Run-on and Run-off Control System Plan

American Electric Power
John E. Amos Landfill
Winfield, West Virginia

GAI Project Number: C130109.03, Task 001
February 2016

Revised September 2016

GAI Project Number C130109.10, Task 003

Revised December 2019

Prepared by: GAI Consultants, Inc.
Murrysville Office
4200 Triangle Lane
Export, Pennsylvania 15632-1358

Prepared for: American Electric Power
1 Riverside Plaza
Columbus, Ohio 43215

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Report Authors:

Kerry L. Frech, PE
Civil Technical Leader

Mark R. Lehner, PE
Senior Engineering Manager

Table of Contents

1.0 Introduction

The John E. Amos Landfill (Landfill) is an existing coal combustion residual (CCR) landfill permitted under West Virginia (WV) Solid Waste Management Rule (33CSR01) as a Class F industrial landfill. The Landfill as permitted consists of the south valley and the north valley areas.

The Code of Federal Regulations Title 40, Part 257.81 (40 CFR 257.81) requires the Owner or Operator of an existing or new CCR landfill, or of a lateral expansion of an existing CCR landfill, to comply with the following:

- Design, construct, operate, and maintain:
  - A run-on control system to prevent flow onto the active portion of the CCR unit, up to and including the peak discharge from a 24-hour, 25-year storm [§257.81(a)(1)]; and
  - A run-off control system to collect and control at least the water volume from a 24-hour, 25-year storm [§257.81(a)(2)].
- Run-off from the active landfill areas must be handled in accordance with the surface water requirements under §257.3-3 [§257.81(b)].
- Prepare the Run-on and Run-off Control System Plan for existing CCR landfills according to the following timelines:
  - Initial Run-on and Run-off Control System Plan – by October 17, 2016, [§257.81(c)(3)]; and
  - Periodic Run-on and Run-off Control System Plans – every five years, [§257.81(c)(4).
- Obtain a certification from a qualified Professional Engineer (PE) stating that the initial and the periodic run-on and run-off control plans meet the requirements of §257.81 [§257.81(c)(5)].
- Comply with the recordkeeping requirements of §257.105(g), the notification requirements specified in §257.106(g), and the internet requirements specified in §257.107(g) [§257.81(d)].

This Run-On and Run-Off (RORO) Control System Plan (Plan) (dated February 2016, revised September 2016 and December 2019) presents the Plan requirements listed above. The Plan is prepared for the John E. Amos flue gas desulfurization (FGD) Landfill located in Winfield, Putnam County, WV. The designs of the RORO controls have been prepared for the WV Solid Waste/National Pollutant Discharge Elimination System (SW/NPDES) permitting for the Landfill (Permit No. WV0116254: WV Department of Environmental Protection (WVDEP), 2008; WVDEP, 2012; WVDEP, 2017), including permit amendments (WVDEP, 2011; WVDEP, 2015). The design events for the RORO controls are consistent with the design events set forth in 40 CFR 257.81. The permitting applicable to the RORO control systems design are:

- The Landfill was permitted in 2008 (WVDEP, 2008). The Landfill began accepting CCRs in April 2009.
- Permit amendment in 2011 (WVDEP, 2011). The Amendment authorized a change in subgrade slopes from a maximum of two horizontal : one vertical (2H:1V), to a maximum slope of 3H:1V for Sequence 3B and subsequent sequences. This amendment altered the subgrade surface within the Landfill footprint, with minor modification to the Landfill footprint.
- Permit re-authorization in 2012 (WVDEP, 2012). The re-authorization incorporated the 2011 amendment.

- Permit amendment in 2015 (WVDEP, 2015). The Amendment authorized modifications to the north pond complex, specifically to the general arrangement of the north valley area sediment collection pond and leachate holding basin, and the addition of a clean water diversion culvert to convey stormwater run-on from outside the active landfill area around the sediment collection pond.
- Permit re-authorization in 2017. The re-authorization incorporated the 2015 amendment and re-configured the landfill which included the elimination of landfill Sequence 10, re-configuring of final haul roads, and minor reductions in the landfill footprint.

Permanent and temporary RORO controls are described in this Plan and shown on the enclosed Figures. Figure 1 "Final Landfill Grades" (Appendix A) shows the Landfill permitted footprint and final landfill grades, and Figures 2 through 8 show the active landfill area and proposed RORO controls as Landfill development progresses.

2.0 Description of Run-On and Run-Off Controls

The purpose of run-on controls is to prevent the flow of water onto the active portion of the Landfill up to the peak discharge from a 24-hour, 25-year storm. The purpose of run-off controls is to collect and control the stormwater within the active disposal area up to the volume of the 24-hour, 25-year storm. Controls may be permanent or temporary, be used for RORO control, and their function may also change over time as landfill development proceeds. RORO design includes the phasing of the landfill development as well as constructed features. Details on the RORO controls are presented on the 2017 SW/NPDES Permit Application Drawings 13-30500-21 through 25 (WVDEP, 2017).

2.1 Phasing

Phasing of the landfill development incorporates the topography and natural features of the site into the design that can facilitate the separation and control of stormwater flows.

2.2 Berms and Dikes

Berms and dikes are barriers to control the flow of water from one area to another. Berms and dikes may be temporary or permanent structures. Down-valley diversion dikes and berms are generally temporary structures which are removed as down-valley landfill development occurs. Up-valley berms, such as perimeter berms, are generally permanent structures. Perimeter berms are constructed along the boundaries of a landfill sequence to prevent stormwater run-on from adjacent Landfill and non-Landfill areas, as well as to prevent stormwater runoff from a sequence (see Drawings 13-30500-24 and 13-30500-25). Perimeter berms are designed to handle the 24-hour, 25-year storm.

2.3 Diversion and Collection Channels

Diversion channels are used to divert stormwater from undisturbed areas around disposal and associated work areas, and convey the water to an appropriate discharge point. Collection channels are used to collect stormwater from disturbed non-active landfill areas (liner and cap construction areas, soil borrow and stockpile areas, etc.) and convey the water to a sediment collection pond or trap for treatment prior to discharge (see Drawing 13-30500-21). Diversion channels are designed for the 24-hour, 100-year storm. Collection channels are designed for the 24-hour, 25-year storm.

2.4 Site Grading

Grading is performed to promote positive drainage and eliminate low-lying areas. The grading accounts for the site's topography and natural features, and the siting of existing and proposed RORO controls.

2.5 Sediment Collection Ponds

Sediment collection ponds are used to treat stormwater from disturbed non-disposal areas both within and outside the Landfill footprint. Disturbed areas include liner construction, soil borrow and stockpile sites, the placement of temporary soil cover, and the installation of final cover (capping). These disturbed areas typically are revegetated (temporary and final cover) areas, and are directed to a sediment pond or trap, unless otherwise diverted. Contact water (stormwater from active disposal areas) does not drain to the sediment ponds or traps. Sediment ponds are designed to treat at least to a 24-hour, two-year storm, and safely handle at least a 24-hour, 25-year storm.

2.6 Sediment Traps

Sediment traps are used to control stormwater from small (less than five acres) working areas outside the Landfill's footprint. These areas are typically associated with soil borrow and stockpiles sites. The design of the sediment traps is in accordance with the "West Virginia Erosion and Sediment Control Manual".

2.7 Leachate Holding Basins

Leachate holding basins receive contact water from the disposal area. Contact water is directed to chimney drains located within the disposal area which drain to the leachate collection piping beneath the disposal area, and which is then conveyed to the leachate holding basin.

3.0 Run-On Controls

Run-on is defined under the CCR Rule as "any liquid that drains over land onto any part of a CCR landfill or any lateral expansion of a CCR landfill". For the purposes of this Plan, stormwater and groundwater are the liquids of concern. This Section describes the existing and proposed run-on controls at the Amos Landfill from both inside and outside the Landfill footprint.

Run-on controls are measures that prevent stormwater from entering active disposal areas from adjacent areas both inside and outside the Landfill footprint. Measures employed at the Amos Landfill as run-on controls include Landfill phasing, perimeter berms, diversion and collection channels, site grading, and sediment ponds and traps. Design calculations for run-on controls are provided in Appendix D.

3.1 Run-On Controls from Inside the Landfill Footprint

The Amos Landfill is being developed in sequences based on the need for disposal capacity. Stormwater and groundwater from areas within the Landfill footprint which have not yet been developed (neither under construction nor in active disposal) is collected and conveyed to a sediment pond, or, where appropriate, diverted around a sediment pond. Perimeter berms along the boundaries of a sequence are used to prevent water from entering in, or exiting from, an active disposal area. Within areas under construction, grading is performed to promote positive drainage, and the water is collected and conveyed to a sediment pond.

3.1.1 Current Phase – South Valley

Current disposal is occurring in Sequences 1 through 3 of the south valley (see Figure 2). Disposal operations are anticipated to move into Sequence 4 by the end of 2019 (Figure 3). Run-on from areas outside the active disposal area in the south valley is collected by perimeter channels PCC-1, PCC-2, or PCC-3 and conveyed to either the Amos Plateau Pond in the case of PCC-1, or to the South Area Sediment Collection Pond (SASCP) for PCC-2 and PCC-3. Run-on from areas outside the active disposal area in the north valley either is collected and conveyed to the North Area Sediment Collection Pond (NASCP) or is diverted by the North Valley Diversion Channel and Culvert (NVDC&C) around the NASCP. Stormwater from areas disturbed by landfill construction but not under active disposal is conveyed to a sediment pond. The exterior slopes of the active disposal area receive temporary cover and are vegetated as disposal occurs, and stormwater from these areas is directed by benches on the landfill face to a perimeter collection channel that discharges to a sediment pond.

3.1.2 Future Phases – Sequences 4 through 9

Sequence 4 was completed in 2019, and disposal activities are anticipated to start by the end of the year (Figure 3). Future Sequences 5 through 9 will be developed as needed (see Figures 4 through 8). Run-on controls in the south valley will be as described above. Run-on from areas outside the active disposal area in the north valley will either be collected and conveyed to the NASCP, or diverted around the pond by the NVDC&C. The areas collected will increase and the areas diverted will decrease as landfill development proceeds along the north valley. Stormwater from areas disturbed by landfill construction but not part of active disposal is conveyed to a sediment pond. The exterior slopes of the active disposal area will receive temporary cover and will be vegetated as disposal occurs, and stormwater from these areas will be directed by benches on the landfill face or by down chute channels to a perimeter collection channel that discharges to a sediment pond.

Run-on from areas within the active disposal area will be confined to the active disposal area by perimeter berms. The water will be collected by the leachate collection system to either the South Area Leachate Holding Basin (SALHB) (Sequences 1 through 3 and 9) or the North Area Leachate Holding Basin (NALHB) (Sequences 4 through 9).

3.2 Run-On Controls from Outside the Landfill Footprint

Grading for the landfill construction directs run-on from outside the Landfill footprint to perimeter collection channels along the exterior boundaries of the Landfill footprint. These channels discharge to one of the sediment ponds. Channel PCC-1 discharges to the Amos Plateau Pond, channels PCC-2 and PCC-3 discharge to the SASCP, and channel PCC-4 discharges to the 2-5 fill pond and then to the NASCP (see Figures 2 and 3). As Landfill development proceeds, proposed channels PCC-5 and PCC-6 will discharge to the proposed Northeast Sediment Pond (Figures 5 through 9), and proposed channels PCC-7 and PCC-8 will discharge to the NASCP (Figures 7 and 8).

4.0 Run-Off Controls

Run-off is defined by the CCR Rule as "any liquid that drains over land from any part of the CCR landfill." For the purposes of this Plan, stormwater and groundwater are the liquids of concern. This Section describes the existing and proposed run-off controls at the Amos Landfill under temporary and final cover conditions, and from active disposal areas.

Run-off controls are measures that prevent stormwater from exiting active disposal areas. Measures employed at the Amos Landfill as run-off controls include containment and perimeter berms, the leachate collection system, and leachate holding basins. Details of the RORO controls are presented on the 2017 SW/NPDES Permit Application Drawings 13-30500-21 through 25 (WVDEP, 2017). Design calculations for run-off controls are provided in Appendix D.

Run-on from areas within the active disposal area is confined to the active disposal area by perimeter berms and a containment berm. The water is collected and conveyed by the leachate collection system to either the SALHB for Sequences 1 through 3, or to the NALHB for Sequence 4 (see Figures 2 and 3).

4.1 Run-off Controls from Temporary and Final Cover

As landfill disposal occurs, the exterior perimeter soil berms on the face of Landfill are constructed and vegetated to prevent water from exiting the active disposal area, with 20-foot-wide benches installed at 20 vertical feet spacing (see Figures 2 and 8). The benches are constructed to drain to either a perimeter collection channel and then to a sediment pond, or first to a down chute (slope drain) that discharges to a perimeter collection channel (see Figure 1). The down chutes are extended up the face of the Landfill as the pile rises.

A minimum of 12 inches of vegetated soil covers the exterior face of the landfill under temporary cover conditions. When areas of the landfill undergo final cover, a Final Cover System is installed that consists of a geomembrane, a geocomposite drainage layer, and a minimum 18 inches of vegetated soil cover. Bench drain pipes are installed to supplement the geocomposite drainage layer and convey infiltrated water above the geomembrane to a perimeter collection channel.

Approximately 16.3 acres of the Final Cover System has been installed as of November 2019 in the south valley to an elevation of approximately 940 feet (North Atlantic Vertical Datum). As areas within the Landfill footprint reach final grade, the Final Cover System will be installed when appropriate in accordance with the WV SW/NPDES Permit (WVDEP, 2017).

4.2 Run-off Controls from Active Fill Areas

The active disposal area is graded to drain from the perimeter berms either to a temporary containment area at the toe of a sequence, or to chimney drains constructed of permeable bottom ash located above the sequence's leachate collection piping system (see Detail 9 on Drawing 13-30500-24 of the 2017 SW/NPDES Permit Re-Authorization). Contact water (leachate) enters leachate pipe inlets within the containment area, or percolates through the chimney drains to the leachate piping system and is then conveyed to either the SALHB (Sequences 1 through 3 and 9) or the NALHB (Sequences 4 through 9).

4.3 Leachate Collection and Management System

The leachate collection system consists of a series of chimney drains, pipe surface inlets, the geocomposite drainage net, and leachate collection pipes, all designed to collect and convey by gravity the contact water (leachate) from the disposal area to either the SALHB or the NALHB. Leachate in the holding basins is pumped back to the dewatering island (see Figure 2). The chimney drains are constructed as the landfill sequences are constructed. The leachate system is designed to limit the head of leachate on the liner system geomembrane to one-foot or less, in accordance with WVDEP Solid Waste regulations and 40 CFR 257 requirements. The leachate collection pipes within the leachate collection system for the landfill are shown on Figures 2-8.

4.4 Leachate Holding Basins

The SALHB and the NALHB receive the leachate collected by the leachate collection system. Each leachate holding basin has a pump station. The NALHB pump station pumps leachate from the NALHB to the sump of the SALHB, where both the NALHB leachate and the SALHB leachate are pumped to the dewatering facility. Both leachate holding basins are operational.

The leachate holding basins are designed in accordance with WVDEP Solid Waste and 40 CFR 257 requirements. Each leachate holding basin has the capacity to hold at least the 30 days leachate volume predicted from the contributory landfill area under the anticipated greatest anticipated landfill development area. The SALHB liner system consists of a leachate detection piping system, an 18-inch-thick, re-compacted clay soil layer, and a 40-mil high-density polyethylene (HDPE) geomembrane. The leachate detection system consists of a network of HDPE piping within an aggregate stone envelope, with a monitored outfall. An underdrain piping system is in-place beneath the leachate detection system to collect groundwater.

The NALHB has an underdrain system consisting of a geonet and piping; a 60-mil HDPE geomembrane; a leachate detection system consisting of a geonet and aggregate blanket drain with piping with a monitored outfall; a minimum 18-inch-thick re-compacted clay soil layer; and a 60-mil HDPE geomembrane.

5.0 Plan Review and Changes in Facility Configuration

The Landfill Owner and/or Operator has the responsibility under 40 CFR 257.81(c)(2) to review and evaluate this Plan every five years from the date of the initial plan preparation. The Owner/Operator may make administrative changes to the Plan at any time. This responsibility also applies when changes occur in facility design, construction, operation, and/or maintenance that materially affect the performance of the RORO control system of the Amos Landfill. For Plan revisions resulting from changes to facility design, construction, operation, and/or maintenance that could affect the performance of the RORO control system, the regulation requires that the revised Plan be reviewed and certified by a Professional Engineer (PE). Plan revisions by the Owner/Operator must be prepared within six months to incorporate the necessary revisions resulting from these changes.

A RORO Plan Amendment Log is provided in Appendix B to document amendments made to this Plan. The log shall include both the five-year reviews of the Plan and any additional revisions resulting from changes that could affect the performance of RORO control systems.

6.0 Professional Engineer Certification

The Plan, and all subsequent reviews and amended plans, must obtain certification from a qualified PE stating that the initial and subsequent RORO control system plans meet the requirements of 40 CFR 257. This certification in no way relieves the Owner or Operator of the Amos Landfill of his/her duty to fully implement this Plan. The PE Certification page is provided in Appendix C.

7.0 References

EPA, 2015. United States Environmental Protection Agency (USEPA) 40 CFR Part 257 *Criteria for Classification of Solid Waste Disposal Facilities and Practices*.

GAI, 2006. Solid Waste/NPDES Permit Application for the John E. Amos Landfill, March 2006.

GAI, 2007. 2007 Site Work Construction for the John E. Amos Landfill, June 2007 (Sequence 1A-1).

GAI, 2007a. 2008-2010 Site Work Construction for the John E. Amos Landfill, November 2007, (Sequences 1A, 1B, & 2).

GAI, 2011. 2011 Site Work Construction for the John E. Amos Landfill, October 2010 (Sequences 2A & 2B).

GAI, 2013a. 2012-2013 Site Work Construction for the John E. Amos Landfill, December 2010 (Sequence 3).

GAI, 2013b. Solid Waste/NPDES Permit Application (Amendment) for the John E. Amos Landfill, South Area Sediment Collection Pond Modifications.

GAI, 2013c. 2014-2015 Site Work Construction for the John E. Amos Landfill, December 2013 (sequence 3 revisions).

GAI, 2014. Solid Waste/NPDES Permit Application (Amendment) for the John E. Amos Landfill, February 2014 (North Pond Complex).

GAI, 2015. 2015-2017 Site Work Construction for the John E. Amos Landfill, April 2015. (North Pond Complex).

GAI, 2016. Drawings prepared for the 2017 Solid Waste/NPDES Permit Application/Re-Authorization.

WVDEP, 2008. Permit Authorization for the John E. Amos FGD Landfill.

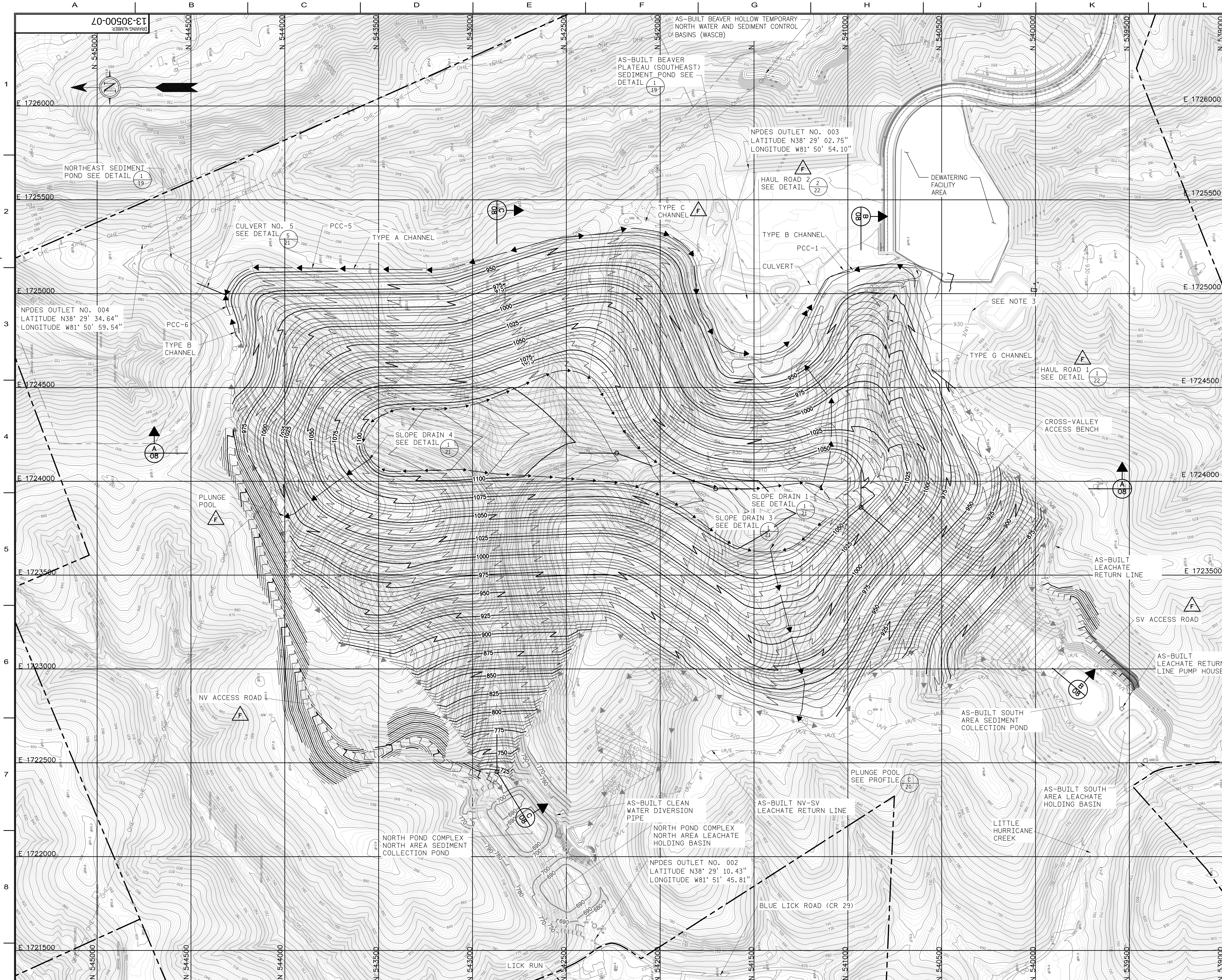
WVDEP, 2011. Permit Amendment Authorization for John E. Amos Landfill (subgrade slope modification).

WVDEP, 2012. Permit Re-Authorization for the John E. Amos FGD Landfill.

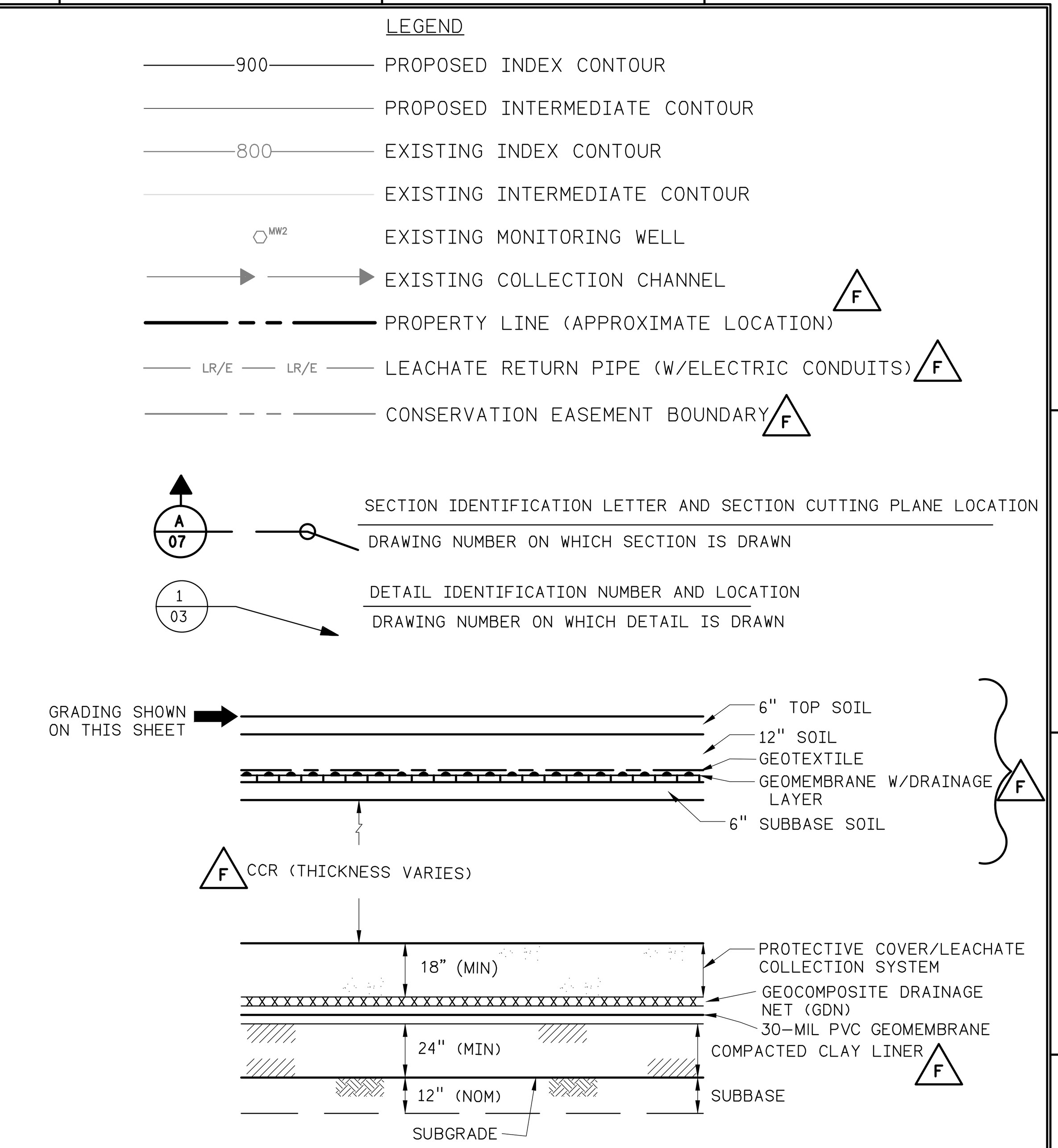
WVDEP, 2015. Permit Amendment Authorization for John E. Amos Landfill (North Pond Complex).

WVDEP, 2017. Permit Re-Authorization for the John E. Amos FGD Landfill.

APPENDIX A
Figures



NPDES OUTLET NO. 001
LATITUDE N38° 28' 41.63"
LONGITUDE W81° 51' 33.88"



SEQUENCE	LINER AREA (ACRES) (APPROX.)	CCB DISPOSAL VOLUME (CUBIC YARDS)
1	34.1	2,400,000
2	22.7	3,000,000
3	14.6	4,682,000
4	28.7 F	3,781,000 F
5	12.3 F	1,353,000 F
6	39.4 F	3,035,000 F
7	5.0 F	2,792,000 F
8	23.5 F	3,630,000 F
9	11.6 F	12,098,000 F
TOTAL	191.9 F	36,771,000 F

NOTES:

1. SEE DETAIL 1/08 FOR TYPICAL FINAL LANDFILL GEOMETRY.
2. SEE EROSION AND SEDIMENT CONTROL PLAN DRAWING 13-30500-17 FOR TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES. AS-BUILT EROSION AND SEDIMENT CONTROL MEASURES ARE SHOWN ON DRAWING 13-30201-02-04.
3. THE SOUTH VALLEY LEACHATE RETURN PIPE TERMINATES AT THE DEWATERING FACILITY. THE LEACHATE IS THEN CONVEYED BY PIPE TO THE JOHN E. AMOS PLANT FOR TREATMENT OR RE-USE. THE NORTH VALLEY TO SOUTH VALLEY LEACHATE LINE TERMINATES AT THE SOUTH VALLEY PUMP STATION.
4. THE LINER AREAS IN THE TABLE ABOVE REPRESENT THE PLAN FOOTPRINT OF THE SEQUENCES, AND DO NOT INCLUDE ADDITIONAL LINER REQUIRED FOR ANCHOR TRENCHES, OVERLAPS BETWEEN SEQUENCES, OR WASTE MATERIAL FROM INSTALLATION.

DATE	NO.	DESCRIPTION	APPD.
12/07/16	F	PERMIT RENEWAL/CCR REGULATIONS, REVISED FINAL LANDFILL GRADES	
9/28/12	E	REVISED SEQUENCE 3B PERIMETER TIE-IN BASED ON REVISED 3H:1V SUBGRADE	GFB
10/10/11	D	ADDED AS-BUILT FEATURES AND TOPOGRAPHY, REVISED DISPOSAL VOLUME TABLE, AND MISC. REVISIONS	MRL
7/1/10	C	UPDATE PER 2010 (6/22/10) CONSTRUCTION PACKAGE	MRL
10/25/06	B	NPDES OUTLET NOS. 001, 002, 003, AND 004 IDENTIFIED ON DRAWING, INCLUDING LATITUDE AND LONGITUDE.	GFB
3/13/06	A	ISSUED FOR PERMIT	MRL

REVISIONS

THIS DRAWING IS CLASSIFIED AS:

REFERENCE AEP's CORPORATE INFORMATION SECURITY POLICY

FIGURE 1

APPALACHIAN POWER CO.

JOHN E. AMOS PLANT

WINFIELD WEST VIRGINIA

JOHN E. AMOS LANDFILL

FINAL LANDFILL GRADES

UNIT: DRAWING NUMBER: 13-30500-07 REV: F

SCALE: AS NOTED
DR: EJM
CH: RH
SUP:
ENG:
DATE: 03/13/2006
APPROVED BY

SCALE 1"=200'
200 0 200 400

gai consultants

AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

PLOT DATE: 20-Nov-2019
PLOT TIME: 08:24 AM
BY: Ed Mayhood

CROSS REFS:

MAP REFERENCES:

TOPOGRAPHIC MAPPING COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY EXPOSED 04/05/05. MAPPING PREPARED BY HENDERSON AERIAL SURVEYS INC., GROVE CITY, OHIO, IN JULY 2005.

THE HORIZONTAL DATUM IS THE NORTH AMERICAN DATUM OF 1983 (NAD 83), WEST VIRGINIA SOUTH, AND THE VERTICAL DATUM IS THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

SOUTH SEDIMENT COLLECTION POND AS-BUILT TOPOGRAPHY OBTAINED FROM AEP FILE 2007-OCT_BLUELICK_PONDS_ASBUILT.DWG VIA EMAIL ON 08/10/2011.

SOUTH LEACHATE HOLDING BASIN AS-BUILT OBTAINED FROM AEP FILE BLUELICK_QTYS_2007-11.DWG VIA EMAIL ON 08/10/2011.

BEAVER PLATEAU POND AS-BUILT OBTAINED FROM AEP FILES BEAVER POND FINAL TOPO-GREG.DWG VIA EMAIL ON 08/04/2011 AND BEAVER POND SPILLWAYS VIA EMAIL ON 08/23/2011, FILES BEAVER POND SPILLWAY BLOCK.DWG AND PIPE EX.DWG

AMOS AS-BUILT CONTOURS OBTAINED FROM AEP FILE "AMOS AS-BUILT" MARCH 29, 2016.DWG VIA EMAIL ON 6/22/2016.

SV ACCESS ROAD LAYOUT OBTAINED FROM GAI DRAWING C130109-03-006-C-WS-002-PLAN.DWG

NV ACCESS ROAD LAYOUT OBTAINED FROM GAI DRAWING C130109-03-001-C-WS-151.DWG

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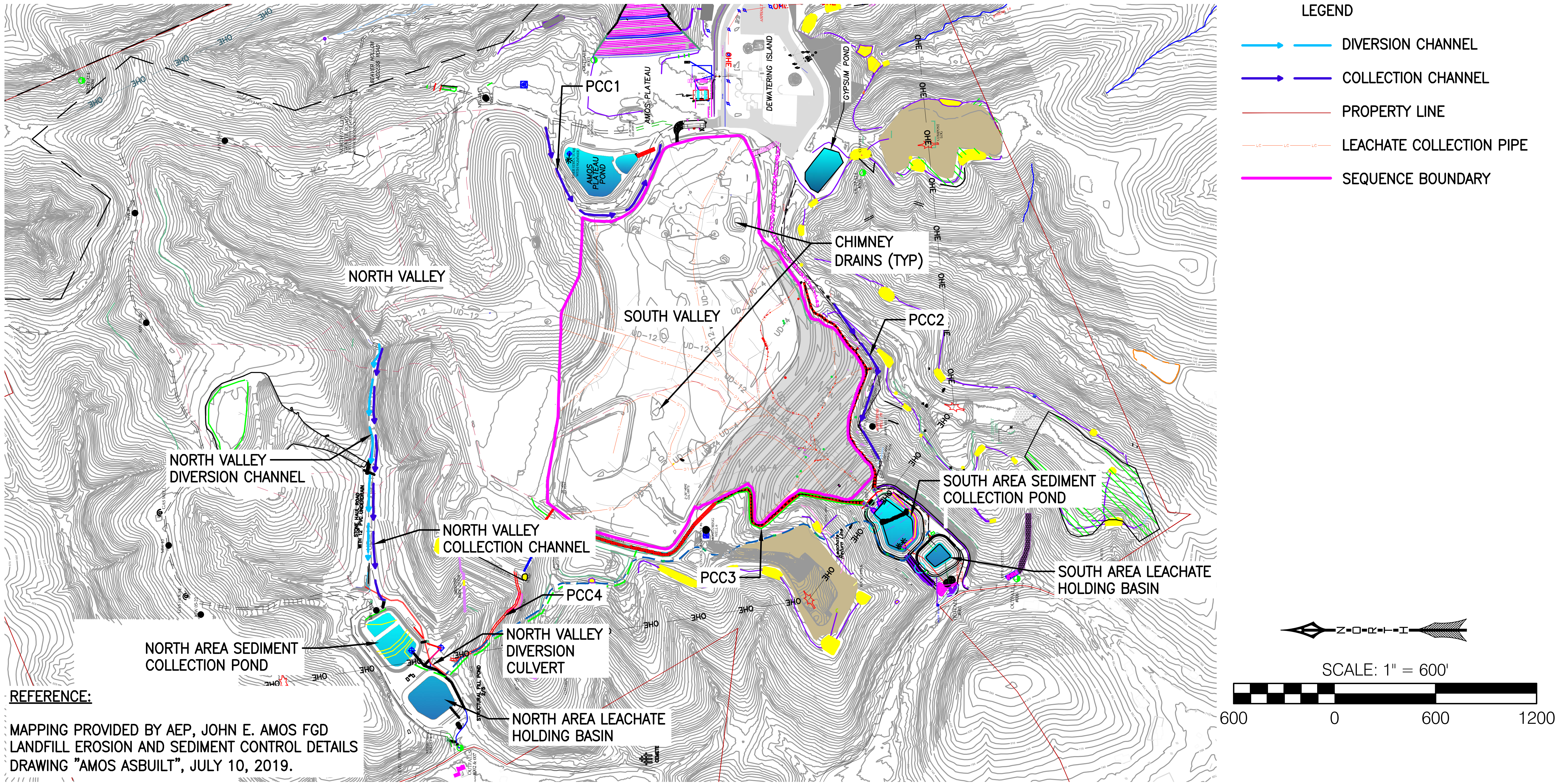

REFERENCE:

MAPPING PROVIDED BY AEP, JOHN E. AMOS FGD LANDFILL EROSION AND SEDIMENT CONTROL DETAILS DRAWING "AMOS ASBUILT", JULY 10, 2019.

NO.:	DATE:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DESCRIPTION:

REVISION RECORD

DRAWING TITLE: **FIGURE 2 - SOUTH VALLEY DISPOSAL CONDITIONS**

PROJECT: **JOHN E. AMOS LANDFILL**
RUN-ON RUN-OFF PLAN

gai consultants

CLIENT: **APPALACHIAN POWER COMPANY**
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

ISSUE DATE: **12/04/2019**
DRAWN BY: **EMAYHOOD**
SCALE: **AS SHOWN**
CHECKED BY: **KFRECH**
APPROVED BY:
REVISION
SHEET NO.: **1** OF **1**

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GAI FILE NUMBER: **C130109-10-003-00-B2-010**

GAI DRAWING NUMBER: **B2-010**

GAI CAD FILE PATH: Z:\Energy\2013\C130109.10 – AEP Seq 4 2018–2020 QAQC\CAD\Production DWGs\C130109-10-003-00-B2-010.dwg

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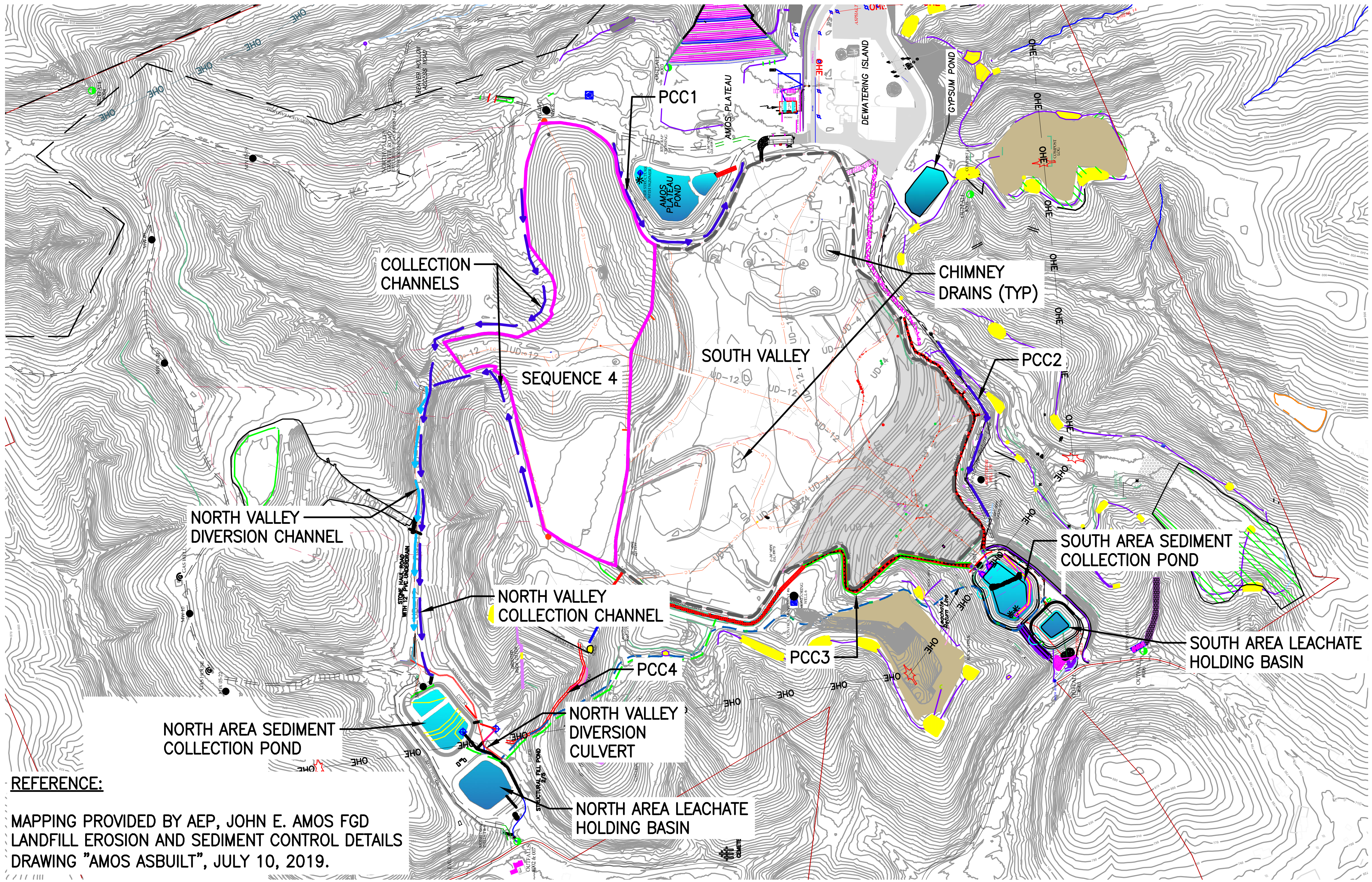

REFERENCE:

MAPPING PROVIDED BY AEP, JOHN E. AMOS FGD LANDFILL EROSION AND SEDIMENT CONTROL DETAILS DRAWING "AMOS ASBUILT", JULY 10, 2019.

LEGEND

- DIVERSION CHANNEL
- COLLECTION CHANNEL
- PROPERTY LINE
- LEACHATE COLLECTION PIPE
- SEQUENCE BOUNDARY

NORTH

SCALE: 1" = 600'

600 0 600 1200

PLOTTED ON: 12/3/2019 9:40:40 AM PLOTTED BY: Ed Mayhood PLOT FILE: GAI.stb

NO.:	DATE:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DESCRIPTION:

REVISION RECORD

DRAWING TITLE

FIGURE 3 - SEQUENCE 4 DISPOSAL CONDITIONS

PROJECT: **JOHN E. AMOS LANDFILL**

RUN-ON RUN-OFF PLAN

gai consultants

CLIENT: **APPALACHIAN POWER COMPANY**

1 RIVERSIDE PLAZA

COLUMBUS, OHIO

ISSUE DATE: **12/04/2019**

DRAWN BY: **EMAYHOOD**

SCALE: **AS SHOWN**

CHECKED BY: **KFRECH**

REVISION

APPROVED BY:

SHEET NO.: **1** OF **1**

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GAI DRAWING NUMBER: **B2-011**

ISSUING OFFICE: Murrysville | 4200 Triangle Lane, Export, PA 15632-1358

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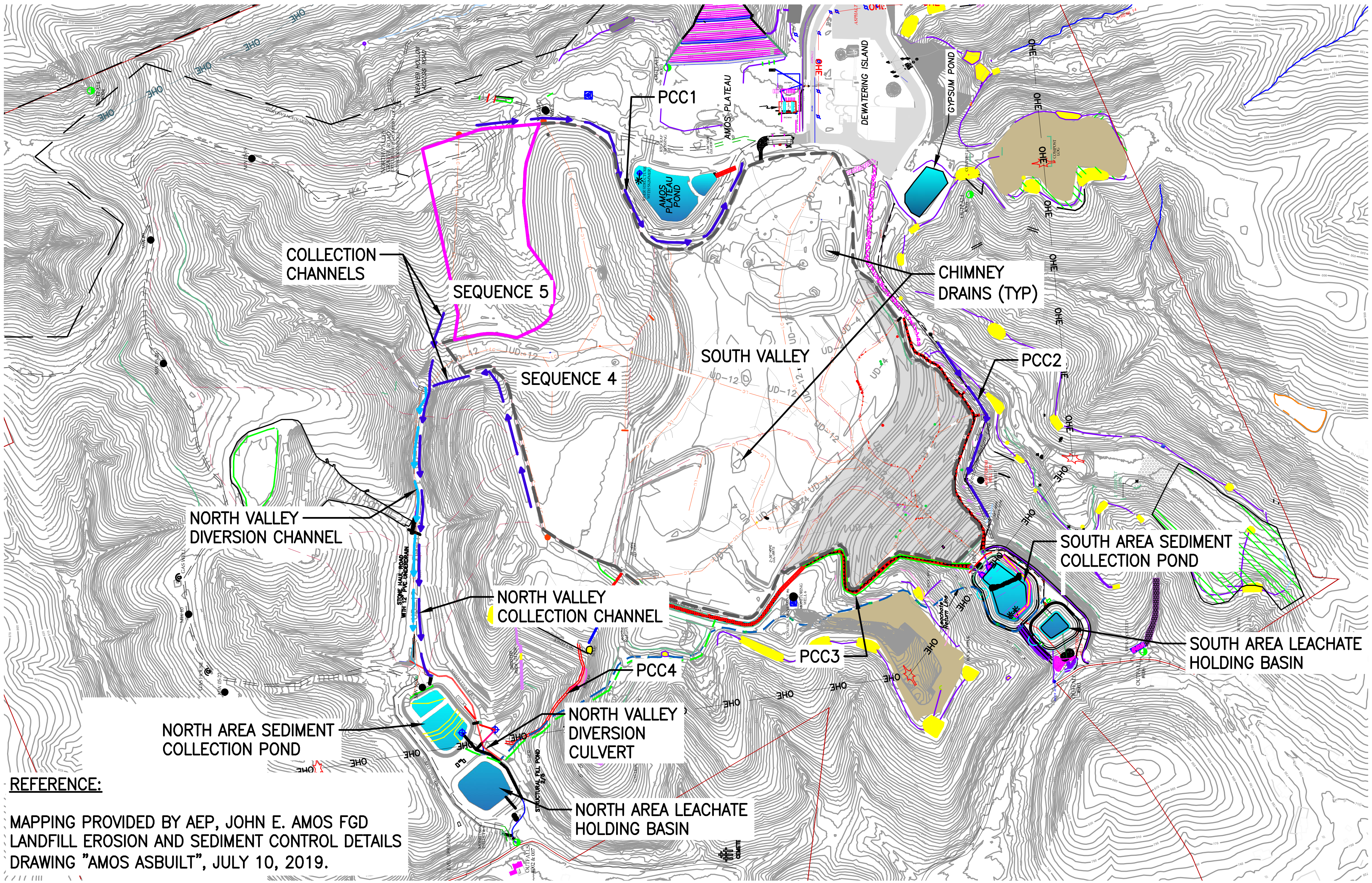

REFERENCE:

MAPPING PROVIDED BY AEP, JOHN E. AMOS FGD LANDFILL EROSION AND SEDIMENT CONTROL DETAILS DRAWING "AMOS ASBUILT", JULY 10, 2019.

LEGEND

- DIVERSION CHANNEL
- COLLECTION CHANNEL
- PROPERTY LINE
- LEACHATE COLLECTION PIPE
- SEQUENCE BOUNDARY

NORTH

SCALE: 1" = 600'

600 0 600 1200

NO.:	DATE:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DESCRIPTION:

REVISION RECORD

DRAWING TITLE: **FIGURE 4 - SEQUENCE 5 DISPOSAL CONDITIONS**

PROJECT: **JOHN E. AMOS LANDFILL**
RUN-ON RUN-OFF PLAN

gai consultants

CLIENT: **APPALACHIAN POWER COMPANY**
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

ISSUE DATE: **12/04/2019**
DRAWN BY: **EMAYHOOD**
SCALE: **AS SHOWN**
CHECKED BY: **KFRECH**
APPROVED BY:
REVISION
SHEET NO.: **1** OF **1**

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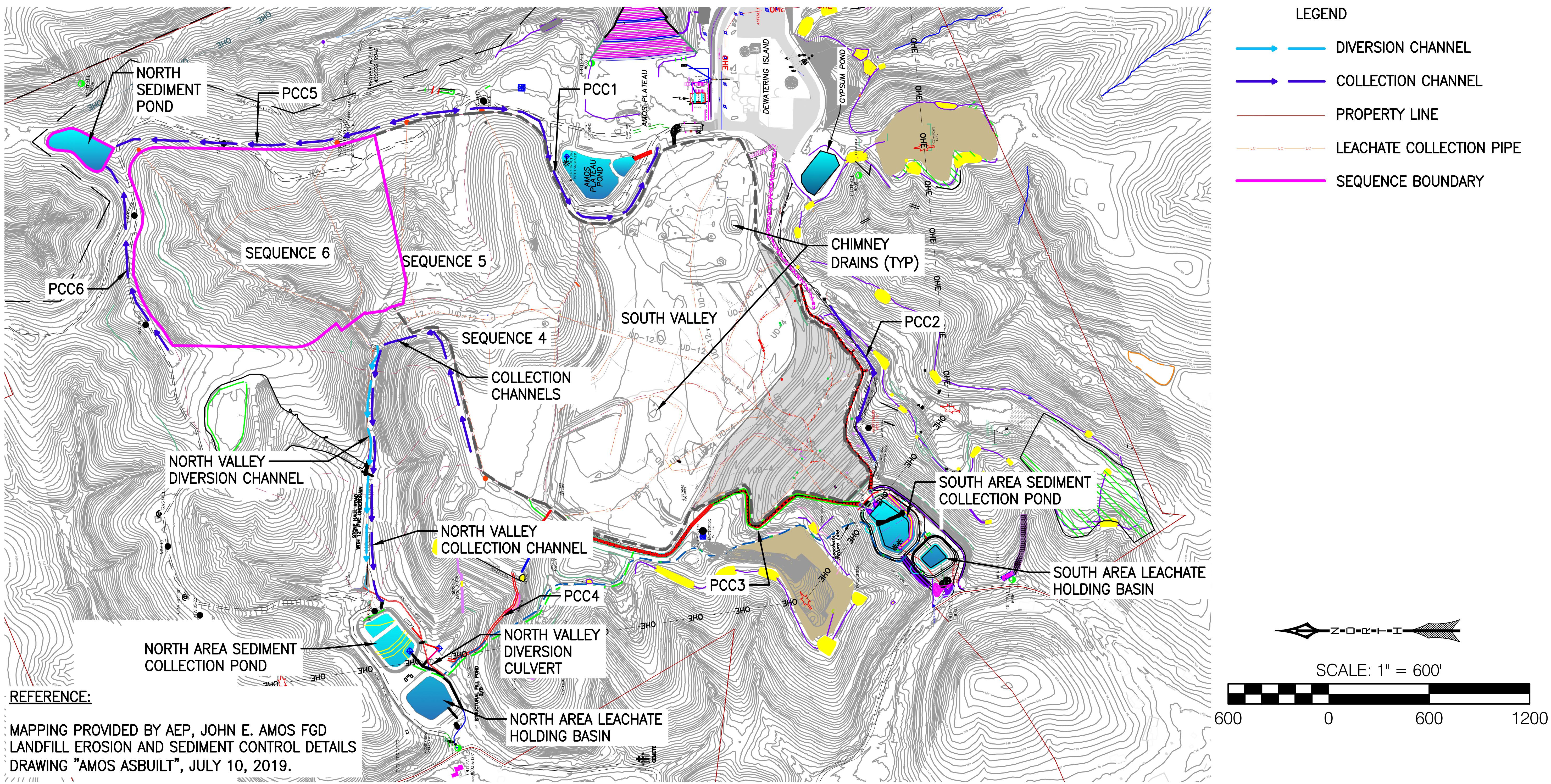
ISSUING OFFICE: Murrysville | 4200 Triangle Lane, Export, PA 15632-1358

GAI FILE NUMBER: **C130109-10-003-00-B2-012**

GAI DRAWING NUMBER: **B2-012**

GAI CAD FILE PATH: Z:\Energy\2013\C130109.10 – AEP Seq 4 2018–2020 QAQC\CAD\Production DWGs\C130109-10-003-00-B2-012.dwg

PLOTTED ON: 12/3/2019 9:39:13 AM PLOTTED BY: Ed Mayhood PLOT FILE: GAI.stb



NO.:	DATE:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DESCRIPTION:

REVISION RECORD

DRAWING TITLE				
FIGURE 5 - SEQUENCE 6 DISPOSAL CONDITIONS			ISSUE DATE: 12/04/2019	DRAWN BY: EMAYHOOD
PROJECT: JOHN E. AMOS LANDFILL RUN-ON RUN-OFF PLAN	gai consultants	CLIENT: APPALACHIAN POWER COMPANY 1 RIVERSIDE PLAZA COLUMBUS, OHIO	SCALE: AS SHOWN	CHECKED BY: KFRECH
			REVISION	APPROVED BY:
				SHEET NO.: 1 OF 1
GAI FILE NUMBER: C130109-10-003-00-B2-013		GAI DRAWING NUMBER: B2-013		

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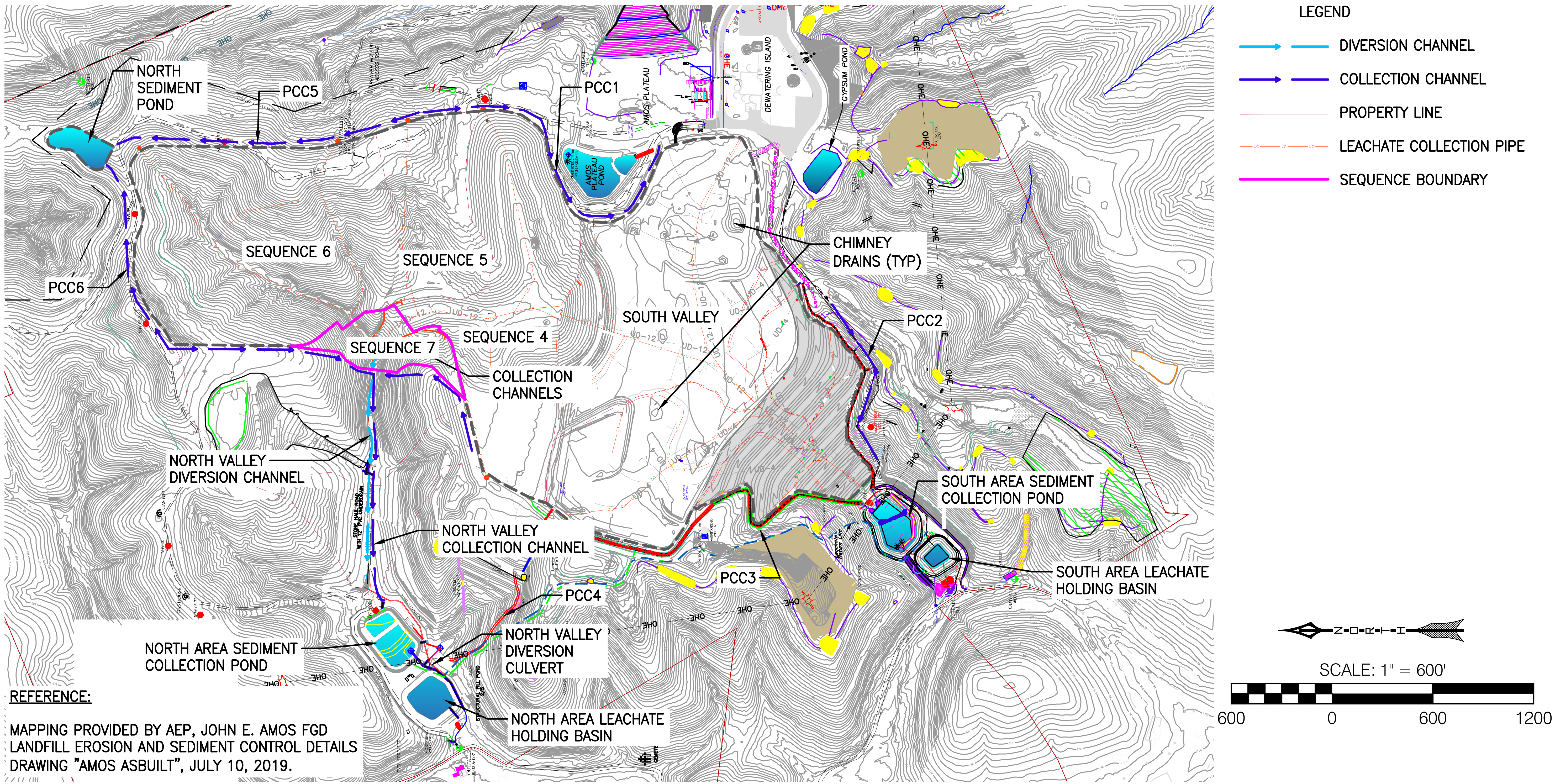
ISSUING OFFICE: Murrysville | 4200 Triangle Lane, Export, PA 15632-1358

GAI CAD FILE PATH: Z:\Energy\2013\C130109.10 – AEP Seq 4 2018–2020 QAQC\CAD\Production DWGs\C130109-10-003-00-B2-013.dwg

PLOTTED ON: 12/3/2019 9:38:40 AM PLOTTED BY: Ed Mayhood PLOT FILE: GAI.stb



REFERENCE:

MAPPING PROVIDED BY AEP, JOHN E. AMOS FGD LANDFILL EROSION AND SEDIMENT CONTROL DETAILS DRAWING "AMOS ASBUILT", JULY 10, 2019.

NO.:	DATE:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DESCRIPTION:

REVISION RECORD

DRAWING TITLE: **FIGURE 6 - SEQUENCE 7 DISPOSAL CONDITIONS**

PROJECT: **JOHN E. AMOS LANDFILL**
RUN-ON RUN-OFF PLAN

gai consultants

CLIENT: **APPALACHIAN POWER COMPANY**
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

ISSUE DATE: **12/04/2019**
DRAWN BY: **EMAYHOOD**
SCALE: **AS SHOWN**
CHECKED BY: **KFRECH**
APPROVED BY:
REVISION
SHEET NO.: **1** OF **1**

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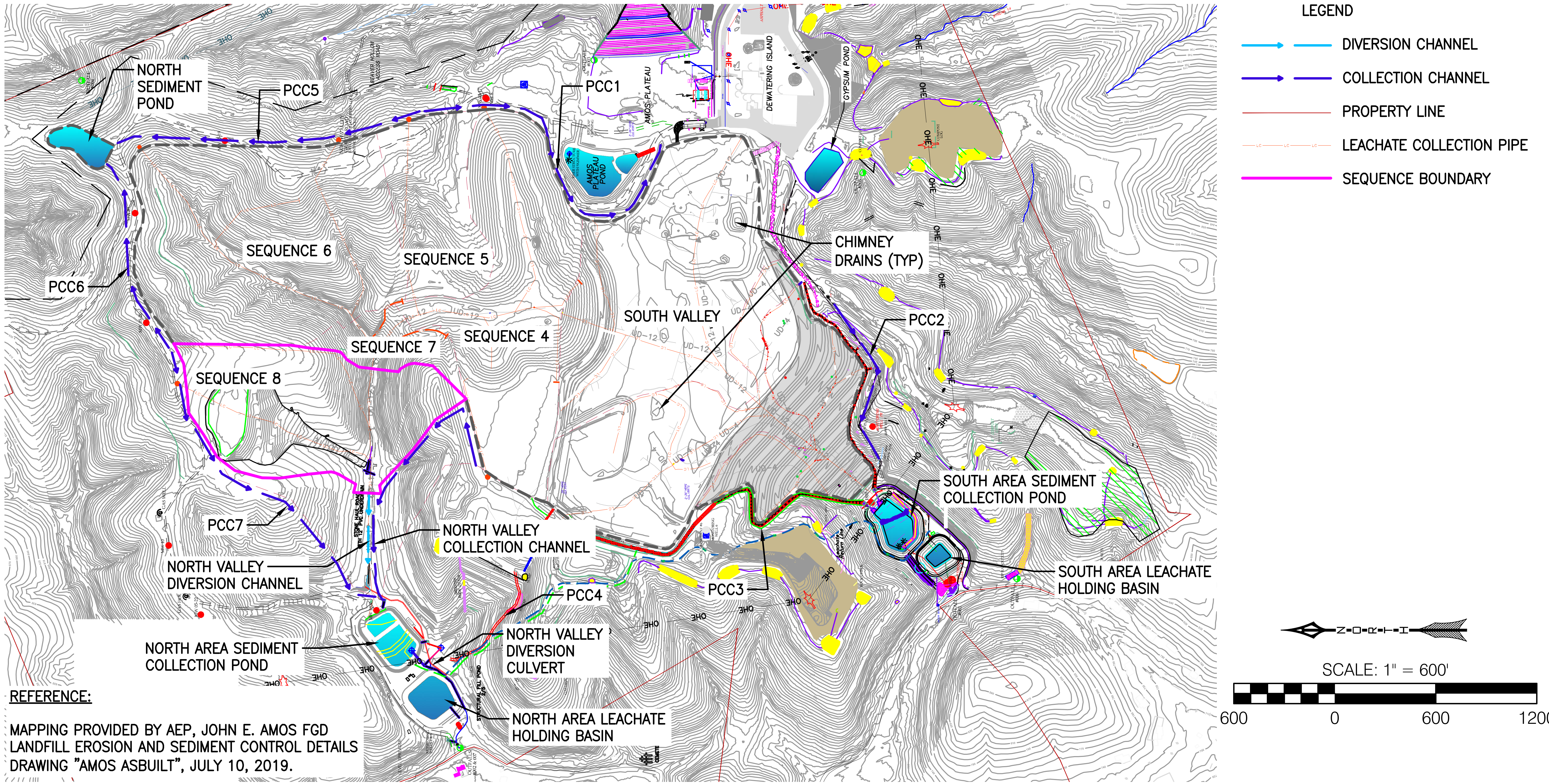
ISSUING OFFICE: Murrysville | 4200 Triangle Lane, Export, PA 15632-1358

GAI FILE NUMBER: **C130109-10-003-00-B2-014**

GAI DRAWING NUMBER: **B2-014**

GAI CAD FILE PATH: Z:\Energy\2013\C130109.10 – AEP Seq 4 2018–2020 QAQC\CAD\Production DWGs\C130109-10-003-00-B2-014.dwg

PLOTTED ON: 12/3/2019 9:38:01 AM PLOTTED BY: Ed Mayhood PLOT FILE: GAI.stb



REFERENCE:

MAPPING PROVIDED BY AEP, JOHN E. AMOS FGD LANDFILL EROSION AND SEDIMENT CONTROL DETAILS DRAWING "AMOS ASBUILT", JULY 10, 2019.

NO.:	DATE:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DESCRIPTION:

REVISION RECORD

DRAWING TITLE

FIGURE 7 - SEQUENCE 8 DISPOSAL CONDITIONS

PROJECT: **JOHN E. AMOS LANDFILL**

RUN-ON RUN-OFF PLAN

gai consultants

CLIENT: **APPALACHIAN POWER COMPANY**

1 RIVERSIDE PLAZA

COLUMBUS, OHIO

ISSUE DATE: **12/04/2019**

DRAWN BY: **EMAYHOOD**

SCALE: **AS SHOWN**

CHECKED BY: **KFRECH**

APPROVED BY:

REVISION

SHEET NO.: **1** OF **1**

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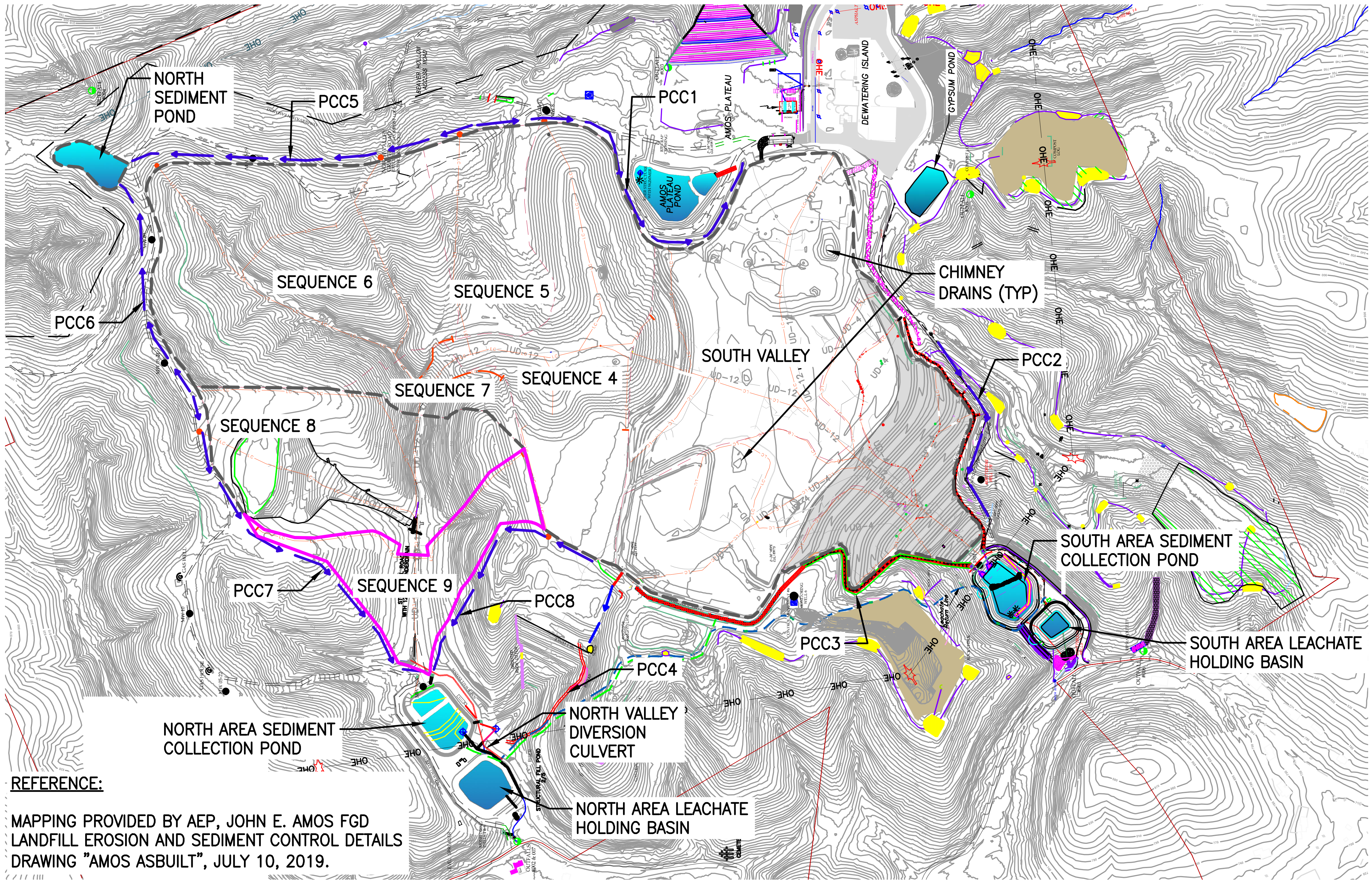
ISSUING OFFICE: Murrysville | 4200 Triangle Lane, Export, PA 15632-1358

GAI FILE NUMBER: **C130109-10-003-00-B2-015**

GAI DRAWING NUMBER: **B2-015**

GAI CAD FILE PATH: Z:\Energy\2013\C130109.10 – AEP Seq 4 2018–2020 QAQC\CAD\Production DWGs\C130109-10-003-00-B2-015.dwg

PLOTTED ON: 12/3/2019 9:37:27 AM PLOTTED BY: Ed Mayhood PLOT FILE: GAI.stb



LEGEND

- DIVERSION CHANNEL
- COLLECTION CHANNEL
- PROPERTY LINE
- LEACHATE COLLECTION PIPE
- SEQUENCE BOUNDARY

NORTH

SCALE: 1" = 600'

600 0 600 1200

REFERENCE:

MAPPING PROVIDED BY AEP, JOHN E. AMOS FGD LANDFILL EROSION AND SEDIMENT CONTROL DETAILS DRAWING "AMOS ASBUILT", JULY 10, 2019.

NO.:	DATE:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DESCRIPTION:

REVISION RECORD

DRAWING TITLE
FIGURE 8 - SEQUENCE 9 DISPOSAL CONDITIONS

PROJECT
JOHN E. AMOS LANDFILL
RUN-ON RUN-OFF PLAN

gai consultants

CLIENT
APPALACHIAN POWER COMPANY
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

ISSUE DATE:	DRAWN BY:
12/04/2019	**EMAYHOOD**
SCALE:	CHECKED BY:
AS SHOWN	**KFRECH**
REVISION	APPROVED BY:
	SHEET NO.: 1 OF 1

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ISSUING OFFICE: Murrysville | 4200 Triangle Lane, Export, PA 15632-1358

GAI FILE NUMBER: **C130109-10-003-00-B2-016**

GAI DRAWING NUMBER: **B2-016**

GAI CAD FILE PATH: Z:\Energy\2013\C130109.10 – AEP Seq 4 2018–2020 QAQC\CAD\Production DWGs\C130109-10-003-00-B2-016.dwg

PLOTTED ON: 12/3/2019 9:52:33 AM PLOTTED BY: Ed Mayhood PLOT FILE: GAI.stb

APPENDIX B
Run-On and Run-Off Plan Amendment Log

Run-On and Run-Off Plan Amendment Log

By	Date	Amendment Description	PE Certification Required?	PE Name	Licensing State: Registration No.
GAI Consultants, Inc.	2-16-2016	Initial Plan	Yes	Kerry Frech	WV 013895
GAI Consultants, Inc.	9-20-2016	Added Appendix D	Yes	Kerry Frech	WV 013895
GAI Consultants, Inc.	12/04/2019	Updated for Landfill development	Yes	Kerry Frech	WV 013895

APPENDIX C
Professional Engineer Certification

Professional Engineer Certification

The Run-on Run-off System Control System Plan for the John E. Amos FGD Landfill was prepared by GAI Consultants (GAI). This Certification/Statement of Professional Opinion is limited to the information available to GAI at the time the Plan was written. On the basis of and subject to the foregoing, it is my professional opinion as a Professional Engineer licensed in the State of West Virginia, that the Plan has been prepared in accordance with good and accepted engineering practices as exercised by other engineers practicing in the same discipline(s), under similar circumstances and at the time and in the same locale. It is my professional opinion that the Plan was prepared consistent with the requirements of the United States Environmental Protection Agency's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," published in the Federal Register on April 17, 2015 with an effective date of October 19, 2015 and meets the requirements of Part 257.81.

The use of the words "certification" and/or "certify" in this document shall be interpreted and construed as a Statement of Professional Opinion, and is not and shall not be interpreted or construed as a guarantee, warranty or legal opinion. This certification in no way relieves the Owner or Operator of the facility of his/her duty to fully implement this Plan

Engineer: ______________________________ 4Dec2019

KERRY L. FRECH
REGISTERED
13895
STATE OF
WEST VIRGINIA
PROFESSIONAL ENGINEER

APPENDIX D
Run-On and Run-Off Control Calculations

Purpose:
To determine the composite CN for each channel and culvert.

page D1

Method:
Refer to worksheets 1, 2 and 3 for drainage areas, time of concentration and pile layout respectively.

Calculations:

Land Cover Type	CN
Wooded	70
Reclaimed benches and slopes	72
Haul Roads (aggregate)	90
Disturbed	90

Composite CN

	Land Cover						
ID	Wooded, AC	Reclaimed Benches and Slopes, AC	Haul Roads, AC	Disturbed, AC	Sum of Drainage Area, AC	Composite CN[1]	
PCC-1	0	32.4	1	0	33.4	72.5	see sheets D26 - D31
PCC-2	8.2	18.8	4.1	0	31.1	73.8	
PCC-3	5	76.3	0.2	0	81.5	71.9	
PCC-4	5	8.8	0	0	13.8	71.3	
PCC-5	0	3.5	0	0	3.5	72.0	
PCC-6	0.9	15.3	0	0	16.2	71.9	
PCC-7	6.7	45.1	4.5	0	56.3	73.2	
PCC-8	3.7	12.5	0	0	16.2	71.5	
Slope Drain 1	0	32.4	0	0	32.4	72.0	see sheets D26 - D31
Slope Drain 2	0	18.6	0	0	18.6	72.0	
Slope Drain 3	0	74.1	0	0	74.1	72.0	see sheets D26 - D31
Slope Drain 4	0	31	0	0	31	72.0	
HRC-1	0	0	1	0	1	90.0	see sheets D26 - D31
HRC-2	0	0	1.7	0	1.7	90.0	
HRC-3	0	0	1.8	0	1.8	90.0	
HRC-4	0	1.7	3.9	0	5.6	84.5	
HRC-5	0	0	4.5	0	4.5	90.0	

see sheets D35-D47 for Culvert 1

ID	Wooded, AC	Reclaimed Benches and Slopes, AC	Haul Roads, AC	Disturbed, AC	Sum of Drainage Area, AC	Composite CN[1]	Flow From
Culvert 1	0	32.4	2	0	34.4	73.0	PCC-1, HRC-1
Culvert 2	0	32.4	3.7	0	36.1	73.8	PCC-1, HRC-1, HRC-2
Culvert 3	0	18.6	1.8	0	20.4	73.6	Slope Drain 2, HRC-3
Culvert 4	0	1.7	3.9	0	5.6	84.5	HRC-4
Culvert 5	0.9	18.8	0	0	19.7	71.9	PCC-5, PCC-6
Culvert 6	0.4	31	4.5	0	35.9	74.2	Slope Drain 4, HRC-5
Culvert 7	8.2	18.8	4.1	0	31.1	73.8	PCC-2
Culvert 8	5	76.3	0.2	0	81.5	71.9	PCC-3
Culvert 9	3.7	12.5	0	0	16.2	71.5	PCC-8
Culvert 10	6.7	45.1	4.5	0	56.3	73.2	PCC-7

1) Composite CN = $(Area_1 \times CN_1 + Area_2 \times CN_2 \ldots)/(\text{Sum of Area})$

Purpose:
To determine the time of concentration to collection and diversion channels.

page D2

Method:
1) Refer to worksheets 1, 2 and 3 for drainage areas, time of concentration and pile layout respectively.
2) Initially the channel flow velocity will be assumed.
3) Once a channel size is determined the velocity will be verified using VTPSUHM.
The TOC will be adjusted if necessary based on the velocity.

Sheet Flow

Design Channel	Segment ID	Surface Description	n	Flow Length	2-yr, 24-hr rainfall	Land Slope, s	T_t	
PCC-1	A-B	Grass	0.15	54	2.65	0.33	0.036	see sheets D26 - D31
PCC-2	F-G	Grass	0.15	63	2.65	0.02	0.124	
PCC-3	K-L	Grass	0.15	63	2.65	0.33	0.040	
PCC-4	P-Q	Grass	0.15	63	2.65	0.33	0.040	
PCC-5	BH-BI	Grass	0.15	63	2.65	0.3	0.042	
PCC-6	BD-BE	Grass	0.15	63	2.65	0.33	0.040	
PCC-7	X-Y	Grass	0.15	20	2.65	0.02	0.050	
PCC-8	T-U	Grass	0.15	92	2.65	0.33	0.055	
HRC-1	1-2	Grass	0.15	54	2.65	0.33	0.036	see sheets D26 - D31
HRC-2	3-4	Grass	0.15	10	2.65	0.33	0.009	
HRC-3	3-4	Grass	0.15	10	2.65	0.33	0.009	
HRC-4	7-8	Grass	0.15	89	2.65	0.02	0.163	
HRC-5	10-11	Grass	0.15	48	2.65	0.02	0.100	
Slope Drain 1	A-B	Grass	0.15	54	2.65	0.33	0.036	see sheets D26 - D31
Slope Drain 2	F-G	Grass	0.15	63	2.65	0.02	0.124	
Slope Drain 3	K-L	Grass	0.15	63	2.65	0.02	0.124	see sheets D26 - D31
Slope Drain 4	X-Y	Grass	0.15	20	2.65	0.02	0.050	see sheets D26 - D31

Channel Flow

Design Channel	Segment ID	Description	Channel Slope, s	n	V, fps	Flow Length	T_t	
PCC-1	B-C	Bench	0.015	0.045	2	2943	0.409	
PCC-1	C-D	Slope Drain 1	0.33	0.025	25	233	0.003	see sheets D26 - D31
PCC-1	D-E	PCC-1	0.01	0.025	5	297	0.017	
PCC-2	G-H	Bench	0.015	0.045	2	2915	0.405	
PCC-2	H-I	Slope Drain 2	0.33	0.025	25	432	0.005	
PCC-2	I-J	PCC-2	0.4	0.025	22	1779	0.022	
PCC-3	L-M	Bench	0.015	0.045	2	3761	0.522	
PCC-3	M-N	Slope Drain 3	0.33	0.025	25	499	0.006	
PCC-3	N-O	PCC-3	0.2	0.025	21	1823	0.024	
PCC-4	Q-R	Bench	0.015	0.045	2	1739	0.242	
PCC-4	R-S	PCC-4	0.25	0.025	16	933	0.016	
PCC-5	BI-BJ	Bench	0.015	0.045	2	458	0.064	
PCC-5	BJ-BG	PCC-5	0.02	0.025	4	1058	0.073	
PCC-6	BE-BF	Bench	0.015	0.045	2	1207	0.168	
PCC-6	BF-BG	PCC-6	0.01	0.025	4	1150	0.080	
PCC-7	Y-Z	Bench	0.015	0.045	2	2134	0.296	
PCC-7	Z-BA	Slope Drain 4	0.33	0.025	25	342	0.004	
PCC-7	BA-BB	PCC-7	0.01	0.025	6	1629	0.075	
PCC-7	BB-BC	PCC-7	0.33	0.025	21	731	0.010	

Design Channel	Segment ID	Description	Channel Slope, s	n	V, fps	Flow Length	T_t
PCC-8	U-V	Bench	0.015	0.045	2	1044	0.145
PCC-8	V-W	PCC-8	0.33	0.025	19	933	0.014
HRC-1	2-E	HRC-1	0.1	0.035	7	517	0.021
HRC-3	4-5	HRC-3	0.1	0.035	7	966	0.038
HRC-2	4-5	HRC-3	0.1	0.035	7	966	0.038
HRC-2	5-6	HRC-2	0.035	0.035	4	509	0.035
HRC-4	8-9	HRC-4	0.1	0.035	7	1708	0.068
HRC-5	11-12	HRC-5	0.1	0.035	7	2595	0.103
Slope Drain 1	B-C	Bench	0.015	0.045	2	6545	0.909
Slope Drain 1	C-D	Slope Drain 1	0.02 min/ 0.33 max	0.025	25	233	0.003
Slope Drain 2	G-H	Bench	0.015	0.045	2	2915	0.405
Slope Drain 2	H-I	Slope Drain 2	0.02 min/ 0.33 max	0.025	25	432	0.005
Slope Drain 3	L-M	Bench	0.015	0.045	2	3761	0.522
Slope Drain 3	M-N	Slope Drain 3	0.02 min/ 0.33 max	0.025	25	499	0.006
Slope Drain 4	Y-Z	Bench	0.015	0.045	2	2134	0.296
Slope Drain 4	Z-BA	Slope Drain 4	0.02 min/ 0.33 max	0.025	25	342	0.004

see sheets D26 - D31

see sheets D26 - D31

see sheets D26 - D31

see sheets D26 - D31

T.O.C. Summary

Segment ID	T.O.C.
PCC-1	0.46
PCC-2	0.56
PCC-3	0.59
PCC-4	0.30
PCC-5	0.18
PCC-6	0.29
PCC-7	0.43
PCC-8	0.21
HRC-1	0.06
HRC-2	0.08
HRC-3	0.05
HRC-4	0.23
HRC-5	0.20
Slope Drain 1	0.95
Slope Drain 2	0.53
Slope Drain 3	0.65
Slope Drain 4	0.35

see sheets D26 - D31

see sheets D26 - D31

see sheets D26 - D31

see sheets D26 - D31

see sheets D26 - D31

PROJECT: AEP - SITE 2/3
PROJ. NO.: 04-384

BY: CRM
DATE: 9/05

CHECKED BY: ✓ RH
DATE: 10/20

OPEN CHANNEL HYDRAULICS - PCC's - FABRIC FORM

WHERE:

ϕ_{50} = 50% PASSING DIAMETER FOR SPECIFIED ROCK LINING
n = MANNING'S COEFFICIENT OF ROUGNESS (N=0.05 FOR GRASS MEDIANS)
S = CHANNEL SLOPE
Z1 = CHANNEL SIDE SLOPE, LT (Z:1)
B = CHANNEL BOTTOM WIDTH
Z2 = CHANNEL SIDE SLOPE, RT (Z:1)
d = FLOW DEPTH
A = FLOW AREA
WP = WETTED PERIMETER
W = WIDTH OF FREE WATER SURFACE

r_h = HYDRAULIC RADIUS
y_h = HYDRAULIC DEPTH (OR MEAN DEPTH OF FLOW) = A / W
Q_M = MANNING'S FLOW
Q_{design} = DESIGN FLOW
v = MANNING'S VELOCITY
v_{al} = ALLOWABALE VELOCITY
S_C = Critical Slope
F = FREEBOARD
D = MINIMUM DESIGN DEPTH

NSA NO.	MAX. v (FPS)
3	4.5
4	6.4
5	8.0
6	9.2
7	10.4

CHANNEL ID	LINING/ NSA NO.	ϕ_{50} (FT)	n	S (FT/FT)	Z1 (Z:1)	B (FT)	Z2 (Z:1)	d (FT)	A (FT²)	WP (FT)	W (FT)	r_h (FT)	y_h (FT)	Q_M (CFS)	Q_{design} (CFS)	v (FPS)	v_{al} (FPS)	F (FT)	D (FT)	LINING OKAY?	
PCC-1	N/A	N/A	0.0250	0.0100	2	2.00	2	1.671	8.93	9.473	8.684	0.942	1.0279	51.00	51	5.71	N/A	0.3000	1.97	YES	
PCC-2	N/A	N/A	0.0250	0.4000	2	2.00	2	0.639	2.10	4.859	4.558	0.431	0.4600	45.00	45	21.46	N/A	0.3000	0.94	YES	MAXIMUM SLOPE
PCC-2	N/A	N/A	0.0250	0.0200	2	2.00	2	1.342	6.29	8.003	7.369	0.786	0.8532	45.00	45	7.16	N/A	0.3000	1.64	YES	MINIMUM SLOPE
PCC-3	N/A	N/A	0.0250	0.2000	2	4.00	2	0.904	5.25	8.042	7.615	0.653	0.6893	105.00	105	20.00	N/A	0.3000	1.20	YES	MAXIMUM SLOPE
PCC-3	N/A	N/A	0.0250	0.0200	2	4.00	2	1.649	12.03	11.373	10.595	1.058	1.1356	105.00	105	8.73	N/A	0.3000	1.95	YES	MINIMUM SLOPE
PCC-4	N/A	N/A	0.0250	0.2500	2	2.00	2	0.531	1.63	4.376	4.125	0.372	0.3944	25.00	25	15.37	N/A	0.3000	0.83	YES	
PCC-5	N/A	N/A	0.0250	0.0200	2	2.00	2	0.567	1.78	4.536	4.268	0.392	0.4163	8.00	8	4.50	N/A	0.3000	0.87	YES	
PCC-6	N/A	N/A	0.0250	0.0100	2	2.00	2	1.305	6.02	7.838	7.222	0.768	0.8335	30.00	30	4.98	N/A	0.3000	1.61	YES	
PCC-7	N/A	N/A	0.0250	0.3333	2	6.00	2	0.592	4.25	8.649	8.369	0.492	0.5084	91.00	91	21.39	N/A	0.3000	0.89	YES	MAXIMUM SLOPE
PCC-7	N/A	N/A	0.0250	0.0100	2	6.00	2	1.570	14.35	13.021	12.280	1.102	1.1686	91.00	91	6.34	N/A	0.3000	1.87	YES	MINIMUM SLOPE
PCC-8	N/A	N/A	0.0250	0.3333	2	2.00	2	0.579	1.83	4.590	4.317	0.399	0.4238	34.00	34	18.58	N/A	0.3000	0.88	YES	

see sheets D26 - D31 for PCC-1

PROJECT: AEP - SITE 2/3
PROJ. NO.: 04-384

BY: CRM
DATE: 9/05

CHECKED BY: RH
DATE: 10/20

OPEN CHANNEL HYDRAULICS - HRC's

WHERE:

ϕ_{50} = 50% PASSING DIAMETER FOR SPECIFIED ROCK LINING
n = MANNING'S COEFFICIENT OF ROUGNESS (N=0.05 FOR GRASS MEDIANS)
S = CHANNEL SLOPE
Z1 = CHANNEL SIDE SLOPE, LT (Z:1)
B = CHANNEL BOTTOM WIDTH
Z2 = CHANNEL SIDE SLOPE, RT (Z:1)
d = FLOW DEPTH
A = FLOW AREA
WP = WETTED PERIMETER
W = WIDTH OF FREE WATER SURFACE

r_h = HYDRAULIC RADIUS
y_h = HYDRAULIC DEPTH (OR MEAN DEPTH OF FLOW) = A / W
Q_M = MANNING'S FLOW
Q_{design} = DESIGN FLOW
v = MANNING'S VELOCITY
v_{al} = ALLOWABALE VELOCITY
S_C = Critical Slope
F = FREEBOARD
D = MINIMUM DESIGN DEPTH

NSA NO.	MAX. v (FPS)
3	4.5
4	6.4
5	8.0
6	9.2
7	10.4

CHANNEL ID	LINING/ NSA NO.	ϕ_{50} (FT)	n	S (FT/FT)	Z1 (Z:1)	B (FT)	Z2 (Z:1)	d (FT)	A (FT^2)	WP (FT)	W (FT)	r_h (FT)	y_h (FT)	Q_M (CFS)	Q_{design} (CFS)	v (FPS)	v_{al} (FPS)	F (FT)	D (FT)	LINING OKAY?	
HRC-1	4	0.50	0.0532	0.1000	2	0.00	2	0.762	1.16	3.408	3.048	0.341	0.3810	5.00	5	4.31	6.40	0.3000	1.06	YES	
HRC-2	4	0.50	0.0499	0.1000	2	0.00	2	0.927	1.72	4.146	3.708	0.415	0.4635	9.00	9	5.24	6.40	0.3000	1.23	YES	MAXIMUM SLOPE
HRC-2	4	0.50	0.0474	0.0350	2	0.00	2	1.107	2.45	4.951	4.428	0.495	0.5535	9.00	9	3.67	6.40	0.3000	1.41	YES	MINIMUM SLOPE
HRC-3	4	0.50	0.0494	0.1000	2	0.00	2	0.960	1.84	4.295	3.842	0.430	0.4802	10.00	10	5.42	6.40	0.3000	1.26	YES	
HRC-4	5	0.75	0.0549	0.1000	2	0.00	2	1.272	3.23	5.688	5.087	0.569	0.6359	19.00	19	5.87	8.00	0.3000	1.57	YES	
HRC-5	5	0.75	0.0549	0.1000	2	0.00	2	1.272	3.23	5.688	5.087	0.569	0.6359	19.00	19	5.87	8.00	0.3000	1.57	YES	

see sheets D26 - D31 for HRC-1

PROJECT: AEP - SITE 2/3
PROJ. NO.: 04-384

BY: CRM
DATE: 9/05

CHECKED BY: RH
DATE: 10/20

OPEN CHANNEL HYDRAULICS - SLOPE DRAINS (FABRIC FORM)

WHERE:

ϕ_{50} = 50% PASSING DIAMETER FOR SPECIFIED ROCK LINING
n = MANNING'S COEFFICIENT OF ROUGNESS (N=0.05 FOR GRASS MEDIANS)
S = CHANNEL SLOPE
Z1 = CHANNEL SIDE SLOPE, LT (Z:1)
B = CHANNEL BOTTOM WIDTH
Z2 = CHANNEL SIDE SLOPE, RT (Z:1)
d = FLOW DEPTH
A = FLOW AREA
WP = WETTED PERIMETER
W = WIDTH OF FREE WATER SURFACE

r_h = HYDRAULIC RADIUS
y_h = HYDRAULIC DEPTH (OR MEAN DEPTH OF FLOW) = A / W
Q_M = MANNING'S FLOW
Q_{design} = DESIGN FLOW
v = MANNING'S VELOCITY
V_{all} = ALLOWABALE VELOCITY
S_C = Critical Slope
F = FREEBOARD
D = MINIMUM DESIGN DEPTH

NSA NO.	MAX. v (FPS)
3	4.5
4	6.4
5	8.0
6	9.2
7	10.4

CHANNEL ID	LINING/ NSA NO.	ϕ_{50} (FT)	n	S (FT/FT)	Z1 (Z:1)	B (FT)	Z2 (Z:1)	d (FT)	A (FT²)	WP (FT)	W (FT)	r_h (FT)	y_h (FT)	Q_M (CFS)	Q_{design} (CFS)	v (FPS)	V_{all} (FPS)	F (FT)	D (FT)	LINING OKAY?	
SD-1	N/A	N/A	0.0250	0.3333	2	2.00	2	0.561	1.75	4.509	4.244	0.388	0.4127	32.00	32	18.27	N/A	0.3000	0.86	YES	MAXIMUM SLOPE
SD-1	N/A	N/A	0.0250	0.0200	2	2.00	2	1.141	4.89	7.103	6.564	0.688	0.7443	32.00	32	6.55	N/A	0.3000	1.44	YES	MINIMUM SLOPE
SD-2	N/A	N/A	0.0250	0.3333	2	2.00	2	0.502	1.51	4.247	4.010	0.355	0.3765	26.00	26	17.22	N/A	0.3000	0.80	YES	MAXIMUM SLOPE
SD-2	N/A	N/A	0.0250	0.0200	2	2.00	2	1.032	4.19	6.614	6.127	0.634	0.6842	26.00	26	6.20	N/A	0.3000	1.33	YES	MINIMUM SLOPE
SD-3	N/A	N/A	0.0250	0.3333	2	8.00	2	0.506	4.56	10.261	10.023	0.444	0.4546	91.00	91	19.97	N/A	0.3000	0.81	YES	MAXIMUM SLOPE
SD-3	N/A	N/A	0.0250	0.0200	2	8.00	2	1.137	11.68	13.083	12.547	0.893	0.9307	91.00	91	7.79	N/A	0.3000	1.44	YES	MINIMUM SLOPE
SD-4	N/A	N/A	0.0250	0.3333	2	4.00	2	0.538	2.73	6.404	6.150	0.426	0.4436	53.00	53	19.43	N/A	0.3000	0.84	YES	MAXIMUM SLOPE
SD-4	N/A	N/A	0.0250	0.0200	2	4.00	2	1.160	7.33	9.187	8.639	0.798	0.8484	53.00	53	7.23	N/A	0.3000	1.46	YES	MINIMUM SLOPE

see sheets D26 - D31 for SD-1, SD-3, and SD-4

PROJECT: AEP - SITE 2/3 BY: CRM CHECKED BY: RH
PROJ. NO.: 04-384 DATE: 9/05 DATE: 10/24

	CN	S	Runoff	Runoff	A (AC)	A (SQ M)	q	FLOW
PCC-1	72.5	3.793	1.8653	1.87	33.4	0.0522	525	51
PCC-2	73.8	3.550	1.9646	1.96	31.1	0.0486	475	45
PCC-3	71.9	3.908	1.8203	1.82	81.5	0.1273	455	105
PCC-4	71.3	4.025	1.7757	1.78	13.8	0.0216	640	25
PCC-5	72.0	3.889	1.8277	1.83	3.5	0.0055	800	8
PCC-6	71.9	3.908	1.8203	1.82	16.2	0.0253	650	30
PCC-7	73.2	3.661	1.9185	1.92	56.3	0.0880	540	91
PCC-8	71.5	3.986	1.7905	1.79	16.2	0.0253	745	34
SD-1	72.0	3.889	1.8277	1.83	32.4	0.0506	347	32
SD-2	72.0	3.889	1.8277	1.83	18.6	0.0291	480	26
SD-3	72.0	3.889	1.8277	1.83	74.1	0.1158	430	91
SD-4	72.0	3.889	1.8277	1.83	31.0	0.0484	595	53
HRC-1	90.0	1.111	3.4053	3.41	1.0	0.0016	1000	5
HRC-2	90.0	1.111	3.4053	3.41	1.7	0.0027	1000	9
HRC-3	90.0	1.111	3.4053	3.41	1.8	0.0028	1000	10
HRC-4	84.5	1.834	2.8717	2.87	5.6	0.0088	760	19
HRC-5	90.0	1.111	3.4053	3.41	4.5	0.0070	805	19

see sheets D26 - D31 for PCC-1, HRC-1, SD-1, SD-3, and SD-4

Worksheet 4: Graphical Peak Discharge method

Project AEP - Site 2/3 By CRM Date 9/05 page D8

Location West Virginia Checked RH Date 10/24/05

Circle one: Present Developed PCC-1 see sheets D26 - D31 for PCC-1

1. Data:

Drainage area .... A_m = 0.0522 mi^2 (acres/640)

Runoff curve number .... CN = 72.5 (From worksheet 2)

Time of concentration .. T_c = 0.46 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	25		
3. Rainfall, P (24-hour)	in	4.51		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.759		
5. Compute I_a/P		0.168		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	525		
7. Runoff, Q .... (From worksheet 2).	in	1.87		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	51		

(210-VI-TR-55, Second Ed., June 1986)

Worksheet 4: Graphical Peak Discharge method

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Project AEP - Site 213 By CRM Date 9/05

Location West Virginia Checked RH Date

Circle one: Present Developed PCC-2

1. Data:

Drainage area .... A_m = 0.0486 mi^2 (acres/640)

Runoff curve number .... CN = 73.8 (From worksheet 2)

Time of concentration .. T_c = 0.56 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

			Storm #1	Storm #2	Storm #3
2.	Frequency	yr	25		
3.	Rainfall, P (24-hour)	in	4.51		
4.	Initial abstraction, I_a (Use CN with table 4-1.)	in	0.710		
5.	Compute I_a/P		0.157		
6.	Unit peak discharge, q_u (Use T_c and I_a/P with exhibit 4-II)	csm/in	475		
7.	Runoff, Q (From worksheet 2).	in	1.96		
8.	Pond and swamp adjustment factor, F_p (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9.	Peak discharge, q_p (Where $q_p = q_u A_m Q F_p$)	cfs	45		

Worksheet 4: Graphical Peak Discharge method

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Project AEP - Site 213   By CRM   Date 9/05

Location West Virginia   Checked RH   Date ____

Circle one: Present Developed   PCC-3

1. Data:

Drainage area .... A_m = 0.1273 mi^2 (acres/640)

Runoff curve number .... CN = 71.9 (From worksheet 2)

Time of concentration .. T_c = 0.59 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

			Storm #1	Storm #2	Storm #3
2.	Frequency	yr	25		
3.	Rainfall, P (24-hour)	in	4.51		
4.	Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.782		
5.	Compute I_a/P		0.173		
6.	Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	455		
7.	Runoff, Q .... (From worksheet 2).	in	1.82		
8.	Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9.	Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	105		

(210-VI-TR-55, Second Ed., June 1986)

Worksheet 4: Graphical Peak Discharge method

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Project AEP - Site 2/3 By CRM Date 9/05

Location West Virginia Checked RH Date ____

Circle one: Present Developed PCC-4

1. Data:

Drainage area .... A_m = 0.0216 mi^2 (acres/640)

Runoff curve number .... CN = 71.3 (From worksheet 2)

Time of concentration .. T_c = 0.30 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

			Storm #1	Storm #2	Storm #3
2.	Frequency	yr	25		
3.	Rainfall, P (24-hour)	in	4.51		
4.	Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.805		
5.	Compute I_a/P		0.178		
6.	Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4- II)	csm/in	640		
7.	Runoff, Q .... (From worksheet 2).	in	1.78		
8.	Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9.	Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	25		

Worksheet 4: Graphical Peak Discharge method

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Project AEP - Site 2/3 By CRM Date 9/05

Location West Virginia Checked RH Date ____

Circle one: Present Developed PCC-5

1. Data:

Drainage area .... A_m = 0.0055 mi^2 (acres/640)

Runoff curve number .... CN = 72.0 (From worksheet 2)

Time of concentration .. T_c = 0.18 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

			Storm #1	Storm #2	Storm #3
2.	Frequency	yr	25		
3.	Rainfall, P (24-hour)	in	4.51		
4.	Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.778		
5.	Compute I_a/P		0.173		
6.	Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	800		
7.	Runoff, Q .... (From worksheet 2).	in	1.83		
8.	Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9.	Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	8		

(210-VI-TR-55, Second Ed., June 1986)

Worksheet 4: Graphical Peak Discharge method

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Project AEP - Site 2/3 By CRM Date 9/05

Location West Virginia Checked RH Date ____

Circle one: Present Developed PCC-6

1. Data:

Drainage area .... A_m = 0.0253 mi^2 (acres/640)

Runoff curve number .... CN = 71.9 (From worksheet 2)

Time of concentration .. T_c = 0.29 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	25		
3. Rainfall, P (24-hour)	in	4.51		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.782		
5. Compute I_a/P		0.173		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	650		
7. Runoff, Q .... (From worksheet 2).	in	1.82		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	30		

(210-VI-TR-55, Second Ed., June 1986)

Worksheet 4: Graphical Peak Discharge method

Project AEP - SITE 2/3 By CRM Date 9/05 page D14

Location WEST VIRGINIA Checked RH Date ______

Circle one: Present Developed PCC-7

1. Data:

Drainage area .... A_m = 0.0880 mi^2 (acres/640)

Runoff curve number .... CN = 73.2 (From worksheet 2)

Time of concentration .. T_c = 0.43 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	25		
3. Rainfall, P (24-hour)	in	4.51		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.733		
5. Compute I_a/P		0.163		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	540		
7. Runoff, Q .... (From worksheet 2).	in	1.92		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	91		

(210-VI-TR-55, Second Ed., June 1986)

Worksheet 4: Graphical Peak Discharge method

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Project AEP - Site 2/3 By CRM Date 9/05

Location West Virginia Checked RH Date

Circle one: Present Developed PCC-8

1. Data:

Drainage area .... A_m = 0.0253 mi^2 (acres/640)

Runoff curve number .... CN = 71.5 (From worksheet 2)

Time of concentration .. T_c = 0.21 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

			Storm #1	Storm #2	Storm #3
2.	Frequency	yr	25		
3.	Rainfall, P (24-hour)	in	4.51		
4.	Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.798		
5.	Compute I_a/P		0.177		
6.	Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	745		
7.	Runoff, Q .... (From worksheet 2).	in	1.79		
8.	Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9.	Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	34		

(210-VI-TR-55, Second Ed., June 1986)

Worksheet 4: Graphical Peak Discharge method

Project AEP - Site 2/3 By CRM Date 9/05

Location West Virginia Checked RH Date

Circle one: Present Developed Slope Drain 1

see sheets D26 - D31 for SD-1

1. Data:

Drainage area .... A_m = 0.0506 mi^2 (acres/640)

Runoff curve number .... CN = 72.0 (From worksheet 2)

Time of concentration .. T_c = 0.95 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	25		
3. Rainfall, P (24-hour)	in	4.51		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.778		
5. Compute I_a/P		0.173		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	347		
7. Runoff, Q .... (From worksheet 2).	in	1.83		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	32		

Worksheet 4: Graphical Peak Discharge method

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Project AEP - Site 2/3 By CRM Date 9/05

Location West Virginia Checked RH Date ____

Circle one: Present Developed SLOPE DRAIN 2

1. Data:

Drainage area .... A_m = 0.0291 mi^2 (acres/640)

Runoff curve number .... CN = 72.0 (From worksheet 2)

Time of concentration .. T_c = 0.53 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

			Storm #1	Storm #2	Storm #3
2.	Frequency	yr	25		
3.	Rainfall, P (24-hour)	in	4.51		
4.	Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.778		
5.	Compute I_a/P		0.173		
6.	Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	480		
7.	Runoff, Q .... (From worksheet 2).	in	1.83		
8.	Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9.	Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	26		

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Worksheet 4: Graphical Peak Discharge method

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Project AEP - Site 2/3 By CRM Date 9/05

Location West Virginia Checked RH Date

Circle one: Present Developed Slope Drain 3

see sheets D26 - D31 for SD-3

1. Data:

Drainage area .... A_m = 0.1158 mi^2 (acres/640)

Runoff curve number .... CN = 72.0 (From worksheet 2)

Time of concentration .. T_c = 0.65 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	25		
3. Rainfall, P (24-hour)	in	4.51		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.778		
5. Compute I_a/P		0.173		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	430		
7. Runoff, Q .... (From worksheet 2).	in	1.83		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	91		

Worksheet 4: Graphical Peak Discharge method

Project AEP - SITE 2|3 By CRM Date 9/05

Location WEST VIRGINIA Checked RH Date

Circle one: Present Developed SLOPE DRAIN 4 see sheets D26 - D31 for SD-4

1. Data:

Drainage area .... A_m = 0.0484 mi^2 (acres/640)

Runoff curve number .... CN = 72.0 (From worksheet 2)

Time of concentration .. T_c = 0.35 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

		Storm #1	Storm #2	Storm #3
2. Frequency	yr	25		
3. Rainfall, P (24-hour)	in	4.51		
4. Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.778		
5. Compute I_a/P		0.173		
6. Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	595		
7. Runoff, Q .... (From worksheet 2).	in	1.83		
8. Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9. Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	53		

(210-VI-TR-55, Second Ed., June 1986)

Worksheet 4: Graphical Peak Discharge method

Project AEP - Site 2/3 By CRM Date 9/05

Location West Virginia Checked RH Date

Circle one: Present Developed HRC-1 see sheets D26 - D31 for HRC-1

1. Data:

Drainage area .... A_m = 0.0016 mi^2 (acres/640)

Runoff curve number .... CN = 90.0 (From worksheet 2)

Time of concentration .. T_c = 0.06 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

			Storm #1	Storm #2	Storm #3
2.	Frequency	yr	25		
3.	Rainfall, P (24-hour)	in	4.51		
4.	Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.222		
5.	Compute I_a/P		0.049		
6.	Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	1000		
7.	Runoff, Q .... (From worksheet 2).	in	3.41		
8.	Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9.	Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	5		

(210-VI-TR-55, Second Ed., June 1986)

Worksheet 4: Graphical Peak Discharge method

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Project AEP - Site 2/3 By CRM Date 9/05

Location West Virginia Checked RH Date ______

Circle one: Present Developed HRC-2

1. Data:

Drainage area .... A_m = 0.0027 mi^2 (acres/640)

Runoff curve number .... CN = 90.0 (From worksheet 2)

Time of concentration .. T_c = 0.08 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

			Storm #1	Storm #2	Storm #3
2.	Frequency	yr	25		
3.	Rainfall, P (24-hour)	in	4.51		
4.	Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.222		
5.	Compute I_a/P		0.049		
6.	Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	1000		
7.	Runoff, Q .... (From worksheet 2).	in	3.41		
8.	Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9.	Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	9		

Worksheet 4: Graphical Peak Discharge method

page D22

Project AEP - Site 2/3 By CRM Date 9/05

Location West Virginia Checked RH Date ______

Circle one: Present Developed HRC-3

1. Data:

Drainage area .... A_m = 0.0028 mi^2 (acres/640)

Runoff curve number .... CN = 90.0 (From worksheet 2)

Time of concentration .. T_c = 0.05 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

			Storm #1	Storm #2	Storm #3
2.	Frequency	yr	25		
3.	Rainfall, P (24-hour)	in	4.51		
4.	Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.222		
5.	Compute I_a/P		0.049		
6.	Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	1000		
7.	Runoff, Q .... (From worksheet 2).	in	3.41		
8.	Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9.	Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	10		

Worksheet 4: Graphical Peak Discharge method

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Project AEP - Site 2/3 By CRM Date 9/05

Location West Virginia Checked RH Date ____

Circle one: Present Developed HRC-4

1. Data:

Drainage area .... A_m = 0.0088 mi^2 (acres/640)

Runoff curve number .... CN = 84.5 (From worksheet 2)

Time of concentration .. T_c = 0.23 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

			Storm #1	Storm #2	Storm #3
2.	Frequency	yr	25		
3.	Rainfall, P (24-hour)	in	4.51		
4.	Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.367		
5.	Compute I_a/P		0.081		
6.	Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4- II)	csm/in	760		
7.	Runoff, Q .... (From worksheet 2).	in	2.87		
8.	Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9.	Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	19		

(210-VI-TR-55, Second Ed., June 1986)

Worksheet 4: Graphical Peak Discharge method

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Project AEP - Site 2/3 By CRM Date 9/05

Location West Virginia Checked RH Date

Circle one: Present Developed HRC-5

1. Data:

Drainage area .... A_m = 0.0070 mi^2 (acres/640)

Runoff curve number .... CN = 90.0 (From worksheet 2)

Time of concentration .. T_c = 0.20 hr (From worksheet 3)

Rainfall distribution type = II (I, IA, II, III)

Pond and swamp areas spread throughout watershed ...... = 0 percent of A_m (____ acres or mi^2 covered)

			Storm #1	Storm #2	Storm #3
2.	Frequency	yr	25		
3.	Rainfall, P (24-hour)	in	4.51		
4.	Initial abstraction, I_a .... (Use CN with table 4-1.)	in	0.222		
5.	Compute I_a/P		0.049		
6.	Unit peak discharge, q_u .... (Use T_c and I_a/P with exhibit 4-II)	csm/in	805		
7.	Runoff, Q .... (From worksheet 2).	in	3.41		
8.	Pond and swamp adjustment factor, F_p .... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)		1.0		
9.	Peak discharge, q_p .... (Where $q_p = q_u A_m Q F_p$)	cfs	19		

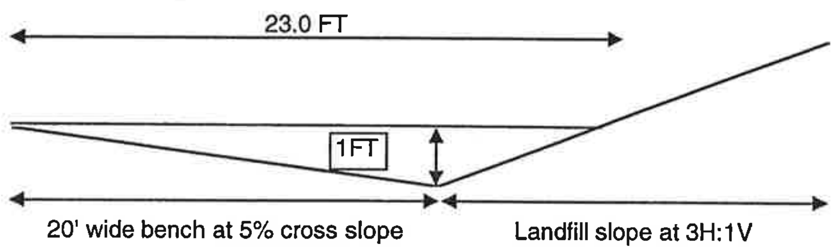
Purpose:

The following worksheet is used to determine maximum allowable longitudinal bench slope lengths prior to placement of slope drains.

Method:

If bench flow width exceeds 23', a slope drain will be required. The 23' top width is derived from a combination of the bench cross slope (5%) and the slope between benches (3H:1V).

The following was determined graphically by CAD



Calculations:

Common Factors

n=	0.045	for grass lining
Left=	20	H:1V
Right=	3	H:1V
Bottom Width=	0	ft
Design Storm=	25-year, 24-hour	
Design Storm Rainfall=	4.51	inches
CN=	72.0	for reclaimed benches and slopes
S=	3.89	abstraction factor = 1000/CN - 10
Vr=	1.83	runoff volume, inches over area: $Vr = (P - 0.2S)^2/(P + 0.8S)$

The criteria below are to check for the newly seeded bench/slope condition.

Design Storm=	2-year, 24-hour	
Design Storm Rainfall=	2.65	inches
CN=	85.0	for newly seeded areas

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Purpose:
To determine the modified time of concentration to collection and diversion channels, where hydrologic conditions (drainage area and/or flow path) for the channel have been revised. The Time of Concentration was modified only if the updated TOC would result in an increased design peak flow rate.

References
"Urban Hydrology for Small Watersheds." TR-55. United States Department of Agriculture. June 1986

Method:
Time of Concentration was calculated by methods found in TR-55 (Reference 1)

Hydrologic conditions have changed for PCC-1, and Slope Drains one and three.

Sheet Flow

Design Channel	Segment ID	Surface Description	n	Flow Length	2-yr, 24-hr rainfall	Land Slope, s	T_t
PCC-1	A-B	Grass	0.15	54	2.65	0.33	0.036
Slope Drain 1	A-B	Grass	0.15	54	2.65	0.33	0.036
Slope Drain 3	K-L	Grass	0.15	63	2.65	0.02	0.124

Channel Flow

Design Channel	Segment ID	Description	Channel Slope, s	n	V, fps	Flow Length	T_t
PCC-1	B-C	Bench	0.015	0.045	2	2242	0.311
PCC-1	C-D	Slope Drain 1	0.33	0.025	25	233	0.003
PCC-1	D-E	PCC-1	0.01	0.025	5	297	0.017
Slope Drain 1	B-C	Bench	0.015	0.045	2	2242	0.311
Slope Drain 1	C-D	Slope Drain 1	0.02 min/ 0.33 max	0.025	25	233	0.003
Slope Drain 3	L-M	Bench	0.015	0.045	2	1825	0.253
Slope Drain 3	M-N	Slope Drain 3	0.02 min/ 0.33 max	0.025	25	499	0.006

T.O.C. Summary

Segment ID	T.O.C.
PCC-1	0.37
Slope Drain 1	0.35
Slope Drain 3	0.38

PROJECT: AEP - John E. Amos Landfill BY: DMO CHECKED BY: CRM
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	CN	S	Runoff	Runoff	A (AC)	A (SQ M)	q	FLOW (CFS)	
PCC-1	72.5	3.793	1.8653	1.87	57.5	0.0898	590	99	
PCC-2	73.8	3.550	1.9646	1.96	13.0	0.0203	475	19	
PCC-3	71.9	3.908	1.8203	1.82	66.4	0.1038	455	86	
PCC-4	71.3	4.025	1.7757	1.78	14.0	0.0219	640	25	
PCC-5	72.0	3.889	1.8277	1.83	4.0	0.0063	800	9	
PCC-6	71.9	3.908	1.8203	1.82	13.8	0.0216	650	26	
PCC-7	73.2	3.661	1.9185	1.92	55.5	0.0867	540	90	
PCC-8	71.5	3.986	1.7905	1.79	6.5	0.0102	745	14	
SD-1	72.0	3.889	1.8277	1.83	48.5	0.0758	600	83	Drains to PCC-1
~~SD-2~~	~~72.0~~	~~3.889~~	~~1.8277~~	~~1.83~~	~~7.0~~	~~0.0109~~	~~480~~	~~10~~	
SD-3	72.0	3.889	1.8277	1.83	39.0	0.0609	575	64	Drains to PCC-3
SD-4	72.0	3.889	1.8277	1.83	30.5	0.0477	595	52	Drains to PCC-7
HRC-1	90.0	1.111	3.4053	3.41	3.0	0.0047	1000	16	
~~HRC-2~~	~~90.0~~	~~1.111~~	~~3.4053~~	~~3.41~~	~~1.7~~	~~0.0027~~	~~1000~~	~~9~~	
~~HRC-3~~	~~90.0~~	~~1.111~~	~~3.4053~~	~~3.41~~	~~1.8~~	~~0.0028~~	~~1000~~	~~10~~	
~~HRC-4~~	~~84.5~~	~~1.834~~	~~2.8717~~	~~2.87~~	~~5.6~~	~~0.0088~~	~~760~~	~~19~~	
~~HRC-5~~	~~90.0~~	~~1.111~~	~~3.4053~~	~~3.41~~	~~4.5~~	~~0.0070~~	~~805~~	~~19~~	

PROJECT: AEP - John E. Amos Landfill | BY: DMO | CHECKED BY: CRM
PROJ. NO.: C130109.03 | DATE: Sep-16 | DATE: 9/29/2016

OPEN CHANNEL HYDRAULICS - SLOPE DRAINS (FABRIC FORM)

WHERE:

- ϕ_{50} = 50% PASSING DIAMETER FOR SPECIFIED ROCK LINING
- n = MANNING'S COEFFICIENT OF ROUGNESS (N=0.05 FOR GRASS MEDIANS)
- S = CHANNEL SLOPE
- Z1 = CHANNEL SIDE SLOPE, LT (Z:1)
- B = CHANNEL BOTTOM WIDTH
- Z2 = CHANNEL SIDE SLOPE, RT (Z:1)
- d = FLOW DEPTH
- A = FLOW AREA
- WP = WETTED PERIMETER
- W = WIDTH OF FREE WATER SURFACE
- r_h = HYDRAULIC RADIUS
- y_h = HYDRAULIC DEPTH (OR MEAN DEPTH OF FLOW) = A / W
- Q_M = MANNING'S FLOW
- Q_{design} = DESIGN FLOW
- v = MANNING'S VELOCITY
- v_{all} = ALLOWABALE VELOCITY
- S_C = Critical Slope
- F = FREEBOARD
- D = MINIMUM DESIGN DEPTH

NSA NO.	MAX. v (FPS)
3	4.5
4	6.4
5	8.0
6	9.2
7	10.4

CHANNEL ID	LINING/ NSA NO.	ϕ_{50} (FT)	n	S (FT/FT)	Z1 (Z:1)	B (FT)	Z2 (Z:1)	d (FT)	A (FT^2)	WP (FT)	W (FT)	r_h (FT)	y_h (FT)	Q_M (CFS)	Q_{design} (CFS)	v (FPS)	v_{all} (FPS)	F (FT)	D (FT)	LINING OKAY?	
SD-1	N/A	N/A	0.0250	0.3333	2	8.00	2	0.479	4.29	10.142	9.916	0.423	0.4328	83.00	83	19.34	N/A	0.3000	0.78	YES	MAXIMUM SLOPE
SD-1	N/A	N/A	0.0250	0.0200	2	8.00	2	1.079	10.96	12.826	12.317	0.855	0.8901	83.00	83	7.57	N/A	0.3000	1.38	YES	MINIMUM SLOPE
~~SD-2~~	~~N/A~~	~~N/A~~	~~0.0250~~	~~0.3333~~	~~2~~	~~2.00~~	~~2~~	~~0.298~~	~~0.77~~	~~3.331~~	~~3.190~~	~~0.232~~	~~0.2421~~	~~10.00~~	~~10~~	~~12.95~~	~~N/A~~	~~0.3000~~	~~0.60~~	~~YES~~	~~MAXIMUM SLOPE~~
~~SD-2~~	~~N/A~~	~~N/A~~	~~0.0250~~	~~0.0200~~	~~2~~	~~2.00~~	~~2~~	~~0.637~~	~~2.09~~	~~4.850~~	~~4.549~~	~~0.430~~	~~0.4588~~	~~10.00~~	~~10~~	~~4.79~~	~~N/A~~	~~0.3000~~	~~0.94~~	~~YES~~	~~MINIMUM SLOPE~~
SD-3	N/A	N/A	0.0250	0.3333	2	8.00	2	0.411	3.63	9.839	9.645	0.369	0.3761	64.00	64	17.64	N/A	0.3000	0.71	YES	MAXIMUM SLOPE
SD-3	N/A	N/A	0.0250	0.0200	2	8.00	2	0.931	9.18	12.164	11.724	0.755	0.7832	64.00	64	6.97	N/A	0.3000	1.23	YES	MINIMUM SLOPE
SD-4	N/A	N/A	0.0250	0.3333	2	6.00	2	0.428	2.94	7.915	7.713	0.371	0.3806	52.00	52	17.71	N/A	0.3000	0.73	YES	MAXIMUM SLOPE
SD-4	N/A	N/A	0.0250	0.0200	2	6.00	2	0.958	7.58	10.283	9.831	0.737	0.7711	52.00	52	6.86	N/A	0.3000	1.26	YES	MINIMUM SLOPE

PROJECT: AEP - John E. Amos Landfill BY: DMO CHECKED BY: CRM page D29
PROJ. NO.: C130109.03 DATE: Sep-16 DATE: 9/29/2016

OPEN CHANNEL HYDRAULICS - SLOPE DRAINS (Hydroturf)

WHERE:
ϕ_{50} = 50% PASSING DIAMETER FOR SPECIFIED ROCK LINING
n = MANNING'S COEFFICIENT OF ROUGNESS (N=0.05 FOR GRASS MEDIANS)
S = CHANNEL SLOPE
Z1 = CHANNEL SIDE SLOPE, LT (Z:1)
B = CHANNEL BOTTOM WIDTH
Z2 = CHANNEL SIDE SLOPE, RT (Z:1)
d = FLOW DEPTH
A = FLOW AREA
WP = WETTED PERIMETER
W = WIDTH OF FREE WATER SURFACE

r_h = HYDRAULIC RADIUS
y_h = HYDRAULIC DEPTH (OR MEAN DEPTH OF FLOW) = A / W
Q_M = MANNING'S FLOW
Q_{design} = DESIGN FLOW
v = MANNING'S VELOCITY
v_{all} = ALLOWABALE VELOCITY
S_C = Critical Slope
F = FREEBOARD
D = MINIMUM DESIGN DEPTH

NSA NO.	MAX. v (FPS)
3	4.5
4	6.4
5	8.0
6	9.2
7	10.4

CHANNEL ID	LINING/ NSA NO.	ϕ_{50} (FT)	n	S (FT/FT)	Z1 (Z:1)	B (FT)	Z2 (Z:1)	d (FT)	A (FT^2)	WP (FT)	W (FT)	r_h (FT)	y_h (FT)	Q_M (CFS)	Q_{design} (CFS)	v (FPS)	v_{all} (FPS)	F (FT)	D (FT)	LINING OKAY?	
SD-1	N/A	N/A	0.0300	0.3333	2	8.00	2	0.533	4.83	10.384	10.132	0.465	0.4770	83.00	83	17.17	N/A	0.3000	0.83	YES	MAXIMUM SLOPE
SD-1	N/A	N/A	0.0300	0.0200	2	8.00	2	1.196	12.43	13.348	12.783	0.931	0.9721	83.00	83	6.68	N/A	0.3000	1.50	YES	MINIMUM SLOPE
~~SD-2~~	~~N/A~~	~~N/A~~	~~0.0300~~	~~0.3333~~	~~2~~	~~2.00~~	~~2~~	~~0.298~~	~~0.77~~	~~3.331~~	~~3.190~~	~~0.232~~	~~0.2421~~	~~8.33~~	~~10~~	~~10.79~~	~~N/A~~	~~0.3000~~	~~0.60~~	~~YES~~	~~MAXIMUM SLOPE~~
~~SD-2~~	~~N/A~~	~~N/A~~	~~0.0300~~	~~0.0200~~	~~2~~	~~2.00~~	~~2~~	~~0.637~~	~~2.09~~	~~4.850~~	~~4.549~~	~~0.430~~	~~0.4588~~	~~8.33~~	~~10~~	~~3.99~~	~~N/A~~	~~0.3000~~	~~0.94~~	~~YES~~	~~MINIMUM SLOPE~~
SD-3	N/A	N/A	0.0300	0.3333	2	8.00	2	0.458	4.08	10.047	9.831	0.406	0.4151	64.00	64	15.68	N/A	0.3000	0.76	YES	MAXIMUM SLOPE
SD-3	N/A	N/A	0.0300	0.0200	2	8.00	2	1.033	10.40	12.619	12.131	0.824	0.8570	64.00	64	6.16	N/A	0.3000	1.33	YES	MINIMUM SLOPE
SD-4	N/A	N/A	0.0300	0.3333	2	6.00	2	0.476	3.31	8.129	7.904	0.407	0.4188	52.00	52	15.71	N/A	0.3000	0.78	YES	MAXIMUM SLOPE
SD-4	N/A	N/A	0.0300	0.0200	2	6.00	2	1.060	8.60	10.739	10.239	0.801	0.8404	52.00	52	6.04	N/A	0.3000	1.36	YES	MINIMUM SLOPE

PROJECT: AEP - John E. Amos Landfill
PROJ. NO.: C130109.03

BY: DMO
DATE: Sep-16

CHECKED BY: CRM
DATE: 9/29/2016

OPEN CHANNEL HYDRAULICS - PCC's - FABRIC FORM

WHERE:

ϕ_{50} = 50% PASSING DIAMETER FOR SPECIFIED ROCK LINING
n = MANNING'S COEFFICIENT OF ROUGNESS (N=0.05 FOR GRASS MEDIANS)
S = CHANNEL SLOPE
Z1 = CHANNEL SIDE SLOPE, LT (Z:1)
B = CHANNEL BOTTOM WIDTH
Z2 = CHANNEL SIDE SLOPE, RT (Z:1)
d = FLOW DEPTH
A = FLOW AREA
WP = WETTED PERIMETER
W = WIDTH OF FREE WATER SURFACE

r_h = HYDRAULIC RADIUS
y_h = HYDRAULIC DEPTH (OR MEAN DEPTH OF FLOW) = A / W
Q_M = MANNING'S FLOW
Q_{design} = DESIGN FLOW
v = MANNING'S VELOCITY
v_{all} = ALLOWABLE VELOCITY
S_C = Critical Slope
F = FREEBOARD
D = MINIMUM DESIGN DEPTH

NSA NO.	MAX. v (FPS)
3	4.5
4	6.4
5	8.0
6	9.2
7	10.4

CHANNEL ID	LINING/ NSA NO.	ϕ_{50} (FT)	n	S (FT/FT)	Z1 (Z:1)	B (FT)	Z2 (Z:1)	d (FT)	A (FT^2)	WP (FT)	W (FT)	r_h (FT)	y_h (FT)	Q_M (CFS)	Q_{design} (CFS)	v (FPS)	v_{all} (FPS)	F (FT)	D (FT)	LINING OKAY?		Existing Schedule BW	Existing Schedule D	UPDATE REQUIRED?	UPDATE PERFORMED	Proposed Schedule BW	Proposed Schedule D
PCC-1	N/A	N/A	0.0250	0.0100	2	4.00	2	1.903	14.85	12.510	11.612	1.187	1.2792	99.00	99	6.66	N/A	0.3000	2.20	YES		2	1.5	YES	Type C Channel	4	2.5
PCC-2	N/A	N/A	0.0250	0.4000	2	2.00	2	0.404	1.13	3.805	3.615	0.298	0.3135	19.00	19	16.77	N/A	0.3000	0.70	YES	MAXIMUM SLOPE	4	1.5	NO	NA	No Change	
PCC-2	N/A	N/A	0.0250	0.0200	2	2.00	2	0.884	3.33	5.952	5.535	0.559	0.6015	19.00	19	5.71	N/A	0.3000	1.18	YES	MINIMUM SLOPE	2	2	NO	NA	No Change	
PCC-3	N/A	N/A	0.0250	0.2000	2	4.00	2	0.811	4.56	7.627	7.244	0.598	0.6294	86.00	86	18.86	N/A	0.3000	1.11	YES	MAXIMUM SLOPE	4	1.5	NO	NA	No Change	
PCC-3	N/A	N/A	0.0250	0.0200	2	4.00	2	1.490	10.40	10.664	9.961	0.975	1.0443	86.00	86	8.27	N/A	0.3000	1.79	YES	MINIMUM SLOPE	4	2.5	NO	NA	No Change	
PCC-4	N/A	N/A	0.0250	0.2500	2	2.00	2	0.531	1.63	4.376	4.125	0.372	0.3944	25.00	25	15.37	N/A	0.3000	0.83	YES		2	1.5	NO	NA	No Change	
PCC-5	N/A	N/A	0.0250	0.0200	2	2.00	2	0.603	1.93	4.698	4.413	0.412	0.4383	9.00	9	4.65	N/A	0.3000	0.90	YES		2	1.5	NO	NA	No Change	
PCC-6	N/A	N/A	0.0250	0.0100	2	2.00	2	1.220	5.41	7.454	6.878	0.726	0.7871	26.00	26	4.80	N/A	0.3000	1.52	YES		2	2	NO	NA	No Change	
PCC-7	N/A	N/A	0.0250	0.3333	2	4.00	2	0.723	3.93	7.232	6.891	0.544	0.5711	90.00	90	22.87	N/A	0.3000	1.02	YES	MAXIMUM SLOPE	4	1.5	NO	NA	No Change	
PCC-7	N/A	N/A	0.0250	0.0100	2	4.00	2	1.815	13.85	12.118	11.261	1.143	1.2300	90.00	90	6.50	N/A	0.3000	2.12	YES	MINIMUM SLOPE	2	2	YES	Type C Channel	4	2.5
PCC-8	N/A	N/A	0.0250	0.3333	2	2.00	2	0.359	0.98	3.605	3.435	0.271	0.2839	14.00	14	14.35	N/A	0.3000	0.66	YES		2	1.5	NO	NA	No Change	

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PROJECT: AEP - John E. Amos Landfill
PROJ. NO.: C130109.03

BY: DMO
DATE: Sep-16

CHECKED BY: CRM
DATE: 9/29/2016

OPEN CHANNEL HYDRAULICS - HRC's

WHERE:
ϕ_{50} = 50% PASSING DIAMETER FOR SPECIFIED ROCK LINING
n = MANNING'S COEFFICIENT OF ROUGNESS (N=0.05 FOR GRASS MEDIANS)
S = CHANNEL SLOPE
Z1 = CHANNEL SIDE SLOPE, LT (Z:1)
B = CHANNEL BOTTOM WIDTH
Z2 = CHANNEL SIDE SLOPE, RT (Z:1)
d = FLOW DEPTH
A = FLOW AREA
WP = WETTED PERIMETER
W = WIDTH OF FREE WATER SURFACE

r_h = HYDRAULIC RADIUS
y_h = HYDRAULIC DEPTH (OR MEAN DEPTH OF FLOW) = A / W
Q_M = MANNING'S FLOW
Q_{design} = DESIGN FLOW
v = MANNING'S VELOCITY
v_{all} = ALLOWABALE VELOCITY
S_C = Critical Slope
F = FREEBOARD
D = MINIMUM DESIGN DEPTH

NSA NO.	MAX. v (FPS)
3	4.5
4	6.4
5	8.0
6	9.2
7	10.4

CHANNEL ID	LINING/ NSA NO.	ϕ_{50} (FT)	n	S (FT/FT)	Z1 (Z:1)	B (FT)	Z2 (Z:1)	d (FT)	A (FT^2)	WP (FT)	W (FT)	r_h (FT)	y_h (FT)	Q_M (CFS)	Q_{design} (CFS)	v (FPS)	v_{all} (FPS)	F (FT)	D (FT)	LINING OKAY?	
HRC-1	4	0.50	0.0532	0.1000	2	0.00	10	0.762	3.50	9.412	9.195	0.372	0.3810	16.00	16	4.57	6.40	0.3000	1.06	YES	
~~HRC-2~~	~~4~~	~~0.50~~	~~0.0499~~	~~0.1000~~	~~2~~	~~0.00~~	~~2~~	~~0.927~~	~~1.72~~	~~4.146~~	~~3.708~~	~~0.415~~	~~0.4635~~	~~9.00~~	~~9~~	~~5.24~~	~~6.40~~	~~0.3000~~	~~1.23~~	~~YES~~	~~MAXIMUM SLOPE~~
~~HRC-2~~	~~4~~	~~0.50~~	~~0.0474~~	~~0.0350~~	~~2~~	~~0.00~~	~~2~~	~~1.107~~	~~2.45~~	~~4.951~~	~~4.428~~	~~0.495~~	~~0.5535~~	~~9.00~~	~~9~~	~~3.67~~	~~6.40~~	~~0.3000~~	~~1.41~~	~~YES~~	~~MINIMUM SLOPE~~
~~HRC-3~~	~~4~~	~~0.50~~	~~0.0494~~	~~0.1000~~	~~2~~	~~0.00~~	~~2~~	~~0.960~~	~~1.84~~	~~4.295~~	~~3.842~~	~~0.430~~	~~0.4802~~	~~10.00~~	~~10~~	~~5.42~~	~~6.40~~	~~0.3000~~	~~1.26~~	~~YES~~	
~~HRC-4~~	~~5~~	~~0.75~~	~~0.0549~~	~~0.1000~~	~~2~~	~~0.00~~	~~2~~	~~1.272~~	~~3.23~~	~~5.688~~	~~5.087~~	~~0.569~~	~~0.6359~~	~~19.00~~	~~19~~	~~5.87~~	~~8.00~~	~~0.3000~~	~~1.57~~	~~YES~~	
~~HRC-5~~	~~5~~	~~0.75~~	~~0.0549~~	~~0.1000~~	~~2~~	~~0.00~~	~~2~~	~~1.272~~	~~3.23~~	~~5.688~~	~~5.087~~	~~0.569~~	~~0.6359~~	~~19.00~~	~~19~~	~~5.87~~	~~8.00~~	~~0.3000~~	~~1.57~~	~~YES~~	

Culverts XLS
10/19/2005 2...
PAGE 1 OF 1

PROJECT: AEP - JOHN E. AMOS PLANT (LANDFILL)
PROJ. NO.: 04-384

BY: CRM
DATE: 10/05

CHK'D BY: RH
DATE: 10/24

CULVERT DESIGN SUMMARY

NOTES:
1. ALL CULVERT MATERIAL WILL BE CORRUGATED TYPE S POLYETHYLENE AND TREATED AS CMP FOR THE HYDRAULIC ANALYSIS.
2. THE COMPUTER NOMOGRAPH CALCULATOR PROGRAMMED BY WILLIAM J. GRENNEY OF UTAH STATE UNIVERSITY WAS UTILIZED TO DETERMINE THE VALUES IN THE TABLE BELOW. THIS COMPUTER PROGRAM IS BASED ON METHODS CONTAINED IN FHWA HDS NO. 5.
3. A MAXIMUM ALLOWABLE HW DEPTH OF 1.0' ABOVE THE PIPE WAS UTILIZED TO SIZE THE CULVERTS.

ID	PIPE SIZE (IN)	NUMBER OF BARRELS	BARREL LENGTH (FT)	BARREL SLOPE (FT/FT)	TOTAL FLOW (CFS)	FLOW/ BARREL (CFS)	HEADWATER CALCULATIONS													CONTROL HW ELEV.	OUTLET VELOCITY (FT/S)	REMARKS
							INLET CONTROL					OUTLET CONTROL										
							EL_I	HW/D	HW (FT)	FALL	EL_{hi}	EL_o	TW	d_c	$(d_c+D)/2$	h_o	K_e	H	EL_{ho}			
Culvert 1	42	1	100	0.030	56	56.0	914.25	1.14	3.98	0.00	918.23	911.25	1.94	2.34	2.92	2.92	0.9	2.06	916.23	918.23	10.2	
Culvert 2	42	1	210	0.015	65	65.0	911.25	1.29	4.50	0.00	915.75	908.00	2.79	2.53	3.02	3.02	0.9	4.33	915.35	915.75	7.9	
Culvert 3	36	1	170	0.015	36	36.0	936.55	1.10	3.29	0.00	939.84	934.00	2.01	1.95	2.48	2.48	0.9	2.45	938.93	939.84	7.0	
Culvert 4	30	1	150	0.030	19	19.0	924.50	0.95	2.38	0.00	926.88	920.00	1.27	1.48	1.99	1.99	0.9	1.54	923.53	926.88	7.8	
Culvert 5	36	1	180	0.034	38	38.0	916.50	1.13	3.40	0.00	919.90	910.30	1.69	2.01	2.51	2.51	0.9	2.84	915.65	919.90	9.7	
Culvert 6	36	2	80	0.030	72	36.0	914.70	1.09	3.27	0.00	917.97	912.30	1.63	1.95	2.48	2.48	0.9	1.56	916.34	917.97	9.2	
Culvert 7	36	1	80	0.030	45	45.0	726.90	1.30	3.89	0.00	730.79	724.50	1.88	2.19	2.60	2.60	0.9	2.44	729.54	730.79	9.6	
Culvert 8	54	1	65	0.030	105	105.0	726.45	1.14	5.12	0.00	731.57	724.50	2.43	3.01	3.76	3.76	0.9	1.92	730.18	731.57	12.0	
Culvert 9	36	1	65	0.030	34	34.0	697.45	1.04	3.13	0.00	700.58	695.50	1.58	1.89	2.45	2.45	0.9	1.26	699.21	700.58	9.0	
Culvert 10	54	1	70	0.030	91	91.0	697.60	1.02	4.60	0.00	702.20	695.50	2.23	2.80	3.65	3.65	0.9	1.48	700.63	702.20	11.6	
Culvert 11	30	1	55	0.100	25	25.0	701.00	1.13	2.83	0.00	703.83	695.50	1.03	2.80	2.65	2.65	0.9	1.46	699.61	703.83	13.1	

see sheets D35 - D47 for Culvert 1

BY: RH

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AEP - JOHN E. AMOS PLANT
JOHN E. AMOS LANDFILL

PIPE OUTLET PROTECTION

Culvert ID	Number of Pipes	Pipe(s) Diameter (D_o)	Total Discharge Q_{25} (cfs)	Discharge per Barrel Q_{25} (cfs)	Outlet Protection Wl (ft)	Outlet Protection Wt (ft)	Outlet Protection La (ft)	d_{50} Riprap Size	NSA Riprap Size	Riprap Thickness Rt
1	1	42"	56	56.0	10.5	23.5	20	0.75'	R-5	27"
2	1	42"	65	65.0	10.5	25.5	22	0.75'	R-5	27"
3	1	36"	36	36.0	9	19	16	0.75'	R-5	27"
4	1	30"	19	19.0	7.5	15.5	13	0.50'	R-4	18"
5	1	36"	38	38.0	9	20	17	0.75'	R-5	27"
6	2	36"	72	36.0	13	23	16	0.75'	R-5	27"
7	1	36"	45	45.0	9	21	18	0.75'	R-5	27"
8	1	54"	105	105.0	13.5	29.5	25	1.00'	R-6	36"
9	1	36"	34	34.0	9	19	16	0.75'	R-5	27"
10	1	54"	91	91.0	13.5	28.5	24	0.75'	R-5	27"

Note: Figure 26 - Minimum Tailwater Condition (West Virginia E&S Handbook) was used to determine riprap size and dimensions.

Input

Test Length	Bench Slope	Drainage Area[1] AC	T.O.C.[2]	I_A[3]	I_A/P	PFF[4]	Qp[5]	Qn / 1.49 $S^{1/2}$	$Y_{balance}$	$A^{5/3} \times P^{-2/3}$ (see footnote 6)	T[7]	Width OK
Reclaimed bench/slope condition												
3500	0.015	6.67	0.5	0.778	0.17	470	9	2.22	0.643	2.22	14.79	OK
2000	0.01	3.81	0.38	0.778	0.17	575	7	2.11	0.630	2.10	14.49	OK
Newly seeded bench/slope condition												
3500	0.015	6.67	0.5	0.353	0.13	510	10	2.47	0.670	2.48	15.41	OK
2000	0.01	3.81	0.38	0.353	0.13	510	6	1.81	0.596	1.81	13.71	OK

1) Drainage area is longitudinal flow length of bench x plan view width of bench (83')
2) From "TOC" worksheet
3) Based on CN from SCS TR-55, Table 4-1
4) SCS TR-55, Exhibit 4-II
5) Qp = Vr x DA/640 x PFF
6) $Q = 1.49/n \; A^{5/3} \; Pw^{-2/3} \; S^{1/2}$

$A = 1/2 \, mL \, y^2 + 1/2 \, mR \, y^2 + b \, y$

and

$Pw = [(mL^2 + 1)^{1/2} + (mR^2 + 1)^{1/2}] \, y + b$

7) Top width $T = b + mL \, y + mR \, y$

Conclusion:
The majority of the landfill benches have 1.5% slope.
Conservatively, slope drains will be placed approximately every 3000' for straight sections.

Purpose

To analyze the adequacy of the permitted and constructed culverts at the John E. Amos FGD Landfill for proposed modifications to the pile from the previously approved permit.

References

1. Hydraulic Design Series (HDS) No. 5 "Hydraulic Design of Highway Culverts" Publication No. FHWA-NHI-01-020. May 2005.
2. GAI, 2006. Solid Waste/NPDES Permit Application for the John. E. Amos Landfill.
3. GAI, 2010. "Beaver Plateau Sediment Pond Plan and Details" John E. Amos 2010 Site Work. DWG No. 13-30201-19-3

Methodology

For culverts where hydrologic conditions are proposed to change, the design of previously-permitted existing culverts will be analyzed to determine if the culverts can convey the proposed 25-yr, 24-hr design storm event peak discharge. If the proposed design flow is less than the design flow from the approved permit, the culverts will be assumed to be adequate.

Culverts that are expected to convey an increased design flow will be analyzed using the computer program HY-8, which is based on the methods contained in HDS No. 5 (Reference 1).

Analysis

In comparison with the design flows from the existing permit, only one culvert is to receive an increase in the design flow. The design flows from the existing permit and proposed design flows are as follows:

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gai consultants

PROJECT: AEP - John E. Amos Landfill BY: DMO CHECKED BY: CRM
PROJ. NO.: C130109.03 DATE: Sep-16 DATE: Sep-16

	CN	S	Runoff	Runoff	A (AC)	A (SQ M)	q	FLOW (CFS)	
PCC-1	72.5	3.793	1.8653	1.87	57.5	0.0898	590	99	
PCC-2	73.8	3.550	1.9646	1.96	13.0	0.0203	475	19	
PCC-3	71.9	3.908	1.8203	1.82	66.4	0.1038	455	86	
PCC-4	71.3	4.025	1.7757	1.78	14.0	0.0219	640	25	
PCC-5	72.0	3.889	1.8277	1.83	4.0	0.0063	800	9	
PCC-6	71.9	3.908	1.8203	1.82	13.8	0.0216	650	26	
PCC-7	73.2	3.661	1.9185	1.92	55.5	0.0867	540	90	
PCC-8	71.5	3.986	1.7905	1.79	6.5	0.0102	745	14	
SD-1	72.0	3.889	1.8277	1.83	48.5	0.0758	600	83	Drains to PCC-1
~~SD-2~~	~~72.0~~	~~3.889~~	~~1.8277~~	~~1.83~~	~~7.0~~	~~0.0109~~	~~480~~	~~10~~	
SD-3	72.0	3.889	1.8277	1.83	39.0	0.0609	575	64	Drains to PCC-3
SD-4	72.0	3.889	1.8277	1.83	30.5	0.0477	595	52	Drains to PCC-7
HRC-1	90.0	1.111	3.4053	3.41	3.0	0.0047	1000	16	
~~HRC-2~~	~~90.0~~	~~1.111~~	~~3.4053~~	~~3.41~~	~~1.7~~	~~0.0027~~	~~1000~~	~~9~~	
~~HRC-3~~	~~90.0~~	~~1.111~~	~~3.4053~~	~~3.41~~	~~1.8~~	~~0.0028~~	~~1000~~	~~10~~	
~~HRC-4~~	~~84.5~~	~~1.834~~	~~2.8717~~	~~2.87~~	~~5.6~~	~~0.0088~~	~~760~~	~~19~~	
~~HRC-5~~	~~90.0~~	~~1.111~~	~~3.4053~~	~~3.41~~	~~4.5~~	~~0.0070~~	~~805~~	~~19~~	

Figure 1: Proposed Channel Flow Rates

PROJECT: AEP - SITE 2/3 BY: CRM CHECKED BY:
PROJ. NO.: 04-384 DATE: Sep-05 DATE:

	CN	S	Runoff	Runoff	A (AC)	A (SQ M)	q	FLOW
PCC-1	72.5	3.793	1.8653	1.87	33.4	0.0522	525	51
PCC-2	73.8	3.550	1.9646	1.96	31.1	0.0486	475	45
PCC-3	71.9	3.908	1.8203	1.82	81.5	0.1273	455	105
PCC-4	71.3	4.025	1.7757	1.78	13.8	0.0216	640	25
PCC-5	72.0	3.889	1.8277	1.83	3.5	0.0055	800	8
PCC-6	71.9	3.908	1.8203	1.82	16.2	0.0253	650	30
PCC-7	73.2	3.661	1.9185	1.92	56.3	0.0880	540	91
PCC-8	71.5	3.986	1.7905	1.79	16.2	0.0253	745	34
SD-1	72.0	3.889	1.8277	1.83	32.4	0.0506	347	32
SD-2	72.0	3.889	1.8277	1.83	18.6	0.0291	480	26
SD-3	72.0	3.889	1.8277	1.83	74.1	0.1158	430	91
SD-4	72.0	3.889	1.8277	1.83	31.0	0.0484	595	53
HRC-1	90.0	1.111	3.4053	3.41	1.0	0.0016	1000	5
HRC-2	90.0	1.111	3.4053	3.41	1.7	0.0027	1000	9
HRC-3	90.0	1.111	3.4053	3.41	1.8	0.0028	1000	10
HRC-4	84.5	1.834	2.8717	2.87	5.6	0.0088	760	19
HRC-5	90.0	1.111	3.4053	3.41	4.5	0.0070	805	19

Figure 2: Design Flows from Existing Permit

PCC-1 is the only channel predicted to receive an increase in design flow. This channel provides the only flow to the Beaver Plateau Entrance Culvert (2-36" HDPE pipes), therefore the proposed design flow for the channel will be used as the design flow in the analysis of the existing culvert. .

A printout of the output from the HY-8 analysis can be found in Attachment 1.

The analysis shows the existing Beaver Plateau Entrance Culverts can convey the 99 CFS design flow from PCC-1 with approximately 18 inches of headwater over the top of the pipe (54" of total headwater). This headwater depth will not overtop the surrounding access road or discharge offsite, and is therefore within the capacity of the previously permitted culvert and channel.

Conclusion

The Beaver Plateau Entrance Culvert is the only culvert predicted to receive an increase in design flow due to the proposed modification to the pile at the John E. Amos Landfill. The Beaver Plateau Entrance Culvert is predicted to convey the proposed design flow without overtopping the surrounding access road or discharging offsite.

Attachment 1
HY-8 Report

HY-8 Culvert Analysis Report

Table 1 - Summary of Culvert Flows at Crossing: Beaver Plateau Entrance

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
922.48	50.00	50.00	0.00	1
922.90	65.00	65.00	0.00	1
923.37	80.00	80.00	0.00	1
924.01	95.00	95.00	0.00	1
924.27	100.00	100.00	0.00	1
925.75	125.00	125.00	0.00	1
926.83	140.00	140.00	0.00	1
928.02	155.00	154.49	0.39	20
928.23	170.00	156.84	13.10	7
928.37	185.00	158.35	26.52	5
928.48	200.00	159.62	40.30	5
928.00	154.23	154.23	0.00	Overtopping

Rating Curve Plot for Crossing: Beaver Plateau Entrance

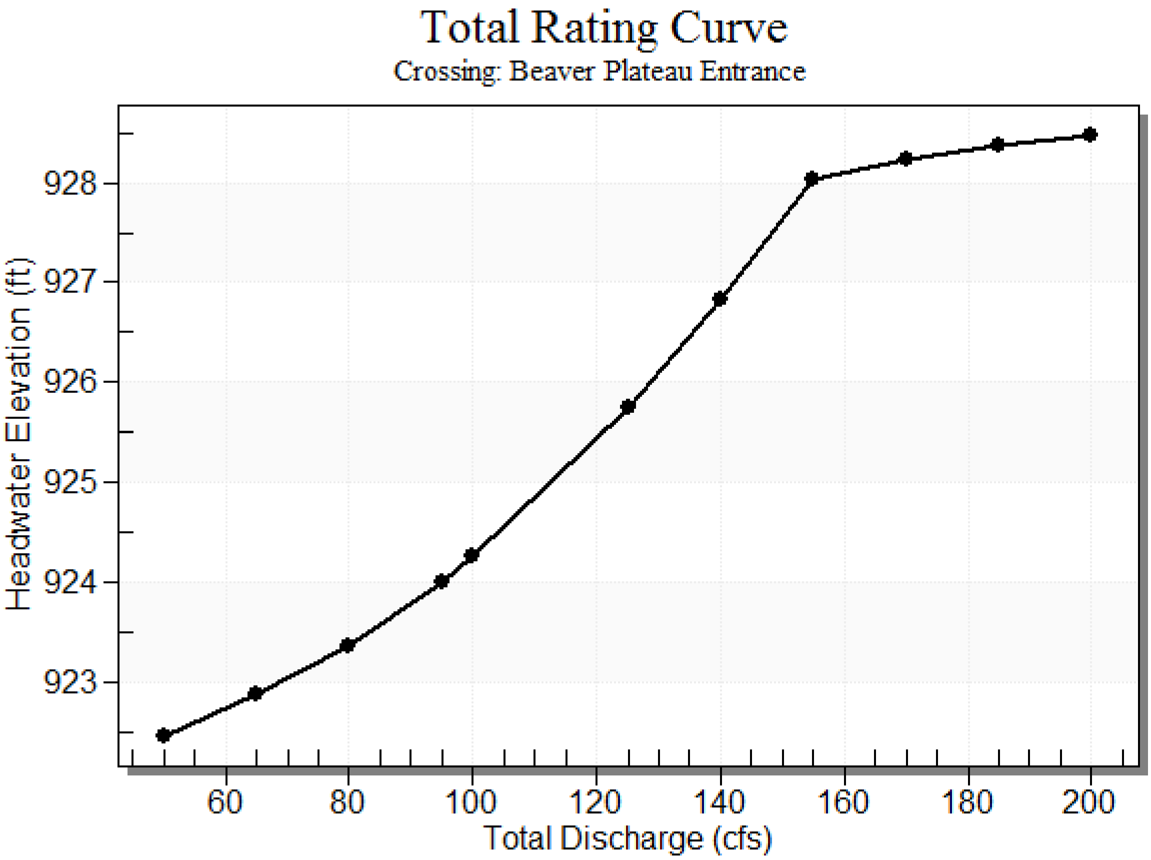


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
50.00	50.00	922.48	2.569	2.827	3-M1t	1.781	1.607	2.560	6.760	3.891	0.000
65.00	65.00	922.90	3.099	3.247	7-M1t	2.148	1.846	2.560	6.760	5.058	0.000
80.00	80.00	923.37	3.685	3.721	3-M2t	2.673	2.056	2.560	6.760	6.226	0.000
95.00	95.00	924.01	4.363	4.272	3-M2t	3.000	2.236	2.560	6.760	7.419	0.000
100.00	100.00	924.27	4.615	4.494	7-M2t	3.000	2.293	2.560	6.760	7.809	0.000
125.00	125.00	925.75	6.096	5.891	7-M2t	3.000	2.526	2.560	6.760	9.761	0.000
140.00	140.00	926.83	7.180	6.849	7-M2c	3.000	2.646	2.656	6.760	10.596	0.000
155.00	154.49	928.02	8.373	7.868	7-M2c	3.000	2.762	2.740	6.760	11.384	0.000
170.00	156.84	928.23	8.579	8.045	7-M2c	3.000	2.781	2.759	6.760	11.579	0.000
185.00	158.35	928.37	8.715	8.159	7-M2c	3.000	2.793	2.758	6.760	11.691	0.000
200.00	159.62	928.48	8.830	8.256	7-M2c	3.000	2.804	2.764	6.760	11.773	0.000

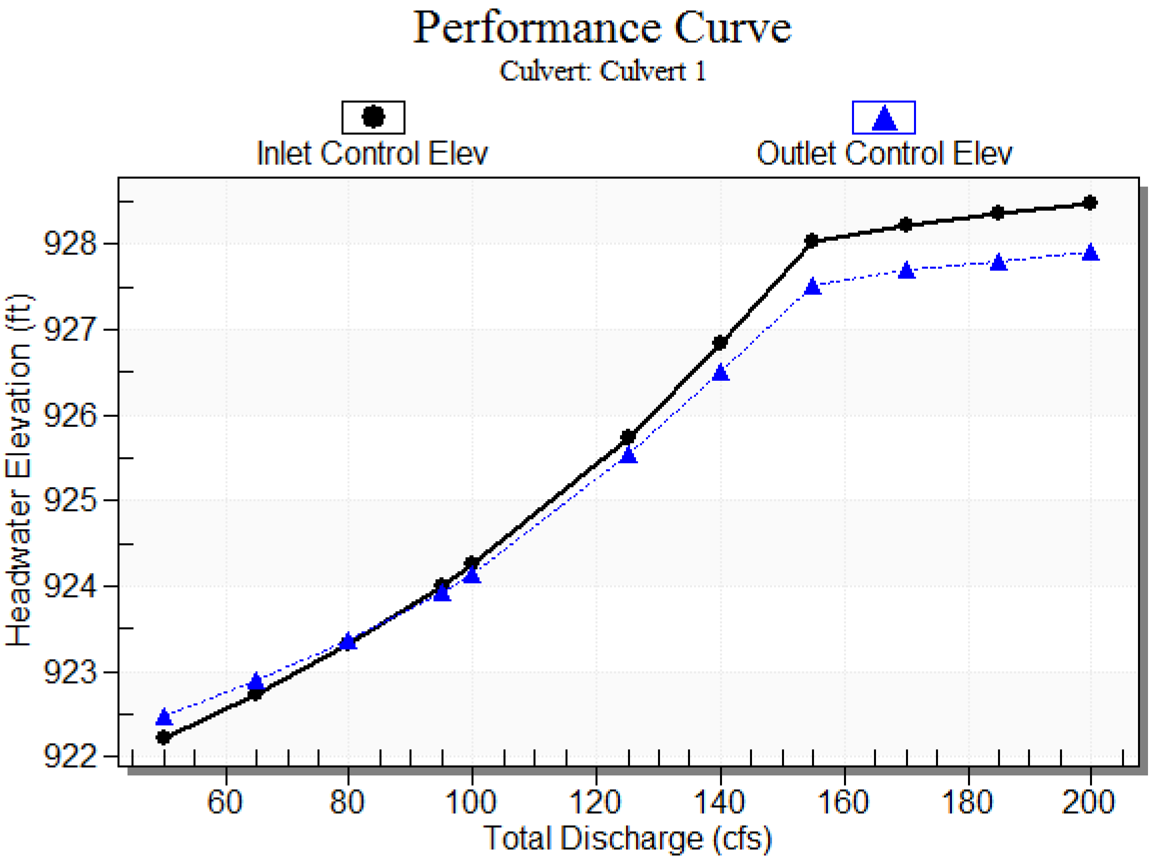
****

Inlet Elevation (invert): 919.65 ft,   Outlet Elevation (invert): 919.20 ft

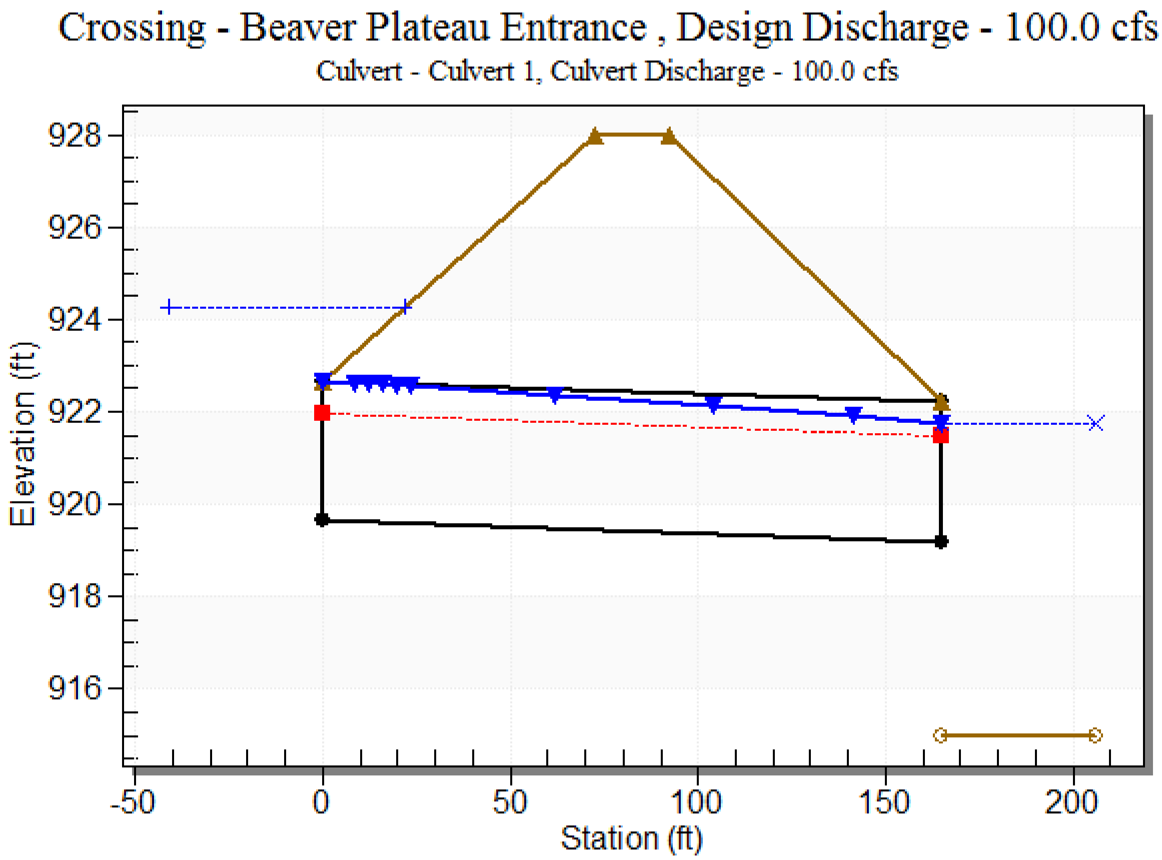
Culvert Length: 165.00 ft,   Culvert Slope: 0.0027

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 919.65 ft

Outlet Station: 165.00 ft

Outlet Elevation: 919.20 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Thin Edge Projecting

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Beaver Plateau Entrance)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
50.00	921.76	6.76
65.00	921.76	6.76
80.00	921.76	6.76
95.00	921.76	6.76
100.00	921.76	6.76
125.00	921.76	6.76
140.00	921.76	6.76
155.00	921.76	6.76
170.00	921.76	6.76
185.00	921.76	6.76
200.00	921.76	6.76

Tailwater Channel Data - Beaver Plateau Entrance

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 921.76 ft

Roadway Data for Crossing: Beaver Plateau Entrance

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 40.00 ft

Crest Elevation: 928.00 ft

Roadway Surface: Paved

Roadway Top Width: 20.00 ft

The accompanying calculations provide the design for the recommended modifications to the South Valley Sediment Collection Pond (South Pond) at the John E. Amos Landfill.

The modifications are recommended so as to improve the effectiveness of the pond to settle out sediments. These calculations incorporate as-built information provided by AEP, and also consideration of the progression of landfill conditions that has occurred, which allows for a re-proportioning of the available storage in the South Pond.

The proposed modifications are as follows:

Raise the design normal pool elevation from 717.3 to 723.3, incorporating the forebay and by raising the principal spillway crest elevation from 723.5 to 727.5

Also contained in this calculation set is worksheet "SSC pond stage-storage", which presents the stage-storage rating for the South Pond, incorporating as-built conditions.

The scenarios analyzed in these calculations are as developed and presented in the permit package for the Amos Landfill, and described below:

Scenario 1 the phase of landfill development at the start of landfill development, when sequences 1A and 1B were under construction and draining to the South Pond. This scenario was determined during analyses for initial permitting of the site to present the most critical development conditions for the South Pond design, and consequently its design parameters were used in the permit application. The conditions for this scenario no longer exist, as landfill development has progressed to sequence 2 conditions.

Scenario 2 the phase of landfill development when sequence 1A is filled to capacity, sequence 1B in near full capacity, sequence 2A is receiving or about to receive CCB waste, sequence 2B is lined, and sequence 3 is disturbed because of site preparation. The South Pond would therefore receive runoff from sequence 3 and stockpiles 5 (clay material) and 6 (topsoil).

Scenario 3 the phase of landfill development when sequence 3 is receiving CCB waste, and is near full capacity. Portions of sequences 1A and 1B, and all of the final piles of sequences 2A and 2B discharge to the South Pond, along with stockpiles 5 (clay material) and 6 (topsoil).

Scenario 4 the phase of landfill development when the largest anticipated drainage to the South Pond would occur, consisting of most of the south valley plus a portion of the north valley pile development that is conveyed back to the South Pond.

Modified to incorporate as-built topo and proposed forebay per 15March2012

[redacted] Modify the Normal Pool Level

Determine the governing criterion to establish the normal pool level in the SSC Pond.
Solid Waste regulations for sediment ponds criterion - based on disturbed area
0.125 ac-ft storage per acre disturbed
NPDES criterion - based on tributary area
1800 cf per acre tributary
Scenarios are described in the worksheet "Calc Brief Sum"
The areas corresponding to each category above for each scenario were obtained from the Solid Waste Permit application package (Scenario 1) and from "Sediment Control and Pond Evaluation Report", GAI Project C110457.00.001, May 2011 (Scenarios 2-4).

Scenario	1	2	3	4	
tributary area (ac)	105.6	43.2	81.4	130.6	*permit application*
tributary area criterion (cf)	190,080	77,760	146,520	235,080	*calc*
disturbed area (ac)	49	25.9	21.7	2.8	*permit application*
disturbed area criterion (cf)	266,805	141,026	118,157	15,246	*calc*
greatest volume required (cf)	266,805	141,026	146,520	235,080	*calc*
controlling criterion	SW	SW	NPDES	NPDES	*calc*
	disturbed	disturbed	tributary	tributary	*calc*

The greatest volume required occurs under Scenario 1, with a volume of 266,805 cf.
Since Scenario 1's time is past, the largest required volume is now 235,080 cf.
Scenario 1 required the highest normal pool level.
Scenario 4 would require a normal pool slightly lower than Scenario 1.

To increase the effectiveness of the pond to settle out sediments, however, the normal pool level shoud be increased, to increase the surface area available.

Estimate the maximum normal pool level, assuming raising the crest of the principal spillway to its maximum allowable elevation.

Evaluate South Sediment Collection Pond with Proposed Forebay

Elevation, existing emergency spillway crest elevation				728.8	ft, MSL	
Minimum vertical height difference between crest elevations of principal and emergency spillways				1	ft, MSL	
Elevation, maximum, principal spillway crest elevation				727.8	ft, MSL	
Pond volume at maximum principal spillway crest elevation				866,598	cf	
elevation	727	volume	808,968	w/ proposed forebay	70,823	surface area
elevation	728	volume	881,005	w/ proposed forebay	73,250	surface area
surface area at maximum principal spillway crest elevation					72,765	sf
Volume requirement between normal pool level and crest elevation of principal spillway				2-yr 24-hr storm runoff volume		
maximum 2-yr 24-hr storm runoff volume, Scenarios 2-4				281,138	cf	
pond volume at maximum normal pool level				585,460	cf	
elevation, modified normal pool level				723.66	ft, MSL	

elevation	723	volume	544,351	w/ proposed forebay
elevation	724	volume	606,993	w/ proposed forebay

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elevation, existing normal pool level	717.29	ft, MSL
increase in normal pool level	6.37	ft

surface area, modified normal pool level	63017.02	sf

elevation	723	surface area	61,468	sf	w/ proposed forebay
elevation	724	surface area	63,815	sf	w/ proposed forebay

Maximum Normal Pool Level	723.66	ft, MSL
Discharge Rate for Existing Skimmers	2.08	cfs
Diameter, Existing Principal Spillway Riser	3.00	ft
Maximum Principal Spillway Riser Crest Elevation	727.80	ft, MSL
Elevation, Existing Emergency Spillway Crest	728.80	ft, MSL

Proposed Normal Pool Level if Elevation of Principal Spillway Crest is Set at a Lower Elevation

Elevation, proposed, principal spillway crest elevation	727.5	ft, MSL
Pond volume at proposed principal spillway crest elevation	844,987	cf

elevation	727	volume	808,968	w/ proposed forebay	70,823	surface area
elevation	728	volume	881,005	w/ proposed forebay	73,250	surface area

surface area at maximum principal spillway crest elevation 72,037 sf

Volume requirement between normal pool level and crest elevation of principal spillway — 2-yr 24-hr storm runoff volume

maximum 2-yr 24-hr storm runoff volume, Scenarios 2-4	281,138	cf
pond volume at maximum normal pool level	563,849	cf
elevation, modified normal pool level	723.31	ft, MSL

elevation	723	volume	544,351	w/ proposed forebay	61,468	surface area
elevation	724	volume	606,993	w/ proposed forebay	63,815	surface area

increase in elevation of normal pool level	6.02	ft
surface area at proposed normal pool level	62,196	sf

This worksheet modified on 12October 2012 to incorporate AEP review comments and to format the submittal package to AEP for permitting purposes. No analyses were changed.
Cells within this worksheet are linked to worksheets "riser crest elev mod" and "SSC POND STAGE-"-STORAGE".

[redacted] **Evaluate Modification of the Crest Elevation of the Principal Spillway Riser** 4/12

EVALUATE SOUTH SEDIMENT COLLECTION POND W/ AS-BUILT TOPO & THE PROPOSED FOREBAY

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REFERENCES

1 "Erosion & Sediment Control Best Management Practices Manual", WVDEP, Division of Water and Waste Management, 2006.
2 "Sediment Control and Pond Evaluation Report", prepared for American Electric Power Service Corporation (AEP) by GAI Consultants, Inc., Project C110457.00.001, May 2011.
3 "Stokes Law calculations", prepared for American Electric Power Service Corporation by GAI Consultants, Inc., Project C091267, August 2010.
4 "Class F Industrial Landfill Facility Application, John E. Amos Landfill" (solid waste permit application, March 2006, volumes 1 (narrative and calculations) and 2 (drawings), GAI Project 2004-384-40.
5 "Sequence 1A 2007 Site Work Construction, John E. Amos Landfill", June 2007, GAI Project C060816-00-001, drawing package
6 as-built topography and elevations provided by AEP, Amos Station

General

1 The discharge systems for the SSC Pond consist of a dewatering device (two Faircloth ® skimmers), a principal spillway (riser and barrel), and an emergency spillway (overflow channel). The SSC Pond was originally designed to handle the 2-year 24-hour runoff volume from the South Valley area under the anticipated development conditions producing the greatest volume of runoff.
2 The WV Best Management Practice manual (REF 1) sets the time for dewatering of sediment ponds from the crest of the principal spillway to the normal pool level at 2-3 days following the end of the storm.
3 The Faircloth® skimmers were designed to provide a dewatering time of 2 days (Ref 2).
4 Scenario 1's time is past, so the most critical parameters for Scenarios 2-4 govern.
(see worksheet "Calc Brief Sum" for description of scenarios)

Summary of Results from Reference 2

SCENARIO	1	2	3	4	
2-Year 24-Hour Storm					
Runoff Volume (cf)	371376	189269	254745	281138	*Ref 2*
Peak Water Elevation (ft)	722.24	719.48	720.38	720.73	*Ref 2*
Height above Riser Crest (ft)	0	0	0	0	*calc*
5-Year 24-Hour Storm					
Runoff Volume (cf)	588496	287009	413397	488132	*Ref 2*
Peak Water Elevation (ft)	723.87	720.94	722.89	723.63	*Ref 2*
Height above Riser Crest (ft)	0.33	0	0	0.09	*calc*
10-Year 24-Hour Storm					
Runoff Volume (cf)	731501	350135	519002	629902	*Ref 2*
Peak Water Elevation (ft)	724.27	721.89	723.7	723.95	*Ref 2*
Height above Riser Crest (ft)	0.73	0	0.16	0.41	*calc*

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25-Year 24-Hour Storm					
Runoff Volume (cf)	942751	442207	676084	844831	*Ref 2*
Peak Water Elevation (ft)	725.28	723.24	724.12	724.6	*Ref 2*
Height above Riser Crest (ft)	1.74	0	0.58	1.06	*calc*

The following information was obtained from the above references, or is calculated from information obtained from those references. Available storage values account for the sediment storage volume below the normal pool level.

Elevation, Normal Pool Level, Existing Pond	717.29	ft	*Ref 2*
Storage at Normal Pool Level	232,169	cf	*interpolated*
elevation 717 storage 218,300 w/ proposed forebay			
elevation 718 storage 266,123 w/ proposed forebay			
Elevation, Crest of Principal Spillway Riser, Existing Pond	723.54	ft	*Ref 2*
Total Storage to Crest of Principal Spillway Riser	578,178	cf	*interpolated*
elevation 723 storage 544,351 w/ proposed forebay			
elevation 724 storage 606,993 w/ proposed forebay			
Available Storage to Crest of Principal Spillway Riser, Existing Pond	346,009	cf	*Ref 2*
Elevation, Crest of Emergency Spillway, as-built conditions	728.8	ft	*Ref 6*
Total Storage to Crest of Emergency Spillway, as-built conditions	940,539	cf	*interpolated*
elevation 728 storage 881,005 w/ proposed forebay			
elevation 729 storage 955,423 w/ proposed forebay			
Available Storage to Crest of Emergency Spillway, as-built cond.	708370	cf	*calc*
Vertical Height between spillway crests, as-built conditions	5.26	ft	*calc*
Minimum Vertical Height Requirement between crests	1	ft	*Ref 1*
Max. Allowable Crest Elevation of Principal Spillway Riser	727.8	ft	*calc*
Max. Allowable height the riser crest can be raised and still maintain the minimum vertical height requirement	4.26	ft	*calc*
Total Storage to Max Allowable P.S. Crest Elevation	866,598	cf	*calc*
727 808,968 *from worksheet "SSC Pond stage storage", w/ propsoed forebay*			
728 881,005 *from worksheet "SSC Pond stage storage", w/ proposed forebay*			
Available Storage to Max Allowable P.S. Crest Elevation	634,429	cf	calc

Scenario	**1**	**2**	**3**	**4**		**critical value**
Question 1	*Can the SSC Pond handle the 2-yr 24-hr runoff volume assuming discharge through the dewatering device (Faircloth ® skimmer)?*					
Crest Elevation of Riser	723.54	723.54	723.54	723.54		
Predicted 2-yr 24-hr WSEL	722.24	719.48	720.38	720.73		
can pond handle 2-yr 24-hr VRO?	yes	yes	yes	yes		
Question 2	*Can the SSC Pond store the 2-yr 24-hr runoff volume below the crest of the principal spillway riser without flow through the Faircloth ® skimmer?*					
Available Storage at Riser Crest	346009	346009	346009	346009		
Predicted 2-yr 24-hr runoff vol.	371376	189269	254745	281138		
can pond store 2-yr 24-hr VRO?	no	yes	yes	yes		

note - scenario 1 conditions no longer are applicable to the south valley. Scenarios 2-4 are present and future conditions. The most critical values of parameters for these scenarios will dictate the pond conditions that will exist, and will determine the amount of modification to pond facilities that may be performed.

Question 3	*What would the crest of the principal spillway riser have to be to be able to store the 2-yr 24-hr runoff volume?*				
2-yr 24-hr VRO	371376	189269	254745	281138	
Total Pond Volume Required	603545	421438	486914	513307	
Minimum Raised Crest Elevation	723.95	720.92	722.05	722.49	**722.49**
interpolation lookup values	723	720	722	722	*(this elevation is lower*
from worksheet "SSC pond stage storage"	544351	370418	484048	484048	*than existing riser*
	724	721	723	723	*crest elevation)*
	606993	426073	544351	544351	
Question 4	*Can the crest of the principal spillway riser be raised without adversely affecting the capacity of the pond to handle the 25-yr 24-hr storm event without discharge through the emergency spillway?*				
Max Allowable Height Increase	4.26	4.26	4.26	4.26	
Required Head on Riser Crest	1.74	0	0.58	1.06	
can crest be raised?	yes	yes	yes	yes	
Question 5	*How much higher (ft) could the crest of the principal spillway riser be raised and the pond still handle the 25-yr 24-hr storm without discharge through the emergency spillway?*				
Max Allowable Height Increase	4.26	4.26	4.26	4.26	
Approx Predicted Head on Riser	1.74	0	0.58	1.06	
Approx Height Increase of Riser	3.52	4.26	4.26	4.2	**4.2**
Approx Raised Riser Crest Elev	727.06	727.8	727.8	727.74	**727.74**

NOTE: routing analyses would predict slightly higher crest elevations, because of the incremental storage being gained in the pond by the raised crest elevation. The above values are approximate, and acceptable for the purposes of these conceptual analyses. For these analyses, AEP's request for no discharge through the emergency spillway for the 25-yr 24-hr storm is assumed.

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Question 6	*Can the pond w/ Question 4 raised principal spillway crest store larger storms?*				
store the 25-yr 24-hr storm?	no	yes	no	no	*store without any*
Approx Raised Riser Crest Elev	727.06	727.74	727.74	727.74	*discharge.*
total pond storage at raised crest	813291	862276	862276	862276	
interpolation lookup values	727	727	727	727	
from worksheet "SSC pond stage storage"	808968	808968	808968	808968	
	728	728	728	728	
	881005	881005	881005	881005	
available pond storage	581122	630107	630107	630107	
25-yr 24-hr runoff volume	942751	442207	676084	844831	
25-yr 24-hr storm elev (peak)	731.78	725.04	728.37	730.57	
	731	725	728	730	
	1111342	671986	881005	1032191	
	732	726	729	731	
	1192923	739314	955423	1111342	

store the 10-yr 24-hr storm?	no	yes	yes	yes	*store without any*
total storage at raised crest	813291	862276	862276	862276	*discharge.*
available pond storage	581122	630107	630107	630107	
10-yr 24-hr runoff volume	731501	350135	519002	629902	
10-yr 24-hr storm elev (peak)	729.11	723.61	726.18	727.74	
	729	723	726	727	
	955423	544351	739314	808968	
	730	724	727	728	
	1032191	606993	808968	881005	

store the 5-yr 24-hr storm?	no	yes	yes	yes	*store without any*
available storage at raised crest	813291	862276	862276	862276	*discharge.*
available pond storage	581122	630107	630107	630107	
5-yr 24-hr runoff volume	588496	287009	413397	488132	
5-yr 24-hr storm elev (peak)	727.17	722.59	724.6	725.72	
	727	722	724	725	
	808968	484048	606993	671986	
	728	723	725	726	
	881005	544351	671986	739314	

Question 6 considers storing the entire volume of the indicated storm, with no discharge through either the Faircloth ® skimmer or through the principal spillway. Since flow through the principal spillway is uncontrolled (occurs automatically when the water level exceeds the crest of the principal spillway riser), a significant portion of a storm (in particular, the 25-yr storm) can be discharged if the head on the principal spillway crest required to pass the 25-yr storm flow can be achieved. The maximum required head is 1.06 *ft. Therefore, the maximum elevation for the principal spillway crest is* 1.06 *ft below the crest of the emergency spillway, or to elevation* 727.74 ft.

Raise the crest of the principal spillway riser by amounts indicated above, up to the limits limits indicated above.

Set Crest of Principal Spillway Riser at Elevation	727.5	ft	*MRL*
this is an increase in vertical height of the riser of	4.2	ft	
modified length of skimmer arm	1.4 x max design head		

this option will require the following steps:

1. remove the trashrack and anti-vortex device
2. Install a section of pipe that will yield the crest elevation indicated above.
   Use a watertight coupler to attach the new section of pipe to the existing riser.
3. reinstall the trashrack and anti-vortex coupler.
4. install extensions to the skimmer arms to compensate for the raised riser crest

errata

Normal (Permanent) Pool Level

Ref 4	*permit package, Drawing 13-30500-19-A (GAI 2004-384-40-E-M024)*	*717.35*	*ft*
Ref 5	*Sequence 1A construction package, June 2007*	*717.29*	*ft*
Ref 2	*"Sediment Control and Pond Evaluation Report", May 2011*	*717.29*	*ft*

A normal pool elevation of 717.29 ft is used in these evaluations. This elevation is drawn

from the construction package (Sequence 1A) that included the South Sediment Collection Pond. It is noted that the elevation of 717.29 would provide slightly less than the Required Permanent Pool Volume under Scenario 1. However, since Scenario 1's time has passed, and its conditions are no longer applicable to the landfill, the matter is now moot as well as effectively insignificant.

design head for existing skimmer		11.51 ft
permanent pool level	717.29	
emergency spillway crest	728.8	
length of existing skimmer arm (1.4 x design head)		17.8 ft

the skimmer arm was originally sized to handle pond levels up to the crest of the emergency spillway. Raising the crest of the principal spillway does not require modification of the skimmer arm length, although the range of floods for which it would operate as the sole discharge device has increased.

design head for modified skimmer		10.21
permanent pool level	717.29	
principal spillway crest	727.5	

minimum length of modified skimmer arm 14.294 ft

the existing length of the skimmer arm is acceptable, and no modification of the skimmer arm is required.

This worksheet modified on 12October2012 to format the submittal package to AEP for permitting purposes. No analyses were changed.

Cells within this worksheet are linked to worksheet SSC POND STAGE-STORAGE.

[redacted] **Addition of a Forebay to the SSC Pond**

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approximate dimensions of the forebay					
elevation, bottom	710	ft			
elevation, crest (normal pool level)	717.29	ft	718		
height	7.29	ft	8	ft	
crest width	4	ft	10	ft	
sideslopes	2	H:1V			
volume per linear foot (cf/lf)	135.4482	cf	208	cf/lf	
approximate length of berm	130	ft	at elev	717.29	ft
				718	
approximate volume of berm	17608	cf	27040	cf	
	652	cy			

Raising the normal pool level can be achieved by raising the bench upon which the skimmer settles upon by the value indicated above.

It is proposed to raise the normal pool level to an elevation of	723.31	ft.
The storage volume corresponding to this proposed normal pool level is	563,849	cf

(see "normal pool mod" worksheet, p. 1)

The normal pool of the existing South Pond as permitted is	717.29	ft
The storage volume corresponding to the existing normal pool level is	232,169	cf

(see "riser crest elev mod", p. 2)

This worksheet modified on 12 October 2012 to incorporate AEP comments and format the submittal package to AEP for permitting purposes. No analyses were changed. Information from other worksheets was added to this worksheet.
Cells within this worksheet are linked to worksheets "normal pool mod" and "riser crest elev mod".

Elevation & Surface Area values taken from "Sediment Control and Pond evaluation Report", May 2011, GAI Project C110457.00.001.
Volumes computed from elevations & surface areas.

DESIGN VALUES

Elevation (ft)	Pond Depth (ft)	Area (sf)	Average Area (sf)	Increm Volume (cf)	Total Volume (cf)	Total Volume (ac-ft)	Total Volume (cy)	Elevation (ft)	Total Volume (cf)		
710	0	0		0	0	0		710	0	712	30927
			15463.5								
712	2	30927		30927	30927	0.709986	1145	712	30927	714	106937
			38005								
714	4	45083		76010	106937	2.454936	3961	714	106937	716	200922
			46992.5								
716	6	48902		93985	200922	4.612534	7442	716	200922	717.29	265623
			50155.5								
717.29	7.29	51409		64701	265623	6.097865	9838	717.29	265623	718	302613
			52099								
718	8	52789		36990	302613	6.947039	11208	718	302613	720	412131
			54759								
720	10	56729		109518	412131	9.461226	15264	720	412131	722	529633
			58751								
722	12	60773		117502	529633	12.1587	19616	722	529633	722.24	544279
			61024								
722.24	12.24	61275		14646	544279	12.49493	20158	722.24	544279	723.54	625704
			62634.5								
723.54	13.54	63994		81425	625704	14.36419	23174	723.54	625704	723.87	646936
			64339								
723.87	13.87	64684		21232	646936	14.85161	23961	723.87	646936	724	655363
			64820								
724	14	64956		8427	655363	15.04506	24273	724	655363	724.25	671669
			65224								
724.25	14.25	65492		16306	671669	15.4194	24877	724.25	671669	724.27	672979
			65513								
724.27	14.27	65534		1310	672979	15.44947	24925	724.27	672979	724.5	688109
			65780.5								
724.5	14.5	66027		15130	688109	15.79681	25486	724.5	688109	724.75	704683
			66295								
724.75	14.75	66563		16574	704683	16.1773	26099	724.75	704683	725	721391
			66831								
725	15	67099		16708	721391	16.56086	26718	725	721391	725.28	740263
			67398.5								
725.28	15.28	67698		18872	740263	16.9941	27417	725.28	740263	726	789561
			68469.5								
726	16	69241		49298	789561	18.12583	29243	726	789561	728	932427
			71433								
728	18	73625		142866	932427	21.40558	34534	728	932427	730	1083862
			75717.5								
730	20	77810		151435	1083862	24.88205	40143	730	1083862	732	1239482
			77810								
732	22	77810		155620	1239482	28.45459	45907	732	1239482		

AEP John E Amos Landfill

South Sediment Collection Pond
Evaluations to Improve Effectiveness
and Storage Capacity -
SSC POND STAGE-STORAGE

GAI Project C110457.00.002
13 June 2011 KLF
rev1 15 March 2012 klf
rev2 20 September 2012 klf

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AS-BUILT VALUES - WITHOUT FOREBAY

Elevation (ft)	Pond Depth (ft)	Area (sf)	Average Area (sf)	Increm Volume (cf)	Total Volume (cf)	Total Volume (ac-ft)	Total Volume (cy)	Elevation (ft)	Total Volume (cf)	interpolation columns elevation	interpolation columns volume
710.7066	0	12,330				0				712	27402
			21,186								
712	1.2934	30,042		27,402	27,402	0.629063	1015	712	27402	713	62570
			35,168								
713	2.2934	40,294		35,168	62,570	1.43641	2317	713	62570	714	104234
			41,664								
714	3.2934	43,033		41,664	104,234	2.392883	3861	714	104234	715	148286
			44,052								
715	4.2934	45,071		44,052	148,286	3.404178	5492	715	148286	716	194353
			46,067								
716	5.2934	47,063		46,067	194,353	4.461731	7198	716	194353	717	242400
			48,047								
717	6.2934	49,031		48,047	242,400	5.564738	8978	717	242400	718	292436
			50,036								
718	7.2934	51,040		50,036	292,436	6.713407	10831	718	292436	719	344506
			52,070								
719	8.2934	53,100		52,070	344,506	7.90877	12759	719	344506	720	398661
			54,155								
720	9.2934	55,209		54,155	398,661	9.151997	14765	720	398661	721	454930
			56,269								
721	10.2934	57,328		56,269	454,930	10.44376	16849	721	454930	722	513336
			58,406								
722	11.2934	59,483		58,406	513,336	11.78457	19012	722	513336	723	573914
			60,578								
723	12.2934	61,673		60,578	573,914	13.17525	21256	723	573914	724	636699
			62,785								
724	13.2934	63,897		62,785	636,699	14.6166	23581	724	636699	725	701733
			65,034								
725	14.2934	66,170		65,034	701,733	16.10957	25990	725	701733	726	769061
			67,328								
726	15.2934	68,485		67,328	769,061	17.65521	28484	726	769061	727	838715
			69,654								
727	16.2934	70,823		69,654	838,715	19.25425	31064	727	838715	728	910752
			72,037								
728	17.2934	73,250		72,037	910,752	20.90799	33732	728	910752	729	985170
			74,418								
729	18.2934	75,585		74,418	985,170	22.61639	36488	729	985170	730	1061938
			76,768								
730	19.2934	77,951		76,768	1,061,938	24.37874	39331	730	1061938	731	1141089
			79,151								
731	20.2934	80,350		79,151	1,141,089	26.1958	42263	731	1141089	732	1222670
			81,581								
732	21.2934	82,811		81,581	1,222,670	28.06864	45284	732	1222670	733	1308508
			85,838								
733	22.2934	88,864		85,838	1,308,508	30.03921	48463	733	1308508	0	0

bottom elevation of 710.7066 determined by trial and error to match CAD tabulation of surface area and volume.

AS-POND WITH PROPOSED FOREBAY

Elevation (ft)	Pond Depth (ft)	Area (sf)	Average Area (sf)	Increm Volume (cf)	Total Volume (cf)	Total Volume (ac-ft)	Total Volume (cy)	Elevation (ft)	Total Volume (cf)	interpolation columns elevation	interpolation columns volume
710.7066	0	0				0				712	21463
			16,595								
712	1.2934	33189		21,463	21,463	0.492723	795	712	21463	713	55790
			34,327								
713	2.2934	35464		34,327	55,790	1.280762	2,066	713	55790	714	92518
			36,728								
714	3.2934	37992		36,728	92,518	2.123921	3,427	714	92518	715	131829
			39,311								
715	4.2934	40629		39,311	131,829	3.026377	4,883	715	131829	716	173763
			41,934								
716	5.2934	43238		41,934	173,763	3.98905	6,436	716	173763	716.43	192595
			43,795								
716.43	5.7234	44351		18,832	192,595	4.421373	7,133	716.43	192595	717	218300
			45,097								
717	6.2934	45843		25,705	218,300	5.011478	8,085	717	218300	718	266123
			47,823								
718	7.2934	49803		47,823	266,123	6.109343	9,856	718	266123	719	317097
			50,974								
719	8.2934	52145		50,974	317,097	7.279545	11,744	719	317097	720	370418
			53,321								
720	9.2934	54496		53,321	370,418	8.503627	13,719	720	370418	721	426073
			55,655								
721	10.2934	56813		55,655	426,073	9.78129	15,780	721	426073	722	484048
			57,975								
722	11.2934	59137		57,975	484,048	11.11221	17,928	722	484048	723	544351
			60,303								
723	12.2934	61468		60,303	544,351	12.49658	20,161	723	544351	724	606993
			62,642								
724	13.2934	63815		62,642	606,993	13.93464	22,481	724	606993	725	671986
			64,993								
725	14.2934	66170		64,993	671,986	15.42668	24,888	725	671986	726	739314
			67,328								
726	15.2934	68485		67,328	739,314	16.97231	27,382	726	739314	727	808968
			69,654								
727	16.2934	70823		69,654	808,968	18.57135	29,962	727	808968	728	881005
			72,037								
728	17.2934	73250		72,037	881,005	20.22509	32,630	728	881005	729	955423
			74,418								
729	18.2934	75585		74,418	955,423	21.93349	35,386	729	955423	730	1032191
			76,768								
730	19.2934	77951		76,768	1,032,191	23.69584	38,229	730	1032191	731	1111342
			79,151								
731	20.2934	80350		79,151	1,111,342	25.5129	41,161	731	1111342	732	1192923
			81,581								
732	21.2934	82811		81,581	1,192,923	27.38574	44,182	732	1192923	733	1278761
			85,838								
733	22.2934	88864		85,838	1,278,761	29.35631	47,362	733	1278761	0	0
					1,277,867	*good agreement with previous CAD-determined values*					

Background

The north area sediment collection pond (NASCP) will collect runoff from the following areas

areas undergoing site preparation (construction of subgrade)
areas undergoing final (and interim, if performed) soil cover (closure)
upland, undisturbed areas unable to be diverted

Therefore, sequence areas and any subdivisions are considered to be one of the following

undisturbed	diverted if possible, otherwise to the NASCP
disturbed, site preparation	to NASCP
disturbed, disposal	to north area leachate holding basin (NALHB)
disturbed, final cover	to NASCP
partially reclaimed, final cover	to NASCP
reclaimed, final cover	to NASCP, operated as a storm water pond

Site Design Conditions

The site conditions for which the NASCP is to operate are as follows:

a sequence with site preparation activities would drain to the NASCP
a sequence being lined, up to the installation of the geomembrane, would drain to the NVSCP (once the geomembrane is installed, measures are installed to collect and convey runoff to the leachate holding basin)
sequences that have active disposal activities, or have not been capped, would drain to the leachate holding basin, and not the sediment collection pond.
sequences with closure activities (once soil has been placed) would drain to the NVSCP

Therefore, two possible scenarios exist,

Scenario 1 operations scenario, during combination of site preparation and lining activities in consecutive sequences, plus undisturbed areas not diverted

Scenario 2 closure scenario, during final closure of the site (not directly related to sequences)

The 2-year 24-hour storm is used as the basis for determining the more critical of the two scenarios. A larger magnitude storm may be used as the design level for the sediment collection pond.

Scenario 1 Determine the combination of sequences undergoing site preparation and lining activities, plus undisturbed non-diverted areas, that produces the greatest volume of runoff. Two options exist under Scenario 1. The first option is to consider each sequence being constructed in its entirety for each construction period. The second option is to consider each sequence being subdivided, in accordance with the current (09Oct2012) construction schedule, and the subdivisions being constructed for each construction period. **NOTE - the current construction schedule follows the second option under Scenario 1.**

Option 1: The NASCP receives runoff from a sequence undergoing subgrade construction, plus runoff from the preceding sequence undergoing initial liner construction. Active waste disposal areas drain to the NALHB. Undisturbed areas will be diverted via the clean water diversion channel/ culvert, or, if unable to be diverted, will drain to the NASCP. Construction is not anticipated in every year under this option.

Option 2: The sequences are subdivided to yield 10 acres or less of subgrade/lining area. This area, plus the subdivision of the preceding sequence that is undergoing initial liner construction, drain to the NASCP. Active waste disposal areas will drain to the NALHB. Undisturbed areas will be diverted via the clean water diversion channel/culvert, or will drain to the NASCP. Option 2 will have reduced runoff volumes, because of the reduced working areas draining to the NASCP.
Option 2 assumes consecutive partial sequence operations, and construction is anticipated every year (current construction schedule).

Scenario 2 Determine the combination of vegetated closed and non-vegetated closed that produces the greatest volume of runoff. Final cover construction is not anticipated until sequence 10 is constructed, and the final slopes are being constructed. The greatest area extent of final closure would occur when the final stage of final cover is being performed.
Final cover is assumed to be placed continuously, as each final bench is completed.
> A maximum of **20** acres is assumed to be undergoing final cover construction at any time. Therefore, of the total drainage area applicable to the final cover scenario:

> **20** acres is assumed to be bare final cover soil
> **20** acres is assumed to be partially revegetated final cover
> remaining acres assumed to be fully-vegetated final cover.

APPLICABLE DESIGN CRITERIA

> in accordance with "Project Design Parameters, Amos CCB Landfill, Amos Power Plant", 2004.

Sediment Storage the larger of the NPDES storage criteria and the E&SC design criteria

> NPDES criteria	3600	cf/acre tributary	of which		
	permanent pool ("wet" volume)			1800	cf/acre tributary
	operating pool ("dry" volume)			1800	cf/acre tributary
> E&SC criteria	0.125	ac-ft/acre disturbed			

Sediment Cleanout Level the level in the pond corresponding to 60 % of the volume in the pond reserved for sediment storage, as determined above.
> Set the sediment cleanout level at the volume corresponding to 60 % of the larger of the Sediment Storage criteria.

Water Quality Storage (Permanent Pool Level) Treat the volume from the larger of the NPDES pond criterion and the runoff from the 2-year 24-hour (or larger) storm under site conditions anticipated to generate the largest runoff volume for that storm.
> Set the crest of the principal spillway at the elevation to store the entire 2-year 24-hour (or larger storm) runoff volume plus the Sediment Storage, without discharge through the principal spillway (over the crest of the principal spillway). The dewatering device (skimmer or other) is allowed to discharge to the principal spillway system.

Forebay AEP has requested that a forebay be provided to improve the settling and cleanout capabilities of the NVSCP. The net volume in the pond is used in the analyses.

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Storm Water Management Handle the runoff from the 10-year 24-hour (or larger) storm without discharge through the emergency spillway. AEP has requested that the pond be designed to prevent discharge through theemergency spillway for the 25-year 24-hour storm and lesser events.
> Set the crest of the emergency spillway to store and discharge only through the principal spillway the runoff volume from the 10-year 24-hour (or larger) storm.

Structure Safety Handle the 25-yr 24-hr (or larger) storm without the structure overtopping.
> Design the emergency spillway to pass the peak flow from the 25-yr 24-hr storm through the pond, with appropriate freeboard.
> Design the structures to not meet the criteria for classification as a dam under WVDEP. Maximum (fill) embankment height, crest of structure to downstream toe, is not to exceed 24 feet, and storage (to crest of embankment) is not to exceed 50 acre-feet.
under WVDEP regulations, a dam is classified as a structure meeting the following criteria:
height >= 25 feet (downstream toe to embankment crest) and
volume >= 15 acre-feet; or
height >= 6 feet and
volume >= 50 acre-feet.

ANALYTICAL METHODS
in accordance with "Project Design Parameters, Amos CCB Landfill, Amos Power Plant", 2004.

Hydrology
> SCS Soil Cover-Complex (Curve Number) Method
the software package HydraFlow Hydrograph is used
> Curve Numbers

active disposal	85
disturbed	90
undisturbed, wooded or fields	70
final cover, partially vegetated	85
final cover, fully vegetated	72

> Time-of-Concentration method SCS segmental method

roughness factor, sheet flow, wooded	0.4
roughness factor, vegetated, non-wooded	0.24
roughness factor, disturbed	0.05

> Precipitation

1-yr 24-hr	2-yr 24-hr	5-yr 24-hr	10-yr 24-hr	25-yr 24-hr	50-yr 24-hr	100-yr 24-hr
2.34	2.65	3.4	3.86	4.51	4.89	5.25

Hydraulics
> Channel Design Manning Equation

Dewatering Time for Sediment Ponds
dewatering time to discharge the water quality volume after end of storm (WV E&S manual, 2006)

minimum time	2	days
maximum time	3	days

Freeboard freeboard is required in accordance with the ES&C criterion

Facilities where H x DA < 400, Freeboard =	1	ft
drainage area(DA) is less than or equal to 400		
Facilities where H x DA > 400, Freeboard =	2	ft

FACILITIES - GENERAL

Existing Treatment Wetlands - to remain to extent practicable (dependent upon layout)
Existing 2/5 Structural Fill Pond - to remain
North Area Sediment Collection Pond (NASCP) - in operation as soon as practicable
North Area Leachate Holding Basin (NALHB) - in operation prior to waste placement in north area
Advanced Treatment System (ATS)
temporary ATS - provision during facilities construction
permanent ATS - installation and operation as soon as practicable
ATS Pad (40' x 100' required footprint for equipment alone)
North Area Leachate Return Pump Station & Control Building (30' x 80' estimated footprint)
includes power facilities (transformer pad, etc) that may be required.
Existing Clean Water Diversion Channel - to remain
Clean Water Diversion Culvert - in place and in operation as soon as practicable
Leachate Collection Pipe
North Area Groundwater Underdrain - to remain
NALHB leachate detection & groundwater underdrains - to gravity discharge to stream

	Minimum cover on pipes (frost protection & structural integrity)	3	ft
	Selected North Area Facilities Layout	4.1	

DESIGN DEVELOPMENT FOR THE NASCP, NALHB, AND OTHER FACILITIES IN THE NORTH AREA

North Area Sediment Collection Pond (NASCP)

1	the north area valley underdrain discharges to the NASCP.		
2	the north area underdrain must remain a free-draining system.		
	Therefore, the invert elevation of the north area underdrain should be at or higher than the elevation of the principal spillway crest.		
GIVEN	Elevation, invert of north area underdrain at toe of landfill	699.4	ft
SET	Assigned Elevation, invert of north area underdrain at NASCP	699.0	ft
SET	Elevation of principal spillway crest	699.5	ft
	(a higher elevation may be permissible, recognizing potential risk of backwater in the valley underdrain pipe and rock drain, and the varying levels of such risk over the life of the landfill.)		
3	West Virginia DEP classifies a dam as meeting the following criteria		
REG	25 ft in height or more and more than 15 acre-feet storage - AEP criterion <= 24 feet (JM-N)		
REG	6 ft in height or more and more than 50 acre-feet storage		
	dam height is measured from the downstream toe to the crest of the embankment		
	storage is measured to the crest of the embankment		
4	the NASCP will have a storage greater than 15 acre-feet, but less than 50 acre-feet		
	Therefore, the height of the NASCP must be less than 25 feet		
SET	maximum height of the NASCP embankment	24	ft
5	Elevation, existing ground at/near downstream toe of embankment	685	ft
SET	maximum Elevation, crest of NASCP embankment	709	ft
	Therefore, the usable storage in the NASCP will be between elevations		
	elevation, bottom of pond	685.0	ft
	elevation, crest of principal spillway	699.5	ft
6	the selected layout for the north area facilities is Layout	4.1	
7	The area selected for the ATS is on the hillside to the east of the proposed NASCP, and		

	adjacent to the 2/5 structural fill pond		
8	The ATS pad access will be a loop around the NASCP		
9	road grades are preferably 5% or less, maximum of 8%		
	grades for the "ridge" road and for pond access ramps may be steeper		
10	Elevation, crest of the 2/5 structural fill pond embankment	712	ft
11	the NASCP embankment will need to tie into the 2/5 pond embankment		
	to facilitate access to the ATS pad within roadway slope preferences		
SET	Elevation, ATS pad	712	ft
SET	Elevation, NASCP embankment	709	ft
12	Excavation slope for mass hillside excavation	2	H:1V
13	Fill slope for NASCP - downstream slope face	2.5	H:1V
14	minimum "water quality" volume (volume above Sediment Storage Level and below principal spillway crest level) by regulation is 2-year 24-hour storm runoff.		
15	the "water quality" volume is discharged via Faircloth©/equivalent skimmers and/or ATS only.		
16	AEP desires "water quality" volume to be 10-year 24-hour storm runoff volume.		
17	AEP has requested a forebay be created in the NASCP.		

Outflow Conditions from the Sed Pond

Principal Spillway system - riser and barrel, with Faircloth© skimmer(s) on riser

discharge to clean water diversion channel/culvert/existing or reconfigured stream channel

minimum vertical distance, crest elevations of principal & emergency spillways	1	ft

riser has anti-vortex device to maintain weir flow to extent practicable

minimum slope of the barrel pipe	0.005	ft/ft

the invert elevation of the barrel at the riser is set equal to the invert elevation of the pond

Emergency Spillway system - discharge to the clean water diversion channel, the clean water diversion channel culvert, or to the downstream valley

North Area Leachate Holding Basin (NALHB)

1	The NALHB receives flow from the north area leachate collection pipe		
2	Elevation, invert of north area leachate collection pipe at landfill toe	715	+/-
3	The north area leachate collection pipe is proposed to run beneath the access road, to discharge into the NALHB.		
4	The NALHB is sized to store, without discharge, the predicted maximum 30-day leachate volume, which includes an annual average storm runoff volume for 30 days from 30 open acres.		
5	An emergency overflow is proposed for the NALHB. The overflow crest is set one foot below the crest of the NALHB embankment crest elevation. There is no regulatory requirement for an emergency overflow. The NALHB includes the regulatory 2 feet of minimum freeboard, with the emergency overflow set at or above the freeboard level.		

A layout for the NALHB was made, considering running the north area leachate collection pipe beneath the access road at a nominal slope to the NALHB. A drop manhole is proposed at the landfill toe to enable sufficient cover to be on the pipe for its entire length under the access road.

SET	Elevation, bottom of NALHB	685	ft
SET	Elevation, 30-day leachate volume level	696	ft
SET	Elevation, crest of emergency overflow	698	ft
SET	Elevation, crest of NALHB embankment	699	ft

ATS

URS has proposed, and AEP has requested, that the ATS pad be relocated to be adjacent to the NASCP and the sequence 2-5 structural fill pond. This location reduces pumping and piping requirements for the ATS. To access the ATS pad at this location, the pad elevation would need to be consistent with the crest of the sequence 2-5 fill pond. The access road will therefore need to meet performance capabilities of the anticpated trucks servicing the ATS, the site constraints due to the sequence 2-5 fill pond embankment, and maintaining the maximum height of the NASCP embankment to no more than 24 feet, per AEP request.

SET	Elevation, ATS pad	712	ft
SET	Elevation, downstream toe of NASCP embankment	685	ft
SET	maximum allowable height (crest to downstream toe)	709	ft
SET	Elevation, Crest of NASCP embankment		
	Assume a depression in the service road to serve as the emergency spillway for the NASCP.		
SET	Slope, crest of NASCP to ATS pad	10	%

Clean Water Diversion Culvert

approximate invert elevation exiting the landfill area	703.5	ft
design minimum slope	0.005	ft/ft
manholes at changes in vertical and horizontal alignment		
energy dissipator at outlet		

North Area Sediment Collection Pond (NASCP)

The two scenarios described in the worksheet "design basis' are evaluated.

Scenario 1 Operations Scenario
Determine the combination of sequences undergoing site preparation and lining activities, plus undiverted, undisturbed areas, that produces the greatest volume of runoff.

Scenario 2 Closure Scenario
Determine the combination of closed vegetated, partially-vegetated, and soil capped areas that produce the greatest volume of runoff.

Scenario 1 Operations Scenario

The following table lists the north valley sequences, their footprint (areas), and the anticipated undisturbed areas that may or may not be diverted from the NASCP.
The undisturbed areas are labeled according to the analysis for the clean water diversion channel.
It is assumed that the northside areas will be diverted from the NASCP, but the southside areas will drain to the NASCP.
Scenario 1 is analyzed considering the sequences are subdivided and constructed in smaller areas, per the current construction schedule (09October 2012).
the north area is subdivided into subsheds for the analyses. The subareas do not correspond to the landfill sequences.

subarea	0	1	2	3	4	5a	5b
area (ac)	15.16	13.64	44.81	19.77	22.54	10.34	18.8

TABLE 1 SUMMARY OF SEQUENCES - OPTION 1

Sequence	Footprint (acres)	Sequence in Site Prep	Sequence in Lining	Disturbed Area (ac)	Undisturbed Areas northside	areas	southside	areas	undisturbed to NASCP
4	24.2	4	*	24.2	0,1,2,3,4	115.92	5A, 5b	29.14	29.14
5	18.5	5	4	42.7	2, 3, 4	87.12	5b	18.8	18.8
6	27	6	5	45.5	3, 4	42.31	5b	18.8	18.8
7	15.4	7	6	42.4	3, 4	42.31	5b	18.8	18.8
8	17.9	8	7	33.3	4	22.54	5b	18.8	18.8
9	14.2	9	8	32.1	4	22.54	---	0	0
10	18.5	10	9	32.7	---	0	---	0	0
10	18.5	---	10	18.5	---	0	---	0	0

** sequence 3, drains to South Area Sediment Collection Pond or South Area Leachate Holding Basin*

Calculate the Required Water Quality Storage in the NASCP Under Scenario 1

the 2-yr 24-hr storm runoff from consecutive sequences is computed in table 2, following the Design Basis

Curve Numbers

disturbed	90
undisturbed, wooded	70
final cover, bare soil	90
final cover, partially vegetated	85
final cover, fully vegetated	72

Precipitation - 24-hour duration

1-yr 24-hr	2-yr 24-hr	5-yr 24-hr	10-yr 24-hr	25-yr 24-hr	50-yr 24-hr	100-yr 24-hr
2.34	2.65	3.4	3.86	4.51	4.89	5.25

Runoff Computation VRO = $(P - 0.2S)^2 / (P + 0.8S)$

	CN	1-yr 24-hr	2-yr 24-hr	5-yr 24-hr	10-yr 24-hr	25-yr 24-hr	50-yr 24-hr	100-yr 24-hr
		2.34	2.65	3.4	3.86	4.51	4.89	5.25
from disturbed areas	90	1.39	1.67	2.35	2.79	3.41	3.77	4.12
from undisturbed areas	70	0.38	0.53	0.95	1.24	1.68	1.96	2.22
final cover, bare soil	90	1.39	1.67	2.35	2.79	3.41	3.77	4.12
final cover, partially vegetated	85	1.05	1.3	1.93	2.33	2.92	3.27	3.6
final cover, vegetated	72	0.45	0.61	1.06	1.36	1.83	2.11	2.39

Scenario 1 - with Sequence Development per Current Construction Schedule

The south valley landfill development has occurred with the individual sequences being subdivided into smaller areas. The current (09 Oct 2012) construction schedule for similar north valley landfill development is given below. The areas for the sequence subdivisions are distributed equally (halves or thirds, as applicable).

TABLE 2 SUMMARY OF SCHEDULED SUBDIVIDED SEQUENCES - OPTION 2

Construction Year	Subdivided Sequence and Approximate Area (acres)														
	4A	4B	5A	5B	6A	6B	6C	7A	7B	8A	8B	9A	9B	10A	10B
	12.1	12.1	9.25	9.25	9	9	9	7.7	7.7	8.95	8.95	7.1	7.1	9.25	9.25
2013															
2014															
2015															
2016	subgrade														
2017	liner	subgrade													
2018	disposal	liner	subgrade												
2019		disposal	liner	subgrade	subgrade										
2020			disposal	liner	liner	subgrade									
2021				disposal	disposal	liner	subgrade								
2022						disposal	liner	subgrade							
2023							disposal	liner	subgrade						
2024								disposal	liner	subgrade					
2025									disposal	liner	subgrade				
2026										disposal	liner	subgrade			
2027											disposal	liner	subgrade		
2028												disposal	liner	subgrade	
2029													disposal	liner	subgrade
2030														disposal	liner
2031															disposal

TABLE 2 - SUMMARY OF SUBDIVIDED SEQUENCE ACTIVITY - PER CURRENT CONSTRUCTION SCHEDULE

Sequence	Footprint (acres)	Sequence in Site Prep	Sequence in Lining	Disturbed Area (ac)	Undisturbed Areas northside	areas	southside	areas	Total Area to NASCP disturbed	undisturb
4A	12.1	4A	---	12.1	1, 2, 3, 4	115.92	5A, 5b	29.14	12.1	29.14
4B	12.1	4B	4A	24.2	0,1,2,3,4	115.92	5A, 5b	29.14	24.2	29.14
5A	9.25	5A	4B	21.35	2, 3, 4	87.12	5b	18.8	21.35	18.8
5B+6A	18.25	5B+6A	5A	27.5	2, 3, 4	87.12	5b	18.8	27.5	18.8
6B	9	6B	5B+6A	27.25	3, 4	42.31	5b	18.8	27.25	18.8
6C	9	6C	6B	18	3, 4	42.31	5b	18.8	18	18.8
7A	7.7	7A	6C	16.7	3, 4	42.31	5b	18.8	16.7	18.8
7B	7.7	7B	7A	15.4	3, 4	42.31	5b	18.8	15.4	18.8
8A	8.95	8A	7B	16.65	4	22.54		0	16.65	0
8B	8.95	8B	8A	17.9	4	22.54		0	17.9	0
9A	7.1	9A	8B	16.05	4	22.54		0	16.05	0
9B	7.1	9B	9A	14.2	4	22.54		0	14.2	0
10A	9.25	10A	9B	16.35		0		0	16.35	0
10B	9.25	10B	10A	18.5		0		0	18.5	0
10B	9.25	---	10B	9.25		0		0	9.25	0

Sequence	Consecutive Totals to NASCP (acres)		Sequence Activity		2-yr 24-hr runoff volume (cf)			5-yr 24-hr runoff volume (cf)			10-yr 24-hr runoff volume (cf)		
	disturbed	undisturb	subgrade	liner	disturbed	undisturb	total	disturbed	undisturb	total	disturbed	undisturb	total
4A	12.1	29.14	4A	---	73,351	56,062	129,413	103,219	100,489	203,708	122,545	131,165	253,710
4B	24.2	29.14	4B	4A	146,703	56,062	202,765	206,438	100,489	306,927	245,090	131,165	376,255
5A	21.35	18.8	5A	4B	129,426	36,169	165,595	182,126	64,832	246,958	216,226	84,623	300,849
5B+6A	27.5	18.8	5B+6A	5A	166,708	36,169	202,877	234,589	64,832	299,421	278,512	84,623	363,135
6B	27.25	18.8	6B	5B+6A	165,192	36,169	201,361	232,456	64,832	297,288	275,980	84,623	360,603
6C	18	18.8	6C	6B	109,118	36,169	145,287	153,549	64,832	218,381	182,299	84,623	266,922
7A	16.7	18.8	7A	6C	101,237	36,169	137,406	142,459	64,832	207,291	169,133	84,623	253,756
7B	15.4	18.8	7B	7A	93,356	36,169	129,525	131,370	64,832	196,202	155,967	84,623	240,590
8A	16.65	0	8A	7B	100,934	0	100,934	142,033	0	142,033	168,626	0	168,626
8B	17.9	0	8B	8A	108,512	0	108,512	152,696	0	152,696	181,286	0	181,286
9A	16.05	0	9A	8B	97,297	0	97,297	136,915	0	136,915	162,550	0	162,550
9B	14.2	0	9B	9A	86,082	0	86,082	121,133	0	121,133	143,813	0	143,813
10A	16.35	0	10A	9B	99,115	0	99,115	139,474	0	139,474	165,588	0	165,588
10B	18.5	0	10B	10A	112,149	0	112,149	157,814	0	157,814	187,362	0	187,362
10B	9.25	0	---	10B	56,074	0	56,074	78,907	0	78,907	93,681	0	93,681

Maximum predicted 2-year 24-hour runoff volume 202,877 cf cf, and occurs when
sequence 4B is subgrade, and sequence 4A is in lining. Disturbed Area = 24.2 acres Undisturbed Area = 29.16 acres
The design criterion for the 2-year 24-hour runoff volume to the NASCP under Scenario 1 Option 2 is adopted for design, because it reflects the current anticipated construction schedule.
The Required Water Quality Storage Volume is 202,877 cf for Scenario 1, Option 2.
This volume is considered to be more representative of the water quality storage volume required, because it is based on the planned construction schedule.

Scenario 2 Closure Scenario

The estimated total area draining to the NASCP at closure conditions is 84.5 acres.
A portion of this area will be vegetated under final closure, as the outside faces are completed. The remaining areas will be in various stages of being reclaimed (final grading, seeding and mulching, etc).
To date, final cover has not been placed at the Amos Landfill. Therefore, no representative values of area closed in a given year are known.
For the purposes of this evaluation, the area that would be disturbed is estimated as that area that would be expected to be closed in a single construction season.
The greatest area draining to the NASCP would be at the final stage of final closure, while the yearly area undergoing closure would not vary signficantly.
AEP has expressed its desire that this area be limited to 20 acres. An additional 20 acres is assumed to be partially vegetated, and the remaining area is assumed to be fully vegetated. These values include some allowance for stockpile areas.

bare cover soil area	20	acres
partial-vegetated area	20	acres
vegetated area	44.5	acres
undisturbed area	0	acres
disturbed area	0	acres

The predicted 2-year 24-hour runoff volume is

bare cover soil area	121,242	cf
partial-vegetated area	94,380	cf
vegetated area	98,536	cf
undisturbed area	0	cf
disturbed area	0	cf
total runoff volume	314,158	cf

COMPARISON OF SCENARIO 1 (OPTION 2 ONLY) TO SCENARIO 2

Predicted Water Quality Storage required under Scenario 1, Condition 2	202,877	cf
Predicted Water Quality Storage required under Scenario 2	314,158	cf

Required Water Quality Volume	314,158	cf
Scenario	Scenario 2	

DESIGN CRITERIA

The design criteria for sizing the Sediment Storage requirements of the NASCP will be governed by Scenario 2
The design parameters for based on the following land cover distribution:

bare cover soil area	20	acres
partial-vegetated area	20	acres
vegetated area	44.5	acres
undisturbed area	0	acres
disturbed area	0	acres

SEDIMENT or "WET" VOLUME

the two criteria for the Sediment Storage or Permanent Pool are the Solid Waste regulations and the NPDES "Wet" Volume / "Permanent Pool" Volume

Solid Waste regulations	217,800	cf	NPDES "Wet" Volume	152,100	cf	(Permanent Pool)
	0.125	ac-ft/acre disturbed		1800	cf/tributary acre	
	40	acres		84.5	acres	

The larger value is based on	the E&SC criterion	217,800	cf

SEDIMENT CLEANOUT VOLUME

60 % of Sediment Storage

Sediment Cleanout Volume =	130,680	cf

WATER QUALITY VOLUME

WV solid waste regulations require treatment for the runoff volume from the 2-year 24-hour storm. AEP has requested that the pond provide sufficient volume to store the runoff from the 10-year 24-hour storm. Therefore, the principal spillway should not discharge for the larger of the 10-year 24-hour storm runoff or the NPDES "Dry" Volume.

				2-yr 24-hr storm		5-yr 24-hr storm		10-yr 24-hr storm		25-yr 24-hr storm		50-yr 24-hr storm		100-yr 24-hr storm	
				2.65	inches	3.4	inches	3.86	inches	4.51	inches	4.89	inches	5.25	inches
land cover	area	CN	S	Vro (inch)	Vro (cf)	Vro (inch)	Vro (cf)	Vro (inch)	Vro (cf)	Vro (inch)	Vro (cf)	Vro (inch)	Vro (cf)	Vro (inch)	Vro (cf)
bare cover soil area	20	90	1.11	1.67	121,242	2.36	171,336	2.79	202,554	3.41	247,566	3.77	273,702	4.12	299,112
partial-vegetated area	20	85	1.76	1.3	94,380	1.93	140,118	2.34	169,884	2.92	211,992	3.27	237,402	3.6	261,360
vegetated area	44.5	72	3.89	0.61	98,536	1.06	171,227	1.36	219,688	1.83	295,609	2.11	340,839	2.39	386,069
undisturbed area	0	70	4.29	0.53	0	0.95	0	1.24	0	1.68	0	1.95	0	2.22	0
disturbed area	0	90	1.11	1.67	0	2.36	0	2.79	0	3.41	0	3.77	0	4.12	0
Storm Criterion				TOTAL =	314,158	TOTAL =	482,681	TOTAL =	592,126	TOTAL =	755,167	TOTAL =	851,943	TOTAL =	946,541

NPDES "Dry" Volume	152,100	cf	700,481	809,926
	1800	cf/acre		
	84.5	acres		

Water Quality Volume =	592,126	cf	the larger value is based on the	10-yr 24-hr criterion	

FOREBAY

A forebay is desired in the pond. The forebay will provide additional treatment capability, and also facilitate pond cleanout when coordinated with the pond access.
The crest of the embankment creating the forebay is assumed to be above the permanent pool level, with a ramp section allowing access to the bottom of the pond.
The forbay is to be constructed of rock, with a wear course of aggregate to facilitate equipment traffic.
The following dimensions are used for the forbay, based on discussions with plant personnel on cleanout procedures and equipment

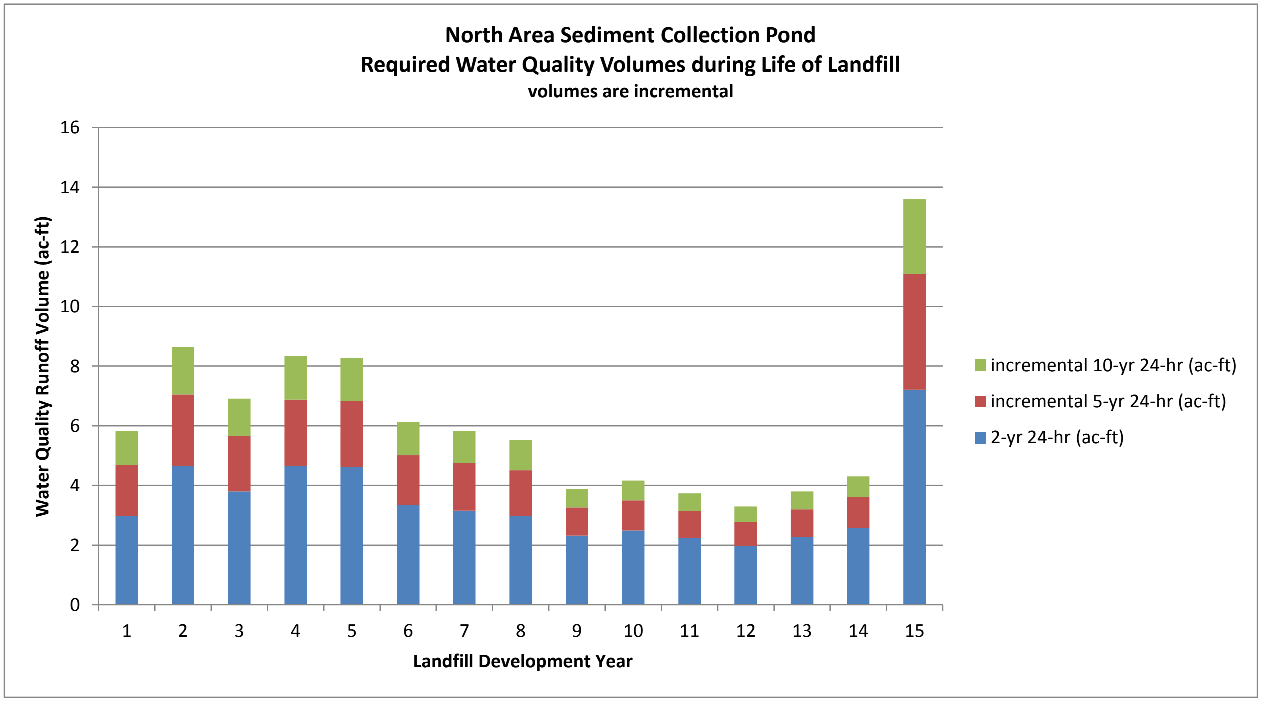
top width	25	ft
sideslopes	2	H:1V

CREST OF SEDIMENT COLLECTION POND

the ATS is proposed to be situated adjacent to the NASCP and the 2/5 Structural Fill Pond. The proposed elevation of the ATS pad is 712 which is the elevation of the crest of the 2/5 structural fill pond. The downstream toe elevation of the NASCP would be approximately 685 and the maximum height of the embankment (to avoid classification of the NASCP as a dam) is therefore 709 ft.

table of plotting values

Sequence	Runoff and Incremental Runoff Volumes			
	2-yr 24-hr (ac-ft)	incremental 5-yr 24-hr (ac-ft)	incremental 10-yr 24-hr (ac-ft)	
4A	2.970914	1.705579	1.147888	*add 2-yr value to 5-yr value to get 5-yr 24-hr runoff volume, add 5-yr value to 10-yr value to get 10-yr 24-hr runoff volume*
4B	4.654844	2.39123	1.5915519	
5A	3.801538	1.867837	1.2371671	
5B+6A	4.657415	2.216345	1.4626722	
6B	4.622612	2.202181	1.4535124	
6C	3.335331	1.678007	1.114348	
7A	3.154408	1.604339	1.0666896	
7B	2.973485	1.530693	1.0190083	
8A	2.317126	0.943503	0.6104913	
8B	2.491093	1.014325	0.6563361	
9A	2.233632	0.909504	0.5884986	
9B	1.976171	0.80466	0.5206612	
10A	2.275367	0.926515	0.5994949	
10B	2.574587	1.048324	0.6783287	
Closure Scenario	7.212083	3.86875	2.5125	*critical design condition*



Elevation-Surface Area-Volume table obtained from CADD

NORTH AREA SEDIMENT COLLECTION POND **LAYOUT** **4.1** *13-Jun-13*

interior sideslopes 2.5 H:1V exterior sideslopes 2.5 H:1V

Elevation	Depth (ft)	Surface Area (sf)	Average Area (sf)	Increm. Volume (cf)	Cumul. Volume (cf)	Interp. Elevations (ft) lower	upper	Cumul. Volume (ac-ft)
685	0	35,376		0	0	685	686	0
			36,611					
686	1	37,845		36,611	36,611	686	687	0.84
			39,102					
687	2	40,359		39,102	75,713	687	688	1.738
			41,647					
688	3	42,935		41,647	117,360	688	689	2.694
			44,254					
689	4	45,573		44,254	161,614	689	690	3.71
			46,924					
690	5	48,274		46,924	208,538	690	691	4.787
			49,655					
691	6	51,035		49,655	258,193	691	692	5.927
			52,447					
692	7	53,859		52,447	310,640	692	693	7.131
			57,501					
693	8	61,143		57,501	368,141	693	694	8.451
			62,285					
694	9	63,426		62,285	430,426	694	695	9.881
			64,582					
695	10	65,737		64,582	495,008	695	696	11.364
			66,907					
696	11	68,076		66,907	561,915	696	697	12.9
			69,234					
697	12	70,392		69,234	631,149	697	698	14.489
			71,567					
698	13	72,741		71,567	702,716	698	699	16.132
			73,939					
699	14	75,137		73,939	776,655	699	700	17.83
			76,350					
700	15	77,562		76,350	853,005	700	701	19.582
			78,797					
701	16	80,031		78,797	931,802	701	702	21.391
			81,288					
702	17	82,545		81,288	1,013,090	702	703	23.257
			83,818					
703	18	85,091		83,818	1,096,908	703	704	25.182
			86,385					
704	19	87,679		86,385	1,183,293	704	705	27.165
			88,989					

705	20	90,299		88,989	1,272,282	705	706	29.208
			92,098					
706	21	93,897		92,098	1,364,380	706	707	31.322
			95,696					
707	22	97,495		95,696	1,460,076	707	708	33.519
			99,294					
708	23	101,093		99,294	1,559,370	708	709	35.798
			102,892					
709	24	104,691		102,892	1,662,262	709		38.16

the area values for elevations 707 -709 are extrapolated based on the areas at elevations 705-706.

ESTABLISH DESIGN LEVELS (ELEVATIONS) IN THE SEDIMENT COLLECTION POND

Required Permanent Pool Volume		217,800	cf	*"sed pond analyses" cell G174*		
Required Sediment Cleanout Volume		130,680	cf	*"sed pond analyses" cell E178*		
Storm Event	2-yr 24-hr	5-yr 24-hr	10-yr 24-hr	25-yr 24-hr	50-yr 24-hr	100-yr 24-hr
Runoff Volumes (cf)	314,158	482,681	592,126	755,167	851,943	946,541

Bottom Of Pond		685	ft	*cell A8*	
Design Sediment Cleanout Elevation					
Required Sediment Cleanout Volume		130,680	cf		
lower interp elevation	688	lower interp volume	117,360	lower interp area	42935
upper interp elevation	689	upper interp volume	161,614	upper interp area	45573
Minimum Sediment Cleanout Elevation		688.3	ft		
DESIGN SEDIMENT CLEANOUT ELEVATION			688.3	ft	*roundup to nearest tenth*
DESIGN SEDIMENT CLEANOUT SURFACE AREA			43,726	sf	
DESIGN SEDIMENT CLEANOUT VOLUME			130,636	cf	

Design Permanent Pool Elevation = Sediment Storage Level					
Required Sediment Storage Volume		217,800	cf		
Design Minimum Sediment Storage Volume		217,800	cf	*based on DESIGN SED CLEANOUT*	
lower interp level	690	lower interp vol	208,538	lower interp area	48274
upper interp level	691	upper interp vol	258,193	upper interp area	51035
Minimum Sediment Storage Elevation			690.19	ft	
DESIGN PERMANENT POOL ELEVATION			690.2	ft	*roundup to nearest tenth*
DESIGN PERMANENT POOL SURFACE AREA			48,826	sf	
DESIGN PERMANENT POOL VOLUME			218,469	cf	

Principal Spillway Crest Elevation

Required Sediment Storage Volume		217,800	cf		
Design Sediment Storage Volume		218,469	cf	*cell F86*	
Water Quality Volume		592,126	cf	*layout 4.1, 10-yr 24-hr runoff volume*	
total volume to crest		810,595	cf		
lower interp level	699	lower interp vol	776,655	lower interp area	75137
upper interp level	700	upper interp vol	853,005	upper interp area	77562
Minimum Principal Spillway Crest Elevation			699.44	ft	
DESIGN PRINCIPAL SPILLWAY CREST ELEVATION			699.5	ft	*roundup to nearest tenth*
DESIGN PRINCIPAL SPILLWAY CREST SURFACE AREA			76,350	sf	
DESIGN PRINCIPAL SPILLWAY CREST VOLUME			814,830	CF	

Emergency Spillway Crest Elevation

The emergency spillway crest must be at least 1 ft above the principal spillway crest
"layout design dev" cell C68

per AEP request, the emergency spillway is not to discharge for events less than the 25-year 24-hour storm.
To facilitate physical layout of the ATS and the pond crest, set the emergency spillway at the anticipated maximum allowable level.

Minimum Emergency Spillway Crest Elevation	700.5	ft	
Embankment Crest of Sed Pond for Layout 4.1	709	ft	*Preliminary*
Maximum Height of Sed Pond Embankment	24	ft	*Preliminary*
Drainage Area to Sed Pond	84.5	acres	
Minimum Freeboard Requirement	2	ft	*for DA x H > 400*
Assume design depth of flow in emergency spillway	1	ft	

DESIGN EMERGENCY SPILLWAY CREST ELEVATION			706	ft	
DESIGN EMERGENCY SPILLWAY CREST SURFACE AREA			93,897	ft	
lower interp level	706	lower interp vol	1,364,380	lower interp area	93897
upper interp level	707	upper interp vol	1,460,076	upper interp area	97495
DESIGN EMERGENCY SPILLWAY CREST VOLUME			1,364,380	cf	
lower interp level	706	lower interp vol	1,364,380	lower interp area	93897
upper interp level	707	upper interp vol	1,460,076	upper interp area	97495

Volume in the sed pond available for runoff prior to flow through the emergency spillway

DESIGN EMERGENCY SPILLWAY CREST VOLUME	1,364,380	cf
DESIGN PERMANENT POOL/SEDIMENT STORAGE VOLUME	218,469	cf
available storage for larger storms	1,145,911	cf

Elevation in Pond for Selected Storm Events

Storm	Runoff Volume	Total Volume	Elevation (approx)	interpolation elevations and volumes lower elev	lower vol	upper elev	upper vol
2-yr 24-hr	314,158	531,958	695.6	695	495008	696	561915
5-yr 24-hr	482,681	700,481	698	697	631149	698	702716
10-yr 24-hr	592,126	809,926	699.5	699	776655	700	853005
25-yr 24-hr	755,167	972,967	701.6	701	931802	702	1013090
50-yr 24-hr	851,943	1,069,743	702.7	702	1013090	703	1096908
100-yr 24-hr	946,541	1,164,341	703.8	703	1096908	704	1183293

For storm events larger in magnitude than the 25-yr 24-hr storm, excess flow from the clean water diversion culvert would also enter the sediment basin. However, the above calculations indicate that the sediment collection pond can handle a significant volume of flow beyond its design volumes.

Forbay

Set the crest elevation of the forbay embankment at pool level (the sediment storage level).	1	ft minimum above the permanent
Permanent Pool Level	690.2	ft
Minimum Forbay Embankment Crest Elevation	691.2	ft
Design Forbay Embankment Crest Elevation	692	ft

Predicted Water Levels in the Sediment Colelction Pond during the life of the site

SUMMARY TABLE, SEDIMENT COLLECTION POND - LAYOUT 4.1

DESCRIPTION	SEDIMENT COLLECTION POND
ELEVATION, BOTTOM OF POND/BASIN (FT)	685
MINIMUM REQUIRED SEDIMENT CLEANOUT VOLUME (AC-FT)	3
DESIGN ELEVATION, SEDIMENT CLEANOUT LEVEL (FT)	688.3
DESIGN VOLUME @ SEDIMENT CLEANOUT LEVEL (AC-FT)	3
MINIMUM REQUIRED SEDIMENT STORAGE VOLUME/PERMANENT POOL (AC-FT)	5
DESIGN SEDIMENT STORAGE VOLUME (AC-FT)	5.02
DESIGN ELEVATION (FT), SEDIMENT STORAGE LEVEL (PERMANENT POOL)	690.2
MINIMUM REQUIRED (2-YR 24-HR) WATER QUALITY STORAGE (AC-FT)	314158.35
DESIGN WATER QUALITY STORAGE (10-YR 24-HR, CF)	13.59
MINIMUM DESIGN STORAGE - 10-YR 24-HR (AC-FT)	18.61
DESIGN STORAGE AT PRINCIPAL SPILLWAY CREST (AC-FT)	18.71
ELEVATION, PRINCIPAL SPILLWAY CREST (FT)	699.5
MINIMUM REQUIRED ELEVATION, EMERGENCY SPILLWAY CREST (FT)	700.5
DESIGN ELEVATION, EMERGENCY SPILLWAY CREST (FT)	706
VOLUME, EMERGENCY SPILLWAY CREST (AC-FT)	31.32
FREEBOARD (FT)	2
DESIGN ELEVATION, CREST OF EMBANKMENT	709
INTERIOR SIDESLOPES (_H:1V)	2.5
EXTERIOR SIDESLOPES (_H:1V)	2.5

PRINCIPAL SPILLWAY

A riser and barrel system is proposed for the principal spillway.

Elevation, Crest of Principal Spillway	699.5	ft	worksheet "summary table"
Length, Principal Spillway Barrel Pipe	510	ft	for Layout 4.1, approximate
Slope, Principal Spillway Barrel Pipe	0.005	ft/ft	SET
Elevation, Bottom of Pond	685	ft	worksheet "summary table"
Elevation, Invert of Riser	685	ft	SET
Elevation, Invert of Barrel at Riser	685	ft	SET

Elevation, Outlet of Principal Spillway Barrel Pipe

Flow through a riser-barrel system is governed by the following equations

orifice flow

$Qo = Co\ A\ (2gHo)^{0.5}$

Qo	orifice flow, cfs		
Co	orifice coefficient,	0.6	
g	gravitational constant	32.2	f/s^2
Ho	orifice head, ft, on riser crest		

weir flow

$Qw = Cw\ Lw\ Hw^{1.5}$

Qw	weir flow, cfs		
Cw	weir coefficient	3.087	critical flow assumed
Lw	weir crest length, = πDr		
Dr	riser diameter		
Hw	weir head, ft, on riser crest		

pipe flow

Hp = TWEL + H

TWEL tailwater elevation

and $H = (1 + ke + kf)Q^2/2gA^2$

H	head above tailwater condition, ft			
ke	entrance loss coefficient	0.5		*square-edge entrance*
kf	friction loss coefficient	$29n^2L/Rh^{2/3}$		
n	Manning roughness coefficient	0.012		*smooth wall PE pipe*
Lb	barrel length (ft)	510	ft	scaled from mapping
Rh	hydraulic radius, ft, = D/4 for pipe flowing full			
Db	barrel diameter, ft			

solving in terms of Qp yields

Qp = (2g A2 H / (1+ke+kf))^0.5

Assume Riser Diameter =	4	ft
Riser Area =	12.57	sf
Riser Crest Length =	12.6	ft
Assume Barrel Diameter =	2	ft
Barrel Area =	3.14	
1+ke+kf	6.87	
TWEL	682.45	

Elevation	Ho	Qo	Hw	Qw	Elevation Ho or Hp	H	Qp	Q controlling	Condition
699.5	0	0	0	0	699.5	17.05	39.7	0	---
700	0.5	42.8	0.5	13.7	700	17.55	40.3	13.7	weir
700.5	1	60.5	1	38.8	700.5	18.05	40.8	43	weir
701	1.5	74.1	1.5	71.3	701	18.55	41.4	41.4	weir
701.5	2	85.6	2	109.8	701.5	19.05	42	42	pipe
702	2.5	95.7	2.5	153.4	702	19.55	42.5	42.5	pipe
702.5	3	104.8	3	201.6	702.5	20.05	43	43	pipe
703	3.5	113.2	3.5	254.1	703	20.55	43.6	43.6	pipe
703.5	4	121	4	310.4	703.5	21.05	44.1	44.1	pipe
704	4.5	128.4	4.5	370.4	704	21.55	44.6	44.6	pipe
704.5	5	135.3	5	433.8	704.5	22.05	45.1	45.1	pipe
705	5.5	141.9	5.5	500.5	705	22.55	45.7	45.7	pipe
705.5	6	148.3	6	570.3	705.5	23.05	46.2	46.2	pipe
706	6.5	154.3	6.5	643	706	23.55	46.7	46.7	pipe
706.5	7	160.1	7	718.7	706.5	24.05	47.1	47.1	pipe
707	7.5	165.8	7.5	797	707	24.55	47.6	47.6	pipe
707.5	8	171.2	8	878	707.5	25.05	48.1	48.1	pipe
708	8.5	176.5	8.5	961.6	708	25.55	48.6	48.6	pipe
708.5	9	181.6	9	1047.7	708.5	26.05	49.1	49.1	pipe
709	9.5	186.5	9.5	1136.2	709	26.55	49.5	49.5	pipe
709.5	10	191.4	10	1227.1	709.5	27.05	50	50	pipe
710	10.5	196.1	10.5	1320.2	710	27.55	50.5	50.5	pipe

EMERGENCY SPILLWAY

	706	ft	*worksheet "summary table"*
Elevation, Design Maximum Water Level	707	ft	*approximation*
Design maximum head on emergency spillway	1	ft	
Shape of emergency spillway section	trapezoidal		
Width, Bottom of emergency spillway section	10		
Sideslopes, emergency spillway section	10	H:1V	
depth-weighted crest length	average of bottom width and water top surface		
weir coefficient	2.6	broad-crested weir	

Elevation	weir head	top width	weighted length	weir flow (cfs)
706	0	10	10	0
706.5	0.5	20	15	14
707	1	30	20	52
707.5	1.5	40	25	119
708	2	50	30	221
708.5	2.5	60	35	360
709	3	70	40	540

FLOW RATING TABLE FOR NORTH VALLEY SEDIMENT COLLECTION POND

Elevation	Principal Spillway	Emergency Spillway	total flow
699.5	0	0	0
701	41.4	0	41.4
701.5	42	0	42
702	42.5	0	42.5
702.5	43	0	43
703	43.6	0	43.6
703.5	44.1	0	44.1
704	44.6	0	44.6
704.5	45.1	0	45.1
705	45.7	0	45.7
705.5	46.2	0	46.2
706	46.7	0	46.7
706.5	47.1	14	61.1
707	47.6	52	99.6
707.5	48.1	119	167.1
708	48.6	221	269.6
709	49.5	540	589.5

Buoyancy of Riser

Buoyant Force FB = volume occupied by the riser * unit weight of water

Resistance Force FR = conteracting weight of structure

Design Water Level	699.5	ft	crest of principal spillway riser
Elevation, Pond Bottom	685		
Effective Depth of Water	14.5	ft	
Unit Weight of Water	62.4	pcf	
Unit Weight of Concrete	150	pcf	

Diameter of Riser (ft)	3	3.5	4	4.5	5	5.5	6
Displaced Volume (cf)	102	140	182	231	285	344	410
Buoyant Force (lb)	6365	8736	11357	14414	17784	21466	25584
Factor of Safety	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Resistance Force (lb)	9548	13104	17036	21621	26676	32199	38376
Riser Pad Dimensions							
width (ft)	6	7	8	9	10	11	12
length (ft)	6	7	8	9	10	11	12
depth (ft)	1.8	1.8	1.8	1.8	1.8	1.8	1.8
weight (lb)	9720	13230	17280	21870	27000	32670	38880

Calculate the dewatering flow applicable to he Layout 4.1 sediment collection pond for use by AEP and URS in the design of the ATS.

Water Quality Volume = volume between the principal spillway crest and the permanent pool level
The design storm of the sediment collection pond for the selected layout (4.1) is 10-yr 24-hr storm.
10-year 24-hour runoff volume to the pond under the anticipated most critical landfill conditions
592,126 cf or 4429099 gal

While actual pond storage between the principal spillway crest and the permanent pool level may be slightly greater than the 10-year 24-hour runoff volume, the 10-yr 24-hr runoff volume is reasonable to use for design purposes for estimating the dewatering times.

Note that for much of the operating life of the sediment collection pond, the 10-year runoff volume will be much less than the design value, because site conditions (total drainage area and disturbed drainage area) are the most critical during final cover activities, and not during site preparation of the individual sequences.

Landfill Sequence Development

Sequence	sequence activity		Consecutive Totals to NASCP (acres)		10-yr 24-hr runoff volume (cf)		
	subgrade	liner	disturbed	undisturb	disturbed	undisturb	total
4A	4A	---	12.1	29.14	122,545	131,165	253,710
4B	4B	4A	24.2	29.14	245,090	131,165	376,255
5A	5A	4B	21.35	18.8	216,226	84,623	300,849
5B+6A	5B+6A	5A	27.5	18.8	278,512	84,623	363,135
6B	6B	5B+6A	27.25	18.8	275,980	84,623	360,603
6C	6C	6B	18	18.8	182,299	84,623	266,922
7A	7A	6C	16.7	18.8	169,133	84,623	253,756
7B	7B	7A	15.4	18.8	155,967	84,623	240,590
8A	8A	7B	16.65	0	168,626	0	168,626
8B	8B	8A	17.9	0	181,286	0	181,286
9A	9A	8B	16.05	0	162,550	0	162,550
9B	9B	9A	14.2	0	143,813	0	143,813
10A	10A	9B	16.35	0	165,588	0	165,588
10B	10B	10A	18.5	0	187,362	0	187,362
10B	---	10B	9.25	0	93,681	0	93,681
closure					372,438	219,688	592,126

Under landfill sequence development conditions, the maximum predicted 10-yr 24-hr runoff volume is 376,255 cf, and occurs when sequence 4A is being lined, and sequence 4B is in site preparation.

The greater 10-yr 24-hr runoff condition occurs for the closure condition, with a 10-yr 24-hr runoff volume of 592,126 cf.

The actual Design Water Quality Volume for the sediment collection pond is 596,361 cf.

The actual volume in the NASCP between Permanent Pool Level and Principal Spillway Crest Level

is	596,361	cf	13.691	ac-ft
Recommended E&S dewatering period			2	days minimum
WV E&S BMP manual			3	days maximum

AEP proposes to use, to the extent practicable, a longer dewatering period, to improve the settling capability of the pond, and better match design parameters of the ATS.
A 5-7 day dewatering period is proposed.

Flow Rate for ATS to dewater the 10-yr 24-hr water quality volume from the pond for selected dewatering periods.

dewatering period (days)	2	3	4	5	6	7
dewatering rate (cf/day)	298181	198787	149090	119272	99394	85194
dewatering rate (gal/day)	2230394	1486927	1115193	892154.6	743467.1	637251.1
dewatering rate (gpm)	1549	1033	775	620	517	443

the table below shows how the required dewatering flow (ATS flow) for the 10-year 24-hour water quality volume would vary over the life of the landfill.

Sequence	10-yr 24-hr runoff volume	Dewatering Rate (gpm) for Selected Dewatering Periods (days)					
		2	3	4	5	6	7
4A	253710	659	440	330	264	220	189
4B	376255	978	652	489	391	326	280
5A	300849	782	521	391	313	261	224
5B+6A	363135	944	629	472	378	315	270
6B	360603	937	625	469	375	313	268
6C	266922	694	463	347	278	232	199
7A	253756	660	440	330	264	220	189
7B	240590	625	417	313	250	209	179
8A	168626	438	292	219	176	146	126
8B	181286	471	314	236	189	157	135
9A	162550	423	282	212	169	141	121
9B	143813	374	250	187	150	125	107
10A	165588	431	287	216	173	144	123
10B	187362	487	325	244	195	163	140
10B	93681	244	163	122	98	82	70
closure	592126	1538	1026	769	616	513	440
ATS Design Flow Rate		---	---	---	616	513	440

Background

The north area sediment collection pond (NASCP) outlet pipe will require an anti-seep collar to control the effects of piping. The design methodology will follow the procedure included in the 2012 PA DEP Erosion and Sediment Pollution Control Manual.

Length of Pipe in Satuation Zone (L_s)

L_s = y(z+4)(1+(pipe slope/(0.25-pipe slope))

y = Distance from upstream invert of principal spillway riser to dewatering volume crest (ft) = 14.5

z = Horizontal component of upstream embankment slope (ft) = 2.5

pipe slope (ft/ft) = 0.005

L_s = 97 ft

Required increase in flow path (I_{fp})

L_f = 1.15 x L_s

L_f = Flow path (ft)

L_f = 112 ft

I_{fp} = L_f - L_s

I_{fp} = Increase in flow path (ft)

I_{fp} = 15 ft

Number of Anti-Seep Collars (N)

N= I_{fp}/2V

V = Collar Projection of Pipe (ft)

	Option 1	Option 2
V=	2.0	3.0
N=	4	3

Collar Spacing = L_s/(N+1)

	Option 1	Option 2	
Spacing =	20	25	ft

Purpose:
This calculation is for the design of the temporary Northeast Borrow Area Sediment Collection Pond (SCP).

Supporting Materials:
1) Worksheet 1 (attached)
2) West Virginia Erosion & Sediment Control Handbook for Developing Areas, May 1993.
3) West Virginia NPDES Permit Requirements, 2002.

Design Method:
1) Collect disturbed runoff and divert as much undisturbed runoff as possible around the SCP.
2) Areas that have been stabilized would not contribute to the required sediment storage volume, but will contribute runoff volume to the SCP.

The following development scheme is assumed:

The landfill will be developed in sequences between two areas: North and South. It is assumed that the entire area within each sequence will be disturbed either for clearing and grubbing, subgrade development and/or liner construction. In addition, the possibility exists that portions of one sequence area that is under construction (i.e., liner construction), may coincide in time with the portions of another sequence area that is also under construction (i.e., clearing & grubbing, and/or subgrade development).

Note that those portions of the sequence areas that are undergoing clearing & grubbing, subgrade development, liner construction, and reclamation will drain to the North Area SCP or the South Area SCP, located at the subgrade low point of the respective area. Portions of the sequence areas where disposal operations are occurring would drain to the LHB.

The landfill will be developed in a south-to-north direction, beginning in the southeast corner of the site. A temporary sediment pond (Northeast Borrow Area SCP) will be required in the northeast borrow area to service the Sequence 6 waste operations. The excavation of the borrow area will be serviced by a network of sediment traps. The construction of the North area of the landfill will be serviced by the North SCP, located at the lowest point of the proposed subgrade. Once final grades are reached in the borrow area and prior to the grading of the eastern slope of Sequence 6, the Northeast SCP will be constructed in the borrow area adjacent to the landfill. The pond is designed to service runoff from the newly graded final cover slopes of the northeast face of the landfill as it is developed. The pond will also service portions of the borrow area.

The landfill will be developed so as to incrementally stabilize the slope between benches as the landfill height increases. The maximum disturbed area from the landfill will consist of the area between the previously constructed(stabilized) bench and the next proposed bench, up the slope (20' vertical spacing of benches on a 3H:1V slope). For the Northeast SCP, a conservative estimate of a maximum disturbed area of 10 acres was selected to account for the largest landfill area between benches and adjacent borrow areas and haul roads, to drain to the pond. The total drainage area to the pond is estimated at 26 acres.

Preliminary Layout of Sediment Collection Pond:

1) For the areas that follow, refer to above referenced Worksheet.
2)The Total Drainage area includes a portion of the borrow area that will drain to the Southeast Borrow Area SCP based on site grading. The total area also includes stabilized areas of the landfill's southeast slope that drain to the pond.
3) The Disturbed area of 20 acres includes the largest slope area between benches draining to the pond as well as a portion of the borrow area and aggregate haul roads.

Drainage Areas	Southeast Area	
Total Area Draining to SCP (AC)	26.0	
Disturbed Area Draining to SCP (AC)	10.0	
Undisturbed Area Draining to SCP (AC)	16.0	
Diverted Area Around SCP (AC)	0.0	

Design Requirements:

Sediment Storage Requirement	Northeast SCP
Sediment Volume Criteria (AC-FT / disturbed area)	0.125
Area (AC), Disturbed Ground	10.0
Required Sediment Storage (AC-FT)	1.25
Required Sediment Storage (CF)	54,450

2-Year 24-Hour Runoff Detention Volume Requirement	Northeast SCP
Total Area Draining to SCP (AC)	26.0
Disturbed Areas (AC)	10.0
Wooded (AC)	0.0
Reclaimed Slopes and Benches	16.0

2-year, 24-hour storage is to the crest of the principal spillway

Curve Numbers	Northeast SCP
Curve Number, Disturbed Areas/Borrow Areas/Haul Roads	90
Curve Number, Wooded	70
Curve Number, Reclaimed Slopes and Benches	72
Composite Curve Number	**79**
S Factor	**2.66**

2-Year 24-Hour Storm	Northeast SCP
2-Yr 24-Hr Rainfall (inches)	2.65
2-Yr 24-Hr Runoff Volume (inches)	0.94
2-Yr 24-Hr Runoff Volume (CF)	88,667
2-Yr 24-Hr Runoff Volume (AC-FT)	2.04

NPDES Minimum Volume Requirement				
NPDES Requirement (CF/acre tributary)			3600	*crest of Principal Spillway*
Drainage Area (AC)			26.0	
Total Volume Required (CF)	3600	CF/acre	93,600	
"Wet" Volume Required (CF) @	1800	CF/acre	46,800	*Sediment Storage volume*
			1.07	AC-FT
"Dry" Volume Required (CF) @	1800	CF/acre	46,800	*Runoff Detention volume*
			1.07	AC-FT

A Comparison of the Volumes Required under Erosion & Sediment Control Handbook to the Volumes Required under NPDES is utilized to determine which govern.

	Southeast Borrow Area	
NPDES "Wet" Volume (CF)	46,800	
E&SC Sediment Storage Volume (CF)	54,450	*governs*
NPDES "Dry" Volume (CF)	46,800	
E&SC Runoff Volume (CF)	88,667	*governs*

SEDIMENT COLLECTION POND DESIGN

The minimum volumes of the Sediment Collection Pond are therefore

		Southeast Borrow Area
Sediment Storage Volume (CF)		54,450
Sediment Storage Volume (AC-FT)		1.25
Clean-Out Storage Volume, CF, @	60%	32,670
of Sediment Storage Volume	(AC-FT)	0.75
Runoff Detention Volume (CF)		88,667
(AC-FT)		2.04

Sediment Storage + 2-Yr 24-Hr Detention Volume (CF)		143,117
	(AC-FT)	3.29

The elevation corresponding to the storage equal to the sum of the Sediment Storage Volume and the Detention Runoff Volume is the crest elevation for the Principal Spillway, under E&SC design criteria.

Spillway Design Criteria:

The Principal Spillway must be capable of handling the 10-year storm by itself, with no flow through the Emergency Spillway. The crest of the Emergency Spillway is therefore set at the elevation corresponding to the **10-year** water level in the SCP.

10-Year 24-Hour Storm	Southeast Borrow Area
10-Yr 24-Hr Rainfall (inches)	3.86
10-Yr 24-Hr Runoff Volume (inches)	1.85
10-Yr 24-Hr Runoff Volume (CF)	174,647
10-Yr 24-Hr Runoff Volume (AC-FT)	4.01
10-Year 24-Hour Flood Storage+Sediment Storage (CF)	229,097
10-Year 24-Hour Flood Storage+Sediment Storage(AC-FT)	5.26

The runoff from the 10-year 24-hour storm must be handled by a combination of the Pond storage volume and the discharge capacity of the Principal Spillway.

Anticipated Height of Embankment is less than	12	feet
Maximum Drainage Area to Pond is approximately	26.0	AC
Product of H x A is	312	

From the WV E&SC Manual for Developing Areas,

H x A <	4000	Emergency Spillway Design Storm is	25-yr 24-hr	
		Freeboard is	1	ft
H x A >	4000	Emergency Spillway Design Storm is	50-yr 24-hr	
		Freeboard is	2	ft

Emergency Spillway Design Storm is	25-yr 24-hr	
Freeboard is	1	ft

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Sedimentation Pond Design

25-Year 24-Hour Storm	Southeast Borrow Area
25-Yr 24-Hr Rainfall (inches)	4.51
25-Yr 24-Hr Runoff Volume (inches)	2.38
25-Yr 24-Hr Runoff Volume (CF)	225,100
25-Yr 24-Hr Runoff Volume (AC-FT)	5.168

The facility must be able to pass the peak flow from the 25-year 24-hour storm without overtopping (WV 33 CSR1 A.7.6). Minimum freeboard shall be 1 ft above the 25-year 24-hour emergency spillway outflow (WV E&SC Manual, p. 4.42).

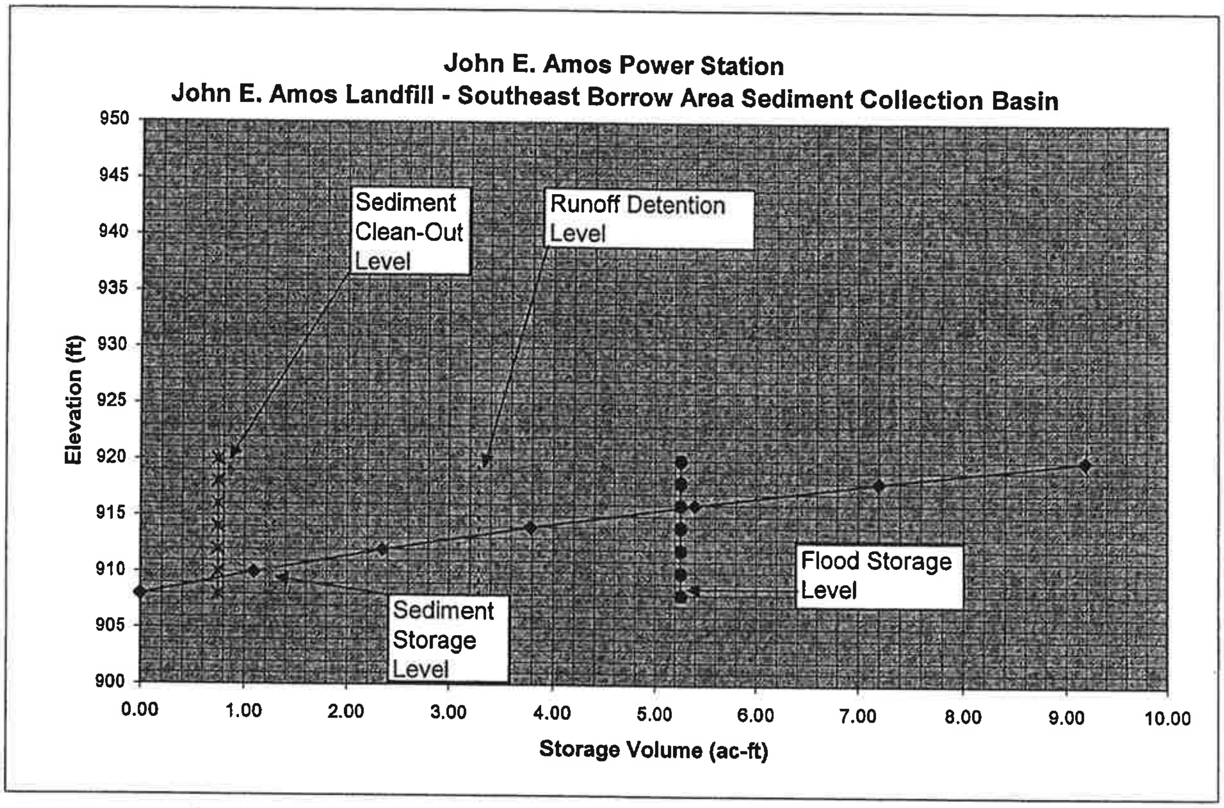
DESIGN DATA

Gabion Dike	*see worksheet "gabion dike design"*		N/A
Excavation Sideslopes, Earth	2	H:1V	
Excavation Sideslopes, Rock	2	H:1V	
Fill (Backside) Sideslopes	3	H:1V	
Elevation, Bed of Pond	908	ft, msl	

SCP Elevation-Storage Rating Table

Elevation and Areas tabulated below are from final layout of the SCP

Elevation (ft, msl)	Depth (ft)	Area (sf)	Average Area (sf)	Increm. Volume (CF)	Total Volume (CF)	Total Volume (cy)	Total Volume (gal)	Total Volume (AC-FT)
908	0	21,998		0	0	0	0	0
			23,798					
910	2	25,597		47,595	47,595	1,763	356,100	1.09
			27,455					
912	2	29,313		54,910	102,505	3,797	766,800	2.35
			31,232					
914	2	33,151		62,464	164,969	6,110	1,234,000	3.79
			35,131					
916	2	37,111		70,262	235,231	8,713	1,759,600	5.40
			39,151					
918	2	41,190		78,301	313,532	11,613	2,345,300	7.20
			43,272					
920	2	45,353		86,543	400,075	14,818	2,992,600	9.18



The information presented below is for use in the graphical plot.

Elevation (ft)	908	910	912	914	916	918	920
Storage (AC-FT)	0.00	1.09	2.35	3.79	5.40	7.20	9.18
	910.00	912.00	914.00	916.00	918.00	920.00	0.00

Sediment Clean-Out Volume (AC-FT)

SE Borrow Area SCP	0.75	0.75	0.75	0.75	0.75	0.75	0.75

Sediment Storage (AC-FT)

SE Borrow Area SCP	1.25	1.25	1.25	1.25	1.25	1.25	1.25

2-Year 24-Hour Detention Volume + Sediment Storage (AC-FT)

SE Borrow Area SCP	3.29	3.29	3.29	3.29	3.29	3.29	3.29

10-Year 24-Hour Flood Storage + Sediment Storage (AC-FT)

SE Borrow Area	5.26	5.26	5.26	5.26	5.26	5.26	5.26

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Northeast Borrow Area
Sedimentation Pond Design

Southeast Borrow Area SCP

SET DESIGN ELEVATIONS (ft) *read off above plot*

	Bottom of SCP Level	908	*from preliminary design layout*
	Sediment Clean-Out Volume	0.75	AC-FT
	Sediment Clean-Out Level	909.4	*from graph*
	Sediment Storage Volume	1.25	AC-FT
	Sediment Storage Level	910.25	*from graph*
	Detention Storage Volume	3.29	AC-FT
	Detention Storage Level	913.3	*2-Year 24-Hour Runoff Volume, from graph*
SET	Crest of Principal Spillway	913.3	*2-Year 24-Hour Runoff Volume, from graph*
	Flood Storage Volume	5.26	AC-FT
	Flood Storage Level	915.8	*10-Year 24-Hour Runoff Volume, from graph*
SET	Crest of Emergency Spillway	915.8	*10-Year 24-Hour Runoff Volume, from graph*

SET DESIGN ELEVATIONS FOR SCP (continued)

Freeboard	1	ft
Design Dike Crest Elevation	920	ft
Estimated Head (ft) for Flow through Emergency Spillway	3.2	ft

(crest length of overflow weir of Emergency Spillway will be set at required value)

Emergency Spillway

The SCP must pass the peak 25-year 24-hour storm flow with the minimum design freeboard.

Design Storm	25-yr 24-hr	
Drainage Area	26.0	AC
Composite Curve Number	79	disturbed
Runoff Volume	2.38	inches
Time-of-Concentration	0.25	hr assumed
Peak Discharge Factor	722	CFS/in/sq mi
Crest Elevation, Emergency Spillway	915.8	ft
Peak Flow	70	CFS

Weir Equation $Q = C L H^{1.5}$

C	3	broad-crested weir
L		crest length of weir (ft)
H	3.2	head on weir (ft) assumed value from above

L = 4.08 ft

USE	L =	10	ft
THEN	H =	1.76	ft
MAX WSEL =		917.56	ft

Min top of embankment with freeboard	918.56 ft
Provided freeboard	2.44 ft

The maximum water surface elevation through the emergency spillway is 917.56 ft, the top of embankment must be no less than 918.56 to accommodate the 1' freeboard requirement. The design top of the embankment is 920, which exceeds the minimum requirement.

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Northeast Borrow Area
Sedimentation Pond Design

Principal Spillway Dewatering

Water Surface Elevation (ft)	Riser					Pond Storage Volume (cf)	Incremental Storage Volume (cf)	Discharge (cfs)	Average Discharge (cfs)	Dewater Time (hr)	Total Dewater Time (hr)
	Head (ft)	Perf. Dia. (in.)	Number of Perf.	Centerline of Perf. (ft)	Orfice Flow (cfs)						
910.3	0	1	4	910.34	0.00	54,450		0.00			0.0
							15,109		0.04	113.0	
910.8	0.5	1	4	910.84	0.07	69,559		0.07			113.0
							13,728		0.13	30.1	
911.3	1	1	4	911.34	0.18	83,287		0.18			143.1
							28,588		0.28	28.3	
912.3	2	—			0.38	111,875		0.38			171.4
							31,232		0.44	19.7	
913.3	3				0.50	143,107		0.50			191.1

8.0 days

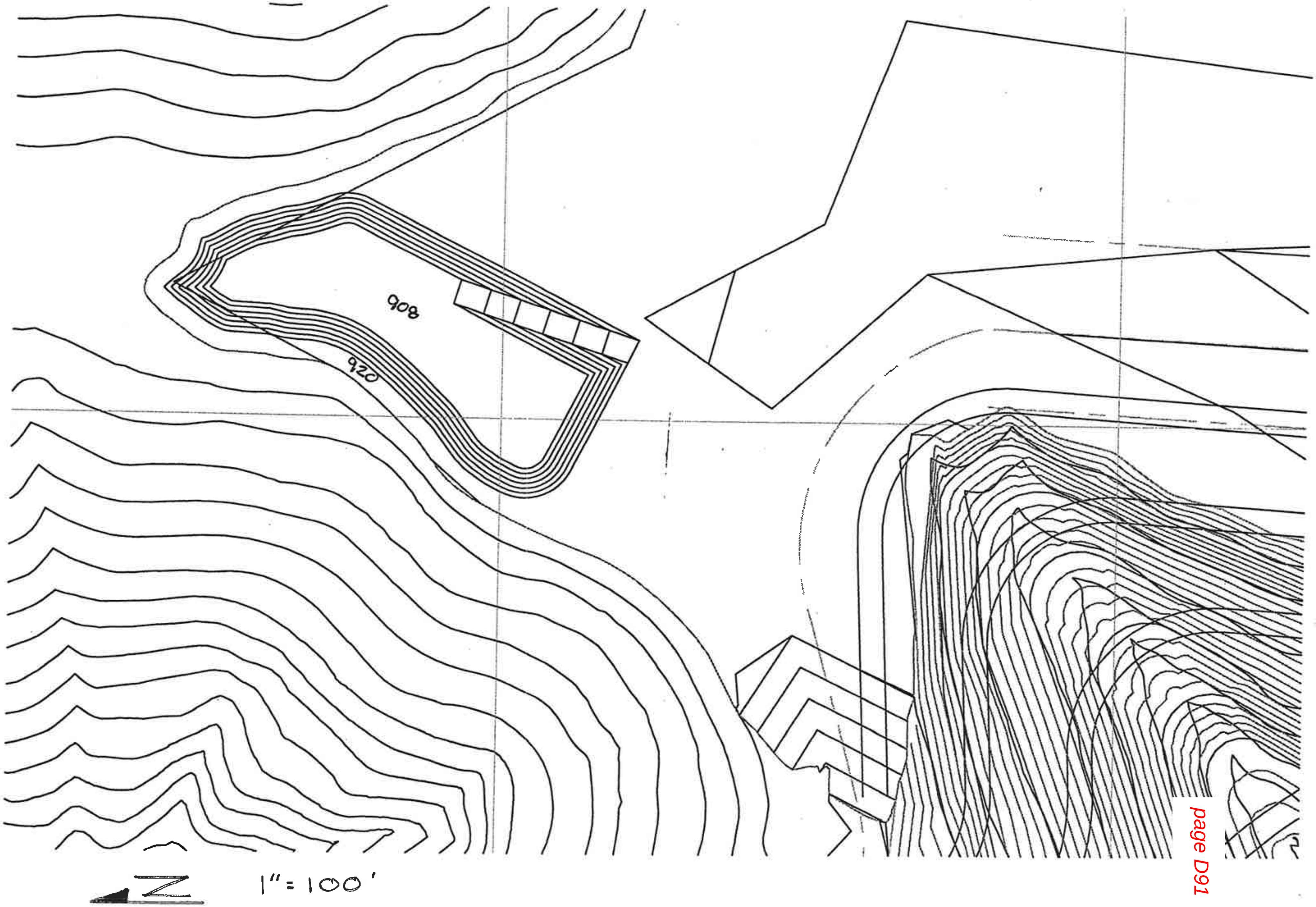
Orfice Data	
Circular	
Dia (in)	1
Area (sf)	0.0055
C	0.6
# per row	4
CL el.	0.04

Notes:

Use a 12-inch diameter HDPE riser and discharge pipes for pond principal spillway.
(See project design drawings for details of sediment pond spillway design.)
Use rows of four (4) 1-inch diameter perforations at elevations 910.3, 910.8, and 911.3 on the riser.
Seminent Storage Elevation = First Row of Dewatering Perforations = 910.3
2-yr, 24-hr Detention Volume + Sediment Storage Volume Elevation = Crest of Principal Spillway = 913.30

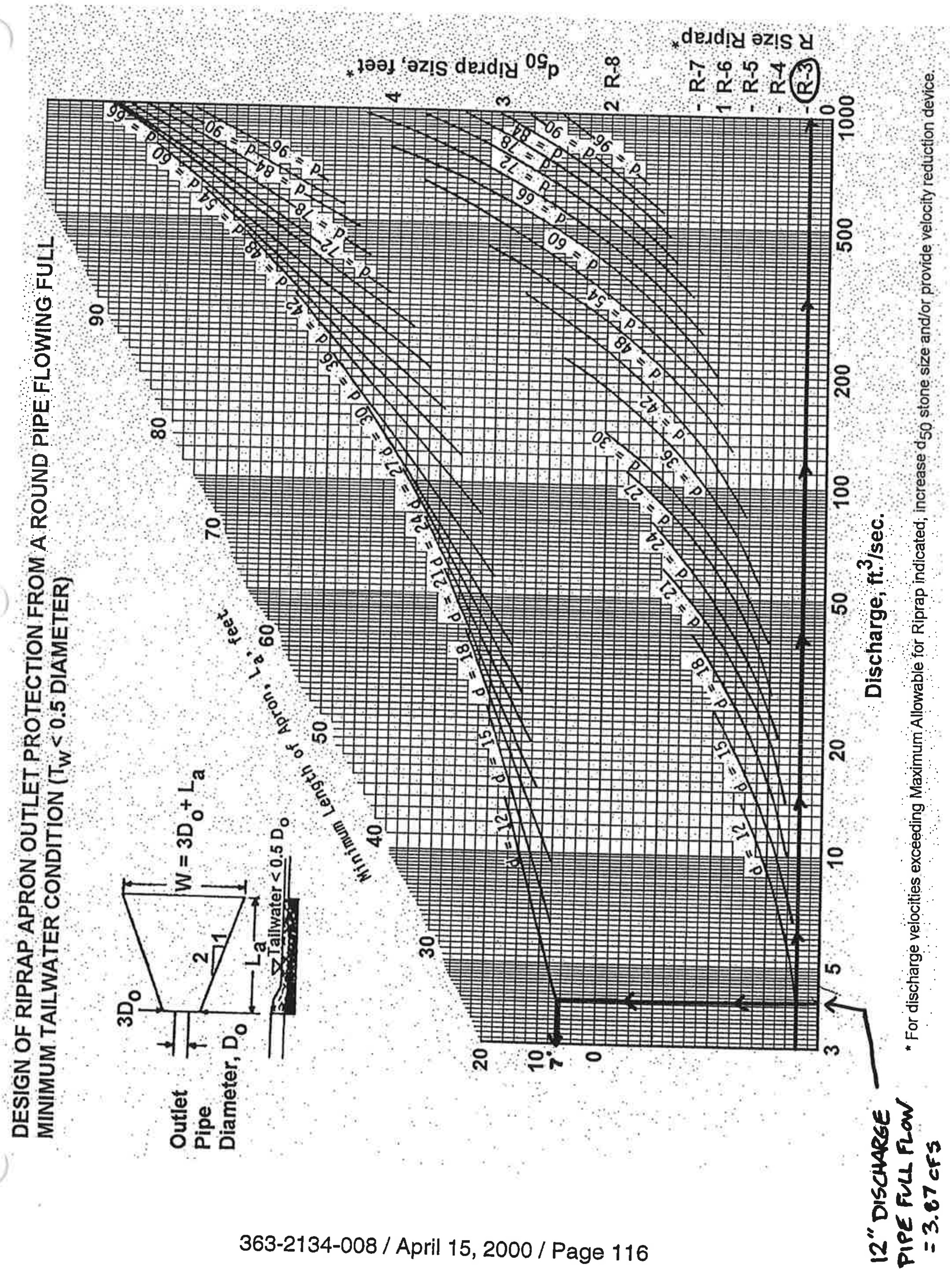
C04038[illegible] , 02 AMOS SITE 2/3 NORTHEAST BORRO[illegible] AREA PRELIMINARY SED POND LAYOUT

TJM [illegible]/05



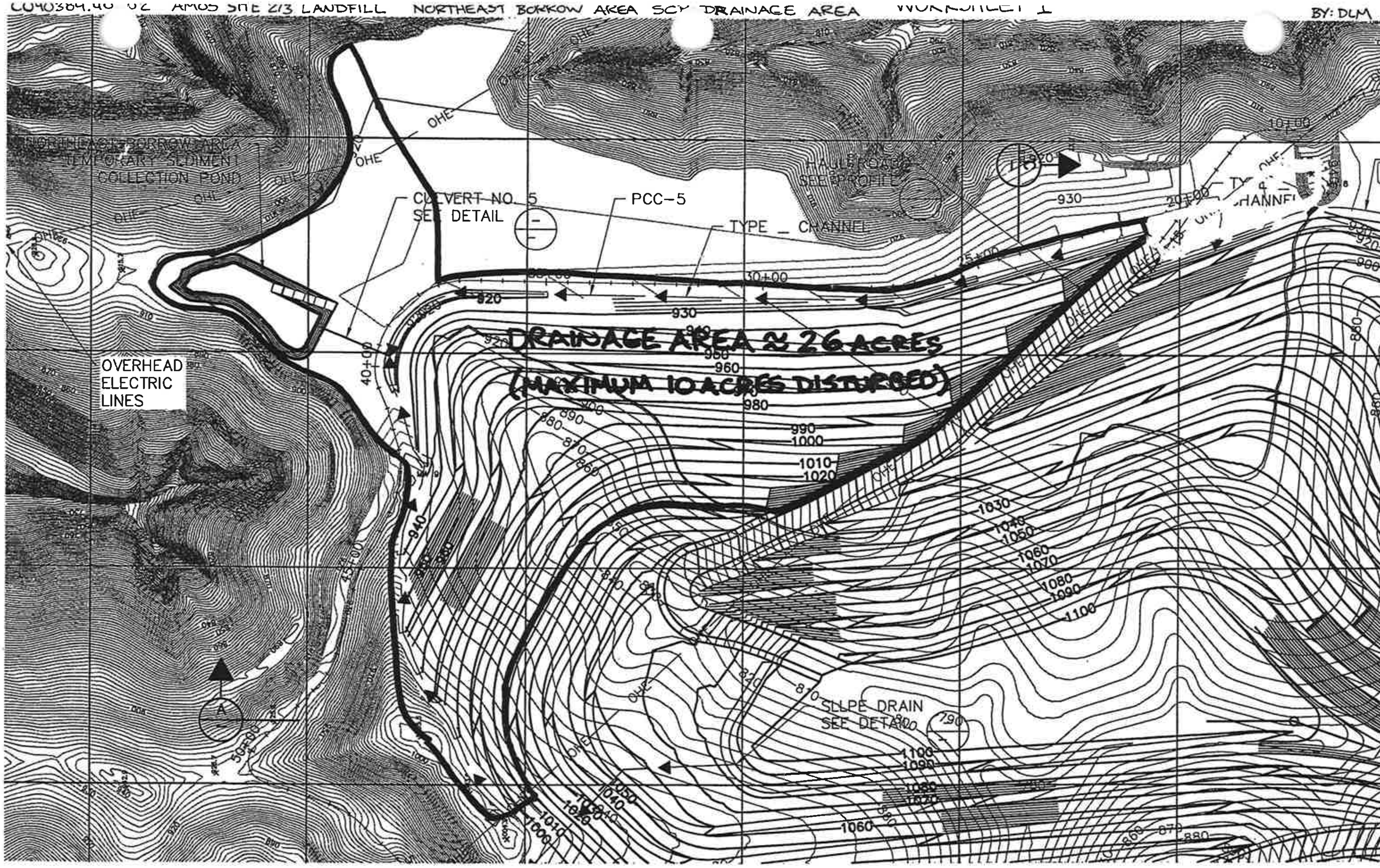
1" = 100'

FIGURE 21
Riprap Apron Design, Minimum Tailwater Condition



* For discharge velocities exceeding Maximum Allowable for Riprap indicated, increase d_{50} stone size and/or provide velocity reduction device.

CO40384.40 02 AMOS SITE 2/3 LANDFILL NORTHEAST BORROW AREA SCP DRAINAGE AREA WORKSHEET 1 BY: DLM



1"=200'

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Subject: Sedimentation Pond Drainage Area Comparison

John E. Amos Landfill

BY: ODONNDM DATE: 9/27/2016 PROJ NO. C130109.03

CHKD BY: MULARCR DATE: 9/28/2016 SHEET NO. 1 OF 1

gai consultants

Purpose: To delineate the drainage areas at the Amos Landfill for the 2016 permit submission. If additional drainage area is diverted to a different pond than existing conditions, the adequacy of the sediment pond will be re-evaluated.

References:

1. GAI, 2006. "Class F Industrial Landfill Permit Application." John E. Amos Landfill, Winfield, West Virginia
2. *"C110441 - HH Worksheet"* AutoCAD file. Z:\Energy\2013\C130109.03 - AEP 2015 Eng. Support\CAD_Task 001\Worksheets
3. GAI, 2013. Solid Waste/NPDES Permit Application (Amendment) for the John E. Amos Landfill, South Area Sediment Collection Pond Modifications
4. GAI, 2014. Solid Waste/NDPES Permit Application (Amendment) for the John E. Amos Landfill, February 2014 (North Pond Complex)

The drainage areas to the four sediment ponds at Amos have been modified to accomodate the changes to the pile design. Drainage areas were balanced as much as possible to reduce potential modifications to the ponds

Proposed Drainage Area Summary

Drainage Area Comparison			
Pond	**Permitted Drainage Area (Ac).**	**Proposed Drainage Area (Ac.)**	**Reanalysis Required?**
Beaver Plateau Pond	38	63.8	**YES**
South Valley Sediment Pond	130.6	89	NO
North Pond Complex	84.5	70.2	NO
Northeast Pond	26	23.4	NO

As a result of the new drainage layout, the Beaver Plateau Pond is the only pond to receive additional drainage area.
The South Valley Pond, North Pond Complex, and Northeast Pond all receive a reduced Drainage Area than originally designed for.
Therefore, these ponds will accept the proposed drainage modifications while complying with applicable regulations

Refer to the proposed BPSP calculations for the required modifications to the Beaver Plateau Sediment Collection Pond Due to site conditions, the BPSP is able to manage the additional drainage area that it is currently proposed with the revised pile layout with minimal modifications. A minor Modification to the Principal spillway riser must be made to accomodate **the required sediment storage volume.**

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Amos Landfill - Proposed Revised Beaver Plateau Sediment Pond for Pile Redesign (2016)
BPSP design worksheet

Previously-permitted Design of the BPSP

REFERENCE Relocated BPSP calculations by KLF, "BPSP design" tab, in P/2006/C060816/DASH 00/TASK 004/Subtask 01/Engineering/H&H/RH H&H/GPD_BeaverPlateauPond.doc, dated 8-17-07.

description	curve number	area (acres) Previously Permitted 2010	SEP 2016
active landfill	90	5.1754	**12.0**
revegetated landfill & off-landfill	74	25.3	**44.2**
haul road, aggregate	90	1.9743	**2.0**
Beaver Plateau, reclaimed	74	0	**0.0**
pond area	100	5.6	**5.6**
total area		38.0497	**63.9**
weighted curve number		81	**80**

Design of Revised Beaver Plateau Sediment Pond for Pile Redesign

Land Covers, Curve Numbers, Drainage Areas, & Runoff Volumes

see Figure 2 DRAINAGE AREAS from 2010 KLF calcs, modified from the original design sketch in the calculations "Graphical Peak Discharge Calculations.doc", and CAD file “C110441 – HH Worksheet” in Z:\Energy\2013\C130109.03 - AEP 2015 Eng. Support\CAD_Task 001\Worksheet

Summary of Runoff Volumes by Curve Number, in inches

Land Cover	Curve Number CN	Initial Abstract. S	Runoff Volumes (inches) 2-yr VRO_2	10-yr VRO_{10}	25-yr VRO_{25}	50-yr VRO_{50}
active landfill	90	1.11	1.67	2.79	3.41	3.77
revegetated landfill & off-landfill	74	3.51	0.7	1.5	1.98	2.28
haul road, aggregate	90	1.11	1.67	2.79	3.41	3.77
Beaver Plateau, reclaimed	74	3.51	0.7	1.5	1.98	2.28
pond area	100	0	2.65	3.86	4.51	4.89

Summary of Runoff Volumes by Curve Number, in ac-ft

Land Cover	Drainage Area (acres)	Runoff Volumes (ac-ft) 2-yr	10-yr	25-yr	50-yr
active landfill	12.0	1.675	2.799	3.42	3.782
revegetated landfill & off-landfill	44.2	2.58	5.529	7.298	8.404
haul road, aggregate	2.00	0.278	0.465	0.568	0.628
Beaver Plateau, reclaimed	0	0	0	0	0
pond area	5.6	1.237	1.801	2.105	2.282
totals	63.9	5.77	10.594	13.391	15.096

AEP John E Amos Plant

Amos Landfill - Proposed Revised Beaver Plateau Sediment Pond for Pile Redesign (2016)

BPSP design worksheet

Sediment Pond Requirements

Permanent Pool Volume = larger of Sediment Storage Volume and "Wet" Storage Volume

Sediment Storage Volume		1.505	ac-ft	65,558	cf
@	0.125 ac-ft/acre disturbed				
"Wet" Storage Volume		114,965	cf	2.639	ac-ft
@	1800 cf/acre tributary				
Permanent Pool Volume =		2.639	ac-ft	'Wet' Storage	

Required Dewatering Storage = larger of 2-yr 24-hr storm runoff volume and "Dry" Storage.

2-yr 24-hr Runoff Volume		5.77	ac-ft	251,341	cf
"Dry" Storage Volume		114,965	cf	2.639	ac-ft
@	1800 cf/acre tributary				
Required Dewatering Storage =		5.77	ac-ft	2-yr 24-hr storm	

The pond is to store the Dewatering Storage without discharge through the principal spillway.
The crest of the principal spillway is therefore no lower than the elevation which corresponds to the Dewatering Storage + the Permanent Pool Volume, or 8.409 ac-ft

The pond is to handle the 10-yr 24-hr storm without discharge through the emergency spillway.
The crest of the emergency spillway is therefore no lower than the elevation which corresponds to the 10-yr 24-hr storm being routed through the pond (discharge through the principal spillway).

Drainage to Pond

Channel PCC-1 is to drain to the pond, via Culverts B1 (twin 36" dia.).
-E-M118, Rev 1 (AEP 13-30201-19-1), the elevations of culvert B1 inlet and outlet are given as 919.65 and 919.2, respectively.
The original design for the Beaver Plateau Sediment Pond had a elevation for the bottom of the pond at elevation 912.0 ft, msl (dwg C060816-00-004-01-E-M118, Rev1(AEP 13-30201-19-1).

AEP John E Amos Plant

Amos Landfill - Proposed Revised Beaver Plateau Sediment Pond for Pile Redesign (2016)

BPSP design worksheet

BPSP Design Parameters

	Elevation, Bottom of Proposed BPSP	915.00	ft, msl	
	Elevation, Bottom of Claystone under Surveyor's Point	940	ft, msl	
	Boring 0518 was constructed near the top of Surveyor's Point			
	Ground Elevation at Boring 0518	1005	ft, msl	Approx.
	Depth to Bottom of claystone, per boring log	62.8	ft	
	Elevation, Bottom of claystone	942.2	ft, msl	Approx.
	USE	940	ft, msl	
SET	Elevation, Crest of BPSP (minimum)	930	ft, msl	
SET	Type of Pond Construction	incised		
SET	Minimum Crest Width	10	ft	
SET	excavation slopes, interior	2	H:1V	
SET	fill slopes, exterior	3	H:1V	
SET	Elevation, Bottom of SPSP	915.00	ft, msl	
SET	Elevation, Littoral Bench	917.00	ft, msl	
SET	Width, Littoral Bench	20	ft	

Elevation-Storage Table for BPSP

Elevation (ft, msl)	Depth (ft)	Area (sf)	Average Area (sf)	Increm. Volume (cf)	Total Volume (cf)	Total Volume (ac-ft)	interpolation columns	
915	0	44,475		0	0	0	915	2
			48,872					
917	2	53,269		97,744	97,744	2.244	917	0.01
			60,809					
917.01	2.01	68349		608	98,352	2.258	917.01	0.29
			68,699					
917.3	2.3	69,049		19,923	118,275	2.715	917.3	2.7
			72,308					
920	5	75,567		195,232	313,507	7.197	920	0.01
			77,784					
920.01	5.01	80,000		778	314,285	7.215	920.01	0.79
			82,091					
920.8	5.8	84183		64,852	379,137	8.704	920.8	1.2
			87,359					
922	7	90,536		104,831	483,968	11.11	922	3
			92,768					
925	10	95,000		278,304	762,272	17.499	925	5
			97,500					
930	15	100,000		487,500	1,249,772	28.691	930	

	Permanent Pool Volume			2.639	ac-ft	114955	cf
	Elevation, Minimum, Permanent Pool			917.25	ft, msl		
	elevation	917.01	storage	2.258			
	elevation	917.3	storage	2.715			
SET	Elevation, Permanent Pool			917.3	ft, msl	*round to tenth*	
	Storage, Permanent Pool Elevation			118,275	cf	2.715	ac-ft
	elevation	917.3	storage	118,275	cf		
	elevation	920	storage	313,507	cf		
	Surface Area, Permanent Pool			69,049	sf		
	elevation	917.3	area	69,049	sf		
	elevation	920	area	75,567	sf		

Sediment Cleanout Volume			0.903	ac-ft		
			60	% of Reqd Sediment Storage		
Elevation, Sediment Cleanout Volume			915.8	ft, msl		
elevation	915	storage	0			
elevation	917	storage	2.244			
Minimum Principal Spillway Crest Storage			8.485	ac-ft	369,607	cf
Permanent Pool Volume	2.715	ac-ft				
Required Dewatering Storage	5.77	ac-ft				
Elevation, Dewatering Volume			920.68	ft, msl		
elevation	920.01	storage	7.215			
elevation	920.8	storage	8.704			

Principal Spillway

The crest of the principal spillway must be no lower than the elevation for the Combined Storage Capacity, or elevation 920.68 ft, msl

SET the crest of the principal spillway at elevation			**920.8**	**ft, msl**	
Storage at Crest of Principal Spillway			**379,137**		260,872
elevation	920.8	storage	379,137		
elevation	922.0	storage	483,968		
Surface Area, Permanent Pool			84,183	sf	
elevation	920.01	area	80,000		
elevation	920.8	area	84,183		

Emergency Spillway

The crest of the emergency spillway must be at least 1 ft higher than the crest of the principal spillway, and no lower than the 10-yr 24-hr storm routed through the pond.

The minimum crest elevation for the emergency spillway is 921.8 ft, msl

The 10-yr 24-hr storm runoff volume is used to obtain a preliminary elevation for the crest of the emergency spillway. No discharge through the principal spillway is considered.

Volume, 10-yr 24-hr storm w/ sediment storage			**13.309**	**ac-ft**	no routing of storm
10-yr 24-hr Runoff Volume		10.594	ac-ft		
Permanent Pool Volume		2.715	ac-ft		
Elevation, 10-yr 24-hr storm w/ sediment storage			**923.03**	**ft, msl**	no routing of storm
elevation	922	storage	11.11		
elevation	925	storage	17.499		

Determine the elevation of the 25-yr 24-hr storm level in the BPSP, given no outflow through the principal or emergency spillways.

Combined 25-yr 24-hr runoff volume w/ sediment storage				**16.106**	**ac-ft**
25-yr 24-hr Runoff Volume			13.391	ac-ft	
Permanent Pool Volume			2.715	ac-ft	
Volume for Storing the 25-yr 24-hr Storm			16.106	ac-ft	
Elevation, 25-yr 24-hr Storm, No outflow			**924.35**	**ft, msl**	
elevation	922	storage	11.11		
elevation	925	storage	17.499		

The emergency spillway was constructed at elevation 922.0.
desireable to have the spillway at as high an elevation as permissible.
Culverts "B1" discharging to the SPSP are 36 "diameter pipes, with an inlet elevation of 919.2 ft, msl.
The overflow elevation for the culverts would be higher than elevation 922.2 ft, msl.

Therefore, the crest of the emergency spillway should be less than elevation 922.2 ft, msl, but greater than the larger of elevation 921.8 ft, msl and the 10-yr 24-hr storm routed through the pond.

Set the Crest Elevation of the Emergency Spillway at elevation 922 ft, msl

Routing of the 10-yr 24-hr storm and the 25-yr 24-hr storm through the BPSP is performed using HydraFlow software.

Input to the Hydraflow model

Drainage Area (total)	63.9	ac
Curve Number (composite)	81.5	

weighted using 2-yr 24-hr storm, see calcs following

composite CN	CN	S	$VRO_{2\ (in)}$	$VRO_{2\ (ac\text{-}ft)}$	previously computed value
weighted by land cover	80	2.53	0.98	5.22	5.770
weighted by runoff volume	81.5	2.27	1.08	5.75	5.770

(solution by trial-USER select trial CN, compare computed VRO2 with previously computed value)

Time of Concentration	0.255	hr	15.3	minutes

REFERENCE original calculations by RH, "Graphical Peak Discharge Calculations, Beaver Plateau Pond", in P/2006/C060816/DASH 00/TASK 004/Subtask 01/Engineering/H&H/RH H&H/GPD_BeaverPlateauPond.doc, dated 8-17-07.

	Permanent Pool Elevation			917.3	ft, msl		
	Elevation, Crest of Principal Spillway			920.8	ft, msl		
SET	Diameter, Principal Spillway Riser			36	inches		
SET	Barrel Information	dia. (in)	inlet inv el	length (ft)	slope (%)	type	n value
		24	915	610	1	PE, Type S	0.011
		251,341	461,475	583,312	657,582		

Results of HydraFlow Analyses

Storm (24-hr)	2-yr	10-yr	25-yr	50-yr	
Peak Flow into Pond (cfs)	87.7	168.4	214	241.0	
Runoff Volume (cf)	253,605	480,016	610,766	689,172	
Runoff Volume (ac-ft)	5.822	11.02	14.021	15.821	*calc*
Maximum Pond Level (ft, msl)	920.77	921.12	921.76	922.19	
Peak Discharge from Pond (cfs)	0.0	6.8	25.2	34.4	
Stored Runoff Volume (cf)	373,473	469,638	474,820	494,434	
Stored Runoff Volume (ac-ft)	8.574	10.781	10.9	11.351	*calc*

Given the results of the HydraFlow analyses, the BPSP can handle the 25-year storm without discharge through the emergency spillway.

The existing Beaver Hollow North channel was designed to pass 27.3 cfs
for the 25-yr storm. *P\PIT\2004\2004-384\D60\E and S\H&H\channel 1 Design.txt*
(The predicted flow was 38.6 cfs, but 45 cfs was used in the channel calculator.
(see worksheet BHNWASCB, cells G259 and G262)
The relocated BPSP will discharge a peak flow of 25.2 cfs for the 25-yr storm (above table).

Therefore, the existing channel **CAN** handle the discharge from the BPSP, and **IS** adequate.

Conclusion

Beaver Plateau Sediment Pond can accept the additional drainage area diverted into the pond due to the revised layout of the Landfill. The Principal Spillway Riser Crest will have to be modified to an elevation of 920.8 ft. The permanent pool elevation will be set an an elevation of 917.3 ft.

Storage, Crest of Emergency Spillway			11.11	ac-ft
Storage, Crest of Embankment	elev	930	28.691	ac-ft