16.44	0.0257
C-5	CA-5 (5)*	16.16	0.0253
C-6	CA-6 (15)*	2.35	0.0037
C-7	CA-7A (4)* + CA-7B (3)*	99.26	0.1551
C-8	CA-8 (13)*+CA-10A + 50% of CA-9A (2)*	9.12	0.01425
C-8A	CA-8A (14)*	4.20	0.0066
C-9	CA-9 (12)* +CA-10 (1)* + 50% of CA-9A (2)*	22.635	0.0354
C-10	CA-10 (1)*	14.10	0.0220
C-10A	CA-10A	4.0	0.00625
C-11	CA-11	3.07	0.0048
C-13	CA-13a,b	9.58	0.0150
C-14	CA-14	7.49	0.0117
C-15	CA-15	3.20	0.0050
C-16	CA-16	3.20	0.0050
C-17	CA-17	4.80	0.0075
C-18	CA-18	1.92	0.003
C-21	CA-21	4.61	0.0072

*computed by GIS analysis. All other areas scaled from drainage area maps using CAD.

Runoff Curve Number

Runoff curve numbers are a function of soil type and land use, as indicated by the SCS hydrologic group rating. Runoff curve numbers for land use conditions applicable to the site are provided in Table 4 (Reference 4).

Table 4 – Runoff Curve Numbers for Land Cover Applicable to This Site

Land Cover	Hydrologic Condition	Soil Types			
		A	B	C	D
Cultivated Crops (straight row)	Good	67	78	85	89
Pasture/Hay	Fair*	49	69	79	84
Deciduous Forest	Good	30	55	70	77
Evergreen Forest	Good	30	55	70	77
Seeded (newly graded and stabilized)	Poor*	68	79	86	89
Barren Land (Newly graded)	NA	77	86	91	94
Woody Wetlands	NA	100	100	100	100
Emergent Herbaceous Wetlands	NA	100	100	100	100
Industrial	NA	81	88	91	93
Developed, Open Space	Poor	68	79	86	89
Impervious (gravel and paved roads/parking	NA	98	98	98	98
Stone ground cover on filter cloth (no fines)	NA	50	70	80	90

*based on field visit to existing site

The distribution of soil types within the site area and also the land use map are obtained using GIS as described in Attachment 4.

Attachment 3 shows the drainage areas and the soil type distributions of the northern portion of the site where the major development will be the construction of the plant access road and the culverts along the road. For the calculation of CN number for these drainage areas, the soil map and the land use map were overlaid by using GIS tools to get the corresponding soil type and land cover type for each of the basins. The calculation of the weighted CN number is included as Attachment 5, and the summary is provided in Table 5. The rest of the drainage areas in the southern portion of the site (included in Attachment 2) will be subject to significant development. The soil type for these areas is conservatively considered to be Type C soil. The weighted CN numbers for these areas are calculated using the estimated land cover for the proposed condition as shown in Table 5.

Table 5 – Weighted Runoff Curve Numbers for the Drainage Areas

Sub basin ID	RCN	
CA-21	87.8	85% Seeded C, 15% Imp
CA-10A	87.2	90% Seeded C, 10% Imp
CA-10*	74.7	
CA-11	98	100% Imp
CA-13a	88.4	40% imp, 40% Stone C, 20% Seeded C
CA-13b	70.0	100% Forest C
CA-14	92.6	70% imp, 30% Stone C
CA-15	89.0	50% imp, 50% Stone C
CA-16	89.0	50% imp, 50% Stone C
CA-17	98	100% Imp
CA-18	89.0	50% imp, 50% Stone C

Sub basin ID	RCN
CA-2*	74.7
CA-1*	71.6
CA-2A*	71.4
CA-3*	76.9
CA-4*	69.7
CA-5*	71.5
CA-6*	72.4
CA-6A*	75.0
CA-7a*	73.5
CA-7b*	80.0
CA-8*	77.8
CA-8A*	74.3
CA-9*	66.1
CA-9A*	82.4

* computed by GIS analysis

All other RCN values computed by weighting by area as shown.

Lag Time

The lag time is taken as 60 percent of the time of concentration, calculated for each subbasin as the total time for overland, shallow concentrated, and channel flow times along the longest total path in the contributing area (Reference 4).

The SCS method gives the sheet-flow travel time as:

$$t_{sheet} = \frac{0.007(NL)^{0.8}}{(P_2)^{0.5} S^{0.4}}$$

in which N = an overland-flow roughness coefficient; L = flow length; P_2 = 2-year, 24-hour rainfall depth, in inches (taken as 3.4 inches based Attachment 11); and S = slope of hydraulic grade line, which is approximated by the land slope.

For this calculation, sheet flow is assumed to become shallow concentrated flow after 100 feet. The average velocity for shallow concentrated flow is estimated as $16.1345*S^{0.5}$ (Ref. 4 derived from graph page 3-2) for unpaved areas and as $20.3282*S^{0.5}$ for paved areas. The channel velocities are estimated to be 3 ft/sec.

The calculations of Tc and Lag Time for the drainage basins are summarized in Tables 6. Flow paths are shown on Attachment 2.

Table 6 – Time of concentration and lag time calculations

	Sheet Flow (Segment A-B)				Shallow Concentrated Flow (Segment B-C)				Pipe/Ditch Flow (Segment C-D)				
Sub-Basin	Length, L (ft)	n	Slope, S	T1 (hr)	Length, L (ft)	Slope S	V (fps)	T2 (hr)	L (ft)	V (fps)	T3 (hr)	Tc (min)	Lag Time (min)
CA-1	100	0.24	0.02	0.227	360	0.07	4.27	0.02	0	3.00	0.000	15.1	9.0
CA-10	100	0.13	0.01	0.184	630	0.04	3.23	0.05	600	3.00	0.056	17.6	10.6
CA-10A	100	0.13	0.01	0.184					1200	3.00	0.111	17.7	10.6
CA-11	100	0.011	0.02	0.019	120	0.02	2.87	0.01	840	3.00	0.078	6.5	3.9
CA-13a	100	0.13	0.012	0.171	700	0.008	1.44	0.13	30	3.00	0.003	18.5	11.1
CA-13b	100	0.13	0.012	0.171	170	0.08	4.56	0.01	120	3.00	0.011	11.5	6.9
CA-14	100	0.13	0.012	0.171	600	0.008	1.44	0.12	170	3.00	0.016	18.1	10.9
CA-15	100	0.13	0.01	0.184	270	0.015	1.98	0.04	0	3.00	0.000	13.3	8.0
CA-16	100	0.13	0.01	0.184	280	0.015	1.98	0.04	0	3.00	0.000	13.4	8.0
CA-17	100	0.011	0.02	0.019	530	0.02	2.87	0.05	0	3.00	0.000	4.2	3.6*
CA-18	100	0.13	0.02	0.139	100	0.02	2.28	0.01	80	3.00	0.007	9.5	5.7
CA-2	100	0.24	0.1	0.119	720	0.014	1.91	0.10	0	3.00	0.000	13.5	8.1
CA-21	100	0.13	0.01	0.184	500	0.005	1.14	0.12	0	3.00	0.000	18.3	11.0
CA-2A	100	0.24	0.03	0.193	200	0.1	5.10	0.01	0	3.00	0.000	12.3	7.4
CA-3	100	0.13	0.01	0.184	960	0.015	1.98	0.13	0	3.00	0.000	19.1	11.5
CA-4	100	0.24	0.01	0.300	1440	0.03	2.79	0.14	0	3.00	0.000	26.6	16.0
CA-5	100	0.24	0.01	0.300	1680	0.03	2.79	0.17	0	3.00	0.000	28.0	16.8
CA-6	40	0.13	0.01	0.088	0	0	0.00	0.00	520	3.00	0.048	8.2	4.9
CA-7a	100	0.24	0.01	0.300	1010	0.015	1.98	0.14	840	3.00	0.078	31.2	18.7
CA-7b	100	0.24	0.02	0.227	1630	0.015	1.98	0.23	550	3.00	0.051	30.4	18.3
CA-8	100	0.24	0.3	0.077	0	0	0	0.00	1320	3.00	0.122	12.0	7.2
CA-8A	100	0.24	0.3	0.077	0	0	0	0.00	1010	3.00	0.094	10.2	6.1
CA-9	100	0.24	0.02	0.227	200	0.05	3.61	0.02	720	3.00	0.067	18.6	11.1
CA-9A	60	0.13	0.2	0.037	100	0.05	3.61	0.01				2.7	3.6*

Sheet flow: n = 0.24 for existing grass, n = 0.13 for new graded area, n=0.011 for paved/ smooth surfaces

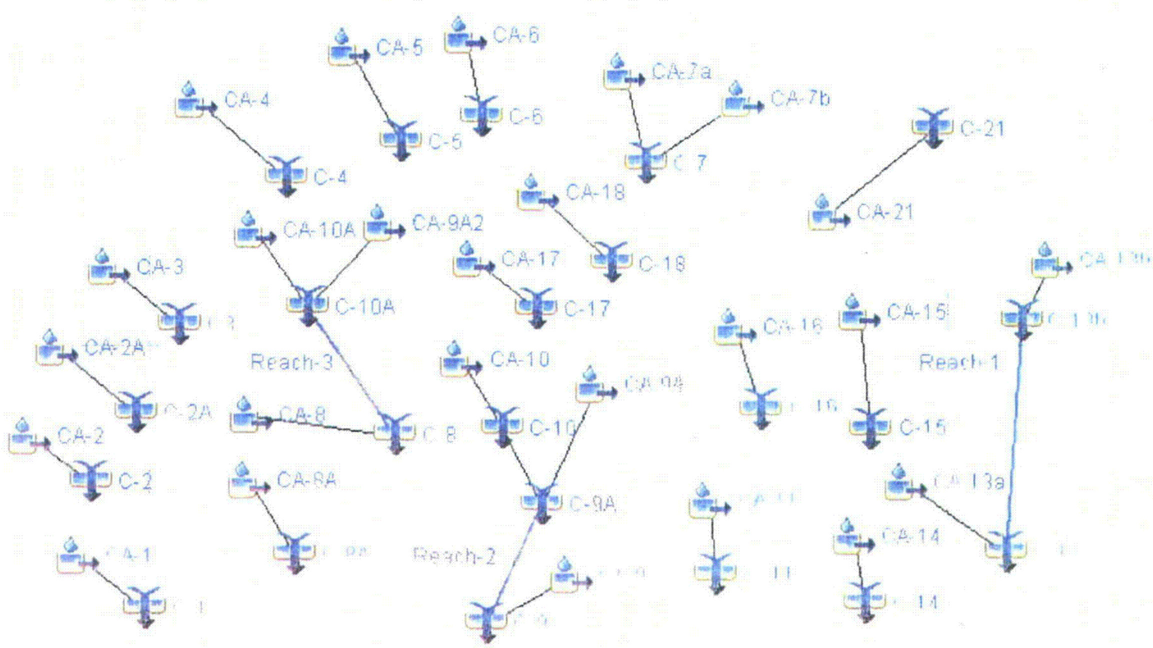
* Minumum Tc = 0.1 hr = 6 min = 3.6 min lag

V. Runoff Modeling

The runoff modeling for the roadway drainage area is performed to calculate the discharge for each of the culverts. Those are discussed below.

The drainage network used to simulate hydrology for the site in HEC-HMS is shown in Figure 1

Figure 1 – HEC-HMS Schematic for the drainage system of the culverts



The culverts are represented by junctions as shown in Figure 1. In addition, reaches are introduced to carry on the flow from one junction to another where required. The reaches are incorporated in the HEC-HMS model by providing lag time for each reach which represents the time required to travel the flow from one junction to another. The calculations of lag times for the reaches are shown in Table 7.

Table 7 – Lag time calculations for the reaches

Reach	Flow path	Length	Vel*	Lag time
1	Shallow flow on finished grade	600 ft	2 fps	5 min
2	Roadside Ditch	1350 ft	3 fps	7.5 min
3	Roadside Ditch	1450 ft	3 fps	8 min

* based on estimated velocities.

The other input parameters for the HEC-HMS are discussed in Section III (Tables 2, 5 and 6). All the input parameters (Tables 2, 5, 6, and 7) are applied to the HEC-HMS network shown in Figure 1 to obtain the peak discharges for all the junctions which represent the peak flow through the culverts in this calculation.

Peak discharges for all junctions for the 2 ,10 and 100-year 24-hour rainfall event modeled in HEC-HMS are shown in Table 8. See Attachment 6 for the HEC-HMS input and output files from which Table 8 was developed.

Table 8 – Results of HEC-HMS modeling

2-year -24 hour rainfall event

HEC-HMS Element	DA (sm)	Q2 (cfs)	HEC-HMS Element	DA (sm)	Q2 (cfs)
C-1	0.00206	1.7	C-2	0.00841	8.6
C-10	0.02203	20.2	C-21	0.00720	11.8
C-10A	0.00625	10.2	C-2A	0.00120	1.0
C-11	0.00480	13.6	C3	0.01858	18.4
C-13	0.01500	22.6	C-4	0.02569	13.5
C-14	0.01170	22.5	C-5	0.02525	14.6
C-15	0.00500	9.7	C-6	0.00367	3.8
C-16	0.00500	9.7	C-7(*)	0.15509	124.7
C-17	0.00750	21.4	C-8	0.01425	16.4
C-18	0.00300	6.4	C-8A	0.00656	7.2
			C-9	0.0354	26.1

Table 8 continuing – Results of HEC-HMS modeling

10-year -24 hour rainfall event

HEC-HMS Element	DA (sm)	Q10 (cfs)	HEC-HMS Element	DA (sm)	Q10 (cfs)
C-1	0.00206	4.1	C-2	0.00841	19.4
C-10	0.02203	45.6	C-21	0.00720	21.1
C-10A	0.00625	18.3	C-2A	0.00120	2.5
C-11	0.00480	21.3	C3	0.01858	39.9
C-13	0.01500	41.6	C-4	0.02569	35.4
C-14	0.01170	37.5	C-5	0.02525	36.3
C-15	0.00500	16.9	C-6	0.00367	8.9
C-16	0.00500	16.9	C-7 (*)	0.15509	265.4
C-17	0.00750	33.6	C-8	0.01425	32.2
C-18	0.00300	11.1	C-8A	0.00656	16.2
			C-9	0.0354	62.1

100-year -24 hour rainfall event

HEC-HMS Element	DA (sm)	Q100 (cfs)	HEC-HMS Element	DA (sm)	Q100 (cfs)
C-1	0.00206	9.6	C-2	0.00841	43.1
C-10	0.02203	102.0	C-21	0.00720	39.5
C-10A	0.00625	34.6	C-2A	0.00120	5.9
C-11	0.00480	36.7	C3	0.01858	86.2
C-13	0.01500	80.7	C-4	0.02569	87.1
C-14	0.01170	67.0	C-5	0.02525	86.6
C-15	0.00500	31.2	C-6	0.00367	20.5
C-16	0.00500	31.2	C-7(*)	0.15509	569.2
C-17	0.00750	58.1	C-8	0.01425	65.0
C-18	0.00300	20.5	C-8A	0.00656	36.2
			C-9	0.0354	144.4

(*) When calculating the flowrate the calculation conservatively neglects the retention due to an upstream storm water basin which is shown in Rough Grade Plan Sheet 4, 25470-000-CG-0100-00004 Rev. 001.

VI Culvert Pipe Sizing

The design discharges for the culverts are taken from the HEC-HMS model outputs (presented in Table 8). Other information for all the culverts (lengths, invert elevations, critical elevations etc) are taken from Bechtel Drawings No 25470-000-CG-0100-00001 though 00016 Rev. 001.

The details of culvert calculation is presented in Attachment 8 and is summarized in Table 9 and 10 for culverts without and with depressed inverts, respectively.

VII 100-year Floodplain

There are riverine flood plains designated within the project area. Attachment No. 1 shows the FEMA map for the project location.

Table 9 – Information for culverts without depressed invert

Calculation Culvert #	Rough Grading Culvert #	Location	Drainage Area (Ac)	Peak Q, cfs (1)	Length, feet	Inlet Inv. Elev., ft	Outlet Inv. Elev, ft	Dia, ft	# of Pipe	Q per pipe, cfs	Vel, V, fps
6	4	37+20 Const Rd	2.35	8.9	98.00	100.50	98.00	1.50	1	8.90	5.04
9	8a,8b	EX Rd 64+50 R	22.64	62.1	90.00	77.00	76.00	2.50	2	31.05	6.33
10	10	79+00 Const Rd	14.10	45.6	141.25	94.00	92.00	3.00	1	45.60	6.45
10A	9	78+00 Const Rd	4.00	18.3	270.00	100.00	95.00	2.00	1	18.30	5.83
17	11a,11b,11c	1+90 N	4.80	33.6	131.00	95.50	95.00	1.50	3	11.20	6.34
18	12	6+05 N	1.92	11.1	131.00	94.00	91.00	1.50	1	11.10	6.28
11	13	88+40 Const Rd	3.07	21.3	84.00	91.00	90.00	2.00	1	21.30	6.78
16	14	108+50	3.20	16.9	80.00	89.38	89.00	2.00	1	16.90	5.38
15	15	112+70	3.20	16.9	80.00	89.38	89.00	2.00	1	16.90	5.38
14	16	4+50 S	7.49	37.5	60.00	86.50	86.00	2.50	1	37.50	7.64
13	17	8+30 S	9.58	41.6	60.00	86.50	86.00	2.50	1	41.60	8.47
21	19a,19b	Laydown 12+25	4.61	21.10	155.50	83.00	82.50	2.00	2	10.55	3.36
2	21	7+45 Const Rd	5.38	19.4	192.75	92.25	89.50	2.00	1	19.40	6.18
2A	22	9+55 Const Rd	0.77	2.5	123.00	102.00	101.40	1.50	1	2.50	1.41

		Outlet Control					Inlet Control						
Calculation Culvert #	Rough Grading Culvert #	ΣK (2)	Head Loss, ft (3)	Normal Depth ft at outfall**	Tail water EL, ft (4)	HW Elev., ft, (5)	HW/D (6)	HW depth, feet (7)	HW Elev., ft, (8)	Control: (9)	Critical elev.or road top (10)	Grade over Pipe elev.	Free-board, ft (11)
6	4	2.50	1.68	0.43	98.43	100.12	1.22	1.83	102.33	Inlet	103.00	105.00	0.67
9	8a,8b	1.50	1.44	1.28	77.28	78.73	1.18	2.95	79.95	Inlet	81.00	82.00	1.05
10	10	1.50	1.63	1.08	93.08	94.71	1.10	3.30	97.30	Inlet	100.00	104.00	2.70
10A	9	1.50	2.55	0.65	95.65	98.20	1.22	2.44	102.44	Inlet	104.00	104.00	1.56
17	11a,11b,11c	1.50	2.42	0.92	95.92	98.33	1.50	2.25	97.75	Outlet	99.30	99.30	0.97
18	12	1.50	2.37	0.49	91.49	93.86	1.48	2.22	96.22	Inlet	98.00	99.00	1.78
11	13	1.50	1.81	0.71	90.71	92.52	1.35	2.70	93.70	Inlet	95.00	97.00	1.30
16	14	1.50	1.12	0.62	89.62	90.74	1.17	2.34	91.72	Inlet	95.00	96.00	3.28
15	15	1.50	1.12	0.62	89.62	90.74	1.17	2.34	91.72	Inlet	95.00	96.50	3.28
14	16	1.50	1.86	0.98	90.10	91.96	1.42	3.55	90.05	Outlet	93.00	93.50	1.04
13	17	1.50	2.29	1.03	90.10	92.39	1.55	3.88	90.38	Outlet	93.00	93.50	0.61
21	19a,19b	1.50	0.60	0.71	83.21	83.81	0.84	1.68	84.68	Inlet	86.00	100.00	1.32
2	21	2.50	2.89	0.68	90.18	93.07	1.28	2.56	94.81	Inlet	104.00	106.00	9.19
2A	22	1.50	0.12	0.21	101.61	101.72	0.56	0.84	102.84	Inlet	105.00	107.80	2.16

** Based on Mannings equation for assumed trapezoidal channel, b=8', ss = 3:1, n=0.035, s=1%

Table 10 – Information for culverts with depressed invert

Calculation Culvert #	Rough Grading Culvert #	Location	Drainage Area (Ac)	Peak Q, cfs (1)	Length, feet	Inlet Inv. Elev., ft	Outlet Inv. Elev, ft	Dia, ft	alpha (rad) (1a)	theta (rad) (1b)	flow area (ft2) (1c)	Wetted Per. (ft) (1d)	Hyd. Radius (ft) (1e)	Hyd. Dia (ft) (1f)	# of Pipe	Q per pipe, cfs	Vel, V, fps
3	1	17+25 Const Rd	11.89	39.9	217.00	103.50	86.57	3.00	1.23	3.82	5.01	8.56	0.58	2.34	1	39.90	7.97
4	2	27+95 Const Rd	16.44	35.4	175.00	86.00	80.00	3.00	1.23	3.82	5.01	8.56	0.58	2.34	1	35.40	7.07
5*	3*	34+20 Const Rd	16.16	40.0	209.50	79.00	76.00	3.00	1.23	3.82	5.01	8.56	0.58	2.34	1	40.00	7.99
7 - 2 years***	5a,5b	42+80 Const Rd	99.26	124.7	495.00	80.00	60.00	5.00	0.93	4.43	16.84	15.07	1.12	4.47	2	62.35	3.70
7 - 10 years	5a,5b	42+80 Const Rd	99.26	265.4	495.00	80.00	60.00	5.00	0.93	4.43	16.84	15.07	1.12	4.47	2	132.70	7.88
7 - 100 years***	5a,5b	42+80 Const Rd	99.26	569.2	495.00	80.00	60.00	5.00	0.93	4.43	16.84	15.07	1.12	4.47	2	284.60	16.90
8	7	61+80 Const Rd	9.12	32.2	100.00	76.00	75.50	3.00	1.23	3.82	5.01	8.56	0.58	2.34	1	32.20	6.43
8A	6	61+40 Const Rd	4.20	16.2	100.00	76.00	75.50	2.50	1.37	3.54	3.08	6.88	0.45	1.79	1	16.20	5.27
1	20	3+10 Const Rd	1.32	4.10	107.00	100.00	97.00	2.00	1.57	3.14	1.57	5.14	0.31	1.22	1	4.10	2.61

* 10% more discharge value from Table 8 due to slight increase in drainage area

Outlet Control					Inlet Control						
ΣK (2)	Head Loss, ft (3)	Normal Depth ft at outfall**	Tail water EL, ft (4)	HW Elev., ft, (5)	HW/Dh (6)	HW depth, feet (7)	HW Elev., ft, (8)	Control: (9)	Critical elev.or road top (10)	Grade over Pipe elev.	Free-board, ft (11)
1.50	6.56	1.01	87.58	94.14	1.80	4.21	107.71	Inlet	108.50	109.70	0.79
1.50	4.39	0.94	80.94	85.33	1.60	3.74	89.74	Inlet	93.00	100.00	3.26
1.50	6.41	1.01	77.01	83.42	1.80	4.21	83.21	Outlet	93.00	99.00	9.58
2.50	1.59	1.85	61.85	63.43	0.75	3.35	83.35	Inlet	100.00	114.00	16.65
2.50	7.19	2.69	62.69	69.88	1.20	5.36	85.36	Inlet	100.00	114.00	14.64
2.50	33.06	3.87	63.87	96.93	2.80	12.51	92.51	Outlet	100.00	114.00	3.07
1.50	2.49	0.90	76.40	78.88	1.50	3.51	79.51	Inlet	82.00	84.00	2.49
1.50	2.11	0.61	76.11	78.22	1.50	2.68	78.68	Inlet	82.00	85.00	3.32
1.50	0.80	0.28	97.28	98.07	1.10	1.34	101.34	Inlet	103.00	104.00	1.66

** Based on Mannings equation for assumed trapezoidal channel, b=8', ss = 3:1, n=0.035, s=1%

*** Design is for 10 years return period, provided for information

VIII Riprap size calculation

Downstream riprap protection is required for all culverts to protect scouring. The required riprap size calculations are performed using the velocity vs stone diameter graph provided in Reference 6 (the graph is provided as Attachment 7). The W50 is converted to MSHA size category (Table 12 from Reference 7). The summary is shown in Table 11.

Table 11 – Riprap size calculation

Calculation Culvert No.	Rough Grading Culvert No	Vel, V, fps	Riprap W50 (from Attachment 7) lb	MSHA Class
1	20	2.6	40*	I
2	21	6.2	40*	I
2A	22	1.4	40*	I
3	1	8.0	60	II
4	2	7.1	40*	I
5	3	8.0	60	II
6	4	5.0	40*	I
7	5a, 5b	7.9	60	II
8	7	6.4	40*	I
8A	6	5.3	40*	I
9	8a, 8b	6.3	40*	I
10	10	6.5	40*	I
10A	9	5.8	40*	I
11	13	6.8	40	I
17	11a, 11b, 11c	6.3	40*	I
18	12	6.3	40*	I
16	14	5.4	40*	I
15	15	5.4	40*	I
14	16	7.6	40	I
13	17	8.5	60	II
21	19a, 19b	3.4	40*	I

* Use minimum 40 lb or 9 inch Riprap

Table 12 – MSHA riprap classes

Class	W50	Range	Maximum V
0*	10 lbs	1 - 33 lbs	5 fps
I	40 lbs	2 - 150 lbs	7.5
II	200 lbs	20 – 700 lbs	10.5
III	600 lbs	40 – 2000 lbs	15

*Erosion matting may be substituted for Class 0 riprap

IX Summary and Conclusions

Twenty one culverts proposed for the Calvert Cliffs Unit 3 are located in Calvert County, Maryland have been sized in this calculation, for passing 10-year 24-hr storm.

Drainage patterns of the site were identified for all the contributing drainage basins. The peak outflow for each culvert was calculated using HEC-HMS modeling. The culverts were sized to provide adequate capacity to pass the peak discharges through them without causing any backwater over roadways or facility pads.

X Reference Drawings

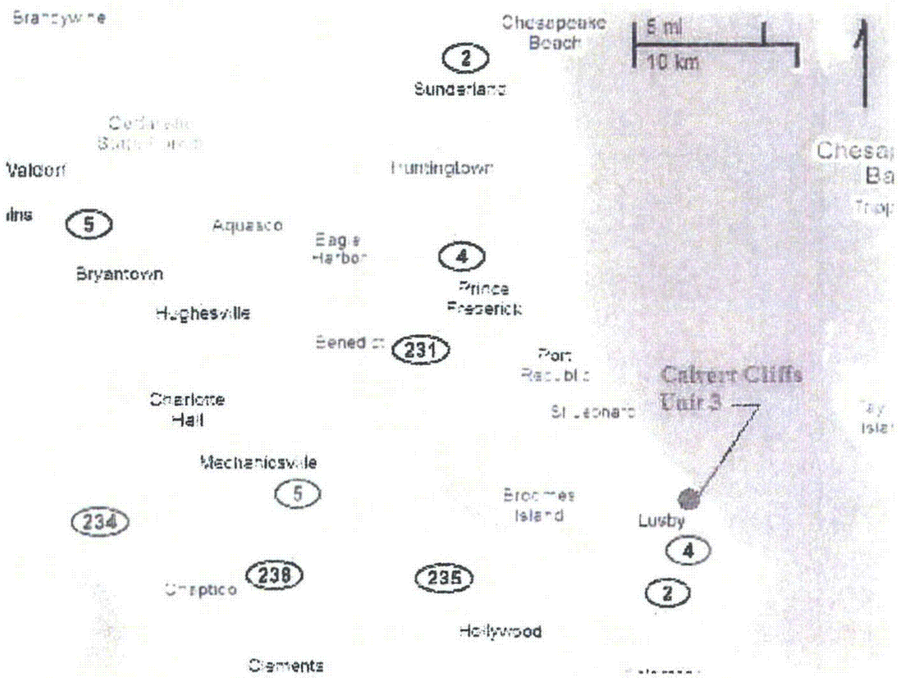
1. 25470-000-CG-0100-00001 Rev 001 through 25470-000-CG-0100-00016 Rev 001, Calvert Cliffs Unit 3, Rough Grade Plan Sheets 1 through 16.

Calvert Cliffs – Unit 3

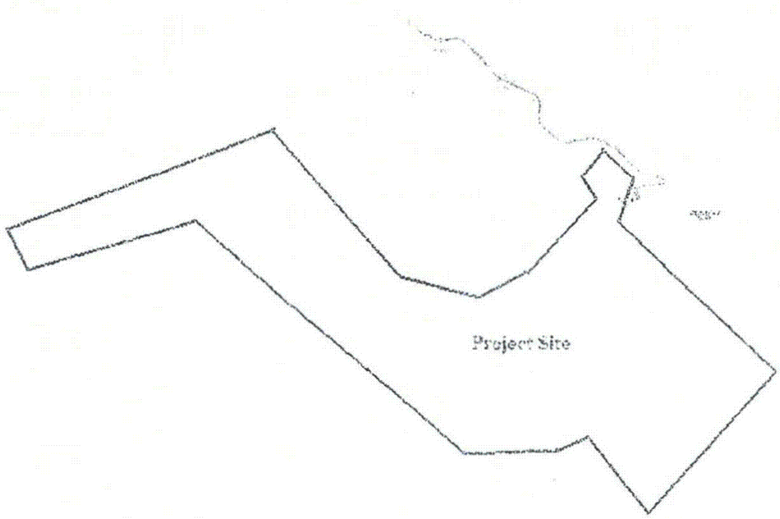
Job No: 25470
Calc No 25470-000-K0C-7400-00003
Rev 002

ATTACHMENT 1 Sheet 1/1

Location Map

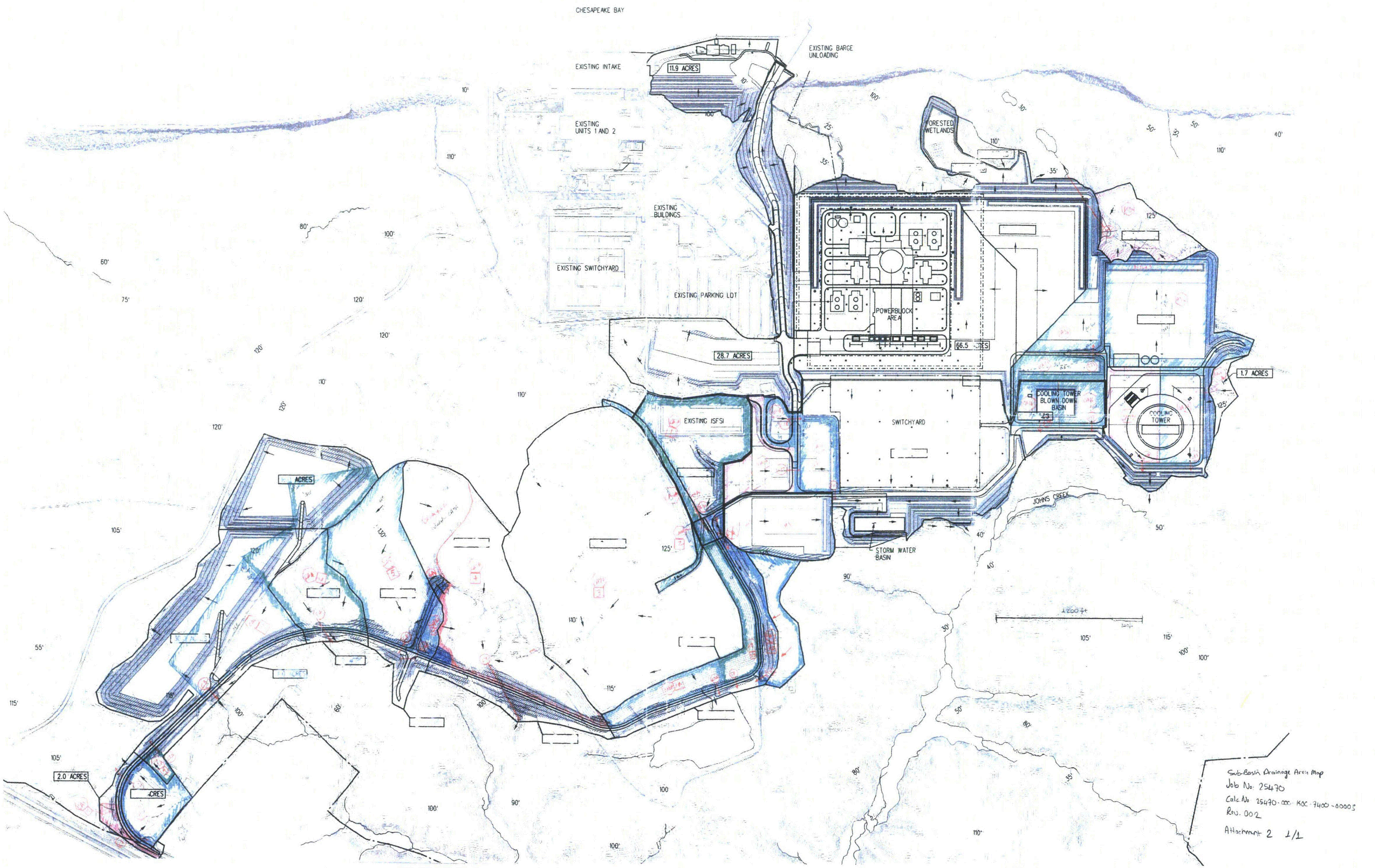


Source: http://maps.yahoo.com/#mvt=m&lat=38.391536&lon=-76.457863&zoom=13&q1=lusby%20calvert%20county(10/13/08)

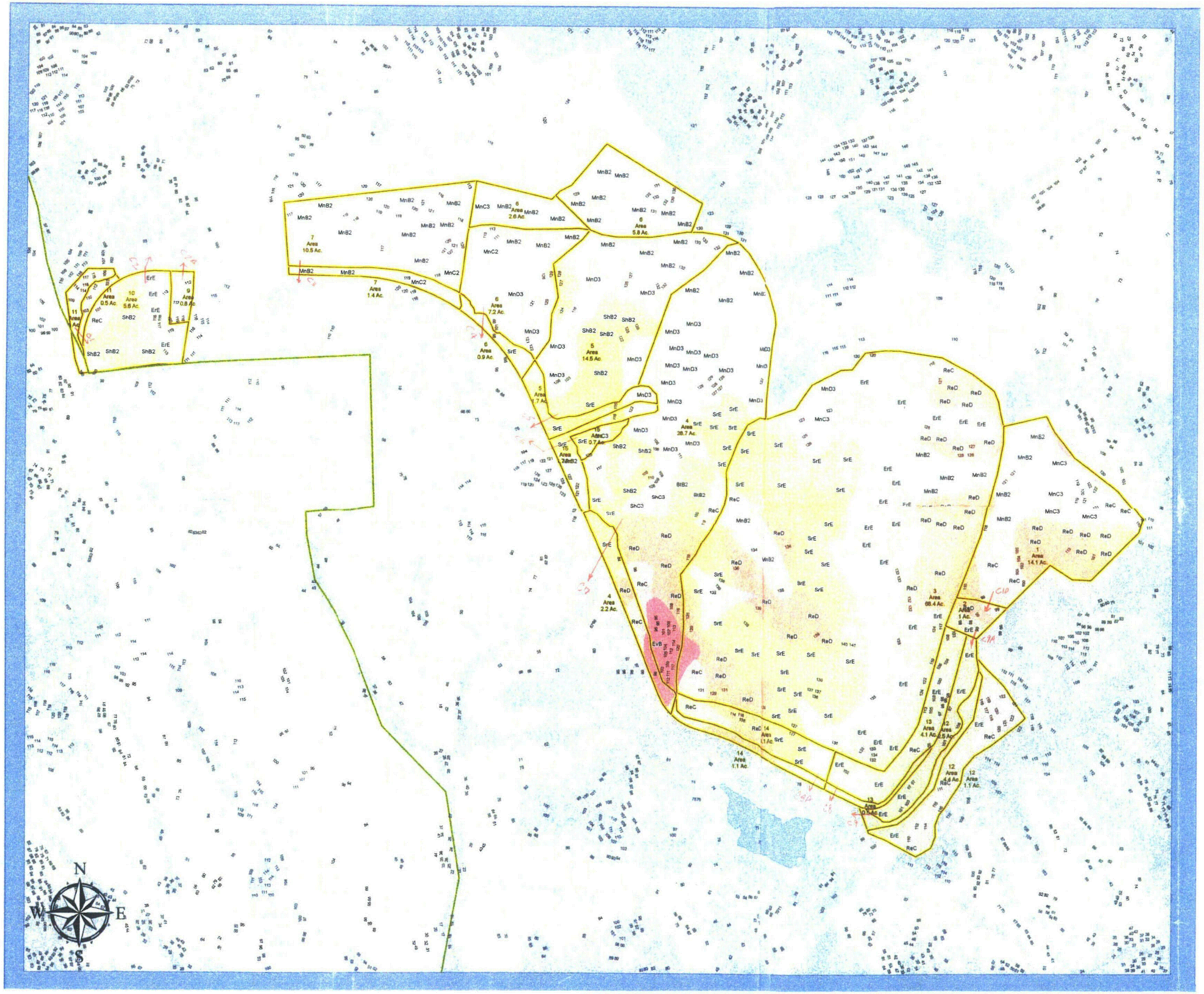


FEMA Map 2400110027D
Calvert County, MD

Source: http://map1.msc.fema.gov/idms/IntraView.cgi?KEY=3657508&IFIT=1(10/13/08)



CHESAPEAKE BAY
EXISTING INTAKE
11.9 ACRES
EXISTING BARGE UNLOADING
EXISTING UNITS 1 AND 2
FORESTED WETLANDS
EXISTING BUILDINGS
EXISTING SWITCHYARD
EXISTING PARKING LOT
POWERBLOCK AREA
66.5 ACRES
28.7 ACRES
1.7 ACRES
COOLING TOWER BLOWN DOWN BASIN
COOLING TOWER
EXISTING ISFSI
SWITCHYARD
JOHNS CREEK
STORM WATER BASIN
2.0 ACRES
1200 ft
Sub-Basin Drainage Area Map
Job No: 25470
Calc No: 25470-000-K0C-7400-00005
Rev. 002
Attachment 2 1/1



Calvert Cliffs Post-Development Culvert Drainage Basins and Soil Classification

Legend

Soil Classification

Soil Type A
- EvB
- EvC
- EvE

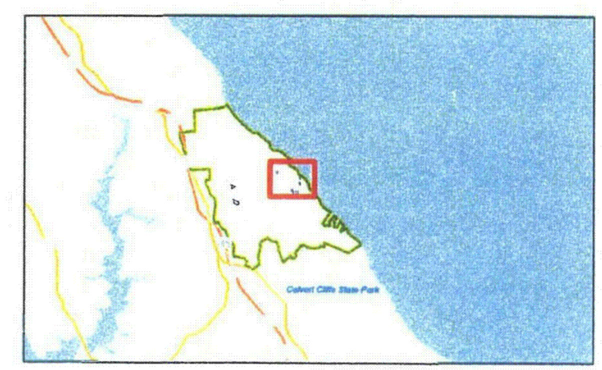
Soil Type B
- ErE
- MnB2
- MnC2
- MnC3
- MnD3
- RdD2
- ReC
- ReD
- SaB2
- SaC2
- ShB2
- ShC3
- ShD2
- SrE

Soil Type C
- BlB2
- BtB2
- WoA
- WoB

Soil Type D
- Co
- My

Other
- Plant Boundary
- Drainage Basin
- Water
- Surface Contours

Overview Map



Miles: 0, 0.05, 0.1, 0.2, 0.3

Kilometers: 0, 0.125, 0.25, 0.5

GIS Map Code: US-CALV-000004-R000E

Coordinate System: Maryland State Plane, FIPS 1900
Projection: Lambert Conformal Conic
Horizontal Datum: North American Datum 1927
Vertical Datum: North American Vertical Datum 1988

Job No. 25470
Calc. No 25470-000-K0C-7400-00002
Rev 002
Attachment 3 1/1

Attachment 4 contains the email stating the source of GIS data used for this calculation.

Akter, Taslima

From: Mclane, Tracy

Sent: Wednesday, October 22, 2008 2:17 PM

To: Akter, Taslima

Subject: Calvert Cliffs Data Source References

Taslima,

As discussed, here are the references for the GIS datasets which were used in the Calvert Cliffs land cover/soils/drainage basin GIS overlay analysis used in your calculation:

National Land Cover Database 2001

MLRC 2001 National Land Cover Database (NLCD), in ESRI RASTER GRID format, downloaded on April 3, 2008 from the Multi-Resolution Land Characteristics (MRLC) Consortium (http://www.mrlc.gov/scripts/mapserv.exe?map=d%3A%5Cinetpub%5Cwwwroot%5Clccp%5Cmrlc2k%5Czones%5Czones.map)

** **Note**: The online web link for this data has changed since we downloaded the data originally, so the new link to the source information is now: http://www.mrlc.gov/nlcd_multizone_map.php

The National Land Cover Database 2001 land cover layer was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium. The MRLC Consortium is a partnership of federal agencies (www.mrlc.gov), consisting of the U.S. Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Environmental Protection Agency (EPA), the U.S. Department of Agriculture (USDA), the U.S. Forest Service (USFS), the National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS), the Bureau of Land Management (BLM) and the USDA Natural Resources Conservation Service (NRCS). One of the primary goals of the project is to generate a current, consistent, seamless, and accurate National Land cover Database (NLCD) circa 2001 for the United States at medium spatial resolution. This landcover map and all documents pertaining to it are considered "provisional" until a formal accuracy assessment can be conducted. For a detailed definition and discussion on MRLC and the NLCD 2001 products, refer to Homer et al. (2004) and http://www.mrlc.gov/mrlc2k.asp.

ATTACHMENT NO. 4

PROJECT Calvert Cliffs Unit 3

JOB NUMBER 25470

SUBJECT Reference Email for Soil and Landuse Data source

CALC NO 25470-000-K0C-7400-00003

SHEET NO 2 OF 3

REV. NO. 002

MLRC - The Multi-Resolution Land Characteristics (MRLC) Consortium is a group of federal agencies who first joined together in 1993 (MRLC 1992) to purchase Landsat 5 imagery for the conterminous U.S. and to develop a land cover dataset called the National Land Cover Dataset (NLCD 1992). In 1999, a second-generation MRLC consortium (see logos) was formed to purchase three dates of Landsat 7 imagery for the entire United States (MRLC 2001) and to coordinate the production of a comprehensive land cover database for the nation called the National Land Cover Database (NLCD 2001).

The MRLC consortium is specifically designed to meet the current needs of Federal agencies for nationally consistent satellite remote sensing and land-cover data. However, the consortium also provides imagery and land cover data as public domain information, all of which can be accessed through this website. (http://www.mrlc.gov/index.asp)

USDA Soils

Soil Type for Calvert Cliffs (Source: ESRI shapefile soilmu_a_md009.shp and relational Access database soildb_US_2002.mdb downloaded from the USDA NRCS http://soildatamart.nrcs.usda.gov on 4/14/2008 and uploaded into the Bechtel Enterprise GIS on 5/15/2008)

This data set is a digital soil survey and generally is the most detailed level of soil geographic data developed by the National
Cooperative Soil Survey. The information was prepared by digitizing maps, by compiling information onto a planimetric correct base
and digitizing, or by revising digitized maps using remotely sensed and other information.

This data set consists of georeferenced digital map data and computerized attribute data. The map data are in a soil survey area
extent format and include a detailed, field verified inventory of soils and miscellaneous areas that normally occur in a repeatable
pattern on the landscape and that can be cartographically shown at the scale mapped. A special soil features layer (point and line
features) is optional. This layer displays the location of features too small to delineate at the mapping scale, but they are large
enough and contrasting enough to significantly influence use and management. The soil map units are linked to attributes in the
National Soil Information System relational database, which gives the proportionate extent of the component soils and their properties.

SSURGO depicts information about the kinds and distribution of soils on the landscape. The soil map and data used in the SSURGO
product were prepared by soil scientists as part of the National Cooperative Soil Survey.

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CALC NO 25470-000-K0C-7400-00003

SHEET NO 3 OF 3

REV. NO. 002

Drainage Basins

Post-Development Culvert Drainage Areas (source:extracted from Microstation design file 003-C2-0010-00002.dgn provided by Michael Basile on 7/30/2008)

USDA National Agriculture Imagery Program (NAIP) Digital Orthophotgraphy

Calvert County, MD CCM (naip_1-1_1n_s_md009_2005_1) National Agriculture Imagery Program (NAIP). USDA FSA Aerial Photography Field Office, Salt Lake City, Utah, December 30, 2005.

This data set contains imagery from the National AgricultureImagery Program (NAIP). NAIP acquires digital ortho imagery
during the agricultural growing seasons in the continental U.S. A primary goal of the NAIP program is to enable availability of
ortho imagery within one year of acquisition. NAIP provides two main products: 1 meter ground sample distance (GSD) ortho
imagery rectified to a horizontal accuracy of within +/- 3 meters of reference digital ortho quarter quads (DOQQ's) from
the National Digital Ortho Program (NDOP); and, 2 meter GSD ortho imagery rectified to within +/- 10 meters of reference
DOQQs. The tiling format of NAIP imagery is based on a 3.75'x 3.75' quarter quadrangle with a 300 meter buffer on all four
sides. NAIP quarter quads are formatted to the UTM coordinate system using NAD83. NAIP imagery may contain as much as 10%
cloud cover per tile. This file was generated by compressing NAIP quarter quadrangle
tiles that cover a county. MrSID compression generation 3, with mosaic option, was used. Target values for the compression ratio
are (15:1) and the maximum compression levels are used.

Regards

Tracy J. McLane
GIS Manager, Bechtel Corporation

"If you don't go after what you want, you'll never have it. If you don't ask, the answer's always no. If you don't step forward, you're always in the same place." - Nora Roberts, **Tears of the Moon**

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ATTACHMENT NO. 5

PROJECT Calvert Cliffs Unit 3

JOB NUMBER 25470

SUBJECT RCN Calculation Spreadsheet

CALC NO 25470-000-K0C-7400-00003

REV. NO. 002

CN numbers using information from Attachment 3.

BASIN	SOIL TYPE	SOIL_NAME	LAND_COVER	SCS CODE	SOIL CODE	RCN VALUE	AREA TOTAL	CN x Area	Wt. CN
1	A	Evesboro loamy sand, 12 to 35 percent slopes	Cultivated Crops	24	EvE	67	0.02531	1.69572	
1	A	Evesboro loamy sand, 12 to 35 percent slopes	Deciduous Forest	65	EvE	30	0.02205	0.66137	
1	A	Evesboro loamy sand, 12 to 35 percent slopes	Industrial	12	EvE	81	0.23173	18.77007	
1	A	Evesboro loamy sand, 12 to 35 percent slopes	Industrial	12	EvE	81	0.06854	5.55175	
1	A	Evesboro loamy sand, 12 to 35 percent slopes	Developed, Open Space	3	EvE	68	0.01064	0.72339	
1	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Cultivated Crops	24	MnB2	78	1.82061	142.00729	
1	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Industrial	12	MnB2	88	0.02978	2.62091	
1	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Industrial	12	MnB2	88	0.72329	63.64972	
1	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Industrial	12	MnB2	88	0.44371	39.04611	
1	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Developed, Open Space	3	MnB2	79	0.03923	3.09931	
1	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Cultivated Crops	24	MnC3	78	0.69471	54.18727	
1	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Industrial	12	MnC3	88	0.19339	17.01831	
1	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Industrial	12	MnC3	88	0.23359	20.55586	
1	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Industrial	12	MnC3	88	1.88674	166.03305	
1	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Cultivated Crops	24	ReC	78	1.34436	104.86017	
1	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Deciduous Forest	65	ReC	55	0.77404	42.57245	
1	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Industrial	12	ReC	88	0.09944	8.75060	
1	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Industrial	12	ReC	88	0.08949	7.87508	
1	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Industrial	12	ReC	88	0.43845	38.58396	
1	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Developed, Open Space	3	ReC	79	0.12818	10.12604	
1	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Emergent Herbaceous Wetlands	-9999	ReC	100	0.10257	10.25672	
1	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Cultivated Crops	24	ReD	78	0.80370	62.68839	
1	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Deciduous Forest	65	ReD	55	1.85454	101.99952	
1	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Industrial	12	ReD	88	0.60656	53.37694	
1	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Industrial	12	ReD	88	0.47314	41.63662	
1	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Industrial	12	ReD	88	0.96641	85.04382	

Drainage Basin

10	B	Eroded land, steep	Cultivated Crops	24	ErE	78	0.20017	15.61340	
10	B	Eroded land, steep	Deciduous Forest	65	ErE	55	0.16436	9.04001	
10	B	Eroded land, steep	Developed, Open Space	3	ErE	79	0.33019	26.08492	
10	B	Eroded land, steep	Pasture/Hay	22	ErE	69	0.34362	23.70971	
10	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Pasture/Hay	22	MnB2	69	0.32481	22.41161	
10	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Cultivated Crops	24	MnC3	78	0.10203	7.95858	
10	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Deciduous Forest	65	MnC3	55	0.12958	7.12674	
10	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Developed, Open Space	3	MnC3	79	0.01795	1.41827	
10	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Pasture/Hay	22	MnC3	69	0.06964	4.80509	
10	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Cultivated Crops	24	ReC	78	0.66845	52.13894	
10	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Developed, Open Space	3	ReC	79	0.00446	0.35251	
10	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Evergreen Forest	65	ReC	55	0.02059	1.13251	
10	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Cultivated Crops	24	ShB2	78	1.66127	129.57913	
10	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Deciduous Forest	65	ShB2	55	0.07639	4.20170	
10	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Developed, Open Space	3	ShB2	79	0.87269	68.94257	
10	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Pasture/Hay	22	ShB2	69	0.39745	27.42388	
Drainage Basin 10							5.38366	401.93956	74.7
11	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Cultivated Crops	24	ReC	78	0.31140	24.28930	
11	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Deciduous Forest	65	ReC	55	0.01549	0.85202	
11	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Industrial	12	ReC	88	0.07267	6.39478	
11	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Evergreen Forest	65	ReC	55	0.40931	22.51222	
11	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Seeded	9999	ReC	79	0.50931	40.23548	
11	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Developed, Open Space	3	ShB2	79	0.00485	0.38300	
11	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Seeded	9999	ShB2	79	0.00036	0.02868	
Drainage Basin 11							1.32339	94.69548	71.6
12	B	Eroded land, steep	Barren Land (Rock/Sand/Clay)	20	ErE	86	0.17976	15.45918	
12	B	Eroded land, steep	Deciduous Forest	65	ErE	55	0.44622	24.54225	
12	B	Eroded land, steep	Developed, Open Space	3	ErE	79	0.00014	0.01109	
12	B	Eroded land, steep	Emergent Herbaceous Wetlands	-9999	ErE	100	0.17951	17.95129	
12	B	Eroded land, steep	Evergreen Forest	65	ErE	55	0.67190	36.95425	
12	B	Eroded land, steep	Seeded	9999	ErE	79	2.14634	169.56071	
12	B	Eroded land, steep	Woody Wetlands	-9999	ErE	100	0.14653	14.65327	
12	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Barren Land (Rock/Sand/Clay)	20	ReC	86	0.21251	18.27607	
12	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Cultivated Crops	24	ReC	78	0.00420	0.32788	

ATTACHMENT NO. 5

PROJECT Calvert Cliffs Unit 3

JOB NUMBER 25470

SUBJECT RCN Calculation Spreadsheet

CALC NO 25470-000-K0C-7400-00003

REV. NO. 002

12	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Deciduous Forest	65	ReC	55	1.28855	70.87020	
12	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Developed, Open Space	3	ReC	79	0.03480	2.74935	
12	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Emergent Herbaceous Wetlands	-9999	ReC	100	0.04075	4.07489	
12	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Evergreen Forest	65	ReC	55	2.32093	127.65108	
12	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Seeded	9999	ReC	79	0.32565	25.72603	
12	D	Mixed alluvial land	Deciduous Forest	65	My	77	0.01495	1.15100	
12	D	Mixed alluvial land	Seeded	9999	My	89	0.00000	0.00037	
Drainage Basin 12							8.01274	529.95891	66.1
13	B	Eroded land, steep	Barren Land (Rock/Sand/Clay)	20	ErE	86	0.03261	2.80466	
13	B	Eroded land, steep	Cultivated Crops	24	ErE	78	2.32675	181.48680	
13	B	Eroded land, steep	Deciduous Forest	65	ErE	55	0.08939	4.91665	
13	B	Eroded land, steep	Industrial	12	ErE	88	0.13404	11.79564	
13	B	Eroded land, steep	Industrial	12	ErE	88	0.01980	1.74274	
13	B	Eroded land, steep	Developed, Open Space	3	ErE	79	0.07972	6.29781	
13	B	Eroded land, steep	Emergent Herbaceous Wetlands	-9999	ErE	100	0.02383	2.38306	
13	B	Eroded land, steep	Pasture/Hay	22	ErE	69	0.71628	49.42321	
13	B	Eroded land, steep	Seeded	9999	ErE	79	0.20919	16.52607	
13	B	Eroded land, steep	Woody Wetlands	-9999	ErE	100	0.07494	7.49423	
13	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Cultivated Crops	24	ReC	78	0.24818	19.35787	
13	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Pasture/Hay	22	ReC	69	0.00379	0.26138	
13	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Seeded	9999	ReC	79	0.07249	5.72707	
13	D	Mixed alluvial land	Cultivated Crops	24	My	89	0.08852	7.87858	
13	D	Mixed alluvial land	Deciduous Forest	65	My	77	0.23532	18.11977	
13	D	Mixed alluvial land	Seeded	9999	My	89	0.23078	20.53912	
Drainage Basin 13							4.58565	356.75467	77.8
14	B	Eroded land, steep	Cultivated Crops	24	ErE	78	0.00406	0.31630	
14	B	Eroded land, steep	Deciduous Forest	65	ErE	55	0.00006	0.00341	
14	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Cultivated Crops	24	ReC	78	0.07340	5.72488	
14	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Developed, Open Space	3	ReC	79	0.18905	14.93508	
14	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Evergreen Forest	65	ReC	55	0.19052	10.47874	
14	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Pasture/Hay	22	ReC	69	0.18538	12.79112	
14	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Seeded	9999	ReC	79	0.23082	18.23498	
14	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Deciduous Forest	65	ReD	55	0.21135	11.62406	
14	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Developed, Open Space	3	ReD	79	0.02419	1.91071	
14	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Pasture/Hay	22	ReD	69	0.80078	55.25414	
14	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Seeded	9999	ReD	79	0.47801	37.76262	

14	B	Sassafras and Westphalia soils, steep	Cultivated Crops	24	SrE	78	0.24478	19.09289	
14	B	Sassafras and Westphalia soils, steep	Deciduous Forest	65	SrE	55	0.01606	0.88357	
14	B	Sassafras and Westphalia soils, steep	Developed, Open Space	3	SrE	61	0.09961	6.07628	
14	B	Sassafras and Westphalia soils, steep	Pasture/Hay	22	SrE	69	0.51399	35.46530	
14	B	Sassafras and Westphalia soils, steep	Seeded	9999	SrE	79	0.00069	0.05442	
14	D	Mixed alluvial land	Cultivated Crops	24	My	89	0.39021	34.72892	
14	D	Mixed alluvial land	Deciduous Forest	65	My	77	0.15349	11.81898	
14	D	Mixed alluvial land	Developed, Open Space	3	My	89	0.04602	4.09569	
14	D	Mixed alluvial land	Seeded	9999	My	89	0.34467	30.67578	
Drainage Basin 14							4.19715	311.92788	74.3
15	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Deciduous Forest	65	MnB2	55	0.01923	1.05762	
15	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Seeded	9999	MnB2	79	0.70759	55.89932	
15	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Deciduous Forest	65	MnD3	55	0.01379	0.75842	
15	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Seeded	9999	MnD3	79	0.29005	22.91386	
15	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Deciduous Forest	65	ShB2	55	0.12185	6.70173	
15	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Developed, Open Space	3	ShB2	79	0.02448	1.93375	
15	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Seeded	9999	ShB2	79	0.11869	9.37635	
15	B	Sassafras fine sandy loam, 5 to 10 percent slopes, severely eroded	Deciduous Forest	65	ShC3	55	0.25014	13.75776	
15	B	Sassafras fine sandy loam, 5 to 10 percent slopes, severely eroded	Developed, Open Space	3	ShC3	79	0.01429	1.12903	
15	B	Sassafras fine sandy loam, 5 to 10 percent slopes, severely eroded	Seeded	9999	ShC3	79	0.05372	4.24427	
15	B	Sassafras and Westphalia soils, steep	Deciduous Forest	65	SrE	55	0.23916	13.15372	
15	B	Sassafras and Westphalia soils, steep	Seeded	9999	SrE	79	0.50066	39.55216	
Drainage Basin 15							2.35365	170.47800	72.4
2	B	Eroded land, steep	Cultivated Crops	24	ErE	78	0.45352	35.37482	
2	B	Eroded land, steep	Industrial	12	ErE	88	0.00280	0.24635	
2	B	Eroded land, steep	Industrial	12	ErE	88	0.00259	0.22783	
2	B	Eroded land, steep	Emergent Herbaceous Wetlands	-9999	ErE	100	0.01760	1.76023	
2	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Cultivated Crops	24	ReC	78	0.04692	3.65956	
2	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Emergent Herbaceous Wetlands	-9999	ReC	100	0.13376	13.37573	
2	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Cultivated Crops	24	ReD	78	0.33705	26.28979	
2	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Emergent Herbaceous Wetlands	-9999	ReD	100	0.05567	5.56689	
Drainage Basin 2							1.04991	86.50120	82.4
3	A	Evesboro loamy sand, 0 to 6 percent slopes	Cultivated Crops	24	EvB	67	0.00047	0.03162	
3	A	Evesboro loamy sand, 0 to 6 percent slopes	Deciduous Forest	65	EvB	30	0.03573	1.07178	

3	A	Evesboro loamy sand, 0 to 6 percent slopes	Developed, Open Space	3	EvB	68	0.06058	4.11946
3	A	Evesboro loamy sand, 0 to 6 percent slopes	Evergreen Forest	65	EvB	30	0.14158	4.24733
3	A	Evesboro loamy sand, 0 to 6 percent slopes	Pasture/Hay	22	EvB	49	0.15734	7.70972
3	B	Eroded land, steep	Cultivated Crops	24	ErE	78	10.36597	808.54581
3	B	Eroded land, steep	Deciduous Forest	65	ErE	55	1.46719	80.69524
3	B	Eroded land, steep	Industrial	12	ErE	88	0.53609	47.17557
3	B	Eroded land, steep	Industrial	12	ErE	88	1.13671	100.03044
3	B	Eroded land, steep	Industrial	12	ErE	88	1.44091	126.80042
3	B	Eroded land, steep	Developed, Open Space	3	ErE	79	2.47392	195.43952
3	B	Eroded land, steep	Woody Wetlands	-9999	ErE	100	0.97643	97.64338
3	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Cultivated Crops	24	MnB2	78	0.95161	74.22561
3	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Deciduous Forest	65	MnB2	55	1.71095	94.10203
3	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Industrial	12	MnB2	88	0.67715	59.58938
3	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Industrial	12	MnB2	88	0.02142	1.88469
3	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Developed, Open Space	3	MnB2	79	0.40200	31.75833
3	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Emergent Herbaceous Wetlands	-9999	MnB2	100	0.61454	61.45423
3	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Cultivated Crops	24	MnC3	78	0.91544	71.40408
3	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Developed, Open Space	3	MnC3	79	0.02435	1.92334
3	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Barren Land (Rock/Sand/Clay)	20	MnD3	86	0.01295	1.11363
3	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Cultivated Crops	24	MnD3	78	0.73368	57.22702
3	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Developed, Open Space	3	MnD3	79	0.32235	25.46587
3	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Cultivated Crops	24	ReC	78	0.53986	42.10945
3	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Industrial	12	ReC	88	0.01897	1.66902
3	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Developed, Open Space	3	ReC	79	0.18833	14.87772
3	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Emergent Herbaceous Wetlands	-9999	ReC	100	0.30248	30.24812
3	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Evergreen Forest	65	ReC	55	0.16773	9.22525
3	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Pasture/Hay	22	ReC	69	0.19519	13.46803
3	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Barren Land (Rock/Sand/Clay)	20	ReD	86	0.09494	8.16444
3	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Cultivated Crops	24	ReD	78	5.13904	400.84532
3	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Deciduous Forest	65	ReD	55	2.26604	124.63231
3	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Industrial	12	ReD	88	2.72484	239.78597
3	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Industrial	12	ReD	88	0.83327	73.32796
3	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Industrial	12	ReD	88	2.08512	183.49038

3	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Developed, Open Space	3	ReD	79	1.02925	81.31088	
3	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Emergent Herbaceous Wetlands	-9999	ReD	100	0.31988	31.98792	
3	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Pasture/Hay	22	ReD	69	1.10012	75.90806	
3	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Woody Wetlands	-9999	ReD	100	0.01946	1.94611	
3	B	Sassafras and Westphalia soils, steep	Barren Land (Rock/Sand/Clay)	20	SrE	86	0.32829	28.23271	
3	B	Sassafras and Westphalia soils, steep	Cultivated Crops	24	SrE	78	9.94646	775.82377	
3	B	Sassafras and Westphalia soils, steep	Deciduous Forest	65	SrE	55	0.74587	41.02272	
3	B	Sassafras and Westphalia soils, steep	Industrial	12	SrE	88	0.29931	26.33933	
3	B	Sassafras and Westphalia soils, steep	Developed, Open Space	3	SrE	79	3.58619	283.30939	
3	B	Sassafras and Westphalia soils, steep	Emergent Herbaceous Wetlands	-9999	SrE	100	2.27933	227.93253	
3	B	Sassafras and Westphalia soils, steep	Pasture/Hay	22	SrE	83	3.11384	258.44850	
3	B	Sassafras and Westphalia soils, steep	Woody Wetlands	-9999	SrE	100	1.56056	156.05569	
3	D	Mixed alluvial land	Cultivated Crops	24	My	89	2.24454	199.76370	
3	D	Mixed alluvial land	Deciduous Forest	65	My	77	0.19188	14.77480	
3	D	Mixed alluvial land	Industrial	12	My	93	0.51673	48.05631	
3	D	Mixed alluvial land	Developed, Open Space	3	My	89	0.57437	51.11921	
3	D	Mixed alluvial land	Pasture/Hay	22	My	84	0.40254	33.81323	
3	D	Mixed alluvial land	Woody Wetlands	-9999	My	100	0.36455	36.45523	
Drainage Basin 3							68.35832	5467.8025	80.0
4	A	Evesboro loamy sand, 0 to 6 percent slopes	Barren Land (Rock/Sand/Clay)	20	EvB	77	0.06199	4.77326	
4	A	Evesboro loamy sand, 0 to 6 percent slopes	Cultivated Crops	24	EvB	67	0.00001	0.00075	
4	A	Evesboro loamy sand, 0 to 6 percent slopes	Deciduous Forest	65	EvB	30	0.83487	25.04610	
4	A	Evesboro loamy sand, 0 to 6 percent slopes	Evergreen Forest	65	EvB	30	0.35548	10.66451	
4	A	Evesboro loamy sand, 0 to 6 percent slopes	Pasture/Hay	22	EvB	49	0.27445	13.44822	
4	A	Evesboro loamy sand, 0 to 6 percent slopes	Seeded	9999	EvB	68	0.52072	35.40898	
4	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Cultivated Crops	24	MnB2	78	0.81867	63.85630	
4	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Deciduous Forest	65	MnB2	55	0.02213	1.21732	
4	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Developed, Open Space	3	MnB2	79	2.77051	218.87004	
4	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Pasture/Hay	22	MnB2	69	0.90712	62.59134	
4	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Seeded	9999	MnB2	79	0.00423	0.33385	
4	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Cultivated Crops	24	MnC3	78	0.00127	0.09884	
4	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Barren Land (Rock/Sand/Clay)	20	MnD3	86	1.32973	114.35690	
4	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Cultivated Crops	24	MnD3	78	1.85326	144.55402	

ATTACHMENT NO. 5

PROJECT Calvert Cliffs Unit 3

JOB NUMBER 25470

SUBJECT RCN Calculation Spreadsheet

CALC NO 25470-000-K0C-7400-00003

REV. NO. 002

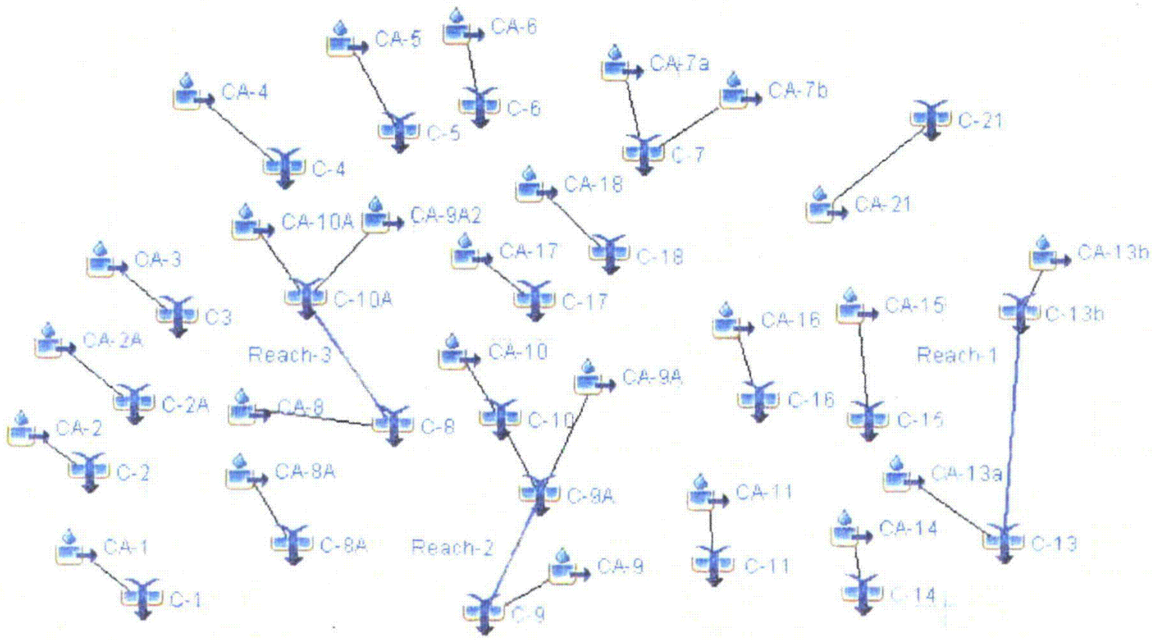
4	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Deciduous Forest	65	MnD3	55	0.07308	4.01931
4	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Developed, Open Space	3	MnD3	79	2.36476	186.81594
4	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Pasture/Hay	22	MnD3	69	3.63778	251.00668
4	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Cultivated Crops	24	ReC	78	0.00101	0.07866
4	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Deciduous Forest	65	ReC	55	0.67059	36.88248
4	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Developed, Open Space	3	ReC	79	0.51162	40.41829
4	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Emergent Herbaceous Wetlands	-9999	ReC	100	0.13942	13.94202
4	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Evergreen Forest	65	ReC	55	0.00224	0.12345
4	B	Rumford-Evesboro gravelly loamy sands, 6 to 12 percent slopes	Seeded	9999	ReC	79	0.57082	45.09486
4	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Barren Land (Rock/Sand/Clay)	20	ReD	86	0.62390	53.65517
4	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Cultivated Crops	24	ReD	78	0.58785	45.85255
4	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Deciduous Forest	65	ReD	55	1.28894	70.89160
4	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Developed, Open Space	3	ReD	79	1.09714	86.67411
4	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Pasture/Hay	22	ReD	69	0.01420	0.97963
4	B	Rumford-Evesboro gravelly loamy sands, 12 to 20 percent slopes	Seeded	9999	ReD	79	0.29639	23.41476
4	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Barren Land (Rock/Sand/Clay)	20	ShB2	86	0.53842	46.30381
4	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Deciduous Forest	65	ShB2	55	0.62071	34.13910
4	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Developed, Open Space	3	ShB2	79	0.41050	32.42961
4	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Pasture/Hay	22	ShB2	69	0.04757	3.28227
4	B	Sassafras fine sandy loam, 5 to 10 percent slopes, severely eroded	Barren Land (Rock/Sand/Clay)	20	ShC3	86	0.05851	5.03168
4	B	Sassafras fine sandy loam, 5 to 10 percent slopes, severely eroded	Deciduous Forest	65	ShC3	55	0.38383	21.11071
4	B	Sassafras fine sandy loam, 5 to 10 percent slopes, severely eroded	Industrial	12	ShC3	88	0.00384	0.33759
4	B	Sassafras fine sandy loam, 5 to 10 percent slopes, severely eroded	Developed, Open Space	3	ShC3	79	1.12806	89.11705
4	B	Sassafras fine sandy loam, 5 to 10 percent slopes, severely eroded	Pasture/Hay	22	ShC3	69	0.06421	4.43053
4	B	Sassafras and Westphalia soils, steep	Barren Land (Rock/Sand/Clay)	20	SrE	86	0.90916	78.18739
4	B	Sassafras and Westphalia soils, steep	Cultivated Crops	24	SrE	78	0.16854	13.14578
4	B	Sassafras and Westphalia soils, steep	Deciduous Forest	65	SrE	55	0.39401	21.67050
4	B	Sassafras and Westphalia soils, steep	Developed, Open Space	3	SrE	79	0.58133	45.92524
4	B	Sassafras and Westphalia soils, steep	Emergent Herbaceous Wetlands	-9999	SrE	100	0.02945	2.94471
4	B	Sassafras and Westphalia soils, steep	Pasture/Hay	22	SrE	69	0.89721	61.90715
4	B	Sassafras and Westphalia soils, steep	Seeded	9999	SrE	79	0.79934	63.14775

4	C	Butlertown silt loam, 2 to 5 percent slopes, moderately eroded	Cultivated Crops	24	BtB2	85	0.00087	0.07354	
4	C	Butlertown silt loam, 2 to 5 percent slopes, moderately eroded	Industrial	12	BtB2	91	0.29980	27.28211	
4	C	Butlertown silt loam, 2 to 5 percent slopes, moderately eroded	Developed, Open Space	3	BtB2	86	1.56521	134.60773	
4	C	Butlertown silt loam, 2 to 5 percent slopes, moderately eroded	Emergent Herbaceous Wetlands	-9999	BtB2	100	0.02044	2.04448	
4	C	Woodstown fine sandy loam, 2 to 5 percent slopes	Barren Land (Rock/Sand/Clay)	20	WoB	91	0.20508	18.66267	
4	C	Woodstown fine sandy loam, 2 to 5 percent slopes	Deciduous Forest	65	WoB	70	0.13635	9.54453	
4	C	Woodstown fine sandy loam, 2 to 5 percent slopes	Developed, Open Space	3	WoB	86	0.00447	0.38477	
Drainage Basin 4							30.90108	2270.7806	73.5
5	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Cultivated Crops	24	MnB2	78	0.92678	72.28902	
5	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Industrial	12	MnB2	88	0.40182	35.36020	
5	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Developed, Open Space	3	MnB2	79	1.26282	99.76291	
5	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Evergreen Forest	65	MnB2	55	0.03367	1.85158	
5	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Pasture/Hay	22	MnB2	69	0.73989	51.05208	
5	B	Matapeake silt loam, 5 to 10 percent slopes, moderately eroded	Deciduous Forest	65	MnC2	55	0.00300	0.16515	
5	B	Matapeake silt loam, 5 to 10 percent slopes, moderately eroded	Evergreen Forest	65	MnC2	55	0.00245	0.13491	
5	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Developed, Open Space	3	MnC3	79	0.00531	0.41944	
5	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Barren Land (Rock/Sand/Clay)	20	MnD3	86	0.88770	76.34253	
5	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Cultivated Crops	24	MnD3	78	0.29398	22.93065	
5	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Deciduous Forest	65	MnD3	55	0.89673	49.32001	
5	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Developed, Open Space	3	MnD3	79	1.74201	137.61889	
5	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Evergreen Forest	65	MnD3	55	0.79872	43.92956	
5	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Pasture/Hay	22	MnD3	69	1.08772	75.05299	
5	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Seeded	9999	MnD3	79	0.53613	42.35415	
5	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Barren Land (Rock/Sand/Clay)	20	ShB2	86	0.97999	84.27879	
5	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Deciduous Forest	65	ShB2	55	2.31195	127.15723	
5	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Industrial	12	ShB2	88	0.22238	19.56955	
5	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Developed, Open Space	3	ShB2	79	0.80634	63.70047	
5	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Evergreen Forest	65	ShB2	55	0.13815	7.59842	
5	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Pasture/Hay	22	ShB2	69	0.17324	11.95385	
5	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Seeded	9999	ShB2	79	0.07554	5.96729	
5	B	Sassafras fine sandy loam, 5 to 10 percent slopes, severely eroded	Seeded	9999	ShC3	79	0.03116	2.46150	
5	B	Sassafras and Westphalia soils,	Deciduous Forest	65	SrE	55	0.74921	41.20666	

		steep							
5	B	Sassafras and Westphalia soils, steep	Seeded	9999	SrE	79	1.05247	83.14544	
Drainage Basin 5							16.15917	1155.6232	71.5
6	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Industrial	12	MnB2	88	1.38669	122.02835	
6	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Developed, Open Space	3	MnB2	79	4.94241	390.45039	
6	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Evergreen Forest	65	MnB2	55	0.78993	43.44592	
6	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Pasture/Hay	22	MnB2	69	2.40698	166.08149	
6	B	Matapeake silt loam, 5 to 10 percent slopes, moderately eroded	Deciduous Forest	65	MnC2	55	0.21720	11.94620	
6	B	Matapeake silt loam, 5 to 10 percent slopes, moderately eroded	Evergreen Forest	65	MnC2	55	0.18045	9.92487	
6	B	Matapeake silt loam, 5 to 10 percent slopes, moderately eroded	Pasture/Hay	22	MnC2	69	0.74845	51.64336	
6	B	Matapeake silt loam, 5 to 10 percent slopes, moderately eroded	Seeded	9999	MnC2	79	0.00429	0.33891	
6	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Deciduous Forest	65	MnC3	55	0.04425	2.43354	
6	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Industrial	12	MnC3	88	0.04494	3.95441	
6	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Developed, Open Space	3	MnC3	79	0.00491	0.38798	
6	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Pasture/Hay	22	MnC3	69	0.35008	24.15577	
6	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Deciduous Forest	65	MnD3	55	2.93422	161.38209	
6	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Evergreen Forest	65	MnD3	55	0.99561	54.75870	
6	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Pasture/Hay	22	MnD3	69	0.37986	26.21014	
6	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Seeded	9999	MnD3	79	0.67512	53.33460	
6	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Deciduous Forest	65	ShB2	55	0.13669	7.51801	
6	B	Sassafras fine sandy loam, 2 to 5 percent slopes, moderately eroded	Evergreen Forest	65	ShB2	55	0.00062	0.03433	
6	B	Sassafras and Westphalia soils, steep	Deciduous Forest	65	SrE	55	0.00651	0.35786	
6	B	Sassafras and Westphalia soils, steep	Evergreen Forest	65	SrE	55	0.00186	0.10243	
6	B	Sassafras and Westphalia soils, steep	Seeded	9999	SrE	79	0.18760	14.82061	
Drainage Basin 6							16.43868	1145.3099	69.7
7	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Cultivated Crops	24	MnB2	78	0.00565	0.44046	
7	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Deciduous Forest	65	MnB2	55	0.09292	5.11078	
7	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Industrial	12	MnB2	88	1.33063	117.09544	
7	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Developed, Open Space	3	MnB2	79	5.63315	445.01923	
7	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Pasture/Hay	22	MnB2	69	2.65585	183.25368	
7	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Seeded	9999	MnB2	79	0.61881	48.88624	
7	B	Matapeake silt loam, 5 to 10 percent slopes, moderately eroded	Industrial	12	MnC2	88	0.00084	0.07356	

7	B	Matapeake silt loam, 5 to 10 percent slopes, moderately eroded	Pasture/Hay	22	MnC2	69	0.57491	39.66897	
7	B	Matapeake silt loam, 5 to 10 percent slopes, moderately eroded	Seeded	9999	MnC2	79	0.73269	57.88243	
7	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Pasture/Hay	22	MnC3	69	0.23006	15.87445	
7	B	Matapeake silt loam, 10 to 15 percent slopes, severely eroded	Seeded	9999	MnD3	79	0.01238	0.97795	
Drainage Basin 7							11.88790	914.28318	76.9
9	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Cultivated Crops	24	MnB2	78	0.01038	0.80988	
9	B	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	Pasture/Hay	22	MnB2	69	0.26921	18.57530	
9	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Cultivated Crops	24	MnC3	78	0.25548	19.92781	
9	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Deciduous Forest	65	MnC3	55	0.04085	2.24680	
9	B	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	Pasture/Hay	22	MnC3	69	0.19643	13.55356	
Drainage Basin 9							0.77235	55.11335	71.4

HEC-HMS Input and Output



Text of Basin Input Files:

```
Basin: -Postdevelopment
     Description: Calvert Cliff
postdevelopment model
     Last Modified Date: 6 August 2009
     Last Modified Time: 12:27:57
     Version: 3 2
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Allow Blending: No
     Compute Local Flow At Junctions:
Yes

     Sediment Grade Scale: NONE
     Enable Sediment Routing: No
     Fall Velocity Method: UNSPECIFIED
End:

Subbasin: CA-13a
     Canvas X: -1560.5042928138064
     Canvas Y: -5165.552416447808
     From Canvas X: 20484.168003326802
     From Canvas Y: -2865.947840551298
     Area: 0.0123
     Downstream: C-13

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 88.4

     Transform: SCS
     Lag: 11.1

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-16
     Canvas X: -7955.665652499236
```

```
     Canvas Y: 665.3299997359645
     From Canvas X: 20988.565268777347
     From Canvas Y: -6339.873430575004
     Area: 0.005
     Downstream: C-16

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 89

     Transform: SCS
     Lag: 8.0

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-13b
     Canvas X: 3982.4895581924575
     Canvas Y: 3131.908026703313
     From Canvas X: 23365.357885763566
     From Canvas Y: -3290.396921929485
     Area: 0.00270
     Downstream: C-13b

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 70

     Transform: SCS
     Lag: 6.9

     Baseflow: None

     Erosion: None
End:

Junction: C-14
     Canvas X: -3099.0407585846624
     Canvas Y: -9663.502822560517
End:

Subbasin: CA-14
     Canvas X: -3509 5014993766417
     Canvas Y: -7176.365063596379
     From Canvas X: 19021 582969313196
     From Canvas Y: -3852.342398374427
     Area: 0 01170
     Downstream: C-14

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 92.6

     Transform: SCS
     Lag: 10.9

     Baseflow: None

     Erosion: None
End:

Junction: C-15
     Canvas X: -2904 182694500345
     Canvas Y: -3171.948354414728
     Label X: 1.0
     Label Y: 1.0
End:

Junction: C-4
     Canvas X: -24884.60905189804
     Canvas Y: 6225.971299626765
End:

Junction: C-5
     Canvas X: -20537.48877318643
     Canvas Y: 7575.077593020025
End:

Junction: C-7
     Canvas X: -11341.339313509161
     Canvas Y: 6809.7007178651
End:

Subbasin: CA-7b
     Canvas X: -7642.177350553866
     Canvas Y: 9192.211812649866
     From Canvas X: 11343 963553530752
     From Canvas Y: 820.0455580865591
     Area: 0.10681
     Downstream: C-7

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0 0
     Curve Number: 80
```

```
     Transform: SCS
     Lag: 18 3

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-4
     Canvas X: -28232.391335503537
     Canvas Y: 9124.05148543451
     From Canvas X: -2308.3371298405473
     From Canvas Y: 210.11389521640012
     Area: 0.02569
     Downstream: C-4

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 69.7

     Transform: SCS
     Lag: 16.0

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-5
     Canvas X: -22486.197863643356
     Canvas Y: 11122 727475646745
     From Canvas X: 2531 6628701594527
     From Canvas Y: 450.1138952164001
     Area: 0.02525
     Downstream: C-5

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 71.5

     Transform: SCS
     Lag: 16 8

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-7a
     Canvas X: -12093.711238178039
     Canvas Y: 10258.072039264105
     From Canvas X: 6211 662870159453
     From Canvas Y: 1090 1138952164001
     Area: 0.04828
     Downstream: C-7

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73.5

     Transform: SCS
     Lag: 18.7

     Baseflow: None

     Erosion: None
End:

Junction: C3
     Canvas X: -28850 14910773171
     Canvas Y: 735.8377493084517
End:

Junction: C-2
     Canvas X: -32152.84057116787
     Canvas Y: -5157.199959959988
End:

Junction: C-1
     Canvas X: -30145 322230647853
     Canvas Y: -9884.581858603902
End:

Junction: C-2A
     Canvas X: -30469.115511376887
     Canvas Y: -2566.8537141277084
End:

Junction: C-6
     Canvas X: -17489 507888112767
     Canvas Y: 8574.415588126143
End:

Subbasin: CA-2
     Canvas X: -34419 39353627112
     Canvas Y: -3473 474900169007
     From Canvas X: -6907.820333974916
     From Canvas Y: -8368.697474292643
     Area: 0.00841
```

```
     Downstream: C-2

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 74.7

     Transform: SCS
     Lag: 8 1

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-2A
     Canvas X: -33448.01369408401
     Canvas Y: -170.7834367328469
     From Canvas X: -6856.1407474116095
     From Canvas Y: -4906.165174551041
     Area: 0.00120
     Downstream: C-2A

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 71 4

     Transform: SCS
     Lag: 7.4

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-3
     Canvas X: -31440.495353563994
     Canvas Y: 2872 8734021200835
     From Canvas X: -4633 918525189387
     From Canvas Y: -1340 2737016828241
     Area: 0.01858
     Downstream: C3

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76.9

     Transform: SCS
     Lag: 11.5

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-6
     Canvas X: -18089.110685176438
     Canvas Y: 11572.429573444499
     From Canvas X: 5546 960027782188
     From Canvas Y: 2535 695290565238
     Area: 0.00367
     Downstream: C-6

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 72.4

     Transform: SCS
     Lag: 4 9

     Baseflow: None

     Erosion: None
End:

Junction: C-8
     Canvas X: -20748.937621567846
     Canvas Y: -3372.5900215165802
     From Canvas X: -9130.334975543434
     From Canvas Y: -5305.456964089162
End:

Subbasin: CA-8
     Canvas X: -26130.285549607815
     Canvas Y: -2631.612370273513
     From Canvas X: 889 2555172663815
     From Canvas Y: -8849 383046529583
     Area: 0.00717
     Downstream: C-8

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0 0
     Curve Number: 77 8
```

```
     Transform: SCS
     Lag: 7 2

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-10
     Canvas X: -18238.08195630717
     Canvas Y: -588.6232080454902
     From Canvas X: 4231.027669165116
     From Canvas Y: -5406.345071846039
     Label X: 1.0
     Label Y: 0.0
     Area: 0 02203
     Downstream: C-10

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 74.7

     Transform: SCS
     Lag: 10 6

     Baseflow: None

     Erosion: None
End:

Junction: C-13
     Canvas X: 2234.0058422556685
     Canvas Y: -7747.5462057922705
     From Canvas X: 4149.78902953587
     From Canvas Y: 918.2812365452519
End:

Junction: C-16
     Canvas X: -7015 20074666314
     Canvas Y: -2469.553019717674
     From Canvas X: -5063 291139240508
     From Canvas Y: 1316 4556962025326
     Label X: 1.0
     Label Y: 1.0
End:

Subbasin: CA-15
     Canvas X: -3253.3411233187726
     Canvas Y: 1166.9112828485486
     From Canvas X: 24937.932357384943
     From Canvas Y: -7200 6329242458905
     Area: 0.005
     Downstream: C-15

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 89

     Transform: SCS
     Lag: 8.0

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-8A
     Canvas X: -26195 044205753624
     Canvas Y: -5092.441303814183
     Area: 0.00656
     Downstream: C-8A

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0 0
     Curve Number: 74 3

     Transform: SCS
     Lag: 6.1

     Baseflow: None

     Erosion: None
End:

Junction: C-8A
     Canvas X: -24511.31914596264
     Canvas Y: -7812.304861938075
End:

Subbasin: CA-9
     Canvas X: -14100 036370628368
     Canvas Y: -8613.92373784681
     Area: 0.01252
     Downstream: C-9

     Canopy: None

     Surface: None
```

```
     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 66 1

     Transform: SCS
     Lag: 11 1

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-11
     Canvas X: -8895.201130200148
     Canvas Y: -5816 051541401961
     Area: 0 0048
     Downstream: C-11

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 98

     Transform: SCS
     Lag: 3 9

     Baseflow: None

     Erosion: None
End:

Junction: C-11
     Canvas X: -8645 366631423622
     Canvas Y: -8614 19792769909
     Label X: 2.0
     Label Y: 0.0
End:

Subbasin: CA-17
     Canvas X: -18135.396024331363
     Canvas Y: 2600.0711892223935
     Area: 0 0075
     Downstream: C-17

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 98

     Transform: SCS
     Lag: 3 6

     Baseflow: None

     Erosion: None
End:

Junction: C-17
     Canvas X: -15440.864998145224
     Canvas Y: 1329 2151236067857
End:

Subbasin: CA-18
     Canvas X: -15353.989578409826
     Canvas Y: 5743.840491250863
     Area: 0.003
     Downstream: C-18

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 89

     Transform: SCS
     Lag: 5.7

     Baseflow: None

     Erosion: None
End:

Junction: C-18
     Canvas X: -12592.751712092788
     Canvas Y: 3078.056615042493
     Label X: 0.0
     Label Y: -1 0
End:

Subbasin: CA-21
     Canvas X: -4413.247840516618
     Canvas Y: 4991.468566581989
     Area: 0.0072
     Downstream: C-21

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 87.8

     Transform: SCS
```

```
     Lag: 11 0

     Baseflow: None

     Erosion: None
End:

Junction: C-21
     Canvas X: -525.9928963941056
     Canvas Y: 8063.653925646557
End:

Reach: Reach-1
     Canvas X: 2234 0058422556685
     Canvas Y: -7747 5462057922705
     From Canvas X: 2881.5924037137374
     From Canvas Y: 865.3550616000648
     Label X: -68.0
     Label Y: 41.0
     Downstream: C-13

     Route: Lag
     Lag: 5
     Channel Loss: None

     Route Sediment: No
End:

Junction: C-10
     Canvas X: -16670 64044658035
     Canvas Y: -3096 529623608403
     Downstream: C-9A
End:

Junction: C-9
     Canvas X: -17283.935975391152
     Canvas Y: -10388.672727535282
End:

Junction: C-9A
     Canvas X: -14967.066024630796
     Canvas Y: -5799 6874146349255
     Downstream: Reach-2
End:

Reach: Reach-2
     Canvas X: -17283.935975391152
     Canvas Y: -10388.672727535282
     From Canvas X: -14967.066024630796
     From Canvas Y: -5799.6874146349255
     Label X: -71.0
     Label Y: 4 0
     Downstream: C-9

     Route: Lag
     Lag: 7 5
     Channel Loss: None

     Route Sediment: No
End:

Subbasin: CA-1
     Canvas X: -32606.15116418852
     Canvas Y: -7941.822174229692
     Area: 0.00206
     Downstream: C-1

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 71.6

     Transform: SCS
     Lag: 9.0

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-9A2
     Canvas X: -20714.269279901593
     Canvas Y: 4073.713049548238
     From Canvas X: -9341.951397971847
     From Canvas Y: 5454.696453849336
     Area: 0.00082
     Downstream: Reach-3

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0 0
     Curve Number: 82 4

     Transform: SCS
     Lag: 3.6

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-9A
     Canvas X: -13159 57146479228
     Canvas Y: -1529.088113881582
     From Canvas X: 1191.2555473923821
     From Canvas Y: -62.697660389070734
```

```
     Area: 0.00082
     Downstream: C-9A

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 82.4

     Transform: SCS
     Lag: 3.6

     Baseflow: None

     Erosion: None
End:

Subbasin: CA-10A
     Canvas X: -26000.768237316202
     Canvas Y: 4297.56383732784
     From Canvas X: -13162.712110574463
     From Canvas Y: 4807.109892391265
     Area: 0 00625
     Downstream: C-10A

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0 0
     Curve Number: 87.2

     Transform: SCS
     Lag: 10.6

     Baseflow: None

     Erosion: None
End:

Junction: C-10A
     Canvas X: -24058.008552941992
     Canvas Y: 1383.4243107665243
     From Canvas X: -12439 40590691758
     From Canvas Y: 940.0064595475014
     Downstream: Reach-3
End:

Reach: Reach-3
     Canvas X: -20748.937621567846
     Canvas Y: -3372.5900215165802
     From Canvas X: -24058 008552941992
     From Canvas Y: 1383.4243107665243
     Label X: -71 0
     Label Y: 4 0
     Downstream: C-8

     Route: Lag
     Lag: 8.0
     Channel Loss: None

     Route Sediment: No
End:

Junction: C-13b
     Canvas X: 2881.5924037137374
     Canvas Y: 865 3550616000648
     From Canvas X: 6999.169899951379
     From Canvas Y: 9272 147879354361
     Label X: -1.0
     Label Y: 0.0
     Downstream: Reach-1
End:

Basin Schematic Properties:
     Last View N: 3743.182044804158
     Last View S: -18539.226930981793
     Last View W: -2767 6565083207024
     Last View E: 16370 608869654956
     Maximum View N: 11572.429573444499
     Maximum View S: -10388.672727535282
     Maximum View W: -34419.39353627112
     Maximum View E: 3982 4895581924575
     Extent Method: Elements
     Buffer: 0
     Draw Icons: Yes
     Draw Icon Labels: Yes
     Draw Gridlines: Yes
     Draw Flow Direction: No
     Fix Element Locations: No
End:
```

Text of Rainfall Input Files:

Meteorology: T02
Description: 2-year rainfall
Last Modified Date: 4 September 2008
Last Modified Time: 21:00:44
Version: 3 1.0
Unit System. English
Precipitation Method: SCS Storm
Snowmelt Method: None
Basin Model List: -Postdevelopment
End:

Precip Method Parameters: SCS Storm
Storm Depth: 3.4
Storm Type: Type II
End:

Meteorology: T10
Description: 10-year rainfall
Last Modified Date: 2 October 2008
Last Modified Time: 17:04:14
Version: 3 1.0
Unit System. English
Precipitation Method: SCS Storm
Snowmelt Method: None
Basin Model List: -Postdevelopment
End:

Precip Method Parameters: SCS Storm
Storm Depth: 5.3
Storm Type: Type II
End.

Meteorology: T100
Description: 100-year rainfall
Last Modified Date: 3 August 2010
Last Modified Time: 12:15:16
Version: 3.2
Unit System: English
Precipitation Method: SCS Storm
Snowmelt Method: None
Use Basin Model: -Postdevelopment
End:

Precip Method Parameters: SCS Storm
Storm Depth: 9.12
Storm Type: Type II
End:

HEC-HMS RESULTS

Project: CulvertRev2 Simulation Run: 2yearpost

Start of Run: 21Apr2008, 10:00 Basin Model: -Postdevelopment
End of Run: 22Apr2008, 16:00 Meteorologic Model: T02
Compute Time: 27Jul2010, 13:08:41 Control Specifications: Control Calvert Cliff

Volume Units: IN

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
C-1	0.00206	1.7	21Apr2008, 22:03	1.03
C-10	0.02203	20.2	21Apr2008, 22:05	1.21
C-10A	0.00625	10.2	21Apr2008, 22:04	2.11
C-11	0.00480	13.6	21Apr2008, 21:57	3.17
C-13	0.01500	22.6	21Apr2008, 22:04	1.98
C-13b	0.00270	2.2	21Apr2008, 22:01	0.95
C-14	0.01170	22.5	21Apr2008, 22:04	2.60
C-15	0.00500	9.7	21Apr2008, 22:01	2.26
C-16	0.00500	9.7	21Apr2008, 22:01	2.26
C-17	0.00750	21.4	21Apr2008, 21:56	3.17
C-18	0.00300	6.4	21Apr2008, 21:59	2.26
C-2	0.00841	8.6	21Apr2008, 22:02	1.21
C-21	0.00720	11.8	21Apr2008, 22:04	2.16
C-2A	0.00120	1.0	21Apr2008, 22:02	1.02
C3	0.01858	18.4	21Apr2008, 22:05	1.35
C-4	0.02569	13.5	21Apr2008, 22:10	0.93
C-5	0.02525	14.6	21Apr2008, 22:11	1.03
C-6	0.00367	3.8	21Apr2008, 21:59	1.08
C-7	0.15509	124.7	21Apr2008, 22:12	1.43
C-8	0.01424	16.4	21Apr2008, 22:05	1.73
C-8A	0.00656	7.2	21Apr2008, 22:00	1.19
C-9	0.03537	26.1	21Apr2008, 22:10	1.06
C-9A	0.02285	20.9	21Apr2008, 22:04	1.23
CA-1	0.00206	1.7	21Apr2008, 22:03	1.03
CA-10	0.02203	20.2	21Apr2008, 22:05	1.21

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
CA-10A	0.00625	10.2	21Apr2008, 22:04	2.11
CA-11	0.00480	13.6	21Apr2008, 21:57	3.17
CA-13a	0.01230	20.5	21Apr2008, 22:04	2.21
CA-13b	0.00270	2.2	21Apr2008, 22:01	0.95
CA-14	0.01170	22.5	21Apr2008, 22:04	2.60
CA-15	0.00500	9.7	21Apr2008, 22:01	2.26
CA-16	0.00500	9.7	21Apr2008, 22:01	2.26
CA-17	0.00750	21.4	21Apr2008, 21:56	3.17
CA-18	0.00300	6.4	21Apr2008, 21:59	2.26
CA-2	0.00841	8.6	21Apr2008, 22:02	1.21
CA-21	0.00720	11.8	21Apr2008, 22:04	2.16
CA-2A	0.00120	1.0	21Apr2008, 22:02	1.02
CA-3	0.01858	18.4	21Apr2008, 22:05	1.35
CA-4	0.02569	13.5	21Apr2008, 22:10	0.93
CA-5	0.02525	14.6	21Apr2008, 22:11	1.03
CA-6	0.00367	3.8	21Apr2008, 21:59	1.08
CA-7a	0.04828	29.6	21Apr2008, 22:13	1.14
CA-7b	0.10681	95.1	21Apr2008, 22:11	1.56
CA-8	0.00717	9.0	21Apr2008, 22:01	1.41
CA-8A	0.00656	7.2	21Apr2008, 22:00	1.19
CA-9	0.01252	6.2	21Apr2008, 22:06	0.75
CA-9A	0.00082	1.5	21Apr2008, 21:57	1.73
CA-9A2	0.00082	1.5	21Apr2008, 21:57	1.73
Reach-1	0.00270	2.2	21Apr2008, 22:06	0.95
Reach-2	0.02285	20.9	21Apr2008, 22:11	1.23
Reach-3	0.00707	11.1	21Apr2008, 22:11	2.07

Project: CulvertRev2 Simulation Run: 10yearpost

Start of Run: 21Apr2008, 10:00 Basin Model: -Postdevelopment
End of Run: 22Apr2008, 16:00 Meteorologic Model: T10
Compute Time: 26Jul2010, 14:15:58 Control Specifications: Control Calvert Cliff

Volume Units: IN

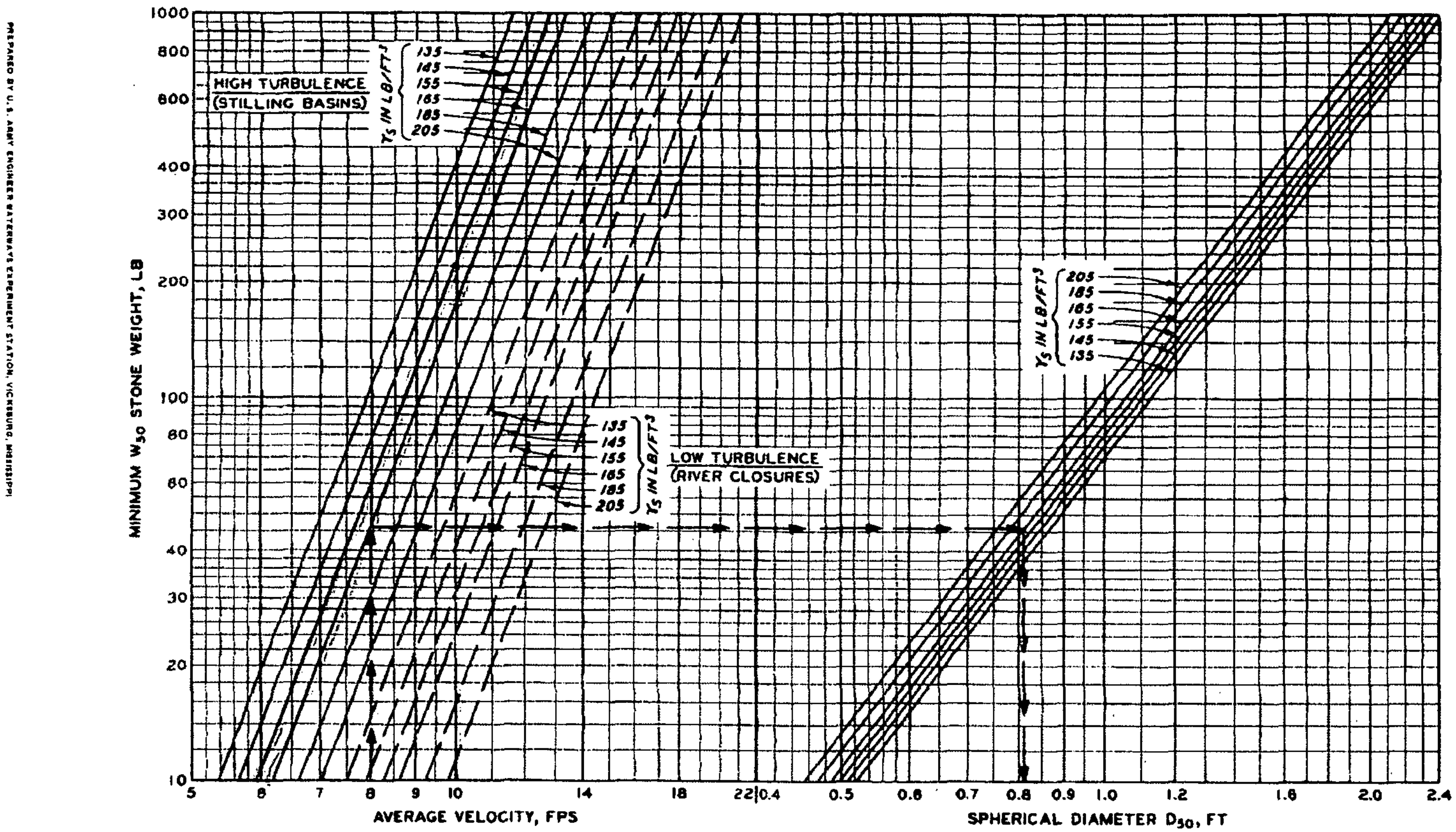
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
C-1	0.00206	4.1	21Apr2008, 22:03	2.40
C-10	0.02203	45.6	21Apr2008, 22:04	2.67
C-10A	0.00625	18.3	21Apr2008, 22:04	3.87
C-11	0.00480	21.3	21Apr2008, 21:57	5.06
C-13	0.01500	41.6	21Apr2008, 22:04	3.68
C-13b	0.00270	5.5	21Apr2008, 22:01	2.26
C-14	0.01170	37.5	21Apr2008, 22:04	4.45
C-15	0.00500	16.9	21Apr2008, 22:01	4.06
C-16	0.00500	16.9	21Apr2008, 22:01	4.06
C-17	0.00750	33.6	21Apr2008, 21:56	5.06
C-18	0.00300	11.1	21Apr2008, 21:59	4.06
C-2	0.00841	19.4	21Apr2008, 22:02	2.67
C-21	0.00720	21.1	21Apr2008, 22:04	3.93
C-2A	0.00120	2.5	21Apr2008, 22:01	2.38
C3	0.01858	39.9	21Apr2008, 22:05	2.87
C-4	0.02569	35.4	21Apr2008, 22:09	2.24
C-5	0.02525	36.3	21Apr2008, 22:10	2.39
C-6	0.00367	8.9	21Apr2008, 21:59	2.47
C-7	0.15509	265.4	21Apr2008, 22:11	2.97
C-8	0.01424	32.2	21Apr2008, 22:04	3.38
C-8A	0.00656	16.2	21Apr2008, 22:00	2.63
C-9	0.03537	62.1	21Apr2008, 22:09	2.43
C-9A	0.02285	47.1	21Apr2008, 22:04	2.69
CA-1	0.00206	4.1	21Apr2008, 22:03	2.40
CA-10	0.02203	45.6	21Apr2008, 22:04	2.67
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
CA-10A	0.00625	18.3	21Apr2008, 22:04	3.87
CA-11	0.00480	21.3	21Apr2008, 21:57	5.06
CA-13a	0.01230	36.3	21Apr2008, 22:04	4.00
CA-13b	0.00270	5.5	21Apr2008, 22:01	2.26
CA-14	0.01170	37.5	21Apr2008, 22:04	4.45
CA-15	0.00500	16.9	21Apr2008, 22:01	4.06
CA-16	0.00500	16.9	21Apr2008, 22:01	4.06
CA-17	0.00750	33.6	21Apr2008, 21:56	5.06
CA-18	0.00300	11.1	21Apr2008, 21:59	4.06
CA-2	0.00841	19.4	21Apr2008, 22:02	2.67
CA-21	0.00720	21.1	21Apr2008, 22:04	3.93
CA-2A	0.00120	2.5	21Apr2008, 22:01	2.38
CA-3	0.01858	39.9	21Apr2008, 22:05	2.87
CA-4	0.02569	35.4	21Apr2008, 22:09	2.24
CA-5	0.02525	36.3	21Apr2008, 22:10	2.39
CA-6	0.00367	8.9	21Apr2008, 21:59	2.47
CA-7a	0.04828	70.1	21Apr2008, 22:12	2.56
CA-7b	0.10681	195.4	21Apr2008, 22:11	3.16
CA-8	0.00717	18.9	21Apr2008, 22:01	2.95
CA-8A	0.00656	16.2	21Apr2008, 22:00	2.63
CA-9	0.01252	18.0	21Apr2008, 22:05	1.94
CA-9A	0.00082	2.8	21Apr2008, 21:57	3.39
CA-9A2	0.00082	2.8	21Apr2008, 21:57	3.39
Reach-1	0.00270	5.5	21Apr2008, 22:06	2.26
Reach-2	0.02285	47.1	21Apr2008, 22:11	2.69
Reach-3	0.00707	20.0	21Apr2008, 22:10	3.82

Project: CulvertRev2 Simulation Run: 100yearpost

Start of Run: 21Apr2008, 10:00 Basin Model: -Postdevelopment
End of Run: 22Apr2008, 16:00 Meteorologic Model: T100
Compute Time: 03Aug2010, 08:18:08 Control Specifications: Control Calvert Cliff

Volume Units: IN

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
C-1	0.00206	9.6	21Apr2008, 22:02	5.64
C-10	0.02203	102.0	21Apr2008, 22:04	6.03
C-10A	0.00625	34.6	21Apr2008, 22:03	7.57
C-11	0.00480	36.7	21Apr2008, 21:57	8.88
C-13	0.01500	80.7	21Apr2008, 22:04	7.31
C-13b	0.00270	13.3	21Apr2008, 22:00	5.44
C-14	0.01170	67.0	21Apr2008, 22:03	8.23
C-15	0.00500	31.2	21Apr2008, 22:01	7.79
C-16	0.00500	31.2	21Apr2008, 22:01	7.79
C-17	0.00750	58.1	21Apr2008, 21:56	8.88
C-18	0.00300	20.5	21Apr2008, 21:59	7.79
C-2	0.00841	43.1	21Apr2008, 22:01	6.03
C-21	0.00720	39.5	21Apr2008, 22:04	7.64
C-2A	0.00120	5.9	21Apr2008, 22:01	5.62
C3	0.01858	86.2	21Apr2008, 22:04	6.30
C-4	0.02569	87 1	21Apr2008, 22:09	5.40
C-5	0.02525	86.6	21Apr2008, 22:09	5.63
C-6	0.00367	20.5	21Apr2008, 21:58	5.74
C-7	0.15509	569.2	21Apr2008, 22:11	6.43
C-8	0.01424	65.0	21Apr2008, 22:04	6.95
C-8A	0.00656	36.2	21Apr2008, 21:59	5.98
C-9	0.03537	144.4	21Apr2008, 22:09	5.67
C-9A	0.02285	105.1	21Apr2008, 22:03	6.06
CA-1	0.00206	9.6	21Apr2008, 22:02	5.64
CA-10	0.02203	102.0	21Apr2008, 22:04	6.03
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
CA-10A	0.00625	34.6	21Apr2008, 22:03	7.57
CA-11	0.00480	36 7	21Apr2008, 21:57	8.88
CA-13a	0.01230	67.6	21Apr2008, 22:04	7.71
CA-13b	0.00270	13.3	21Apr2008, 22:00	5.44
CA-14	0.01170	67.0	21Apr2008, 22:03	8.23
CA-15	0.00500	31.2	21Apr2008, 22:01	7.79
CA-16	0.00500	31.2	21Apr2008, 22:01	7.79
CA-17	0.00750	58.1	21Apr2008, 21:56	8.88
CA-18	0.00300	20.5	21Apr2008, 21:59	7.79
CA-2	0.00841	43.1	21Apr2008, 22:01	6.03
CA-21	0.00720	39.5	21Apr2008, 22:04	7.64
CA-2A	0.00120	5.9	21Apr2008, 22:01	5.62
CA-3	0.01858	86.2	21Apr2008, 22:04	6.30
CA-4	0.02569	87 1	21Apr2008, 22:09	5.40
CA-5	0.02525	86.6	21Apr2008, 22:09	5.63
CA-6	0.00367	20.5	21Apr2008, 21:58	5.74
CA-7a	0.04828	161 9	21Apr2008, 22:11	5.88
CA-7b	0 10681	407.3	21Apr2008, 22:10	6.68
CA-8	0.00717	40.2	21Apr2008, 22:00	6.41
CA-8A	0.00656	36.2	21Apr2008, 21:59	5.98
CA-9	0.01252	47.1	21Apr2008, 22:04	4.95
CA-9A	0.00082	5.6	21Apr2008, 21:57	6.98
CA-9A2	0.00082	5.6	21Apr2008, 21:57	6.98
Reach-1	0.00270	13 3	21Apr2008, 22:05	5.44
Reach-2	0.02285	105.1	21Apr2008, 22:10	6.06
Reach-3	0.00707	38.1	21Apr2008, 22:10	7.50



BASIC EQUATIONS

$$V = C\left[2g\left(\frac{\gamma_S-\gamma_W}{\gamma_W}\right)\right]^{1/2}(D_{50})^{1/2}$$

$$D_{50} = \left(\frac{6W_{50}}{\pi\gamma_S}\right)^{1/3}$$

WHERE:
- V = VELOCITY, FPS
- γ_S = SPECIFIC STONE WEIGHT, LB/FT^3
- γ_W = SPECIFIC WEIGHT OF WATER, 62.5 LB/FT^3
- W_{50} = WEIGHT OF STONE. SUBSCRIPT DENOTES PERCENT OF TOTAL WEIGHT OF MATERIAL CONTAINING STONE OF LESS WEIGHT
- D_{50} = SPHERICAL DIAMETER OF STONE HAVING THE SAME WEIGHT AS W_{50}
- C = ISBASH CONSTANT (0.86 FOR HIGH TURBULENCE LEVEL FLOW AND 1.20 FOR LOW TURBULENCE LEVEL FLOW)
- g = ACCELERATION OF GRAVITY, FT/SEC^2

STONE STABILITY
VELOCITY VS STONE DIAMETER

HYDRAULIC DESIGN CHART 712-1
(SHEET 1 OF 2)

REV 8-58, 9-70 WES 6-57

Job No. 25490
Calc. No. 25490-000-K0C-7400-0006
Rev 002
Attachment 7 1/1

Information for culverts without depressed invert

												Control Regime: Outlet Control					Control Regime: Inlet Control						
Calculation Culvert #	Rough Grading Culvert #	Location	Drainage Area (Ac)	Peak Q, cfs (1)	Length, feet	Inlet Inv. Elev., ft	Outlet Inv. Elev, ft	Dia, ft	# of Pipe	Q per pipe, cfs	Vel, V, fps	ΣK (2)	Head Loss, ft (3)	Normal Depth ft at outfall**	Tail water EL, ft (4)	HW Elev., ft, (5)	HW/D (6)	HW depth, feet (7)	HW Elev., ft, (8)	Control: (9)	Critical elev.or road top (10)	Grade over Pipe elev.	Free-board, ft (11)
6	4	37+20 Const Rd	2.35	8.9	98.00	100.50	98.00	1.50	1	8.90	5.04	2.50	1.68	0.43	98.43	100.12	1.22	1.83	102.33	Inlet	103.00	105.00	0.67
9	8a,8b	EX Rd 64+50 R	22.64	62.1	90.00	77.00	76.00	2.50	2	31.05	6.33	1.50	1.44	1.28	77.28	78.73	1.18	2.95	79.95	Inlet	81.00	82.00	1.05
10	10	79+00 Const Rd	14.10	45.6	141.25	94.00	92.00	3.00	1	45.60	6.45	1.50	1.63	1.08	93.08	94.71	1.10	3.30	97.30	Inlet	100.00	104.00	2.70
10A	9	78+00 Const Rd	4.00	18.3	270.00	100.00	95.00	2.00	1	18.30	5.83	1.50	2.55	0.65	95.65	98.20	1.22	2.44	102.44	Inlet	104.00	104.00	1.56
17	11a,11b,11c	1+90 N	4.80	33.6	131.00	95.50	95.00	1.50	3	11.20	6.34	1.50	2.42	0.92	95.92	98.33	1.50	2.25	97.75	Outlet	99.30	99.30	0.97
18	12	6+05 N	1.92	11.1	131.00	94.00	91.00	1.50	1	11.10	6.28	1.50	2.37	0.49	91.49	93.86	1.48	2.22	96.22	Inlet	98.00	99.00	1.78
11	13	88+40 Const Rd	3.07	21.3	84.00	91.00	90.00	2.00	1	21.30	6.78	1.50	1.81	0.71	90.71	92.52	1.35	2.70	93.70	Inlet	95.00	97.00	1.30
16	14	108+50	3.20	16.9	80.00	89.38	89.00	2.00	1	16.90	5.38	1.50	1.12	0.62	89.62	90.74	1.17	2.34	91.72	Inlet	95.00	96.00	3.28
15	15	112+70	3.20	16.9	80.00	89.38	89.00	2.00	1	16.90	5.38	1.50	1.12	0.62	89.62	90.74	1.17	2.34	91.72	Inlet	95.00	96.50	3.28
14	16	4+50 S	7.49	37.5	60.00	86.50	86.00	2.50	1	37.50	7.64	1.50	1.86	0.98	90.10	91.96	1.42	3.55	90.05	Outlet	93.00	93.50	1.04
13	17	8+30 S	9.58	41.6	60.00	86.50	86.00	2.50	1	41.60	8.47	1.50	2.29	1.03	90.10	92.39	1.55	3.88	90.38	Outlet	93.00	93.50	0.61
21	19a,19b	Laydown 12+25	4.61	21.10	155.50	83.00	82.50	2.00	2	10.55	3.36	1.50	0.60	0.71	83.21	83.81	0.84	1.68	84.68	Inlet	86.00	100.00	1.32
2	21	7+45 Const Rd	5.38	19.4	192.75	92.25	89.50	2.00	1	19.40	6.18	2.50	2.89	0.68	90.18	93.07	1.28	2.56	94.81	Inlet	104.00	106.00	9.19
2A	22	9+55 Const Rd	0.77	2.5	123.00	102.00	101.40	1.50	1	2.50	1.41	1.50	0.12	0.21	101.61	101.72	0.56	0.84	102.84	Inlet	105.00	107.80	2.16

** Based on Mannings equation for assumed trapezoidal channel, b=8', ss = 3:1, n=0.035, s=1%

-1 Q= Peak inflow discharge for 10-year, 24-hour storm

-2 ΣK = Kv + Ke = 0.5 + 1.0 = 1.5 for culverts with no manhole (full exit loss), 0.5 + 0.5 = 1.0 for pipes with intermediate manhole

-3 $$H = \left(\Sigma K + \frac{29n^2L}{R^{4/3}} \right) \frac{V^2}{2g}$$ (Ref 2, Page 34) n=0.013, estimated from Table 5-6 of Reference 8

-4 Tailwater for outlet control = Invert + normal depth in outfall channel

-5 Trial Headwater (Outlet Control) = D/S Inv + H+ Normal depth

-6 HW/D from Chart (Attachment 8), Entrance type groove end with headwall

-7 HW = HW/D * D

-8 Trial Headwater depth (inlet control) = U/S Inv + HW

-9 Governing control for maximum trial HW.

-10 Critical elevation is top of roadway. In a few cases this is equal to the ground elevation.

-11 Freeboard = Governing Elev - HW Elev

Additional notes: For Culvert #13 and 14, discharging into Ditch #4, column (4) reads 90.10 ft for tailwater, which is based on Ditch #4 water level during 10-year storm (see calculation 25470-000-K0C-7400-00001, Rev. 001)

Culvert Pipe Sizing Calculation

ATTACHMENT 8

Sheet 1/3

Job # 25470

Calc. # 25470-000-K0C-7400-00003

Rev 002

Information for culverts with depressed invert

																		Control Regime: Outlet Control					Inlet Control						
Calculation Culvert #	Rough Grading Culvert #	Location	Drainage Area (Ac)	Peak Q, cfs (1)	Length, feet	Inlet Inv. Elev., ft	Outlet Inv. Elev, ft	Dia, ft	alpha (rad) (1a)	theta (rad) (1b)	flow area (ft2) (1c)	Wetted Per. (ft) (1d)	Hyd. Radius (ft) (1e)	Hyd. Dia (ft) (1f)	# of Pipe	Q per pipe, cfs	Vel, V, fps	ΣK (2)	Head Loss, ft (3)	Normal Depth ft at outfall**	Tail water EL, ft (4)	HW Elev., ft, (5)	HW/Dh (6)	HW depth, feet (7)	HW Elev., ft, (8)	Control: (9)	Critical elev.or road top (10)	Grade over Pipe elev.	Free-board, ft (11)
3	1	17+25 Const Rd	11.89	39.9	217.00	103.50	86.57	3.00	1.23	3.82	5.01	8.56	0.58	2.34	1	39.90	7.97	1.50	6.56	1.01	87.58	94.14	1.80	4.21	107.71	Inlet	108.50	109.70	0.79
4	2	27+95 Const Rd	16.44	35.4	175.00	86.00	80.00	3.00	1.23	3.82	5.01	8.56	0.58	2.34	1	35.40	7.07	1.50	4.39	0.94	80.94	85.33	1.60	3.74	89.74	Inlet	93.00	100.00	3.26
5*	3*	34+20 Const Rd	16.16	40.0	209.50	79.00	76.00	3.00	1.23	3.82	5.01	8.56	0.58	2.34	1	40.00	7.99	1.50	6.41	1.01	77.01	83.42	1.80	4.21	83.21	Outlet	93.00	99.00	9.58
7 - 2 years***	5a,5b	42+80 Const Rd	99.26	124.7	495.00	80.00	60.00	5.00	0.93	4.43	16.84	15.07	1.12	4.47	2	62.35	3.70	2.50	1.59	1.85	61.85	63.43	0.75	3.35	83.35	Inlet	100.00	114.00	16.65
7 - 10 years	5a,5b	42+80 Const Rd	99.26	265.4	495.00	80.00	60.00	5.00	0.93	4.43	16.84	15.07	1.12	4.47	2	132.70	7.88	2.50	7.19	2.69	62.69	69.88	1.20	5.36	85.36	Inlet	100.00	114.00	14.64
7 - 100 years***	5a,5b	42+80 Const Rd	99.26	569.2	495.00	80.00	60.00	5.00	0.93	4.43	16.84	15.07	1.12	4.47	2	284.60	16.90	2.50	33.06	3.87	63.87	96.93	2.80	12.51	92.51	Outlet	100.00	114.00	3.07
8	7	61+80 Const Rd	9.12	32.2	100.00	76.00	75.50	3.00	1.23	3.82	5.01	8.56	0.58	2.34	1	32.20	6.43	1.50	2.49	0.90	76.40	78.88	1.50	3.51	79.51	Inlet	82.00	84.00	2.49
8A	6	61+40 Const Rd	4.20	16.2	100.00	76.00	75.50	2.50	1.37	3.54	3.08	6.88	0.45	1.79	1	16.20	5.27	1.50	2.11	0.61	76.11	78.22	1.50	2.68	78.68	Inlet	82.00	85.00	3.32
1	20	3+10 Const Rd	1.32	4.10	107.00	100.00	97.00	2.00	1.57	3.14	1.57	5.14	0.31	1.22	1	4.10	2.61	1.50	0.80	0.28	97.28	98.07	1.10	1.34	101.34	Inlet	103.00	104.00	1 66

* 10% more discharge value from Table 8 due to slight increase in drainage area

** Based on Mannings equation for assumed trapezoidal channel, b=8', ss = 3:1, n=0.035, s=1%

*** Design is for 10 years return period, provided for information

1 Q= Peak inflow discharge for 10-year, 24-hour storm

1a Angle alpha, see figure

1b Angle theta, see figure

1c $A = \frac{D^2}{8}(theta - \sin theta)$ (Ref. 5 Page 659)

1d $P = \frac{D\,theta}{2} + D \sin alpha$

1e $Rh = A / P$

1f $Dh = 4\,Rh$

2 ΣK = Kv + Ke = 0.5 + 1.0 = 1.5 for culverts with no manhole (full exit loss), 0.5 + 0.5 = 1 0 for pipes with intermediate manhole

3 $H = \left(\Sigma K + \frac{29 n^2 L}{Rh^{4/3}} \right) \frac{V^2}{2g}$ (Ref. 2 Page 34) n=0.02, estimated from Table 5-6 of Reference 8

4 Tailwater for outlet control = Invert + normal depth in outfall channel

5 Trial Headwater (Outlet Control) = D/S Inv + H+ Normal depth

6 HW/Dh from Chart (Attachment 8), Entrance type groove end with headwall

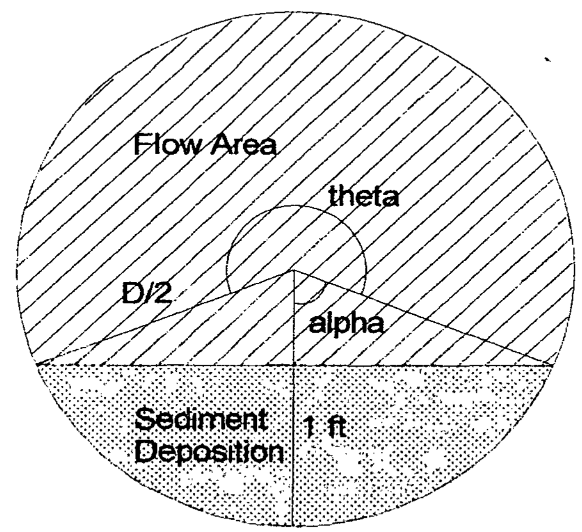
7 HW = HW/Dh * Dh

8 Trial Headwater depth (inlet control) = U/S Inv + HW

9 Governing control for maximum trial HW.

10 Critical elevation is top of roadway. In a few cases this is equal to the ground elevation.

11 Freeboard = Governing Elev HW Elev

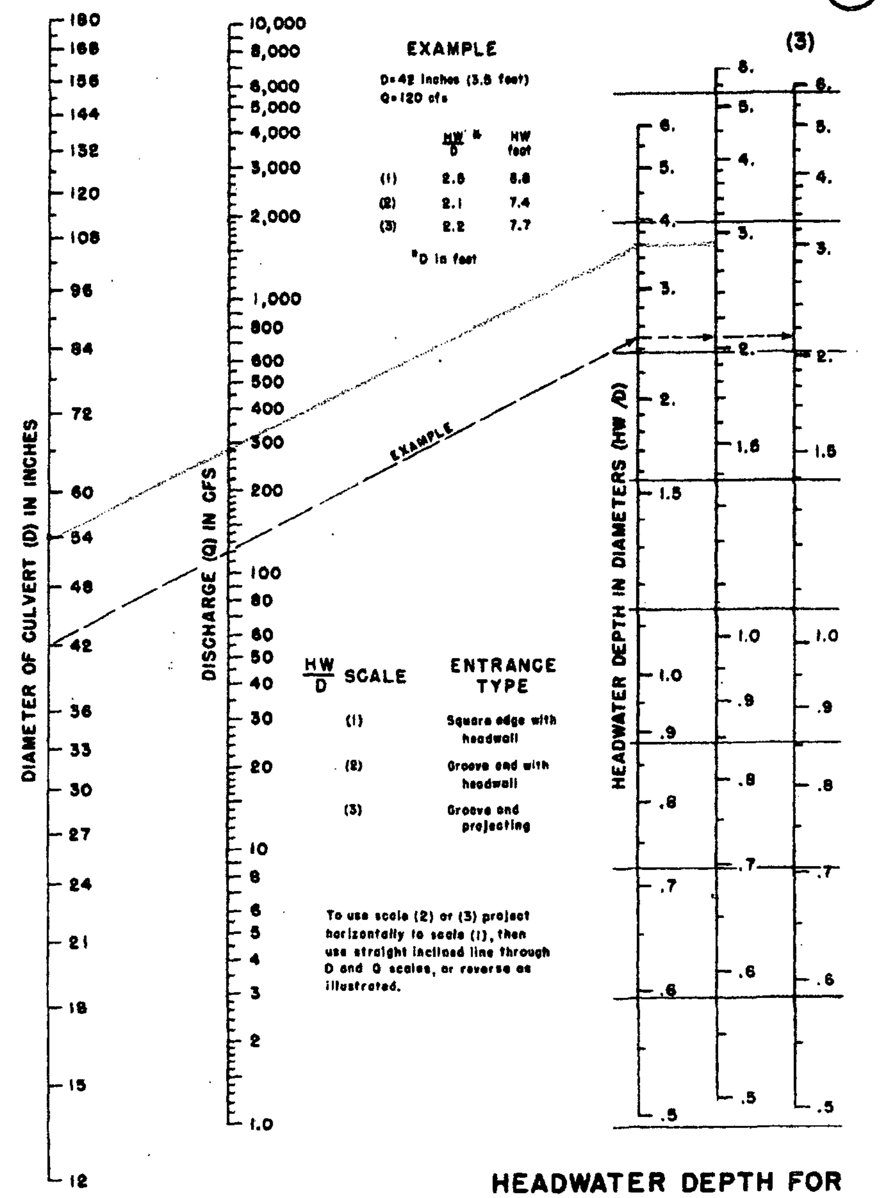


Culvert Pipe Sizing Calculation
ATTACHMENT 8
Sheet 2/3
Job # 25470

Calc. # 25470-000-K0C-7400-00003
Rev 002

Job No 25470
Calc. No: 25470-000-K0C-740-00003
Rev. 002
Attachment 8 3/3

CHART 1B



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3 REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

Job No: 25470
Calc. No: 25470-000-K0C-7400-00003
Rev 002
Attachment 9 1/3

Turan, Cagri

From: Akter, Taslima
Sent: Thursday, July 15, 2010 9:46 AM
To: Turan, Cagri
Subject: FW: CCNPP UNIT 3/ NEW CONSTRUCTION, 08-NT-0191/200862335

Attachments: 080191cheryl.doc

080191cheryl.doc
(72 KB)

MDE Comments

Taslima Akter
x 8174
-----Original Message-----
From: Rabideau, Lee
Sent: Monday, January 04, 2010 4:15 PM
To: Demitz, John
Cc: Wyant, Matthew; Akter, Taslima; Basile, Michael
Subject: FW: CCNPP UNIT 3/ NEW CONSTRUCTION, 08-NT-0191/200862335

Please review these and let's get together to make sure we understand the comments and we either address them or indicated to Ed that these are EA's to resolve.

Thanks,
Lee Rabideau
FR1-3E2
301-228-6897

-----Original Message-----
From: Miller, Edward A [mailto:Edward.Miller@constellation.com]
Sent: Monday, January 04 2010 11:07 AM
To: Rabideau, Lee
Cc: Demitz, John; Konerth, Thomas L; Mccready, William R; Wyant, Matthew
Subject: FW: CCNPP UNIT 3/ NEW CONSTRUCTION, 08-NT-0191/200862335

Lee,
Attached are comments received from MDE regarding their review of the grading plan I believe most of the comments will be resolved by EA. However, you should review the comments and incorporate any requested changes as appropriate

Thanks,
Ed

-----Original Message-----
From: Mohammad Ebrahimi [mailto:mebrahimi@mde state.md us]
Sent: Friday, December 18, 2009 3:51 PM
To: Lutchenkov, Dimitri; Miller, Edward A; Burkman, Jim
Cc: Amanda Sigillito; Cheryl Kerr; Kelly Neff
Subject: CCNPP UNIT 3/ NEW CONSTRUCTION, 08-NT-0191/200862335

Hello-

Please see attached for my comments and concerns for the above referenced project.

Thanks,

Mohammad Ebrahimi, P E

Job No. 25470
Calc. No. 25470-000-K0C-7400-00003
Rev. 002
Attachment 9 2/3

Water Resources Engineer
Maryland Department of the Environment
Wetlands and Waterways Program
1800 Washington Blvd., Suite 430
Baltimore, MD 21230
410-537-3816
410-537-3751 (fax)

Job No. 25470
Calc No. 25470-000-K0C-7600-00003
Rev. 002
Attachment 9 3/3

MEMORANDUM (2)

TO: CHERYL KERR

FROM: MOHAMMAD B. EBRAHIMI, P.E.

SUBJECT: CCNPP UNIT 3/NEW CONSTRUCTION
FILE NO. 08-NT-0191/200862335

DATE: 12/15/08

CC:

Pleased be advised that I have received and reviewed the sediment control plans and the stormwater management computation.

For further review of the above referenced project the consultant still needs to address the following comments and concerns:

1) Every effort shall be made to avoid or minimized the stream loss.

2) Stream stability analysis for ecological restoration and rehabilitation of the channel. For stream stability analysis tractive force computations should be used to demonstrate that the channel will remain stable for 2 and 10-year storm events. Increase in tractive force should be less than 10%; otherwise, channel bank reinforcement should be applied.

3) Computation for estimating bankfull discharge should be provided.

4) The proposed culverts should be depressed at least one foot below the existing stream bed.

5) Detailed hydrologic analysis for culvert 5A, 5B should be provided. Technical Release 20 (TR-20) computer program may be used for determination of peak discharges for the above referenced project. Peak discharges for 2, 10, and 100-year storm events shall be determined based on ultimate land development.

6) Detailed hydraulic analysis for culvert 5A, 5B should be provided. HEC-2 or HEC-RAS computer programs needs to be used for determination of water surface elevations for the 2, 10, and 100 year storm events. Water surface elevations should be computed for pre and post construction. The hydraulic study report should include the delineation of the 100-year floodplain for pre and post construction; the floodplain map should clearly show all the property lines, roadway right of ways and the existing buildings.

7) Best Management Practices (BMP) for working in waterways, and 100-year floodplains. The final construction plans should include the attached BMP.

Job No. 25470
Calc No: 25470-000-K0C 7400-00003
Rev. 002
Attachment 10 1/1

Turan, Cagri

From: Akter, Taslima
Sent: Thursday, July 15, 2010 10:00 AM
To: Turan, Cagri
Subject: FW: Revise Culverts @ Construction access road.

Attachments: 25470-000-CD-0190-00005.pdf; 25470-000-CD-0190-00004.pdf

List of culverts that needs revision

Taslima Akter
x 8174

From: Akter, Taslima
Sent: Thursday, July 15, 2010 9:46 AM
To: Basile, Michael
Subject: FW: Revise Culverts @ Construction access road.

Taslima Akter
x 8174

From: Basile, Michael
Sent: Tuesday, July 06, 2010 9:53 AM
To: Akter, Taslima
Cc: Demitz, John
Subject: Revise Culverts @ Construction access road.

Taslima,

The culverts to be revised will be culverts no. 1, no. 2, no. 3, no. 5A & 5B, no. 6, no. 7 & no. 20.

25470-000-CD-0190-00005.pdf (5...

25470-000-CD-0190-00004.pdf (6...

Michael Basile
301-228-8386

Job No: 25470
Calc. No: 25470-000-KOC-7400-00003
Rev. 002
Attachment 11 1/3

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

MARYLAND 38.414 N 76.492 W 49 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 2, Version 3
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2004

Extracted: Tue Aug 3 2010

Confidence Limits | Seasonality | Related Info | GIS data | Maps | Docs | Return to State Map

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.36	0.58	0.73	1.00	1.24	1.51	1.64	2.01	2.40	2.79	3.18	3.57	4.13	4.68	6.25	7.75	9.71	11.61
2	0.44	0.70	0.88	1.21	1.52	1.84	2.00	2.44	2.91	3.39	3.87	4.33	4.98	5.62	7.43	9.19	11.46	13.65
5	0.52	0.83	1.05	1.49	1.92	2.33	2.54	3.09	3.71	4.41	5.04	5.58	6.31	7.01	8.99	10.94	13.42	15.79
10	0.58	0.93	1.17	1.70	2.21	2.71	2.96	3.62	4.39	5.29	6.03	6.64	7.43	8.15	10.25	12.34	14.93	17.39
25	0.66	1.04	1.32	1.96	2.61	3.23	3.56	4.40	5.43	6.62	7.53	8.23	9.10	9.82	12.01	14.26	16.91	19.43
50	0.71	1.13	1.44	2.16	2.93	3.66	4.06	5.06	6.33	7.79	8.85	9.60	10.53	11.20	13.43	15.76	18.41	20.93
100	0.77	1.22	1.54	2.36	3.25	4.11	4.58	5.77	7.34	9.12	10.31	11.12	12.10	12.70	14.91	17.29	19.87	22.36
200	0.82	1.30	1.64	2.56	3.59	4.57	5.14	6.55	8.47	10.61	11.96	12.81	13.82	14.30	16.45	18.85	21.31	23.72
500	0.89	1.41	1.77	2.82	4.04	5.23	5.93	7.69	10.18	12.89	14.46	15.34	16.38	16.73	18.58	20.97	23.18	25.43
1000	0.94	1.48	1.86	3.02	4.40	5.76	6.59	8.65	11.67	14.88	16.64	17.52	18.55	18.79	20.28	22.61	24.56	26.66

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

* Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.40	0.64	0.80	1.10	1.37	1.67	1.83	2.25	2.71	3.14	3.57	3.97	4.54	5.10	6.72	8.29	10.32	12.29
2	0.48	0.77	0.97	1.34	1.68	2.04	2.23	2.72	3.29	3.81	4.34	4.82	5.47	6.13	8.00	9.84	12.19	14.45
5	0.57	0.92	1.16	1.65	2.11	2.58	2.83	3.44	4.18	4.95	5.64	6.21	6.93	7.63	9.68	11.72	14.29	16.72
10	0.64	1.02	1.29	1.87	2.44	3.00	3.29	4.03	4.95	5.92	6.74	7.38	8.16	8.88	11.03	13.21	15.90	18.41
25	0.72	1.16	1.46	2.17	2.89	3.59	3.96	4.89	6.11	7.39	8.40	9.11	9.97	10.67	12.92	15.26	17.98	20.57
50	0.79	1.26	1.59	2.40	3.25	4.07	4.52	5.64	7.14	8.68	9.84	10.61	11.51	12.16	14.43	16.87	19.59	22.17
100	0.85	1.36	1.71	2.62	3.62	4.58	5.11	6.46	8.30	10.14	11.46	12.27	13.22	13.78	16.03	18.51	21.14	23.69
200	0.92	1.45	1.83	2.85	4.00	5.12	5.76	7.36	9.60	11.78	13.29	14.11	15.09	15.52	17.68	20.19	22.69	25.15
500	1.00	1.58	1.99	3.16	4.54	5.88	6.69	8.71	11.64	14.29	16.07	16.87	17.88	18.16	19.99	22.48	24.72	27.00
1000	1.07	1.68	2.11	3.41	4.98	6.53	7.47	9.87	13.43	16.50	18.49	19.29	20.25	20.41	21.87	24.28	26.25	28.35

* The upper bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are greater than.
** These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

* Lower bound of the 90% confidence interval Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.33	0.53	0.66	0.90	1.12	1.36	1.47	1.81	2.15	2.51	2.86	3.24	3.79	4.33	5.83	7.24	9.13	10.94
2	0.39	0.63	0.79	1.09	1.37	1.66	1.80	2.20	2.60	3.05	3.48	3.94	4.57	5.20	6.93	8.58	10.78	12.88
5	0.47	0.75	0.95	1.35	1.73	2.10	2.27	2.77	3.30	3.96	4.52	5.07	5.79	6.47	8.38	10.21	12.62	14.89
10	0.52	0.83	1.05	1.53	1.99	2.44	2.65	3.23	3.89	4.73	5.38	6.01	6.80	7.52	9.54	11.50	14.03	16.39
25	0.59	0.94	1.19	1.76	2.34	2.90	3.15	3.90	4.76	5.88	6.69	7.40	8.29	9.02	11.13	13.25	15.85	18.29

Job No: 25470
Calc No: 25470-000-K0C-7400-00003
Rev 002

Attachment 11

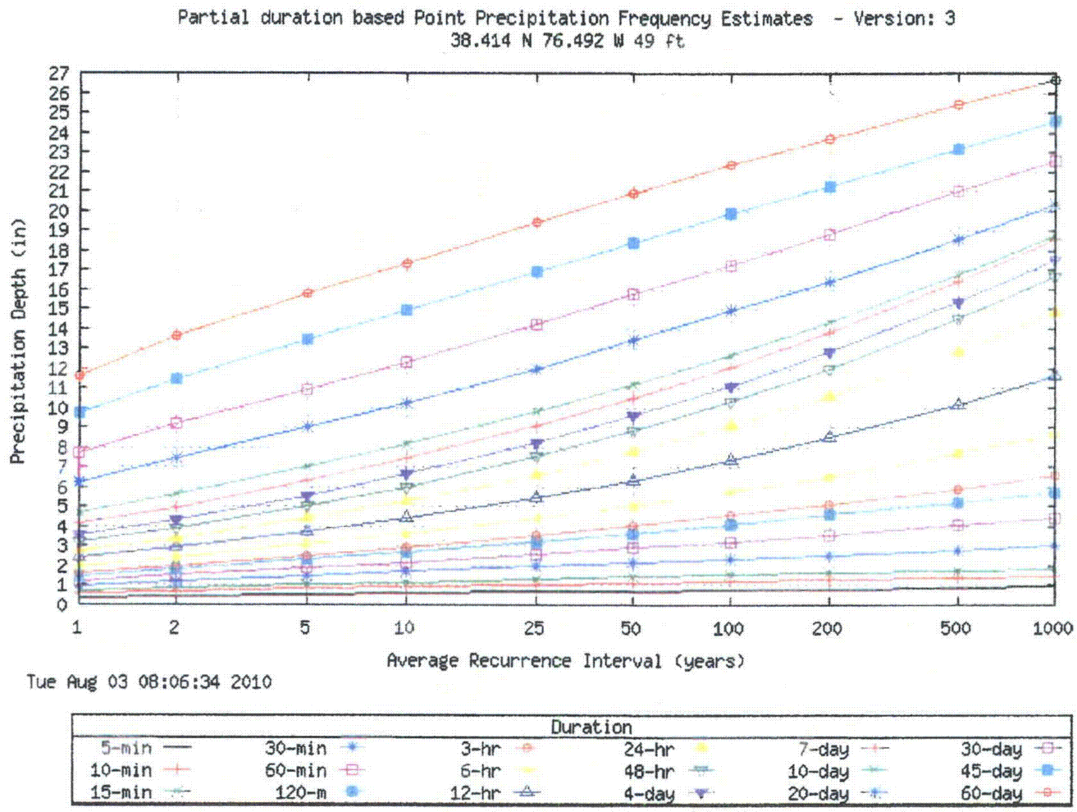
2/3

50	0.64	1.01	1.28	1.93	2.62	3.26	3.57	4.45	5.50	6.87	7.80	8.59	9.53	10.25	12.41	14.62	17.23	19.67
100	0.68	1.08	1.37	2.10	2.89	3.63	4.00	5.03	6.29	7.96	9.02	9.87	10.88	11.55	13.72	15.99	18.56	20.98
200	0.72	1.15	1.45	2.26	3.16	4.01	4.45	5.63	7.16	9.17	10.37	11.29	12.33	12.92	15.07	17.36	19.84	22.20
500	0.78	1.23	1.54	2.46	3.53	4.53	5.07	6.51	8.42	10.97	12.35	13.35	14.44	14.96	16.88	19.20	21.50	23.71
1000	0.81	1.28	1.61	2.61	3.81	4.94	5.55	7.21	9.48	12.51	14.03	15.09	16.17	16.66	18.32	20.61	22.71	24.78

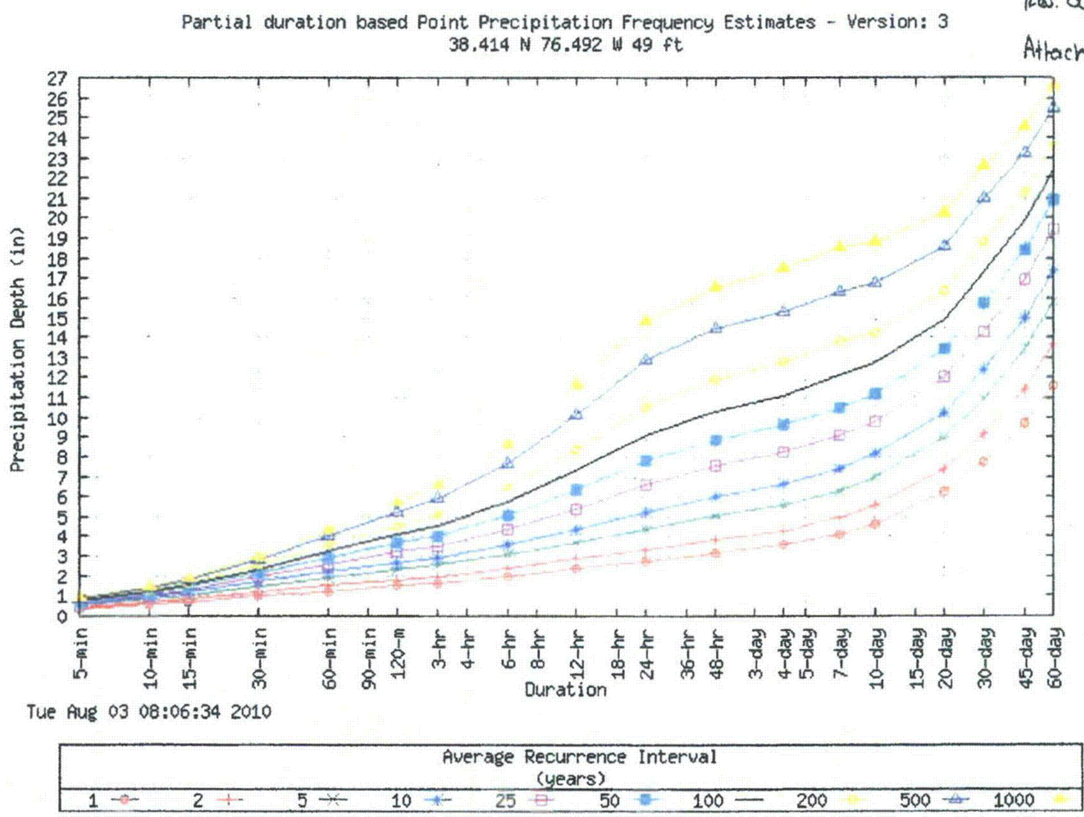
* The **lower** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **less** than.
** These precipitation frequency estimates are based on a partial duration maxima series. **ARI** is the Average Recurrence Interval.

Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

Text version of tables



Job No. 25470
Calc No. 25470-000-K0C-7400-00003
Rev. 002
Attachment 11 3/3



Related Information

Maps & Aerials

Click here to see topographic maps and aerial photographs available for this location from Microsoft Research Maps

Watershed/Streamflow Information

Click here to see watershed and streamflow information available for this location from the U.S. Environmental Protection Agency's site

Climate Data Sources

National Climatic Data Center (NCDC) database

Locate NCDC climate stations within:

+/-30 minutes or +/-1 degree of this location. Digital ASCII data can be obtained directly from NCDC.

Note: Precipitation frequency results are based on analysis of precipitation data from a variety of sources, but largely NCDC. The following links provide general information about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study, please refer to the matching documentation available at the PF Document page

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

CALCULATION COVER SHEET

PROJECT	JOB NO.	CALC NO.	SHEET
Calvert Cliffs Nuclear Power Plant, Unit 3 (CCNPP3)	25470	25470-000-K0C-7400-00009	1 of 16
US EPR Doc No. CCNP3-032-K0C-SWC-00001	Rev 000	UNE Doc No. 000006821	Rev 000

SUBJECT	DISCIPLINE
Hydraulic Analysis of Culvert 5A, 5B Area	G&HES

CALCULATION STATUS DESIGNATION	PRELIMINARY	CONFIRMED with PRELIMINARY INFORMATION	CONFIRMED	SUPERSEDED	VOIDED
	[ ]	[ ]	[X]	[ ]	[ ]

COMPUTER PROGRAM/TYPE	SCP	PROGRAM NO.	VERSION/RELEASE	OPERATING SYSTEM
	X	GE221	4.0	Windows XP

NUCLEAR QUALITY CLASSIFICATION	SAFETY-RELATED	AUGMENTED QUALITY	NONSAFETY-RELATED
	[ ]	[ ]	[X]

LIST OF ATTACHMENTS

1. "Rough Grade Plan Sheet 3, 4, 6 and 13", Bechtel Document 25470-000-CG-0100-00003, -00004, -00006 and -00013, Rev. 001 and "Construction Access Road Culvert Pipe Profiles, Sheet 1", Bechtel Document 25470-000-CD-0190-00004, Rev. 001 (5 Sheets).
2. Location of cross-sections and 100-yr flood level map for pre- and post-construction conditions (3 Sheets).
3. HEC-RAS simulation reports for pre- and post-construction conditions (17 Sheets)
4. HEC-RAS cross-section plots for pre- and post-construction conditions (17 Sheets)
5. Drainage Areas for Culvert 5A, 5B (1 sheet)
6. HEC-RAS input and output files (CD-ROM folder name: 25470-000-K0C-7400-00009_Rev000_Attch_6)
7. List of files in Attachment 6 (1 Sheet)

DIT No. 25470-000-30X-K04G-00031

Computer Program Validation Statement

Computer and software application were verified to be functioning correctly. A problem with a known answer was run, and the results were then compared to the known solution and found to be the same.

The U.S. Army Corps of Engineers' River Analysis System (HEC-RAS) is a software that performs a one-dimensional steady and unsteady flow river hydraulics calculation. It is validated as detailed in Calc No. 54921-510-BSAPHH-HEC-RAS-4.0, Rev 000.

REV. NO.	REASON FOR REVISION	TOTAL NO. OF SHEETS	LAST SHEET NO.	BY	CHECKED	APPROVED/ ACCEPTED	DATE
000	Issued for use	60 + 1 CD	Att. 7, Sh. 1	PS	YK	[signature] /MN/GNM	19 Aug 2010

RECORD OF REVISIONS

I. Objectives & Methodology

The objectives of this calculation are to determine the maximum flood elevations upstream of the roadway Culvert No. 5A, 5B for the flood elevations of the 2, 10 and 100-year 24-hour design storm and to determine the extent of the 100-year flooding with respect to the property line and existing buildings and structures, if any. Water surface elevations are computed for pre- and post-construction conditions.

A discharge hydrograph is developed in Bechtel Calculation No 25470-000-K0C-7400-00003, Rev. 002 "Roadway Culvert Sizing" (Reference 1) for the culvert, taking into account all the upstream drainage areas. Hydrographs were generated for 2, 10 and 100-year 24 hour storms and are used as an input for the current calculation. Water surface elevations are determined using the U.S. Army Corps of Engineers computer program HEC-RAS (Reference 2).

The U.S. Army Corps of Engineers' River Analysis System (HEC-RAS) is validated as detailed in Calc No. 54921-510-BSAPHH-HEC-RAS-4.0, Rev 000. The culvert option has not been validated. It is used in this calculation only for comparison purposes. No conclusions are drawn from the use of the culvert modeling option of HEC-RAS.

II. Drainage Description

The Culvert 5A, 5B has been sized and designed in Reference 1, where was named as "Culvert 7". As shown in Attachment 5 (from Reference 1, Attachment 2), there are two drainage areas that contribute runoff to this culvert, areas CA-7A and CA-7B. The location of the Culvert 5A, 5B is shown in Attachment 1, Sheet 2 (Bechtel Document 25470-000-CG-0100-00004, Rev. 001, "Rough Grade Plan Sheet 4"). There are two streams that contribute runoff to culvert 5A, 5B as seen in Attachment 2. The first stream, labeled as 'west' stream, collects runoff from drainage area CA-7A. The second stream, labeled as 'east' stream, collects runoff from drainage area CA-7B. These two streams are selected based on the flow paths of the two drainage areas as indicated in Attachment 2 of Reference 1. The two streams join together at a distance of approximately 100 ft upstream of the entrance of Culvert 5A, 5B and flow into a stream (labeled as 'south' stream in Attachment 2) towards the Culvert 5A, 5B. The runoff hydrographs from the two streams are added to determine the flow in the "south" stream.

III. Drainage Area Hydrologic Parameters and Peak Discharges

Runoff hydrographs for the site conditions were developed in HEC-HMS, version 3.2.0 and the parameters used for modeling are described in Reference 1. The results are summarized in the following table and can be found in Attachment 6 of Reference 1:

Table 1 – Drainage Area Peak Discharges (cfs)

Drainage	Drainage Area (ac)	Flood flow return period		
		2-year	10-year	100-year
CA-7A	30.90	29.6	70.1	161.9
CA-7B(*)	68.36	95.1	195.4	407.3
Total to culvert 5A, 5B	99.26	124.7	265.5	569.2

(*) When calculating the flow rate, the calculation conservatively neglects the retention due to an upstream storm water basin which is shown in "Rough Grade Plan", Sheet 4, 25470-000-CG-0100-00004 Rev. 001 (Attachment 1, Sheet 2). Based on the delineation of the drainage areas shown in Attachment 5, there are no major changes in the ground cover conditions for the pre- and post-construction. The major change is the proposed entrance road on the west side of the two drainage areas. Therefore, it is assumed that the pre-construction flows are the same as the post-construction flows.

IV. Drainage Network and Channel Cross-Sections

The maximum water levels resulting from the 2-year, 10-year and 100-year events are determined for the streams in the drainage network using the computer program HEC-RAS (Reference 2). As discussed in Section II of this calculation, the drainage system network consists of three streams: the "west", "east" and "south" streams.

Cross-section geometry coordinates and stationing data for the streams in the drainage network are obtained from the surface topographic contours (Attachment 2) based on contour lines shown in Attachment 1 and input into the HEC-RAS model. The location of cross-sections 14 and 15 (downstream of the culvert) can be found in Attachment 1, sheet 2 and the rest of the cross-sections are shown in Attachment 2. The channel reaches, cross-section station names and the distance between cross-sections are shown in Table 2.

Culvert 5A, 5B is modeled with the use of the culvert option in HEC-RAS. The schematic representation of the stream network, cross section locations and the location of culvert 5A, 5B are shown in Figure 1. The flood flows from the "west" and "east" streams are combined at Junction J1 and flow in the "south" stream and through the culvert 5A, 5B. Roughness coefficient parameters selected for the streams and culvert are discussed in Section V.

As indicated in Reference 1 and Attachment 1, sheet 2, there is a manhole in each barrel of culvert 5A, 5B. This creates additional headloss across the culvert. The current version of HEC-RAS does not have the option to add a headloss across a pipe of a culvert. An additional run with HEC-RAS is performed without the use of the culvert option, but with a boundary condition specified at the upstream cross-section of the culvert. The boundary condition is the calculated water level upstream of the culvert from Reference 1. The design of the culvert 5A, 5B in Reference 1 includes the headloss due to the manhole.

Table 2 – HEC-RAS Cross-Section Location Spacing

Stream	Reach	Cross Section No (Att. 2)	Cross Section Station	Downstream Reach Length (ft)	Comments
West	1	20	440	55	Upstream cross-section
West	1	19b	385	55	Interpolated
West	1	19a	330	55	Interpolated
West	1	19	275	70	
West	1	18a	190	42	
West	1	18	145	60	
West	1	17	85	65	
West	1	16	40	135	To "south" stream cross-section "20"
East	2	1	370	55	Upstream cross-section
East	2	2	315	55	
East	2	3	260	60	
East	2	4	200	50	
East	2	4a	150	50	Interpolated
East	2	5	100	190	To "south" stream cross-section "20"
South	3	12	20	20	
South	3	11	0	10	
South	3		-10	500	Culvert 5A, 5B
South	3	14	-510	140	Attach.1 Sheet 2
South	3	15	-650	0	Attach.1 Sheet 2

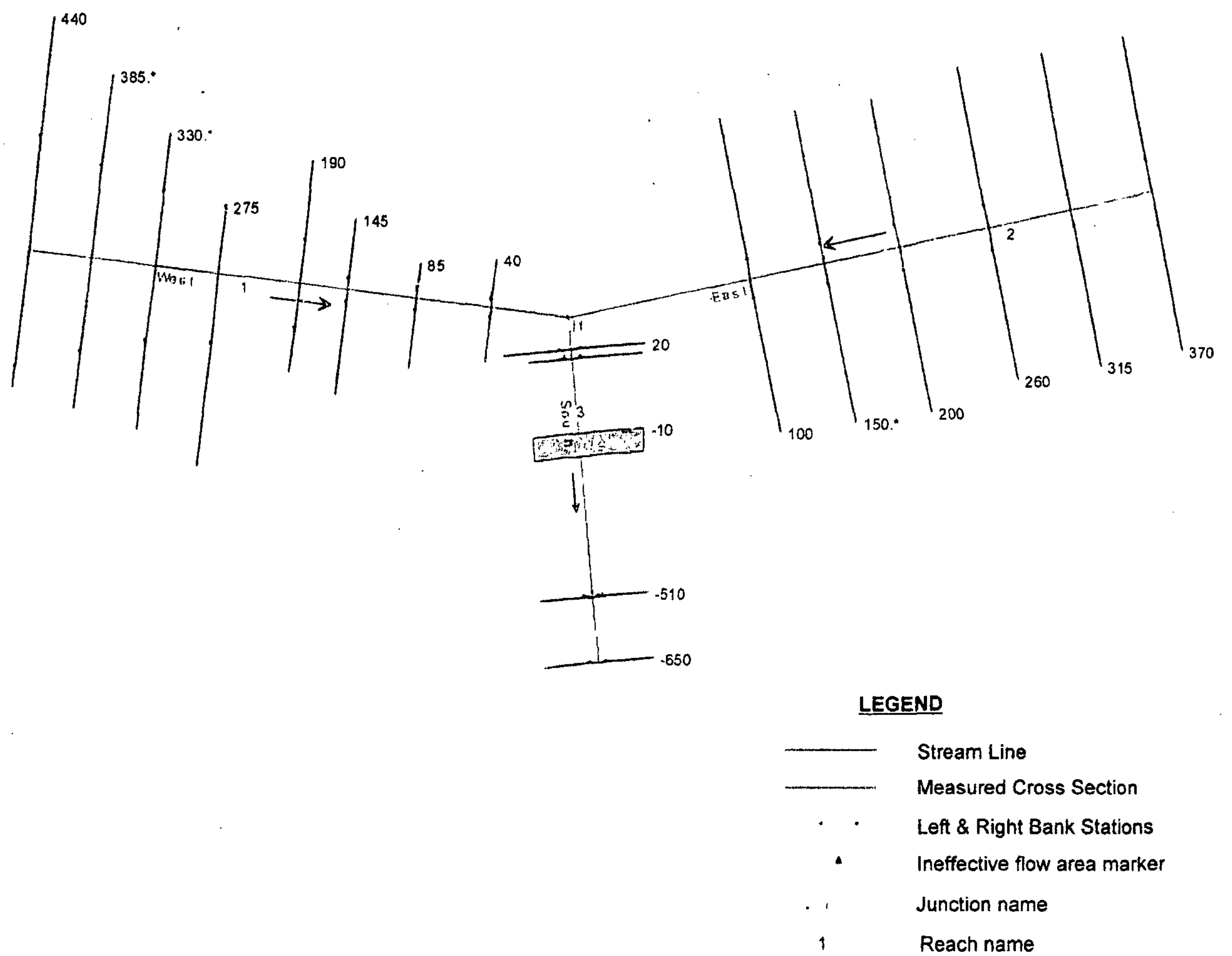


Figure 1 – HEC-RAS Schematic of Stream Network and Cross Sections

V. Manning's Roughness Coefficients

Manning's roughness coefficients "n" for the streams are estimated based on values described in Table 5-6 by Chow (Reference 3). Based on site visit, the channel is covered with weeds and some tree logs and an 'n' value of 0.050 is used for the channels. This value in Reference 3 corresponds to the normal value of mountain streams with cobbles and large boulders at the bottom of the channel. The floodplains with these channels are assumed to be dense willows, straight, in summer (conservatively) that has a maximum 'n' value of 0.200 (Reference 3). Based on Reference 1, the area upstream of the culvert has a mixed land cover described as "Barren Land (Rock/Sand/Clay)", "Cultivated Crops", "Deciduous Forest", "Developed, Open Space" "Pasture/Hay" and "Seeded". The descriptions cover a wide range of Manning's roughness coefficients and conservatively a value of 0.200 is selected.

VI. Culvert modeling

Culvert 5A, 5B is a two-5 foot diameter concrete culvert. The approximate length is 495 feet and it has a flared end section (Attachment 1, Sheet 5). The entrance of the culvert is grooved with a headwall (Reference 1). There is a manhole in each barrel and as shown on Attachment 1, Sheet 2, the storm water from catch basin CB-204 is directed in one of the pipes of the culvert. The area that drains into CB-204 is very small compared to the two drainage areas CA-7A and CA-7B and the peak flow from CB-204 to the culvert is assumed not to affect the design flow.

For the culvert calculation, HEC-RAS uses the Federal Highway Administration standard equations for computing the inlet control losses at the structure. For the outlet control losses, the Energy Equation (standard step method) is used. Details can be found in Reference 2. Four cross sections are required for a complete culvert model. This total includes one cross section sufficiently downstream from the culvert such that flow is not affected by the culvert, one at the downstream end of the culvert, one at the upstream end of the culvert and one cross section located far enough upstream that the culvert has no effect on the flow.

The HEC-RAS ineffective area option is used to restrict the effective flow area near the culvert structure. It is used for both the upstream and downstream cross-sections. Because the flow is contracting rapidly as it enters the culvert, the effective flow area upstream of the culvert is generally wider than the width of the culvert opening. In general a reasonable assumption is to assume a 1:1 contraction rate over the distance between the upstream cross-section and the entrance of the culvert (Reference 2). Based on Attachment 2, the distance between the entrance of the culvert and the upstream cross-section (cross-section '-10' on "south" stream), is approximately 10 ft. Therefore, the effective area is approximately 20.0 ft wider than the culvert opening (10.0 ft on each side of the culvert).

Similarly, the flow will expand as it exits the culvert and the effective flow area downstream of the culvert is wider that the width of the culvert opening. Reference 2 recommends the use of a 1.5:1 expansion rate over the distance between the exit of the culvert and the downstream cross-section. Based on Attachment 1, Sheet 2, the distance between the exit of the culvert and the downstream cross-section (cross-section '-510' on "south" stream), is approximately 20 ft. Therefore, the effective area is approximately 26.67 ft wider than the culvert opening (13.33 ft on each side of the culvert).

As indicated in Reference 1, Maryland Department of the Environment (MDE) requested to depress the culvert inverts on natural streams by 1 foot. Furthermore, the bottom 1 ft of the pipe is assumed to be blocked by sediment, which is included in the HEC-RAS culvert options. Following the culvert design from Reference 1, the size of the culvert is 5.0 ft, the Manning's n for the pipe is taken equal to 0.020 (as in Reference 1) and the entrance of the culvert is assumed as grooved with a headwall.

VII. Boundary Conditions

The upper part of the "east" stream and the area upstream and downstream of the culvert has significant elevation change. Therefore, super-critical flow conditions appear in these areas. The rest of the streams have relatively mild slopes and sub-critical flow conditions appear in these areas. For the model simulation performed in HEC-RAS, the mixed flow option is selected, and both upstream and downstream boundary conditions are specified. The boundary conditions for the three streams are summarized in the following table, with the slopes estimated based on the rough grade drawings.

Table 3 – HEC-RAS boundary conditions

Stream	Reach	Upstream	Downstream
West	1	Normal Depth, S=0.015	Junction J1
East	2	Normal Depth, S=0.200	Junction J1
South	3	Junction J1	Normal Depth, S=0.007

As mentioned in Section IV, HEC-RAS cannot model the additional headloss inside the culvert due to the manholes. An additional run of the model is performed, but without including the culvert. Instead of using the culvert option of HEC-RAS, a boundary condition (known water surface elevation) is specified at the cross-section just upstream of the culvert (cross-section at station '0' of the "south" stream). The known water surface elevations for the three flow rates of 2-yr, 10-yr and 100-yr, are estimated in Reference 1 and are 83.35 ft, 85.36 ft and 96.93 ft, respectively. These water surface elevations are input into the HEC-RAS model as downstream boundary conditions.

VIII. Junction Data

The junction in the model (node where the east and west streams meet) is modeled using energy equation option in the HEC-RAS model.

IX. HEC-RAS Results

IX. A. Post-construction

The HEC-RAS simulation provides the maximum water surface elevation for the three flood flow conditions. As discussed earlier, the retention due to an upstream storm water basin is not taken into account and it is assumed that the pre-construction flows are the same as the post-construction flows. A summary of discharge, minimum channel elevation, peak water levels, channel velocity, and channel Froude numbers for the "east", "west" and "south" streams is shown in Table 4 for the 100-yr flood condition and with the culvert modeling option used. The input files for HEC-RAS can be found in Attachment 6 (CD-ROM).

Table 4 – Maximum Water Levels for 100-yr Flood Condition (culvert option used)

Stream	Reach	River Station	Total Discharge (cfs)	Min. Channel Elevation (ft)	Water Surface Elevation (ft)	Velocity Total (ft/s)	Froude # XS
West	1	440	161.9	109.00	109.89	1.90	0.51
West	1	385.*	161.9	108.33	109.16	1.97	0.54
West	1	330.*	161.9	107.67	108.44	1.99	0.50
West	1	275	161.9	107.00	107.66	2.56	0.61
West	1	190	161.9	105.00	105.67	4.32	1.00
West	1	145	161.9	99.00	100.25	11.12	2.41
West	1	85	161.9	95.00	96.57	6.24	1.11
West	1	40	161.9	90.00	92.56	3.55	0.49
East	2	370	407.3	108.00	109.01	11.55	2.34
East	2	315	407.3	96.75	98.80	12.82	2.12
East	2	260	407.3	94.25	98.63	4.50	0.51
East	2	200	407.3	94.75	97.32	7.12	1.03
East	2	150.*	407.3	92.38	94.82	9.07	1.37
East	2	100	407.3	90.00	92.63	8.57	1.21
South	3	20	569.2	79.75	92.74	0.70	0.05
South	3	0	569.2	78.75	92.72	1.26	0.06
South	3	-10	Culvert				
South	3	-510	569.2	54.00	58.49	7.08	0.71
South	3	-650	569.2	53.00	57.26	5.02	0.54

Note: Interpolated cross-sections are indicated by "*".

The results for the culvert are reported in Table 5, for the three flood conditions.

Table 5 – Culvert Hydraulics Results for the 2-yr, 10-yr and 100-yr Flood Condition

Variable	100-yr	10-y	2-yr
Q Culv Group (cfs)	569.2	265.5	124.7
# Barrels	2	2	2
Q Barrel (cfs)	284.6	132.8	62.4
W.S. U/S (ft)	92.7	85.1	83.0
W.S. D/S (ft)	58.5	57.3	56.4
Culv Nml Depth (ft)	4.5	2.8	2.1
Culv Vel U/S (ft/s)	16.9	10.0	7.4
Culv Vel D/S (ft/s)	16.9	15.7	12.6
Culv Inv El U/S (ft)	79	79	79
Culv Inv El D/S (ft)	59	59	59

As shown in Tables 4 and 5, the maximum water level upstream of the culvert for the 100-yr flood condition is 92.7 ft at cross-section "0". Also, from Table 5 the velocity in the culvert for the 100-yr flood is 16.9 ft/s. As noted in Section IV, the design of the culvert 5A, 5B in Reference 1 has included an additional headloss induced by a manhole. The loss coefficient for the manhole is taken equal to 1. So the additional headloss due to the manhole is:

$$H_{manhole} = K\frac{V^2}{2\cdot g} = 1.0\cdot\frac{16.9^2}{2\cdot 32.2} = 4.4\text{ ft}$$

W.S. U/S of culvert = 92.7 + 4.4 = 97.1 ft

which is very close with the calculated water surface elevation of 96.9 ft upstream of the culvert, estimated in Reference 1.

The results of the HEC-RAS simulation without the culvert option are provided in Table 6. Instead of the culvert option, a downstream boundary condition (known water surface elevation) is specified for cross-section '0' of the "south" stream, as described in Section VII. For the delineation of the 100-yr flood level, the results of Table 6 are used. A summary of discharge, minimum channel elevation, peak water levels, channel velocity, and channel Froude numbers for the "east", "west" and "south" streams is shown in Table 6 for the 100-yr flood condition. A more detailed report of the results can be found in Attachment 3 and the input and output files for HEC-RAS can be found in Attachment 5 (CD-ROM).

Table 6 – Maximum Water Levels for the 100-yr Flood Condition (culvert option not used)

Stream	Reach	River Station	Total Discharge (cfs)	Min. Channel Elevation (ft)	Water Surface Elevation (ft)	Velocity Total (ft/s)	Froude # XS
West	1	440	161.9	109.00	109.89	1.90	0.51
West	1	385.*	161.9	108.33	109.16	1.97	0.54
West	1	330.*	161.9	107.67	108.44	1.99	0.50
West	1	275	161.9	107.00	107.66	2.56	0.61
West	1	190	161.9	105.00	105.67	4.32	1.00
West	1	145	161.9	99.00	100.25	11.12	2.41
West	1	85	161.9	95.00	96.57	6.24	1.11
West	1	40	161.9	90.00	96.94	0.59	0.06
East	2	370	407.3	108.00	109.01	11.55	2.34
East	2	315	407.3	96.75	98.80	12.82	2.12
East	2	260	407.3	94.25	98.63	4.50	0.51
East	2	200	407.3	94.75	97.32	7.13	1.03
East	2	150.*	407.3	92.38	96.84	3.10	0.34
East	2	100	407.3	90.00	96.89	1.60	0.15
South	3	20	569.2	79.75	96.94	0.31	0.02
South	3	0	569.2	78.75	96.93	0.95	0.04

Note: Interpolated cross-sections are indicated by "*"

The two cross-sections on the "south" stream downstream of the culvert (at stations '-510' and '-650') are not included in the simulation. The water surface elevation at river station '0' is set as a boundary condition and the simulation results are not affected by the two cross-sections downstream of river station '0'.

Figures 2 and 3 are plots of the water surface profile for the "east & south" and "west & south" streams, respectively, for the simulation that the culvert option is not used. The "east" and "west" streams are plotted together with the "south" stream so that the area surrounding the junction is included in the profile. The plots of the cross-sections with the calculated water surface elevations can be found in Attachment 4. Based on the results shown in Table 6, the 100-yr flood map is drawn for the post-construction conditions and can be found in Attachment 2, sheet 2.

CALCULATION SHEET

SUBJECT Hydraulic Analysis of Culvert 5A, 5B Area

PROJECT: Calvert Cliffs Nuclear Power Plant, Unit 3
JOB NUMBER: 25470
CALC NO. 25470-000-K0C-7400-00009

SHEET NO. 11 of 16

BY Periandros Samothrakis

DATE August 3, 2010

SHEET REV. 000

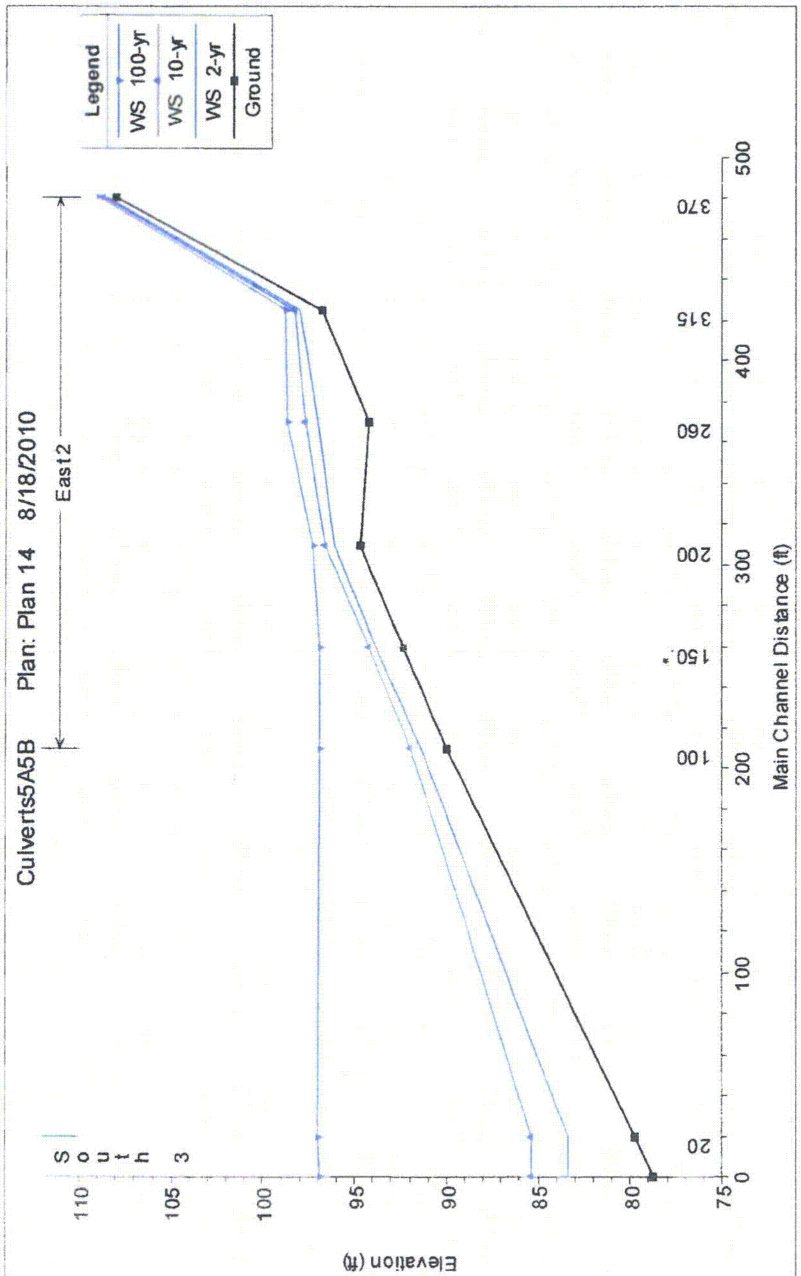


Figure 2 – "East & South" stream water surface profile, post-construction (no culvert option).

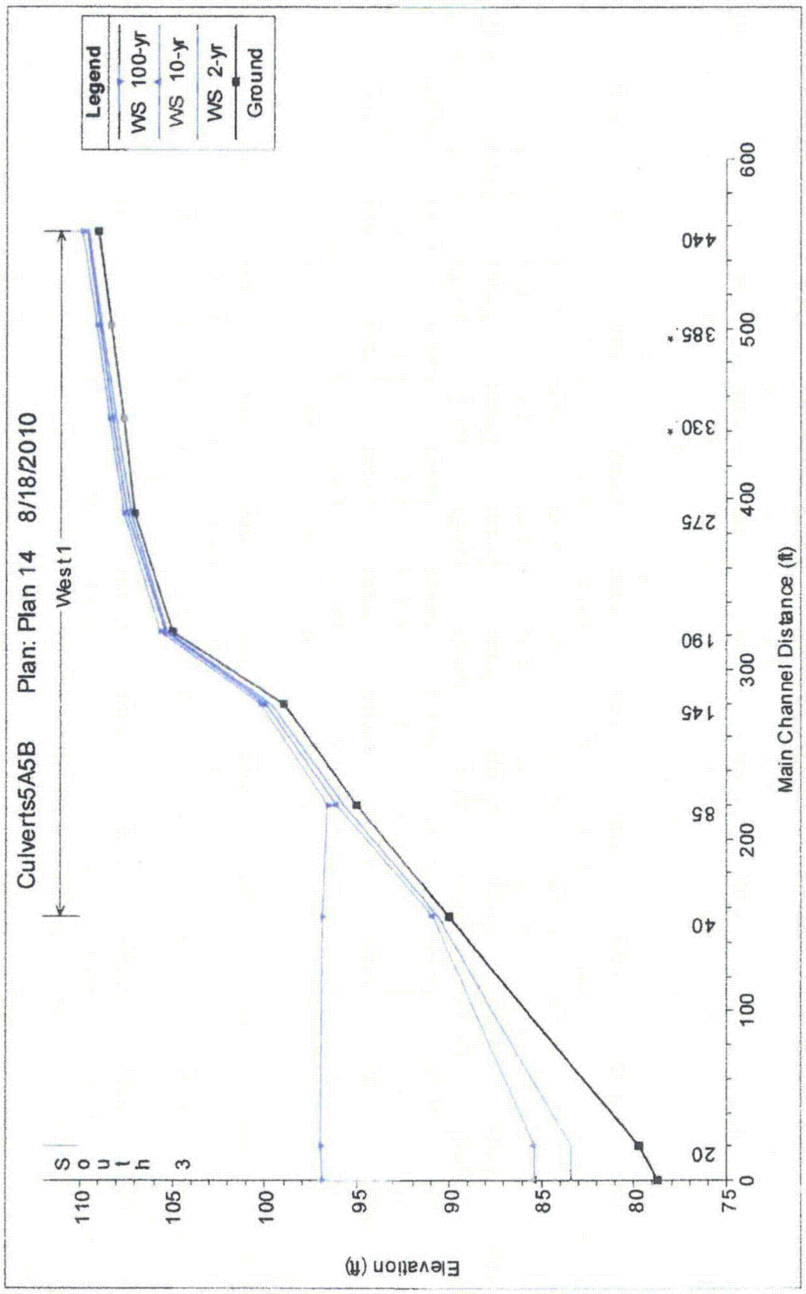


Figure 3 – "West & South" stream water surface profile, post-construction (no culvert option).

IX. B. Pre-construction

The pre-construction stream network configuration is similar to the one presented in Figure 1, with the only difference that the culvert is not included. The HEC-RAS simulation provides the maximum water surface elevation for the three flood flow conditions. A summary of discharge, minimum channel elevation, peak water levels, channel velocity, and channel Froude numbers for the "east", "west" and "south" streams is shown in Table 7 for the 100-yr flood condition. A more detailed report of the results can be found in Attachment 3 and the input and output files for HEC-RAS can be found in Attachment 6 (CD-ROM).

Table 7 – Maximum Water Levels for the 100-yr Flood Condition (pre-construction)

Stream	Reach	River Station	Total Discharge (cfs)	Min. Channel Elevation (ft)	Water Surface Elevation (ft)	Velocity Total (ft/s)	Froude # XS
West	1	440	161.9	109.00	109.89	1.90	0.51
West	1	385.*	161.9	108.33	109.16	1.97	0.54
West	1	330.*	161.9	107.67	108.44	1.99	0.50
West	1	275	161.9	107.00	107.66	2.56	0.61
West	1	190	161.9	105.00	105.67	4.32	1.00
West	1	145	161.9	99.00	100.25	11.12	2.41
West	1	85	161.9	95.00	96.57	6.24	1.11
West	1	40	161.9	90.00	91.29	10.18	1.92
East	2	370	407.3	108.00	109.01	11.55	2.34
East	2	315	407.3	96.75	98.80	12.82	2.12
East	2	260	407.3	94.25	98.63	4.50	0.51
East	2	200	407.3	94.75	97.32	7.12	1.03
East	2	150.*	407.3	92.38	94.82	9.07	1.37
East	2	100	407.3	90.00	92.63	8.57	1.21
South	3	20	569.2	79.75	82.28	10.50	1.42
South	3	0	569.2	78.75	81.59	9.06	1.15
South	3	-510	569.2	54.00	58.34	7.44	0.75
South	3	-650	569.2	53.00	57.26	5.02	0.54

Note: Interpolated cross-sections are indicated by "*"

Based on the results shown in Table 7, the 100-yr flood map is drawn for the pre-construction conditions and can be found in Attachment 2, sheet 3. Figures 4 and 5 (sheets 15 and 16) are plots of the water surface profile for the "east & south" and "west & south" streams, respectively, for the pre-construction condition. The plots of the cross-sections with the calculated water surface elevation can be found in Attachment 4. Based on the results presented in Tables 6 and 7, the water surface elevation in the "west" stream, from the river station '440' to '85', is not affected by the culvert, as it is the same in both pre- and post- construction conditions.

X. Summary

The maximum flood elevations upstream of the roadway Culvert No. 5A, 5B have been determined. An analysis of the flood elevations for 2, 10 and 100-year flows was performed and a 100-year flood map was drawn to determine the extent of flooding with respect to the property line and existing buildings and structures. The water surface elevations are computed for pre- and post-construction conditions. The simulation for the post-construction condition has been performed with and without the culvert modeling option of HEC-RAS. In the latter case, the water surface elevation upstream of the culvert was specified as a boundary condition based on the results of Reference 1. The analysis assumes that the flood flow rates are the same for the pre- and post-construction conditions.

XI. List of Drawings

1. Rough Grading Plan Sheets 3, 4, 6 and 13, Calvert Cliffs 3 Nuclear Project, Bechtel Document No. 25470-000-CG-0100-00003, -00004, -00006 and -00013 Rev. 001
2. Construction Access Road Culvert Pipe Profiles Sheet 1, Calvert Cliffs 3 Nuclear Project, Bechtel Document No. 25470-000-CD-0190-00004, Rev. 001

XII. References

1. Bechtel Calculation 25470-000-K0C-7400-00003, Rev. 002 "Roadway Culvert Sizing"
2. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-RAS, River Analysis System, Version 4.0, March 2008.
3. Chow, Ven Te, *Open-Channel Hydraulics*, 1959.

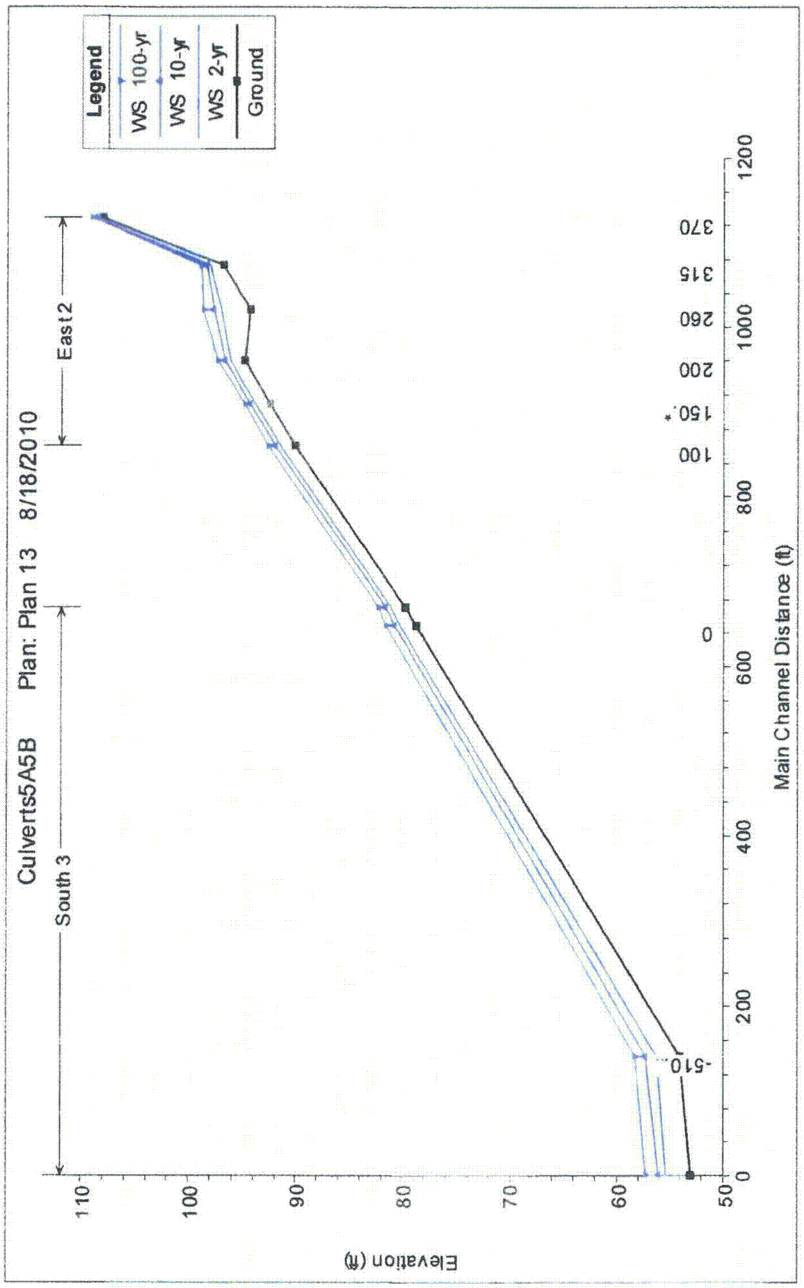


Figure 4 – "East & South" stream water surface profile, pre-construction.

CALCULATION SHEET

PROJECT: Calvert Cliffs Nuclear Power Plant, Unit 3
JOB NUMBER: 25470
CALC NO. 25470-000-K0C-7400-00009

SUBJECT Hydraulic Analysis of Culvert 5A, 5B Area

BY Periandros Samothrakis

DATE August 3, 2010

SHEET REV. 000

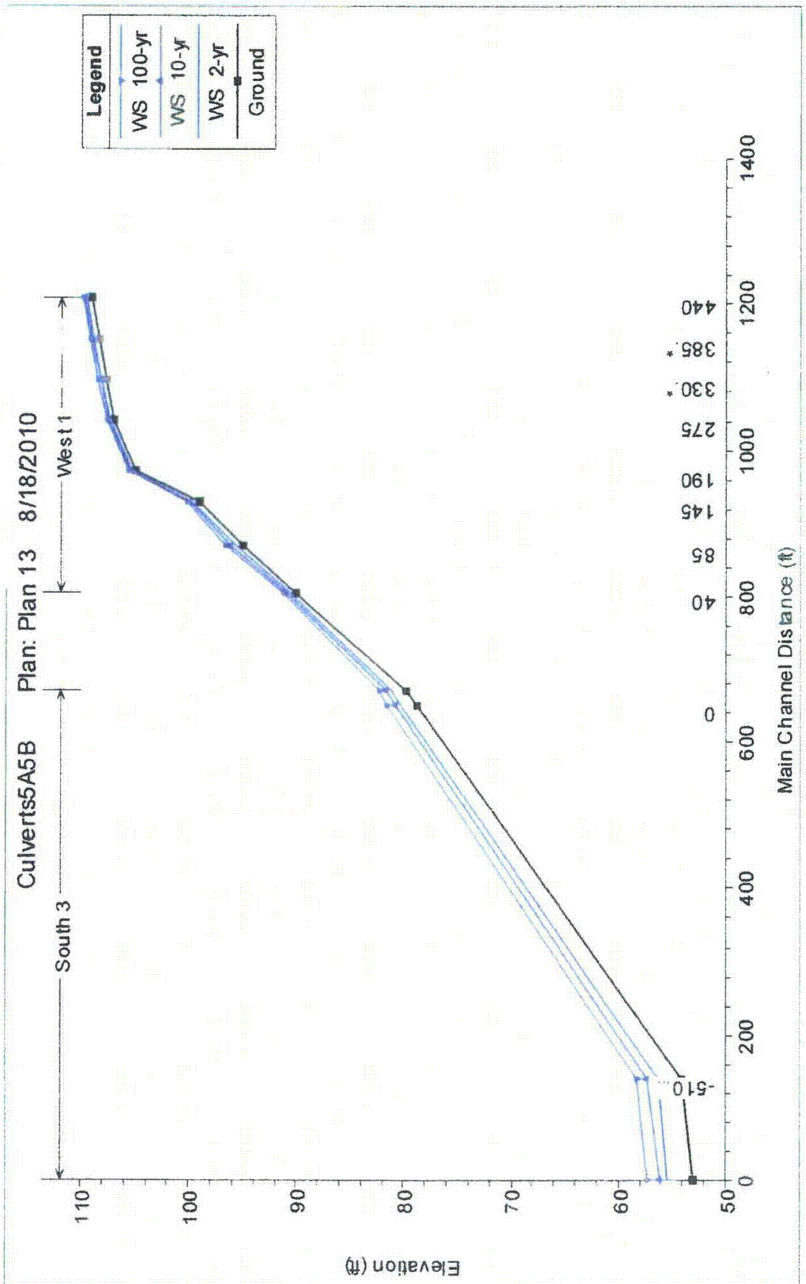
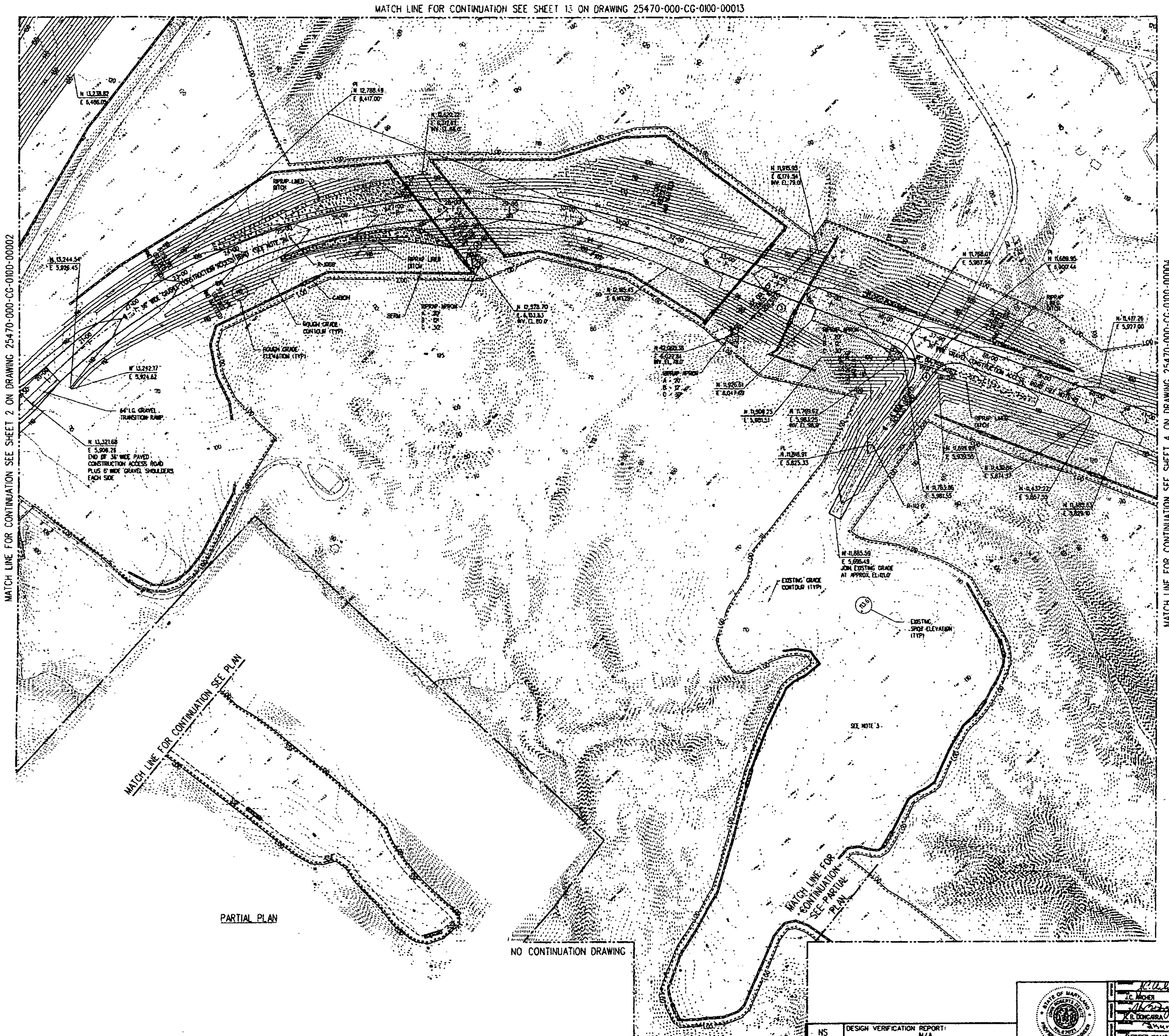


Figure 5 – "West & South" stream water surface profile, pre-construction.

ATTACHMENT 1
Sheet 1/5

Job 25470
Calc: 25470-000-K0C-7400-00009, Rev.000



KEY PLAN

		SHEET 14	SHEET 15	SHEET 16	
		SHEET 11	SHEET 10	SHEET 9	
SHEET 12	SHEET 13	SHEET 6	SHEET 7	SHEET 8	
SHEET 2	SHEET 3	SHEET 4	SHEET 5		
SHEET 1					

TRUE NORTH
PLANT NORTH

NOTES

1. FOR NOTES AND REFERENCE DRAWINGS SEE DRAWING 25470-000-CG-0000-00001.
2. FOR CONSTRUCTION ACCESS ROAD PROFILE SEE DRAWINGS 25470-000-CG-0190-00002 AND 25470-000-CG-0190-00003.
3. GRADING IN THIS AREA IS TO BE LIMITED TO THE INSTALLATION OF A 6" AGGREGATE BASE COURSE.
4. FOR CATCH BASIN DETAILS SEE DRAWING 25470-000-CD-0190-00001.
5. FOR FLARED END SECTIONS AND RIPRAP APRON DETAILS SEE DRAWING 25470-000-CD-0000-00008.
6. FOR CULVERT PIPE PROFILES SEE DRAWING 2547-000-CD-0190-00004.

LEGEND

- PROPERTY LINE
- 1' EXISTING GRADE CONTOUR
- 2' PROPOSED CONTOUR
- 10' PROPOSED CONTOUR
- STORM DRAIN PIPE OR CULVERT
- IDA LINE
- ℄ DRAINAGE DITCH
- LOD — LIMITS OF DISTURBANCE
- SUPER SILT FENCE/ ORANGE SAFETY FENCE
- BERM ROUGH GRADE/CENTERLINE
- GABION
- RIPRAP
- CB — SQUARE CATCH BASIN - TYPE 1 & 2
- CB — CIRCULAR CATCH BASIN - TYPE 3
- MH — MANHOLE
- PI — POINT OF INTERSECTION
- PAVING GRID
- AGGREGATE
- (X) CULVERT NUMBER

0 60 120 180 240FT

NS	DESIGN VERIFICATION REPORT: N/A
	REVISION DESCRIPTION
REVISED TITLE BLOCK	

STATE OF MARYLAND — JOHN ROBERTS DEMITZ — No. 27021 — PROFESSIONAL ENGINEER
License No. 27021
Expiration Date 4/27/2011

Name	Date
J.C. ARCHER	1/15/2010
R. B. DONGARRA	1/15/2010
SURINDER KUMAR	1/15/2010
MICHAEL BASILE	1/15/2010
JOHN DEMITZ	1/15/2010
LEE RABIDEAU	1/15/2010

AREVA
U.S. EPR™ DRAWING
CALVERT CLIFFS 3 NUCLEAR PROJECT

CONTRACT NO. 300208 | JOB NO. 25470

ROUGH GRADE PLAN SHEET 3

U.S. EPR™ Document No.	CCNP3-002-CG-BY-00006	001
UniStar Document No.	000004866	001
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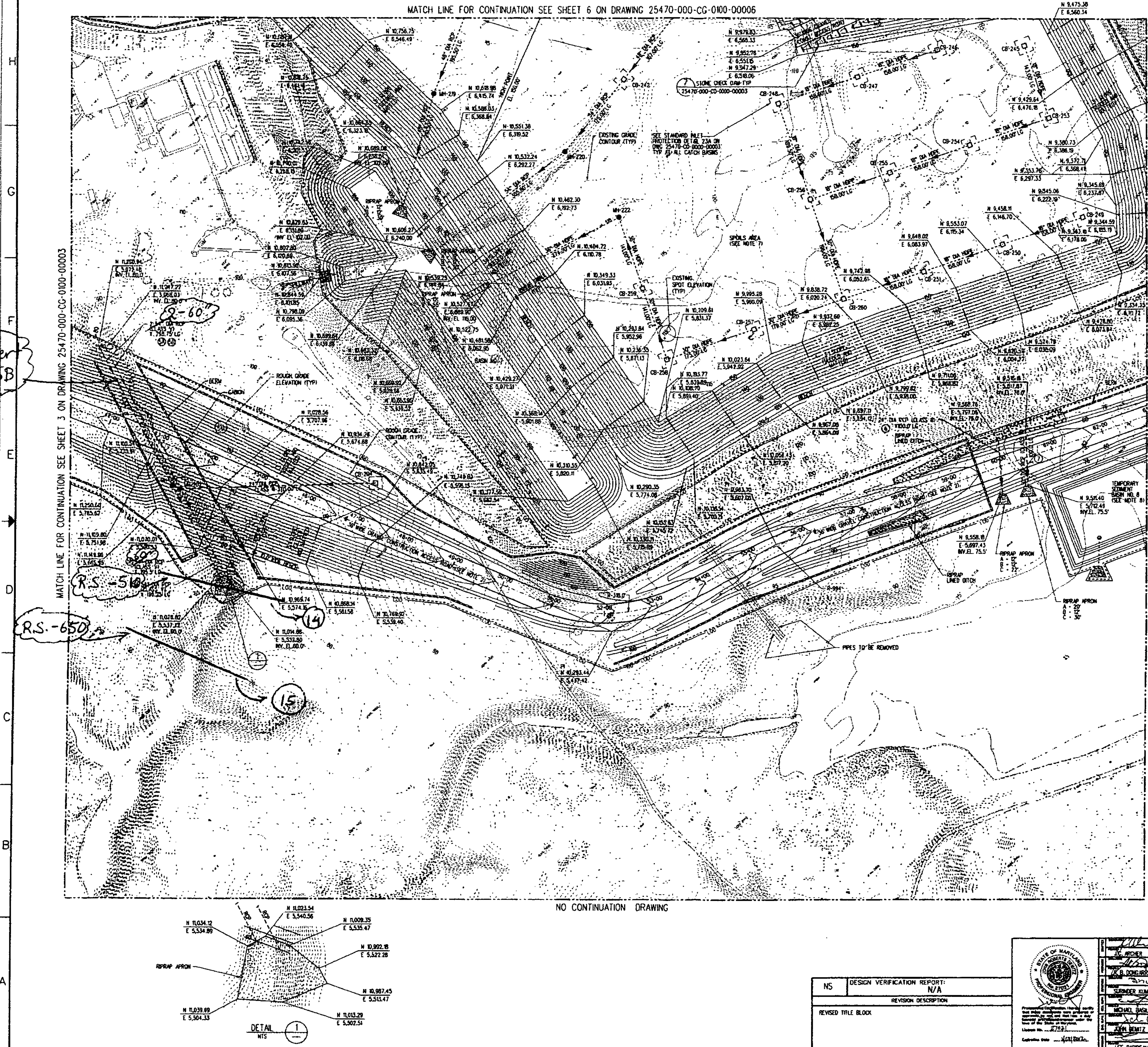

ATTACHMENT 1
Sheet 2/5

Job 25470
Calc 25470-000-K0C-7400-00009, Rev.000

KEY PLAN

SHEET 14	SHEET 15	SHEET 16
SHEET 11	SHEET 10	SHEET 9
SHEET 12	SHEET 13	SHEET 6	SHEET 7	SHEET 8
SHEET 2	SHEET 3	SHEET 4	SHEET 5
SHEET 1

TRUE NORTH
PLANT NORTH

NOTES

1. FOR NOTES AND REFERENCE DRAWINGS SEE DRAWING 25470-000-CG-0000-00001.
2. FOR CONSTRUCTION ACCESS ROAD PROFILE SEE DRAWINGS 25470-000-CG-0190-00003 AND 25470-000-CG-0190-00004.
3. FOR CATCH BASIN DETAILS SEE DRAWING 25470-000-CD-0190-00001.
4. FOR FLARED END SECTIONS AND RIPRAP APRON DETAILS SEE DRAWING 25470-000-CD-0000-00008.
5. FOR CULVERT PIPE PROFILES SEE DRAWING 2547-000-CD-0190-00004.
6. DO NOT REMOVE VEGETATION ON SIDE SLOPES OF EXISTING SPOILS BERMS.
7. SPOILS SHALL BE PLACED IN THE DESIGNATED AREAS FOR SPOILING, WORKING FROM THE OUTSIDE OF THE SPOILS PILE INWARD, STARTING WITH A CONTAINMENT BERM WHICH IS BLENDED IN THE GRADING AS THE SPOILS ARE PLACED.
8. TEMPORARY SEDIMENT BASIN 8 WILL BE REMOVED AFTER CONSTRUCTION.

LEGEND

- 1' EXISTING GRADE CONTOUR
- 2' PROPOSED CONTOUR
- 10' PROPOSED CONTOUR
- STORM DRAIN PIPE OR CULVERT
- IDA LINE
- ℄ DRAINAGE DITCH
- LIMITS OF DISTURBANCE
- SUPER SILT FENCE/ ORANGE SILT FENCE
- BERM ROUGH GRADE/CENTERLINE
- GABION
- RIPRAP
- □ CB SQUARE CATCH BASIN TYPE 1 & 2
- ○ CB CIRCULAR CATCH BASIN TYPE 3
- ● MH MANHOLE
- PI POINT OF INTERSECTION
- PAVING GRID
- AGGREGATE
- (X) CULVERT NUMBER

0 60 120 180 240FT

NS	DESIGN VERIFICATION REPORT: N/A
	REVISION DESCRIPTION
	REVISED TITLE BLOCK

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CALVERT CLIFFS 3 NUCLEAR PROJECT

CONTRACT NO. 300206 | JOB NO. 25470

ROUGH GRADE PLAN SHEET 4

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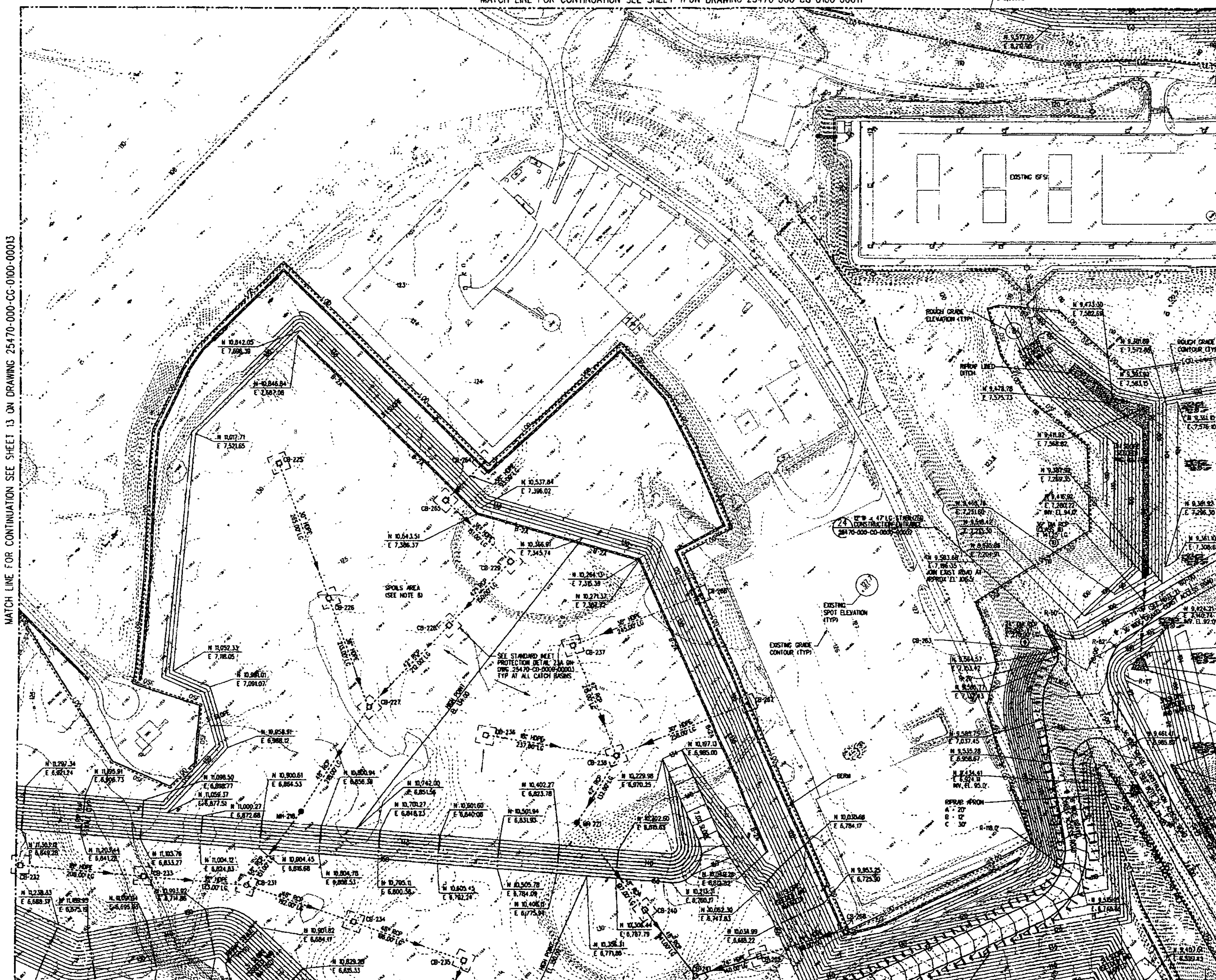
UNISTAR Document No.	000004867	001
AREVA or BECHTEL Document No.	25470-000-CG-0100-00004	001
DOC TYPE: 02	SCALE: 1"=60' SIZE: E	REV.

J.C. ARCHER 1/15/2010
B. DONCHESS 1/15/2010
SURINDER KUMAR 1/16/2010
MICHAEL BAGLE 1/15/2010
JOHN BEMITZ 1/15/2010
LEE RABIDEAU 1/19/2010

State of Maryland Professional Engineer seal. License No. 27931. Expiration Date: 1/23/2012

MATCH LINE FOR CONTINUATION SEE SHEET 11 ON DRAWING 25470-000-CG-0100-00011



MATCH LINE FOR CONTINUATION SEE SHEET 4 ON DRAWING 25470-000-CG-0100-00004

KEY PLAN

PLANT NORTH

NOTES

1. FOR NOTES AND REFERENCE DRAWINGS SEE DRAWING 25470-000-CG-0000-00001.
2. FOR CONSTRUCTION ACCESS ROAD PROFILE SEE DRAWING 25470-000-CG-0190-00005.
3. FIELD TO VERIFY REQUIRED CLEARANCES BENEATH AND ADJACENT TO OVERHEAD TRANSMISSION LINES.
4. FOR CATCH BASIN DETAILS SEE DRAWING 25470-000-CD-0190-00001.
5. FOR FLARED END SECTIONS AND RIPRAP APRON DETAILS SEE DRAWING 25470-000-CD-0000-00006.
6. FOR CULVERT PIPE PROFILES SEE DRAWING 2547-000-CD-0190-00004.
7. DO NOT REMOVE VEGETATION ON SIDE SLOPES OF EXISTING SPOILS BERMS.
8. SPOILS SHALL BE PLACED IN THE DESIGNATED AREAS FOR SPOILING, WORKING FROM THE OUTSIDE OF THE SPOILS PILE INWARD, STARTING WITH A CONTAINMENT BERM WHICH IS BLENDED IN THE GRADING AS THE SPOILS ARE PLACED.

LEGEND

- 1' EXISTING GRADE CONTOUR
- 2' PROPOSED CONTOUR
- 10' PROPOSED CONTOUR
- STORM DRAIN PIPE OR CULVERT
- IDA LINE
- ℄ DRAINAGE DITCH
- LIMITS OF DISTURBANCE
- SUPER SILT FENCE
- BERM ROUGH GRADE/CENTERLINE
- GABION
- RIPRAP
- CB SQUARE CATCH BASIN - TYPE 1 & 2
- CB CIRCULAR CATCH BASIN - TYPE 3
- MH MANHOLE
- PI POINT OF INTERSECTION
- PAVING GRID
- AGGREGATE
- CULVERT NUMBER

0 60 120 180 240FT

NS	DESIGN VERIFICATION REPORT: N/A
	REVISION DESCRIPTION
	REVISED TITLE BLOCK REVISED NOMENCLATURE OF BERMS

STATE OF MARYLAND JOHN ROBERTS DEMITZ No. 27021 PROFESSIONAL ENGINEER

License No. 27021
Expiration Date 6/28/2012

L. HOFFACKER 1/15/2010
R. B. DONGARRA
SURINDER KUMAR 1/15/2010
MICHAEL BASLE 1/15/2010
JOHN DEMITZ 1/13/2010
LEE RABIDEAU 1/15/2010

AREVA

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CALVERT CLIFFS 3 NUCLEAR PROJECT

CONTRACT NO. 300206 | JOB NO. 25470

ROUGH GRADE PLAN SHEET 6

U.S. EPR™ Document No.	CCNP3-002-CG-BY-00009	001
UNISTAR Document No.	000004869	001
AREVA or BECHTEL Document No.	25470-000-CG-0100-00006	001
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ATTACHMENT 1
Sheet 3/5

Job. 25470
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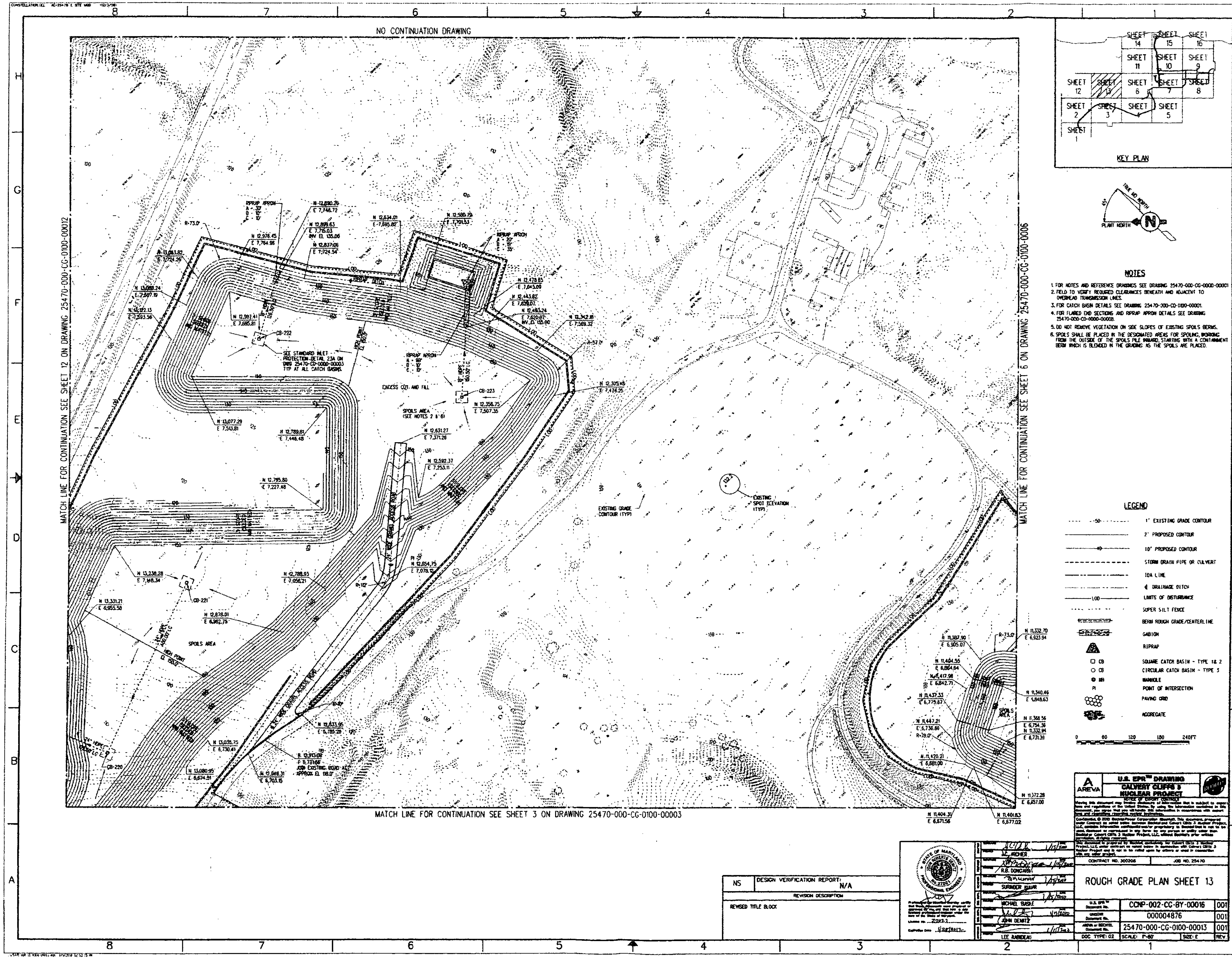


ATTACHMENT 1

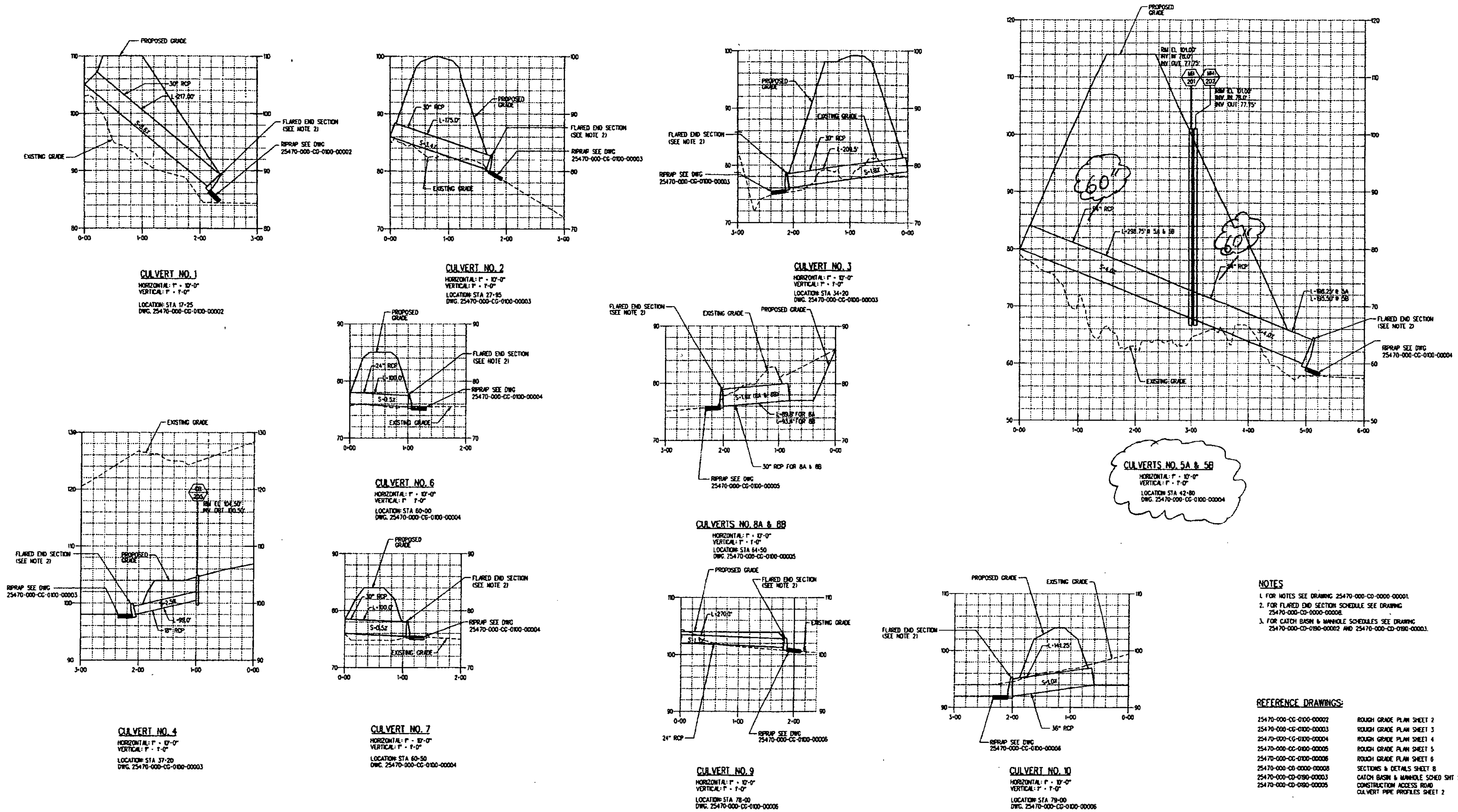
Sheet 4/5

Job: 25470

Calc. 25470-000-K0C-7400-00009, Rev.000

ATTACHMENT 1
Sheet 5/5

Job: 25470
Calc: 25470-000-KOC-7400-00009, Rev.000



NOTES

1. FOR NOTES SEE DRAWING 25470-000-C0-0000-00001.
2. FOR FLARED END SECTION SCHEDULE SEE DRAWING 25470-000-C0-0000-00008.
3. FOR CATCH BASIN & MANHOLE SCHEDULES SEE DRAWING 25470-000-CD-0190-00002 AND 25470-000-CD-0190-00003.

REFERENCE DRAWINGS:

25470-000-CG-0100-00002	ROUGH GRADE PLAN SHEET 2
25470-000-CG-0100-00003	ROUGH GRADE PLAN SHEET 3
25470-000-CG-0100-00004	ROUGH GRADE PLAN SHEET 4
25470-000-CG-0100-00005	ROUGH GRADE PLAN SHEET 5
25470-000-CG-0100-00006	ROUGH GRADE PLAN SHEET 6
25470-000-C0-0000-00008	SECTIONS & DETAILS SHEET 8
25470-000-CD-0190-00003	CATCH BASIN & MANHOLE SCHED SHT 2
25470-000-CD-0190-00005	CONSTRUCTION ACCESS ROAD CULVERT PIPE PROFILES SHEET 2

CULVERT	LOCATION	Drainage Area (Ac)	PEAK Qa, cfs	LENGTH FEET	INLET INV ELEV FEET	OUTLET INV ELEV FT	DIA FT	# OF PIPE	Q PER PIPE, CFS	VEL. V, FPS	OUTLET CONTROL: 3 X (2)	OUTLET CONTROL: HEAD LOSS, FT	OUTLET CONTROL: NORMAL DEPTH FT AT OUTFALL	OUTLET CONTROL: TAIL WATER ELEV, FT	OUTLET CONTROL: HW ELEV, FT	INLET CONTROL: HW/D	INLET CONTROL: HW DEPTH, FT	INLET CONTROL: HW ELEV, FT	CONTROL	CRITICAL ELEV OR ROAD	GRADE ELEV OVER PIPE	FREE-BOARD FT
1	17+25 CONST RD	11.89	39.9	217.0	103.50	86.57	2.50	1	39.90	8.13	1.50	3.58	1.01	87.58	91.16	1.51	3.78	107.28	INLET	108.50	109.70	1.22
2	27+95 CONST RD	16.44	33.4	175.00	86.00	80.00	2.50	1	33.40	7.21	1.50	2.51	0.94	80.94	83.45	1.35	3.38	89.38	INLET	93.00	100.00	3.63
3	34+20 CONST RD	18.16	40.0	209.50	79.00	76.00	2.50	1	40.00	8.15	1.50	3.53	1.01	77.01	80.54	1.50	3.75	82.75	INLET	93.00	99.00	10.25
4	37+20 CONST RD	2.35	8.9	98.00	100.50	98.00	1.50	1	8.90	5.04	2.50	1.68	0.43	98.43	100.12	1.22	1.83	102.33	INLET	103.00	105.00	0.67
5A	42+80 CONST RD	99.26	265.4	495.00	80.00	60.00	4.50	1	132.70	8.34	2.50	4.94	2.69	62.69	67.64	1.20	5.40	85.40	INLET	100.00	104.00	14.60
5B	42+80 CONST RD	99.26	265.4	495.00	80.00	60.00	4.50	1	132.70	8.34	2.50	4.94	2.69	62.69	67.64	1.20	5.40	85.40	INLET	100.00	104.00	14.60
6	61+40 CONST RD	4.20	18.2	100.00	76.00	75.50	2.0	1	16.20	5.16	1.50	1.13	0.61	76.11	77.24	1.10	2.20	78.20	INLET	82.00	85.00	3.80
7	61+80 CONST RD	9.12	32.20	100.00	78.00	75.50	2.50	1	32.20	6.56	1.50	1.62	0.90	76.40	78.01	1.25	3.13	79.13	INLET	82.00	84.00	2.88
8A	EX RD 64+50 R	22.64	62.10	90.00	77.00	76.00	2.50	1	31.05	6.33	1.50	1.44	1.28	77.28	78.73	1.18	2.95	79.95	INLET	81.00	82.00	1.05
8B	EX RD 64+50 R	22.64	62.10	90.00	77.00	76.00	2.50	1	31.05	6.33	1.50	1.44	1.28	77.28	78.73	1.18	2.95	79.95	INLET	81.00	82.00	1.05
9	78+00 CONST RD	4.00	18.30	270.00	100.00	95.00	2.00	1	18.30	5.83	1.50	2.55	0.65	95.65	98.20	1.22	2.44	102.44	INLET	104.00	104.00	1.56
10	79+00 CONST RD	14.10	45.6	141.25	94.00	92.00	3.00	1	45.60	6.45	1.50	1.63	1.08	93.08	94.71	1.10	3.30	97.30	INLET	100.00	104.00	2.70

NS	DESIGN VERIFICATION REPORT: N/A
REV.	REVISION DESCRIPTION
	REVISED TITLE BLOCK

JON ARCHER 1/15/2010
JON ARCHER 1/15/2010
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U.S. EPR™ DRAWING

CALVERT CLIFFS 3 NUCLEAR PROJECT

NOTICE OF EXPORT CONTROLS

CONTRACT NO. 300206 | JOB NO. 25470

CONSTRUCTION ACCESS ROAD CULVERT PIPE PROFILES SHEET 1

U.S. EPR™ Document No.	CCNP3-002-CD-BY-00006	001
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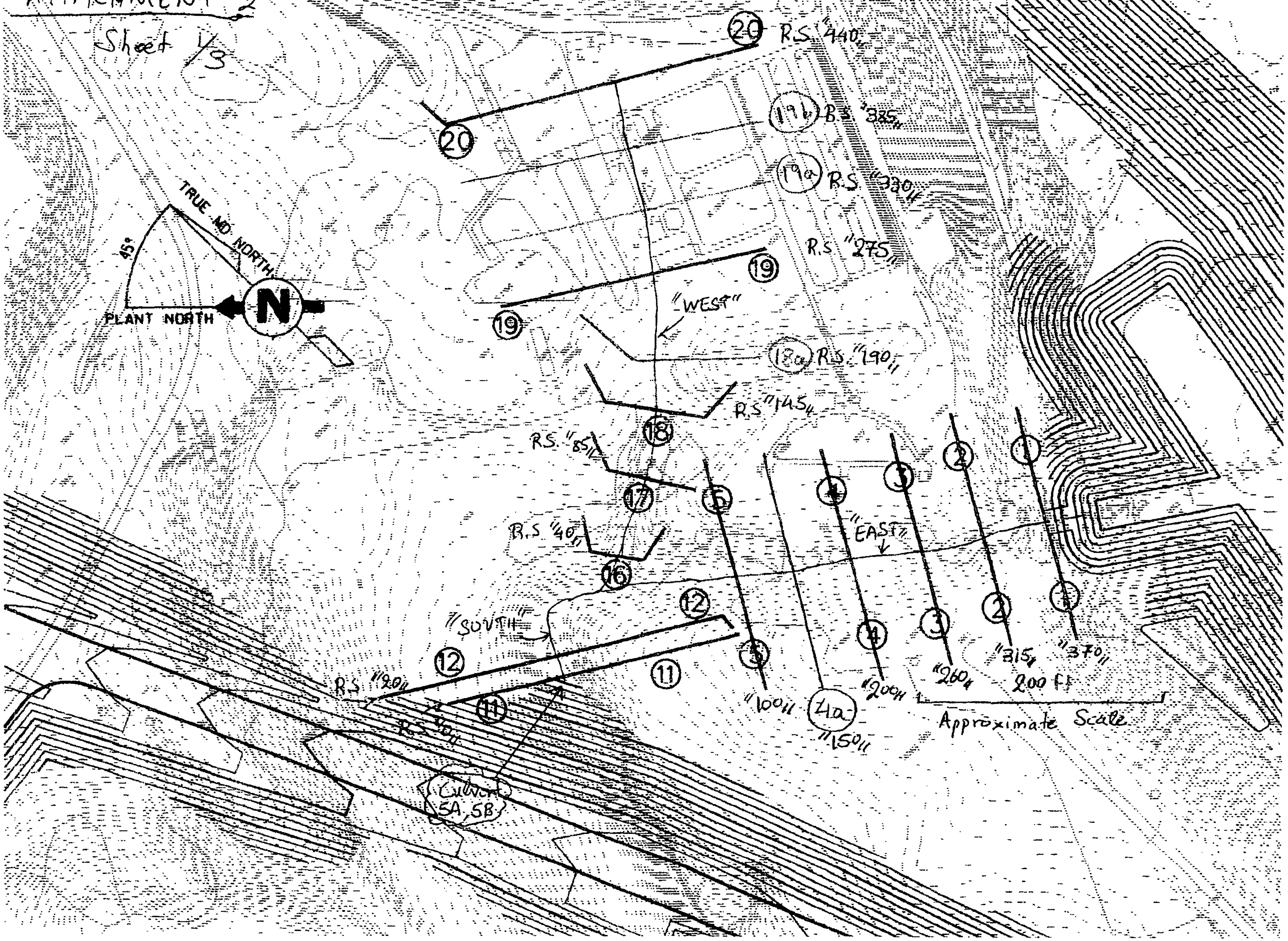
34" x 44" E SIZE
AS-720

Jos 25470
Calc 25470-000-KOC-7400-00009, Rev 000

Cross section Locations

ATTACHMENT 2

Sheet 1/3



Job 25470

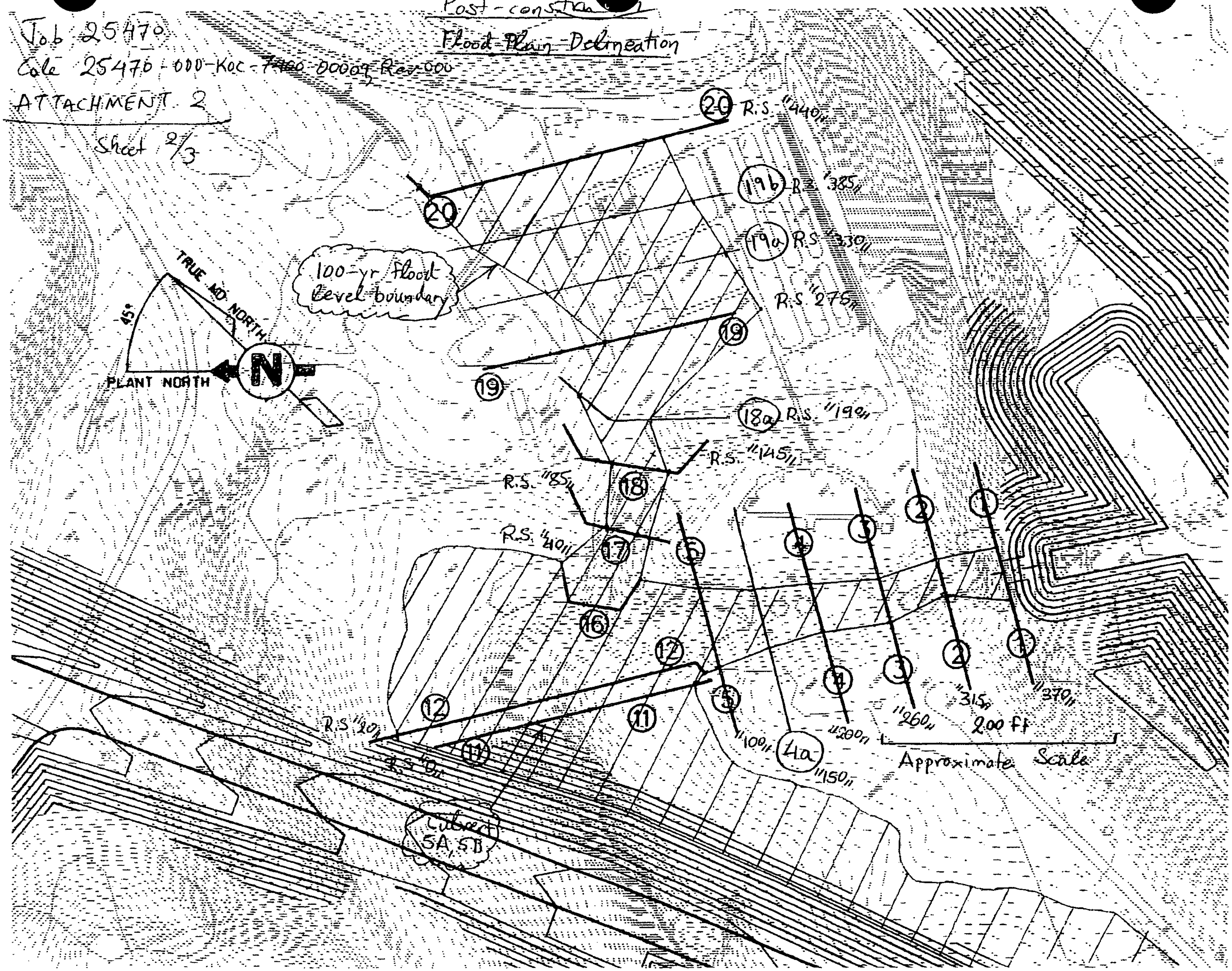
Calc 25470-000-Koc-7400-00009 Rev 000

ATTACHMENT 2

Sheet 2/3

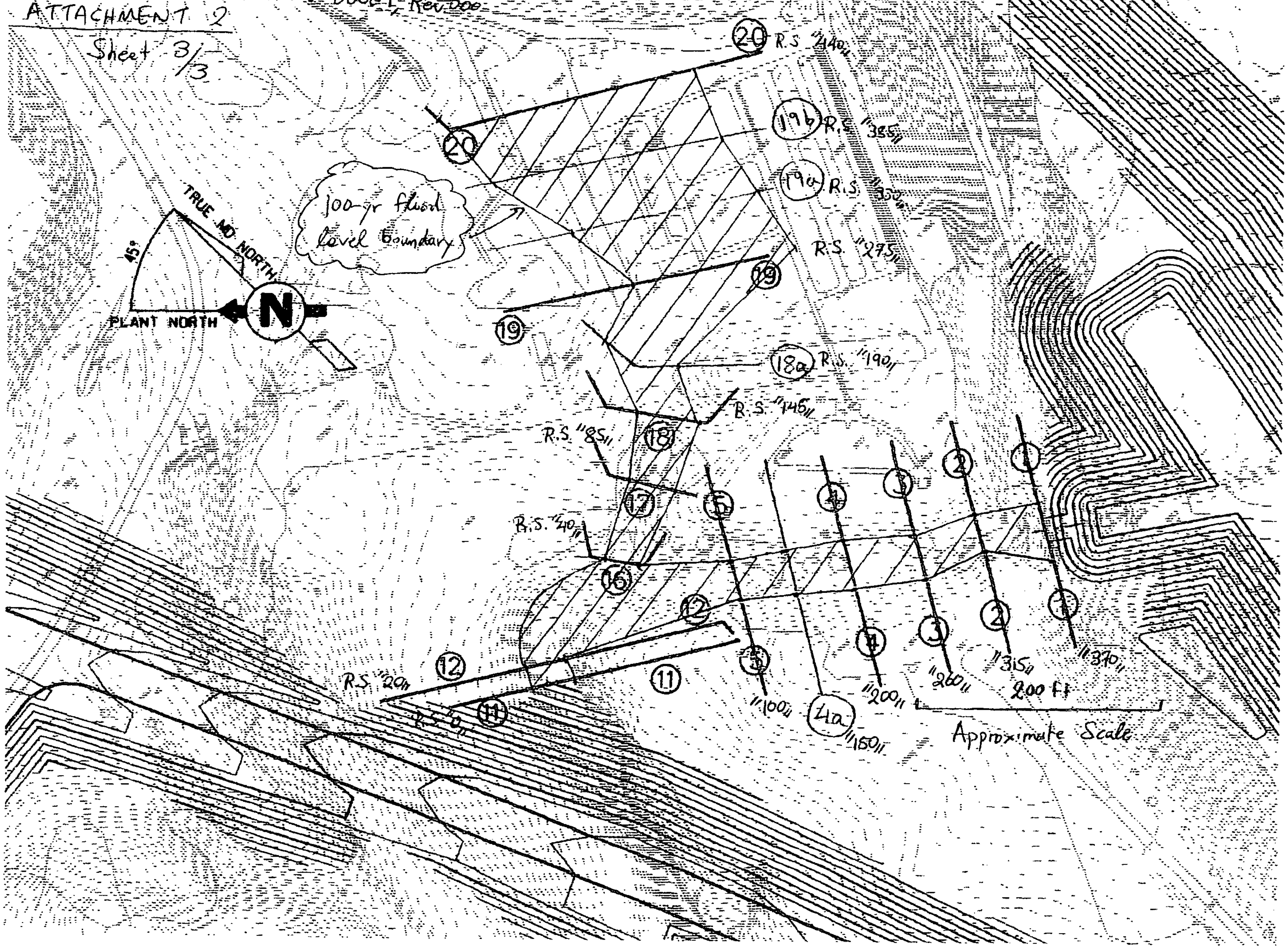
Post-construction

Flood Plain Delineation



Job 25470
Calc 25470-000-K0C-T400-D0009, Rev 000
ATTACHMENT 2
Sheet 3/3

Pre-construction
Flood Plain Delineation



River	Reach	RS	2-yr	10-yr	100-yr
East	2	370	95.1	195.4	407.3
South	3	20	124.7	265.5	569.2
West	1	440	29.6	70.1	161.9

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
East	2	2-yr	Normal S = 0.2	
East	2	10-yr	Normal S = 0.2	
East	2	100-yr	Normal S = 0.2	
South	3	2-yr		Normal S = 0.007
South	3	10-yr		Normal S = 0.007
South	3	100-yr		Normal S = 0.007
West	1	2-yr	Normal S = 0.015	
West	1	10-yr	Normal S = 0.015	
West	1	100-yr	Normal S = 0.015	

GEOMETRY DATA

Geometry Title: Pre-development
Geometry File : C:\HEC-RAS Projects\C5A5B\Culverts5A5B.g01

Reach Connection Table

River	Reach	Upstream Boundary	Downstream Boundary
East	2		J1
South	3	J1	
West	1		J1

JUNCTION INFORMATION

Name: J1
Description:
Energy computation Method

Length across Junction River	Reach	Tributary River	Reach	Length	Angle
West	1	to South	3	135	
East	2	to South	3	190	

CROSS SECTION

RIVER: East
REACH: 2 RS: 370

INPUT
Description: Section 1
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	110.75	20	112.5	30	113	40	110.25	50	109
60	110.25	80	108.75	90	108	100	108	110	108
120	108.5	122	108.85	140	112	160	115.5	180	116
200	116.25								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.2	80	05	122	.2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
80	122	60	55	55	.1	.3

CROSS SECTION

RIVER East
REACH: 2 RS: 315

INPUT
Description Section 2
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	102 75	20	103 25	40	103 75	50	104 25	60	102.75
70	101.5	80	101	90	98	100	96.75	110	98
120	99.5	140	102	150	103	160	103.25	180	103 5
200	104 25								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	90	05	110	2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
90	110	55	55	55	.1	.3

CROSS SECTION

RIVER: East
REACH: 2 RS: 260

INPUT
Description: Section 3
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	103.5	20	104	40	104.5	60	102.25	80	98.5
83	97.6	90	95.5	100	94 25	113	97 663	120	99.5
130	101.5	140	102.5	150	103	160	103.5	180	103.75
200	103 75								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	83	05	113	.2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
83	113	60	60	60	.1	3

CROSS SECTION

RIVER East
REACH: 2 RS: 200

INPUT
Description: Section 4
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	102.75	20	103.75	30	104 25	40	104.25	60	102
80	98	91	96 488	100	95.25	110	94.75	120	96.5
140	101	160	102.5	180	103.25	200	103.75		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	91	.05	120	2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
91	120	50	50	50	1	3

CROSS SECTION

RIVER: East
REACH: 2 RS: 150 *

INPUT
Description:
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	100.75	20	101 75	30	101.75	40	101.5	50	100.81
60	99.5	77	96.1	84.29	94.91	89	94 139	94	93.32

```
   102.5   92.38     108   93.03  111.67   93.54   113.5   93.85     115  94.205
     119   95.15     130      98   147 5  100.81  153 33   101.5     165  102.69
  173 75  102 83  176.67  102.79   182 5  102.69     200  101.62

Manning's n Values          num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0        2      89       05     115        2

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
            89      115                 50       50       50                1         3

CROSS SECTION


RIVER: East
REACH: 2                    RS: 100

INPUT
Description: Section 5
Station Elevation Data      num=      17
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0    98.75      20    99.75      40    98.75      50     98.5      60       97
      80       93      85       92      95       90     100    90.25     105    90.75
     110       92     120       95     140     99 5     160    102 5     170    102 5
     180      102     200     99.5

Manning's n Values          num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0        2      85       05     110       .2

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
            85      110                  0        0        0                1        .3

CROSS SECTION


RIVER: South
REACH: 3                    RS: 20

INPUT
Description: Section 12
Station Elevation Data      num=      25
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0     97.5       5       97      10       96      20       95      41       94
      58       93      78     92.5      98     91 5     118    90.25     138       86
     142     84.8     158       80     163    79.75     178    80.75     189   84 738
     198       88     218       92     238    93.25     258     94.5     264       95
     277       96     288       96     300       97     304       98     317      101

Manning's n Values          num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0        2     142       05     189        2

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan
           142      189                 20       20       20               .1         3

CROSS SECTION


RIVER: South
REACH  3                    RS: 0

INPUT
Description: Section 11
Station Elevation Data      num=      22
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0     98.5       6       98      19       97      30       96      44       95
      55     94 5      75     93.5      95     92.5     105    92.25     115       90
     125       88     135    84 25     145       80     155       79     160    78.75
     170       80     175       82     182   84 188     195    88.25     215    91 75
     235    93 25     255       94

Manning's n Values          num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
```

```
     0        2      135       05      182        2

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr     Expan
            135     182               560      510     455                1         3

CROSS SECTION


RIVER: South
REACH: 3                    RS:  510

INPUT
Description  Section 2c
Station Elevation Data      num=      18
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0     78 5       14       78       58       77       69       76       74       75
      95       70      110       58      115       54      125       54      134    57.96
     150       65      162       69      176       70      190       71      204       72
     219       73      233       74      240     74 5

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0        2      110       05      134        2

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr     Expan
            110     134               160      140     125                1         3

CROSS SECTION


RIVER: South
REACH: 3                    RS:  650

INPUT
Description: Section 1c
Station Elevation Data      num=      16
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0       70       19       70       48       71       57       70       67       69
      74       68       95       60      103       56      105       55      115       54
     129       53      135       55      138     55.9      185       70      233       80
     242       82

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0        2      103      .05      138        2

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr     Expan
            103     138                 0        0       0                1         3

CROSS SECTION


RIVER: West
REACH: 1                    RS: 440

INPUT
Description: Section 20
Station Elevation Data      num=      10
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0    110 5       47      110       98    109.5      141      109      176      110
     204      110      282      109      288    109.5      294      110      306      111

Manning's n Values          num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0        2       98      .05      288        2

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr     Expan
             98     288                60       55      60                1         3

CROSS SECTION


RIVER: West
REACH: 1                    RS: 385.*
```

INPUT
Description:
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	109.5	31 33	109.17	73 65	108.74	109.33	108.33	138.13	109
161.16	109	225 33	108.33	227.61	108 72	230.79	109.12	243.52	109 74
248 52	110.18	255.33	110.67	276	111 6				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.2	73 65	.05	227.61	2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr	Expan.
73.65	227.61	50	55	60	.1	.3

CROSS SECTION

RIVER: West
REACH: 1 RS: 330 *

INPUT
Description:
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	108 5	15.67	108 33	49.3	107.99	77.67	107.67	100.26	108
118.33	108	168.67	107.67	172 3	108.36	177.39	109 06	197.76	109 87
205.76	110.59	216.67	111.33	246	112.2				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	49.3	.05	172.3	2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr	Expan
49.3	172.3	55	55	60	1	.3

CROSS SECTION

RIVER: West
REACH: 1 RS: 275

INPUT
Description: Section 19
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	107 5	46	107	112	107	114.5	107.5	117	108
124	109	152	110	163	111	178	112	216	112 8

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	0	05	114.5	2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan
0	114.5	105	70	50	1	3

CROSS SECTION

RIVER: West
REACH: 1 RS 190

INPUT
Description: Section 18a
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	115.5	29	111	37	110	43	109	51	108
58	107	65	106	72	105	119	105	139	106
158	107	167	108	176	109				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	65	05	139	2

```
Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr      Expan.
           65      139                38       42       65                  1          3

CROSS SECTION


RIVER: West
REACH: 1                   RS: 145

INPUT
Description: Section 18
Station Elevation Data     num=      17
     Sta     Elev     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0      107       4      106        8      105       13      104       19      103
      24      102      41      101       50      100       58       99       69      100
      72      101      75      102       83      103       95      104      111      105
     127      106     147      107

Manning's n Values         num=       3
     Sta    n Val     Sta    n Val      Sta    n Val
       0       2       50      .05       69       2

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.     Expan
           50       69                75       60       60                 .1         .3

CROSS SECTION


RIVER: West
REACH: 1                   RS: 85

INPUT
Description: Section 17
Station Elevation Data     num=    . 14
     Sta     Elev     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0       99     6 5       98       13       97       20       96     26 5       95
      33       95    39 5       96     44 5       97       48       98       51       99
      63      100      75      101       80      102       88      103

Manning's n Values         num=       3
     Sta    n Val     Sta    n Val      Sta    n Val
       0       2       20      .05     39.5       2

Bank Sta: Left    Right     Lengths  Left Channel    Right       Coeff Contr      Expan
           20     39.5                58       65       70                  1         .3

CROSS SECTION


RIVER: West
REACH: 1                   RS: 40

INPUT
Description: Section 16
Station Elevation Data     num=      16
     Sta     Elev     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0       97       8       96       13       95       19       94       25       93
      29       92      33       91       37       90       43       90       49       91
      53       92      57       93       63       94       67       95       71       96
      87       97

Manning's n Values         num=       3
     Sta    n Val     Sta    n Val      Sta    n Val
       0       2       33      .05       49       .2

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.     Expan
           33       49                 0        0        0                 .1          3

Profile Output Table - Standard Table 1

  River        Reach        River Sta    Profile   Q Total   Min Ch El   W.S  Elev    Crit W.S    E.G. Elev    E.G.
Slope   Vel Chnl   Flow Area   Top Width   Froude # Chl
```

(ft/ft)	(ft/s)	(sq ft)	(ft)		(cfs)	(ft)	(ft)	(ft)	(ft)
West	1	440		2-yr	29.60	109.00	109.47	109.35	109.50
0.012069	1.25	23.68	99.98		0.45				
West	1	440		10-yr	70 10	109.00	109.65	109.49	109.69
0.011612	1.61	44.82	139.65		0.47				
West	1	440		100-yr	161.90	109.00	109.89	109.67	109.96
0.012112	2.09	85 15	194.46		0 52				
West	1	385 *		2-yr	29.60	108 33	108.78		108.80
0.013238	1.28	23 11	103.98		0.47				
West	1	385.*		10-yr	70 10	108.33	108.93		108.98
0.014680	1 73	42.41	142 39		0.53				
West	1	385 *		100-yr	161.90	108.33	109.16		109.23
0.014614	2.18	82 17	198.85		0 56				
West	1	330.*		2-yr	29.60	107.67	108.06	107.96	108.09
0.013063	1 18	25 26	128.83		0.46				
West	1	330.*		10-yr	70.10	107.67	108.21		108.25
0.012140	1 63	45 23	144.08		0.48				
West	1	330 *		100-yr	161.90	107.67	108.44		108 52
0.011635	2.23	81 44	167.66		0.52				
West	1	275		2-yr	29.60	107.00	107.27	107.18	107 30
0.016019	1.41	21.03	91.85		0.52				
West	1	275		10-yr	70.10	107 00	107.43		107.48
0.016638	1.89	37 15	107.53		0.57				
West	1	275		100-yr	161.90	107.00	107.66		107 76
0.016456	2.56	63 25	115.29		0.61				
West	1	190		2-yr	29.60	105.00	105.23	105.23	105 33
0.060974	2.62	11 31	53.10		1.00				
West	1	190		10-yr	70.10	105.00	105.39	105 39	105.57
0 051418	3.40	20.64	57.65		1 00				
West	1	190		100-yr	161.90	105 00	105.67	105.67	105 96
0.044092	4 32	37 49	65.07		1.00				
West	1	145		2-yr	29.60	99.00	99.65	99.90	100 50
0.279444	7 39	4 00	12.34		2.29				
West	1	145		10-yr	70.10	99 00	99.90	100 25	101.21
0 282566	9.21	7 61	17.01		2.43				
West	1	145		100-yr	161.90	99.00	100.25	100.81	102 25
0 217909	11.38	14 56	21.97		2.32				
West	1	85		2-yr	29.60	95.00	95.68	95.68	95 93
0 047364	3.97	7 45	15 36		1 01				
West	1	85		10-yr	70.10	95 00	96.07	96.07	96.44
0.041728	4.91	14 31	20.29		1.01				
West	1	85		100-yr	161.90	95 00	96.57	96.62	97 26
0 038749	6.69	25 94	26.29		1.06				
West	1	40		2-yr	29.60	90.00	90 56	90.73	91 12
0.129077	6.00	4.94	11 61		1.62				
West	1	40		10-yr	70.10	90.00	90.86	91 15	91 83
0 140616	7 92	8 85	14.60		1.79				
West	1	40		100-yr	161.90	90.00	91.29	91 79	92 96
0 128681	10 38	15.90	18.29		1.85				
South	3	20		2-yr	124.70	79.75	81 05	81 17	81 66
0.059936	6.30	19.79	24.32		1.23				
South	3	20		10-yr	265.50	79.75	81.53	81.79	82 58
0 062726	8 24	32 22	27.25		1 34				
South	3	20		100-yr	569.20	79.75	82.28	82 75	83 99
0.062864	10 50	54.23	31.79		1.42				
South	3	0		2-yr	124.70	78.75	80 20	80.24	80 70
0 046465	5.69	21.91	25 96		1 09				
South	3	0		10-yr	265.50	78.75	80.80	80.84	81 54
0.037434	6.89	38.52	28.90		1.05				
South	3	0		100-yr	569.20	78.75	81.59	81 79	82 87
0 040135	9 06	62.85	32.73		1.15				

South	3	510	2 yr	124.70	54 00	56.32	55.53	56 55
0.008232	3.81	32 73	18.18	0.50				
South	3	-510	10-yr	265.50	54 00	57.21	56.40	57.64
0.011279	5.29	50 16	21.29	0.61				
South	3	510	100-yr	569.20	54.00	58.34	57.70	59.20
0.015170	7.46	76.54	25.28	0.74				
South	3	650	2-yr	124 70	53 00	55.33	54.68	55.46
0.007002	2.97	42.04	31.73	0 45				
South	3	-650	10-yr	265.50	53.00	56.12	55.28	56 35
0.007012	3.85	69.01	35.98	0 48				
South	3	-650	100-yr	569.20	53.00	57.26	56 16	57.68
0.007002	5 22	113.37	42.05	0 52				
East	2	370	2 yr	95.10	108.00	108.49	108 71	109.24
0.200101	6.94	13 69	36.23	1.99				
East	2	370	10-yr	195.40	108.00	108.70	109.05	109 92
0.200176	8.85	22 07	40.57	2 12				
East	2	370	100-yr	407 30	108 00	109.01	109 62	111.13
0.200293	11 71	35 27	46.48	2 27				
East	2	315	2-yr	95.10	96.75	97.93	98.26	99.07
0 170051	8.57	11.10	18.85	1.97				
East	2	315	10-yr	195.40	96.75	98.27	98.81	100 11
0 157980	10.91	18 25	22.69	2.03				
East	2	315	100-yr	407 30	96 75	98.80	99 70	101.85
0.141464	14 10	31 77	28.02	2 08				
East	2	260	2-yr	95.10	94.25	96.98	95.98	97.07
0.003955	2.45	38 88	25.33	0.35				
East	2	260	10-yr	195.40	94 25	97.70	96.60	97 87
0.005247	3.32	58 95	30.47	0.42				
East	2	260	100-yr	407 30	94 25	98.63	97.50	98 97
0.006212	4.67	90 45	37.38	0.48				
East	2	200	2-yr	95.10	94.75	96.10	96.10	96 50
0.040621	5.07	18 74	23.84	1.01				
East	2	200	10-yr	195.40	94.75	96.60	96.60	97 17
0.036535	6.06	32.30	30.22	1 01				
East	2	200	100-yr	407 30	94 75	97.32	97.32	98 21
0.029542	7.61	57 17	38.68	0.99				
East	2	150 *	2-yr	95.10	92.38	93.82	93.87	94 29
0.047763	5.46	17 42	22.42	1.09				
East	2	150.*	10-yr	195.40	92 38	94 25	94.37	95 01
0.051038	7.00	27.97	26.88	1.19				
East	2	150.*	100-yr	407.30	92 38	94.82	95 15	96 21
0.053489	9.50	44 89	32.75	1.31				
East	2	100	2-yr	95.10	90 00	91.40	91.45	91.91
0.047185	5.73	16.59	19.59	1.10				
East	2	100	10-yr	195.40	90 00	91.95	92.03	92.67
0.042779	6 77	28 86	24.59	1.10				
East	2	100	100-yr	407.30	90.00	92.63	92.82	93 85
0.040368	8.86	47 53	30.29	1.15				

Post-construction (culvert option not used)

```
               HEC-RAS Version 4.0.0 March 2008
                U.S  Army Corps of Engineers
               Hydrologic Engineering Center
                      609 Second Street
                      Davis  California

X     X  XXXXXX    XXXX        XXXX       XX       XXXX
X     X  X        X    X       X   X     X  X     X
X     X  X        X            X   X    X    X    X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX     XXXX
X     X  X        X            X  X     X    X        X
X     X  X        X    X       X   X    X    X        X
X     X  XXXXXX    XXXX        X    X   X    X    XXXXX
```

PROJECT DATA
Project Title: Culverts5A5B
Project File : Culverts5A5B.prj
Run Date and Time: 8/18/2010 3:41:13 PM

Project in English units

PLAN DATA

Plan Title: Plan 14
Plan File : C:\HEC-RAS Projects\C5A5B\Culverts5A5B.p14

Geometry Title: Post-development_no culvert
Geometry File : C:\HEC-RAS Projects\C5A5B\Culverts5A5B.g03

Flow Title : Post_development_no culver
Flow File : C:\HEC-RAS Projects\C5A5B\Culverts5A5B.f02

```
Plan Summary Information:
Number of:  Cross Sections =   16    Multiple Openings  =    0
            Culverts       =    0    Inline Structures  =    0
            Bridges        =    0    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.01
    Critical depth calculation tolerance =  0.01
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0 3
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Mixed Flow
```

FLOW DATA

Flow Title: Post_development_no culver
Flow File : C:\HEC-RAS Projects\C5A5B\Culverts5A5B.f02

Flow Data (cfs)

River	Reach	RS	2-yr	10-yr	100-yr
East	2	370	95.1	195.4	407.3
South	3	20	124.7	265.5	569.2
West	1	440	29.6	70 1	161 9

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
East	2	2-yr	Normal S = 0 2	
East	2	10-yr	Normal S = 0 2	
East	2	100-yr	Normal S = 0 2	
South	3	2-yr		Known WS = 83.35
South	3	10-yr		Known WS = 85.36
South	3	100-yr		Known WS = 96 93
West	1	2-yr	Normal S = 0.015	
West	1	10-yr	Normal S = 0.015	
West	1	100-yr	Normal S = 0.015	

GEOMETRY DATA

Geometry Title: Post-development_no culvert
Geometry File : C:\HEC-RAS Projects\C5A5B\Culverts5A5B.g03

Reach Connection Table

River	Reach	Upstream Boundary	Downstream Boundary
East	2		J1
South	3	J1	
West	1		J1

JUNCTION INFORMATION

Name: J1
Description:
Energy computation Method

Length across Junction River	Reach	Tributary River	Reach	Length	Angle
West	1	to South	3	135	
East	2	to South	3	190	

CROSS SECTION

RIVER: East
REACH: 2 RS: 370

INPUT
Description: Section 1
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	110.75	20	112.5	30	113	40	110.25	50	109
60	110.25	80	108.75	90	108	100	108	110	108
120	108.5	122	108.85	140	112	160	115 5	180	116
200	116.25								

Manning s n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	80	05	122	2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan
80	122	60	55	55	.1	3

CROSS SECTION

RIVER: East
REACH: 2 RS: 315

INPUT
Description: Section 2

Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	102 75	20	103.25	40	103.75	50	104 25	60	102.75
70	101.5	80	101	90	98	100	96.75	110	98
120	99.5	140	102	150	103	160	103.25	180	103.5
200	104 25								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	90	.05	110	2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
90	110	55	55	55	.1	.3

CROSS SECTION

RIVER: East
REACH: 2   RS: 260

INPUT
Description: Section 3
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	103.5	20	104	40	104.5	60	102.25	80	98.5
83	97.6	90	95.5	100	94.25	113	97.663	120	99.5
130	101.5	140	102.5	150	103	160	103 5	180	103.75
200	103 75								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	83	05	113	.2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
83	113	60	60	60	.1	3

CROSS SECTION

RIVER: East
REACH: 2   RS: 200

INPUT
Description: Section 4
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	102.75	20	103.75	30	104.25	40	104.25	60	102
80	98	91	96 488	100	95.25	110	94.75	120	96.5
140	101	160	102 5	180	103.25	200	103 75		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	91	05	120	.2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr	Expan.
91	120	50	50	50	.1	3

CROSS SECTION

RIVER: East
REACH: 2   RS: 150.*

INPUT
Description:
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	100.75	20	101.75	30	101.75	40	101.5	50	100.81
60	99.5	77	96.1	84.29	94 91	89	94.139	94	93.32
102 5	92.38	108	93.03	111.67	93 54	113.5	93 85	115	94.205
119	95.15	130	98	147.5	100.81	153 33	101.5	165	102.69
173 75	102.83	176.67	102.79	182 5	102.69	200	101.62		

Manning's n Values num= 3

```
     Sta   n Val      Sta   n Val      Sta   n Val
       0      .2       89     05       115     .2

Bank Sta: Left   Right    Lengths: Left Channel    Right      Coeff Contr      Expan
            89     115                50      50      50                .1          3

CROSS SECTION


RIVER: East
REACH: 2                  RS: 100

INPUT
Description: Section 5
Station Elevation Data    num=       17
     Sta    Elev      Sta    Elev     Sta    Elev      Sta    Elev      Sta    Elev
       0   98 75       20   99.75      40   98 75       50    98.5       60      97
      80      93       85      92      95      90      100   90 25      105   90.75
     110      92      120      95     140    99.5      160   102.5      170   102.5
     180     102      200    99.5

Manning's n Values        num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
       0       2       85      05     110       2

Bank Sta: Left   Right    Lengths: Left Channel    Right      Coeff Contr      Expan
            85     110                 0       0       0                 1          3

CROSS SECTION


RIVER: South
REACH: 3                  RS: 20

INPUT
Description: Section 12
Station Elevation Data    num=       25
     Sta    Elev      Sta    Elev     Sta    Elev      Sta    Elev      Sta    Elev
       0    97.5        5      97      10      96       20      95       41      94
      58      93       78    92.5      98    91.5      118   90 25      138      86
     142    84.8      158      80     163   79.75      178   80.75      189  84 738
     198      88      218      92     238   93 25      258    94.5      264      95
     277      96      288      96     300      97      304      98      317     101

Manning's n Values        num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
       0       2      142      05     189      .2

Bank Sta: Left   Right    Lengths: Left Channel    Right      Coeff Contr      Expan
           142     189                20      20      20                 6          8

CROSS SECTION


RIVER: South
REACH: 3                  RS: 0

INPUT
Description: Section 11
Station Elevation Data    num=       22
     Sta    Elev      Sta    Elev     Sta    Elev      Sta    Elev      Sta    Elev
       0    98.5        6      98      19      97       30      96       44      95
      55    94.5       75    93.5      95    92.5      105   92 25      115      90
     125      88      135   84 25     145      80      155      79      160   78.75
     170      80      175      82     182  84 188      195   88.25      215   91 75
     235   93 25      255      94

Manning's n Values        num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
       0       2      135      05     182       2

Bank Sta: Left   Right    Lengths: Left Channel    Right      Coeff Contr.     Expan
           135     182               560     510     455                 6          8
Ineffective Flow     num=        2
```

Sta L	Sta R	Elev	Permanent
0	139.5	100	F
174.5	255	100	F

CROSS SECTION

RIVER: West
REACH: 1 RS: 440

INPUT
Description: Section 20
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	110.5	47	110	98	109.5	141	109	176	110
204	110	282	109	288	109 5	294	110	306	111

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	98	.05	288	.2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan
98	288	60	55	60	1	.3

CROSS SECTION

RIVER: West
REACH 1 RS: 385.*

INPUT
Description:
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	109.5	31 33	109.17	73.65	108.74	109 33	108.33	138.13	109
161.16	109	225.33	108.33	227.61	108.72	230 79	109.12	243.52	109.74
248.52	110.18	255 33	110.67	276	111.6				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	73.65	05	227.61	2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
73.65	227.61	50	55	60	.1	.3

CROSS SECTION

RIVER: West
REACH: 1 RS: 330.*

INPUT
Description:
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	108 5	15.67	108.33	49 3	107.99	77.67	107.67	100.26	108
118 33	108	168.67	107.67	172.3	108.36	177.39	109.06	197.76	109.87
205.76	110.59	216.67	111 33	246	112.2				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	49.3	.05	172.3	2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
49.3	172.3	55	55	60	1	.3

CROSS SECTION

RIVER: West
REACH: 1 RS: 275

INPUT
Description: Section 19

```
Station Elevation Data     num=      10
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   107.5      46     107     112     107   114.5   107.5     117     108
     124     109     152     110     163     111     178     112     216   112.8

Manning's n Values         num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .2       0      05   114 5      .2

Bank Sta: Left   Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0   114.5               105      70       50               1        .3

CROSS SECTION


RIVER: West
REACH: 1                   RS: 190

INPUT
Description: Section 18a
Station Elevation Data     num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   115.5      29     111      37     110      43     109      51     108
      58     107      65     106      72     105     119     105     139     106
     158     107     167     108     176     109

Manning's n Values         num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .2      65      05     139       2

Bank Sta: Left   Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
            65     139                38      42       65               1        .3

CROSS SECTION


RIVER: West
REACH: 1                   RS: 145

INPUT
Description: Section 18
Station Elevation Data     num=      17
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0     107       4     106       8     105      13     104      19     103
      24     102      41     101      50     100      58      99      69     100
      72     101      75     102      83     103      95     104     111     105
     127     106     147     107

Manning's n Values         num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0       2      50     .05      69      .2

Bank Sta: Left   Right     Lengths: Left Channel    Right      Coeff Contr.    Expan
            50      69                75      60       60              .1         3

CROSS SECTION


RIVER: West
REACH: 1                   RS: 85

INPUT
Description: Section 17
Station Elevation Data     num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0      99     6.5      98      13      97      20      96    26.5      95
      33      95    39.5      96    44 5      97      48      98      51      99
      63     100      75     101      80     102      88     103

Manning's n Values         num=      3
     Sta   n Val     Sta   n Val     Sta   n Val
       0       2      20      05    39.5       2

Bank Sta: Left   Right     Lengths: Left Channel    Right      Coeff Contr     Expan.
```

20 39.5 58 65 70 .1 3

CROSS SECTION

RIVER: West
REACH: 1 RS: 40

INPUT
Description: Section 16
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	97	8	96	13	95	19	94	25	93
29	92	33	91	37	90	43	90	49	91
53	92	57	93	63	94	67	95	71	96
87	97								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	2	33	05	49	.2

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan
33	49	0	0	0	1	3

Profile Output Table - Standard Table 1

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
West	1	440	2 yr	29.60	109.00	109.47	109.35	109.50	0.012069	1 25	23.68	99.98	0 45
West	1	440	10-yr	70.10	109.00	109.65	109.49	109.69	0.011612	1.61	44 82	139.65	0 47
West	1	440	100-yr	161.90	109.00	109.89	109.67	109.96	0.012112	2.09	85 15	194 46	0.52
West	1	385 *	2 yr	29.60	108 33	108.78		108.80	0.013238	1 28	23 11	103 98	0 47
West	1	385 *	10-yr	70.10	108 33	108 93		108.98	0.014680	1.73	42.41	142 39	0 53
West	1	385 *	100-yr	161 90	108 33	109.16		109.23	0.014614	2.18	82 17	198.85	0.56
West	1	330 *	2 yr	29.60	107.67	108 06	107.96	108.09	0.013063	1.18	25.26	128 83	0.46
West	1	330 *	10-yr	70.10	107.67	108.21		108.25	0.012140	1.63	45.23	144 08	0 48
West	1	330 *	100-yr	161 90	107.67	108.44		108.52	0.011635	2 23	81.44	167.66	0 52
West	1	275	2-yr	29.60	107.00	107.27	107.18	107.30	0.016019	1.41	21.03	91 85	0 52
West	1	275	10-yr	70.10	107.00	107 43		107.48	0.016638	1.89	37 15	107 53	0 57
West	1	275	100-yr	161 90	107.00	107.66		107.76	0.016456	2 56	63.25	115.29	0 61
West	1	190	2-yr	29.60	105.00	105 23	105.23	105.33	0.060974	2.62	11 31	53 10	1 00
West	1	190	10-yr	70.10	105.00	105 39	105.39	105.57	0.051418	3.40	20.64	57 65	1 00
West	1	190	100-yr	161 90	105.00	105 67	105.67	105.96	0.044092	4.32	37.49	65.07	1 00
West	1	145	2-yr	29.60	99.00	99.65	99.90	100.50	0.279444	7.39	4.00	12 34	2.29
West	1	145	10-yr	70.10	99.00	99.90	100.25	101.21	0.282566	9.21	7.61	17 01	2 43
West	1	145	100-yr	161 90	99.00	100.25	100.81	102.25	0.217909	11 38	14.56	21.97	2 32

HEC-RAS Simulation Report

Pre-construction

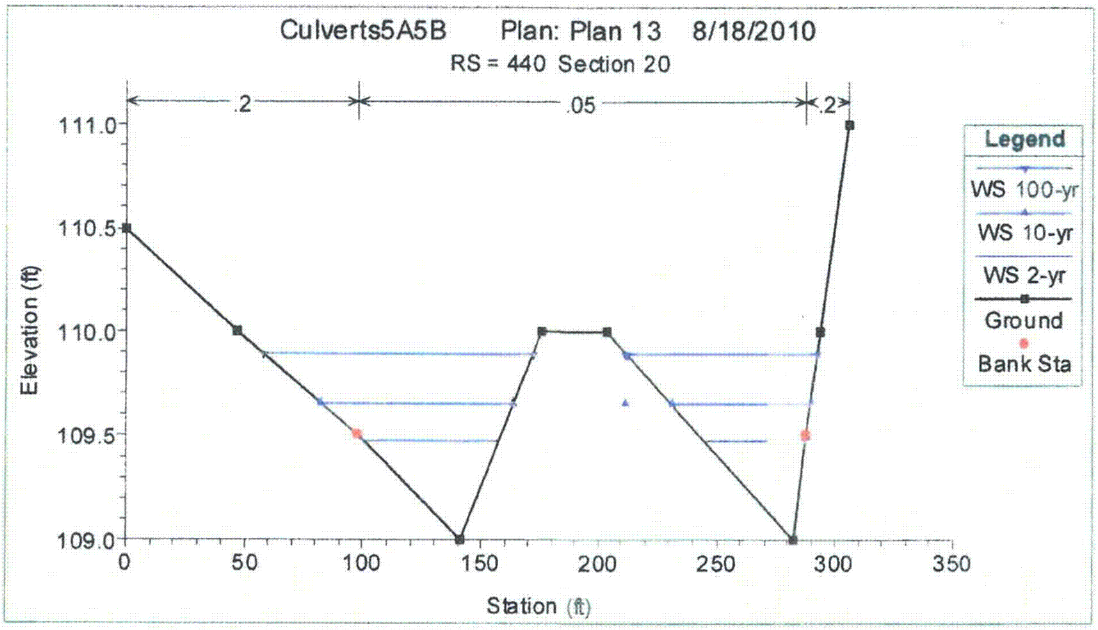
```
                HEC-RAS Version 4.0.0 March 2008
                 U S  Army Corps of Engineers
                 Hydrologic Engineering Center
                       609 Second Street
                       Davis, California

   X     X  XXXXXX   XXXX        XXXX      XX     XXXX
   X     X  X       X    X      X   X     X  X   X
   X     X  X       X           X   X    X    X  X
   XXXXXXX  XXXX    X      XXX  XXXX     XXXXXX   XXXX
   X     X  X       X           X  X     X    X      X
   X     X  X       X    X      X   X    X    X      X
   X     X  XXXXXX   XXXX       X    X   X    X  XXXXX
```

```
PROJECT DATA
Project Title: Culverts5A5B
Project File : Culverts5A5B.prj
Run Date and Time: 8/18/2010 3:43:57 PM

Project in English units


PLAN DATA

Plan Title: Plan 13
Plan File : C:\HEC-RAS Projects\C5A5B\Culverts5A5B.p13

          Geometry Title: Pre-development
          Geometry File : C:\HEC-RAS Projects\C5A5B\Culverts5A5B.g01

          Flow Title    : Post_development
          Flow File     : C:\HEC-RAS Projects\C5A5B\Culverts5A5B f01

Plan Summary Information:
Number of:  Cross Sections =   18   Multiple Openings  =    0
            Culverts       =    0   Inline Structures  =    0
            Bridges        =    0   Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.01
    Critical depth calculation tolerance =  0 01
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.3
    Flow tolerance factor                =  0 001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Mixed Flow


FLOW DATA

Flow Title: Post_development
Flow File : C:\HEC-RAS Projects\C5A5B\Culverts5A5B.f01

Flow Data (cfs)
```

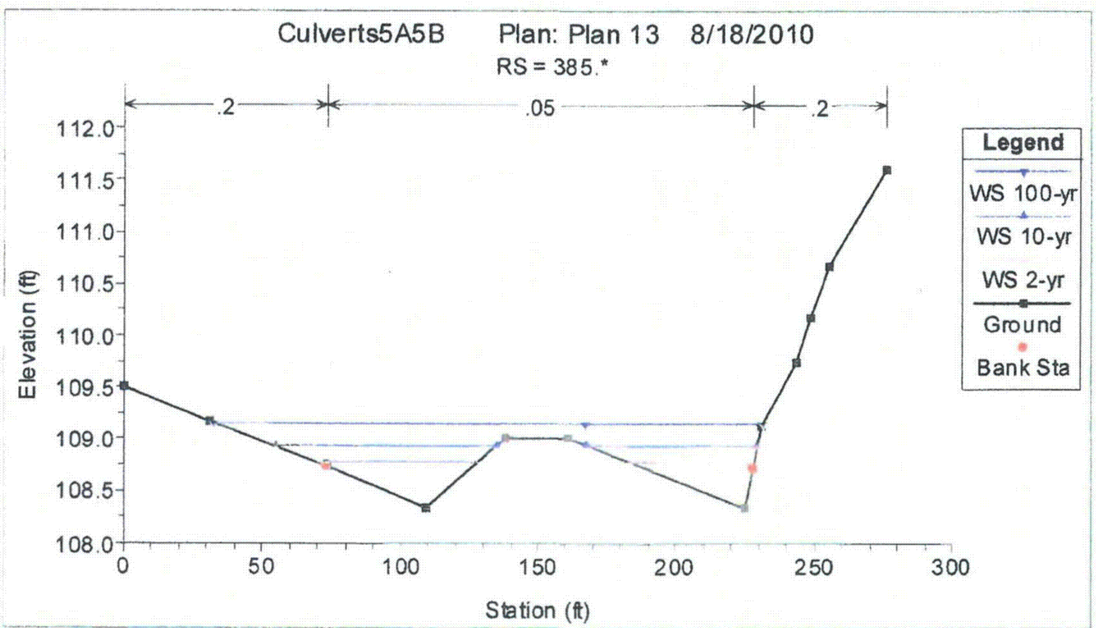
West	1	85		2-yr	29.60	95 00	95.68	95.68	95 93
0 047364	3.97	7.45	15.36		1.01				
West	1	85		10-yr	70.10	95.00	96.07	96.07	96 44
0 041728	4.91	14 31	20.29		1.01				
West	1	85		100-yr	161.90	95.00	96.57	96.62	97 26
0 038749	6.69	25.94	26.29		1.06				
West	1	40		2-yr	29.60	90.00	90.56	90.73	91 12
0 129077	6.00	4.94	11.61		1.62				
West	1	40		10-yr	70.10	90.00	90.86	91 15	91 83
0.140616	7.92	8 85	14.60		1.79				
West	1	40		100-yr	161.90	90.00	96.94	91.79	96.96
0 000149	1.27	273.92	85.45		0.09				
South	3	20		2-yr	124 70	79.75	83.35	81 17	83 38
0.000669	1.35	92.08	38.37		0.15				
South	3	20		10-yr	265.50	79.75	85.37	81.79	85.40
0.000424	1.47	181 53	50.61		0.13				
South	3	20		100-yr	569.20	79.75	96.94		96 95
0.000014	0.67	1807 11	294.03		0.03				
South	3	0		2-yr	124.70	78.75	83.35	80.25	83 37
0.000222	1.01	123.65	42.20		0.09				
South	3	0		10-yr	265.50	78.75	85.36	80.85	85 39
0.000224	1.37	194.00	53.71		0.10				
South	3	0		100-yr	569.20	78 75	96.93	81.80	96 94
0 000024	0.95	598.95	235.23		0.04				
East	2	370		2-yr	95.10	108.00	108.49	108.71	109 24
0 200101	6.94	13.69	36.23		1.99				
East	2	370		10-yr	195.40	108.00	108 70	109.05	109 92
0 200176	8.85	22.07	40.57		2.12				
East	2	370		100-yr	407.30	108.00	109.01	109.62	111.13
0.200293	11.71	35 27	46.48		2 27				
East	2	315		2-yr	95.10	96.75	97.93	98.26	99 07
0.170051	8.57	11 10	18.85		1.97				
East	2	315		10-yr	195.40	96.75	98.27	98.81	100.11
0 157980	10.91	18.25	22.69		2.03				
East	2	315		100-yr	407.30	96.75	98.80	99 70	101 85
0 141464	14 10	31 77	28.02		2.08				
East	2	260		2-yr	95 10	94.25	96.98	95.98	97 07
0 003955	2.45	38.88	25.33		0.35				
East	2	260		10-yr	195.40	94.25	97.70	96.60	97.87
0.005247	3.32	58.95	30.47		0.42				
East	2	260		100-yr	407.30	94.25	98.63	97.50	98 97
0 006209	4.67	90 47	37.39		0.48				
East	2	200		2-yr	95.10	94.75	96.10	96 10	96 50
0.040621	5.07	18.74	23.84		1 01				
East	2	200		10-yr	195.40	94.75	96.60	96.60	97 17
0.036535	6 06	32 30	30.22		1 01				
East	2	200		100-yr	407 30	94.75	97.32	97.32	98 21
0.029625	7.61	57 11	38.66		0.99				
East	2	150 *		2-yr	95.10	92.38	93.82	93.87	94.29
0.047763	5.46	17 42	22.42		1.09				
East	2	150.*		10-yr	195.40	92 38	94.25	94.37	95 01
0.051038	7.00	27.97	26.88		1.19				
East	2	150.*		100-yr	407.30	92 38	96.84	95.15	97.09
0.003367	4.07	131 56	52.25		0.37				
East	2	100		2-yr	95.10	90.00	91 40	91.45	91 91
0.047185	5 73	16 59	19.59		1.10				
East	2	100		10-yr	195.40	90.00	91.95	92.03	92.67
0.042779	6.77	28.86	24.59		1.10				
East	2	100		100-yr	407.30	90.00	96.89		96 98
0.000626	2.46	254 10	67.88		0.18				

HEC-RAS cross-section plots

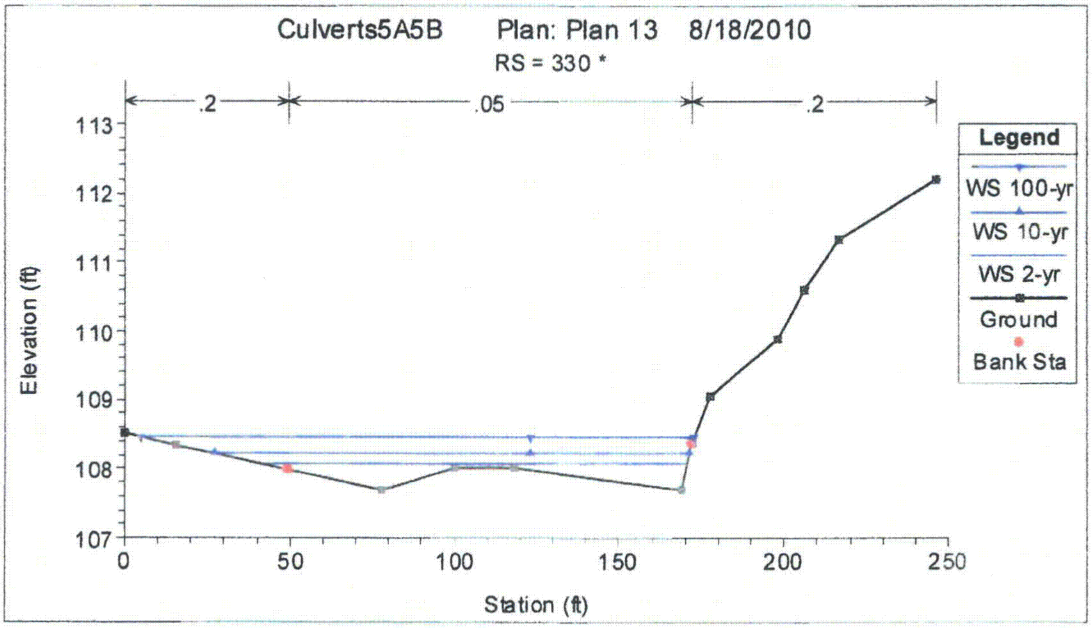
Pre-construction



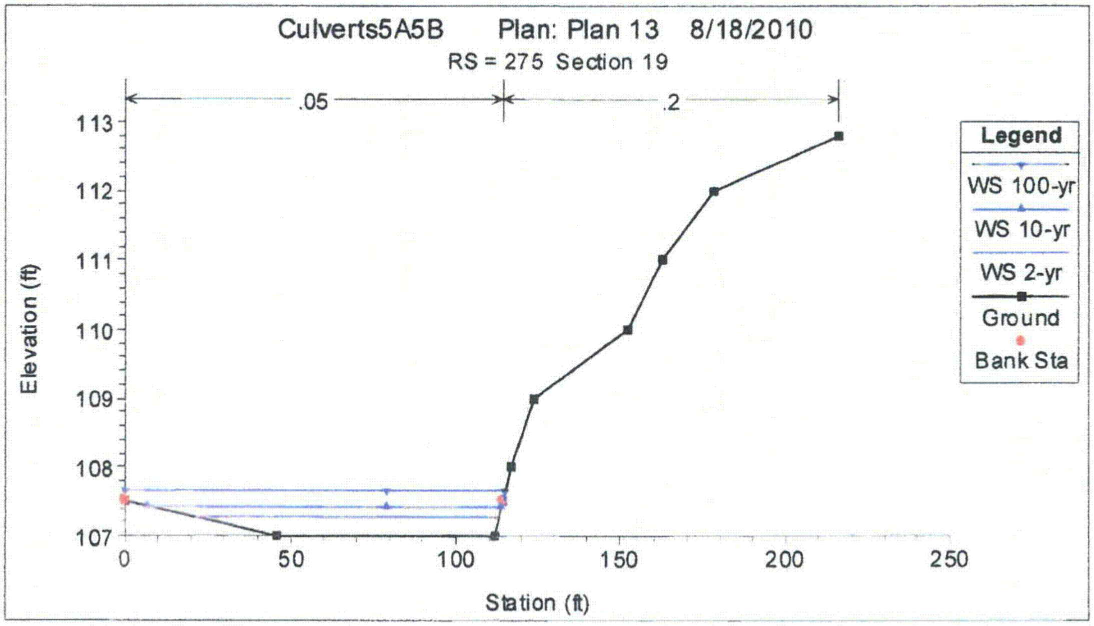
"WEST" STREAM – RIVER STATION 440



"WEST" STREAM – RIVER STATION 385*



"WEST" STREAM – RIVER STATION 330*



"WEST" STREAM – RIVER STATION 275

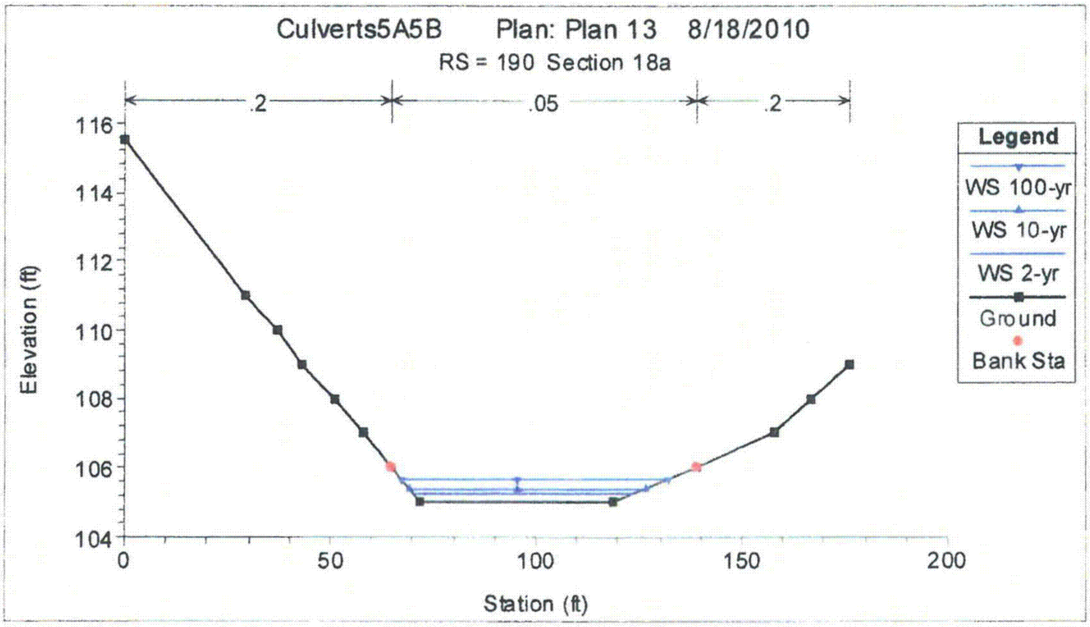
ATTACHMENT NO 4

PROJECT: Calvert Cliffs 3 Nuclear Project

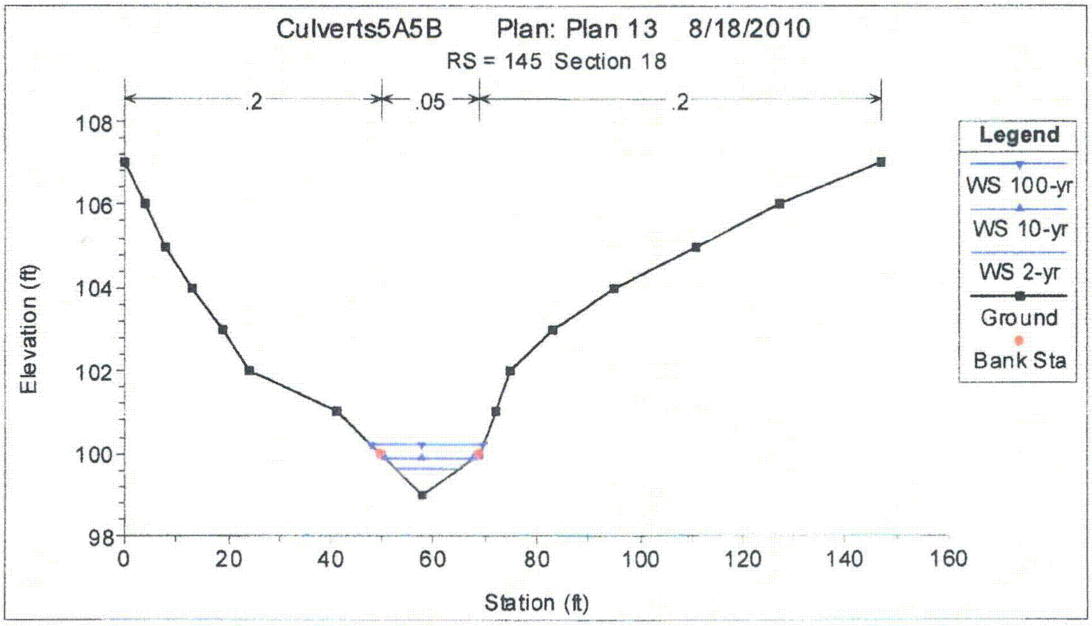
SUBJECT Hydraulic Analysis of Culvert

JOB NUMBER: 25470
CALC NO. 25470-000-K0C-7400-00009
SHEET NO. 3 OF 17
SHEET REV. 000

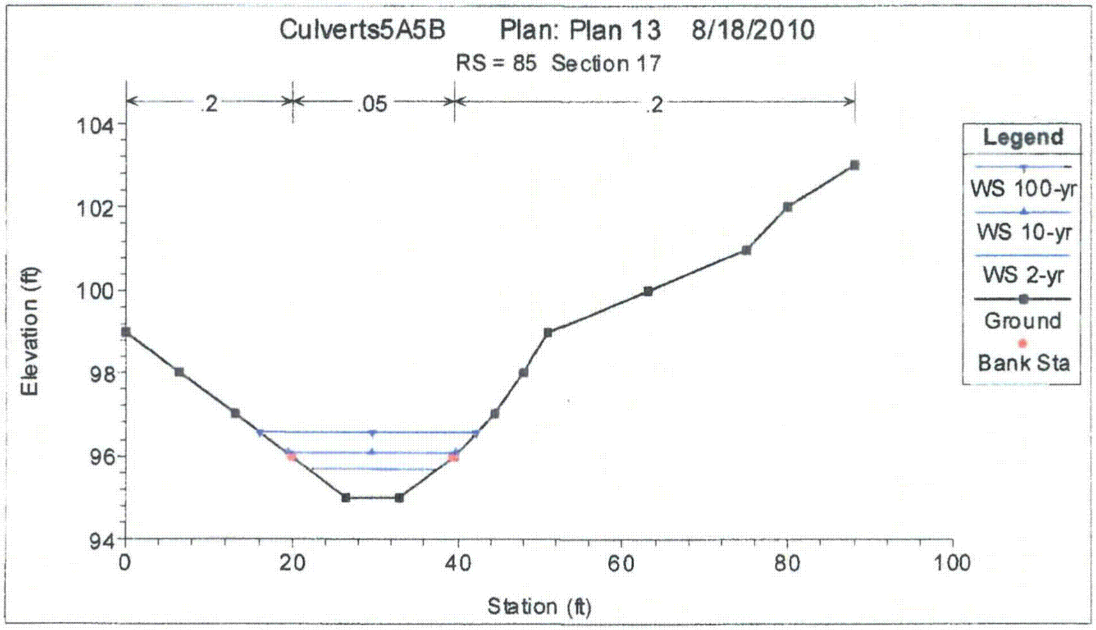
BY: P. Samothrakis DATE August 3, 2010



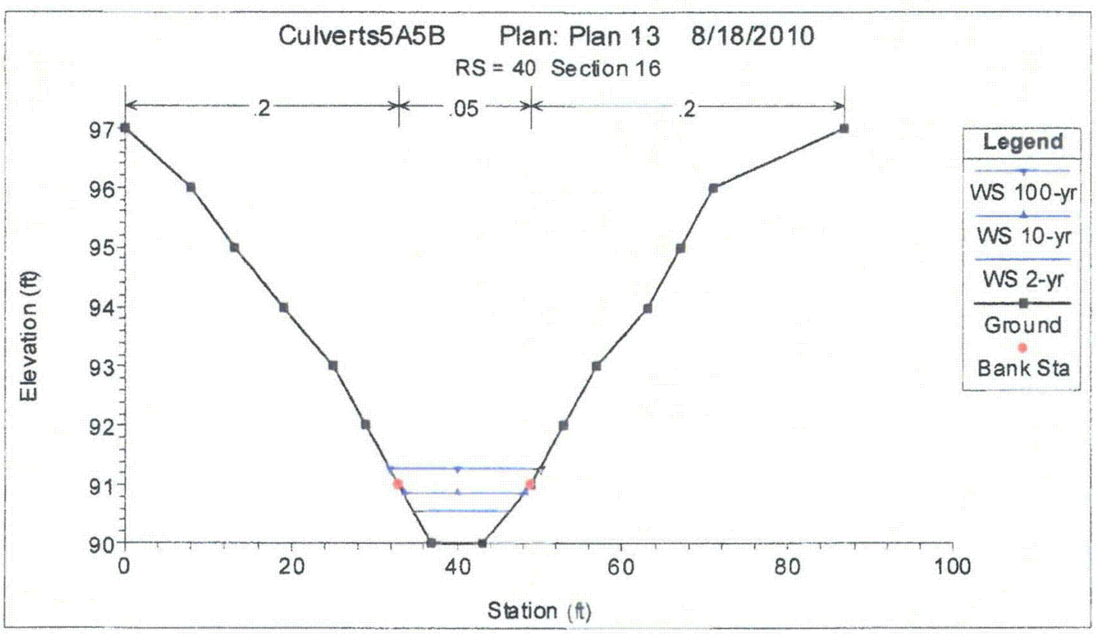
"WEST" STREAM – RIVER STATION 190



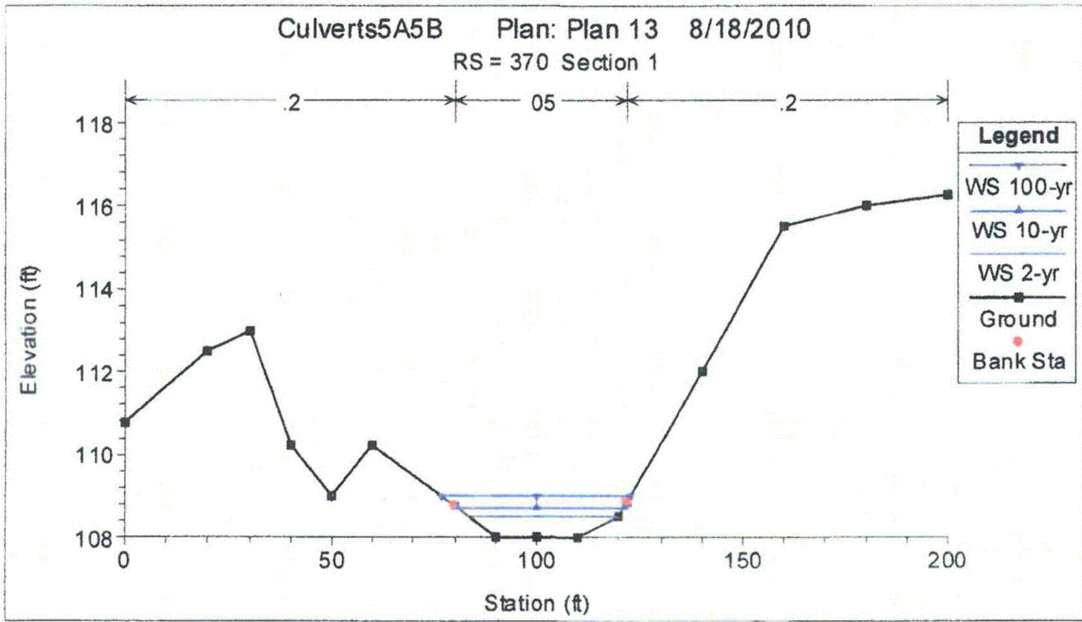
"WEST" STREAM – RIVER STATION 145



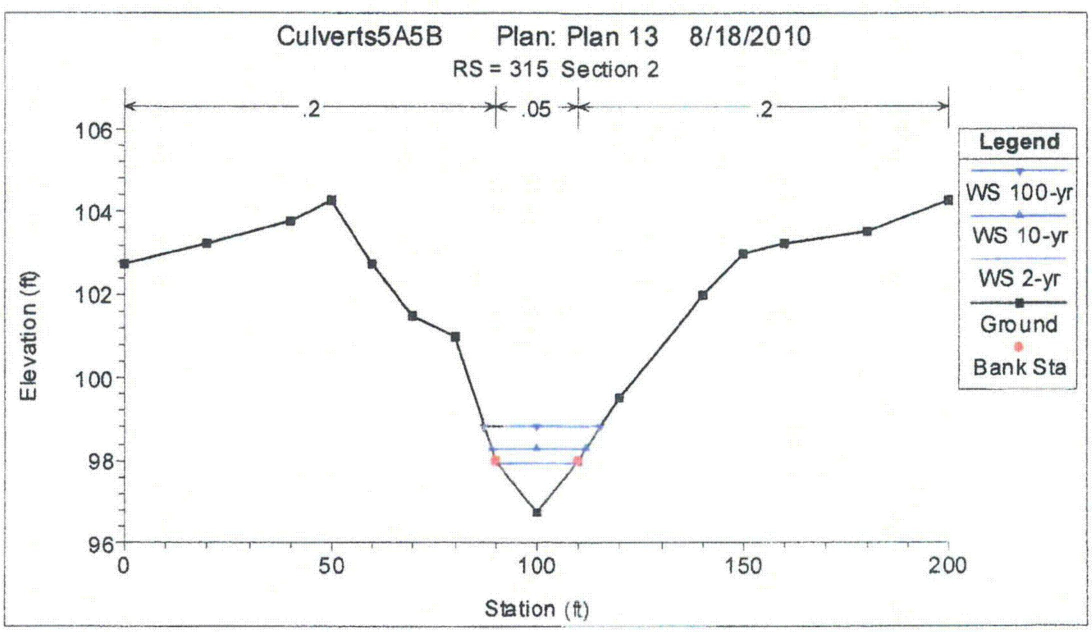
"WEST" STREAM – RIVER STATION 85



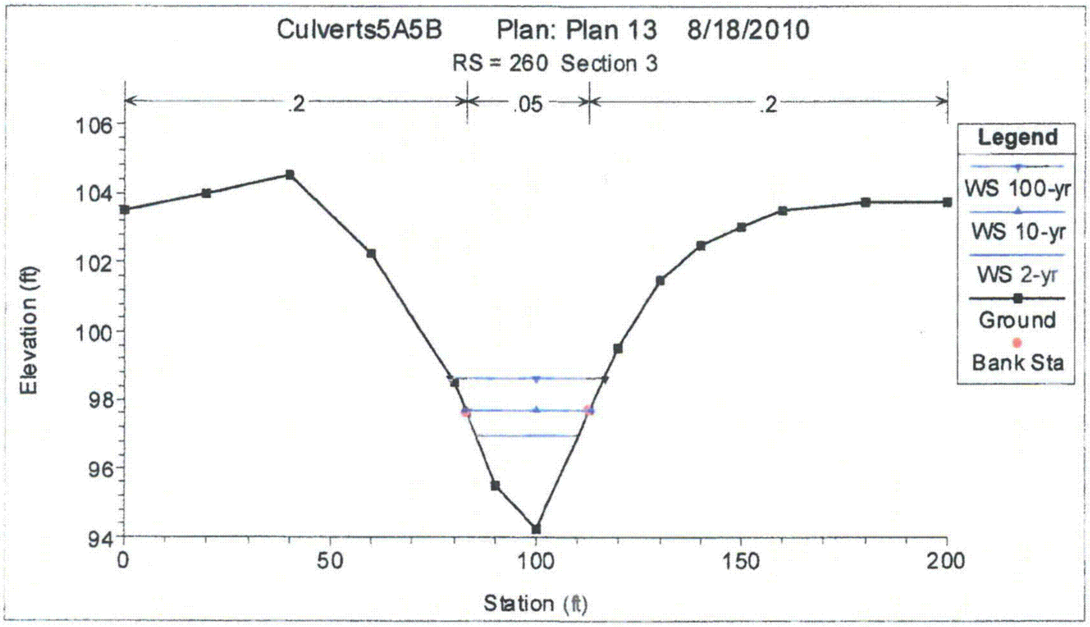
"WEST" STREAM – RIVER STATION 40



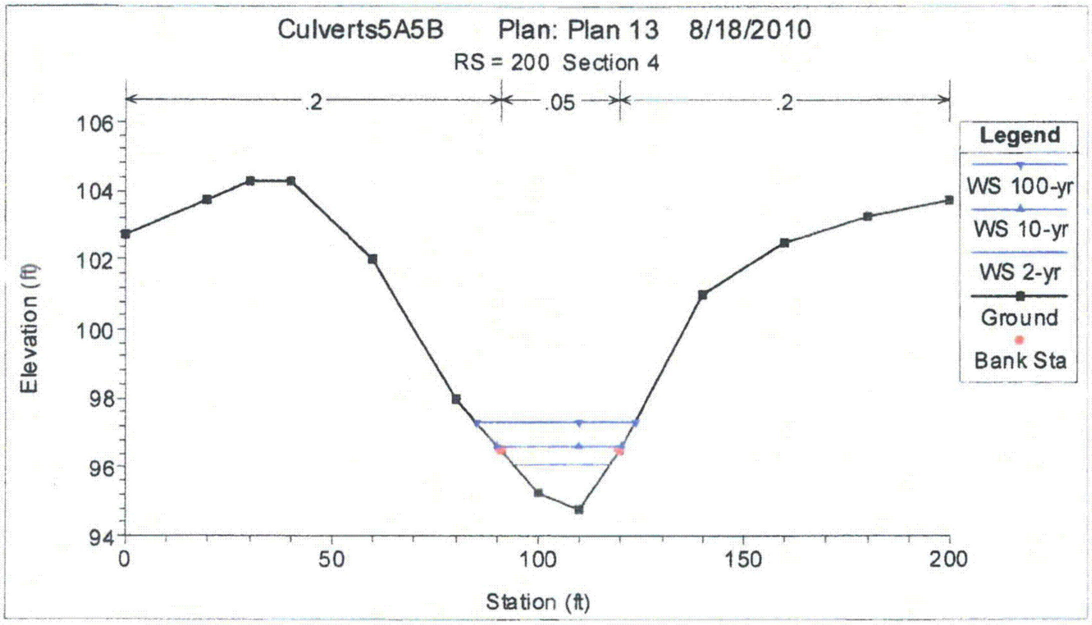
"EAST" STREAM – RIVER STATION 370



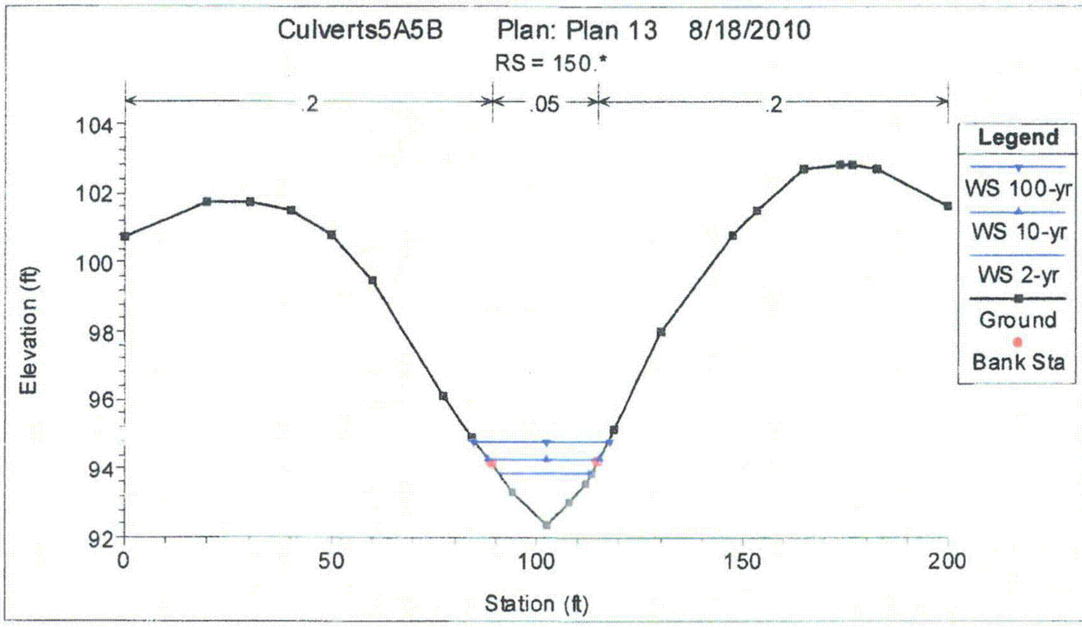
"EAST" STREAM – RIVER STATION 315



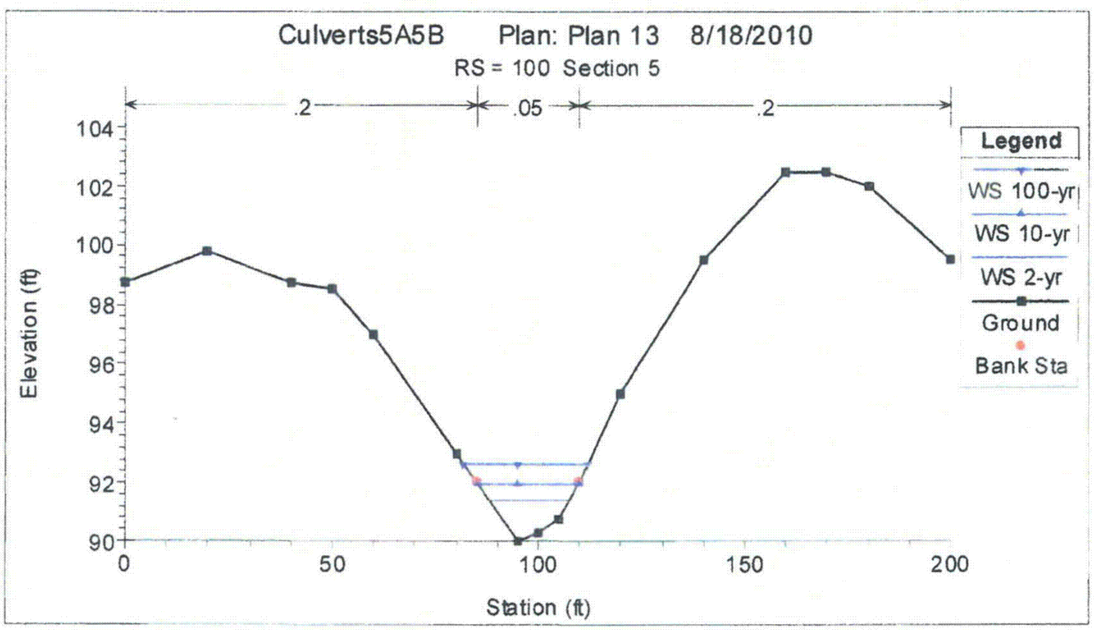
"EAST" STREAM – RIVER STATION 260



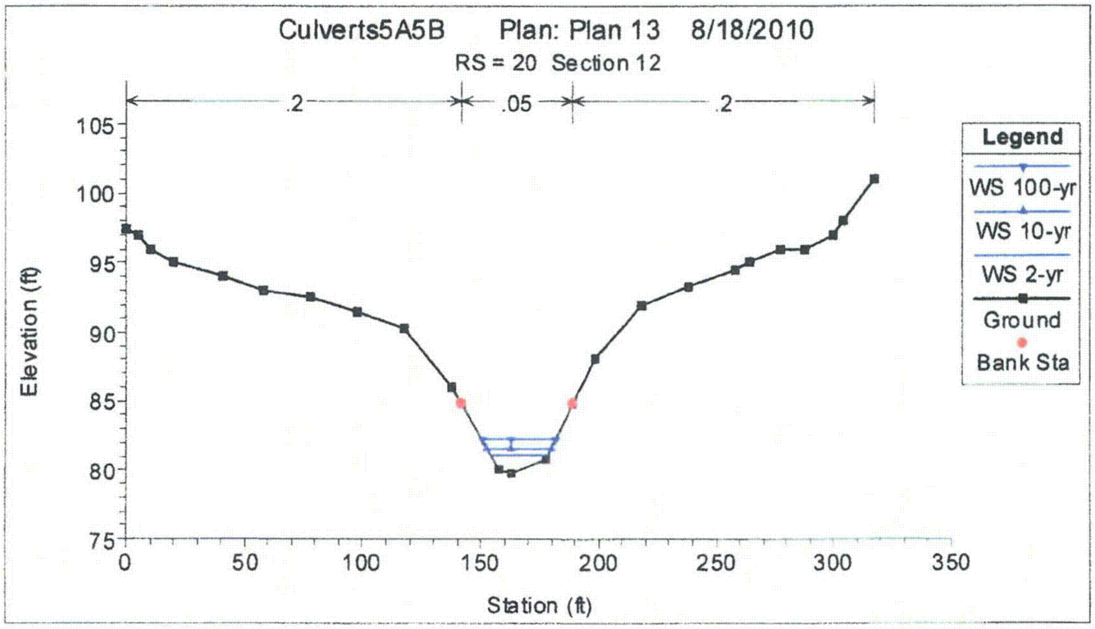
"EAST" STREAM – RIVER STATION 200



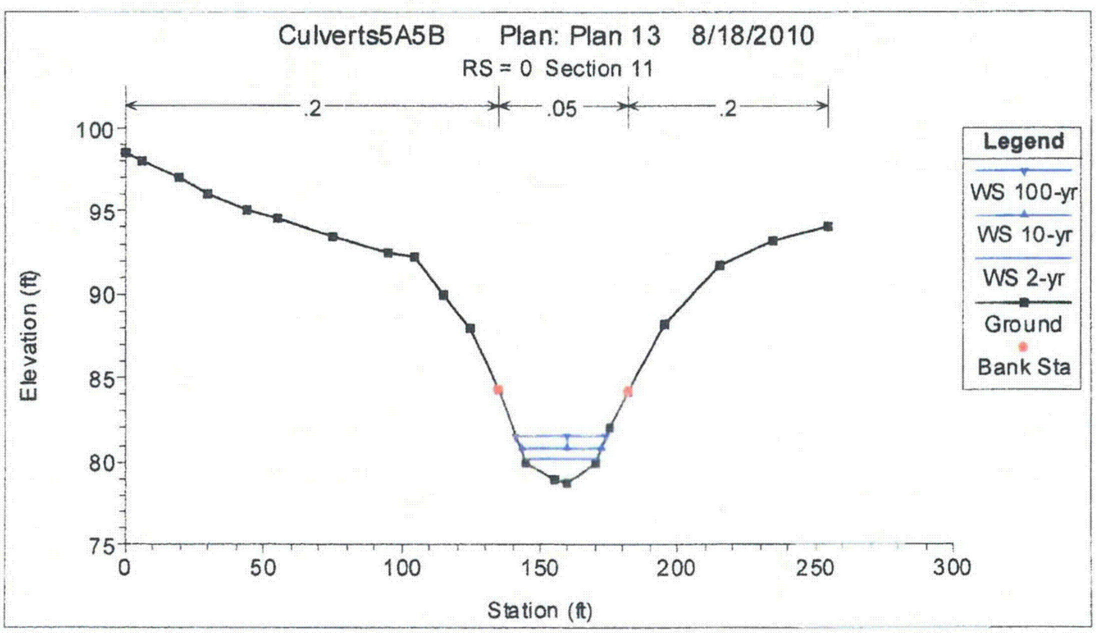
"EAST" STREAM – RIVER STATION 150*



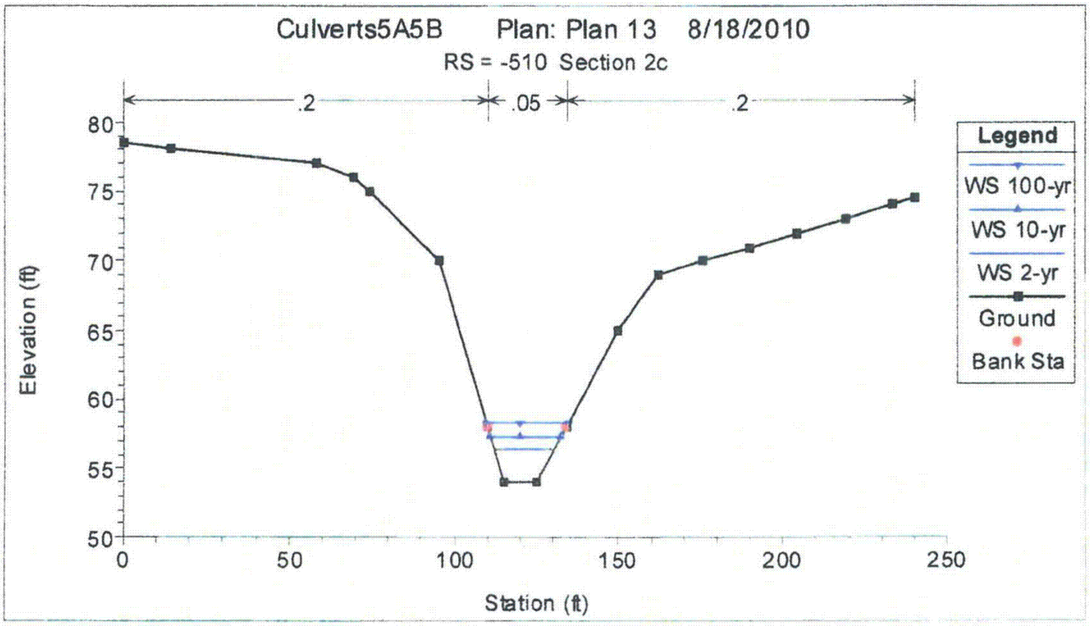
"EAST" STREAM – RIVER STATION 100



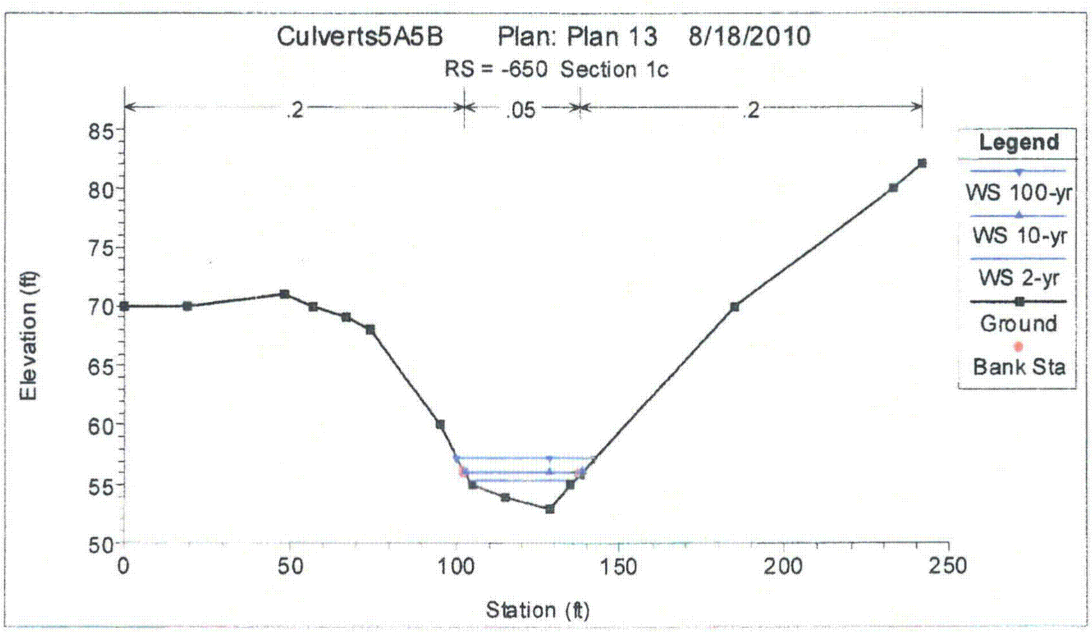
"SOUTH" STREAM – RIVER STATION 20



"SOUTH" STREAM – RIVER STATION 0

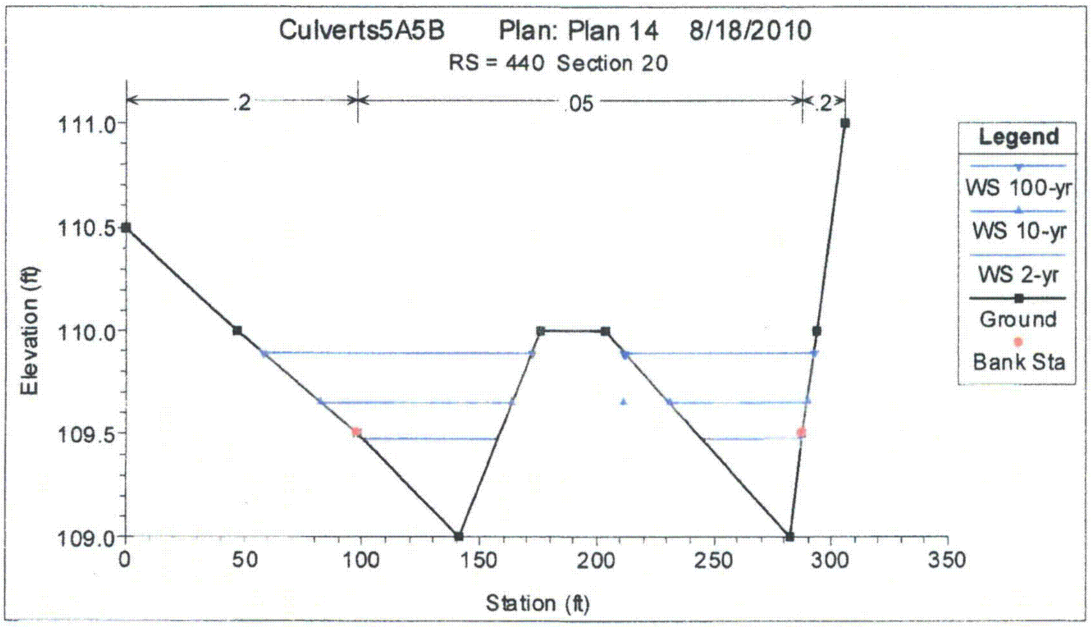


"SOUTH" STREAM – RIVER STATION -510



"SOUTH" STREAM – RIVER STATION -650

Post-construction (no culvert option used)



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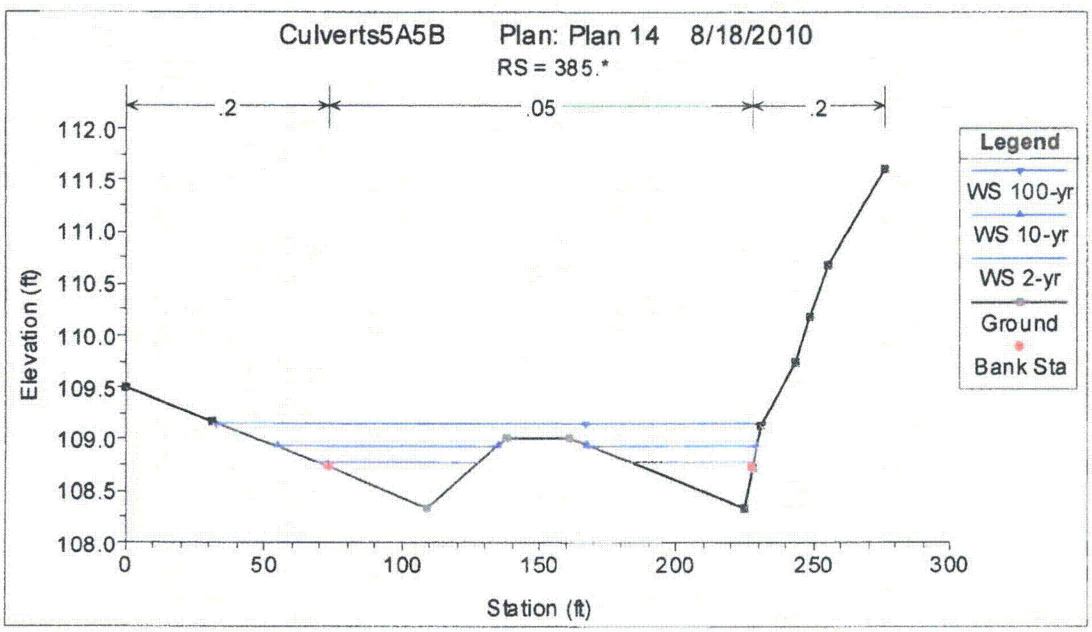
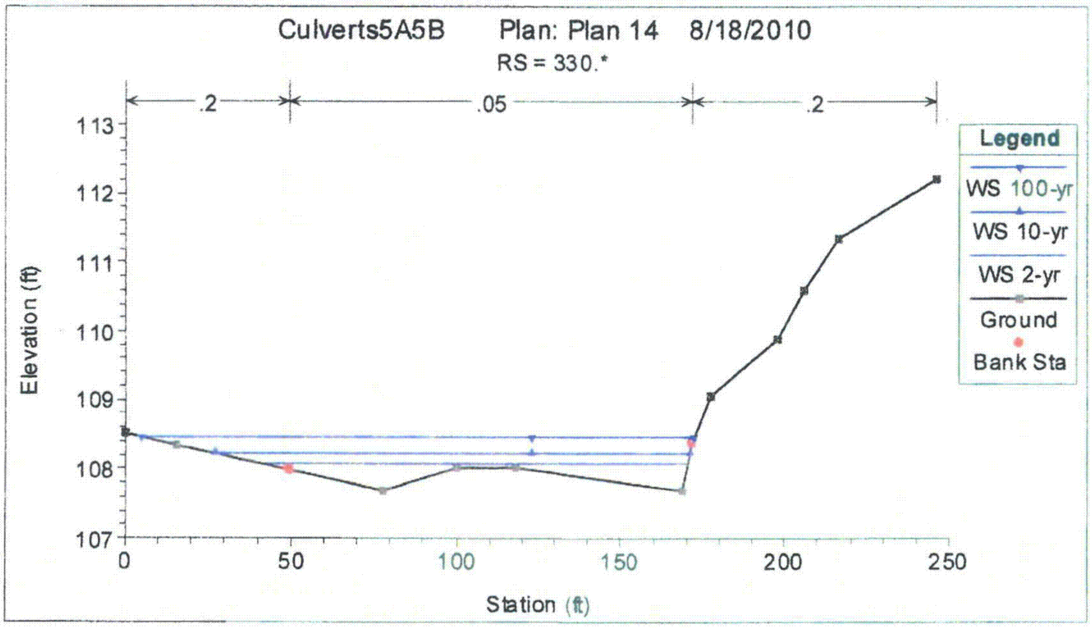
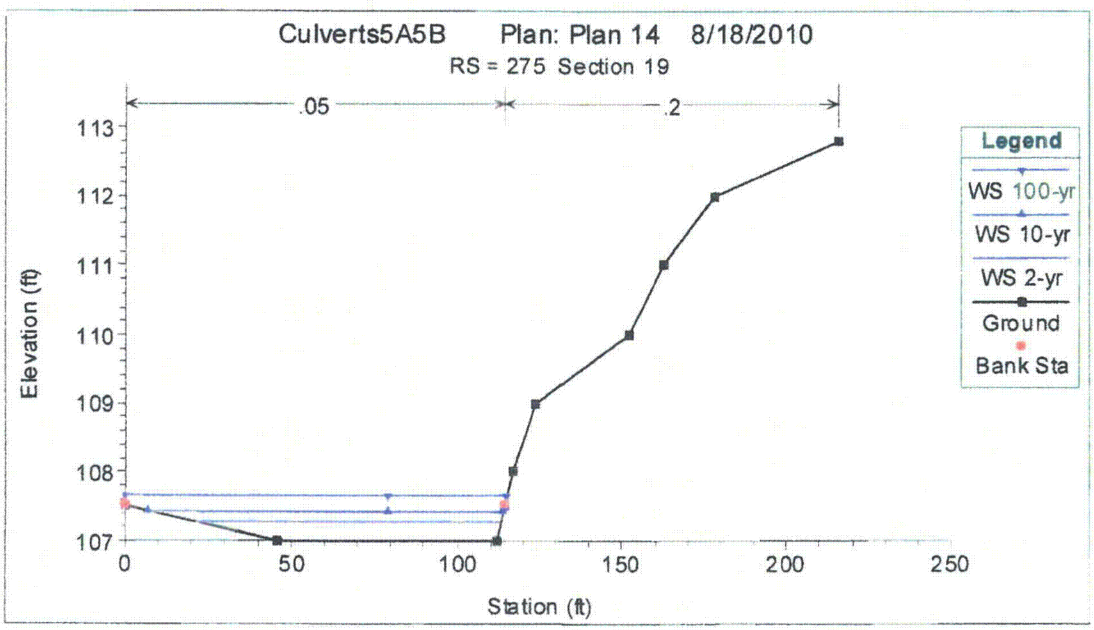


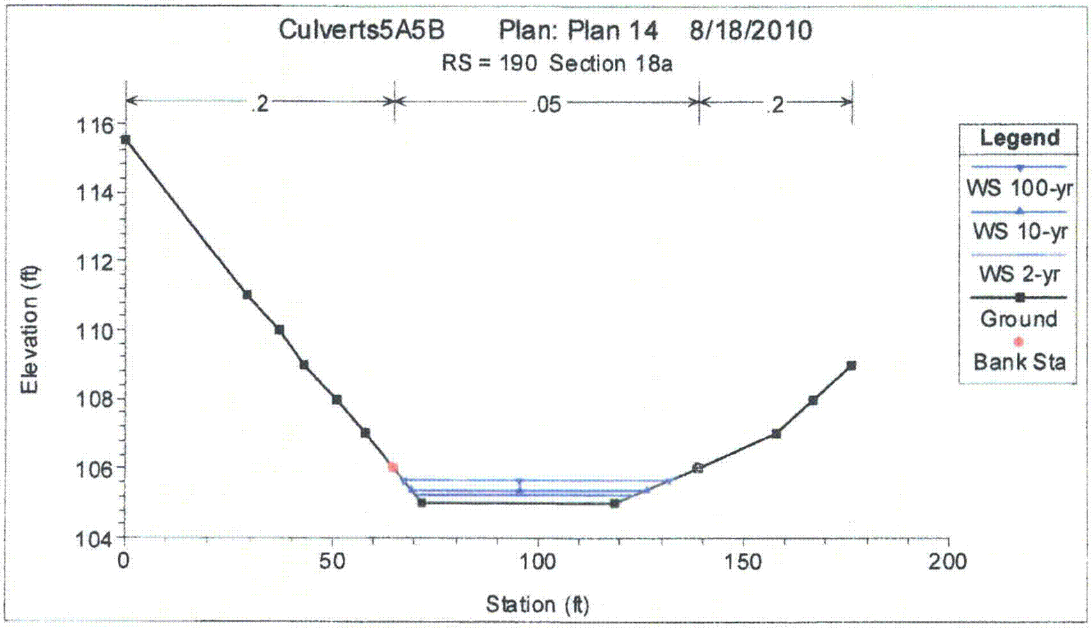
"WEST" STREAM – RIVER STATION 385*



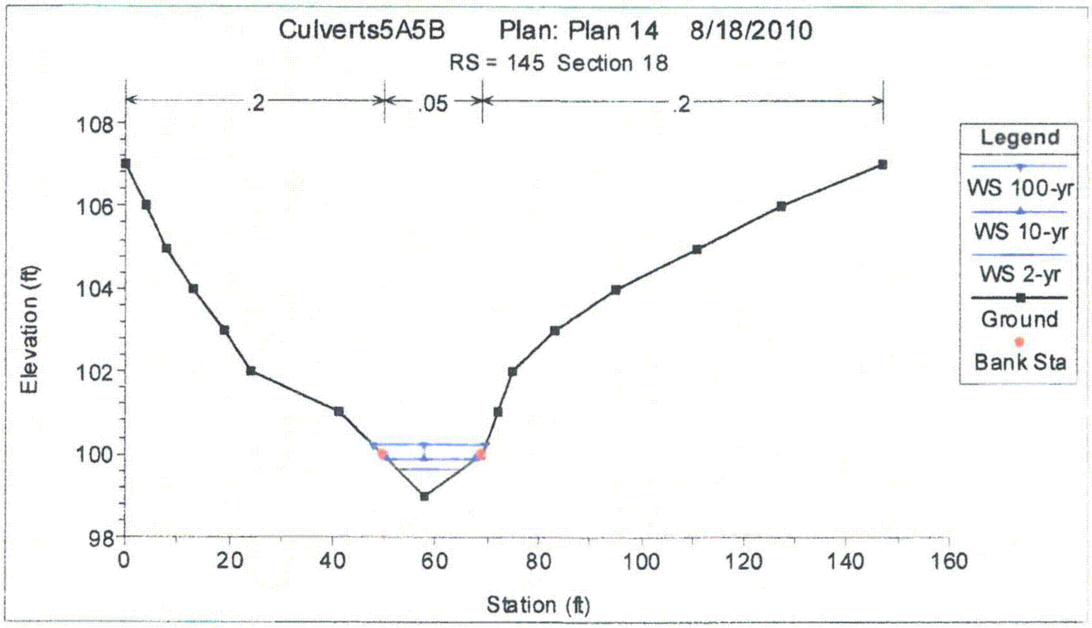
"WEST" STREAM – RIVER STATION 330*



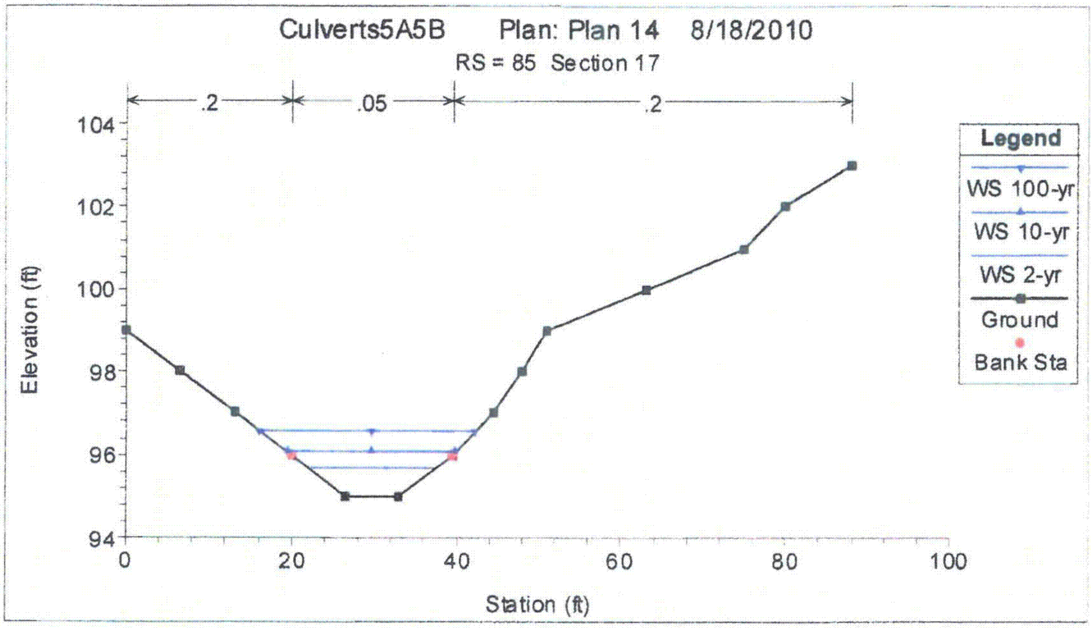
"WEST" STREAM – RIVER STATION 275



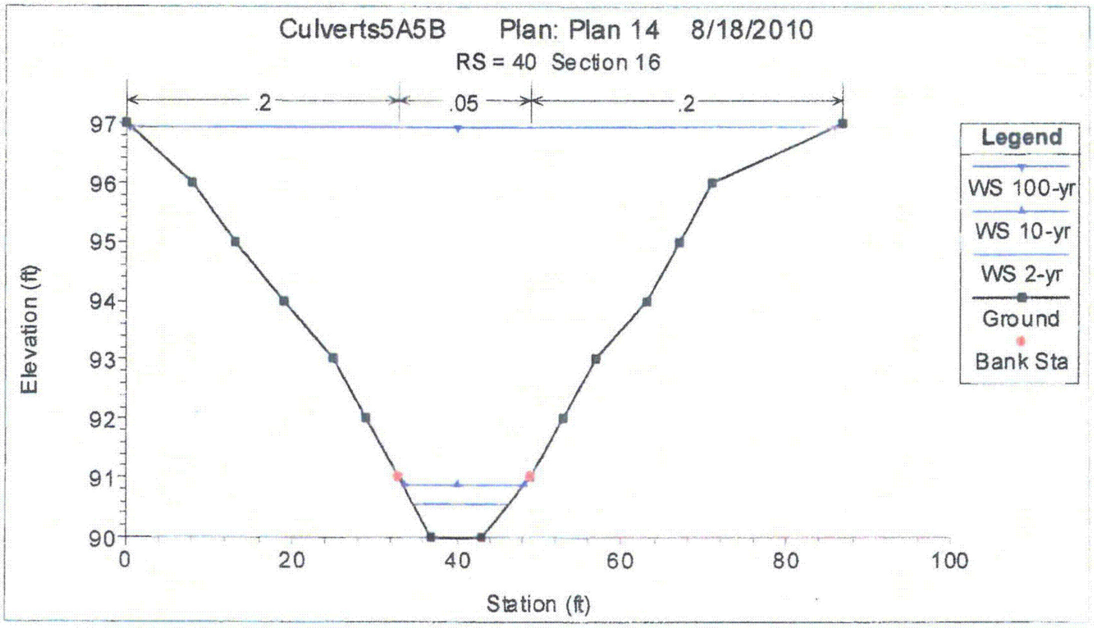
"WEST" STREAM – RIVER STATION 190



"WEST" STREAM – RIVER STATION 145



"WEST" STREAM – RIVER STATION 85



"WEST" STREAM – RIVER STATION 40

ATTACHMENT NO 4

PROJECT: Calvert Cliffs 3 Nuclear Project

JOB NUMBER: 25470

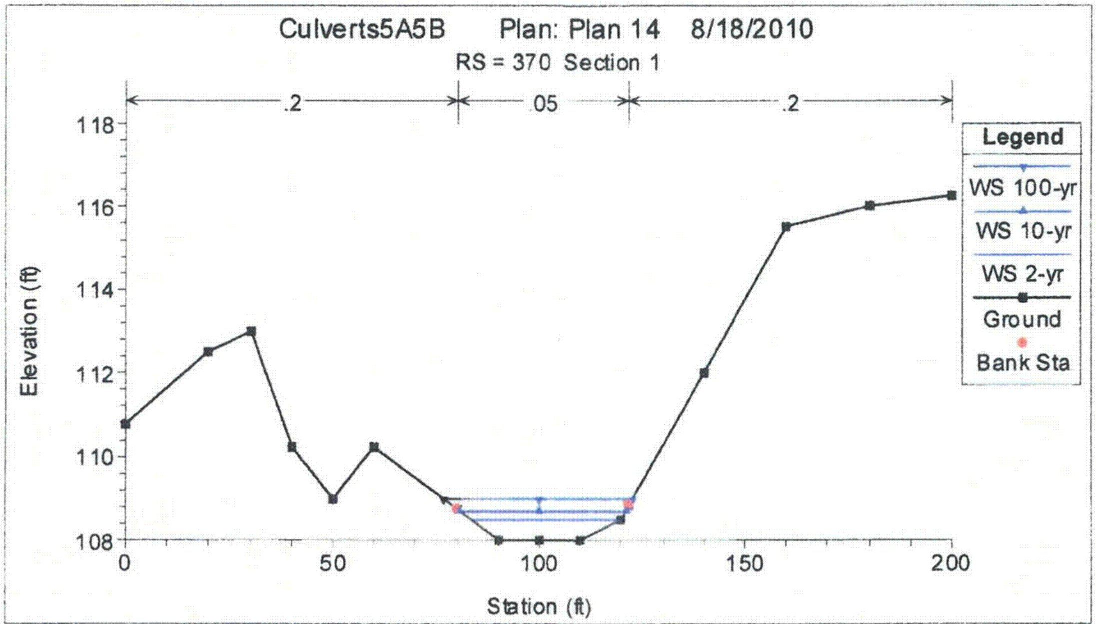
CALC NO. 25470-000-K0C-7400-00009

SHEET NO. 14 OF 17

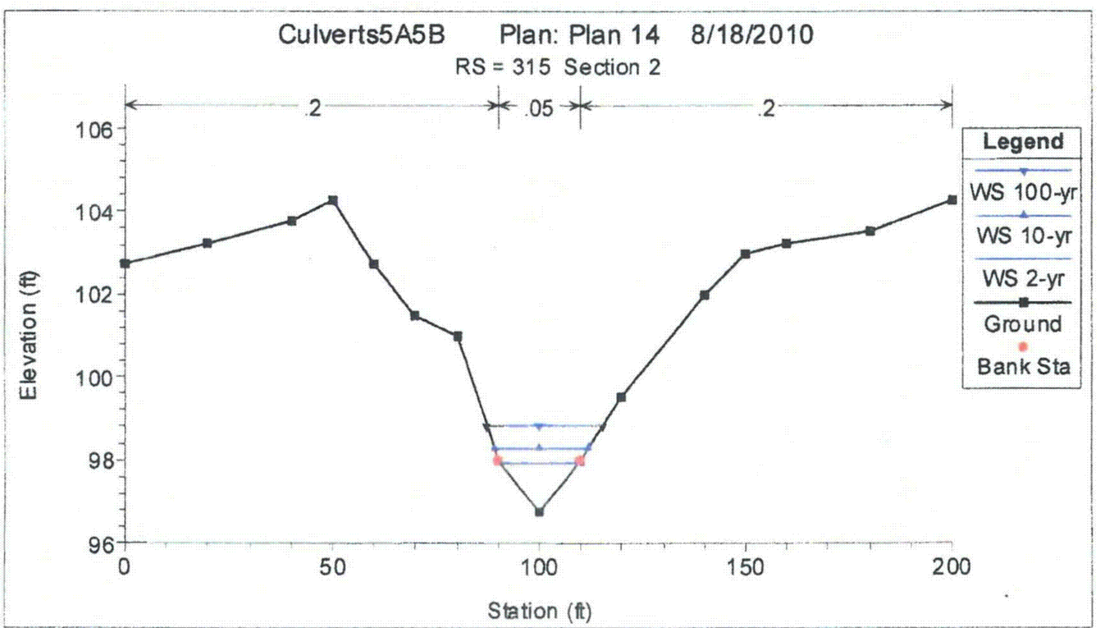
SHEET REV. 000

SUBJECT Hydraulic Analysis of Culvert

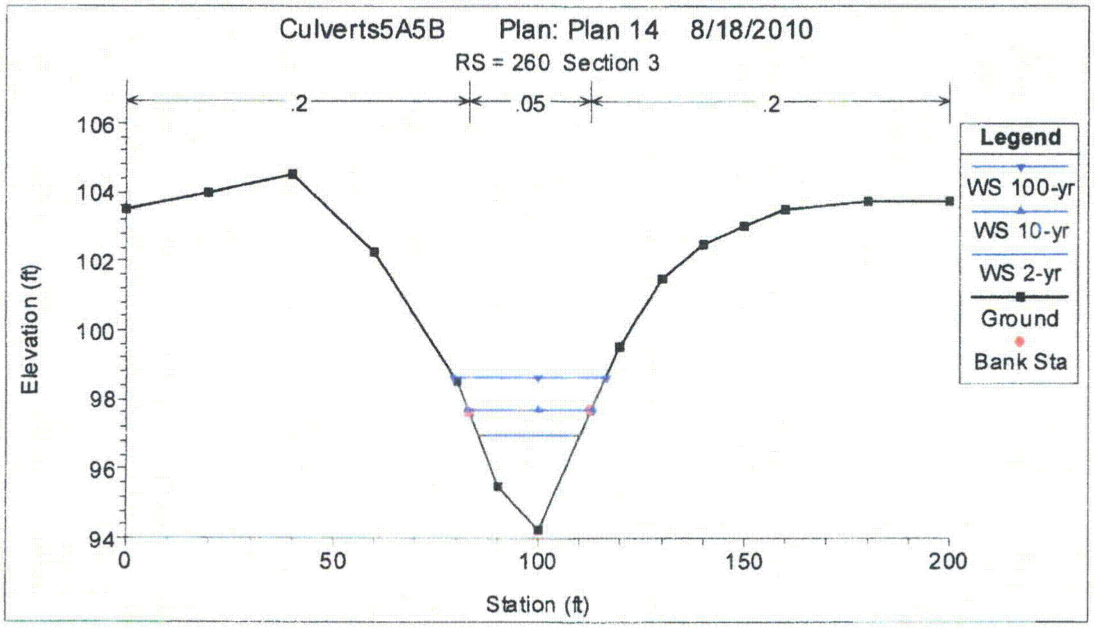
BY: P. Samothrakis DATE August 3, 2010



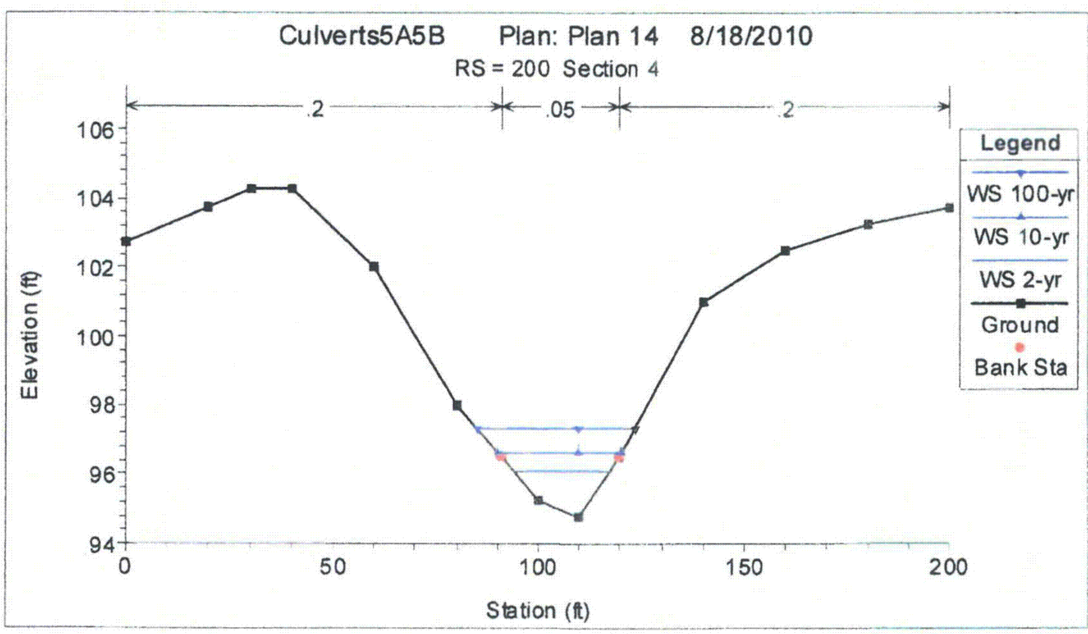
"EAST" STREAM – RIVER STATION 370



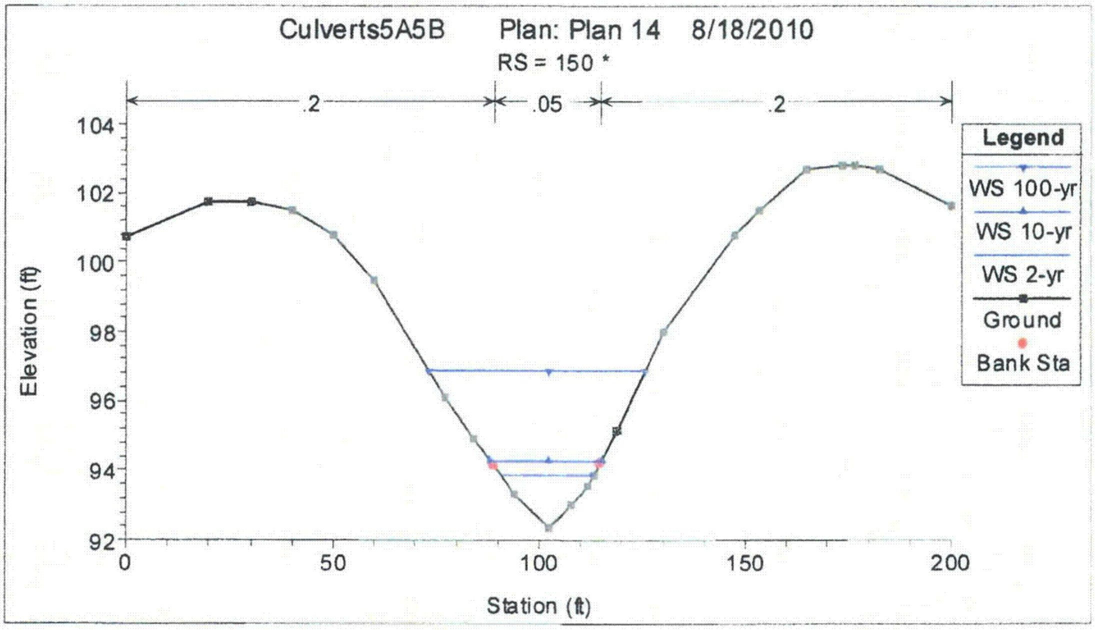
"EAST" STREAM – RIVER STATION 315



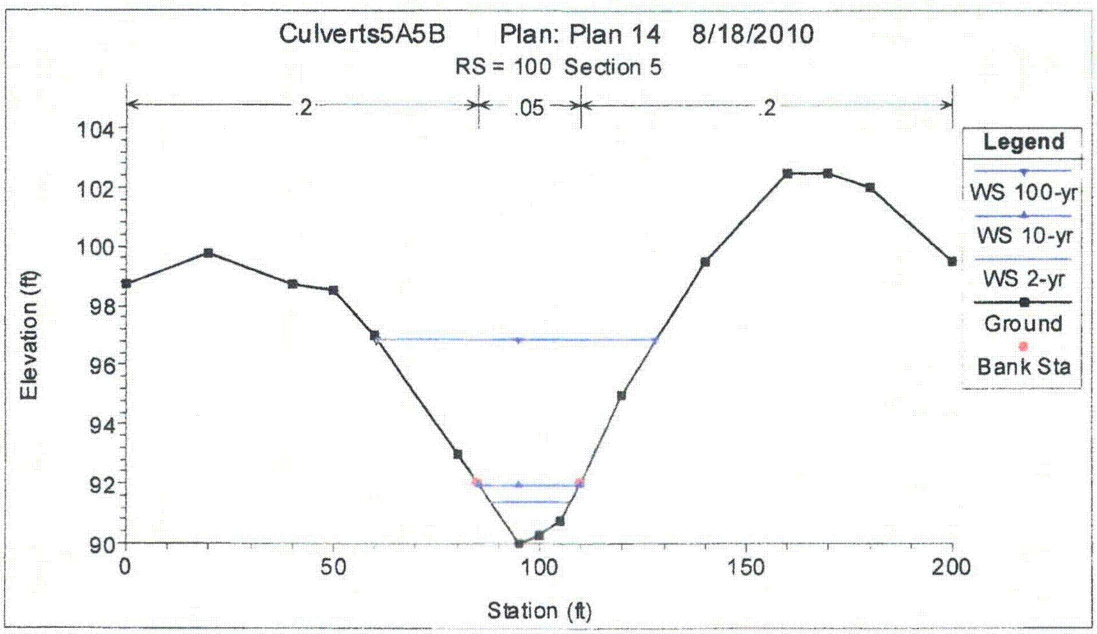
"EAST" STREAM – RIVER STATION 260



"EAST" STREAM – RIVER STATION 200



"EAST" STREAM – RIVER STATION 150*



"EAST" STREAM – RIVER STATION 100

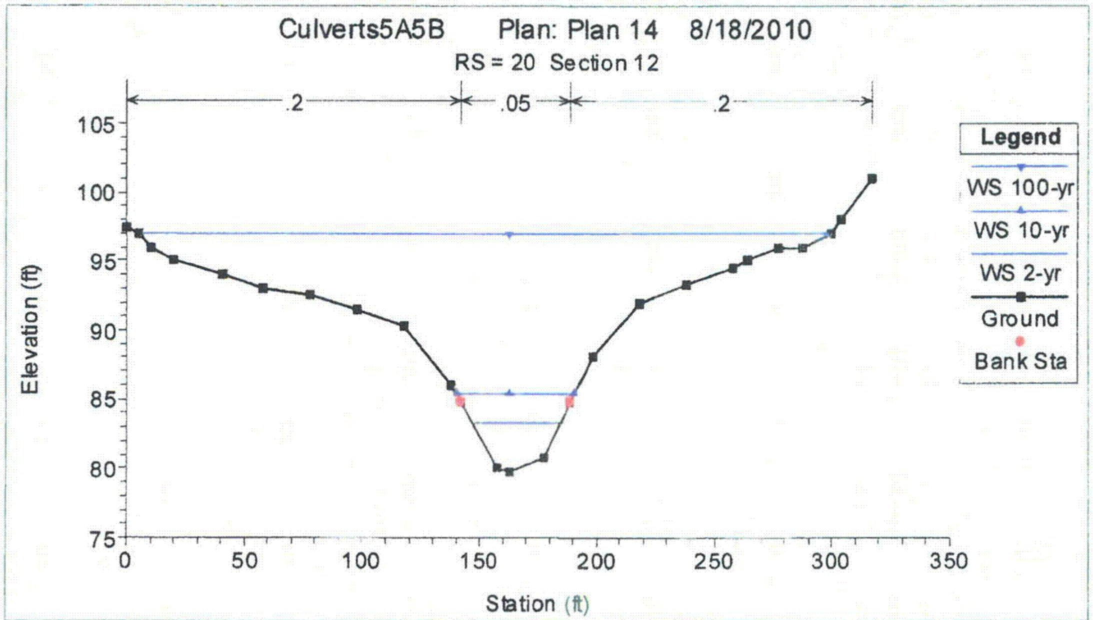
ATTACHMENT NO 4

PROJECT: Calvert Cliffs 3 Nuclear Project

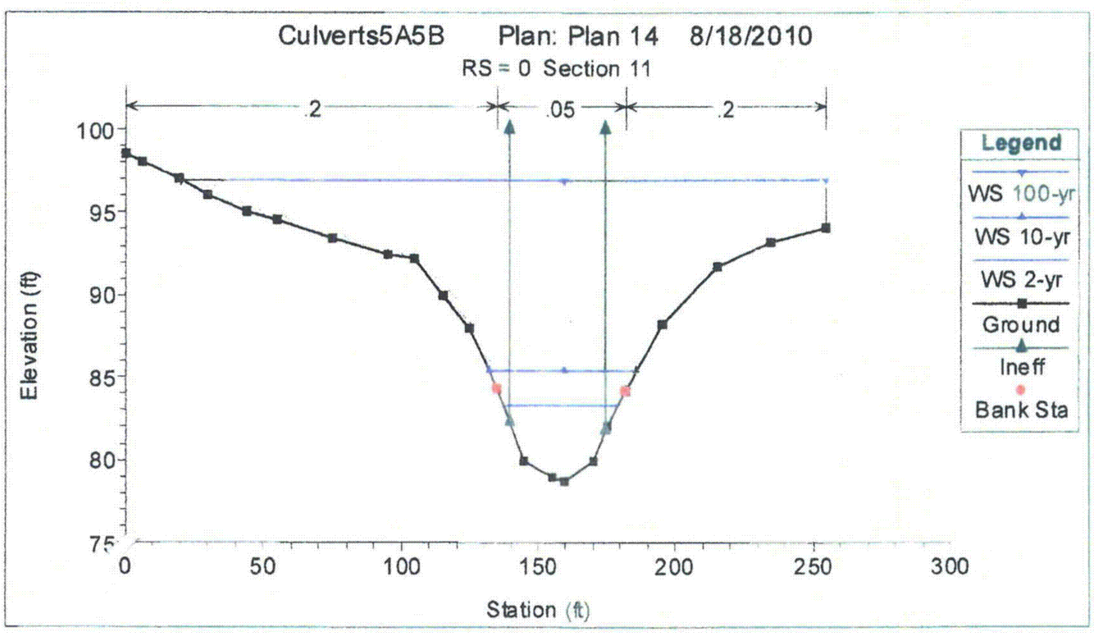
JOB NUMBER: 25470
CALC NO. 25470-000-K0C-7400-00009
SHEET NO. 17 OF 17
SHEET REV. 000

SUBJECT Hydraulic Analysis of Culvert

BY: P. Samothrakis DATE August 3, 2010



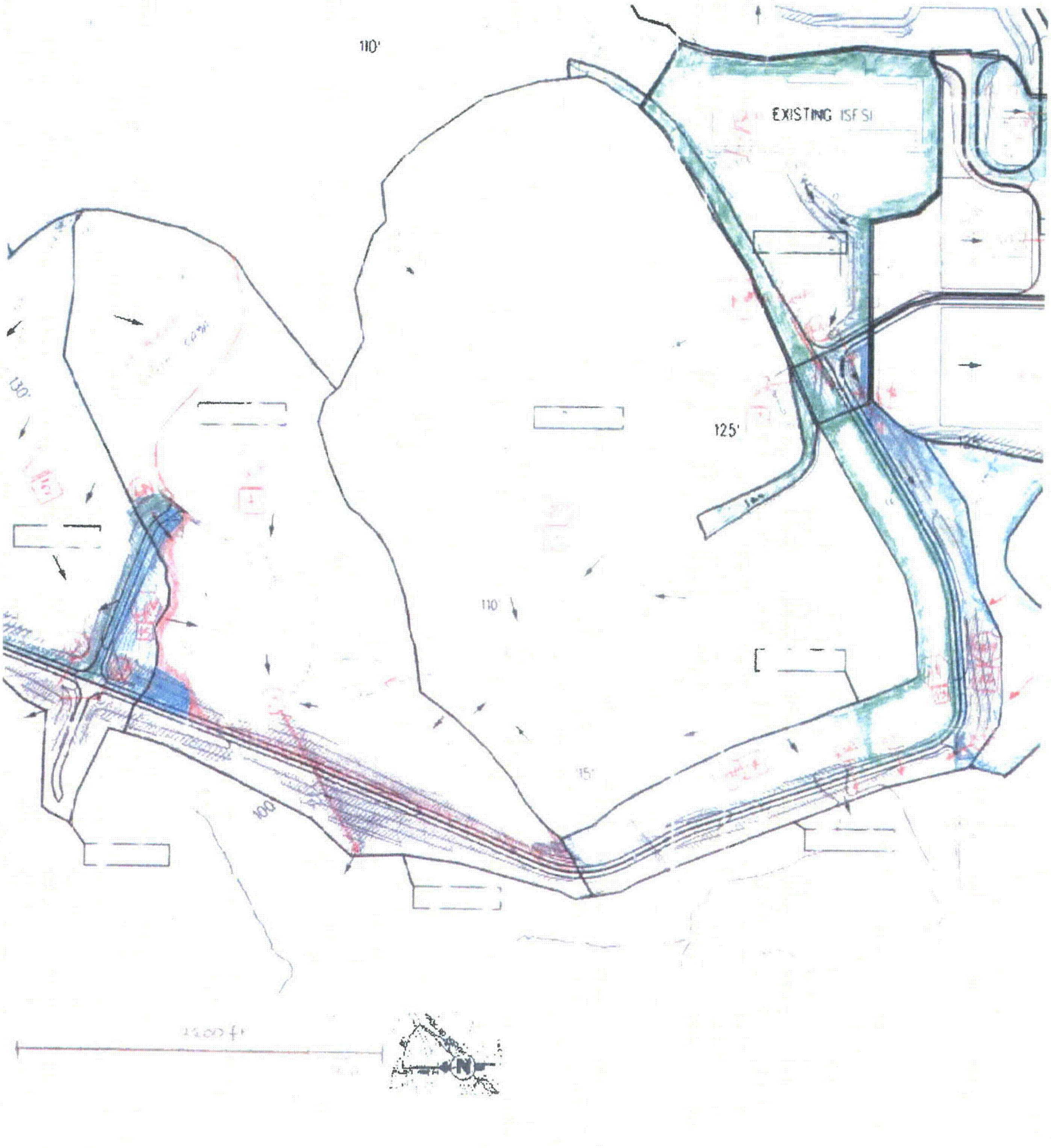
"SOUTH" STREAM – RIVER STATION 20



"SOUTH" STREAM – RIVER STATION 0

Job 25470
Calc 25470-000-K0C-7400-00009, Rev.000

ATTACHMENT 5
Sheet 1/1



Electronic List of Files for the CD ROM (Attachment 6)

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Backup.p01	3 KB	P01 File	8/15/2010 5:28 PM
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Culverts5A5B.f01	2 KB	F01 File	8/14/2010 11:16 AM
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THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLE: DRAWING NO:

CALVERT CLIFFS POST-DEVELOPMENT CULVERT DRAINAGE BASINS AND SOIL CLASSIFICATIONS

SUB-BASH DRAINAGE AREA MAP

JOB NO. 25470
COLO. NO.25470-000-KOC-74000-00003
REV.002

ATTACHMENT 2 1/1

D01

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLE : DRAWING NO:

CALVERT CLIFFS POST-DEVELOPMENT
CULVERT DRAINAGE BASINS AND SOIL CLASSIFICATIONS

JOB NO. 25470
COLO. NO.25470-000-KOC-74000-00003
REV.002

ATTACHMENT 3 1/1

D02x