Engineering Report

Chaffee Landfill – Area 7/8 Development

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PRESENTED TO

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REPORT CERTIFICATION

The material and data in this report were prepared under the supervision and direction of the undersigned.

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This is the Engineering Report for Waste Management of New York, LLC (WMNY) application to the New York State Department of Environmental Conservation (NYSDEC) for a solid waste management facility permit modification. This modification would allow for the construction and operation of the Area 7/8 Development of the Chaffee Facility Landfill. The requirements for the Engineering Report are described in 6 NYCRR Parts 360.16(c)(3) and 363-4.3.

In addition, since the Area 7/8 Development overlies a portion of the Closed Landfill which is classified as a "Class 4" inactive hazardous waste site by the NYSDEC, this report will also present information regarding the requirements of Part 360.16(h)(1). This regulatory subsection states that for facilities proposed to be located within 150 feet of the boundary of a site undergoing a remedial program, the applicant must submit a report that discusses the potential impacts of the facility on the remedial program for that site. Additionally, the proposed facility must not interfere significantly with potential, ongoing or completed remedial program. The specific requirements of subsection 360.16(h)(1) are addressed in Section 12 of this report.

The purpose of this engineering report is to describe the basis for the design, construction and operation of the Area 7/8 Development. The design for the landfill development is depicted in the accompanying set of 39 engineering drawings, which are separately bound. These drawings are intended for concurrent review with this report.

Section 1.2, below, summarizes the organization of the engineering drawings and report.

WMNY presently operates the Chaffee Facility under Part 360 Solid Waste Management Permit No. 9-1462-00001/00006 (existing Part 360 permit). The Area 7/8 Development is a lateral development of the Chaffee Facility to the south of the existing landfill areas (Western, Valley, and Closed Landfills) and includes a vertical development overlying portions of the Western Landfill Development, Valley Fill, and the Closed Landfill. The engineering design for the Western Landfill Development was detailed in the February 2005 permit application. The approved Western Landfill Development consists of six double lined landfill cells covering approximately 57.3 acres. The engineering design for the 13.7-acre Valley Fill that connects the Western Landfill to the Closed Landfill was detailed in the December 2012 approved permit application. The Closed Landfill covers an approximately 51-acre area and was operated between 1958 and 2010. The closed landfill has been capped with an engineered cover system and contains leachate and landfill gas collection systems.

This Report is for the proposed Area 7/8 Development at the Chaffee Landfill and was prepared in conformance with the permit application requirements contained in the NYS Part 360 Regulations. Once the permit modification is approved, WMNY will continue to submit detailed construction plans and technical specifications to the NYSDEC in accordance with the requirements of Part 363-6 for review and approval prior to commencement of construction for each landfill development feature.

1.2 ORGANIZATION

1.2.1 Organization of Engineering Drawings

The engineering drawings are listed below:

General:

1. Title Sheet
2. Legend & General Notes
3. Regional and Vicinity Maps
4. Existing Site Conditions
5. Existing Site Conditions with Final Cover
6. Existing Utility / Boring Plan

Liner Plans and Details:

7. Subgrade Development Plan - Overall
8. Subgrade Development Plan
9. Conceptual Cover Grading Plan
10. Landfill Sections
11. Landfill Sections
12. 100 Foot Grid Map
13. 100 Foot Grid Coordinates and Elevations
14. Perimeter Berm Sections and Liner Details
15. Floor Intercell Berm Sections and Details
16. Floor to Overliner Sections
17. MSE Berm Sections and Details

Leachate Collection System Plans and Details:

18. Leachate Collection and Transmission Plan
19. Leachate Sump and Riser Plans
20. Leachate Sump and Riser Plans
21. Leachate Sump and Riser Sections
22. Leachate Sump and Riser Sections
23. Leachate Sump and Riser Sections
24. Leachate Collection System Details

Stormwater/Erosion and Sediment Control:

25. Stormwater Drainage Plan
26. Stormwater Basin Plan
27. Stormwater Drainage Sections and Details
28. Stormwater Drainage Sections and Details
29. Erosion and Sediment Control Details
30. Conceptual Closure and Stormwater Sections

Phased Operation Plans:

31. Phased Operation Plan – Cell 7 Baseliner Construction
32. Phased Operation Plan – Cell 8 Baseliner Construction
33. Phased Operation Plan – Cell 8 Waste Progression

Gas Collection System Plans and Details

34. Existing Gas Collection and Decommissioning Plan
35. Proposed Gas Collection System Plan
36. Gas Collection and Control System Details
37. Gas Collection and Control System Details
38. Gas Collection and Control System Details
39. Gas Collection and Control System Details

1.2.2 Organization of Engineering Report

This report is organized as follows:

- Section 1 describes the features and general design of the proposed Area 7/8 Development, outlines the organization of this report, and discusses the technical specifications.
- Section 2 describes the location and layout for the Area 7/8 Development, including horizontal and vertical layout and setbacks.
- Section 3 describes the Closed Landfill site controls and remedial actions, including a brief discussion on the historical landfill developments.
- Section 4 describes the Environmental Monitoring Plan
- Section 5 describes the liner systems for the Area 7/8 Development. This section also describes several site preparation measures that will be completed prior to construction.
- Section 6 provides a conceptual closure and post closure care plan for the Area 7/8 Development.
- Section 7 describes the soils management considerations for the Area 7/8 Development.
- Section 8 describes the leachate management system for the Area 7/8 Development.
- Section 9 describes the geotechnical analyses completed for the design of the Area 7/8 Development.
- Section 10 describes the surface water management system.
- Section 11 describes the landfill gas management system in the proposed landfill.
- Section 12 discusses compliance with hazardous waste regulations

It should be noted that there are stand-alone reports submitted under separate cover, but as part of the overall Chaffee Area 7/8 Development application that show how the proposed project meets the Engineering Report Requirements of the Part 363 regulations. These include a Borrow Area Use Plan (Part VIII of the Application) a Part 360 Noise Assessment and Natural Resources Report (appendices to the Supplemental Draft Environmental Impact Statement for the project).

1.3 TECHNICAL SPECIFICATIONS AND CONSTRUCTION QA/QC PLAN

Technical Specifications and a Construction QA/QC Plan were developed as part of the Western Landfill and Valley Fill Landfill permit applications. Updated versions of these documents, to cover the Area 7/8 Development, have been included in QA/QC Plan as required under 6 NYCRR Parts 363-4.5 which is Part V of the Chaffee Area 7/8 Development Application.

Prior to commencement of construction of each cell at the Chaffee Facility, WMNY will submit construction plans, Technical Specifications, and a Construction QA/QC Plan to the NYSDEC, for approval. As part of this process, the Technical Specifications and Construction QA/QC Plan will be updated as necessary to address specific individual cell construction issues or requirements.

2.0 LOCATION

The following sections describe the site location and demographics of the area, the service area, and the horizontal and vertical layout of the proposed Area 7/8 Development.

2.1 SITE LOCATION AND DEMOGRAPHICS

The Chaffee Facility, as shown on Sheet 3, is located in the southeast portion of Erie County, in the Town of Sardinia, approximately 36 miles south of the City of Buffalo. NYS Route 16, a regional north-south transportation link, connects Sardinia to Buffalo.

The Town of Sardinia had a population of 2,775, with total housing units numbering 1,182 based on the 2010 census data. Population centers in the town include the Hamlets of Chaffee and Sardinia. The Hamlet of Chaffee is on NYS Route 16 about 1 mile southeast of the Chaffee Facility and the Hamlet of Sardinia is located on Savage Road about 2.5 miles south of the facility. Detailed demographics were provided in Section 4.11 of the March 2005 Draft Environmental Impact Statement (DEIS). Changes in the demographics of the region since that date have been very minor.

2.2 SITE ACCESS AND SERVICE AREA

Access to the site is from NYS Route 16. Waste will originate from the current service area, which covers most of New York State, with the majority of the waste coming from within Erie County. It should be noted that future waste could originate from any Planning Units, Counties, and Municipalities located within the service area. Waste from WMNY's service area is primarily transported on NYS Route 400 and NYS Route 39 to NYS Route 16. NYS Route 400 is used to access the facility from the New York State Thruway. NYS Route 39 is an east-west roadway that connects with NYS Route 16 south of the facility.

A Vicinity Map is provided on Sheet 3. The vicinity map depicts a one-mile perimeter around the proposed Area 7/8 Development at the Chaffee Facility site.

2.2.1 Transportation

NYS Route 16 has a New York State Department of Transportation (DOT) Level of Service of "C", which indicates that it is capable of safely handling approximately 16,000 vehicles/day. No vehicular accidents have been recorded by DOT at the Chaffee Facility. DOT records indicate that the present traffic level/rate on Route 16 is between approximately an annual average daily traffic rate of 8,000 to 10,000 vehicles and on that basis the two-lane highway is operating satisfactorily.

The Norfolk-Southern railroad line is located to the east of Route 16 and roughly parallels the highway in the vicinity of the site (NYCRR Part 360 Permit Renewal Application, March, 1999, see Reference 2). The railroad is not expected to be used in transporting waste to the facility.

Hand Road is to the north of the facility (see Sheets 3 and 4). Traffic conditions on Hand Road were evaluated by Edward 0. Watts, P.E., P.C. in Appendix N of the March 2005 DEIS (see Reference 1). This analysis indicated that Hand Road is a relatively straight paved road with some rolling hills and has estimated traffic volumes of less than 500 vehicles per day. The Town of Sardinia has established a regulatory speed limit of 55 miles per hour for Hand Road.

The Chaffee landfill is accessed by waste transport vehicles through an entrance on Route 16 (see Sheets 3 and 4). The facility offices are accessed through a second entrance on Route 16. Three site entrances are also located on Hand Road (see Sheet 4) but are not used for waste transport into the site.

The number of waste hauling trucks entering the facility from Route 16 is not expected to increase since the proposed development does not include a waste tonnage increase above the presently permitted level of 600,000 tons per year. Therefore, the annual traffic volumes entering the facility from Route 16 will not be affected by the Area 7/8 Development.

Offsite soil materials required for construction will be trucked to the site through the main Route 16 entrance. As discussed in Section 4.7 of the March 2005 DEIS, the proposed project does not require an increase in the amount of soil imported to the site above that which is currently permitted.

Other traffic associated with the site includes tank trucks used to transport leachate offsite. These trucks will access the site through the Route 16 entrance.

2.2.2 Noise Assessment

Appendix D of the DSEIS includes a Noise Assessment to demonstrate compliance with the leq energy sound levels prescribed in Part 360.19(j) and, for purposes of this Report, to comply with Part 360.16(c)(3). Noise impacts due to the operation of the proposed Area 7/8 Development were found to be compliant with the implementation of mitigation measure during the operation of the facility. These mitigation measures will include increased setback distances to the active disposal area achieved through purchase of noise easements and use of noise attenuation berms where needed. Figure 1 of Appendix D of the DSEIS shows key noise study compliance locations including the noise easement areas. The noise attenuation berm will be located around the north and west edges of Borrow Area C as seen in the Borrow Area Use Plan (Part VIII of the Chaffee Area 7/8 Development application).

2.2.3 Zoning

The Chaffee Facility is located on 500 contiguous acres. Sheet 3 depicts zoning in the vicinity of the site. The current zoning for the landfill areas at the Chaffee Facility is approximately 423 acres of BL - Business/Light Industrial, 10 acres of LC – Light Commercial, and the remaining acreage (67 acres) is zoned AR – Agricultural/Residential based on the October 12, 2005 Town of Sardinia Zoning Map. The facility currently maintains the 51 acre Closed Landfill, operates the 57.3 acre Western Landfill Development and is constructing and operating the 13.7 acres Valley Fill landfill (which includes 9.6 acres overlying the closed landfill), The zoning requires WMNY to apply for and obtain a special use permit when applying for a landfill development or permit modification. The two proposed borrow areas are zoned AR – Agricultural-Residential. As with the previous Western Landfill Development, WMNY will work with the Town to obtain a Special Use Permit and Zoning Amendment for the borrow areas, in order to proceed with that aspect of the project.

2.3 SITE LOCATION

Sheet 4 depicts the current site conditions for the Chaffee Facility. The proposed Area 7/8 Development is a lateral development of the Chaffee Facility to connect the Western Landfill Development to the Closed Landfill. The development is located on the south side of Hand Road to the south of the 57.3 acre Western Landfill Development and 13.7 acre Valley Fill landfill, and overlies a portion of the 51 acre Closed Landfill. WMNY currently owns over 700 acres of property in the Town of Sardinia. The Chaffee Facility is located on 500 contiguous acres.

The entrance to the landfill site is located on NYS Route 16 (Olean Road), in the Town of Sardinia. A sign at the entrance provides information to the public about the facility. It displays the permit number, and days and hours of operation. The site has a maintenance facility, which includes a truck wash area, a recycling facility, a grounds maintenance building, the main office, a scale house, a landfill gas to energy plant and a leachate loadout/ landfill operations building. The location of these structures is shown on Sheet 4.

The Area 7/8 Development waste fill footprint area consists of approximately 63.3 acres of area consisting of 19.1 acres of new liner to the South of the existing Closed Landfill and Western Landfill, 9.5 acres of overliner (Closed Landfill), with the remaining 34.7 acres overlying the Closed Landfill and Western Landfill.

2.3.1 Topography and Drainage

The site is located on a natural ridge, with drainage to the north toward the East Branch of Cazenovia Creek and to the south toward Hosmer Brook. Hosmer Brook flows to the south from the project area and discharges into Cattaraugus Creek. Tributary No. 30 to Cazenovia Creek (also known as the East Branch) flows north. For further discussion of surface water conditions, refer to the Hydrogeologic Investigation Report for the Area 7/8 Development (Part IV of the Application). The site topography mapped on June 8, 2019, is shown on Sheet 4. The elevations in the Area 7/8 Development area range from approximately 1490 to 1640 feet National Geodetic Vertical Datum (NGVD).

NYSDEC and Federal freshwater wetlands are not located in the footprint of the proposed Area 7/8 Development. Several wetlands have been located and delineated surrounding the site, as shown on Sheets 3 and 4. In addition, the 100-year floodplain boundary for Hosmer Brook is approximately 1500 feet south of the Area 7/8 Development area as mapped by FEMA (see Sheet 3).

2.3.2 Subsurface Conditions

Subsurface conditions are extensively reported in the Hydrogeologic Investigation Report for the Area 7/8 Development (Part IV of the Application). This report also includes a summary of the regional geology and historical hydrogeologic studies performed at the facility. As mentioned previously, a portion of the Area 7/8 Development footprint lies on the support berm and final cap of the Closed Landfill. The support berm, which surrounds the Closed Landfill was constructed using the on-site clay till material. The proposed Area 7/8 Development footprint also overlies a portion of the Western Landfill and includes a lateral development to the south of the existing landfill and closed landfill. The following sections provide a brief summary of the subsurface conditions as they relate to the engineering design of the facility.

The proposed site is underlain by low permeability clay till. A silty sand and gravel unit is present below the clay till. Based upon test borings made at the site, bedrock is not present to a depth of at least 140 feet below the current ground surface. Previous applications indicate and as described in the Hydrogeologic Investigation Report the depth to bedrock in the Landfill Development area is greater than 400 feet.

The groundwater table at the proposed project site occurs in the silty sand and gravel. The groundwater elevation beneath the Area 7/8 Development varies between 1432 to 1439 feet NGVD. The Area 7/8 Development is located at higher grades than observed groundwater with the lowest subgrade elevation occurring at approximately 1450 feet NGVD, which is in the secondary sump areas (see Sheets 7 and 8).

2.4 PROHIBITED SITING/SITING CRITERIA

Part 360.8 specifies siting prohibitions for solid waste facilities. Additionally, Part 363-5.1 contains various siting criteria and evaluation requirements that apply to new solid waste landfills or lateral or vertical developments of existing solid waste landfills. The Area 7/8 Development project is designed to comply with the prohibited siting requirements of Part 360.8 and the siting criteria Part 363-5.1. The purpose of this section is to review and confirm the compliance of the Area 7/8 Development with the referenced requirements.

2.4.1 Special Flood Hazard Areas

As indicated in Part 360.8(a), solid waste facility development in a special flood hazard area is prohibited unless flood protection measures for the landfill development are provided. If the landfill development is to be located

within a special flood hazard area with flood protection measures, the protection measures must ensure that the landfill does not pose a significant hazard to human life, wildlife, fisheries, or land or water resources. The flood plain boundary is shown on Sheet 3 of the Engineering Drawings based on the Town of Sardinia Flood Insurance Rate Map - Community Panel Number 360256 0010B dated 10/21/83 published by the Federal Emergency Management Agency. This information indicates that the proposed development area is not in a floodplain.

Therefore, the Area 7/8 Development conforms to this siting criterion.

2.4.2 Endangered Species

As indicated in Part 360.8(b) solid waste facility development that causes or contributes to the taking of endangered or threatened species or to the destruction or adverse modifications of their critical habitat is prohibited. Earth Dimensions, Inc conducted a habitat assessment described in a report (see Appendix F of the DSEIS) dated July 16, 2020, which identified potential critical habitat or threatened or endangered species on-site. The assessment concluded that the proposed project may effect, but it is not likely to adversely effect, the fourteen migratory bird species identified in the assessment or the Northern long-eared bat due to tree clearing areas of potentially suitable habitat. During the investigation, no threatened or endangered species or critical habitat were noted as occurring on-site.

Therefore, the Area 7/8 Development conforms to this siting criterion.

2.4.3 Wetlands

As indicated in Part 360.8(c) siting of a solid waste facility within the boundaries of a New York State or Federally regulated wetland is prohibited unless appropriate permits are obtained.

Wetland boundaries shown on Sheet 3 of the Engineering Drawings are taken from NYSDEC freshwater wetland quadrangle maps of Sardinia and Arcade, published by NYSDOT. This information indicates that no state delineated wetlands are located within the proposed development area.

Earth Dimensions, Inc conducted a wetland delineation described in a report (see Appendix B of the DSEIS) dated July 16, 2020, which identified potential federal and NYSDEC jurisdictional wetlands. The purpose of the delineation was to determine if any federal or NYSDEC jurisdictional wetlands were present in areas proposed to be developed as part of the proposed Area 7/8 development. The results of the wetland delineation indicated that there would be no impacts to jurisdictional wetlands. This delineation was confirmed by Heather Adams of the USACOE in a letter dated June 17, 2019, included in Appendix B of the DSEIS. The NYSDEC Regulated Freshwater Wetlands were confirmed by Anne O. Rothrock NYSDEC Senior Wildlife Biologist, in a letter dated September 26, 2019. The boundaries of the confirmed wetlands are documented in the wetland delineation report in Appendix B of the DSEIS.

Based on this information the Area 7/8 Development conforms to this siting criterion.

2.4.4 Bedrock and Unconsolidated Deposits

Part 363-5.1(a) regulates landfill development within areas containing bedrock that is subject to rapid or unpredictable groundwater flow, and if such bedrock exists, it must be demonstrated that a containment failure of the landfill would not result in contamination entering the bedrock system. Rapid or unpredictable groundwater flow is typically associated with carbonaceous geologic deposits such as limestone in which dissolution channels or karst may form. Furthermore, this part indicates that the unconsolidated deposits underlying the proposed landfill exist or are constructed to be 10 feet or greater in thickness as measured from the base of the constructed liner system.

As described in the Hydrogeologic Report, groundwater flow in the clay till and sand and gravel hydrostratigraphic units are not considered to be rapid or unpredictable. In particular, the two water-bearing units are not associated with karst or other carbonaceous deposits. The Hydrogeologic Report provides a detailed characterization of the significant hydrostratigraphic units underlying the facility area. These units are a deposit of clay till material that is underlain by sand and gravel. The depth to bedrock beneath the site is greater than 400 feet.

This part in the regulation provides that sites that are active on or after November 4, 1992 and can demonstrate that the landfill will have no significant adverse impact on groundwater have no siting restrictions on the type of soils present below subgrade. As discussed in the Hydrogeologic Report, the proposed engineering controls for landfill construction are consistent with current regulations and the soil below the expansion area consists of low permeability silty clay or ablation till with soil properties conducive to minimizing the movement of chemical constituents, and therefore, there will be no significant adverse impact to groundwater. Therefore, no additional soil type restrictions are required.

The above information demonstrates that the Area 7/8 Landfill Development conforms to this siting criterion.

2.4.5 Anomalous Features

Part 363-5.1(b) provides that the landfill must not be in proximity to areas where anomalous features such as mines or caves that could alter groundwater flow. There is no history of subsurface mining at the site or karst/cave geology and therefore the siting criteria does not apply.

2.4.6 Agricultural Land

Part 363-5.1(c) places certain restrictions landfill development where agricultural soils are present. Part 363-5.1(c)(1)(i) states that the landfill cannot be located on property taken by eminent domain. None of the landfill property, including the Area 7/8 Development is owned by the Applicant as a result of eminent domain.

Part 363-5.1(c)(1)(ii) specifies that a landfill development may not be located on land areas that consists of more than 50 percent agricultural Soil Groups 1 or 2.

The surficial soil types on the portions of the site to be disturbed, and surrounding on-site areas, are shown on Figure 1. A NYS Soil Group Number of 3 or 4 represents relatively fertile soils, while a NYS Soil Group Number of 1 or 2 represents an area of prime agricultural importance. Figure 1 indicates areas of Soil Group 2. There are no Soil Group 1 areas within the project area and none of the land within the proposed borrow areas is classified as Soil Groups 1 or 2. Borrow Area C has been owned by WMNY for approximately 27 years, and during that period has not been used for agriculture. The South Borrow Area has been owned by WMNY for only about 2 years, and has recently been used for agriculture, although this has no bearing on the permitted future use of the area. There are approximately 11 acres of soil in the proposed Area 7/8 Development area, classified as soil types Chenango gravelly loam (CkB) and Castile gravelly loam (CeB), which are both classified as NYS Soil Group 2. However, the Area 7/8 Development area is currently within the BL (Business Light Industrial) district created for the Chaffee facility. More importantly, this land has been impacted by past earthwork operations, and has no potential for future use as agricultural land, regardless of the outcome of the landfill permit application. Even if the Area 7/8 development area were not already in the BL district, and the surficial soils had not already been impacted, these Siting Requirements regarding agricultural lands would not be an issue. For this project, the proposed incremental project areas (not including the borrow areas) consist of only 38 percent Group 2 soils, with no Group 1 soils. These areas are shown in Figure 1.

In addition, Part 363-5.1(c)(2) provides that if a proposed landfill development is located within a New York State agricultural district, the landfill development must be in compliance with described requirements of the New York State Agricultural and Markets Law Article 25-AA, Section 305. The entire Chaffee Facility, including the proposed

Area 7/8 Development area, Borrow Area C, and the South Borrow Area, is in the Erie County Agricultural District #15. Section 305, Part 1.h of the New York State Agricultural and Markets Law Article 25-AAprovides as follows:

> h. Notwithstanding any other provision of law to the contrary, no solid waste management facility shall be sited on land in agricultural production which is located within an agricultural district, or land in agricultural production that qualifies for and is receiving an agricultural assessment pursuant to section three hundred six of this article. Nothing contained herein, however, shall be deemed to prohibit siting when:
> (i) The owner of such land has entered into a written agreement which shall indicate his consent for site consideration; or
> (ii) The applicant for a permit has made a commitment in the permit application to fund a farm land protection conservation easement within a reasonable proximity to the proposed project in an amount not less than the dollar value of any such farm land purchased for the project; or
> (iii) The commissioner in concurrence with the commissioner of environmental conservation has determined that any such agricultural land to be taken, constitutes less than five percent of the project site.

Because Waste Management is the owner of the property on which the development will occur, Part 363-5.1(c)(2) does not apply and therefore, the Area 7/8 Development conforms to the Part 363-5.1(c) siting criterion.

2.4.7 Primary and Principal Aquifers and Public Water Supplies

Part 363-5.1(d) places certain restrictions on landfill siting over primary water supply aquifers or principal aquifers, and public water supplies.

Part 363-5.1(d)(1), provides that a lateral expansion cannot be constructed over a primary water supply aquifer, principal aquifers, within a public water supply stabilized cone of depression area, or within a minimum distance of 500 feet to surface waters that are actively used as a source of municipal drinking water supply." The Chaffee Landfill Facility, including the Area 7/8 Development area, is situated on the Lake Escarpment Moraine. Mapping and boring data indicates the moraine complex extends approximately 1,600 feet south of the proposed landfill development footprint. NYSDEC GIS New York State Aquifer mapping identifies the moraine as "not a Primary Aquifer" and well yield is "unknown". Site investigation to depths of 80 feet within and outside the development area footprint did not identify hydrogeologic conditions that would meet the NYSDEC definition of a Principal Aquifer described in TOGS 2.1.3, October 1990. GIS aquifer mapping shows a "High Yield Unconfined Aquifer" approximately 1,600 feet south of the development area (see Figure 7 of the Hydrogeological Report – Part IV of this application) and represents the Sardinia Aquifer consisting of outwash sand and gravel deposits having laterally continuity and a thickness of more than 20 feet.

Part 363-5.1(d)(2), provides that the required horizontal separation between deposited waste and primary water supply aquifers, principal aquifers, capture zones of public water supply stabilized cone of depression areas or surface waters that are actively used as sources of municipal drinking water supply must be sufficient to preclude contravention of groundwater standards in the aquifer and surface water standards in waters that are currently used as a source of municipal drinking water supply." The hydrogeologic report demonstrates that any release from the landfill assuming vertical migration to groundwater in the Upper Silty Sand and Gravel) would transport constituents in a northeast direction and not toward the aquifer, thereby precluding the possibility of contravening of groundwater standards in the aquifer. The development area is not located near surface water that is used as a source of municipal supply.

Based on this information, the Area 7/8 Development conforms to this siting criterion.

2.4.8 Aircraft Safety

The Part 360 requirements contain various criteria regarding facility height and the proximity of putrescible waste landfills to airports. As identified by Part 360-2(b)(6), an airport is defined as a facility open to the public without

prior permission and without restrictions within the physical capabilities of available facilities; and an active military airfield. The aircraft safety criteria specified in Part 363-5.1(e) is as follows:

> (1) A landfill into which putrescible waste is to be disposed must not be sited closer than 10,000 feet from any area of an airport used or intended to be used for landing, taking off, or surface maneuvering of turbine-powered fixed-wing aircraft or 5,000 feet from any area of an airport used or intended to be used for landing, taking off, or surface maneuvering of piston-powered fixed-wing aircraft.
>
> (2) A landfill into which putrescible waste is to be disposed which is located within five miles of any area of an airport used or intended to be used for landing, taking off, or surface maneuvering of aircraft must not, as determined by the Federal Aviation Administration, pose a potential bird or obstruction hazard to aircraft.
>
> (3) The owner or operator of an existing landfill that is authorized to dispose of putrescible waste and that is located less than 10,000 feet from any area of an airport used or intended to be used for landing, taking off, or surface maneuvering of turbine powered fixed-wing aircraft or less than 5,000 feet from any area of an airport used or intended to be used for landing, taking off, or surface maneuvering of only piston powered fixed wing aircraft must provide in its permit renewal application documentation that the Federal Aviation Administration has determined that the facility does not pose a bird hazard to aircraft.
>
> (4) A landfill containing only nonputrescible waste may be located less than 10,000 feet from any area of an airport used or intended to be used for landing, taking off, or surface maneuvering of turbine-powered fixed-wing aircraft or less than 5,000 feet from any area of an airport used or intended to be used for landing, taking off, or surface maneuvering of only piston-powered fixed-wing aircraft, if the Federal Aviation Administration has determined that the landfill will not present a safety hazard to air traffic.
>
> (5) The final elevation of a new landfill or development of an existing landfill must not extend more than 200 feet above the highest elevation of the land surface that existed prior to landfill development, unless the Federal Aviation Administration determines that the proposed fill height in excess of 200 feet will not present a safety hazard to air traffic.

Local maps and FAA resources were reviewed to evaluate the minimum distance requirements specified by the Part 363 requirements. The nearest public use airport within five miles of the proposed facility is the Arcade Tri County Airport and its runways are approximately 3.5 miles from the edge of the landfill. Therefore, sections (1), (3), and (4) are not applicable. Additionally, the final elevation of the Area 7/8 Development will not extend more than 200 feet above the land surface at the site. The existing highest elevation of land surface that existed prior to landfill development in the center portion of the site was elevation 1490 amsl, located in the Western Landfill and the highest proposed fill height in that area is 198 feet (top of proposed landfill is at elevation 1688 amsl). In the proposed Area 7/8 Development footprint the highest elevation of land surface that existed prior to landfill development in the southern portion of the site was elevation 1450 amsl, and the proposed fill height in that area is 190 feet (top of proposed landfill is at elevation 1640 amsl in that area). Therefore, Section 363-5.1(e)(5) is not applicable.

The one criterion that applies is contained in Section 2 of Part 363-5.1(e) that requires a determination of potential bird or obstruction hazard to an airport within 5 miles of the site.

As noted above, the regulations define an airport as a facility open to the public without prior permission and without restrictions within the physical capabilities of available facilities; and an active military airfield. The Tri County Airport in Arcade is within 5 miles of the landfill site (it is actually about 3.5 miles away). While it is listed with the FAA as privately owned, it can be used by the public. The FAA designates the airport as a public use airport, since it is available for use by the general public without a requirement for prior approval from the owner or operator. The airport also shows up on the NYDOT public use airport map. DEC's regulations and its definition of an airport aligns with EPA's definition of "airport" under the federal siting restrictions for MSW landfills (40 CFR

Part 258.10 – containing the same siting requirements for airport safety as Section 363-5.1(e)). The EPA regulations were originally drawn from FAA's rules. In EPA's early rulemaking, they stated that airports covered by this definition are airfields defined by the FAA as public-use airports. 44 Fed. Reg. at 53459.

As a result, a request was made to the FAA on 12/26/2019, in accordance with FAA requirements (based on the height at the four corners of the landfill and the maximum height) to obtain a determination of the potential safety hazard posed by the Area 7/8 Development. Based on this submittal, the FAA determined, on 01/15/2020 (2019-AEA-14953-OE through 2019-AEA-14957-OE) that the proposed structure would not pose a hazard to air navigation. Additional clarifying correspondence with the FAA via email, indicated that the proposed Area 7/8 Development project meets the requirements for siting facilities near airports as it relates to potential bird or wildlife hazard to aircraft.

Supporting documentation, including the submittal information, the letter of determination, and email correspondence from the FAA can be seen in Appendix A.

Based on this information, the Area 7/8 Development conforms to this siting criterion.

2.4.9 Unstable Areas

Part 363-5.1(f) regulates landfill development within areas where inadequate support for the structural components of the landfill exists or where subsurface features exist that would impair the integrity of the landfill containment structures. Part 363-5.1(f) defines unstable areas as areas that are susceptible to natural or human induced events of forces capable of impairing the integrity of some or all of the landfill structural components designed to prevent releases from the landfill." This includes, areas having an active or substantial probability of mass movement or areas of karst topography.

The Hydrogeologic Investigation Report (Part IV of the Chaffee Area 7/8 Development Application). indicates that the subsurface soils consist of glacial-derived till and sand and gravel overburden layers overlying a shale bedrock unit. The hydrogeologic investigation does not identify any unstable areas or karst areas at the site. The topography at the site (relatively flat), the glacial history and subsurface stratigraphy the site (thick, non-residual soils) are also not typically associated with poor foundation conditions or a susceptibility to mass movement.

Most significantly, pursuant to the requirements of Part 363-4.3(c), the engineering design described in this report includes a detailed analysis of the integrity and overall stability of the structural components associated with the proposed landfill. This analysis confirms that adequate support will be provided for the components of the proposed landfill development

The above information demonstrates that the Area 7/8 Development meets this siting criterion.

2.4.10 Unmonitorable or Unremediable areas

Part 363-5.1(g) applied mostly to new landfills and the requirement that they be located at sites where environmental monitoring and site remediation can be conducted. For such landfills groundwater and surface water flows must be able to be sufficiently characterized, such that releases from the landfill can be detected and remediated, as appropriate.

As noted in Section 2.4.4 above, karst terrain, a potential indicator of unmonitorable or unremediable areas, is not present at the facility location.

The December 2009 Environmental Monitoring Plan (EMP) for the Chaffee Facility describes the current overall site monitoring requirements for both the Western Landfill Development and Closed Landfill. The proposed Area 7/8 Development will not affect the current monitorability of either landfill area, monitoring wells and gas probes surround the facility will continue to be sampled and tested.

The above information demonstrates that the Area 7/8 Development complies with this siting criterion.

2.4.11 Holocene Fault Areas

Part 363-5.1(h) regulates landfill development within 200 feet of a fault that has had displacement within the last 10,000 years (Holocene time), unless it can be demonstrated that a lesser separation distance will not impact the structural integrity of the landfill and will be protective of human health and the environment. Review of online interactive fault mapping presented by the USGS (https://www.usgs.gov/natural-hazards/earthquake-hazards/hazards) indicates that the site is not located within 200 feet of a fault that has had displacement within the last 10,000 years.

Therefore, the Area 7/8 Development meets this siting criterion.

2.4.12 Seismic Impact Zones

Part 363-5.1(i) regulates landfill development in seismic impact zones, unless a seismic analysis [Part 363-4.3(d)] is completed which demonstrates that the permanent containment structures for the landfill, including liners, leachate collection systems, surface water control systems and final cover systems, have been designed to resist the maximum horizontal acceleration in lithified earth material for the site. Seismic impact zones are defined as areas with a 10 percent or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10g in 250 years (or two percent or greater probability in 50 years) as delineated on a United States Geological Survey (USGS) National Earthquake Hazard Reduction Program (NEHRP) Probabilistic Earthquake Acceleration and Velocity Map for the United States and Puerto Rico, or other equivalent seismic hazard map, or site-specific probabilistic seismic hazard analysis approved by the department.

As described in the calculations in Appendix B to this report, the current U.S. Geological Survey (USGS) Earthquake Hazards mapping and data was reviewed to determine if the site was within a seismic impact zone. The USGS Earthquake Hazards program contains an online Unified Hazard Tool which provides ground motion information for locations across the US based on different type of sites. To assess the ground motion for the Area 7/8 Development site, the tool was used to obtain the Peak Ground Acceleration (PGA). To assess the PGA in a manner that is consistent with the NYSDEC Part 360 definition - which is based on the acceleration in lithified material (i.e., rock) - a Site Class of B/C was selected when using the Unified Hazard Tool. This Site Class represents the interface between National Earthquake Hazard Reduction Program(NEHRP) classes B and C, or the interface between rock (Class B) and very dense soil soft rock (Class C). The current USGS data and mapping shows the site to have a maximum horizontal acceleration of 0.086g (reduced since the last permit application was submitted for this site), which indicates that the site is no longer within a seismic impact zone and additional analyses are therefore, not required.

2.5 LANDFILL LAYOUT

The Area 7/8 Development waste fill footprint area consists of approximately 63.3 acres of area consisting of 19.1 acres of new liner to the South of the existing Closed Landfill and Western Landfill, 9.5 acres of overliner (Closed Landfill), with the remaining 34.7 acres overlying the Closed Landfill and Western Landfill.

Sheets 7 through 11 show the horizontal and vertical layout of the proposed Area 7/8 Development.

2.5.1 Horizontal Landfill Layout and Setbacks

Limits of waste placement for the proposed Area 7/8 Development will provide a 520-foot separation to the edge of waste from Hand Road. Other horizontal separations that will be maintained include a 5000-foot separation from Savage Road and 4000 feet from Allen Road, to the edge of new waste to be placed. The minimum distance between the edge of the liner system for Area 7/8 and the property line is 162 feet. Therefore, the Area 7/8 Development will be located more than 100 feet from WMNY's property lines, in conformance with the minimum horizontal separation requirements of Part 363-6.2. Also, the Area 7/8 Development will be located more than

100 feet from local surface water bodies to protect against contravention of State surface water standards in these water bodies, in conformance with the requirements of Part 363-5.1(d)(2). Additionally, since the Area 7/8 Development will be located adjacent to and above the classified portion of the Closed Landfill, the requirements of Part 360.16(h)(1) will be complied with, as discussed in Section 12 of this report.

2.5.2 Vertical Landfill Layout and Setbacks

The Area 7/8 Development has been designed to maintain a subgrade fill thickness of at least 10 total feet below the base of the constructed liner system in compliance with Part 363-6.4 and 6.5. Information obtained during hydrogeologic studies has identified that the soil below the Area 7/8 Development consists of low permeability soils with silty and clayey characteristics and with the ability to attenuate and absorb contaminants. As discussed in the Hydrogeologic Report, the proposed engineering controls for landfill construction are consistent with current regulations and the low permeability silty clay or ablation till soils below the expansion have soil properties conducive to minimizing the movement of chemical constituents and allow for the detection of contaminants before off-site migration. The depth to bedrock is more than 400 feet below the Chaffee Facility and is not recharged by surface water or shallow groundwater near the facility.

Sheet 9 shows the conceptual cover grading plan for the landfill. The Area 7/8 Development side slopes will be constructed with maximum slopes of 3 horizontal (H) to 1 vertical (V) and the upper portion of the proposed landfill will be constructed at a minimum slope of 4 percent. The proposed landfill will rise to a maximum elevation of 1688 feet NGVD, which is approximately 30 feet above the maximum elevation of the Western Development. As shown on the cross sections for the proposed landfill (Sheets 10 and 11), the proposed Chaffee landfill will extend a maximum of approximately 198 feet above the existing ground surface upon completion. This maximum elevation above existing ground surface meets the limitation of 200 feet specified at Part 363-5.1(e)(5).

The vertical layout for the landfill is also based on the results of the landfill stability analysis provided in Section 8. This analysis indicates that the maximum 3H:1V slope of the final cover system for the proposed landfill meet the requirements in Part 363-4.3(c). This final cover slope also meets the final cover system slope requirements specified by Part 363-4.3(c)(3)(iv).

2.5.3 Design Life of Facility

The Area 7/8 Development will create 5,075,000 CY of airspace.

The phased filling of the Area 7/8 Development will correspond to the sequence of liner construction, as follows:

1. Cell 1 South/Cell 7 Baseliner Construction
2. Cell 8 Baseliner Construction
3. Cell 7/8 Overliner Construction

Each phase of construction is shown on Sheets 31 through 33 of the engineering drawings.

The approved design capacity for the landfill is 2,770 tons per day (not a limit), The maximum waste receipt at the landfill during any given quarter shall not exceed 180,000 tons. This rate is not proposed to change upon construction of the Area 7/8 Development. Further discussion on waste amounts and characterization is located in the Facility Manual (Part VI of the Chaffee Area 7/8 Development application). The types, minimum specifications and number of pieces of machinery needed to operate the facility at this design capacity are also described in the Facility Manual (Part VI of the Chaffee Area 7/8 Development application).

The site life for the combined Western Landfill Development and Area 7/8 Development is presented in the following table:

Table 2-1. Site Life for the Area 7/8 Development

Designation	Individual Cell Capacity (cubic yards)	Site Life (years)
Cells 1 South/Cell 7	1,058,500	1.5
Cell 8	1,682,500	2.4
Cell 7/8 Overliner	2,334,000	3.3
Total	5,075,000	7.2

Table Notes: The site life in the above table has been estimated by converting the cell capacity into tons using a waste density of 1700 pounds per cubic yard. The site life was then estimated using this value and annual waste acceptance rate of 600,000 tons per year.

Based on this design capacity, the Area 7/8 Development will provide approximately 7.2 years of airspace, beyond the currently permitted landfill. Because the actual waste density and annual receipts can vary from the values used in these calculations, the incremental site life from the Area 7/8 Development could also vary.

3.0 SITE HISTORY

In November 1981, Chaffee Landfill, Inc. received a Part 360 Construction and Operation Permit (No. 2629) for a solid waste management facility. The Closed Landfill at the Chaffee Facility is classified as a "Class 4" inactive hazardous waste site by NYSDEC because it reportedly received cyanide salts, solvents and PCBs prior to 1965. Class 4 indicates that no further remedial action is required but that on-going monitoring is needed.

In accordance with the requirements of 6 NYCRR Part 360, WMNY's permit for the Chaffee Facility and NYSDEC oversight, WMNY has installed various site controls and remedial measures for the Closed Landfill. These site controls and remedial measures are summarized in the following sections.

3.1 HISTORICAL LANDFILL DEVELOPMENT

The Site includes areas which have previously been utilized for waste management activities, other than those that are currently permitted. These areas are discussed below.

The Chaffee Facility was a farmstead, prior to its use as a disposal area. It was converted to a landfill under the ownership and direction of Mr. Hugh Smith in 1958. Chaffee Landfill, Inc., under the direction of Richard Penfold, President, acquired the 36-acre landfill (the “original fill area”) and associated properties in October 1977.

Chaffee Landfill, Inc. received a NYSDEC 6 NYCRR Part 360 Operation Permit (No. 2629) for a solid waste management facility in November 1981. The area permitted for landfill development increased from the original 36 acres to 50.93 acres (see area designated "Closed Landfill" on Sheet 4). The permit included provisions for construction of a leachate collection system in and around the 36 acre "original fill area".

The Closed Landfill was included in NYSDEC’s Inactive Hazardous Waste Disposal Sites Registry (“Registry”) in 1983 as a “Class 4” inactive hazardous waste site, defined as a site where no further remedial action is required but operation, maintenance, and/or monitoring must continue. The Site was classified as a "Class 4" (lowest priority) site due in part to the construction of a recompacted clay till cut-off trench constructed around the east and south sides of the solid waste in the "original fill area", as shown on Sheet 4. Subsequent to the original listing in 1983, the limits of the Class 4 site were determined by the NYSDEC to be less than the entirety of the Closed Landfill and limited to a 33.5-acre area of the Closed Landfill. (See Inactive Hazardous Waste Site Limits designated on Sheet 4).

The site continues to be listed as a Class 4 site on the Registry.

3.2 SITE STUDIES AND FACILITY MODIFICATIONS

Several geologic and engineering studies have been completed at the facility, which were thoroughly discussed in the March 2005 DEIS for the Western Landfill. Many of the studies and facility modifications were initiated and completed at the direction of the NYSDEC to improve the monitorability and performance of the Closed Landfill.

3.3 CLOSED LANDFILL DESIGN

The Closed Landfill design components can be grouped into the following general categories:

- Leachate containment,
- Leachate collection and storage,
- Landfill gas control,
- Surface water control, and
- Environmental monitoring.

The Closed Landfill is separated into the original fill area and five lined areas as denoted by the variances discussed in Section 3.1.

3.3.1 Containment Support Berm

The original 33.5-acre fill area is on top of the 30 to 50 foot thick natural clay till layer that exists beneath the entire footprint of the landfill. A recompacted clay till cut-off trench was constructed around the east and south sides of the solid waste in the original 33.5 acre fill area by excavating into the natural clay till to a depth of about 20 feet. The purpose of the cut-off trench is to prevent lateral movement of leachate. The trench was located based on the extent of solid waste observed at the ground surface. The trench was backfilled to grade with recompacted clay till.

A vertical clay till containment berm with a minimum initial height of 10 feet was constructed around the entire perimeter of the landfill as additional cell areas were constructed. This vertical clay till berm was constructed around the entire 50.93 acre landfill site from the initial height of 10 feet to its current design elevation as shown on Sheet 4. The vertical containment berm had a minimum top width of 10 feet. The exterior face of the vertical containment berm is supported by an exterior soil support berm with a maximum outside slope of 2H:1V.

Construction of the north vertical berm and exterior support berm was completed in 2000/2001. This area of the containment berm was completed so that final cover placement could take place along the north slope of the landfill in 2001. Some reconstruction of the northwest corner of the exterior support berm occurred in late 2000 as the result of sloughing of topsoil that had been placed over the existing slope surface.

Construction of the east vertical containment berm and exterior support berm was completed to a point about 200 feet north of the southeast corner of the landfill in 2001. Part of the construction of this section of the exterior support berm required placement of soil in the state wetland AR-11 near the northeast portion of the landfill. This soil placement within the wetland received approval from the NYSDEC (DEC # 9-1462-00001/00003) on October 18, 1999, and the U.S. Army Corps of Engineers (USACOE), Buffalo District (Permit #96-936-37). A section of the exterior support berm along the northeast portion of the landfill was redesigned to include a nearly vertical engineered support wall to limit encroachment into the wetland. Soil that had eroded from the support berm during construction encroached on the wetland when silt fences were breached after several heavy rains in 2001. The on-site contractor removed this soil from the wetland at the direction of the NYSDEC. The slope of the berm was stabilized with erosion mats and grass vegetation was established.

A portion of the south and west vertical containment berms was constructed in 2002, with the remaining south and east vertical containment berms being constructed in 2003. Additional support berm was constructed in the south east corner to stabilize horizontal berm movement in that area. It was believed that a buried layer of weak material existed below the subgrade elevations, which required that the support be flattened and buttressed to create a stable condition.

3.3.2 Landfill Liner System

The liner beneath the cells constructed outside of the original fill area of the Closed Landfill consists of a minimum of 24 inches of compacted barrier soil with an in-place hydraulic conductivity of less than 1.0×10^{-7} cm/sec, which the NYSDEC had established as being an acceptable low permeability system for containing leachate. This layer was placed directly on the in-situ clay till subsoil. The liner slopes at a minimum 3 percent grade towards the leachate collection lines. The maximum distance that leachate travels along the liner to the collection pipes is 100 feet. The base liner system connects to the vertical containment berm.

3.3.3 Leachate Collection System

The leachate collection system of the Closed Landfill consists of a series of perforated pipes, placed within stone beds, flowing by gravity to four collection tanks located around the perimeter of the site (see Figure 2 for leachate

collection pipe and tank locations). The leachate collection system is designed to collect and remove leachate generated by infiltration of storm and melt water through the final cover system into the original fill area and the lined fill area.

The leachate collection system originally included five collection tanks. Four of the tanks were constructed of steel and one was constructed of reinforced concrete. The collection tanks were installed inside the landfill containment berm and just below the base elevation of the landfill. There was concern by WMNY that the bare single walled steel tanks would eventually corrode and plans were made to replace the steel tanks with double walled cathodically protected steel tanks. Removal and replacement of the interior steel leachate storage tanks began with tanks 3 and 4 in 1999. A single double walled steel tank located outside the southwest corner of the Existing Landfill replaced these two tanks. Leachate tanks 1 and 2 were replaced in 2001 and 2003 by installing HDPE sump pipes within the landfill, the leachate would then be pumped from the sump to double walled steel tanks located outside of the Closed Landfill.

As part of the Western Landfill Development, additional tank modifications were completed in 2011. Specifically, the 1999 tanks 3 and 4 replacement tank was abandoned in place and replaced with a dual contained HDPE manhole. Leachate is pumped from this new manhole to the above ground storage tanks installed as part of the Western Landfill Development. In addition, Leachate tank 5, shown on Figure 2 which was constructed of reinforced concrete has remained in place as originally designed. A new pump discharge line was installed as part of the Western Landfill Development to connect the tank to the north leachate transmission pipe. Leachate from this tank is also now directed into the above ground storage tanks installed as part of the Western Landfill Development.

The amount of leachate removed from the Closed Landfill increased during the early 2000's, which can be attributed to improvements in the gas collection system. The condensate from the interim gas system installed in the mid 1990's discharges to the leachate collection tanks. Removal of landfill gas reduces the internal pressure within the landfill, which allows liquid to more freely move downward into the leachate collection system.

As stated above, the present leachate transmission and storage system for the Closed Landfill is constructed with a series of interior leachate collection sumps (LCS) and exterior leachate storage tanks (LST) used to manage the leachate collected within the Closed Landfill. As part of the gas control system there are currently four condensate knockouts, which either transmit condensate directly to a LST or collect it in a storage tank for subsequent disposal. Two of the condensate knockouts drain liquid directly into either LST 1 or LST 2, the third drains into the LST 3/4 manhole. The fourth condensate knockout consists of a double walled steel tank, which collects liquid from the gas header and power production plant.

3.3.4 Closed Landfill Gas Control and Collection

Landfill gas is currently extracted from the Closed Landfill by using vertical collection wells. The gas is then transferred to either an enclosed flare or power production plant for combustion. The control of landfill gas is addressed in both the solid waste regulations, 6 NYCRR Part 360 as well as the federal air regulations, 40 CFR Part 60, Subpart WWW, and 40 CFR Part 63, Subpart AAAA. The Part 360 solid waste regulations control the migration of landfill gas off-site through subsoils. The federal regulations regulate the landfill emissions from the surface of the landfill as part of the New Source Performance Standards for MSW landfills.

The amount of gas removed from the Closed Landfill has increased steadily as the control and collection system has been installed. Continued decomposition of the waste mass in conjunction with gas extraction will continue to deplete the amount of gas potentially generated within the Closed Landfill. It is predicted that substantial amounts of gas will be removed for the next 15 to 20 years. After that period, the gas control and collection system may be reduced from an active system to a passive system.

3.3.4.1 Gas Collection System Components

Fifty vertical collection well were installed through the waste mass of the Closed Landfill. Vacuum is applied to these wells through a series of pipes to allow for gas to be extracted. Each collection well is monitored and adjusted to maintain extraction rates and monitor gas content. As gas is extracted from the wells, it flows laterally through HDPE pipes buried within the final cover. These pipes then flow into a large diameter HDPE header pipe, which rings the Closed Landfill. The header pipe collects the extracted gas and transports it to the enclosed flare or power production plant. As the Phase 2 Valley Fill has progressed ten of these wells have been retrofitted/ overdrilled.

As discussed in Section 3.3, condensate, which forms within the gas collection system, is treated as leachate and is discharged from the system via knockouts.

3.3.4.2 Gas Combustion Components

As stated above, extracted gas is combusted using either the enclosed flare or power production plant. Gas is primarily combusted by the eight internal combustion engines located at the power production plant. These engines are connected to electric generators, which generate electric power for distribution on the power grid. The enclosed flare is used when excess gas is being generated or during power plant shutdowns.

3.3.4.3 Gas System Monitoring

Routine monitoring of potential landfill gas migration is required to demonstrate that the concentration of methane and other explosive gases generated by the landfill areas do not exceed:

- Twenty-five percent of the lower explosive limit for gases in structures on or off-site, excluding gas control or recovery system components; and
- The lower explosive limit for the gases at or beyond the property boundary.

Monitoring for the presence of landfill gas, pressure and water level is completed quarterly at the gas probes surrounding the Existing Landfill.

3.3.5 Closed Landfill Final Cover System

Placement of the final cover at the Closed Landfill began along the north slope in 2001 with subsequent capping projects in 2002, 2008 and 2010. The final cap was designed in accordance with the 6 NYCRR Part 360 regulations at the time of the closure with a geomembrane barrier layer, 24 inches of barrier protection and 6 inches of topsoil. A subsurface drainage layer and landfill gas venting layer is also included in the final cover design. Final location of gas collection wells were accomplished prior to installation of the final cover with final gas collection piping being buried within the barrier protection soils.

At the completion of each construction, a certification report was submitted to the NYSDEC. These independent firms for each construction are listed below:

- 2001 Benchmark Environmental Engineering Science, PLLC;
- 2002 Golder Associates; and
- 2008 and 2010 engineering was provided by Ensol, Inc. with construction oversight by Golder Associates.

WMNY presently provides on-going inspection and maintenance of the final cover system in accordance with the Part 360 post closure requirements.

3.3.5.1 Cover System Components

The final cover system for the Closed Landfill consists of the following minimum components:

- 6-inch minimum prepared grading layer over the waste,
- Geosynthetic gas venting layer,
- Geomembrane liner,
- Geosynthetic drainage layer,
- 24-inch barrier protection layer, and
- 6-inch topsoil layer.

Each final cover construction project included these components, though different materials and installation techniques were utilized for the geomembrane, gas venting and drainage layers. In addition to the final cover, drainage swales and downchutes were constructed to transmit surface water to the permanent drainage channels located along the support berms.

3.3.5.2 Surface Water Management

Surface water run-off from the eastern part of the Closed Landfill is collected by drainage swales, downchutes and perimeter channels and directed to existing Sedimentation Basin #4 at the southeast corner of the landfill. This basin eventually discharges to state wetland SD-1 that is part of the Hosmer Brook watershed.

Surface water run-off from the western part of the Closed Landfill is directed to the reconstructed Sedimentation Basins #1, #2 and #3 located at the southwest corner of the landfill through drainage swales, downchutes and perimeter channels. These basins were reconstructed and lined in accordance with the New York State Stormwater Management Design Manual as part of the Western Landfill Development. The basins also drain to state wetland SD-1, which forms the headwater of Hosmer Brook.

3.4 WESTERN LANDFILL/VALLEY FILL DESIGN

The currently permitted landfill at the site consists of the Western Landfill and the Valley Fill Landfill. The engineering design for the Western Landfill Development was detailed in the February 2005 permit application, and the engineering design for the Valley Fill Landfill Development was detailed in the December 2012 permit applications. The major design components of these landfills are summarized below.

3.4.1 Landfill Liner System

The Western Landfill Development consists of six double lined landfill cells covering approximately 57.3 acres. The subgrade consists of both in-situ and placed low-permeability clay till ranging in thickness from 20.4 to over 100 feet. The dual composite lined landfill cells are graded at a minimum of 2.5% towards a central leachate collection pipe which drains to sumps located on the outside edge of each cell. The sideslopes of each cell were graded at a slope of 3H:1V.

The Valley Fill Development consists of two double lined overliner cells covering approximately 13.7 acres and connects Cells 1 and 2 of the Western Landfill to the Closed Landfill. The subgrade for the Valley Fill Development consists of areas previously filled for the either the Closed Landfill's support berm or the final cap of the Closed Landfill. Topsoil was removed from the support berm and final cap prior to establishing the subgrade surface. Portions of the support berm were regraded to create the required 3H:1V slopes. The majority of the support berm was constructed using on-site clay till soils and additional fill was placed in accordance with embankment material specifications. A portion of the Closed Landfill cap and support berm were removed to create a bench area and 2H:1V slope at the transition of the overliner from support berm to existing waste to mitigate the effects of differential settlement.

3.4.2 Leachate Collection System

The primary leachate collection system is comprised of a continuous stone drainage layer above the liners. Leachate flows through the granular collection stone to 8" diameter perforated collection pipes. The landfill base grades and permeable stone drainage layer provide rapid drainage through the stone drainage layer and collection pipes to a sump located at the low point of each cell. Leachate collected in the sump is pumped into the leachate transmission system to the leachate storage facility.

The secondary leachate collection system is comprised of a continuous geocomposite drainage media. Secondary leachate flows through the geocomposite to 4" diameter perforated collection pipes. The landfill base grades and piping direct secondary flow to a sump located at the low point of each cell. Secondary leachate is collected separately from the primary leachate in the sump and then pumped into the leachate transmission system to the leachate storage facility.

Overliner areas of Cells 1 and 2 of the Valley Fill Landfill Development use common sump and pump systems designed for the adjacent baseliner areas of Cells 1 and 2 of the Western Landfill Development.

The leachate transmission system consists of north and south piping, which combines into a single pipe prior to entering the storage tanks.

The leachate storage system consists of two above ground storage tanks within a secondary containment tank. Each tank has a capacity of approximately 405,000 gallons for a total storage volume of 810,000 gallons.

3.4.3 Landfill Gas Management

The landfill gas collection system for the Western and Valley Fill Landfills consists of vertical gas extraction wells, horizontal collectors and associated piping. The collected gas is sent to an existing enclosed flare, or to the on-site power generation plant. A condensate knockout is located at the northwest corner where condensate is pumped into the leachate transmission system for the site.

3.4.4 Surface Water Management

Surface water run-off from the Western and Valley Fill Landfills is collected by drainage swales, downchutes and perimeter channels and directed to existing Sedimentation Basins#5 #1, #2, and #3, at the southwest corner of the landfill. These basins eventually discharge to state wetland SD-1 that is part of the Hosmer Brook watershed.

4.0 ENVIRONMENTAL MONITORING PLAN

WMNY will implement an Environmental Monitoring Plan (EMP) (Part VII of the Chaffee Area 7/8 Development application) to assess the potential impacts of the Chaffee Facility on groundwater, surface water and the other aspects of the environment surrounding the facility. The EMP describes proposed on-site and off-site monitoring, including:

- Landfill gas migration monitoring programs,
- Water quality monitoring programs, and
- A contingency water quality monitoring plan which specifies trigger mechanisms for its initiation.

The potential for off-site migration of landfill gas is monitored through permanent landfill gas monitoring probes. These gas monitoring probes (constructed and proposed) can be seen at the locations shown on Figure 2 of the EMP. Routine monitoring of potential landfill gas migration is required to demonstrate that the concentration of methane and other explosive gases generated by the landfill areas do not exceed:

- Twenty-five percent of the lower explosive limit for gases in structures on or off-site, excluding gas control or recovery system components; and
- The lower explosive limit for the gases at or beyond the property boundary.

Quarterly monitoring for the presence of landfill gas, pressure and water level is currently performed at the gas probes. The quarterly gas monitoring results are submitted as an attachment to the main body of each quarterly report.

The groundwater monitoring wells for the site, including the Closed Landfill, Western Landfill, Valley Fill Landfill, and Area 7/8 Development, can be seen on Figure 2 of the EMP. Groundwater monitoring wells are installed as couplets in the clay till and the silty sand and gravel at each location. These groundwater monitoring wells have been located to enable detection of impacts from active and inactive landfills at the site.

Surface water samples will be collected quarterly from Sedimentation Basins as described in the EMP. These samples are analyzed for the same list of parameters as the concurrent groundwater sampling program. In addition to the surface water samples, sediment samples are also collected from the basins and analyzed for the same parameters.

Leachate in the collection and removal system will be collected and analyzed on a semi-annual basis for the Part 360 Expanded list of parameters. Composite samples of leachate are obtained from various collection points and described in the EMP. The leachate collection infrastructure can be seen in Figure 2.

5.0 AREA 7/8 LANDFILL LINER SYSTEMS

Design of the leachate collection system is shown on the engineering drawings and is addressed in the appendices to this report.

Sheets 7 through 11 provide the sections and details of the baseliner and overliner system. Sheets 18 through 24 provide the plans, sections and details for the leachate collection system.

5.1 SITE PREPARATION

Prior to landfill liner construction, the Area 7/8 liner areas will be cleared and stripped of topsoil. The existing leachate collection system and gas collection system will be modified to accommodate the Area 7/8 Development.

5.1.1 Existing Leachate Collection System Modification

Leachate generated along the south and western sides of the Closed Landfill is collected in perforated drain pipes, which slope to two solid drain pipes, which combine and gravity drain into LCS 3/4 manhole. The LCS is a dual contained HDPE manhole pump station that was installed in 2011. The LCS 3/4 manhole currently consists of a dual contained HDPE manhole, which contains a submersible pump, level controls and leak monitoring system. The submersible pump allows for leachate to be discharged into a transmission line for transfer directly into the landfill's above ground leachate storage tanks. As part of the Area 7/8 Development the LCS 3/4 manhole will be relocated to the southwest of its current location, outside the Cell 1 South footprint and the dual contained piping will be extended. As seen on Sheet 18 of the Engineering Drawings the relocated pump station will operate in a similar fashion to the current condition, only it will be installed at a lower elevation.

To check the adequacy of the existing leachate collection pipes underlying the Closed Landfill to withstand the load to be imposed by the proposed development, we considered existing leachate pipe J (see Sheet 18). Leachate pipe J will be under the largest weight thickness upon completion of the Area 7/8 Development and is representative of the loading for the other existing Closed Landfill leachate collection pipes. We estimated the deflection and strength of the leachate pipes for the proposed maximum loading. Record drawings indicate that the leachate pipes are schedule 40 Polyvinyl Chloride PVC and were bedded in a mound of crushed stone. The estimates indicate that the leachate pipe deflection and strength are within recommended values. These calculations are described in more detail in Section 7.3.3.

The modifications to the leachate collection system will allow the leachate collection lines to remain operational beneath the proposed landfill development.

5.1.2 Existing Gas Collection System Modification

The existing gas control wells located along the south slope of the Closed Landfill will be evaluated prior to constructing the overliners. Plans and details depicting proposed modifications are shown on Sheets 34 and 35. At a minimum, the vertical well components will be removed to at least 35 feet below the bottom of the Closed Landfill cap. The wells will be abandoned, relocated or connected to horizontal trenches located beneath the Closed Landfill cap. The geosynthetic gas venting layer will be repaired and connected to a relocated gas vent connection outside the limits of the overliner.

The modifications to the gas collection system will allow the leachate collection lines to remain operational beneath the Cell 7/8 Overfill.

5.1.3 Subgrade Construction

The landfill subgrade is the uppermost in situ soil layer or select fill layer that will be graded and prepared for landfill liner construction.

The Hydrogeologic Investigation Report (Part IV of the Chaffee Area 7/8 Development application) provides a detailed characterization of the in situ unconsolidated soils that comprise the subgrade for the Area 7/8 Landfill Development.

As described in the Hydrogeologic Investigation Report, the soils at the site consist of low permeability clay tills over a deposit of sand and gravel. The unconsolidated clay and ablation till soils meet the requirements in Part 363-6.5. These soils are also present below the support berm, Western Landfill, and Closed Landfill.

The Area 7/8 Development also includes overliner cells that will be constructed on areas previously filled for either the Western Landfill, the Closed Landfill's support berm, or the final cap of the Closed Landfill. Portions of the support berm will require regrading to create the required 3H:1V slopes. The majority of the support berm was constructed using on-site clay till soils; additional fill will be placed in accordance with current embankment material specifications. The final cap's barrier protection layer will serve as the subgrade for the liner system above the support berm.

A portion of the Closed Landfill cap and support berm will be removed to create a bench area and 2H:1V slope at the transition of the overliner from support berm to existing waste. The bench area and 2H:1V slope are intended to mitigate the effects of differential settlement as further discussed in Section 8 of this report. The 2H:1V slope is a temporary condition since settlement estimates indicate that the slope will eventually be less than 3H:1V after waste placement.

The requirements in Part 363-6.7(b)(2)(i) state that the soil component of the liner system must be placed at a slope not greater than 33 percent (3H:1V) to minimize erosion and facilitate construction. As discussed above, a portion of the overliner cells are planned to be constructed on a 2H:1V slope; therefore, the secondary soil component of the overliner system will be initially constructed at a slope that is steeper than specified in the regulations. As such, a variance request will be submitted supporting the proposed liner system slope.

This overliner slope is consistent with previously approved overliner slope portions in the currently permitted Valley Fill Landfill Development.

The 2H:1V overliner slope is intended to allow for differential settlement as described in Section 9 of this report. The 2H:1V slope is a temporary condition since settlement analyses (Appendix B) indicate that the slope will be less than 3H:1V after waste placement and settlement occur.

As stated in the regulations, the secondary soil liner will be installed in a manner to minimize erosion and facilitate construction. The issue of erosion is mitigated by several factors. The work area is small and the upslope drainage area will be diverted around it to limit the quantity of stormwater and erosion during construction. In addition, stormwater controls such as silt fences and hay bales will be installed on the bench located at the toe of the 2H:1V slope to mitigate erosion during construction.

The stability analysis (Appendix B) indicates that the components of the liner will be stable when placed on the 2H:1V slope. Experience with construction on similar slopes indicates that while construction is more difficult on steeper slopes, the liner system components can be constructed at this slope and achieve the project design requirements. As required by Part 363-6.7(a)(2)(ii) and (iii) the secondary soil liner must be at least 24 inches in compacted thickness and must have a maximum remolded coefficient of permeability of 1x10-7 cm/sec. Sheet 11 of the engineering drawings indicates that the secondary soil liner along the 2H:1V slope will be constructed to 36 inches in compacted thickness, which exceeds the thickness requirements. In addition, the technical specifications and construction QA/QC plan (Part V of the application) include material, placement and testing requirements for the secondary soil liner to ensure that the regulatory requirements are met.

The liner components will continue to meet design criteria after settlement. As shown in the settlement analysis (Appendix B) the geomembrane can accommodate the deformation. Settlement data for the Closed Landfill cover shows that settlement results in a relatively uniform slope without areas of concentrated deformation. Our analyses described in Section 9.0 support this observation and indicate that more settlement will occur upslope than at the berm, resulting in a relatively uniform flattening of the slope. Under these conditions, it is expected that the secondary soil liner will maintain its liner characteristics and comply with the project requirements.

The bench area and subgrade slopes are depicted in plan view on Sheets 7 and 8. An overall cross section is shown on Sheets 10 and 11 with construction sequencing details shown on Sheets 31 through 33. As shown in the details, the Closed Landfill cap will be removed, subsurface drainage will be redirected, limited waste will be removed and placed into the operational cells of the Western Landfill Development and the cap will be replaced on the 2H:1V slope.

Prior to establishing the subgrade surface, topsoil will be removed from the support berm and final cap.

5.1.3.1 Mechanically Stabilized Earth Berm

During the construction of Cell 7, a mechanically stabilized earth (MSE) berm will be constructed to allow for perimeter berm construction without disturbing the proposed stormwater basins. The components of the MSE berm are shown on Sheet 17 and will be designed to level appropriate for construction and submitted to the NYSDEC for approval prior to the construction phase of Cell 7.

5.2 BASELINER AND LEACHATE COLLECTION SYSTEMS

Consistent with the requirements of the regulations, the components of the baseliner system, from top to bottom, are as follows:

- 2-ft thick drainage layer used for the primary leachate collection system;
- 12 oz/yd2 nonwoven geotextile cushion layer;
- 60-mil thick, textured, high density polyethylene (HDPE) geomembrane component of the primary composite liner;
- Geocomposite clay liner (GCL) upper soil component of the primary composite liner;
- 12-in thick drainage layer used for the secondary collection system;
- geocomposite secondary leachate collection layer consisting of a geonet with a layer of nonwoven geotextile heat-bonded to it on top and bottom;
- 60-mil thick, textured, HDPE geomembrane component of the secondary composite liner; and
- 2-ft thick soil component of the secondary composite liner.

Material specifications are described in Part V of the application and Sheets 14, 15, 16, 18 and 24 provide construction details for the base liner and leachate collection system, including toe-of-slope details, cell-to-cell construction details and liner connection details for cell overlaps.

5.3 SIDESLOPE LINER AND LEACHATE COLLECTION SYSTEMS

The components of the typical sideslope liner system, from top to bottom, are as follows:

- 2-ft thick drainage layer used for the primary leachate collection system;
- 12 oz/yd2 nonwoven geotextile cushion layer;
- 60-mil thick, textured, high density polyethylene (HDPE) geomembrane component of the primary composite liner;
- geocomposite secondary leachate collection layer consisting of a geonet with a layer of nonwoven geotextile heat-bonded to it on top and bottom;

- 60-mil thick, textured, HDPE geomembrane component of the secondary composite liner; and
- 2-ft thick soil component of the secondary composite liner.

Material specifications are described Part V of the application and Sheets 14, 15, 16, 18 and 24 provide construction details for the sideslope liner and leachate collection system.

The side slope liner system will extend upward onto the landfill perimeter berm, with the geomembranes anchored into the perimeter berm by use of a compacted low-permeable soil anchor trench. Sheet 14 provides a detail showing the top of the side slope at the perimeter berm and the geomembrane anchor trench.

A temporary HDPE flap is provided on the inter-cell berm detail as shown on Sheet 15. This flap will be installed to provide a seal against the potential for landfill gas to escape from the waste mass to the atmosphere through the soil drainage layer, during intermediate disposal operations.

The landfill gas seal will also be extended up the 3H:1V excavation side slopes from the inter cell berm, within the primary soil drainage layer interval. On the excavation side slopes the flap will angle back toward the active area as it progresses up the side slope, to accommodate connection with the intermediate cover placed.

5.4 OVERLINER AND LEACHATE COLLECTION SYSTEMS

The components of the typical overliner system, from top to bottom, are as follows:

- 2-ft thick leachate collection drainage layer;
- 12 oz/yd2 nonwoven geotextile cushion layer;
- 60-mil thick, textured, high density polyethylene (HDPE) geomembrane component of the primary composite liner;
- geocomposite secondary leachate collection layer consisting of a geonet with a layer of nonwoven geotextile heat-bonded to it on top and bottom;
- 60-mil thick, textured, HDPE geomembrane component of the secondary composite liner; and
- 2-ft thick soil component of the secondary composite liner.

Material specifications are described in Part V of the application and Sheet 14 provides construction details for the overliner system.

6.0 CONCEPTUAL CLOSURE, POST-CLOSURE CARE, CUSTODIAL CARE, AND END USE PLAN

As the landfill reaches final grade, an intermediate cover will be put in place to control gas emissions and infiltration of precipitation, while additional waste settlement occurs. Once settlement is complete, final cover will be placed, and monitored and maintained to ensure its integrity. Multiple aspects of closure are covered in this section, including in the conceptual closure phase, final closure requirements, and post closure monitoring and maintenance.

Information related to landfill closure located in several locations throughout this report and application. This section is intended to address the following regulatory sections or refer to appropriate application documentation.

- Part 363-4.3(a)(3)(iv) – A description of the materials and construction methods for the final cover system can be found in Section 6.1 of this report.
- Part 363-4.3(a)(4) – The post construction care measures are discussed throughout this section, and also within Tables 16-1 and 16-2 of the Facility Manual (Part VI of the application)
- Part 363-4.3(h)(1) – A description of the materials and construction methods for the final cover system can be found in Section 6.1 of this report.
- Part 363-4.3(h)(2) – the post-closure water quality monitoring program is discussed in Section 6.2.1 of this report.
- Part 363-4.3(h)(3) – the closure plan for the leachate collection treatment, and storage facilities is discussed in Section 6.2.2 of this report.
- Part 363-4.3(h)(4) – the closure plan for the landfill gas management system is discussed in Section 6.2.3 of this report.
- Part 363-4.3(h)(5) – the proposed end use is discussed in Section 6.6 of this report.
- Part 363-4.6(p)(1) – The proposed final cover grading plan for the landfill facility is included on Sheet 9.
- Part 363-4.6(p)(2) – Typical details for the landfill facility closure construction are included on Sheet 30.
- Part 363-4.6(p)(3) –The sequential closure of the landfill in concert with the fill progression is described in Sections 6.1 of this report.
- Part 363-4.6(p)(4) – The largest active area of the landfill is the total landfill area excluding the property buffers, which is approximately 100 acres.
- Part 360-4.6(p)(5) – An estimate of the maximum inventory of wastes, (including alternative operating covers) on site during the active life of the landfill will occur on the day the landfill is at capacity and the facility is ready for closure. It is estimated that this capacity is approximately 15.4 million cubic yards for the combined Western Landfill, Valley Fill, and the Area 7/8 Development.
- Part 363-4.6(p)(6) – Closure and post closure material quantity and cost estimates including monitoring and maintenance are included in Tables 16-1 and 16-2 of the Facility Manual (Part VI of the application)

This portion of the Engineering Report is consistent with the conceptual closure, post-closure care, custodial care and end use discussed as part of the Facility Manual (Part VI of the application).

6.1 FINAL COVER SYSTEM

The actual area capped on a year by year basis may vary based on fill conditions at that point in time. The final cell capping events will proceed within 5 years of attaining final grades.

Prior to the installation of the final cover system, the intermediate or operating cover will be stripped and removed to a minimum thickness of 6 inches. The final cover system will be constructed once portions of the site have reached design height and initial settling has occurred.

The final cover system (6NYCRR Part 363-6.16 to 6.18 of Part 363 regulations) for the proposed landfill will consist of the following components:

- For 3H:1V slopes
  - Prepared grading layer over the waste;
  - Geosynthetic Gas venting layer;
  - 40 mil (minimum) textured LLDPE geomembrane liner;
  - Geosynthetic Drainage layer;
  - 18-inch barrier protection layer; and
  - 6-inch topsoil layer.

- For 4 percent slopes
  - Prepared grading layer over the waste;
  - Geocomposite Gas venting layer – non-woven geotextile with venting strips;
  - Geosynthetic Clay Barrier (GCL)
  - 40 mil textured LLDPE geomembrane liner;
  - Geosynthetic Drainage Layer;
  - 18-inch barrier protection layer; and
  - 6-inch topsoil layer.

The specifications, construction requirements, and specific products and configurations for the final cap materials will meet the requirements of 6 NYCRR Part 363-6.7, 363-6.8, and 363-6.12. Construction level design and Construction QA/QC procedures must be submitted and approved by the NYSDEC prior to constructing the final cap. A construction certification report will be submitted to the NYSDEC within 45 days after the completion of landfill closure construction. The report will include items required under Part 363-9.4.

6.2 CLOSURE OF ENVIRONMENTAL CONTROL SYSTEMS

This section contains a brief overview of each of the landfill's existing and proposed environmental control systems including the leachate management system; the landfill gas management system; the stormwater management system; groundwater monitoring system, and the final cover system. Each of these systems will continue to operate in some capacity after closure, and the functionality of each system and anticipated long-term use is discussed.

6.2.1 GROUNDWATER MONITORING SYSTEM

The groundwater monitoring network consists of either single wells or well pairs located at the perimeter of the Closed Landfill, Western Landfill Area, and Area 7/8 Development. Groundwater samples will be collected from monitoring wells identified in the Environmental Monitoring Plan (Part VII of the application) to monitor groundwater quality at the facility during landfill operation. Sampling and analysis of groundwater will consist of three (3) quarters of sampling for the Part 363 Routine List of parameters and one (1) quarter of sampling for the Baseline List. Once final capping has been completed it is anticipated that the operating monitoring program will continue during the initial post-closure period. Reduced frequency sampling will be requested as appropriate during the post closure period.

6.2.2 LEACHATE MANAGEMENT SYSTEM

Leachate management in the Closed Landfill, the Western Landfill, the Valley Infill and the proposed Area 7/8 Development is accomplished through the following sequence of activities: collection and removal, storage, and off-site transportation and disposal. Leachate management is generally accomplished by gravity draining individual sections of the landfill into sumps, from which leachate is pumped into horizontal leachate recirculation headers or forcemains for transport to leachate storage tanks and eventual disposal. Consult Section 8 of this

report for a description of the Leachate Management System, which includes detail on leachate collection systems.

Management of collected leachate during post-closure will include the off-site transport and treatment at Publicly Owned Treatment Works. During post-closure, the overall rate of leachate generation will be reduced over time, as the infiltration rate comes into a new equilibrium established by the low permeability final cover. The leachate system will be maintained and operational during the course of the post-closure period.

6.2.3 LANDFILL GAS MANAGEMENT SYSTEM

For the Closed Landfill, the Western Landfill, the Valley Infill and the proposed Area 7/8 Development, the gas collection system consists, or will consist of a series of horizontal trenches, vertical wells, laterals and headers sized to provide removal of landfill gas and conveyance to the Landfill Gas to Energy Facility (LFGTE).

The facility conducts and will continue to conduct quarterly monitoring at the site to detect the presence of explosive gases migrating in the subsurface soils as described in the facility Environmental Monitoring Plan (Part VII of the Part 360 application). In general, perimeter gas probes are installed in the soil around the footprint of the landfill and tested on a quarterly basis to document that explosive gases are not permeating subsurface soils. It is anticipated that the probes will be monitored on a quarterly basis during the post closure period.

A gas venting layer will be installed in the final cover system to provide relief of landfill gas pressure, allowing it to be actively collected or passively vented to the atmosphere, thus preventing subsurface migration.

Much of the LFG collected by the Facility is combusted and converted to energy at the facility's Landfill Gas to Energy facility (LFGTE). It is currently expected that the LFGTE plant will continue to operate as long as sufficient LFG is being produced to continue profitable operation. Landfill gas generation will decrease with time over the course of the closure and post-closure periods, with generation eventually reaching a point at which landfill gas will only need to be flared or passively vented.

6.2.4 STORMWATER MANAGEMENT SYSTEM

The site stormwater management system consists of a network of diversion and conveyance structures that convey stormwater to a series of stormwater sedimentation basins that will provide water quality treatment and discharge into adjacent site wetlands. Under the post-closure condition, stormwater discharges will be treated in the same manner as they are during operation.

Permanent cap drainage structures, namely diversion swales, downchutes, and culverts, will be constructed as part of the final cap system. These drainage design features are presented on Sheet 25 through 28 of the Engineering Drawings. These conveyance systems will discharge into the stormwater sediment ponds for treatment/discharge. In order to continue to minimize leachate infiltration and prevent the transportation of soils and sediments off-site, the stormwater controls will be maintained as described in the Engineering Report and site SWPPP during the closure and post-closure periods.

Eventually, once final capping has been completed and the potential for waste-based contaminant transport by stormwater is minimized, the site SWPPP will be updated. The SWPPP will reflect the conditions at the time of closure and will outline appropriate stormwater sampling procedures based on the Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity in place at that time.

6.3 FINAL CLOSURE

The final cover system of the site will be constructed once portions of the site have reached design height and initial settling has occurred (see Sheet 9 of the Engineering Drawings). A final cover system will be installed on landfill cells that have achieved final grades in accordance with Subpart 363-6 of this Part within five years of

attaining final grades. Details on the final cover system design, layout, and implementation can be found in Section 6.1.

Completion of the final closure system and final cover will be completed within 365 days of receipt of final waste unless an extension is approved in the landfill's closure plan, in accordance with Part 363-9.3(b). Additional activities to be completed after receipt of final waste, in accordance with Part 360.21, are listed as follows:

1) notify the department in writing 30 days prior to the anticipated final receipt of waste and within seven days of completion of closure activities;
2) within 30 days after receiving the final quantity of wastes, submit an annual report to the department as required under this Part;
3) within 60 days after receiving the final quantity of waste, remove and deliver remaining waste to a facility authorized to accept the waste;

Additionally, the Facility Closure Plan will be submitted at least 180 days prior to the commencement of construction of final facility closure that meets the requirements of Parts 363-9.3(c) and 363-9.3(d).

Finally, a construction certification report will be submitted to the NYSDEC after the completion of landfill closure construction. The report will include items required under Part 363-9.3(c).

6.3.1 Closure Site Investigation Report/Closure Plan

A site investigation will be done in accordance with Part 363-9.2 to demonstrate that the closure plan described above is adequate. The closure investigation report will be completed in stages prior to placement of the final cover system. The closure investigation will include a hydrogeological investigation using methods described in Part 363-4.4, an explosive gas survey in accordance with Part 363-9.2(a)(2), a surface leachate investigation and a vector investigation. The closure investigation will be based upon the hydrogeologic investigation, environmental monitoring data, and gas probe monitoring data collected during operation of the landfill.

Upon completion of the closure site investigation, data will be compiled in a closure investigation report that complies with Part 363-9.2 and submitted to the department for approval. WMNY personnel will meet with NYSDEC staff to review specific landfill considerations and findings of the closure investigation. A facility closure plan will be submitted to the Department at least 180- days before commencement of final facility closure in accordance with Part 363-9.3(c).

6.4 POST CLOSURE PLAN AND MAINTENANCE

It is anticipated that WMNY will monitor the site for a period of at least 30 years after closure (i.e., after the last receipt of solid waste at the landfill). Facility and environmental monitoring points will be maintained and be made available for sampling during the post-closure period. Post-closure monitoring and maintenance will require various activities to be undertaken at the site on both a scheduled and "as needed" basis. A cost estimate for the Post-Closure care period of 30 years has been developed and can be seen in Table 16-2 of the Facility Manual (Part VI of the application).

A Post-Closure Care Plan will be provided to the NYSDEC for approval prior to the last receipt of waste, at least 180-days before commencement of final facility closure, and will provide information needed to effectively monitor and maintain the landfill facility for the post-closure period. At a minimum, under Part 363-9.6(a)(2), the plan will include:

- Descriptions of type, location, sampling and sample preservation methodology, and record keeping and reporting requirements for environmental monitoring activities;
- Descriptions of environmental control systems including;

    - Process control monitoring types, locations, record keeping and reporting requirements. Leachate management activities will include recording of the total volume of leachate stored and removed from the facility, sampling and analysis, and proper maintenance; and
    - Environmental control maintenance requirements including description, type, frequency, and recordkeeping;
- Descriptions of the types, location and frequency of other facility maintenance activities including;
    - Maintaining the integrity and effectiveness of final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, maintaining the appropriate vegetative cover, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover;
    - Maintaining the leachate collection system in accordance with Part 363-7.1(f)
    - Maintaining and operating the gas control and monitoring systems in accordance with 6 NYCRR Part 363-7.1(e); and
    - Record keeping and reporting requirements in order to maintain compliance with Part 363-9.6(a)(1);
- Description of resource requirements including;
    - Personnel qualifications and numbers; and
    - Equipment needs;
- Name, address and telephone number of the person or office to contact on post-closure monitoring and maintenance, and corrective measure concerns during the post-closure period;
- A summary of financial assurance criteria concerns that must be addressed to remain in compliance with the provisions of 6 NYCRR Part 360-2.22 which includes;
    - Submittal to the NYSDEC of annual adjustments to cost estimates of post-closure care and corrective measures; and
    - Notification to the NYSDEC of increases in post-closure care costs and corrective measure costs; and
- A description of the planned uses of the property during the post-closure period.
- A list of changes to the approved post-closure plan by topic, author, date of submittal, and date approved by the department from the time of original closure plan approval.

The plan will be updated every 5 years during the post closure period.

6.5 CUSTODIAL CARE PLAN

It is anticipated that after 30 years of post-closure care, the landfill will be functionally stable and will not present a threat to human health and the environment at the point of exposure. This is based on the WMNY experience at other sites, the experience of the industry, and the functional lifetime of the critical components (e.g., geomembrane cap) of the landfill which will extend well beyond the 30-years.

Additionally, the landfill systems will be monitored and managed by WMNY with a goal to cease maintenance at the end of the 30-year period. More specifically, it is anticipated that the following systems will be functionally stable and ceasing maintenance will not impact human health and the environment at potential points of exposure:

- leachate collection system;
- LFG monitoring system;
- groundwater monitoring system; and
- the cover system.

At the end of the post-closure period, potential impacts to human health and the environment will be assessed considering leachate quality and quantity, gas composition and production, cover integrity, and groundwater

quality. Additionally, potential impacts to human health and the environment will be assessed in the context of the proposed end-use which is anticipated to be passive green space for the Town.

It is anticipated that this justification will be able to be made based on the 30 years of historical monitoring that has occurred at the site in the period after closure. Analysis of this monitoring will be submitted as part of the justification. This evaluation will consider: groundwater quality, landfill gas emissions, leachate management, settlement, vegetation cover, surface water and the end use of the landfill. Should continued care beyond the anticipated 30-year post-closure period be necessary, the Operator and Owner are committed to working with the NYSDEC to actively maintain the site in a manner that appropriately mitigates impacts to human health or the environment.

6.6 CONCEPTUAL END USE

The final cover system has been designed to incorporate a native seed mixture that will provide the necessary vegetative cover for stabilization of the landfill final cover as well as to serve as a grassland habitat for local wildlife. During post-closure, it is anticipated that the closed landfill area will not be accessible to the general public due to the required operations and maintenance of stormwater, final cover, and landfill gas systems.

7.0 SOIL MANAGEMENT

Construction of the Chaffee Facility proposed Area 7/8 Development requires the use of soil material for construction. The soil types needed for construction include embankment material for subgrade construction, clay liner soil and drainage stone for leachate collection. Additionally, soil material is used as cover during operation of the landfill (Facility Manual – Part VI of application). The following table summarizes the estimated quantity of each type of material needed to construct the baseliner for Cell 1 South, Cells 7, and 8 as well as the Cell 8 overliner. These estimates are based on the landfill design grades and liner system component thickness. The estimates do not include additional material that might be needed because of soil losses that occur during excavation, transportation and placement.

Table 7-1. Soil Management

Structural Fill Required (cy)	*Compacted Clay Liner Required (cy)*	*Leachate Collection Stone Required (cy)*	*Operating Cover (cy)*
99,700	95,000	130,000	510,000

Note: The structural fill soil quantity listed in the table is the net of the soil material that will be excavated and the soil material that will be placed to achieve the subgrade elevation, berm grading, and sediment basin regrading.

The final cover system discussed in Section 6.1 of this report will also require the use of soil material for construction. The soil types needed for construction include suitable subgrade soils, barrier protection soil and topsoil. The following table summarizes the estimated quantity of each type of material needed to construct the additional cap for the Area 7/8 Development. These estimates are based on the landfill design grades and conceptual cover system component thickness. The estimates do not include additional material that might be needed because of soil losses that occur during excavation, transportation and placement.

Table 7-2. Soil Types Needed for Final Cover Construction

Barrier Protection Soil Required (cy)	*Topsoil Required (cy)*
334,000	83,500

The total estimated quantity of soil including leachate collection stone and operating cover required for construction and operation is approximately 1,252,200 cubic yards.

These materials will be obtained from a combination of on-site borrow sources and purchase from off-site NYSDEC permitted soil, gravel and stone sources. The facility is currently permitted to import material at a rate of 15 trucks per hour. If all of the 1,252,200 cubic yards of soil have to be imported over the approximate 7.2-year life of the development, this would result in about 175,000 cubic yards imported per year. Assuming each truck contains 20 cubic yards of soil and 260 workdays per year this equates to about 34 trucks of soil per workday – which would not result in the need for more than 15 off-site soil hauling trucks per hour to enter the site.

8.0 LEACHATE MANAGEMENT SYSTEM

This section provides a description of the engineering design for the leachate management system that will be constructed for the proposed Area 7/8 Development. This information is provided in accordance with Part 363-4.3 and Part 363-6.

Section 8.1 provides a brief overview of the leachate management system. Section 8.2 describes the estimated leachate quantities generated by the proposed landfill operation. The design of the leachate collection and removal system is described in Section 8.3 and Section 8.4 describes the design of the leachate transmission and storage system.

Additional analysis of the leachate management system can be found in Appendix B.

The requirements of Part 363-6 address construction requirements for the primary and secondary leachate collection systems. These requirements are addressed throughout Section 4 and in the Technical Specifications contained in this report (Part V of the application).

8.1 LEACHATE MANAGEMENT SYSTEM OVERVIEW

The principal components of the leachate collection and removal system include the primary and secondary liners, leachate collection layers, leachate collection pipes (8-inch diameter primary and 6-inch diameter secondary), leachate removal sumps, side slope risers and associated extraction pumps, leachate transmission lines and storage tanks. Engineering drawings, Sheets 18 to 24 show the various components of the leachate management system.

Leachate generation will also be controlled by the use of temporary berms, temporary tarps and soil cover placement (i.e., either intermediate or final cover). These operational provisions are further discussed in the Facility Manual (Part VI of the Chaffee Area 7/8 Development application).

8.2 LEACHATE GENERATION QUANTITIES

This section summarizes estimates of leachate generation rates for the proposed landfill development in compliance with Part 363-4.3(e)(1). Leachate generation can be estimated using the USEPA's Hydrologic Evaluation of Landfill Performance (HELP) Model [USEPA, 1994], Version 3.07 (Reference 10). As part of the February 2005 Engineering Report (Reference 5), leachate generation was estimated using the HELP Model, since historical data for a 6 NYCRR Part 360 designed landfill was not available for the facility. The HELP Model results provided daily and monthly leachate generation rates for use in design.

Currently the facility has constructed the six Western Landfill Development Cells and has tracked leachate collection data through its construction. Data for the last 5 years was (2015-2019), which included the start-up of several cells was reviewed in detail to assess landfill leachate generation rates. For purposes of the design of the Area 7/8 Development, the historical data was also compared to the most recent application (Valley Fill).

The historical data was collected for a variety of conditions, including open cell conditions with limited waste depths over the primary collection system to assess the overall facility leachate that would be storage in the existing on-site storage tanks. The leachate from the Closed Landfill going to LSTs 1 and 2 was not considered as those systems will not receive additional leachate from the Area 7/8 Development.

Analysis of monthly data indicates a maximum monthly average leachate generation rate of 1885 gallons per acre per day (gpad). This occurred in Cell 4 of the Western Expansion in February of 2016. While this does not represent a start-up condition for this cell, it is the highest monthly average and is greater than the monthly averages from the start-up of Cells 1 and 2. Therefore it has conservatively been used to represent a start-up

condition for the leachate generation in Cells 7/8. For generation from other cells (Western Expansion, Valley Fill), the maximum average annual generation rate of 521 gpad was used on the overall facility generation. The exceptions to this include the rates for Cell 3 and Cell 4, which had higher maximums (553 and 869 gpad, respectively). The leachate generation from the secondary cells was assumed to be 20 gpad and the leachate generation from other systems going to the storage tank (LCS 5, LCS/Manhole 3/4, and condensate or the CPs) was taken as the daily average over the analysis period.

8.2.1 Leachate Storage

Using the various generation rates described above and as detailed in the calculations, a design maximum leachate generation rate was developed. This conservative approach assumed the Area 7/8 development was fully constructed and leachate was being collected from the new cells, there were 3.5 acres of Cell 8 that received a 25-year storm and no waste was in place, the remaining Cell 8 area had limited waste and was generating 1885 gpad, and the remaining lined landfill (Including Cell 7, and the larger Cell 1) was not capped and was generating leachate at a rate between 521 and 869 gpad. The total maximum daily generation was developed and used to asses the leachate storage capability of the landfill (effected by the addition of Cells 7/8) as it relates to Part 363-6.20 requiring a system that can store at least three consecutive months of leachate. As seen in the calculations the total leachate generated in a 3-month period (91.5 days), is estimated to be approximately 6,781,000 gallons. This volume also includes runoff from a 24-hour, 25-year storm event that is assumed to occur during a time when little or no waste is in place in the landfill. For purposes of design, leachate generation based on a 3.5-acre open area will be used to plan stormwater tarping and diversion during the development of the cells prior to waste placement. The calculations show this 3.5-acre area is assumed to be part of Cell 8 and generates 371,000 gallons of leachate during the 24-hour, 25-year storm event.

The combined storage capacity of the existing tanks (811,000 gallons) and the disposal capacity over 91.5 days (7,009,000 gallons), exceeds the estimated generation by greater than 1,000,000 gallons. As shown in the calculations in Appendix B, the two existing above ground tanks can adequately store the leachate and will meet the requirements in Part 363-6.20. The existing storage facility will not be modified and currently has secondary containment that meets the Part 363 requirements.

The increase in leachate generation as a result of the proposed Area 7/8 Development over a 3-month period is estimated to be 3,002,000 gallons which could result in up to an additional 7 trucks per day to haul leachate during the development of Cells 7/8.

8.2.2 Managing the 25-year storm event

In accordance with Part 363-6.11(a)(1), the leachate collection and removal pipe network must be sized to remove the 25-year, 24-hour storm volume within seven days. Analysis of the open cell condition for this storm event (corresponding to 3.9 inches of rain) indicates leachate generation of 114,055 gallons per acre. As required, the piping system must be sized to allow this storm event to be removed within 7 days. As seen in the calculations in Appendix B, using a hydrograph model, an 8-inch diameter pipe was determined to effectively drain the flow from a 24-hour storm event (over the entire lined area that is proposed for the Area 7/8 Development) in approximately 6.5 days.

8.2.3 Assessing 500-year storm event

In addition to the design requirements related to leachate generation and the capacity of the pipe network, the regulations, Part 363-4.3(e)(1)(ii), require that an evaluation of a 500-year storm event be completed for the leachate collection and removal system. To perform this evaluation a HELP model was completed for Cell 8, and a 500-year storm even was applied to a 1-acre area representing a portion of Cell 8. The 500-year, 24-hour storm event for the Chaffee area is 7.65 inches. The 7.65-inch storm event was inserted into the rainfall input file for the HELP model to occur on the 316th day of the first year of a 5-year analysis. This day was selected because the

model generated rainfall data indicated this day had the highest rainfall total over a 24-hour period. It was assumed that most of the area was relatively flat, only daily cover was in place over the waste, and there was an average of 50 feet of waste in place at the time of the storm. With those parameters, the HELP model indicated that 3,529 gallons per acre per day of leachate would enter the primary drainage system. As this value is less than the peak impingement rate of 3,770 gallons per acre per day (1,885 gpad with a factor of safety of 2) used to determine the appropriate leachate collection and drainage system material permeabilities, it is not anticipated that the 500-year storm under the assumed conditions would have a significant impact on the leachate collection and removal system.

8.3 LEACHATE COLLECTION AND REMOVAL SYSTEM DESIGN

The primary leachate collection system will be comprised of a continuous stone drainage layer above the liners. Leachate flows through the granular collection stone to 8-inch diameter perforated collection pipes. The landfill base grades and permeable stone drainage layer will provide rapid drainage through the stone drainage layer and collection pipes to a sump located at the low point of each cell. Leachate collected in the sump will be pumped to the existing leachate storage tanks and loadout facility.

The secondary leachate collection system will be comprised of a continuous geocomposite drainage media. As shown in Appendix B, the geocomposite will be sized in a manner that allows the secondary system to exceed the requirements in Part 363-6.12. Secondary leachate will flow through the geocomposite to 6-inch (minimum) diameter perforated collection pipes. The landfill base grades and piping will direct secondary flow to a sump located at the low point of each cell. Secondary leachate will be collected separately from the primary leachate in the sump and then pumped to the existing leachate storage tanks and loadout facility.

8.3.1 Leachate Heads

The peak daily static leachate head on the primary liner (see calculations in Appendix B) is less than 1 foot, which satisfies the design requirements of Part 363-6.6(a)(3).

8.3.2 Allowable Leakage Rate

Part 363-7.1(f) requires that the flow in the secondary leachate collection layer not exceed 20 gallons per acre per day based on a 30-day rolling average. Appendix B includes the historical data for the six constructed cells within the Western Landfill Development. This data indicates that for all but the initial startup of Cell 6, the flow in the secondary collection layer is less than 20 gallons per acre per day and meets the requirement of Part 363-7.1(f). Therefore, since the liner system and components are similar for the Area 7/8 Development, the proposed secondary systems will have similar performance.

As shown on the engineering drawings, the landfill cells are separated by permanent intercell berms. This configuration provides for independently functioning cells with the ability to distinctly monitor the secondary leachate flows.

8.3.3 Leachate Collection Pipe Strength

The leachate collection pipes have been assessed to confirm that it will retain its structural and functional integrity throughout the lifetime of the landfill. Two conditions have been assessed. These conditions include:

- the newly proposed leachate collection pipe that will be installed as a component of the landfill development, and
- the existing leachate collection pipes in landfill cells that will be overlined and/or overfilled.

The flexible pipe/soil system proposed for use has been designed to withstand the physical stresses imposed during construction, normal waste placement operations and over the post closure period. The criteria used to evaluate the physical characteristics necessary for the HDPE pipe/soil system include:

Ring Deflection

Ring deflection in flexible HDPE Pipe is nearly elliptical and the vertical and horizontal deflections are nearly equal for small deflections. By transposing the Modified Iowa Deflection Equation, the ring deflection can be calculated as follows:

$$\frac{\Delta Y}{D_m} = \frac{L_f K P_T R^3}{E_p I + 0.061 E_s R^3}$$

Where:

ΔY = Vertical Pipe Deflection
D_m = Mean Pipe Diameter
L_f = Deflection Lag Factor
K = Bedding Constant
R = Mean Pipe Radius
P_T = Total Pipe Load
E_p = Pipe Modulus of Elasticity
E_s = Modulus of Soil Reaction
I = Moment of Inertia

Pipe Buckling

Pipe buckling is determined by comparing the critical buckling pressure of the pipe to the total load on the pipe. The critical buckling pressure can be calculated as follows:

$$P_{cr} = 0.55\left[E_S \frac{E_P I}{0.149 R^3}\right]^{1/2}$$

Where:

P_{cr} = Critical Buckling Pressure
E_p = Pipe Modulus of Elasticity
E_s = Modulus of Soil Reaction
I = Moment of Inertia

Wall Crushing

Wall crushing is determined by comparing the axial stress applied to the pipe with the initial and long-term compressive yield strength. The long-term compressive yield value was determined for a 50-year service life. The applied axial stress can be calculated as follows:

$$P_{SA} = \frac{P_T D_m}{2 A_W}$$

Where:

P_{sa} = Axial Stress
P_T = Total Pipe Load
A_w = Area of Pipe Wall
D_m = Mean Pipe Diameter

HDPE pipe is proposed for the new landfill development. In addition to the long-term considerations associated with waste filling, the piping is designed to resist stresses during baseliner construction. Equipment traffic above the pipe will however be limited to small and/or low ground pressure equipment as approved by the Engineer.

Proposed Leachate Collection Pipe

The proposed leachate collection pipes for the landfill development were analyzed under the proposed loading conditions. The pipe criteria for each of the pipes analyzed meets the factor of safety of 1.25, the industry standard for pipe performance. Calculations are provided in Appendix B to this report.

Existing Leachate Collection Pipes

The existing leachate collection pipes for the Western Landfill and the Closed Landfill were also analyzed under the proposed development loading conditions. The pipe criteria for each of the pipes analyzed meets the factor of safety of 1.25, the industry standard for pipe performance. Calculations are provided in Appendix B to this report.

8.3.4 Leachate Collection Pipe Capacities

For the primary collection system, the calculations in Appendix B demonstrate that an 8-inch diameter pipe and perforations have sufficient capacity for the design flow, based upon the maximum historical flows. Similarly, Appendix B indicates that the 6-inch diameter secondary collection pipe and perforations have sufficient capacity for the secondary leachate flow for the design flow of 1,000 gallons per acre per day. The factor of safety for the pipe reaching capacity is 13.4 and 27.8 for the primary and secondary systems, respectively.

8.3.5 Collection Sumps and Siderisers

The proposed landfill areas are divided into two separate drainage sub-areas from which leachate generation and secondary collection system monitoring can be performed separately. The sump configurations, construction components and dimensions are shown on Sheets 19 through 24. A secondary-drainage-only collection sump will be located near the northwest corner of Cell 8 and is intended to collect and monitor leachate the from the secondary collection system of overliner area (separate from the main cells). The primary sumps are designed to be 2 feet below the base liner grade with the leachate level in the sump set by the pump controls. When the sump reaches the 2-foot mark, the pumps will turn on and run until the sump level reaches the 1-foot mark.

The collection system includes the sump pumps, flow meters, sampling ports, check valves and dual contained pipes leading into the transmission line. The sump pumps are designed to turn on and off when the leachate reaches certain levels within the sump.

8.4 LEACHATE TRANSMISSION AND STORAGE SYSTEM DESIGN

The leachate conveyance system consists of north and south piping systems, which combines into a single pipe prior to entering the storage tanks. The pipe is 8-inches in diameter and was designed to accommodate the flow resulting from the primary and secondary pumps and existing Tank pumps discharging at the same time.

8.4.1 Leachate Transmission Piping

The proposed leachate transmission piping is dual contained SDR 17 HDPE pipe. The inner pipe carries the leachate and is 8-inches in diameter and the outer protective pipe is 12-inches in diameter. The transmission line has a minimum slope of 0.5 percent, which will allow for positive flow of both liquids and solids.

8.4.2 Leachate Storage Tank

The leachate storage system consists of two above ground storage tanks within a secondary containment tank. Each tank has a capacity of approximately 405,000 gallons for a total storage volume of 810,000 gallons. The

storage system was designed and constructed as part of the Western Landfill Development. In addition to onsite storage, the facility has trucking and disposal contracts to allow for up to 77,000 gallons of leachate per day five days a week to be taken to the Buffalo Sewer Authority waste water treatment plant (WWTP), 30,000 gallons per day six days per week to Jamestown WWTP, Steuben County WWTP, or other approved WWTP.

As indicated in the calculations in Appendix B, the leachate storage tanks have sufficient storage capacity to meet the applicable storage scenarios.

9.0 GEOTECHNICAL EVALUATION

9.1 SETTLEMENT ANALYSIS

The intent of this settlement analysis is to support the design of the leachate collection and baseliner systems and to verify minimally required post-settlement slopes specified in Part 363-4.3(b). Specifically, Part 363-4.3(b)(2) provides that post-settlement slopes for leachate collection piping are at least 1% and, for leachate collection systems (as well as liner and subgrade), are at least 2%. As described throughout this section, the settlement analysis show that the proposed cell design configuration provides appropriate post settlement liner and pipe slopes and minimize strain such that the subbase (and overliner liner and leachate collection and removal systems) will maintain their integrity and function and perform as required after settlement has occurred.

9.1.1 Selection of Critical Settlement Analysis Locations

The sections where the post-settlement slope was evaluated, as well as the points analyzed along the sections, were chosen according to the following criteria:

- geometry - local and global subgrade minimum, local and global subgrade maximum, change in subgrade slope, sump locations, etc.
- geology - significant changes in underlying soil type, thickness of specific units, or total overburden thickness

The landfill geometry was determined based on existing landfill features and standard landfill geometry allowed by NYSDEC regulations. The location and structure of the existing landfill footprint are based on record drawings and surveys. The soil conditions are based upon historical site investigation. The locations of selected sections are presented in the Settlement Calculations in Appendix B.

In total, three critical settlement sections were analyzed. The first section evaluated is located through existing Cell 4 in the Western Landfill. The settlement points in this section are the same as the points analyzed in the Appendix D.1 of the 2005 Western Expansion Engineering Report. This section was chosen to evaluate the post-settlement slopes in the Western Landfill with the additional 30 feet of overfill proposed in the Area 7/8 Development.

The second section evaluated is located along the leachate collection pipe on the baseliner of Cell 7. This section was considered because it will also experience the full landfill load (e.g., the full waste thickness) and the subgrade slope and pipe slope are typical of the Cell 8 conditions.

The third section evaluated is located through the proposed cell overliner which extends from Cells 7/8 up the South slope of the Closed Landfill. This section was considered because it will experience the full landfill load (e.g., the full waste thickness) and the liner slopes for this section are typical for the entire overliner construction.

9.1.2 Settlement Methodology

In general, the settlement evaluation consisted of the following steps:

1. Divide the material beneath the liner into layers. The underlying layers for the selected settlement sections generally consist of recompacted clay, in-situ clay, and in-situ sand and gravel with silt and clay lenses. Settlement points located on the overliner portion of the proposed Area 7/8 Development also considered the layer of existing waste within the closed landfill. Soil and waste parameters were estimated for each of these layers for use in the settlement analyses.
2. Estimate the stress increase at the center of each layer. The stress increase due to the landfill is estimated from elastic theory. Stress increases are estimated at different locations and depths beneath the embankment.
3. Estimate the settlement of each layer. The settlement of each layer is estimated using elastic and consolidation theory. (Elastic settlement for sands and low plasticity soils and consolidation settlement for clay-like soils). Secondary consolidation settlement was conservatively analyzed over a 40-year period.
4. Sum the settlement in each layer. The settlement of each layer is added to estimate the total settlement at each point considered in the evaluation.
5. Evaluate the effect on the liner system. The effect on the leachate collection system is evaluated by estimating the slope of the leachate collection pipes and the landfill floor after settlement. The strain in the liner is also estimated to evaluate the effect of the settlement on the liner.

While not required, the analysis included a factor of safety of 2.0 (by multiplying the unit weight of waste by 2.0) to provide added conservatism to the analysis and for consistency with previous Part 360 applications at this site.

The following sections describe the general procedure to estimate the settlement for each of the layers.

9.1.2.1 Recompacted and In-Situ Clay Till Soil

The thickness of the recompacted clay till and in-situ clay till soils beneath the selected sections are estimated. The recompacted clay till thickness includes the soil component of the liner system plus the distance between the subgrade surface and the estimated ground surface prior to fill placement. The Hydrogeologic Report, (Part IV of the Chaffee Area 7/8 Development application), provides additional information regarding the thickness of the ablation and clay tills.

The settlement of the clay till soils includes an estimate of the elastic settlement and the consolidation settlement. The selected settlement properties of the recompacted till and the in-situ clay till are based on geotechnical testing completed on soil samples obtained from the site. Geotechnical laboratory test data were included in Appendix D.3 of the Western Landfill Expansion Engineering Report (Part VI of the application package, dated February 2005).

9.1.2.2 Sand and Gravel with Silt and Clay Zones

The thickness of the sand and gravel is estimated as the distance from the base of the ablation and clay tills to bedrock. The top of bedrock was estimated based on information presented in the Western Landfill Expansion Hydrogeologic Report (Part III dated February 2005) that indicates that the depth to bedrock increases from west to east across the proposed area. The bedrock elevation used in the calculations was based on a natural gas well located to the east of the site, a log of this well was included in Appendix D.3 of the Western Landfill Expansion Engineering Report.

The boring logs presented in the Hydrogeologic Report (Part IV of this application) indicate that the sand and gravel soils beneath clay till include zones of silt and clay soils. To account for these zones in the settlement

analyses, an estimated average percentage of the sand and gravel layer consisting of silt and clay was assumed to occur throughout the entire layer of the sand and gravel deposit.

The selected settlement properties of the sand and gravel deposit were assigned based on the characteristics of the soil observed in the borings and field and laboratory testing completed on these soils.

9.1.2.3 Waste Zone

The thickness of the Closed Landfill waste mass is based on current existing conditions and bottom of landfill conditions recorded on the 1999 permit renewal engineering drawings. As indicated on the historical drawings much of the Closed Landfill underlying portions of the Area 7/8 Development was constructed in the late 1980's and early 1990's.

Estimates for waste settlement are based on many variables but has been expressed as consisting of a two-phase settlement similar to that expressed for the consolidation of clay soils. Primary settlement of waste is the rapid component that will occur during placement of new loads on the existing waste mass. Secondary settlement of waste is the long-term component that will occur as the existing waste continues to degrade over time.

The selected settlement properties of the existing waste are based on typical values for similarly aged MSW and are consistent with the Appendix D.1 of the 2012 Valley Fill Expansion Engineering Report.

9.1.3 Settlement Results

Using the above methods and parameters, the subgrade settlement was evaluated for each of the critical cross sections to assess total and differential settlement of the landfill subbase materials (and overlying liner and leachate collection and removal systems). The locations of each section and the calculation results are presented in Appendix B. Each of the baseliner sections analyzed resulted in post-settlement slopes that exceed the requirements of Part 363-4.3(b). Post-settlement slopes of the leachate collection pipes remain greater than 1.0%. Post-settlement slopes of the baseliner floor remain greater than 2.0%.

As described in Appendix B, the overliner cells are proposed to be constructed utilizing four different slopes as depicted on the cross section included in Appendix B. The liner system will begin at a 3H:1V slope from the base of Cells 7 or 8 up to a bench that will be excavated into the Closed Landfill. The bench area will be sloped at 12.5 percent and will be supported on the berm support soil and the perimeter clay berm. The liner to the east of the bench will be sloped at 2H:1V, which will require relocating waste from the Closed Landfill and reconstructing a portion of the cap system. The remaining liner system will be constructed on top of the Closed Landfill cap with estimated slopes varying between 3H:1V and 3.5H:1V.

The reason for creating the bench area and 2H:1V slope to the east of the bench area is to accommodate the greater settlement of the upper slope (underlain by waste) compared with the lower slope (underlain by the berm support soil) and to provide for positive drainage down to the Cell 7/8 floor areas. A variance from Part 363-6.7 will be requested for the section of double composite liner that are initially constructed at slopes steeper than 3H:1V, and consistent with the ongoing construction at the site, will be requested.

As summarized in the table and on the cross section in Appendix B, post settlement slopes for the four different slope areas will remain positive allowing leachate to flow to Cells 7/8. It is estimated that the constructed 2H:1V slope will settle to approximately a 5H:1V slope. In addition, primary leachate collection pipes will be placed along the toe of the bench area and at the toe of the overliner cells where they meet the baseliner cells.

As seen in the settlement analyses, the total predicted settlement exceeds 1.0 foot, and therefore, settlement monitoring plan is required in order to meet the requirements of Part 363-4.3(b)(3). More specifically the regulations require demonstration that the leachate collection and removal system is functioning as designed and the integrity of key collection appurtenances is maintained. The functionality and integrity of these features will be demonstrated through the regular inspection and monitoring of the leachate collection system as outlined in the

Facility Manual. The functionality of the various leachate collection systems is verified as part of the regular daily and monthly site inspections and leachate flows to the collection sumps (primary and secondary) are monitored daily. Routine maintenance will consist, at a minimum, of annual jetting or flushing of laterals and headers in the primary leachate collection system. The collection system (primary and secondary) will also be video inspected every other year. These activities will be documented and evidence of clogging or system impact will be assessed and action plans developed as needed.

9.1.4 Liner System Strain

Geomembrane strain results from differential settlement between two areas of the liner system and a resulting lengthening, or extension, of the geomembrane within the liner system. Based on the calculations provided in Appendix B, the maximum anticipated extension or strain is 0.38%. Because the allowable strain for geomembrane liner is on the order of 13%, the anticipated settlement for the Area 7/8 Development is not expected to result in excessive strains in the geomembrane that would impact its long-term performance.

9.1.5 Soil Bearing Capacity

Part 363-4.3(c)(3)(i) requires a minimum factor of safety of 2.0 for the subgrade soil-bearing capacity of loaded structures associated with the landfill as full load conditions. Part 363-4.3(c)(3)(i)(a) goes on to state that if the soil bearing capacity factor of safety is less than 3.0, it must be demonstrated that the structures can accommodate settlements over the life of the facility. As seen in the calculations in Appendix B, the soil bearing capacity of the proposed MSE Berm (see Sheet 17) was evaluated and resulted in a factor of safety greater than 3.0. Therefore, the requirements of the above subsections are met and no supplemental settlement analysis for the MSE Berm is required.

9.2 STABILITY ANALYSIS

9.2.1 Stability Approach

A stability analysis has been performed in accordance with Part 363-4.3(c) to demonstrate the structural integrity and overall stability of the landfill site, the subgrade, each component of the liner, leachate collection and removal system, and final cover system. The failure modes that have been evaluated include:

- Global Stability – Static and Seismic
- Baseliner Stability – Static and Seismic
- Veneer Cover Stability

The procedure for evaluating landfill stability, along with acceptable factors of safety, are described herein. Details of the evaluation and results are included in Appendix B.

9.2.2 Acceptable Factors of Safety for Slope Stability

The following factors of safety were considered acceptable while evaluating the results of the slope stability analyses:

Global Stability

For deeper failure surfaces that pass through the subgrade, a factor of safety 1.50 was required for configurations where the stability of waste was potentially impacted. This requirement is consistent with Part 363-4.3(c)(1)(i). Configurations without potential for impacting waste are considered under construction stability.

Seismic Stability

The site has historically been considered to be located within a Seismic Impact Zone as defined in Part 363-4.3(d). As indicated in Section 2.4.12, a more recent review of the seismicity at the site (Appendix B) indicates that the proposed Area 7/8 Development is located in an area with less than a 0.10g (fraction of Earth's gravitational pull) horizontal acceleration at a 10% probability of exceedance in 250 years and is therefore not within a seismic impact zone and inclusion of seismic forces in the stability analyses is not required. However, to maintain consistency with previous analyses (2005 Western Expansion Engineering Report Appendix D.2), a horizontal acceleration of 0.16g was used in the pseudostatic seismic stability analyses.

Baseliner Stability

A factor of safety of 1.50 was considered acceptable for peak strength baseliner stability, in accordance with Part 363-4.3(c)(3). A factor of safety of 1.25 was considered acceptable for residual strength baseliner stability. This stability is the stability of the liner system on slopes that are 3H:1V.

Final Cover Stability

A factor of safety of 1.50 was considered acceptable for final cover stability using saturated soil densities and assuming seepage/drainage patterns that typically develop, in accordance with Part 363-4.3(c)(3)(iv). Additional analysis (not required by the regulations) were performed to assess the factor of safety in the case where the cover drainage system was not functioning and 12" of head built up in the final cover system soil. This showed that in the event that there was a failure of the drainage system, the cover would still maintain stability, and a factor of safety of 1.25 was considered acceptable for this atypical condition.

9.2.3 Stability Methodology

Global, liner, and cover stability analyses were performed using the computer program SLOPE/W. The program uses the Morgenstern-Price Method, an iterative approach that tests for moment and force equilibrium, for computing factors of safety. The program includes options for circular, or block specified failure surfaces to allow users to specify and optimize critical failure surfaces. Stability analyses were performed for static and appropriate dynamic conditions.

9.2.3.1 Short-term Analysis Versus Long-term Analysis

Short-term analyses are performed using the total stress (undrained) strength parameters. Long-term analyses are performed using the effective stress (drained) strength parameters. The type of analysis that is critical for design depends on the subsurface conditions and the nature of loading. Since only appreciable difference between short-term conditions and long-term conditions is a likely strength gain in cohesive soils, long-term conditions have been used for the final configuration. Short-term undrained conditions are considered for post-construction and operational slopes.

For soils where there is limited possibility for pore pressure development during loading or unloading (i.e., granular soils or soils with a sizable proportion of coarse-grained particles and low moisture content), drained soil conditions are applicable. This is represented by the use of a Mohr-Coulomb failure criterion, modeled with a friction angle and cohesion

9.2.3.2 Selection of Strength Parameters

Strength parameters were assigned to each of the layers and components of the proposed landfill, the existing landfill, the landfill lining systems, and landfill subgrade. The value, and basis for selection, are presented below.

Soil Strength Parameter Selection

The in-situ clay units were assigned undrained shear strength parameters. Placed fills, in-situ tills, and wastes were selected to exhibit drained behaviors. The selected strength parameters are supported by laboratory test data and are presented as follows:

Layer Name	Unit Weight (pcf)	Cohesion	Phi
Structural Fill	128	0	28
In-situ Clay (drained)	132	0	28
In-situ Clay (undrained)	132	3,000	0
Liner	120	0	15
Solid Waste	65	0	33
Sand and Gravel	138	0	36

Geosynthetic Parameter Selection

The Construction QA/QC Plan (Part V of the application) involves the specification of required interface strengths such that the proposed geosynthetic systems achieve a satisfactory factor of safety. These requirements apply to all geosynthetic-geosynthetic and soil-geosynthetic interfaces in the proposed baseliner and final cover system.

Once appropriate materials have been selected, laboratory testing shall be performed to confirm that the interfaces described in Sections 9.2.4 will meet or exceed these requirements. The geosynthetic interface data included in the calculations Appendix B are generally attainable with materials that are available for these particular applications. It should be noted that residual conditions only apply to the interface with the lowest peak strength, and therefore, not all interfaces will be required to have the residual strengths reported herein. Likewise, the specified strengths assume no cohesion. Once testing has been completed, further analysis can show that interfaces that would otherwise not meet the specifications can, when consideration for cohesion is determined to be appropriate, be acceptable under specific loading conditions. Based on experience, suitable materials can be obtained to possess the required material properties.

9.2.4 Stability Results

The locations for analysis were chosen with consideration for either the existing soil conditions, as documented by field and laboratory tests, or the proposed landfill geometry. Slope stability section locations are shown in Appendix B and the applicability of the sections are summarized below:

Section 1 – Final waste western slope configuration and stability of MSE berm

Section 2 – Final waste southern slope configuration

Section 3 – Final waste eastern slope configuration

Section 4 – Stability of MSE berm

The calculated factors of safety for the cases analyzed are summarized in Appendix B. The values of factor of safety meet or exceed the requirements of Part 363. Seismic stability analysis indicate the factors of safety under seismic load exceed 1.0 which exceeds the requirements of Part 363.

The Construction QA/QC Plan (Part V of the application) will address the required friction angles for the liner system components. This includes a minimum peak friction angle of 15° for the baseliner, peak friction angle of 24° for the overliner after construction and prior to waste placement (i.e. low normal stress condition), and a residual friction angle of 19° after waste placement (at the applicable normal stress condition).

10.0 SURFACE WATER MANAGEMENT SYSTEM

The surface water management system for the Area 7/8 Development has been designed in accordance with Part 360.19(b) and Part 363-4.3(f). In general, Part 360.19(b) states requirements for surface water run-on and run-off during the active landfill period, while Part 363-4.3(f) describes post-closure surface water management. The surface water management system has also been developed using the New York State Stormwater Management Design Manual (Reference 11) and the New York State Standards and Specifications for Erosion and Sediment Control (Reference 14).

The surface water management system includes the following components:

- Final cover mid-slope swales and downchutes to collect and carry the surface water from the landfill cover to the perimeter drainage channels;
- Perimeter drainage channels designed to convey surface water run-off from both intermediate and final developed landfill areas to sedimentation basins;
- Culverts designed to convey drainage under access roads, for the completed landfill development condition; and
- Sedimentation basins designed to collect surface water run-off to promote and control sedimentation and to regulate the discharge of surface waters to the adjacent receiving areas.

Part of the surface water management system has been designed and installed as part of the Western Landfill Development or during the capping of the Closed Landfill. In addition, cap drainage for the Valley Fill Landfill was previously designed and will be expanded for the Area 7/8 Development. Appendix B provides the additional analyses completed for the Area 7/8 Development.

Sheet 25 of the engineering drawings presents the stormwater drainage plan including the final grading plan, location of existing and proposed stormwater features including culverts, drainage channels and sedimentation basins. Sheets 26 through 28 depict details of the proposed culverts, channels and sedimentation basins. Temporary erosion and sediment control features (e.g., hay bales, silt fences, stockpile erosion protection, etc.) are shown on Sheet 29.

The following methods were used to design the surface water management systems and erosion and sedimentation control structures for the Area 7/8 Development:

1. Evaluate drainage areas and surface characteristics using USDA/SCS Technical Release No. 55 (TR-55) Methods (Reference 12) with HydroCAD Software (Reference 13).
2. Calculate peak flows for each drainage structure for the design storm events using HydroCAD Software (Reference 13).
3. Calculate Water Quality Volume (WQV) in accordance with the New York State Stormwater Design Manual (Reference 11).
4. Provide Stream Channel Protection Volume (Cpv) requirements of 24 hour extended detention of the post-development 1-year, 24-hour storm event.
5. Provide Overbank Flood Control (Qp) and Extreme Flood Control (Qf) and control the peak discharge from the 10-year, 24-hour and 100-year, 24-hour storm events to pre-development rates.
6. Design channels for the calculated peak run-off for the 10-year 24-hour design storm with 0.5 feet of freeboard in accordance with the New York State Stormwater Design Manual (Reference 11). The calculated peak run-off for the 100-year 24-hour storm was used to check that the proposed channels would not overtop during this storm.
7. Design culverts for the calculated peak run-off for the 10-year 24-hour design storm for closed conveyance systems in accordance with the New York State Stormwater Design Manual (Reference 11).

The calculated peak run-off for the 100-year 24-hour storm was used to check that the proposed channels and culverts would not overtop during this storm.

8. Prepare engineering calculations for the design of channels and culverts in accordance with the New York State Standards and Specifications for Erosion & Sediment Control (Reference 14) and the methods presented in Hydraulic Design Series Number 5, Hydraulic Design of Highway Culverts (HDS-5, Reference 15).
9. Check each channel and culvert outlet for permanent revetment requirements to limit erosion and dissipate energy in accordance with the New York State Standards and Specifications for Erosion & Sediment Control (Reference 14) and the methods presented in Hydraulic Engineering Circular Number 15, Design of Roadside Channels with Flexible Linings (HEC-15, Reference 16).
10. Size forebay, permanent pools, basin grading features and outlet device in accordance with New York State Stormwater Management Design Manual (Reference 11).
11. Perform basin routings for the sedimentation basins using the HydroCAD Software (Reference 13).
12. Evaluate impacts on the conveyance system from a 500-year, 24-hour storm.

Section 10.1 describes the existing site conditions, the surface water management system requirements and the implementation of the surface water management system. Section 10.2 describes the surface water management system design. This includes a discussion of the design and maintenance of final cover, drainage ditches, culverts, sedimentation basin, revegetation and silt fences, and a demonstration of compliance with applicable requirements of the above-referenced documents. Section 10.3 presents the drainage routing procedures that will be implemented during and after facility development to manage surface water and to control erosion and sedimentation. Section 10.4 discusses the impacts of a 500-year, 24-hour storm on the conveyance features. Calculations for the drainage channels, culverts and sedimentation basins are presented in Appendix B.

10.1 EXISTING CONDITIONS

The Area 7/8 Development is a continuation of the Valley Fill Landfill and will utilize some of the existing stormwater drainage system with additional perimeter stormwater drainage features, final cap drainage channels and downchutes. The pre-development drainage analysis for the site is presented in Appendix B. The pre-development drainage analysis was updated with current rainfall data and based on the pre-development drainage analysis presented in Appendix E.1 of the February 2005 Engineering Report for the NYCRR Part 360 Solid Waste Management Permit Modification Application prepared by McMahon & Mann Consulting Engineers, P.C. (reference 5). The purpose of estimating the pre-development run-off is to compare it with the post development run-off for the Channel Protection Volume (Cpv), Overbank Flood (Qp) and Extreme Storm (Qf) requirements in accordance with the New York State Stormwater Design Manual (Reference 11).

10.2 FEATURES OF SURFACE WATER MANAGEMENT SYSTEM

This section describes surface water management related to the final landfill cover system, perimeter landfill drainage ditches, sedimentation basins, and temporary and permanent erosion control measures. The structures associated with the surface water management system have been sized at a minimum to accommodate the calculated peak run-off from the 100-year, 24-hr storm without sustaining damage, as required by Part 363-4.3(f). Calculations related to the stormwater management system are presented in Appendix B of this report.

10.2.1 Final Cover Drainage

Cover drainage will be allowed to sheet flow off the landfill to three tiers of mid-slope drainage channels. The mid-slope drainage channels are directed to one of the three proposed downchute channels. The downchute channels will collect surface water from each tier of mid-slope channels and discharge it into the perimeter channels. The mid-slope channels as shown on Sheet 25 will be constructed at either 1 percent or 4 percent slopes and be grass lined. The downchutes (designated as Proposed Downchute #1, #6 and #7 on Sheet 25) will

consist of a 12 foot bottom width and 1 foot deep rock lined channel underlain by a geomembrane liner to prevent soil erosion.

Seeding and mulching will occur upon completion of final cover construction, followed by installation of cross slope silt fences and/or straw bales to temporarily divert and slow the stormwater. These devices will also act to retain the soil until permanent vegetation is established.

The seed mixture will be in accordance with the mixture contained in the Technical Specifications (Part V of the application) for either temporary or permanent uses. The seeded areas will be mulched to conserve soil moisture and provide additional temporary erosion protection. Mulch may consist of clean hay, straw or wood-fiber. Alternatively, hydroseeding may be used or the inclusion of a natural or synthetic erosion mat may be installed prior to seeding.

10.2.2 Perimeter Drainage Channel Design

A drainage channel will be located on the interior (upslope) side of the perimeter access roads (see Sheet 25). This channel will be rip-rap lined on the bottom and grass-lined on the slopes and will collect run-off from the lower portion of the landfill cover. This channel will be constructed in approximate 200 foot lengths sloped at 1 percent toward a culvert that flows beneath the access road to a channel located on the slope of the berm (see Sheet 25). The perimeter drainage channel has been installed along the constructed Western Landfill Development cells.

The channel design calculations are presented in Appendix B. The drainage channel system was designed to convey the 10-year, 24-hour storm with at least 0.5 feet of freeboard and the 100-year, 24-hour storm without overtopping. The erosion protection for each channel was selected based on the flow velocities calculated for the 100-year, 24-hour storm.

10.2.3 Berm Drainage Channel Design

A drainage channel will be located on the slope of the berm on the southern side of Future Cells 7/8 (see Sheet 25). This channel will be rip-rap lined and will collect run-off from the proposed access road and upper portion of the berm. Run-off collected by the perimeter drainage channels will be conveyed to this berm channel through the culverts under the access road. This channel will be sloped at 1 percent. This channel is directed to Sedimentation Basin #5. The drainage channel on the outside slope of the berm has been installed along the constructed Western Landfill Development cells.

The channel design calculations are presented in Appendix B. The drainage channel system was designed to convey the 25-year, 24-hour storm with at least 0.5 feet of freeboard and the 100-year, 24-hour storm without overtopping. The erosion protection for each channel was selected based on the flow velocities calculated for the 100-year, 24-hour storm.

10.2.4 Culvert Design

Culverts are included in the surface water management system to convey stormwater under access roads (see Sheet 25). Culverts are used to convey water from the perimeter channels, access road channels and other areas around the site into downstream channels for continued conveyance to the sedimentation basins.

The culvert design calculations are presented in Appendix B. The culvert system was designed to convey the 100-year, 24-hour storm without exceeding the pipe cover elevation. The outlet protection for each culvert was selected based on the flow velocities calculated for the 100-year, 24-hour storm.

10.2.5 Sedimentation Basins

Run-off from the landfill areas will flow to the four proposed sedimentation basins (see Sheet 25). Sedimentation Basins #5, #1, #2 and #3 will require modification due to the proposed development as shown on Sheets 25 and 26. Part of the Area 7/8 Development stormwater is directed into some of the existing channels constructed as part of the Western Landfill Development. The remaining Area 7/8 Development stormwater is directed into proposed channels and culverts (see Sheet 25). Stormwater from the Area 7/8 Development will be directed to Sedimentation Basins #5, #1, #2 and #3. Stormwater will first enter Sedimentation Basin #5 and then pass through Sedimentation Basins #1, #2 and #3 prior to discharging from Sedimentation Basin #3.

Sedimentation Basin #5 was designed to meet the following objectives:

1. Provide storage for the sediment volume that is calculated to accumulate over a 6 month period based on a disturbed area of 30 acres (an area that might be disturbed during typical construction activities),
2. Retain the 100-year, 24-hour storm with outflow through the discharge riser and emergency spillway while maintaining 1.0 feet of freeboard to the basin banks, and
3. Contain 3 million gallons of potentially contaminated stormwater in the event that there was a spill in the active landfill area.

As shown in Appendix B, Sedimentation Basin #5 is sufficient as designed to meet the above objectives.

Sedimentation Basins #1, #2 and #3 were designed to meet the following objectives:

1. Pre-treatment of 100 percent of the water quality volume in the forebay area (Sedimentation Basin #5);
2. Treatment of 100 percent of the water quality volume in the permanent pool areas;
3. Provide channel protection volume by providing 24-hours of extended detention of the 1-year, 24-hour storm;
4. Provide overbank flood protection by controlling the peak discharge form the 10-year, 24-hour storm to the pre-development rates,
5. Provide extreme storm protection by controlling the peak discharge from the 100-year, 24-hour storm to the pre-development rates and safely passing the 100-year, 24-hour storm event;
6. Retain the 10-year, 24-hour storm with outflow through only the discharge riser; and
7. Retain the 100-year, 24-hour storm with outflow through the discharge riser and emergency spillway while maintaining 1.0 feet of freeboard to the basin banks.

The existing outlet structure for Sedimentation Basins #1, #2 and #3 will continue to be utilized. Appendix B presents the water quality volume estimates and summarizes the stormwater routing results. As shown, Sedimentation Basin #1, #2 and #3 are sufficient as designed to meet the above objectives.

10.2.6 Temporary Features

Temporary surface water management features include silt fences, hay bales, rock check dams and temporary drainage ditches. The temporary drainage features are shown on Sheets 31 through 33. This includes the use of temporary stormwater drainage swales on the sideslopes of the constructed landfill to divert stormwater away from newly constructed landfill cells. With the phased construction as shown on the engineering drawings, surface water on the outsides slopes will be directed into the perimeter stormwater controls, whereas surface water on the inside slopes will naturally flow to low spots so that it can be piped or pumped into the perimeter channels.

The remaining temporary water management features will be installed during either individual cell construction or during site activities where non-vegetated surfaces will exist. Silt fences will be used during facility development to reduce erosion and to control sedimentation. Silt fences will be used as necessary at 40-foot vertical intervals along intermediate cover surfaces to reduce the sediment load in the receiving drainage ditches. A detail of an installed silt fence is shown on Sheet 29. In addition, silt fences will be placed on the down-slope sides of disturbed areas (5 feet) from the toe of slope until the permanent drainage and erosion control structures are

established. Hay bales or rock check dams will be placed at 200-foot intervals along the temporary and permanent drainage ditches in which vegetation is being established. Hay bales or rock check dams will be placed as necessary in ditches to control flow velocity and reduce downstream sedimentation.

10.2.7 Maintenance

Activities will be performed to maintain the surface water management system throughout the active and post-closure care period. Maintenance will be performed to:

- Re-establish vegetation on cover slopes and other areas, as necessary;
- Remove sediment from drainage channels to allow unimpeded flow in channels;
- Remove sediment from Sedimentation Basin #5 semi-annually and from Sedimentation Basins #1, #2 and #3 when the pool depths have been reduced by approximately 50 percent; and
- Re-establish erosion prevention measures in drainage channels, including revegetation or replacement of riprap, as appropriate.

10.3 DRAINAGE ROUTING PLAN: RUN-OFF AND RUN-ON CONTROL

During facility development, the surface water management system will be constructed to convey surface water run-off from disturbed areas to the sedimentation basins and, ultimately, to off-site natural watercourses. Construction of erosion and sediment control structures will precede development of each portion of the facility, such that drainage control features are in place prior to disturbance of surface soils. Run-off to areas under development will be managed as described below:

- Water in constructed landfill cells (prior to waste placement): Water (primarily precipitation) in constructed landfill cells prior to waste placement will be allowed to percolate into the leachate collection system and will then be pumped by a submersible pump into the landfill perimeter drainage ditch.
- Run-off from Daily Cover Surfaces or Exposed Working Faces of the Disposal Area: Run-off from daily cover surfaces or exposed working faces is required to be treated as leachate. Exposed working faces will slope toward the center of the cell. This will enable stormwater run-off that comes in contact with the exposed working faces to percolate to the leachate pumps at the low point of the cell. Intermediate cover will be placed on the slopes, which drain away from the working face and into the perimeter drainage ditch. Outboard slopes, which have not received intermediate cover, are required to be treated as leachate and will drain stormwater run-off to a collection ditch within the limits of the primary liner system. From the collection ditch, the stormwater run-off will drain and percolate to the leachate pumps at the low point of the cell.
- Surface Water Run-off from Intermediate Cover Surfaces: Most of the run-off from intermediate cover surfaces will be collected in temporary drainage swales constructed on the intermediate cover or allowed to sheet flow across the cover. If the water is allowed to sheet flow, a series of temporary silt fences will be installed on the slope to decrease both the water velocity and potential soil loss. The run-off from these locations will then be conveyed to the sedimentation basins by the perimeter ditches. Run-off from intermediate cover surfaces below the elevation of the perimeter berm will be allowed to percolate into the leachate collection system rather than being collected in the manner described above.
- Run-off from Perimeter and Access Roads: Run-off from perimeter access roads will be intercepted by the perimeter drainage channels.

Disturbed and/or completed construction areas will be vegetated as soon as possible to stabilize the soil and minimize erosion. Temporary vegetation will be established on intermediate cover surfaces and temporary surfaces. Permanent vegetation will be established on final cover surfaces, grass-lined permanent drainage channels, and perimeter berm and sedimentation basin slopes. The seed mixture will be in accordance with the mixture contained in the Technical Specifications (Part V of the application).

Seeded areas will be mulched following seeding to conserve soil moisture and provide additional temporary erosion protection. Mulch will consist of clean hay, straw, or cellulose wood-fiber material. Alternatively, disturbed or completed areas may be hydroseeded as appropriate.

10.4 500-YEAR, 24-HOUR STORM EVENT

An evaluation of the impact of the 500-year, 24-hour storm event on the stormwater management system was completed as required by Part 363-4.3(f). The existing and proposed conveyance features that direct run-off which is ultimately routed to Sedimentation Basin #5 were evaluated. These features were evaluated to determine the overall impact to the stormwater management system contributing to the proposed Sedimentation Basins #5, #1, #2 and #3.

10.4.1 Downchutes

The downchutes will not overtop during the 500-year, 24-hour storm event. However, the high flow through the downchutes may cause erosion of some of the downchutes. As described in the Facility Manual and Stormwater Pollution Prevention Plan (SWPPP), repairs of eroded downchutes shall be completed after the storm event.

10.4.2 Perimeter Drainage Channels

During the 500-year, 24-hour storm, some of the proposed perimeter channels could overtop. The overtopping of the perimeter channels along the Area 7/8 Development cells may cause damage to adjacent roadways or structures. Additionally, due to the large flow, erosion of some of the perimeter channels may occur. As described in the Facility Manual and SWPPP, the contingency plan for such event would be to repair eroded channels after the storm event.

10.4.3 Berm Drainage Channels

During the 500-year, 24-hour storm, the proposed channels located on the slope of the berm south of the Area 7/8 Development will not overtop. A majority of the existing channels located on the outside slope of the berm along the Western Landfill Development cells will overtop. The overtopping of the berm channels along the Western landfill Development cells may cause damage to adjacent roadways or structures. Additionally, due to large flow, erosion of some of the channels may occur. As described in the Facility Manual and SWPPP, repairs of eroded channels as well as effected adjacent roadways or structures shall be completed after the storm event.

10.4.4 Culverts

A majority of the culverts will back-up during the 500-year, 24-hour storm event and may overtop adjacent roadways and potentially cause damage to roadways or structures. As described in the Facility Manual and SWPPP, the contingency plan for such occurrences would be to repair the effected areas due to flooded culverts and to complete such repairs after the storm event.

10.4.5 Sedimentation Basins

Sedimentation Basin #5 does not have the capacity to handle the peak discharge from a 500-year, 24-hour storm event without overtopping. The overtopping of Sedimentation Basin #5 may cause erosion to adjacent roadways, structures or sedimentation basins. Additionally, the large flows through Sedimentation Basin #5 may cause erosion of the separation berm between Sedimentation Basin #5 and Sedimentation Basin #1, but overall, Sedimentation Basins #1, #2 and #3 have the capacity to handle the peak discharge from a 500-year, 24-hour storm event without overtopping.

As described in the Facility Manual and SWPPP, repairs to eroded areas as well as effected adjacent areas due to the flooded Sedimentation Basin #5 shall be completed after the storm event.

11.0 LANDFILL GAS MANAGEMENT SYSTEM

11.1 INTRODUCTION

Owners and operators of solid waste landfills are required to restrict emissions and obtain permits to construct and operate control units for landfill gas. These requirements are described primarily by 6NYCRR Parts 200, 201, 212 and 231. In addition, 6 NYCRR Part 360 Solid Waste Management Facilities regulations govern the construction and operation of landfill gas recovery facilities that remove gas from landfill as well as 6 NYCRR Part 363-6.15. The Part 360 requirements generally address gas collection and control systems and environmental monitoring requirements.

This section of the Engineering Report provides an overview of the landfill gas management system design in compliance with Part 363-4.3(a)(3)(ii) and Part 363-4.3(a)(5). The active gas collection system for the proposed landfill development will be similar to the system that is currently installed, and will be designed to prevent the build-up of excess LFG pressure within the landfill and to control subsoil gas migration or surface emissions to the atmosphere. The design will consist of features to ensure compliance (if needed in the future) with the gas collection standards specified under NSPS for new MSW landfill sites (40 CFR Part 60, Subpart WWW, Standards of Performance for New Municipal Solid Waste Landfills and 6 NYCRR Part 208). Engineering drawings that provide the landfill gas management system design are provided in Engineering Drawings 34-39.

11.2 PROPOSED LANDFILL GAS COLLECTION SYSTEM AND CONTROL

Landfill gas extraction system vacuum pipe, extraction wells, and collection trenches will be sized based on the expected maximum flow rates determined by computer modeling of landfill gas generation. The LandGEM model was used to determine to maximum expected generation based on historical waste acceptance rates and predicted future waste intake rates. Sizing requirements of the landfill gas system components and control devices are based upon the volume of landfill gas generated within the landfill. The landfill gas generation is based on the waste intake rate, waste composition, moisture, pH, and other environmental factors, therefore, an engineer will update the landfill gas generation model to determine the proper sizing of landfill gas collection and control system components when issuing construction documents.

A generation potential (Lo) value of 139.6 m3/Mg and generation rate (k) of 0.04 yr-1 were utilized by GHD for the Area 7/8 Development. The concentration of non-methane organic compounds (NMOC) in the LFG is assumed to be 595 ppm, per AP-42, and a methane content of 50 percent by volume is assumed. For a conservative generation estimate, GHD assumed all accepted waste to be putrescible and waste acceptance to be 720,000 TPY (600,000 TPY MSW and 120,000 TPY ADC (which is the permitted acceptance rate for the facility)). An 85 percent collection efficiency was used to determine the amount of gas collected and the resulting fugitive emissions. Figure 1 presents the LFG model for the Area 7/8 Development, which shows the estimated amount of LFG generated. GHD calculated the peak year of LFG generation for the Area 7/8 Development will be approximately 2029, with a total of 2,466 cfm generated (approximately 2,096 cfm of collected LFG in 2029) See Figures 1 and 2 in the Title V Application (Appendix C of the DSEIS).

The landfill gas generated within the landfill will be collected from wells installed within the waste mass. These wells will either be constructed by using caissons to build the well vertically during the active filling of waste or by the traditional method of drilling into the waste mass after the waste has been placed. The spacing of the wells is based upon the calculated radius of influence, see Appendix C of the DSEIS, which required a spacing of 199 feet on shallow wells and 225 feet for medium depth wells. For deep wells the conservative medium well spacing will be used. The wellbore will be sealed to minimize the occurrence of fugitive emissions and a landfill gas wellhead will be installed on top of the installed well casing. Well casings will be constructed of schedule 80 PVC plastic or

SDR 17 HDPE pipe. A vacuum will be generated by the control devices and landfill gas will be collected via a header and lateral piping system constructed of HDPE pipe.

Landfill gas will continue to be collected from the existing landfill and proposed landfill development through an active system consisting of vertical recovery wells and horizontal collectors, and existing wells will be modified to remain below the overliner/baseliner system where construction of the development will occur over previously landfilled areas. Where the development of the proposed landfill occurs in location that have existing landfill gas extraction wells or horizontal collectors, the existing devices will be evaluated prior to construction and an engineer will determine whether the device will be abandoned, connected to a new horizontal collection trench, or remotely connected to the collection system by adding solid plastic pipe to extend the location of the well outside of the overfill area. The engineer will determine the proper action for each existing extraction point based on the age, condition, location, landfill gas flow and landfill gas quality for each device. These components are principally illustrated in the Engineering Drawings.

Landfill gas will be conveyed to the landfill gas control facilities, which consist of a 910 cfm open flare, 3,300 cfm enclosed flare, and the eight (8) Caterpillar 3516 gensets (2,400 cfm total capacity) for total site capacity of 6,610 cfm. Based on GHD's calculations, the peak year of LFG generation will be approximately 2029, with a total of 7,377 cfm generated from the entire facility (approximately 6,237 cfm of collected LFG in 2029), therefore the site has sufficient capacity with the existing control devices.

Condensate generated by the gas recovery operation and leachate collected by the extraction trenches will be collected within traps at the low points of the gas piping system, or by the leachate collection systems at strategic locations in the proposed Development landfills as shown in the Drawings. Condensate will be drained by gravity or pumped from the individual tanks or transferred directly to the leachate storage tank with collected leachate and disposed of at an approved off-site treatment and disposal location.

12.0 CONSISTENCY WITH EXISTING REMEDIAL PROGRAMS COMPLIANCE WITH HAZARDOUS WASTE SITE REGULATIONS

Subparagraph 360.16(h)(1) states that for facilities proposed to be located within 150 feet of the boundary of a site undergoing a remedial program, the applicant must submit a report that discusses the potential impacts of the facility on the remedial program for that site. Additionally, the proposed facility must not interfere significantly with potential, ongoing or completed remedial program.

As mentioned previously, the Area 7/8 Development overlies a portion of the Closed Landfill, which is classified as a "Class 4" inactive hazardous waste site by the NYSDEC and is therefore subject to the requirements of this subparagraph.

The leachate containment and collection systems for the Closed Landfill are described in Section 3.3.3 of this report. The landfill gas collection system for the Closed Landfill is described in Section 3.3.4, and the final cover system is described in Section 3.3.5. These systems in combination will continue to be effective in controlling migration of contaminants from the Closed Landfill. Potential impacts and modifications to these systems are discussed above in Section 4.1. Since the Class 4 designation indicates that no further remedial action is required but ongoing monitoring is required, and since the proposed Area 7/8 Development will not impact the ongoing monitoring of the site, the conditions in Section 360.16(h)(1) are satisfied.

13.0 REFERENCES

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2. The CID Group, Inc., C,.I.D. Landfill, Inc., 6 NYCRR Part 360 Permit Renewal Application, March 1999.
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15. United States Department of Transportation, Hydraulic Engineering Circular No. 5, "Hydraulic Charts for Selection of Highway Culverts", December 1965.
16. United States Department of Transportation, Hydraulic Engineering Circular No. 15, "Design of Roadside Channels With Flexible Linings", Publication No. FHWA-IP-87-7, April 1988.
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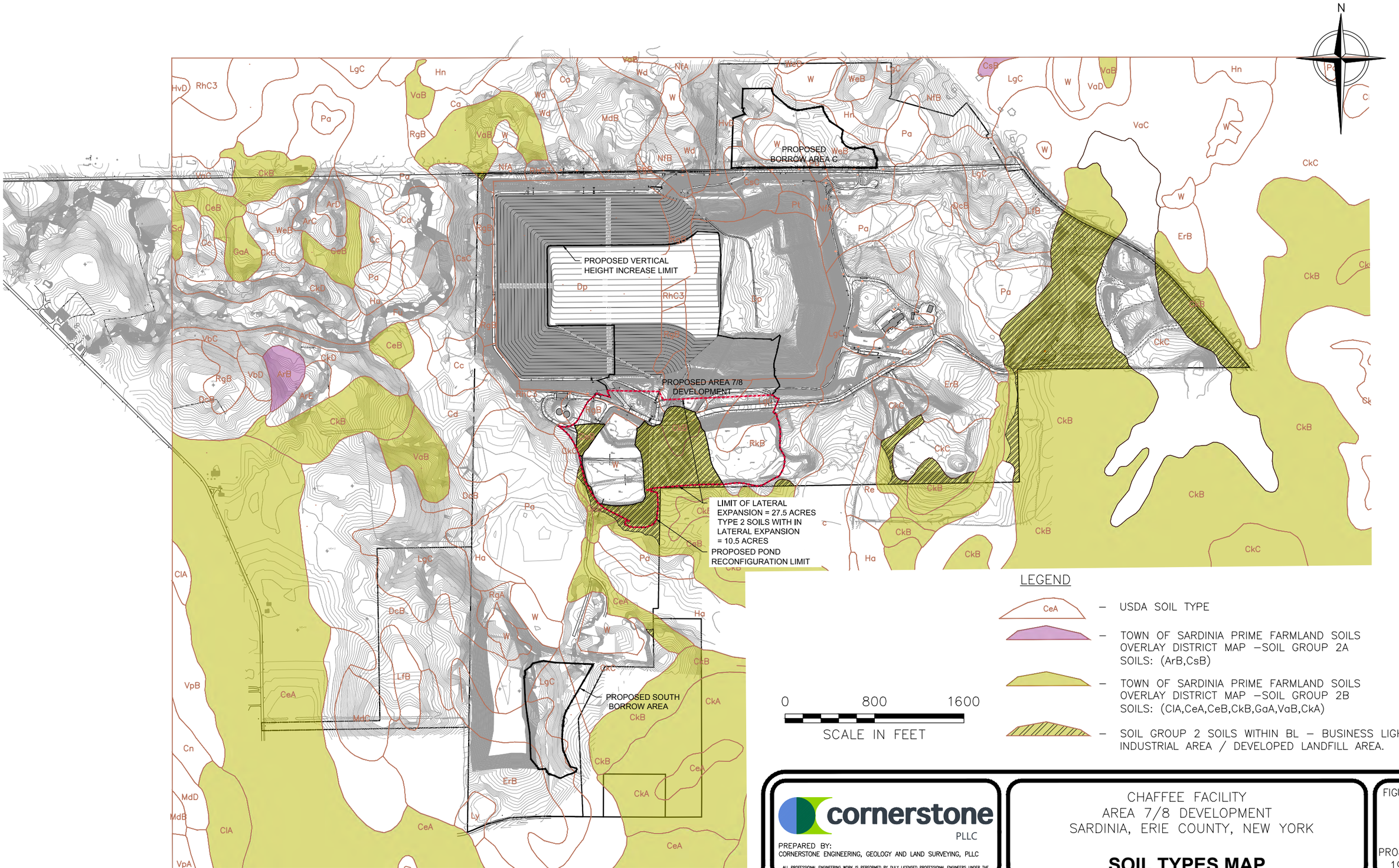
14.0 LIMITATIONS

The work product included in the attached was undertaken in full conformity with generally accepted professional consulting principles and practices and to the fullest extent as allowed by law we expressly disclaim all warranties, express or implied, including warranties of merchantability or fitness for a particular purpose. The work product was completed in full conformity with the contract with our client and this document is solely for the use and reliance of our client (unless previously agreed upon that a third party could rely on the work product) and any reliance on this work product by an unapproved outside party is at such party's risk.

The work product herein (including opinions, conclusions, suggestions, etc.) was prepared based on the situations and circumstances as found at the time, location, scope and goal of our performance and thus should be relied upon and used by our client recognizing these considerations and limitations. Cornerstone Environmental Group, LLC shall not be liable for the consequences of any change in environmental standards, practices, or regulations following the completion of our work and there is no warrant to the veracity of information provided by third parties, or the partial utilization of this work product.

FIGURES



cornerstone PLLC

PREPARED BY:
CORNERSTONE ENGINEERING, GEOLOGY AND LAND SURVEYING, PLLC

ALL PROFESSIONAL ENGINEERING WORK IS PERFORMED BY DULY LICENSED PROFESSIONAL ENGINEERS UNDER THE APPROPRIATE STATE REGISTERED PROFESSIONAL ENTITY.

CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

SOIL TYPES MAP

FIGURE NO. 1

PROJECT NO. 190260

File: D:\PROJECTS\190260 – SOUTHERN EXPANSION TITLE_Project Drawings\190260-FIGURE 1-SOIL SURVEY FIGURE.dwg Layout: FIGURE 10 User: DAVID.STENSHORN Jul 08, 2020 – 4:00pm

File: D:\PROJECTS\190260 – SOUTHERN EXPANSION TITLE_Project Drawings\190260–FIGURE 2 (LEACHATE PLAN).dwg Layout: FIGURE 2 User: DAVID.STENSHORN Jun 22, 2020 – 1:35pm

N

LEGEND

- EXISTING CONTOURS (SEE NOTE 1 ON FIGURE 3)
- EXISTING STORMWATER BASIN
- EXISTING CULVERT
- EXISTING RIP-RAP
- CLOSED LANDFILL'S CLAY BERM
- PROPERTY LINE (SEE NOTE 2 ON FIGURE 3)
- APPROXIMATE CELL BOUNDARIES
- LEACHATE TRANSMISSION LINES
- LEACHATE COLLECTION PIPE
- 1.0% SLOPE — PROPOSED 12"/8" DUAL CONTAINED TRANSMISSION LINE SLOPE AND FLOW DIRECTION
- C.O. — CLEANOUT RISER AND DIRECTION OF CLEANING
- LANDFILL FLOOR AREAS AT LESS THAN 25% SLOPE
- LANDFILL FLOOR AREAS BETWEEN 25% AND 33% SLOPE
- LEACHATE COLLECTION LATERAL (PRIMARY)
- LEACHATE COLLECTION LATERAL (SECOND)
- LEACHATE TRANSMISSION HEADER (PRIMARY)
- LEACHATE TRANSMISSION HEADER (SECOND)
- LEACHATE TRANSMISSION FORCE MAIN

0 400 800

SCALE IN FEET

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CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

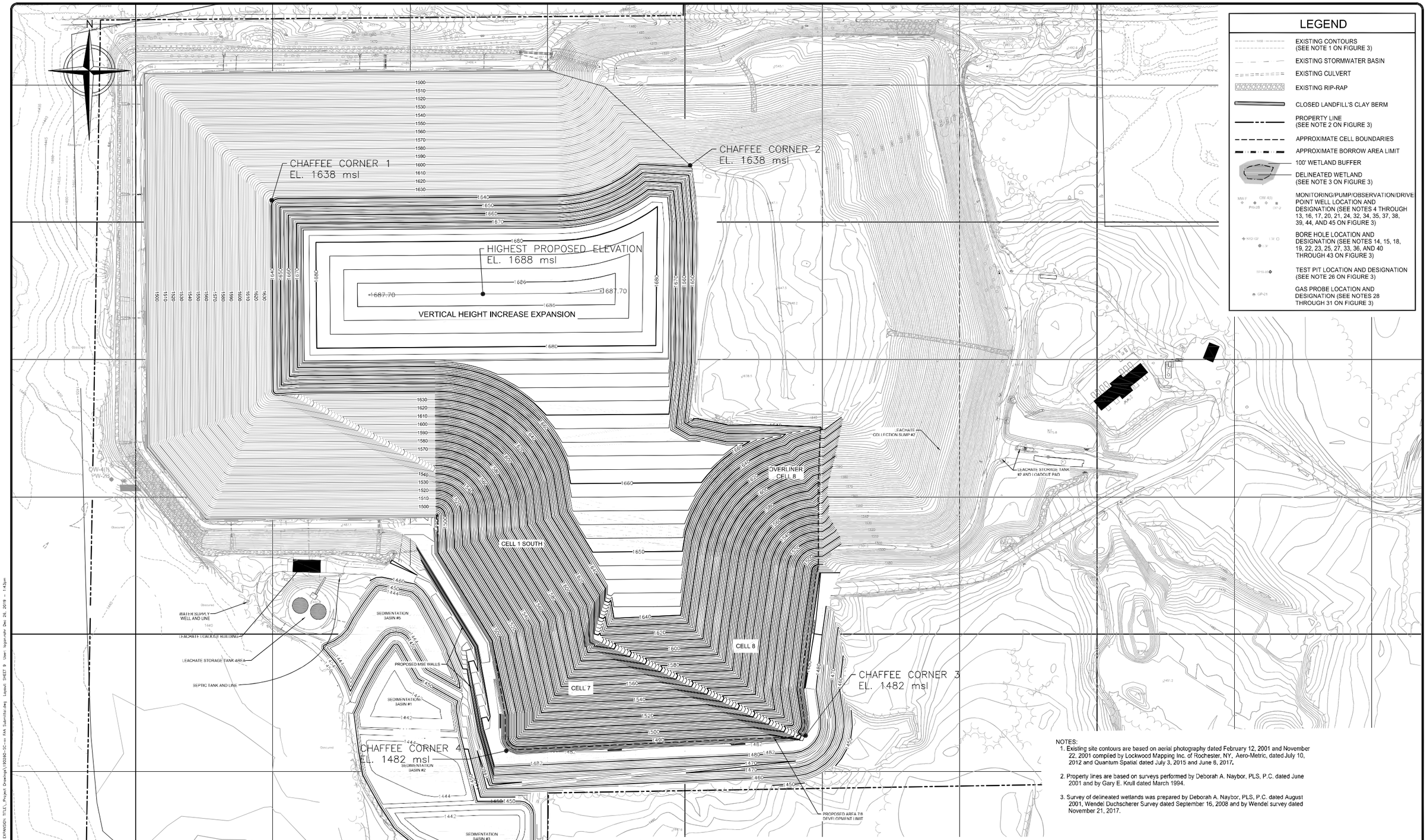
LEACHATE PLAN

FIGURE NO. 2

PROJECT NO. 190260

APPENDIX A

FAA Submittal Documents



LEGEND

- EXISTING CONTOURS (SEE NOTE 1 ON FIGURE 3)
- EXISTING STORMWATER BASIN
- EXISTING CULVERT
- EXISTING RIP-RAP
- CLOSED LANDFILL'S CLAY BERM
- PROPERTY LINE (SEE NOTE 2 ON FIGURE 3)
- APPROXIMATE CELL BOUNDARIES
- APPROXIMATE BORROW AREA LIMIT
- 100' WETLAND BUFFER
- DELINEATED WETLAND (SEE NOTE 3 ON FIGURE 3)
- MONITORING/PUMP/OBSERVATION/DRIVE POINT WELL LOCATION AND DESIGNATION (SEE NOTES 4 THROUGH 13, 16, 17, 20, 21, 24, 32, 34, 35, 37, 38, 39, 44, AND 45 ON FIGURE 3)
- BORE HOLE LOCATION AND DESIGNATION (SEE NOTES 14, 15, 18, 19, 22, 23, 25, 27, 33, 36, AND 40 THROUGH 43 ON FIGURE 3)
- TEST PIT LOCATION AND DESIGNATION (SEE NOTE 26 ON FIGURE 3)
- GAS PROBE LOCATION AND DESIGNATION (SEE NOTES 28 THROUGH 31 ON FIGURE 3)

NOTES:

1. Existing site contours are based on aerial photography dated February 12, 2001 and November 22, 2001 compiled by Lockwood Mapping Inc. of Rochester, NY, Aero-Metric, dated July 10, 2012 and Quantum Spatial dated July 3, 2015 and June 8, 2017.
2. Property lines are based on surveys performed by Deborah A. Naybor, PLS, P.C. dated June 2001 and by Gary E. Krull dated March 1994.
3. Survey of delineated wetlands was prepared by Deborah A. Naybor, PLS, P.C. dated August 2001, Wendel Duchscherer Survey dated September 16, 2008 and by Wendel survey dated November 21, 2017.

Unauthorized alteration or addition to this plan bearing a licensed professional's seal is a violation of Section 7209, Sub-Division 2, of the New York Education Law. Only copies from the original of this plan marked with an original professional's seal shall be considered to be valid true copies.

This drawing represents intellectual property of Cornerstone Engineering, Geology and Land Surveying, PLLC. Any modification to the original by other than Cornerstone Engineering, Geology and Land Surveying, PLLC personnel violates its original purpose and as such is rendered void. Cornerstone Engineering, Geology and Land Surveying, PLLC will not be held liable for any changes made to this document without express written consent of the originator.

ROBERT A. HOLMES

N.Y.P.E. Lic. No. 077317 Date

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DATE OF ISSUE JAN 2020
DRAWN BY DSS
DESIGNED BY
CHECKED BY
APPROVED BY

cornerstone PLLC

PREPARED BY:
CORNERSTONE ENGINEERING, GEOLOGY AND LAND SURVEYING, PLLC
ALL PROFESSIONAL ENGINEERING WORK IS PERFORMED BY NEW YORK LICENSED PROFESSIONAL ENGINEERS UNDER THE OWNERSHIP, DIRECTION AND RESPONSIBILITY OF NEW YORK LICENSED PROFESSIONAL ENGINEERS.

CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

CONCEPTUAL COVER GRADING PLAN

SHEET NO. **9**

PROJECT NO. 190260

1" 1/2" 0" 1"

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Federal Aviation Administration

« OE/AAA

Notice of Proposed Construction or Alteration - Off Airport

Add New Multiple Cases Off Airport - Desk Reference Guide V_2018.2.1

Add a New Case (Off Airport) for Wind Turbines - Met Towers (with WT Farm) - WT-Barge Crane - Desk Reference Guide V_2018.2.1

Project Name: WASTE-000559313-19 **Sponsor:** Waste Management - Chaffee Landfill

Details for Case : Chaffee Corner 1

Show Project Summary

Case Status

ASN:	2019-AEA-14954-OE	**Date Accepted:**	12/26/2019
Status:	Accepted	**Date Determined:**	
		Letters:	None
		Documents:	None
Public Comments:	None		Project Documents: 12/26/2019 Chaffee Area 7-8 ... 12/26/2019 OECaseDataSpreads...

Construction / Alteration Information

Notice Of:	Construction
Duration:	Permanent
if Temporary :	Months: Days:
Work Schedule - Start:	01/01/2023
Work Schedule - End:	12/31/2030

For temporary cranes-Does the permanent structure require separate notice to the FAA?
To find out, use the Notice Criteria Tool. If separate notice is required, please ensure it is filed.
If it is not filed, please state the reason in the Description of Proposal.

State Filing:	Not filed with State

Structure Summary

Structure Type:	Landfill
Structure Name:	Chaffee Corner 1
FDC NOTAM:	
NOTAM Number:	
FCC Number:	
Prior ASN:	

Structure Details

Latitude:	42° 34' 57.80'' N
Longitude:	78° 30' 18.60'' W
Horizontal Datum:	NAD83
Site Elevation (SE):	1490 (nearest foot) PASSED
Structure Height (AGL):	148 (nearest foot)
Current Height (AGL): **** For notice of alteration or existing provide the current AGL height of the existing structure. Include details in the Description of Proposal***	(nearest foot)
Minimum Operating Height (AGL): **** For aeronautical study of a crane or construction equipment the maximum height should be listed above as the Structure Height (AGL). Additionally, provide the minimum operating height to avoid delays if impacts are identified that require negotiation to a reduced height. If the Structure Height and minimum operating height are the same enter the same value in both fields.***	(nearest foot)
Requested Marking/Lighting:	None
Other :	
Recommended Marking/Lighting:	
Current Marking/Lighting:	N/A Proposed Structure
Other :	
Nearest City:	Chaffee
Nearest State:	New York
Description of Location: ***On the Project Summary page upload any certified survey.***	Adjacent to Olean Road and Hand Road, Chaffee, NY.
Description of Proposal:	Area 7/8 Landfill Development on the Waste Management - Chaffee Landfill property.

Proposed Frequency Bands

Select any combination of the applicable frequencies/powers identified in the Colo Void Clause Coalition, Antenna System Co-Location, Voluntary Best Practices, effective 21 Nov 2007, to be evaluated by the FAA with your filing. If not within one of the frequency bands listed below, manually input your proposed frequency(ies) and power using the Add Specific Frequency link.

Add Specific Frequency

Low Freq	High Freq	Freq Unit	ERP	ERP Unit

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Federal Aviation Administration

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Notice of Proposed Construction or Alteration - Off Airport

Add New Multiple Cases Off Airport - Desk Reference Guide V_2018.2.1

Add a New Case (Off Airport) for Wind Turbines - Met Towers (with WT Farm) - WT-Barge Crane - Desk Reference Guide V_2018.2.1

Project Name: WASTE-000559313-19 **Sponsor:** Waste Management - Chaffee Landfill

Details for Case : Chaffee Corner 2

Show Project Summary

Case Status

ASN:	2019-AEA-14955-OE	**Date Accepted:**	12/26/2019
Status:	Accepted	**Date Determined:**	
		Letters:	None
		Documents:	None
Public Comments:	None		Project Documents: 12/26/2019 Chaffee Area 7-8 ... 12/26/2019 OECaseDataSpreads...

Construction / Alteration Information

Notice Of:	Construction
Duration:	Permanent
if Temporary :	Months: Days:
Work Schedule - Start:	01/01/2023
Work Schedule - End:	12/31/2030

For temporary cranes-Does the permanent structure require separate notice to the FAA?
To find out, use the Notice Criteria Tool. If separate notice is required, please ensure it is filed.
If it is not filed, please state the reason in the Description of Proposal.

State Filing:	Not filed with State

Structure Summary

Structure Type:	Landfill
Structure Name:	Chaffee Corner 2
FDC NOTAM:	
NOTAM Number:	
FCC Number:	
Prior ASN:	

Structure Details

Latitude:	42° 34' 58.30'' N
Longitude:	78° 29' 57.60'' W
Horizontal Datum:	NAD83
Site Elevation (SE):	1490 (nearest foot) PASSED
Structure Height (AGL):	148 (nearest foot)
Current Height (AGL): **** For notice of alteration or existing provide the current AGL height of the existing structure. Include details in the Description of Proposal***	(nearest foot)
Minimum Operating Height (AGL): **** For aeronautical study of a crane or construction equipment the maximum height should be listed above as the Structure Height (AGL). Additionally, provide the minimum operating height to avoid delays if impacts are identified that require negotiation to a reduced height. If the Structure Height and minimum operating height are the same enter the same value in both fields.***	(nearest foot)
Requested Marking/Lighting:	None
Other :	
Recommended Marking/Lighting:	
Current Marking/Lighting:	N/A Proposed Structure
Other :	
Nearest City:	Chaffee
Nearest State:	New York
Description of Location: ***On the Project Summary page upload any certified survey.***	Adjacent to Olean Road and Hand Road, Chaffee, NY.
Description of Proposal:	Area 7/8 Landfill Development on the Waste Management - Chaffee Landfill property.

Proposed Frequency Bands

Select any combination of the applicable frequencies/powers identified in the Colo Void Clause Coalition, Antenna System Co-Location, Voluntary Best Practices, effective 21 Nov 2007, to be evaluated by the FAA with your filing. If not within one of the frequency bands listed below, manually input your proposed frequency(ies) and power using the Add Specific Frequency link.

Add Specific Frequency

Low Freq	High Freq	Freq Unit	ERP	ERP Unit

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Notice of Proposed Construction or Alteration - Off Airport

Add New Multiple Cases Off Airport - Desk Reference Guide V_2018.2.1

Add a New Case (Off Airport) for Wind Turbines - Met Towers (with WT Farm) - WT-Barge Crane - Desk Reference Guide V_2018.2.1

Project Name: WASTE-000559313-19 **Sponsor:** Waste Management - Chaffee Landfill

Details for Case : Chaffee Corner 3

Show Project Summary

Case Status

ASN:	2019-AEA-14956-OE	**Date Accepted:**	12/26/2019
Status:	Accepted	**Date Determined:**	
		Letters:	None
		Documents:	None
Public Comments:	None		Project Documents: 12/26/2019 Chaffee Area 7-8 ... 12/26/2019 OECaseDataSpreads...

Construction / Alteration Information

Notice Of:	Construction
Duration:	Permanent
if Temporary :	Months: Days:
Work Schedule - Start:	01/01/2023
Work Schedule - End:	12/31/2030

For temporary cranes-Does the permanent structure require separate notice to the FAA?
To find out, use the Notice Criteria Tool. If separate notice is required, please ensure it is filed.
If it is not filed, please state the reason in the Description of Proposal.

State Filing:	Not filed with State

Structure Summary

Structure Type:	Landfill
Structure Name:	Chaffee Corner 3
FDC NOTAM:	
NOTAM Number:	
FCC Number:	
Prior ASN:	

Structure Details

Latitude:	42° 34' 37.70'' N
Longitude:	78° 29' 52.80'' W
Horizontal Datum:	NAD83
Site Elevation (SE):	1455 (nearest foot) PASSED
Structure Height (AGL):	27 (nearest foot)
Current Height (AGL): **** For notice of alteration or existing provide the current AGL height of the existing structure. Include details in the Description of Proposal***	(nearest foot)
Minimum Operating Height (AGL): **** For aeronautical study of a crane or construction equipment the maximum height should be listed above as the Structure Height (AGL). Additionally, provide the minimum operating height to avoid delays if impacts are identified that require negotiation to a reduced height. If the Structure Height and minimum operating height are the same enter the same value in both fields.***	(nearest foot)
Requested Marking/Lighting:	None
Other :	
Recommended Marking/Lighting:	
Current Marking/Lighting:	N/A Proposed Structure
Other :	
Nearest City:	Chaffee
Nearest State:	New York
Description of Location: ***On the Project Summary page upload any certified survey.***	Adjacent to Olean Road and Hand Road, Chaffee, NY.
Description of Proposal:	Area 7/8 Landfill Development on the Waste Management - Chaffee Landfill property.

Proposed Frequency Bands

Select any combination of the applicable frequencies/powers identified in the Colo Void Clause Coalition, Antenna System Co-Location, Voluntary Best Practices, effective 21 Nov 2007, to be evaluated by the FAA with your filing. If not within one of the frequency bands listed below, manually input your proposed frequency(ies) and power using the Add Specific Frequency link.

Add Specific Frequency

Low Freq	High Freq	Freq Unit	ERP	ERP Unit

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Federal Aviation Administration

« OE/AAA

Notice of Proposed Construction or Alteration - Off Airport

Add New Multiple Cases Off Airport - Desk Reference Guide V_2018.2.1

Add a New Case (Off Airport) for Wind Turbines - Met Towers (with WT Farm) - WT-Barge Crane - Desk Reference Guide V_2018.2.1

Project Name: WASTE-000559313-19 **Sponsor:** Waste Management - Chaffee Landfill

Details for Case : Chaffee Corner 4

Show Project Summary

Case Status

ASN:	2019-AEA-14957-OE	**Date Accepted:**	12/26/2019
Status:	Accepted	**Date Determined:**	
		Letters:	None
		Documents:	None
Public Comments:	None		Project Documents: 12/26/2019 Chaffee Area 7-8 ... 12/26/2019 OECaseDataSpreads...

Construction / Alteration Information

Notice Of:	Construction
Duration:	Permanent
if Temporary :	Months: Days:
Work Schedule - Start:	01/01/2023
Work Schedule - End:	12/31/2030

For temporary cranes-Does the permanent structure require separate notice to the FAA?
To find out, use the Notice Criteria Tool. If separate notice is required, please ensure it is filed.
If it is not filed, please state the reason in the Description of Proposal.

State Filing:	Not filed with State

Structure Summary

Structure Type:	Landfill
Structure Name:	Chaffee Corner 4
FDC NOTAM:	
NOTAM Number:	
FCC Number:	
Prior ASN:	

Structure Details

Latitude:	42° 34' 37.50'' N
Longitude:	78° 30' 7.00'' W
Horizontal Datum:	NAD83
Site Elevation (SE):	1450 (nearest foot) PASSED
Structure Height (AGL):	32 (nearest foot)
Current Height (AGL): **** For notice of alteration or existing provide the current AGL height of the existing structure. Include details in the Description of Proposal***	(nearest foot)
Minimum Operating Height (AGL): **** For aeronautical study of a crane or construction equipment the maximum height should be listed above as the Structure Height (AGL). Additionally, provide the minimum operating height to avoid delays if impacts are identified that require negotiation to a reduced height. If the Structure Height and minimum operating height are the same enter the same value in both fields.***	(nearest foot)
Requested Marking/Lighting:	None
Other :	
Recommended Marking/Lighting:	
Current Marking/Lighting:	N/A Proposed Structure
Other :	
Nearest City:	Chaffee
Nearest State:	New York
Description of Location: ***On the Project Summary page upload any certified survey.***	Adjacent to Olean Road and Hand Road, Chaffee, NY.
Description of Proposal:	Area 7/8 Landfill Development on the Waste Management - Chaffee Landfill property.

Proposed Frequency Bands

Select any combination of the applicable frequencies/powers identified in the Colo Void Clause Coalition, Antenna System Co-Location, Voluntary Best Practices, effective 21 Nov 2007, to be evaluated by the FAA with your filing. If not within one of the frequency bands listed below, manually input your proposed frequency(ies) and power using the Add Specific Frequency link.

Add Specific Frequency

Low Freq	High Freq	Freq Unit	ERP	ERP Unit

Previous Back to Search Result Next

Federal Aviation Administration

« OE/AAA

Notice of Proposed Construction or Alteration - Off Airport

Add New Multiple Cases Off Airport - Desk Reference Guide V_2018.2.1

Add a New Case (Off Airport) for Wind Turbines - Met Towers (with WT Farm) - WT-Barge Crane - Desk Reference Guide V_2018.2.1

Project Name: WASTE-000559313-19 **Sponsor:** Waste Management - Chaffee Landfill

Details for Case : Chaffee Maximum Height

Show Project Summary

Case Status

ASN:	2019-AEA-14953-OE	**Date Accepted:**	12/26/2019
Status:	Accepted	**Date Determined:**	
		Letters:	None
		Documents:	None
Public Comments:	None		Project Documents: 12/26/2019 Chaffee Area 7-8 ... 12/26/2019 OECaseDataSpreads...

Construction / Alteration Information

Notice Of:	Construction
Duration:	Permanent
if Temporary :	Months: Days:
Work Schedule - Start:	01/01/2023
Work Schedule - End:	12/31/2030

For temporary cranes-Does the permanent structure require separate notice to the FAA?
To find out, use the Notice Criteria Tool. If separate notice is required, please ensure it is filed.
If it is not filed, please state the reason in the Description of Proposal.

State Filing:	Not filed with State

Structure Summary

Structure Type:	Landfill
Structure Name:	Chaffee Maximum Height
FDC NOTAM:	
NOTAM Number:	
FCC Number:	
Prior ASN:	

Structure Details

Latitude:	42° 34' 57.00'' N
Longitude:	78° 30' 13.20'' W
Horizontal Datum:	NAD83
Site Elevation (SE):	1490 (nearest foot) PASSED
Structure Height (AGL):	198 (nearest foot)
Current Height (AGL): **** For notice of alteration or existing provide the current AGL height of the existing structure. Include details in the Description of Proposal***	(nearest foot)
Minimum Operating Height (AGL): **** For aeronautical study of a crane or construction equipment the maximum height should be listed above as the Structure Height (AGL). Additionally, provide the minimum operating height to avoid delays if impacts are identified that require negotiation to a reduced height. If the Structure Height and minimum operating height are the same enter the same value in both fields.***	(nearest foot)
Requested Marking/Lighting:	None
Other :	
Recommended Marking/Lighting:	
Current Marking/Lighting:	N/A Proposed Structure
Other :	
Nearest City:	Chaffee
Nearest State:	New York
Description of Location: ***On the Project Summary page upload any certified survey.***	Adjacent to Olean Road and Hand Road, Chaffee, NY.
Description of Proposal:	Area 7/8 Landfill Development on the Waste Management - Chaffee Landfill property.

Proposed Frequency Bands

Select any combination of the applicable frequencies/powers identified in the Colo Void Clause Coalition, Antenna System Co-Location, Voluntary Best Practices, effective 21 Nov 2007, to be evaluated by the FAA with your filing. If not within one of the frequency bands listed below, manually input your proposed frequency(ies) and power using the Add Specific Frequency link.

Add Specific Frequency

Low Freq	High Freq	Freq Unit	ERP	ERP Unit

Previous Back to Search Result Next

FAA Determination Documents

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2019-AEA-14954-OE

Issued Date: 01/15/2020

Jonathan Rizzo
Waste Management - Chaffee Landfill
10860 Olean Road
Chaffee, NY 14030

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Landfill Chaffee Corner 1
Location:	Chaffee, NY
Latitude:	42-34-57.80N NAD 83
Longitude:	78-30-18.60W
Heights:	1490 feet site elevation (SE)
	148 feet above ground level (AGL)
	1638 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure does not exceed obstruction standards and would not be a hazard to air navigation provided the following condition(s), if any, is(are) met:

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be e-filed any time the project is abandoned or:

__X__ At least 10 days prior to start of construction (7460-2, Part 1)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part 2)

FAA Advisory Circular 150/5200-33B, Hazardous Wildlife Attractants on or Near Airports, identifies this land use as a hazardous wildlife attractant, and provides procedures and conditions to ensure compatibility with safe airport operations. You must contact The NY Airports District Office at ((718) 553-3345) before beginning any construction at the site to verify that no potential to attract hazardous wildlife on or near public-use airports exists.

Based on this evaluation, marking and lighting are not necessary for aviation safety. However, if marking/ lighting are accomplished on a voluntary basis, we recommend it be installed in accordance with FAA Advisory circular 70/7460-1 L Change 2.

This determination expires on 07/15/2021 unless:

(a) the construction is started (not necessarily completed) and FAA Form 7460-2, Notice of Actual Construction or Alteration, is received by this office.

(b) extended, revised, or terminated by the issuing office.

(c) the construction is subject to the licensing authority of the Federal Communications Commission (FCC) and an application for a construction permit has been filed, as required by the FCC, within 6 months of the date of this determination. In such case, the determination expires on the date prescribed by the FCC for completion of construction, or the date the FCC denies the application.

NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE E-FILED AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE. AFTER RE-EVALUATION OF CURRENT OPERATIONS IN THE AREA OF THE STRUCTURE TO DETERMINE THAT NO SIGNIFICANT AERONAUTICAL CHANGES HAVE OCCURRED, YOUR DETERMINATION MAY BE ELIGIBLE FOR ONE EXTENSION OF THE EFFECTIVE PERIOD.

This determination is based, in part, on the foregoing description which includes specific coordinates, heights, frequency(ies) and power. Any changes in coordinates, heights, and frequencies or use of greater power, except those frequencies specified in the Colo Void Clause Coalition; Antenna System Co-Location; Voluntary Best Practices, effective 21 Nov 2007, will void this determination. Any future construction or alteration, including increase to heights, power, or the addition of other transmitters, requires separate notice to the FAA.This determination includes all previously filed frequencies and power for this structure.

If construction or alteration is dismantled or destroyed, you must submit notice to the FAA within 5 days after the construction or alteration is dismantled or destroyed.

This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

If we can be of further assistance, please contact our office at (404) 305-6531, or darin.clipper@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2019-AEA-14954-OE.

Signature Control No: 426127367-427924173 (DNE)
Darin Clipper
Specialist

Attachment(s)
Case Description
Map(s)

Area 7/8 Landfill Development on the Waste Management - Chaffee Landfill property.

Verified Map for ASN 2019-AEA-14954-OE

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2019-AEA-14955-OE

Issued Date: 01/15/2020

Jonathan Rizzo
Waste Management - Chaffee Landfill
10860 Olean Road
Chaffee, NY 14030

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Landfill Chaffee Corner 2
Location:	Chaffee, NY
Latitude:	42-34-58.30N NAD 83
Longitude:	78-29-57.60W
Heights:	1490 feet site elevation (SE)
	148 feet above ground level (AGL)
	1638 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure does not exceed obstruction standards and would not be a hazard to air navigation provided the following condition(s), if any, is(are) met:

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be e-filed any time the project is abandoned or:

__X__ At least 10 days prior to start of construction (7460-2, Part 1)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part 2)

FAA Advisory Circular 150/5200-33B, Hazardous Wildlife Attractants on or Near Airports, identifies this land use as a hazardous wildlife attractant, and provides procedures and conditions to ensure compatibility with safe airport operations. You must contact The NY Airports District Office at ((718) 553-3345) before beginning any construction at the site to verify that no potential to attract hazardous wildlife on or near public-use airports exists.

Based on this evaluation, marking and lighting are not necessary for aviation safety. However, if marking/ lighting are accomplished on a voluntary basis, we recommend it be installed in accordance with FAA Advisory circular 70/7460-1 L Change 2.

This determination expires on 07/15/2021 unless:

(a) the construction is started (not necessarily completed) and FAA Form 7460-2, Notice of Actual Construction or Alteration, is received by this office.

(b) extended, revised, or terminated by the issuing office.

(c) the construction is subject to the licensing authority of the Federal Communications Commission (FCC) and an application for a construction permit has been filed, as required by the FCC, within 6 months of the date of this determination. In such case, the determination expires on the date prescribed by the FCC for completion of construction, or the date the FCC denies the application.

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This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

If we can be of further assistance, please contact our office at (404) 305-6531, or darin.clipper@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2019-AEA-14955-OE.

Signature Control No: 426127368-427924172 (DNE)
Darin Clipper
Specialist

Attachment(s)
Case Description
Map(s)

Area 7/8 Landfill Development on the Waste Management - Chaffee Landfill property.

Verified Map for ASN 2019-AEA-14955-OE

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2019-AEA-14956-OE

Issued Date: 01/15/2020

Jonathan Rizzo
Waste Management - Chaffee Landfill
10860 Olean Road
Chaffee, NY 14030

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Landfill Chaffee Corner 3
Location:	Chaffee, NY
Latitude:	42-34-37.70N NAD 83
Longitude:	78-29-52.80W
Heights:	1455 feet site elevation (SE) 27 feet above ground level (AGL) 1482 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure does not exceed obstruction standards and would not be a hazard to air navigation provided the following condition(s), if any, is(are) met:

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be e-filed any time the project is abandoned or:

__X__ At least 10 days prior to start of construction (7460-2, Part 1)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part 2)

FAA Advisory Circular 150/5200-33B, Hazardous Wildlife Attractants on or Near Airports, identifies this land use as a hazardous wildlife attractant, and provides procedures and conditions to ensure compatibility with safe airport operations. You must contact The NY Airports District Office at ((718) 553-3345) before beginning any construction at the site to verify that no potential to attract hazardous wildlife on or near public-use airports exists.

Based on this evaluation, marking and lighting are not necessary for aviation safety. However, if marking/ lighting are accomplished on a voluntary basis, we recommend it be installed in accordance with FAA Advisory circular 70/7460-1 L Change 2.

This determination expires on 07/15/2021 unless:

(a) the construction is started (not necessarily completed) and FAA Form 7460-2, Notice of Actual Construction or Alteration, is received by this office.

(b) extended, revised, or terminated by the issuing office.

(c) the construction is subject to the licensing authority of the Federal Communications Commission (FCC) and an application for a construction permit has been filed, as required by the FCC, within 6 months of the date of this determination. In such case, the determination expires on the date prescribed by the FCC for completion of construction, or the date the FCC denies the application.

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This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

If we can be of further assistance, please contact our office at (404) 305-6531, or darin.clipper@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2019-AEA-14956-OE.

Signature Control No: 426127369-427924174 (DNE)
Darin Clipper
Specialist

Attachment(s)
Case Description
Map(s)

Area 7/8 Landfill Development on the Waste Management - Chaffee Landfill property.

Verified Map for ASN 2019-AEA-14956-OE

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2019-AEA-14957-OE

Issued Date: 01/15/2020

Jonathan Rizzo
Waste Management - Chaffee Landfill
10860 Olean Road
Chaffee, NY 14030

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Landfill Chaffee Corner 4
Location:	Chaffee, NY
Latitude:	42-34-37.50N NAD 83
Longitude:	78-30-07.00W
Heights:	1450 feet site elevation (SE)
	32 feet above ground level (AGL)
	1482 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure does not exceed obstruction standards and would not be a hazard to air navigation provided the following condition(s), if any, is(are) met:

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be e-filed any time the project is abandoned or:

__X__ At least 10 days prior to start of construction (7460-2, Part 1)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part 2)

FAA Advisory Circular 150/5200-33B, Hazardous Wildlife Attractants on or Near Airports, identifies this land use as a hazardous wildlife attractant, and provides procedures and conditions to ensure compatibility with safe airport operations. You must contact The NY Airports District Office at ((718) 553-3345) before beginning any construction at the site to verify that no potential to attract hazardous wildlife on or near public-use airports exists.

Based on this evaluation, marking and lighting are not necessary for aviation safety. However, if marking/ lighting are accomplished on a voluntary basis, we recommend it be installed in accordance with FAA Advisory circular 70/7460-1 L Change 2.

This determination expires on 07/15/2021 unless:

(a) the construction is started (not necessarily completed) and FAA Form 7460-2, Notice of Actual Construction or Alteration, is received by this office.

(b) extended, revised, or terminated by the issuing office.

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This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

If we can be of further assistance, please contact our office at (404) 305-6531, or darin.clipper@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2019-AEA-14957-OE.

Signature Control No: 426127370-427924170 (DNE)
Darin Clipper
Specialist

Attachment(s)
Case Description
Map(s)

Area 7/8 Landfill Development on the Waste Management - Chaffee Landfill property.

Verified Map for ASN 2019-AEA-14957-OE

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2019-AEA-14953-OE

Issued Date: 01/15/2020

Jonathan Rizzo
Waste Management - Chaffee Landfill
10860 Olean Road
Chaffee, NY 14030

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Landfill Chaffee Maximum Height
Location:	Chaffee, NY
Latitude:	42-34-57.00N NAD 83
Longitude:	78-30-13.20W
Heights:	1490 feet site elevation (SE)
	198 feet above ground level (AGL)
	1688 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure does not exceed obstruction standards and would not be a hazard to air navigation provided the following condition(s), if any, is(are) met:

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be e-filed any time the project is abandoned or:

__X__ At least 10 days prior to start of construction (7460-2, Part 1)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part 2)

FAA Advisory Circular 150/5200-33B, Hazardous Wildlife Attractants on or Near Airports, identifies this land use as a hazardous wildlife attractant, and provides procedures and conditions to ensure compatibility with safe airport operations. You must contact The NY Airports District Office at ((718) 553-3345) before beginning any construction at the site to verify that no potential to attract hazardous wildlife on or near public-use airports exists.

Based on this evaluation, marking and lighting are not necessary for aviation safety. However, if marking/ lighting are accomplished on a voluntary basis, we recommend it be installed in accordance with FAA Advisory circular 70/7460-1 L Change 2.

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(a) the construction is started (not necessarily completed) and FAA Form 7460-2, Notice of Actual Construction or Alteration, is received by this office.

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If we can be of further assistance, please contact our office at (404) 305-6531, or darin.clipper@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2019-AEA-14953-OE.

Signature Control No: 426127366-427924171 (DNE)
Darin Clipper
Specialist

Attachment(s)
Case Description
Map(s)

Area 7/8 Landfill Development on the Waste Management - Chaffee Landfill property.

Verified Map for ASN 2019-AEA-14953-OE

FAA Email Correspondence Regarding Wildlife

Holmes, Rob

From: Felix, Guillermo (FAA) <guillermo.felix@faa.gov>
Sent: Wednesday, January 22, 2020 3:08 PM
To: Holmes, Rob
Subject: RE: Chaffee Landfill Project - Aeronautical Study No 2019-AEA-14953-OE

The proposed landfill is in conformance with FAA Advisory Circular referenced in the letter of determination. I have No objection

Guillermo

From: Holmes, Rob <Rob.Holmes@tetratech.com>
Sent: Wednesday, January 22, 2020 12:03 PM
To: Felix, Guillermo (FAA) <guillermo.felix@faa.gov>
Cc: Rohr, Logan <Logan.Rohr@tetratech.com>
Subject: Chaffee Landfill Project - Aeronautical Study No 2019-AEA-14953-OE

Guillermo,

Thanks for taking the time today to discuss the obstruction analysis determination we received for our proposed project.

Our proposed project is an expansion to an existing landfill, located in Chaffee NY. The obstruction analyses requests were submitted to define the high point of the proposed site and the corners (because it is a large site). However, all of the determination letters we received indicate that the land use is a potential hazardous wildlife attractant and that we need to contact your office prior to construction to confirm that no potential to attract hazardous wildlife exists. The site is an existing landfill and we are approximately 4.5 miles from the closest public airport (Arcade Tri-County Airport D23)

Please advise upon your review. Based on the fact that the site is an existing landfill we were hoping to obtain a more detailed determination from your office that the proposed project does not pose a hazard – but if needed work with your office or the airport to identify appropriate mitigation.

Thanks.

Rob Holmes | Client Manager
Direct **+1 (585) 450-4007** Cell **+1 (585) 831-7862** | rob.holmes@tetratech.com

Tetra Tech | Complex World, Clear Solutions™
3136 South Winton Road, Suite 303 | Rochester, NY 14623 | cornerstoneeg.com | tetratech.com

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APPENDIX B

APPENDIX B

DESIGN CALCULATIONS

LIST OF DESIGN CALCULATIONS

B.1 - Geocushion Calculations

B.2 - Cell Drainage Calculations

B.3 - Global Stability Analysis

B.4 - Baseliner Stability Analysis

B.5 - Final Cover Stability Calculation

B.6 - Seismic Analysis

B.7 - Settlement Analysis

B.8 - Bearing Capacity Calculation

B.9 - South Borrow Area Sediment Basin Design

B.10 - Leachate Generation Analysis

B.11 - HELP Model Analysis

B.12 - Stormwater Calculations

B.13 - Leachate Collection Pipe Flow Calculations

B.14 - Leachate Pipe Loading Calculations

B.1 - Geocushion Calculations

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	13-Jul-20	190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Chaffee Area 7/8 Development	Geomembrane Cushioning Calculation	
PREPARED BY	**CHECKED BY**	
L.Rohr	R. Holmes	

Description and Purpose:

To assess the proposed cushioning material versus the proposed stone to be used in the primary and secondary drainage layers. More specifically, the primary leachate drainage layer will be against the primary liner and will be cushioned with a 12oz fabric and the secondary drainage layer will be cushioned against the primary and secondary liners with GCL and drainage composite, respectively.

Design Basis/References/Assumptions:

Ref #1 - Designing with Geosynthetics, Robert Koerner, 4th Edition

Ref #2 - GRI White Paper #14 - Modification to the GRI Method for the RFcr Factor Used in the Design of Geotextiles for Puncture Protection of Geomembranes

We have estimated a total proposed loading of approximately 12,000 psf - from 185 feet of waste with a unit weight of 65 pcf.

For the secondary drainage layer cushioning, an 8-oz geotextile is conservatively analyzed as the cushioning material.
This is a conservative assumption since both the GCL and drainage composite provide greater protection than an 8-oz geotextile.

Remarks/Conclusions/Results:

The cushion analysis concludes that the Factors of Safety for the anticipated combinations of soils and liners that are proposed for the Area 7-8 Development are greater than 3. Using the anticipated drainage layer material (#2 stone, rounded 1.5 inch clean stone), the factor of safety for puncture for the 12-oz geotextile against the primary liner is 4.32. The factor of safety for puncture for the 8-oz geotextile (conservative representation of GCL or GDC) against the secondary liner is 3.29. The proposed Area 7-8 Development baseliner system provides adequate cushioning with calculated factors of safety against puncture above the recommended level of 3.0.

Client Name:	Waste Management - Chaffee			Project Name:	Area 7/8 Development
Subject:	Cushion Design			Project #:	190260
Designed by:	LDR	Date:	7/13/2020		
Checked by:	RAH	Date:	7/13/2020		

Purpose: To determine the impoundment size needed

shaded cells represent values to be input
shaded cells represent values to be calculated

Methodology: Modification to the "GRI-Method" for the RF CR-Factor Used in the Design of Geotextiles for Puncture Protection of Geomembranes

$$p_{allow} = \left(50 + 0.00045\ \frac{M}{H^2}\right)\left(\frac{1}{MF_s\ x\ MF_{PD}\ \ x\ MF_A}\right)\left(\frac{1}{RF_{CBD}\ \ x\ RF_{CR}}\right)$$

P_{allow}	allowable pressure (kPa)
M	geotextile mass per unit area (g)
H	protrusion height (m)
MF_S	modification factor for protrusion shape
MF_{PD}	modification factor for packing density
MF_A	modification factor for arching in soils
RF_{CBD}	reduction factor for long-term chemical/biological degradation
RF_{CR}	reduction factor for long-term creep

Primary Leachate Drainage Layer - #2 Stone versus 12 oz geotextile

Calculations:

			Notes:
M	12	oz/yd2	Geotextile Cushion
H	1.50	inch	Maximum anticipated size of #2 Stone
MF_S	0.25		Rounded #2 Stone
MF_{PD}	0.67		Dense - 25mm
MF_A	0.25		Deep Geostatic - not liquid
RF_{CBD}	1.3		Moderate Leachate
RF_{CR}	1.3		Mass per unit area 592 g/m2

M	407	g/m2
H	0.038	m
P_{allow}	2489	kPa
P_{allow}	51992	psf

Density	65	pcf	waste density
$Depth_{all}$	799.9	ft	allowable waste depth
$Depth_{act}$	185	ft	actual waste depth
FS	4.32		FS based on allowable and actual waste depth

Secondary Leachate Drainage Layer - #2 Stone versus GCL / GDC

Calculations:

			Notes:
M	8	oz/yd2	Geotextile Cushion
H	1.50	inch	Maximum anticipated size of #2 Stone
MF_S	0.25		Rounded #2 Stone
MF_{PD}	0.67		Dense - 25 mm
MF_A	0.25		Deep Geostatic - not liquid
RF_{CBD}	1.3		Moderate Leachate
RF_{CR}	1.3		Mass per unit area 592 g/m2

M	271	g/m2
H	0.038	m
P_{allow}	1895	kPa
P_{allow}	39581	psf

Density	65	pcf	waste density
$Depth_{all}$	608.9	ft	allowable waste depth
$Depth_{act}$	185	ft	actual waste depth
FS	3.29		FS based on allowable and actual waste depth

B.2 - Cell Drainage Calculations

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee Landfill	17-Jul-20	190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	GDC Calculations	
PREPARED BY	**CHECKED BY**	
L.Rohr	R.Holmes	

Description and Purpose:

Purpose was to evaluate the requirements of the materials to be used in the LCRS on the Chaffee Landfill Cell 7/8 liner system. These requirements are as follows:

' The sideslope GDC for the secondary LCRS must have a transmissivity that keeps the maximum head build-up in the GDC less than the thickness of the GDC.

' The baseliner (floor) secondary LCRS (sand / GDC blanket) must have a minimum sand permeability of 0.1 cm/s and only allow a maximum head build-up of 1-inch.

' The sideslope drainage material in the primary LCRS must have a minimum permeability of 0.1 cm/s and result in a maximum head build-up of 1-foot.

' The baseliner (floor) drainage material in the primary LCRS must have a minimum permeability of 1.0 cm/s and result in a maximum head build-up of 1-foot.

' The proposed secondary LCRS must allow for a design capacity of 1,000 gallons per acre per day (gpad) with a maximum leak detention time of 24-hours.

Design Basis/References/Assumptions:

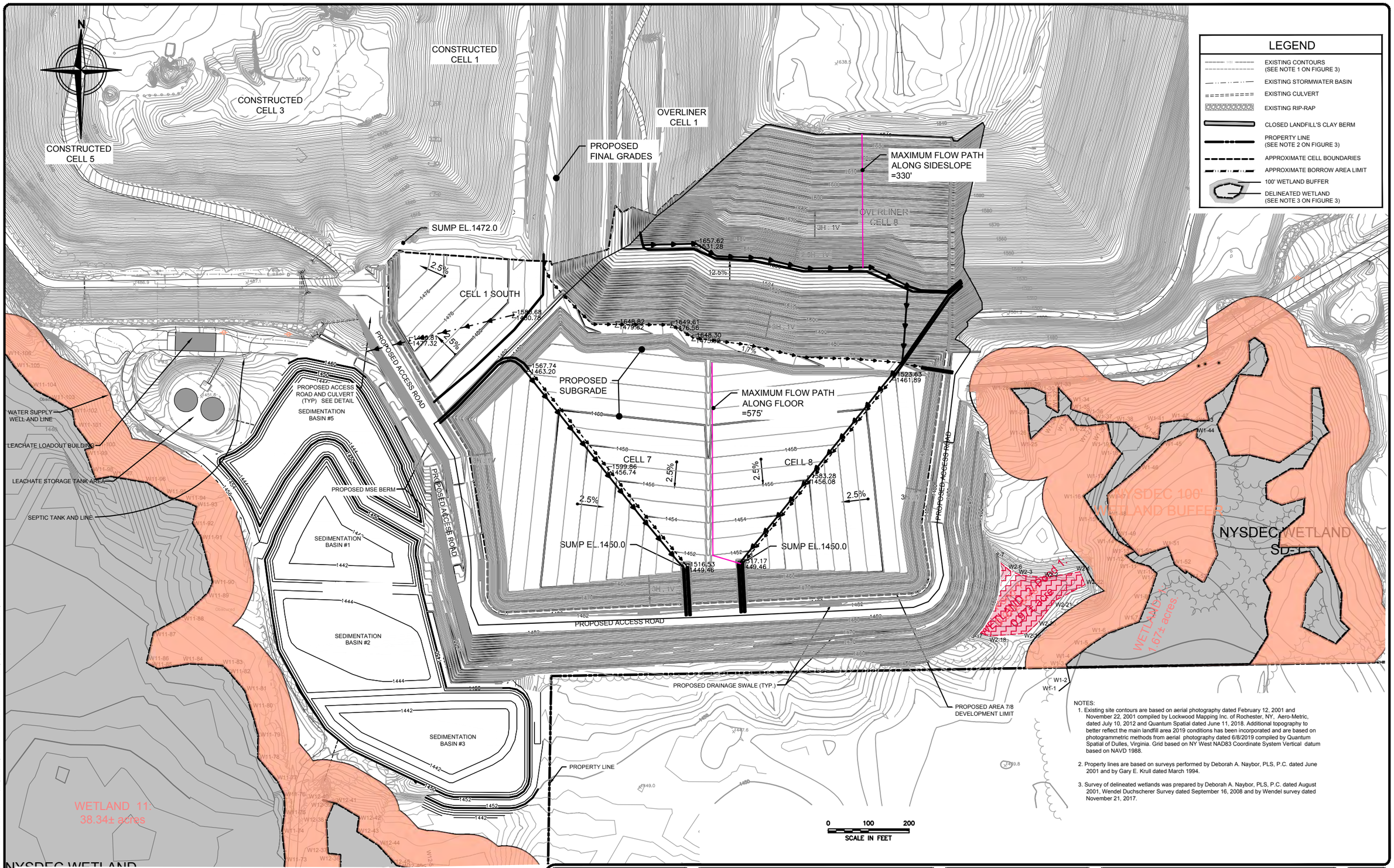
The Primary LCRS is designed based on the maximum historical leachate generation rate (See Leachate Generation Calcs). This maximum leachate condition is 1885 gpad is doubled to 3770 gpad in this analysis for conservatism. The Secondary LCRS is designed for the regulatory design capacity of 1000 gpad.

Design References:

1. "Hydraulic Design of Liquid Drainage Layers", Giroud, Zornberg, and Zhao (2000), Geosynthetics International - Special Issue on Liquid Collection Systems, Vol. 7, Nos. 4-6, 2000.
2. "Liquid flow equations for drainage systems composed of two layers including a geocomposite". Giroud, Zhou, Tomlinson, Zornberg (2004). Geosynthetics International, 2004. Vol. 11. No. 1.
3. "The design of geonets in landfill leak-detection systems" Designer's Forum. Pages 130 - 132 (Pages Attached)
4. Max flow length on floor = 575' and = 330' on slope (See Figure 1)

Remarks/Conclusions/Results:

- The specified GDC exhibiting a minimum transmissivity of 5.2×10^{-5} m^2/s will meet the design functions for the Chaffee Landfill Cell 7/8 sideslope GDC.
- The specified GDC exhibiting a minimum transmissivity of 1.4×10^{-3} m^2/s will meet the design functions for the Chaffee Landfill Cell 7/8 floor GDC.
- A minimum permeability of 0.1 cm/s will meet the design functions for the Chaffee Landfill Cell 7/8 baseliner secondary LCRS drainage material.
- A minimum permeability of 0.1 cm/s will meet the design functions for the Chaffee Landfill Cell 7/8 sideslope primary LCRS drainage material.
- A minimum permeability of 1.0 cm/s will meet the design functions for the Chaffee Landfill Cell 7/8 baseliner primary LCRS drainage material.



NOTES:

1. Existing site contours are based on aerial photography dated February 12, 2001 and November 22, 2001 compiled by Lockwood Mapping Inc. of Rochester, NY. Aero-Metric, dated July 10, 2012 and Quantum Spatial dated June 11, 2018. Additional topography to better reflect the main landfill area 2019 conditions has been incorporated and are based on photogrammetric methods from aerial photography dated 6/8/2019 compiled by Quantum Spatial of Dulles, Virginia. Grid based on NY West NAD83 Coordinate System Vertical datum based on NAVD 1988.
2. Property lines are based on surveys performed by Deborah A. Naybor, PLS, P.C. dated June 2001 and by Gary E. Krull dated March 1994.
3. Survey of delineated wetlands was prepared by Deborah A. Naybor, PLS, P.C. dated August 2001, Wendel Duchscherer Survey dated September 16, 2008 and by Wendel survey dated November 21, 2017.

SUBGRADE DEVELOPMENT PLAN
SCALE: 1"=100' (1/8)

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CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

GDC CALCULATION FIGURE

SHEET NO. 1
PROJECT NO. 190260

File: X:\PROJECTS\SW-CHAFFEE\190260 - SOUTHERN EXPANSION TITLE_Project Drawings\190260-SC-20 MAX GRADE PLAN CHAFFEE.dwg Layout: SHEET 8 User: logan.rohr Jul 17, 2020 - 11:31am

ATTACHMENT A
SECONDARY LCRS - SIDESLOPE GDC FLOW EVALUATION

Performed by: LDR
Purpose: Determine the required transmissivity for sideslope GDC
Conditions: The maximum flow path along Chaffee Landfill Cell 7/8 sideslope occurs along the southern berm.
The flow path along the 3:1 berm is approximately 127 feet long.

Reduction Factors	
Creep [4]	1.386
Chemical Clogging	1.2
Biological Clogging	3
Factor Safety - GDC	3

Slope (i) = 0.33
β (degrees) = 18.2629
sinβ = 0.3134
tanβ = 0.33
$\tan^2\beta$ = 0.1089
cosβ = 0.9496

q_h - liquid impingement rate (1,000 gallons per acre per day)
L - horizontal projection of length of drainage layer in direction of flow
k - hydraulic conductivity of drainage composite
$\theta_{required}$ [3] - required hydraulic transmissivity of lower layer with reduction factors considered
t_1 - thickness of GDC
λ - parameter defined by Equation 17 from Note (6)
t_{max} - maximum head above liner

Notes:
(1) Minimum GDC transmissivity is determined based on the requirement to keep the maxiumum head build-up in the GDC less than the thickness of the GDC.
(2) Minimum required sideslope GDC transmissivity highlighted in yellow.
(3) $\theta_{requd} = \theta_{SF\text{-}LTIS} \times RF_{IN} \times RF_{CR} \times RF_{CC} \times RF_{BC} \times FS$
(4) Creep Reduction Factor of 1.386 appropriate for biplanar GDC
(5) Actual product transmisivity shall be determined using site specific loading conditions
(6) Equations taken from "Hydraulic Design of Liquid Drainage Layers", Giroud, Zornberg, and Zhao (2000), *Geosynthetics International* - Special Issue on Liquid Collection Systems, Vol. 7, Nos. 4-6, 2000.

Equation 1:
$$\theta_{measured-req} = FS \prod (RF) \frac{q_h L}{\sin \beta}$$
$$\prod RF = RF_{CR} \times RF_{BC} \times RF_{CC}$$

Equation 2:
$$k = \frac{\theta}{t_{LCL}}$$

Equation 9:
$$\lambda = \frac{q_h}{k \tan^2 \beta}$$

Equation 17:
$$t_{max} = \frac{\sqrt{1+4\lambda}-1}{2\cos\beta / \tan\beta} L$$

q_h (in/yr)	q_h (m/s)	L [2] (ft)	L [2] (m)	θreqd [3] (m^2/s)	$\theta_{SF\text{-}LTIS}$ (m^2/s)	t_1 (mil)	t_1 (mm)	k (m/s)	λ -	t_{max} (m)	t_{max} (mm)
FULL FLOW PATH											
13.4	1.08E-08	330	100.32	5.2E-05	3.5E-06	220	5.59	6.2E-04	1.6E-04	0.0056	5.59
13.4	1.08E-08	330	100.32	5.2E-05	3.5E-06	270	6.86	5.0E-04	2.0E-04	0.0069	6.86
13.4	1.08E-08	330	100.32	5.2E-05	3.5E-06	330	8.38	4.1E-04	2.4E-04	0.0084	8.38

Conclusion: **A GDC exhibiting a minimum transmissivity of 5.2 x 10^{-5} m^2/s will meet design function for the Chaffee Landfill Cell 7/8 sideslope secondary GDC.**

ATTACHMENT B
SECONDARY LCRS - BASELINER SAND/GDC BLANKET (CONTINUOUS) FLOW EVALUATION

Performed by: LDR
Purpose: Determine the required transmissivity for baseliner GDC
Conditions: The maximum flow path along the Chaffee Landfill Cell 7/8 floor is approximately 575 feet long.

Reduction Factors	
Creep	1.386
Chemical Clogging	1.2
Biological Clogging	3
Factor Safety - GDC	3
Factor Safety - Sand	3
Sand Clogging	3

Slope (i) =	0.02
β (degrees) =	1.1458
sinβ =	0.0200
tanβ =	0.02
$\tan^2\beta$ =	0.0004
cosβ =	0.9998

q_h - liquid impingement rate (1,000 gallons per acre per day)
L - horizontal projection of length of drainage layer in direction of flow
k_2 - hydraulic conductivity of drainage material used in upper layer
$k_{2,LTIS}$ - long-term in soil hydraulic conductivity of drainage material used in upper layer
θ_1 - hydraulic transmissivity of lower layer
$\theta_{required}$ [3] - required hydraulic transmissivity of lower layer with reduction factors considered
t_1 - thickness of lower layer
λ_2 - parameter defined by Equation 17 from Note (5)
j_2 - paramter defined by Equation 26 from Note (5)
h_{max} - maximum head above liner
$h_{prescribed}$ - site specific design treshold
$h_{sand\ max}$ - maximum head if just the sand layer were modeled for secondary drainage system

Notes:

(1) Minimum GDC transmissivity is determined based on the required sand permeability of 0.1cm/s, the required maximum head of 1 inch, and the maximum flow length of 575 feet.
(2) Minimum required baseliner GDC transmissivity highlighted in yellow.
(3) $\theta_{requd} = \theta_1 \times RF_{IN} \times RF_{CR} \times RF_{CC} \times RF_{BC} \times FS$
(4) Actual product transmisivity shall be determined using site specific loading conditions
(5) Equations taken from "Liquid flow equations for drainage systems composed of two layers including a geocomposite". Giroud, Zhou, Tomlinson, Zornberg (2004). *Geosynthetics International* , 2004. Vol. 11. No. 1.

Equation 17: $$\lambda_2 = \frac{q_h}{k_2 \tan^2 \beta}$$

Equation 26: $$j_2 = 1 - 0.12 \exp\left\{-\left[\log(8\lambda_2/5)^{5/8}\right]^2\right\}$$

Equation 39: $$h_{max} = t_1 \cos\beta + j_2 \frac{\left(\sqrt{1+4\lambda_2}-1\right)\tan\beta}{2}\left(L - \frac{\theta_1 \sin\beta}{q_h}\right)$$

											GDC only evaluation Eq. 19	GDC only evaluation Eq. 18		Sand only Eq. 21			Eq. 17	Eq. 26	Eq. 39	
q_h		L [2]		k_{test}	$k_{2,LTIS}$	$k_{required}$	$k_{required}$	θreqd [3]	$\theta_{SF\text{-}LTIS}$	t_1	t_1	L_u	L_u	$L_u > L$	h_{GDCmax}	$h_{sand\ max}$	λ_2	j_2	h_{max}	h_{max} [1]
(in/yr)	(m/s)	(ft)	(m)	(cm/s)	(cm/s)	cm/s	(m/s)	(m^2/s)	(m^2/s)	(mil)	(mm)	(m)	(ft)	(Y/N)	(m)	(ft)	-	-	(m)	(in)
FULL FLOW PATH																				
13.4	1.08E-08	575	174.68	0.10	0.033	0.011	1.11E-04	1.4E-03	9.1E-05	220	5.59	169.2	554.8	N	#N/A	2.783	0.2428	0.8876	0.0254	1.00
13.4	1.08E-08	575	174.68	0.10	0.033	0.011	1.11E-04	1.4E-03	9.1E-05	270	6.86	169.5	556.0	N	#N/A	2.783	0.2428	0.8876	0.0254	1.00
13.4	1.08E-08	575	174.68	0.10	0.033	0.011	1.11E-04	1.4E-03	9.2E-05	330	8.38	169.9	557.4	N	#N/A	2.783	0.2428	0.8876	0.0254	1.00

Conclusion: **A GDC exhibiting a transmissivity of 1.4 x 10^{-3} m^2/s will meet the design function for the Chaffee Landfill Cell 7/8 baseliner secondary GDC. The secondary baseliner liner sand must have a minimum permeability of 0.1cm/s as required by the regulations.**

ATTACHMENT C

PRIMARY LCRS - SIDESLOPE DRAINAGE MATERIAL CALCULATIONS

CALCULATIONS
PERFORMED BY: LDR
PURPOSE: Evaluation for maximum distance/head relationships for sand drainage layer (L) on baseliner sideslopes

Reduction Factors	
RF BC	1
RFCC	1
FS	3

Slope (i) = 0.33
β (degrees) = 18.2629
sinβ = 0.3134
tanβ = 0.33
cosβ = 0.94962865

Notes:
1) Evaluation for maximum distance/head relationships for primary sand drainage layer (L)
(2) Equations taken from "Hydraulic Design of Liquid Drainage Layers", Giroud, Zornberg, and Zhao (2000), *Geosynthetics International - Special Issue on Liquid Collection Systems* , Vol. 7, Nos. 4-6, 2000.

qh = Design leachate impingement rate.
L - horizontal projection of length of drainage layer in direction of flow
k - hydraulic conductivity of drainage material
k_{LTIS} - long-term in soil hydraulic conductivity of drainage material
t - thickness of layer
λ - parameter defined by Equation 9 from Note (2)
j - parameter defined by Equation 39 from Note (2)
h_{max} - maximum head above liner
$h_{prescribed}$ - site specific design treshold

Equation 9: $\lambda = \frac{q_h}{k \tan^2 \beta}$

Equation 39: $$j = 1 - 0.12 \exp\left[- \left[\log\left(\frac{8(\lambda)}{5} \right)^{\frac{5}{8}} \right]^2 \right]$$

Equation 41: $$t_{max} = j \frac{\sqrt{1+4\lambda} - 1}{2\cos\beta / \tan\beta} L$$

ATTACHMENT C (cont)

PRIMARY LCRS - SIDESLOPE DRAINAGE MATERIAL CALCULATIONS

Permeability vs. Flow Path - Primary Sideslope

										Eq. 9	Eq. 39	Eq. 41	
	q_h		L		k_{test}	$k_{2,LTIS}$	$k_{required}$	$k_{required}$		λ	j	$t_{sand\ max}$	
	(in/yr)	(m/s)	(ft)	(m)	(cm/s)	(cm/s)	cm/s	(m/s)		-	-	(m)	(ft)
Critical Case:	50.7	4.08E-08	330.00	100.61	0.50	0.50	0.167	1.67E-03		0.0002	0.9988	0.008	0.03
qh = 3770	50.7	4.08E-08	330.00	100.61	0.40	0.40	0.133	1.33E-03		0.0003	0.9985	0.010	0.03
RF = 1	50.7	4.08E-08	330.00	100.61	0.30	0.30	0.100	1.00E-03		0.0004	0.9979	0.013	0.04
FS = 3	50.7	4.08E-08	330.00	100.61	0.20	0.20	0.067	6.67E-04		0.0006	0.9968	0.020	0.06
	50.7	4.08E-08	330.00	100.61	0.15	0.15	0.050	5.00E-04		0.0007	0.9957	0.026	0.09
	50.7	**4.08E-08**	**330.00**	**100.61**	**0.10**	**0.10**	**0.033**	**3.33E-04**		**0.0011**	**0.9937**	**0.039**	**0.13**

Cells in yellow indicate acceptable permeability for specific condition.

Critical Case: Based on 3770 gpad impingement rate (which includes FS = 2) during early operations. Permeability FS=3, RF = 1 assumed primary LCRS drainage material functions w/o biological or chemical clogging during early operations.

Conclusion: The minimum permeability of 0.1 cm/s listed in the regulations results in a maximum head buildup less than 1 foot.

ATTACHMENT D
PRIMARY LCRS - BASELINER PERMEABILITY CALCULATIONS

CALCULATIONS
PERFORMED BY: LDR
PURPOSE: Evaluation for maximum distance/head relationships for drainage layer (L) on baseliner

Reduction Factors	
RF BC	1
RFCC	1
FS	3
Slope (i) =	0.02
β (degrees) =	1.1458
sinβ =	0.0200
tanβ =	0.02
cosβ =	0.9998001

L - horizontal projection of length of drainage layer in direction of flow
k_2 - hydraulic conductivity of drainage material used in upper layer
$k_{2,LTIS}$ - long-term in soil hydraulic conductivity of drainage material used in upper layer
θ_1 - hydraulic transmissivity of lower layer
$\theta_{required}$ [(2)] - required hydraulic transmissivity of lower layer with reduction factors considered
t_1 - thickness of lower layer
h_{max} - maximum head above liner

Permeability vs. Flow Path - Primary Floor

	Max Flow Path	
Limiting Permeability - test	575	ft

Notes:
(1) Evaluation for maximum distance/head relationships for sand drainage layer (L)

(2) Equations taken from "Hydraulic Design of Liquid Drainage Layers", Giroud, Zornberg, and Zhao (2000), *Geosynthetics International - Special Issue on Liquid Collection Systems, Vol. 7, Nos. 4-6, 2000.*

Equation 9:
$$\lambda = \frac{q_h}{k \tan^2 \beta}$$

Equation 39:
$$j = 1 - 0.12 \exp\left[-\left[\log\left(\frac{8(\lambda)}{5} \right)^{\frac{5}{8}} \right]^2 \right]$$

Equation 41:
$$t_{max} = j \frac{\sqrt{1+4\lambda}-1}{2\cos\beta/\tan\beta} L$$

ATTACHMENT D (cont)
PRIMARY LCRS - BASELINER PERMEABILITY CALCULATIONS

TABLE 1 - SUMMARY OF REQUIRED PERMEABILITY VS. FLOW PATH, PRIMARY LCRS COLLECTION STONE

									Eq. 9	Eq. 39		
	q_h		L		k_{test}	$k_{2,LTIS}$	$k_{required}$	$k_{required}$	λ	j	$t_{sand\ max}$	
	(in/yr)	(m/s)	(ft)	(m)	(cm/s)	(cm/s)	cm/s	(m/s)	-	-	(m)	(ft)
Condition 1:	50.7	4.08E-08	575	175.30	50.00	50.00	16.667	1.67E-01	0.0006	0.9965	0.002	0.01
qh = 3770 gpad	50.7	4.08E-08	575	175.30	40.00	40.00	13.333	1.33E-01	0.0008	0.9956	0.003	0.01
RF = 1	50.7	4.08E-08	575	175.30	30.00	30.00	10.000	1.00E-01	0.0010	0.9942	0.004	0.01
FS = 3	50.7	4.08E-08	575	175.30	25.00	25.00	8.333	8.33E-02	0.0012	0.9932	0.004	0.01
	50.7	4.08E-08	575	175.30	20.00	20.00	6.667	6.67E-02	0.0015	0.9916	0.005	0.02
	50.7	4.08E-08	575	175.30	15.00	15.00	5.000	5.00E-02	0.0020	0.9893	0.007	0.02
	50.7	4.08E-08	575	175.30	10.00	10.00	3.333	3.33E-02	0.0031	0.9851	0.011	0.03
	50.7	4.08E-08	575	175.30	8.00	8.00	2.667	2.67E-02	0.0038	0.9823	0.013	0.04
	50.7	4.08E-08	575	175.30	6.00	6.00	2.000	2.00E-02	0.0051	0.9781	0.017	0.06
	50.7	4.08E-08	575	175.30	4.00	4.00	1.333	1.33E-02	0.0077	0.9712	0.026	0.08
	50.7	4.08E-08	575	175.30	3.50	3.50	1.167	1.17E-02	0.0087	0.9687	0.029	0.10
	50.7	4.08E-08	575	175.30	3.00	3.00	1.000	1.00E-02	0.0102	0.9655	0.034	0.11
	50.7	4.08E-08	575	175.30	2.00	2.00	0.667	6.67E-03	0.0153	0.9565	0.051	0.17
	50.7	**4.08E-08**	**575**	**175.30**	**1.00**	**1.00**	**0.333**	**3.33E-03**	**0.0306**	**0.9386**	**0.098**	**0.32**

Cells in yellow indicate acceptable permeability for specific condition.

Critical Case: Based on 3770 gpad impingement rate (which includes FS = 2) during early operations. Pemeability FS = 3, RF = 1 assumed primary LCRS drainage material functions w/o biological or chemical clogging during earl

Conclusion: The minimum permeability of 1.0 cm/s listed in the regulations results in a maximum head buildup less than 1 foot.

Attachment E
Chaffee Landfill Cell 7/8 Secondary LCRS 24-hour detection time

Evaluate the detection time of a leak within the secondary LCRS

* Equations taken from: "The design of geonets in landfill leak-detection systems" Designer's Forum. Pages 130 - 132 (Pages Attached)

L = Flow Length =	574.62	ft	=	175.1	m
i. = gradient =	0.025				
t = GDC thickness =	5.59	mm	=	0.00559	m
n = GDC porosity =	0.55				
θ_{req} = GDC transmissivity =	1.4E-03	m^2/s			

**GDC transmissivity from Attachment C*

Reduction Factors		
Creep	1.386	
Chemical Clogging	1.2	
Biologic Clogging	3	

θ_{LTIS} = Long-Term GDC transmissivity = 2.8E-04 m^2/s

T = time = $L/(\theta_{LTIS}*i/t*n)$ 76765.818 seconds = 21.3 hours

Conclusion: A GDC exhibiting a transmissivity of 1.4 x 10^{-3} m^2/s for the Chaffee Landfill Cell 7/8 baseliner secondary GDC results in a maxiumum leak detection time of 21.3 hours.

DESIGNER'S FORUM

The design of geonets in landfill leak-detection systems

By Aigen Zhao and Gregory Richardson

OF ALL THE VARIED APPLICATIONS in which geonets serve, their use in waste-containment leak-detection systems (LDSs) probably is their most natural. These systems must provide two important functions in liner structures:

1. Allow leakage from an overlying primary liner system to be monitored (hence the term LDS)

2. Minimize the head acting on an underlying secondary liner system.

While most regulatory attention is focused on the first role, the latter actually is more important for environmental protection. This paper reviews the natural role of a geonet in LDS systems, presents the equations required for their proper design, and reviews construction and operational considerations.

LDS-design objectives

The LDS system must be designed to satisfy the following objectives:

- provide rapid detection of a major breach in the primary liner system (a maximum detection time of 24 hours commonly is required)
- limit the head acting on the secondary liner to less than the LDS thickness.

Unfortunately, regulators commonly focus on the first objective and on the leachate quantity drained by the LDS system. However, it is important to remember that the second objective will be met, regardless of flow rate, if the LDS is not saturated. This is ensured by defining an action leakage rate (ALR) that is less than the saturated flow of the LDS.

If the ALR is exceeded, then the facility must implement supplemental efforts to limit the generation of leachate in the refuse and/or increase the rate of its removal from the primary collector system. Leachate generation can be reduced by minimizing the size of the active working face and by increasing runoff from interim covers that use tarps. The removal rate can be advanced by increased or continuous operation of leachate-recovery pumps.

Leak-detection design

Geonets provide the most efficient material for rapid detection of leaks in an overlying liner system. Because of limited field capacity and high transmissivity, the geonet minimizes the time lag between leak occurrence and detection time. LDSs constructed of sand or gravel have significant liquid-storage potential that can delay leakage detection in the primary liner.

Travel time

The travel time of liquids that drain through the LDS is estimated by assuming that the system is saturated. Given this assumption, the apparent velocity of flow in the drainage net, v, can be estimated from Darcy's Law as follows:

Equation 1: $Q = kIA = (kt)Iw = \psi Iw$
$= vA = vwt$

or Equation 2: $v = \psi I/t$

where ψ is the transmissivity of the geonet, A is the cross sectional area of the net (A = w x t, where w is the width, and t is the thickness, of the geonet or geocomposite), and I is the flow gradient. The thickness of the geonet or geocomposite is determined under design load (at least twice the anticipated service load). **Figure 1** presents the

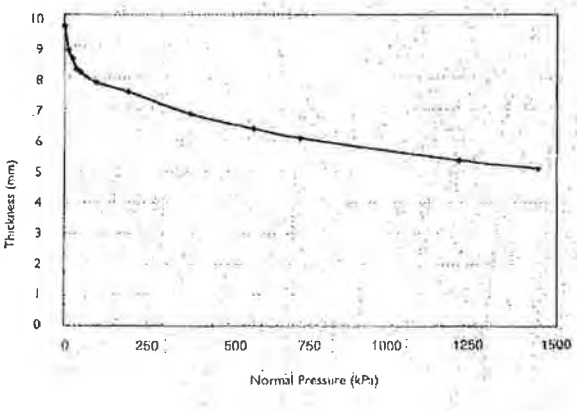

Figure 1. Geocomposite thickness under a range of normal loads.

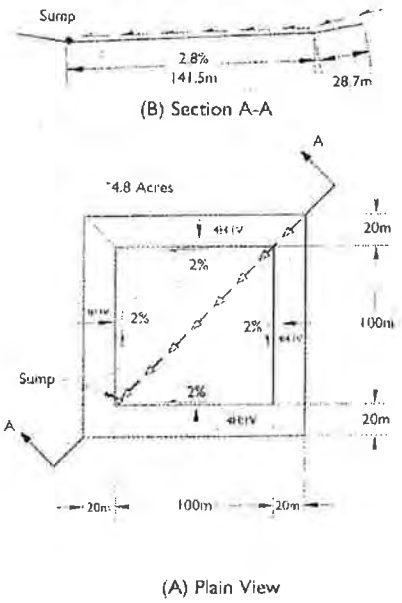

Figure 2. Common landfill-cell profile.

curve of thickness for a geocomposite under a range of normal loads.

The drainage geonet's design transmissivity must be obtained from laboratory transmissivity-test data (ASTM D 4716), which typically is provided by the manufacturer, and divided by a factor of safety (typically 10.0). For the LDS, the product of the long-term reduction factors for intrusion, compressive creep, biological and chemical clogging proposed by R.M. Koerner is 4.7–16 (1997). The recommended safety factor of 10 is equal approximately to the average value of the above range.

The transmissivity test must be performed with normal loads and boundary conditions that replicate field-service situations. For LDS testing, the lower boundary of the geonet typically is the geomembrane. The upper boundary is either another geomembrane or a filter-fabric/soil-barrier layer that forms part of a composite-primary liner system. In the case of a composite primary, the upper boundary in the transmissivity test must include both the filter geotextile and a soil layer to properly simulate intrusion into the upper boundary and the resulting loss of transmissivity.

The true velocity of flow, v_{true}, is calculated by dividing the apparent velocity by the porosity, n, of the geonet. Because of the volume of flow space occupied by the drainage-geonet ribs, v_{true} actually is greater than the apparent velocity calculated above. Here, porosity is the volume of the voids divided by the geonet's total volume. Typical porosity values for geonets range from 0.3 to 0.8.

Figure 2 (p. 20) shows a common landfill-cell geometry, or profile. The maximum travel time, T, for this system can be calculated by applying Equation 2 as follows:

Equation 3: $$T = T_1 + T_2 = L_1/v_1 + L_2/v_2$$

or Equation 4: $$T = L_1/\{\psi_1 I_1/t_1 n_1\} + L_2/\{\psi_2 I_2/t_2 n_2\}$$

where the transmissivities, ψ, are obtained from a manufacturer's chart such as **Figure 3** (p. 22); the geonet's thickness is obtained from a manufacturer's chart, such as the example in Figure 1; the geonet porosity, n, is provided by the manufacturer; and I is the flow gradient in the field. All geonet properties should be determined at normal loads that reflect field-service levels.

For the conditions on Figure 2, we can assume that the following properties reflect field-service conditions for the geonets represented on Figures 1 and 3:

- $\psi_1 = 3.2 \times 10^{-4} m^2/sec$,
- $\psi_2 = 1.8 \times 10^{-4} m^2/sec$ (FS=10),
- $n1 = n2 = 0.6$,
- $t_1 = t_2 = .006$ m at a design normal load of 750 kpa (15,000 psf).

By using these values, the travel time for the example cell is determined to be approximately 16.7 hours. This analysis is conservative, since our goal in the next design phase will be to ensure that the LDS does not become saturated.

Action leakage rate

The ALR is a fraction of the flow rate that would be generated if the LDS became saturated. For the geometry of the example used above, the saturated-flow rate can be calculated by modeling the LDS as one-fourth of a confined aquifer drained by a fully penetrating well. Therefore, the max-

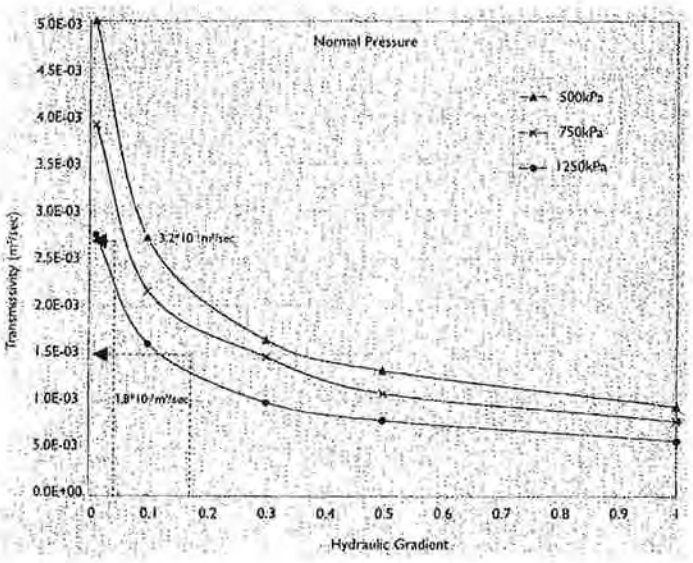

Figure 3. Manufacturer-supplied transmissivity chart

Photo 1. The geonet in the LDS of this landfill not only ensures rapid leak detection, it actually lowers the leakage rate.

imum saturated flow into the LDS sump can be estimated as follows:

Equation 5:

$$Q = 0.25 \times [2\pi\psi\Delta h/\ln(R/R_{sump})]$$

(McWhorter and Sunada 1981)

where Δh is the head loss (2.8 m), R is the radius of the drain field (100 m), and R_{sump} is the radius of the sump area (0.5 m). The 0.25 factor reflects that only one- fourth of an equivalent circular field drains to the sump. Maximum saturated flow into the LDS sump on Figure 2 then can be estimated as follows:

Equation 6:

$$Q = 0.25 \times [2\pi 3.2 \times 10^{-4} \times 2.8/\ln(100/0.5)] = 2.65 \times 10^{-4}\ m^3/sec$$

or approximately 6040 gallons per day. For the 4.8-acre cell, this amounts to 1260 gal/acre/day (gad). The actual value selected for the ALR must be less than the estimated maximum saturated flow into the LDS sump. If the value is too low, the facility will risk being forced into a heightened monitoring/operational mode or even facing closure each time the ALR is exceeded. Picking a value that is too high will increase the cost of the LDS recovery-pump system, since it must be sized to handle the ALR-flow rate. Typical ALR values range from a low of 20 gad for liner systems with a composite-primary liner to as much as 200 gad for those that include only a single primary liner.

Recent studies sponsored by the U.S. Environmental Protection Agency (EPA) show that, for systems with a composite-primary liner that includes a compacted-clay liner and a geomembrane, actual peak flows measured in LDS systems range from 0–114 gad initially and drop to 0–63 gad during cell operation (Othman et al. 1998). For systems with a composite primary liner that includes a GCL, the flows measured in LDS systems range from 0–86 gad initially to 0–15 gad during operation. These flows can include construction water draining from the LDS and pore water from the consolidating primary clay liner, in addition to leakage through the primary liner. The results indicate that most LDS systems currently installed are not saturated and effectively are limiting the head acting on the secondary liner system.

The same study clearly showed the value of a composite primary liner in lowering flow rates to the LDS. Those cells with only a geomembrane primary liner had a range of peak initial-flow rates to the LDS of 0–367 gad and operational peak-flow rates of 0–254 gad. Limited post-closure data indicates a significant drop in the long-term flow rate to the LDS after placement of the final cover. This study also demonstrates the need to actually calculate the ALR, rather than using "rules of thumb" to set it.

Head-reduction design

The LDS's most important environmental role is to limit the head acting on the secondary composite-liner system. As discussed in the previous "Designer's Forum" (August, *GFR*, pp. 21–23), the leakage through a penetration, Q (m^3/sec), in a geomembrane can be estimated with the following equations (Giroud et al. 1992):

for good contact, Equation 7:

$$Q = 0.21\, h^{0.9} a^{0.1} k^{0.74}$$

for poor contact, Equation 8:

$$Q = 1.15\, h^{0.9} a^{0.1} k^{0.74}$$

where a is the area of individual penetration (m^2) in the geomembrane component of the barrier, k is the permeability of the soil component of the barrier system (m/s), and h (m) is the head acting on the barrier. Be aware that this equation is valid only with the above SI units.

The area of penetration is limited by a comprehensive construction-quality assurance (CQA) program. In liner systems, the permeability typically is less than 1×10^{-7} cm/sec. Therefore, the designer's role is limited to ensuring that the head acting on the secondary barrier system is minimal.

For municipal solid-waste landfills, Resource Conservation and Recovery Act (RCRA) Subtitle D limits the allowable head to less than 30 cm. With standard CQA and a 1×10^{-7} cm/sec liner system, this implies typical liner leakage of approximately 0.84

gad (assuming good contact and six penetrations at 1 cm^2 each per acre). The data presented by Othman et al. indicates that many primary liners are performing below this level, which is no doubt due to poor liner/clay contact and the impact of geomembrane wrinkles (1998).

The addition of an LDS system allows the designer to limit the design head to something less than the thickness of the geonet component. For a typical geonet, this means that the maximum head acting on the geomembrane is less than its thickness of approximately 8 mm. If the field conditions originally considered in Equation 7 are applied and this value is substituted into the equation, the predicted total leakage is reduced to less than 0.03 gad.

The elimination of wrinkles in the liner system obviously is of great importance in LDS construction. A wrinkle that may be acceptable in a single composite-liner system with an allowable 30 cm head clearly is not acceptable beneath a LDS system that is trying to achieve a 6-mm maximum head. Therefore, the CQA program for LDS systems must provide decisive measures to minimize geomembrane wrinkling. Typically, such measures include limiting the amount of liner that is allowed to be installed before placement of the geonet and primary liner system. This forces the construction of the full liner-system section across the facility, as opposed to the current practice of layered construction.

Summary

Geonets provide the correct balance of low water-storage capacity and high-flow transmissivity for the design of LDS systems. Contrary to its name, the leak-detection system goes well beyond monitoring the performance of the primary liner system. The system's ability to reduce the head that acts on the secondary liner system, thereby lowering the leakage rate, should be considered its more important role. Its capacity to do so even when subjected to significant leakage from the primary liner system must be recognized.

This role is particularly important since, for political reasons, it is almost impossible to empty a waste-containment cell once it is completed. Therefore, the designer's emphasis should be on preventing future leaks and not simply on detecting them. Geonets are essential for accomplishing this goal. GFR

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Giroud, J.P., Badu-Tweneboah, K., and R. Bonaparte. 1992. Rate of Leakage Through a Composite Liner due to Geomembrane Defects. *Geotextiles and Geomembranes*. (vol. 11, no. 1, pp. 1–28).

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B.3 - Global Stability Analysis

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	10-Mar-20	190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	Global Slope Stability Analyses	
PREPARED BY	**CHECKED BY**	
L. Rohr	C. Eller	

Description and Purpose:

▪ To evaluate the Global Stability of the proposed Area 7/8 baseliner system using the SLOPE/W computer program under both static and seismic conditions.

▪ The critical cross sections analyzed (as shown on Figure 1) were selected based on our interpretation of cell construction, liner configuration, and waste placement to be representative of the range of site conditions.

Design Basis/References/Assumptions:

▪Global Stability was evaluated using a minimum factor of safety (FOS) of 1.5 under static conditions and 1.0 under seismic conditions as acceptable in accordance with the guidelines of the New York State Department of Environmental Conservation and accepted geotechnical engineering practice.
▪ The horizontal seismic coefficient used for this analysis was 0.16g (2% probability of exceedance in 50 years) and is consistent with past seismic analyses at the site. (2005 Western Expansion Engineering Report)
▪ The material properties of the waste and underlying soils are consistent with the properties used in slope stability analyses for the 2005 Western Expansion Engineering Report and are based on historical test borings and laboratory testing. The material properties are also consistent with the supplemental laboratory testing completed to support this application and summarized in the Site Investigation Report.

▪ The analyses were conducted using the Morganstern-Price analysis method. Each section was evaluated under both static and seismic conditions for block failures, as well as, circular failures. The critical failure cross section (failure surface with the lowest FOS) was selected in each case and is presented in this summary.

Remarks/Conclusions/Results:

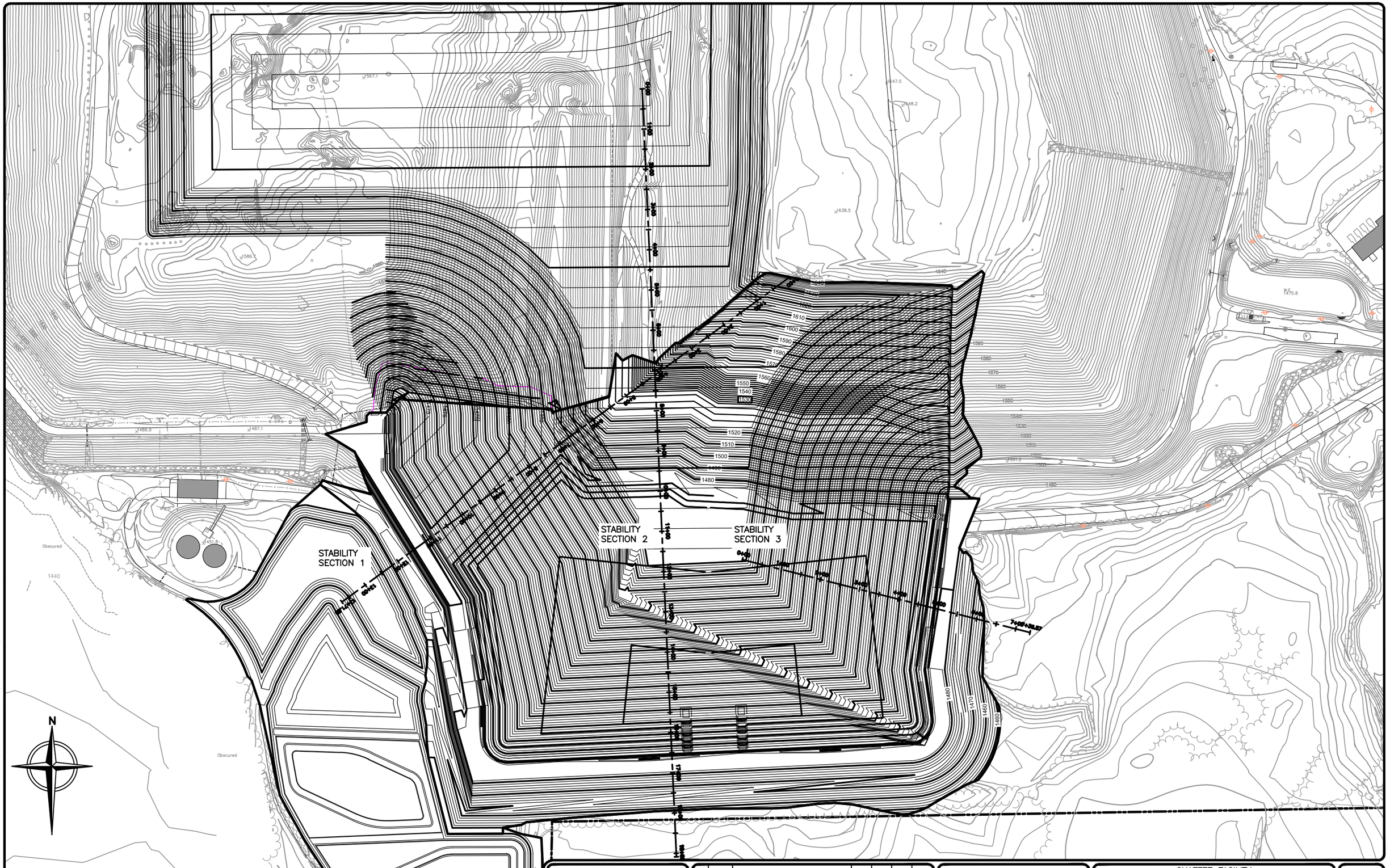
▪ The critical failure surface for each of the analyzed sections occurred as a block failures through the proposed liner system.

▪ For Section 1, the critical FOS under static conditions was 1.54. The critical FOS under seismic conditions was 0.86.
▪ Since the resulting FOS under seismic conditions was less than 1.0, a deformation analysis was performed in accordance with USEPA guidance. The computed deformation was less than 1-inch and this is acceptable under the USEPA guidance.

▪ For Section 2, the critical FOS under static conditions was 1.67. The critical FOS under seismic conditions was 1.00.

▪ For Section 3, the critical FOS under static conditions was 1.68. The critical FOS under seismic conditions was 1.00.

▪ The proposed Area 7/8 Development demonstrates acceptable slope stability in accordance with the guidelines of the NYSDEC, USEPA, and accepted geotechnical engineering practice.



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ROBERT A. HOLMES

N.Y.P.E. Lic. No. 077317 Date

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CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

STABILITY SITE PLAN

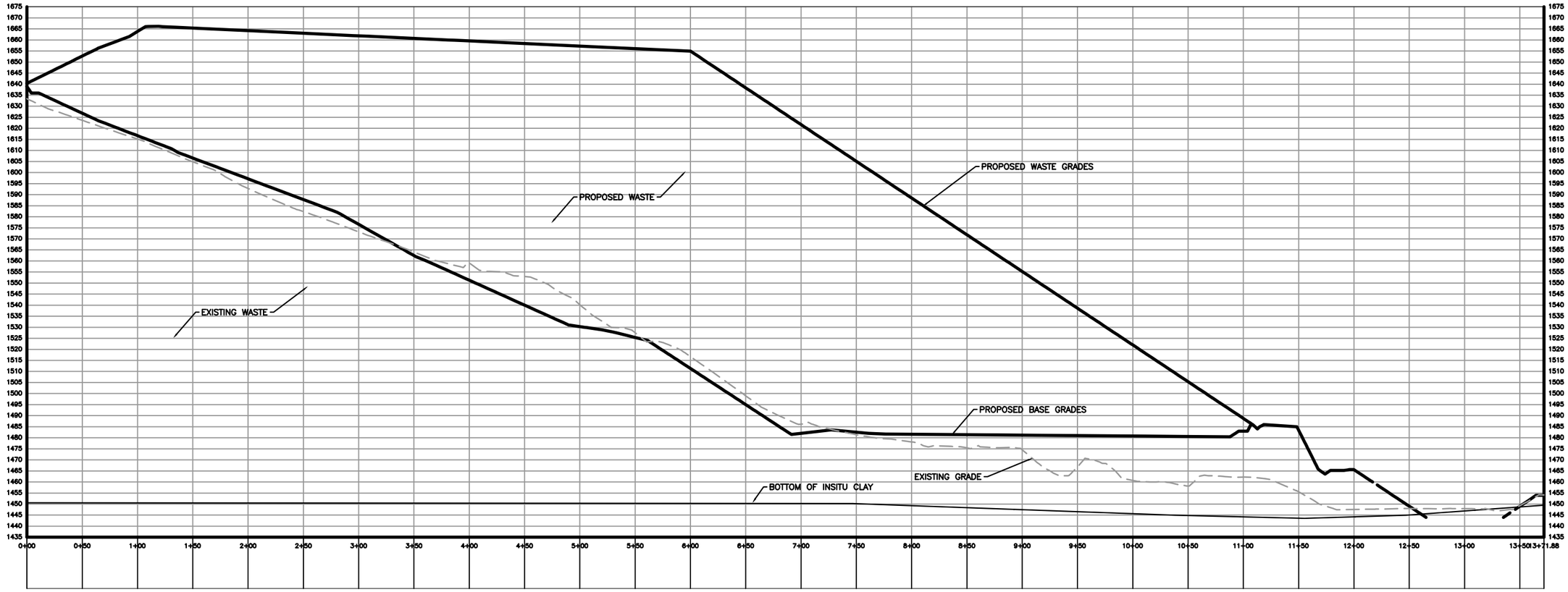
SHEET NO. 1

PROJECT NO. 190260

1" 1/2" 0" 1"

File: X:\PROJECTS\WM-CHAFFEE\190260 - SOUTHERN EXPANSION TITLE_Project Drawings\190260-LDM-STABILITY.DWG Layout: SHEET X User: logan.carr Feb 24, 2020 - 1:38pm

STABILITY SECTION 1



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N.Y.P.E. Lic. No. 077317 Date

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DATE OF ISSUE FEB 2020

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CHECKED BY

APPROVED BY

cornerstone PLLC

PREPARED BY:
CORNERSTONE ENGINEERING, GEOLOGY AND LAND SURVEYING, PLLC

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CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

STABILITY SECTION 1

SHEET NO. 2

PROJECT NO. 190260

1" 1/2" 0" 1"

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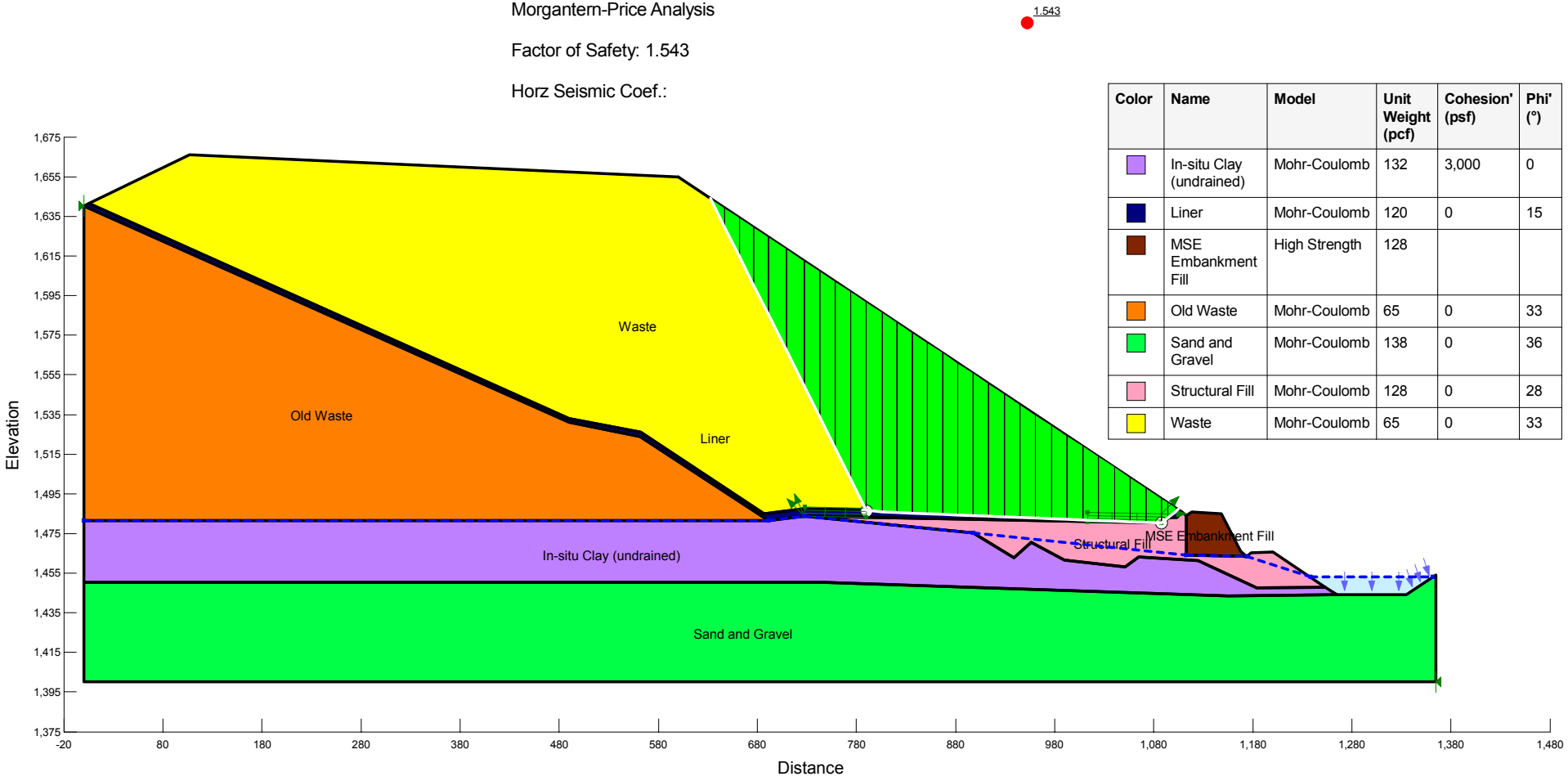
Chaffee Area 7/8 Development
Section 1 - Global Stability

Morgantern-Price Analysis

Factor of Safety: 1.543

Horz Seismic Coef.:



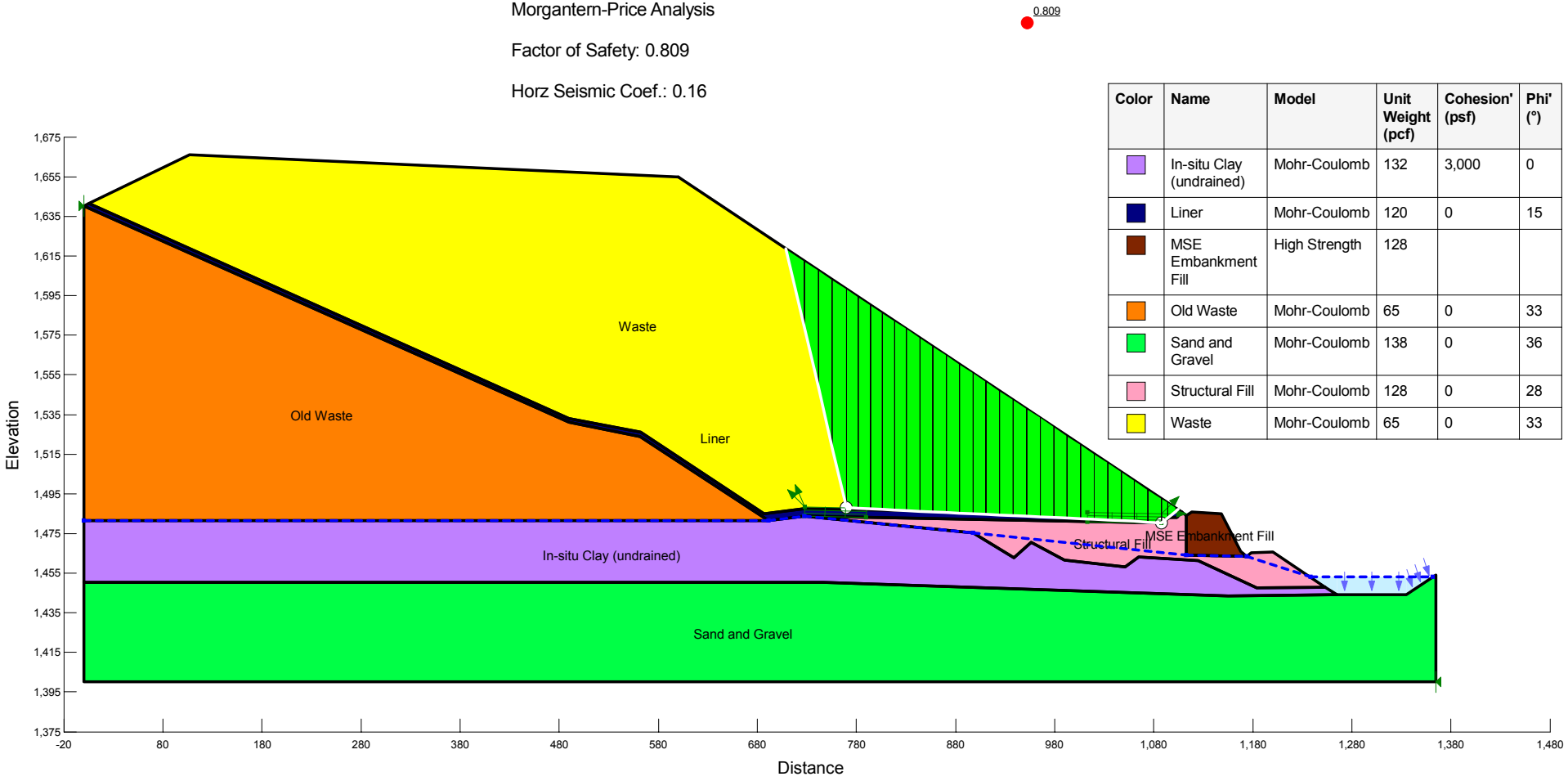
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	MSE Embankment Fill	High Strength	128		
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 1 - Global Stability

Morgantern-Price Analysis

Factor of Safety: 0.809

Horz Seismic Coef.: 0.16



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
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	Liner	Mohr-Coulomb	120	0	15
	MSE Embankment Fill	High Strength	128		
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Project:	Chaffee Section 1 Seismic Deformation
Project Number:	190260
Date:	2/24/2020
Performed:	L. Rohr
Checked BY:	C. Eller

- Check Seismic Deformation for Section 1 since computed F.S. < 1.0 under seismic conditions

- From Slope/W - Determine what Yield Acceleration (Ky) results in F.S. = 1.0 (+ or -)

Kmax = 0.16g which results in F.S. of 0.858
Ky = 0.13g which results in F.S. of 1.003

Ky/Kmax = 0.13/0.16 = 0.8125

From Fig 6.6, p.123 (Makdisi & Seed, 1978)

Where M = 6.5 and Ky/Kmax = 0.8125
Displacement = 0.2 cm = 0.1 in

Less than 1-inch of Deformation is Acceptable

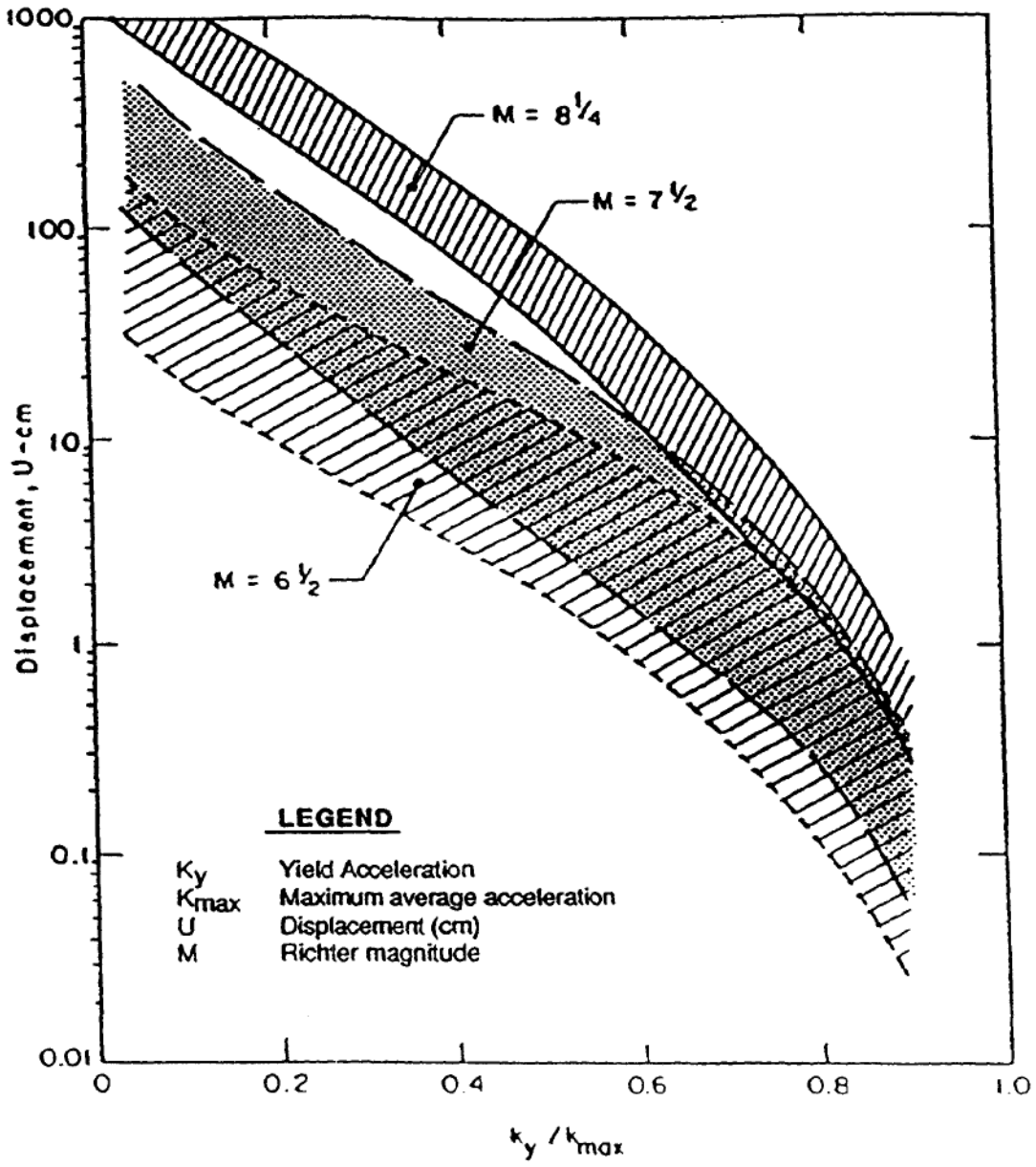


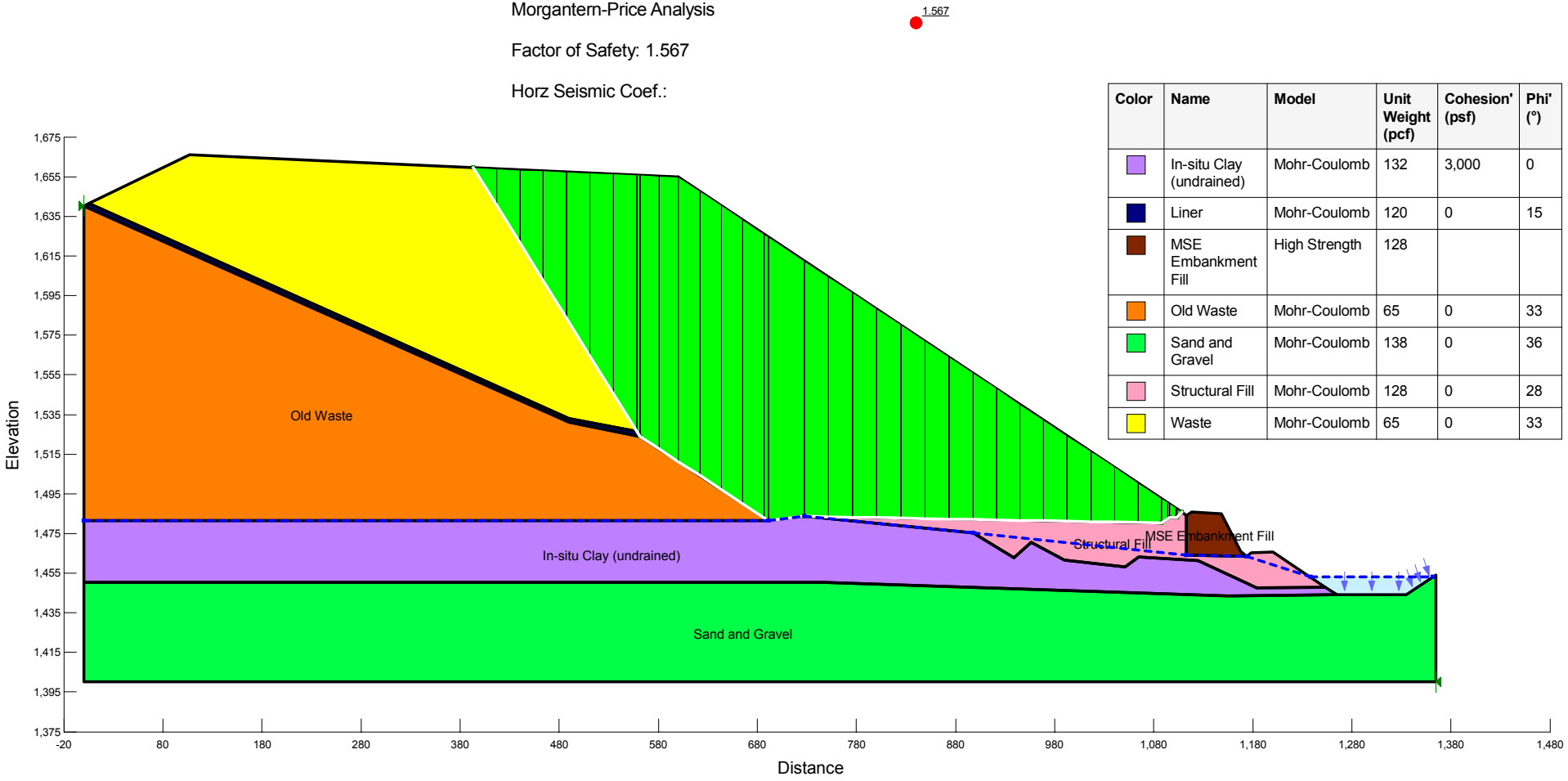
Figure 6.6 Makdisi and Seed Permanent Displacement Chart (Makdisi and Seed, 1978).

Chaffee Area 7/8 Development
Section 1 - Global Stability

Morgantern-Price Analysis

Factor of Safety: 1.567

Horz Seismic Coef.:



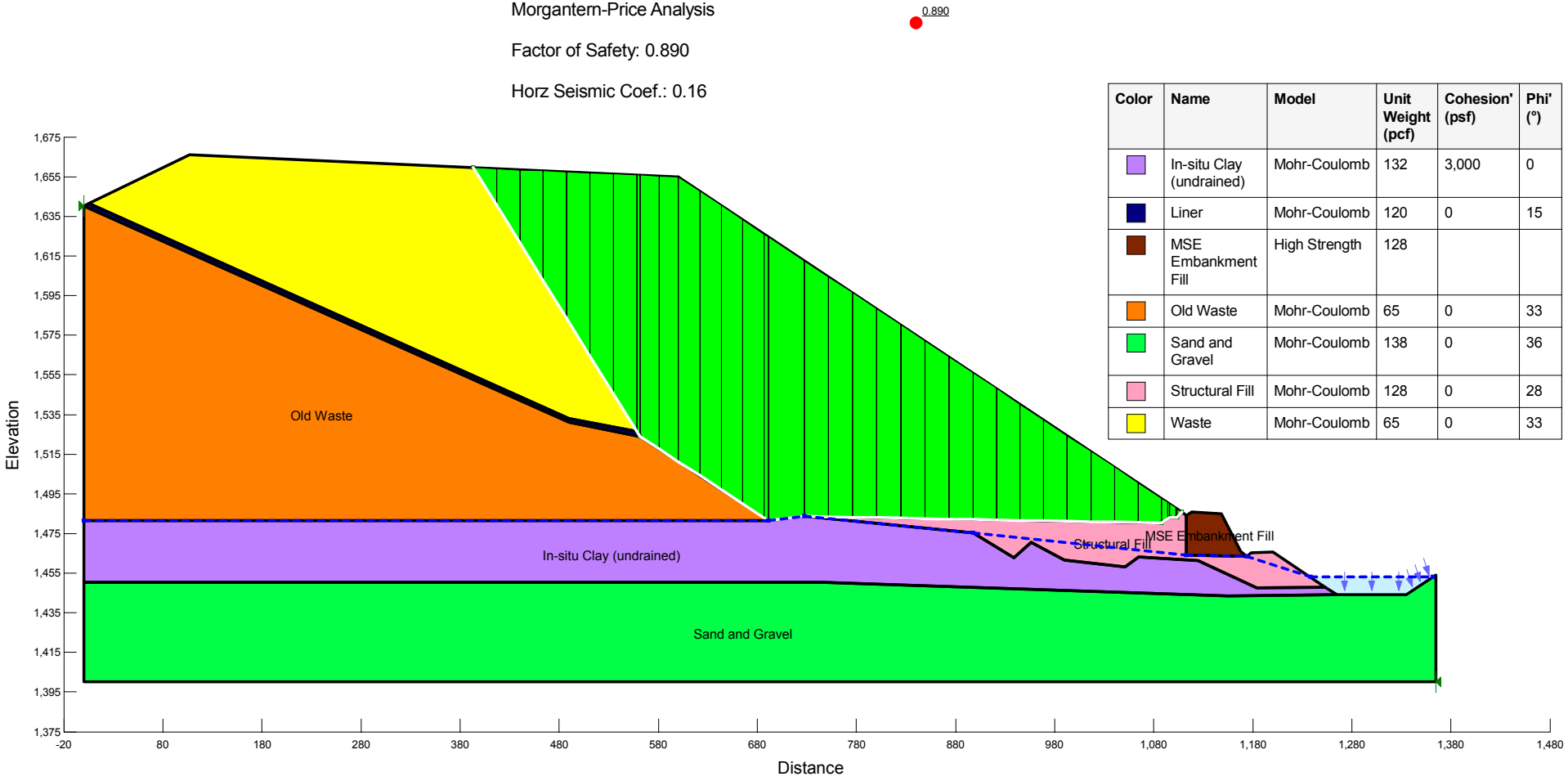
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	MSE Embankment Fill	High Strength	128		
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 1 - Global Stability

Morgantern-Price Analysis

Factor of Safety: 0.890

Horz Seismic Coef.: 0.16



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	MSE Embankment Fill	High Strength	128		
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Project:	Chaffee Section 1 Seismic Deformation
Project Number:	190260
Date:	3/10/2020
Performed:	L. Rohr
Checked BY:	C. Eller

- Check Seismic Deformation for Section 1 since computed F.S. < 1.0 under seismic conditions

- From Slope/W - Determine what Yield Acceleration (Ky) results in F.S. = 1.0 (+ or -)

Kmax = 0.16g which results in F.S. of 0.89
Ky = 0.13g which results in F.S. of 1.01

Ky/Kmax = 0.13/0.16 = 0.8125

From Fig 6.6, p.123 (Makdisi & Seed, 1978)

Where M = 6.5 and Ky/Kmax = 0.8125
Displacement = 0.2 cm = 0.1 in

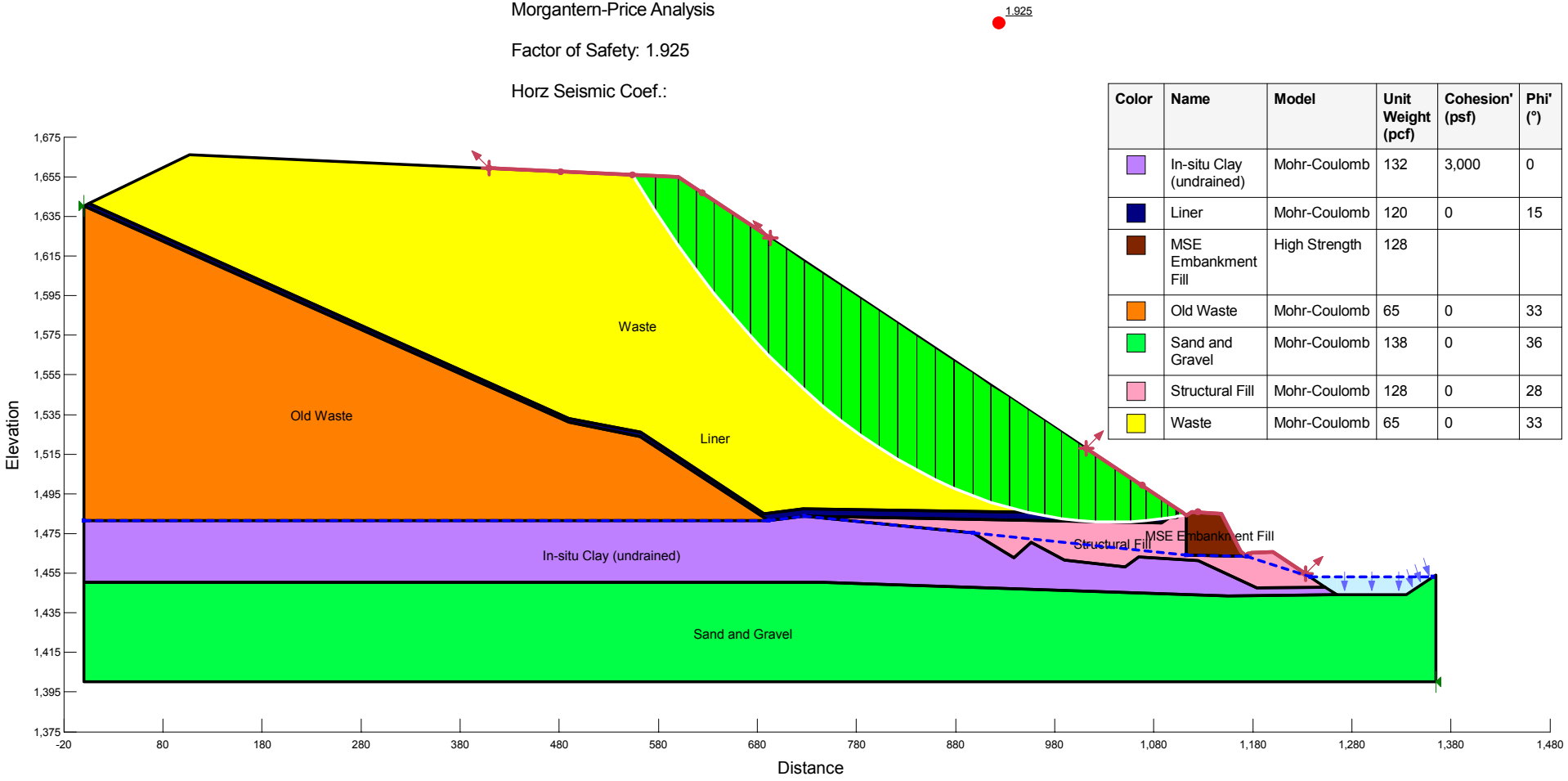
Less than 1-inch of Deformation is Acceptable

Chaffee Area 7/8 Development
Section 1 - Global Stability

Morgantern-Price Analysis

Factor of Safety: 1.925

Horz Seismic Coef.:



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
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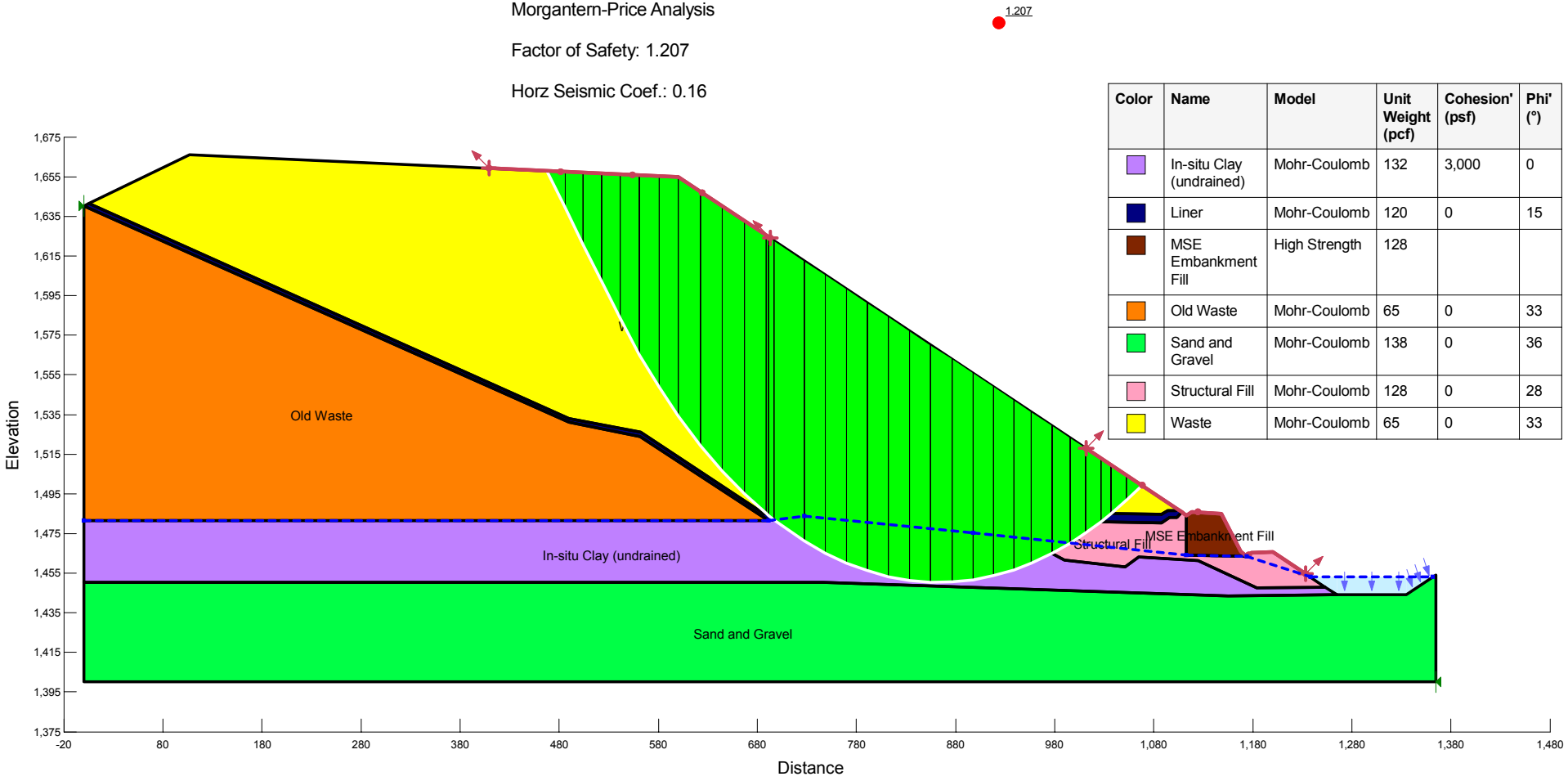
	Liner	Mohr-Coulomb	120	0	15
	MSE Embankment Fill	High Strength	128		
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 1 - Global Stability

Morgantern-Price Analysis

Factor of Safety: 1.207

Horz Seismic Coef.: 0.16



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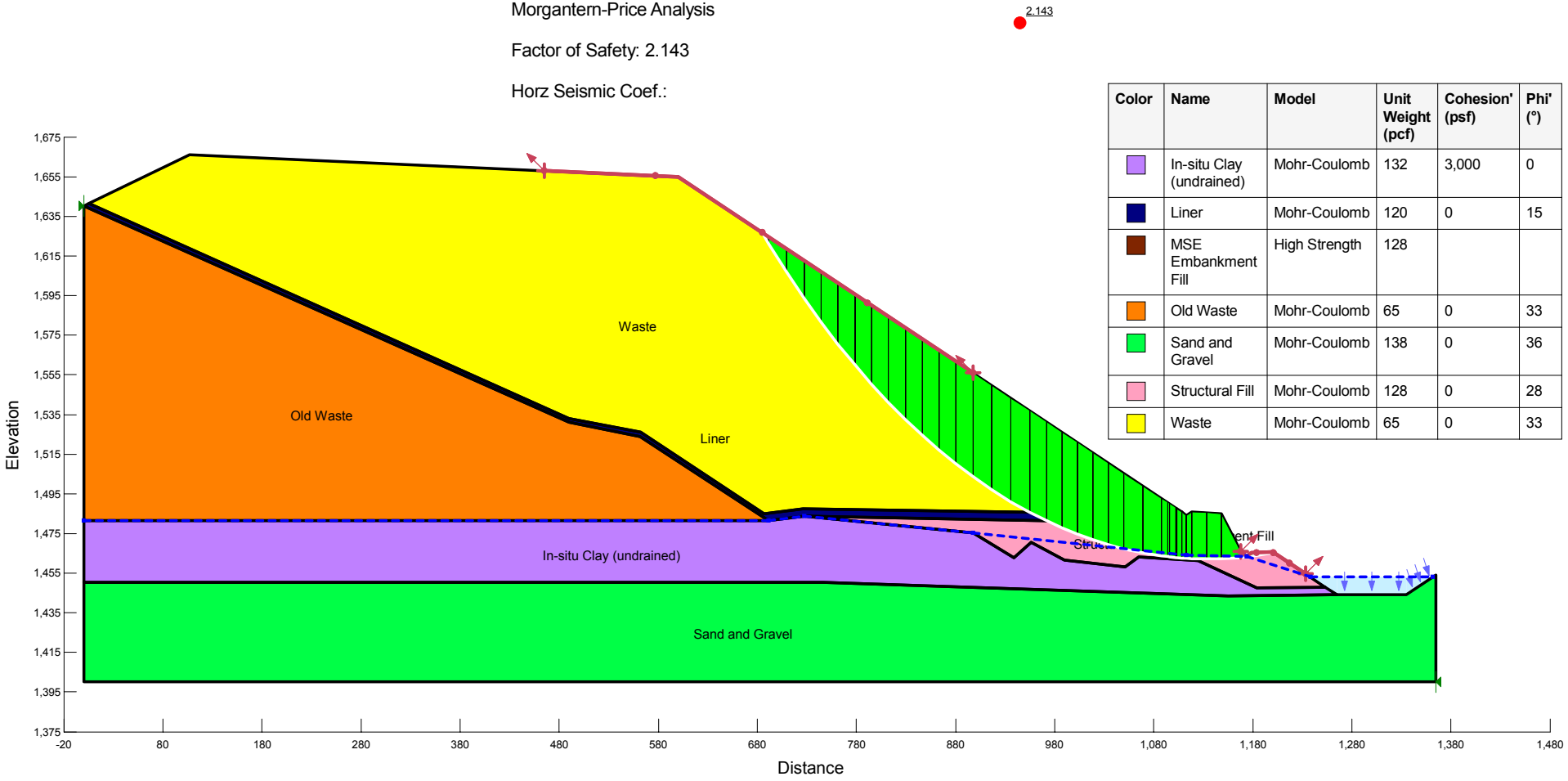
	Liner	Mohr-Coulomb	120	0	15
	MSE Embankment Fill	High Strength	128		
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 1 - Global Stability

Morgantern-Price Analysis

Factor of Safety: 2.143

Horz Seismic Coef.:



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
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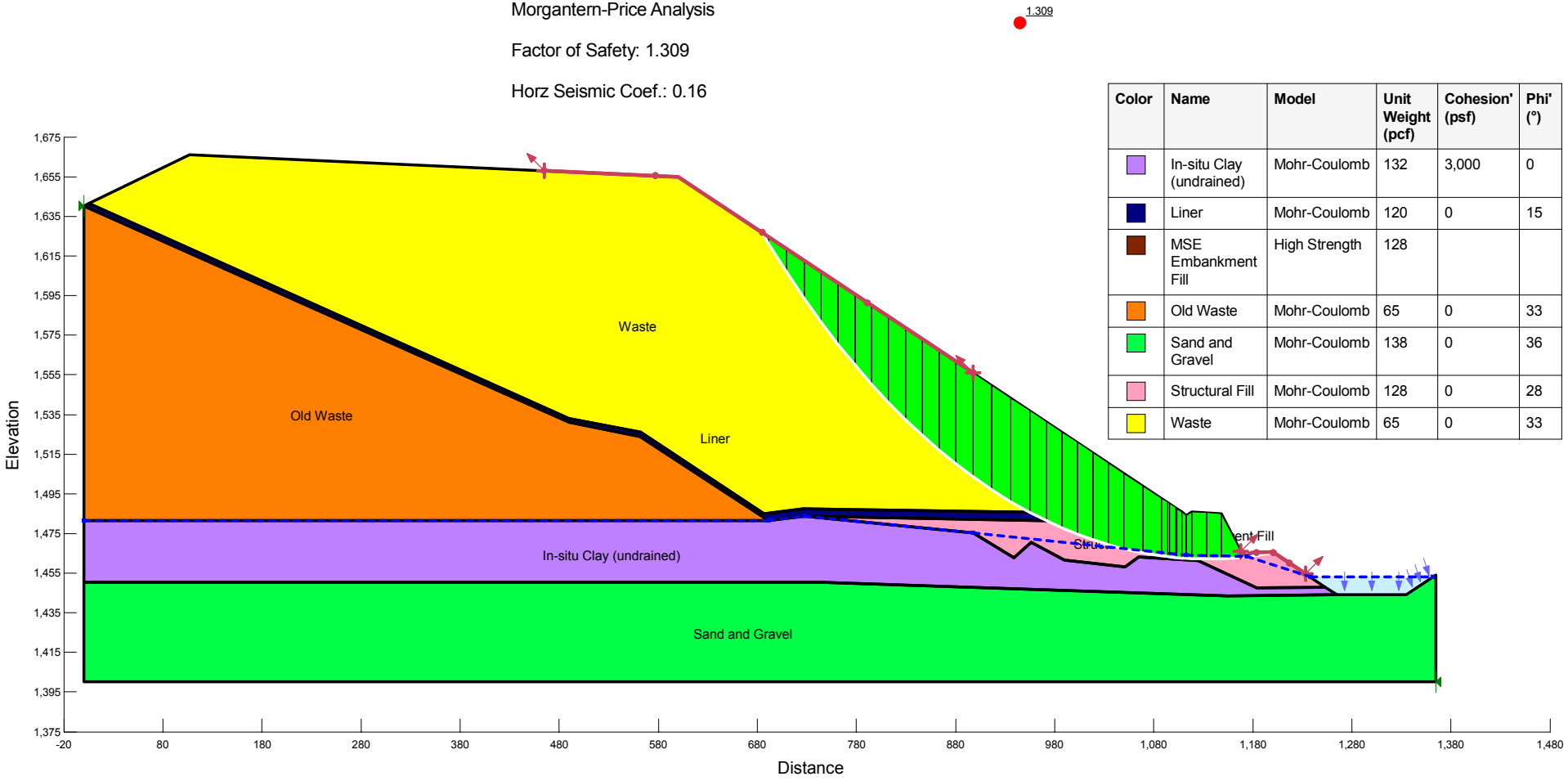
	Liner	Mohr-Coulomb	120	0	15
	MSE Embankment Fill	High Strength	128		
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 1 - Global Stability

Morgantern-Price Analysis

Factor of Safety: 1.309

Horz Seismic Coef.: 0.16



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
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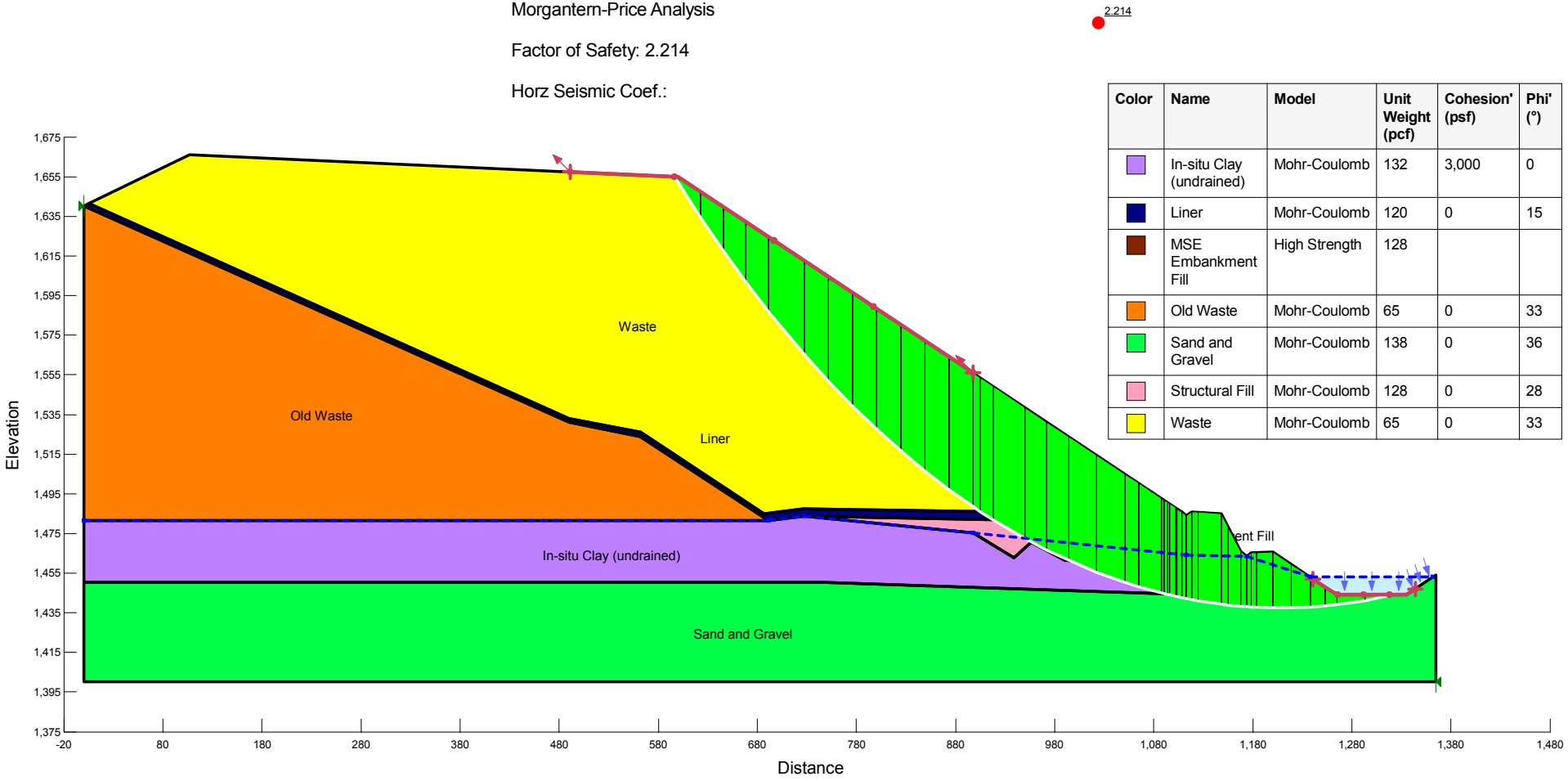
	Liner	Mohr-Coulomb	120	0	15
	MSE Embankment Fill	High Strength	128		
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 1 - Global Stability

Morgantern-Price Analysis

Factor of Safety: 2.214

Horz Seismic Coef.:



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
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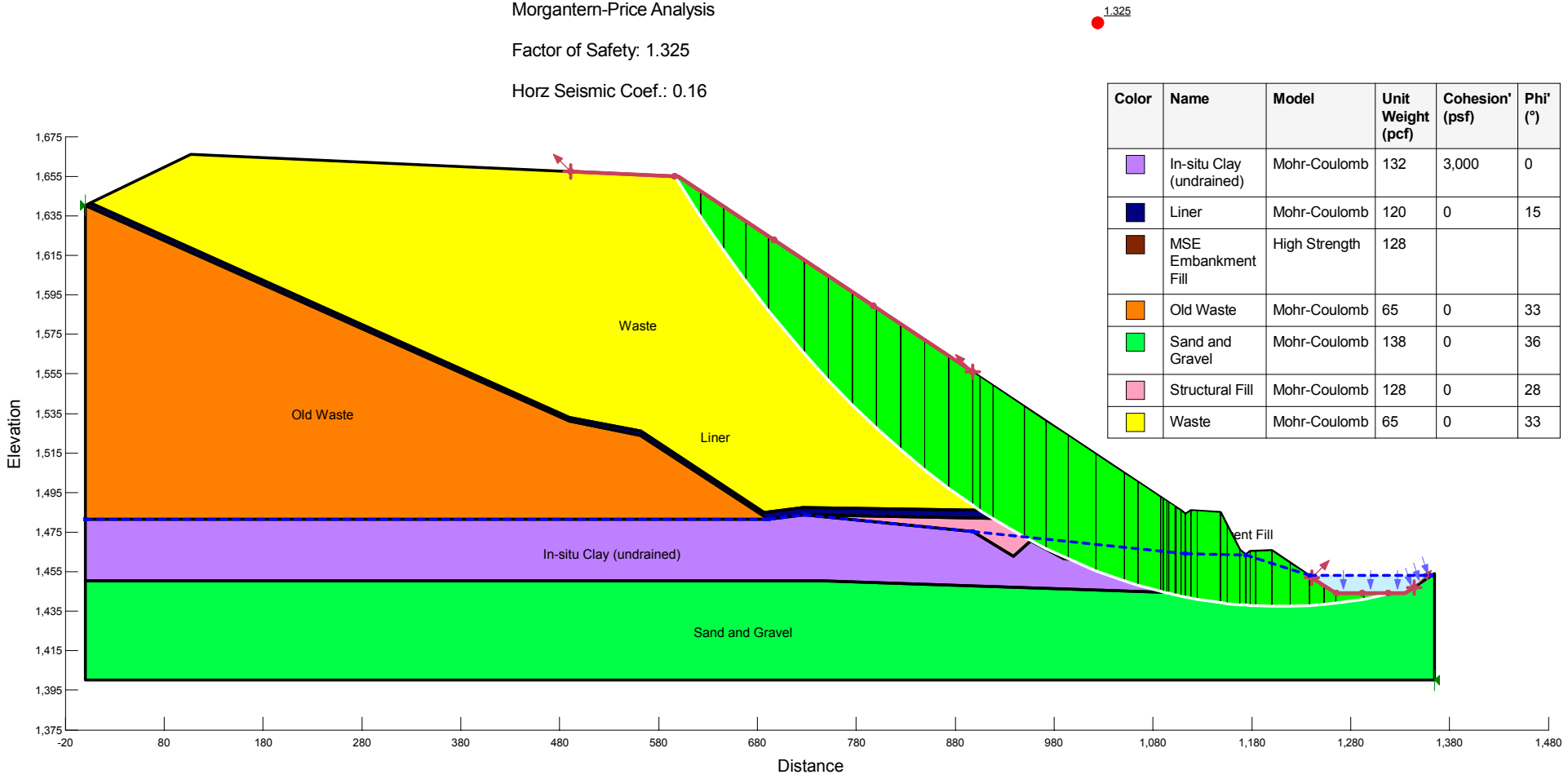
	MSE Embankment Fill	High Strength	128		
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 1 - Global Stability

Morgantern-Price Analysis

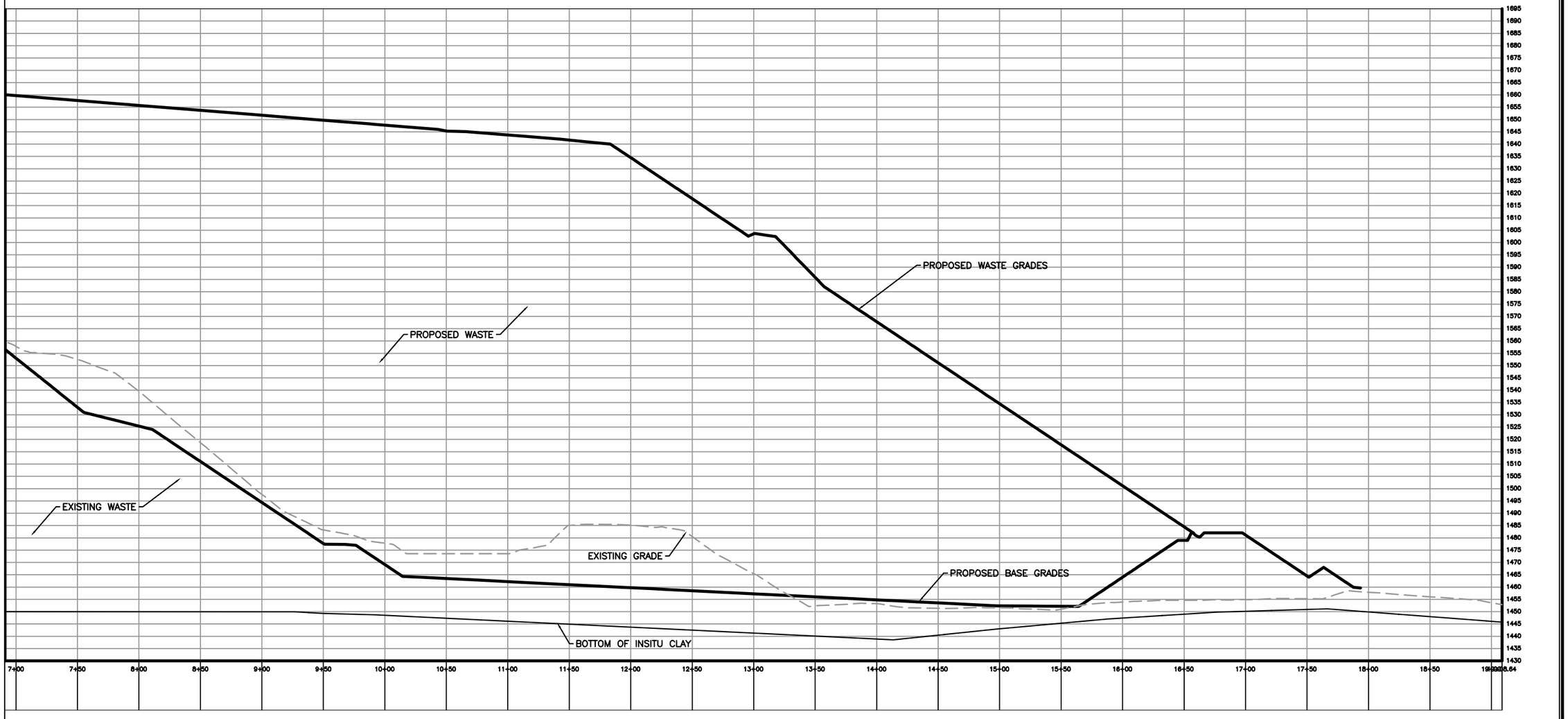
Factor of Safety: 1.325

Horz Seismic Coef.: 0.16



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	MSE Embankment Fill	High Strength	128		
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

STABILITY SECTION 2



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ROBERT A. HOLMES

N.Y.P.E. Lic. No. 077317 Date

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DATE OF ISSUE FEB 2020

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DESIGNED BY

CHECKED BY

APPROVED BY

cornerstone PLLC

PREPARED BY:
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CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

SETTLEMENT SECTION 2

SHEET NO. 3

PROJECT NO. 190260

1" 1/2" 0" 1"

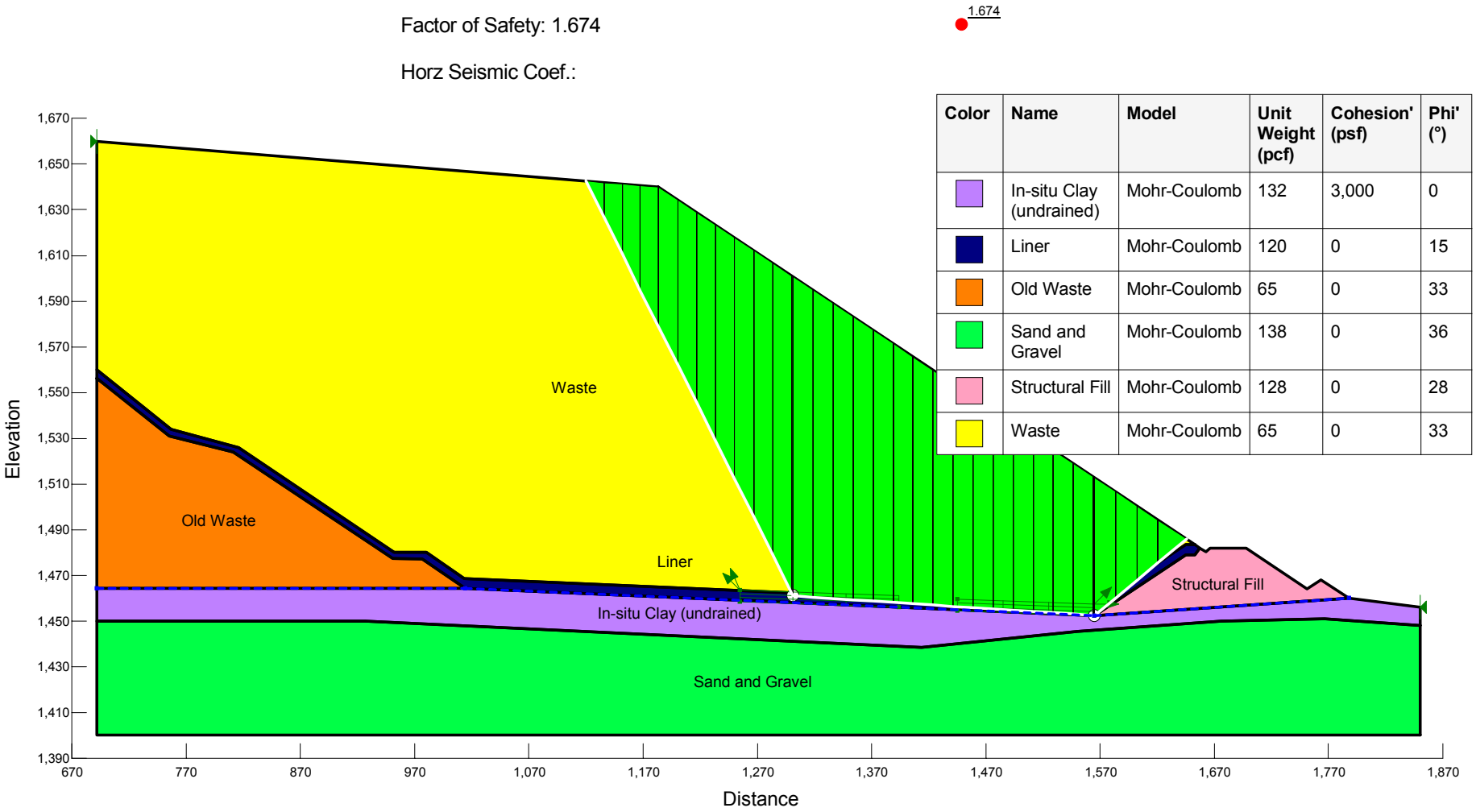
File: X:\PROJECTS\WM-CHAFFEE\190260 - SOUTHERN EXPANSION TITLE_Project Drawings\190260-LDK-STABILITY.DWG Layout: SECTION 2 User: tagarunov Feb 24, 2020 - 2:01pm

Chaffee Area 7/8 Development
Section 2 - Global Stability

Morganstern-Price Analysis

Factor of Safety: 1.674

Horz Seismic Coef.:



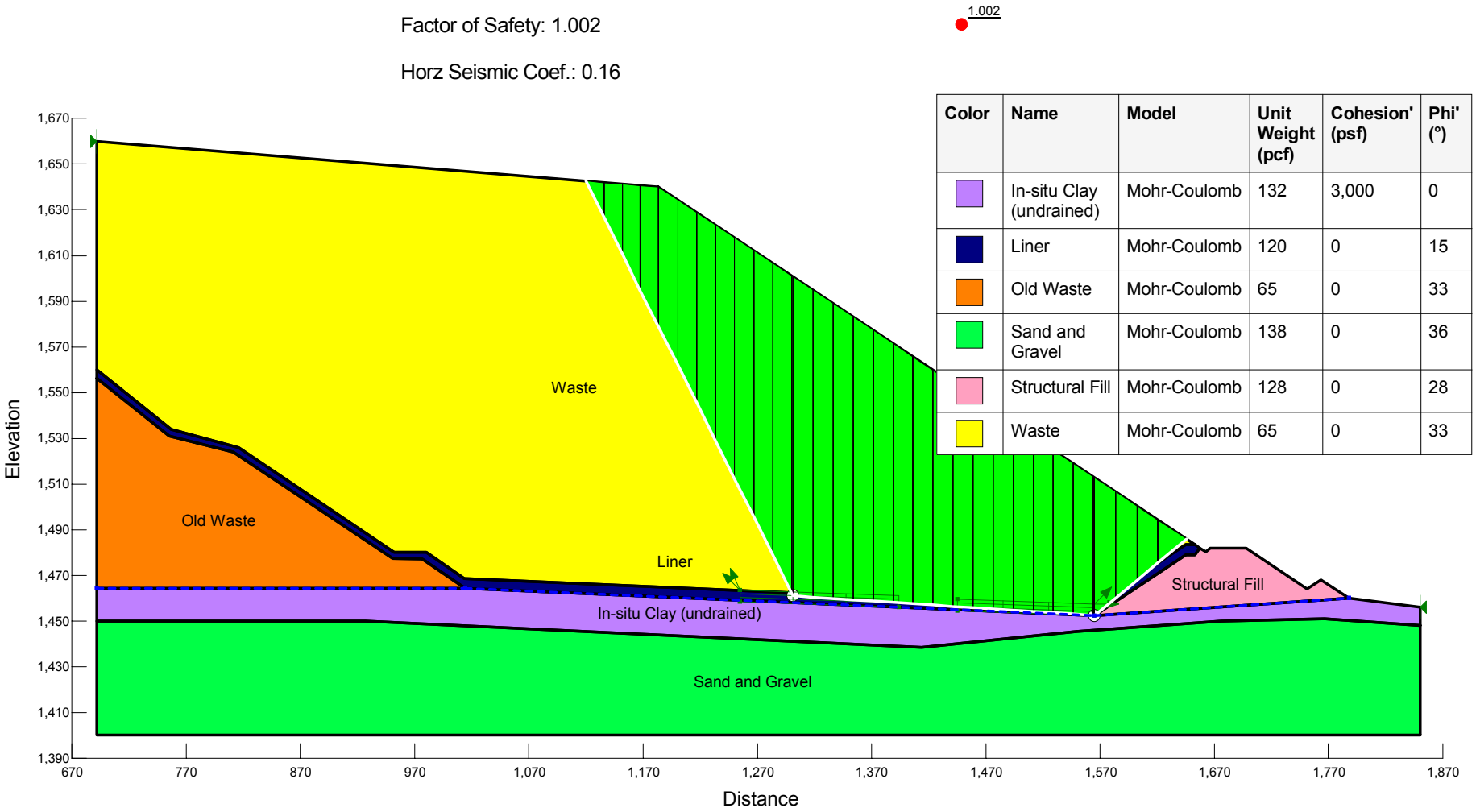
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 2 - Global Stability

Morganstern-Price Analysis

Factor of Safety: 1.002

Horz Seismic Coef.: 0.16



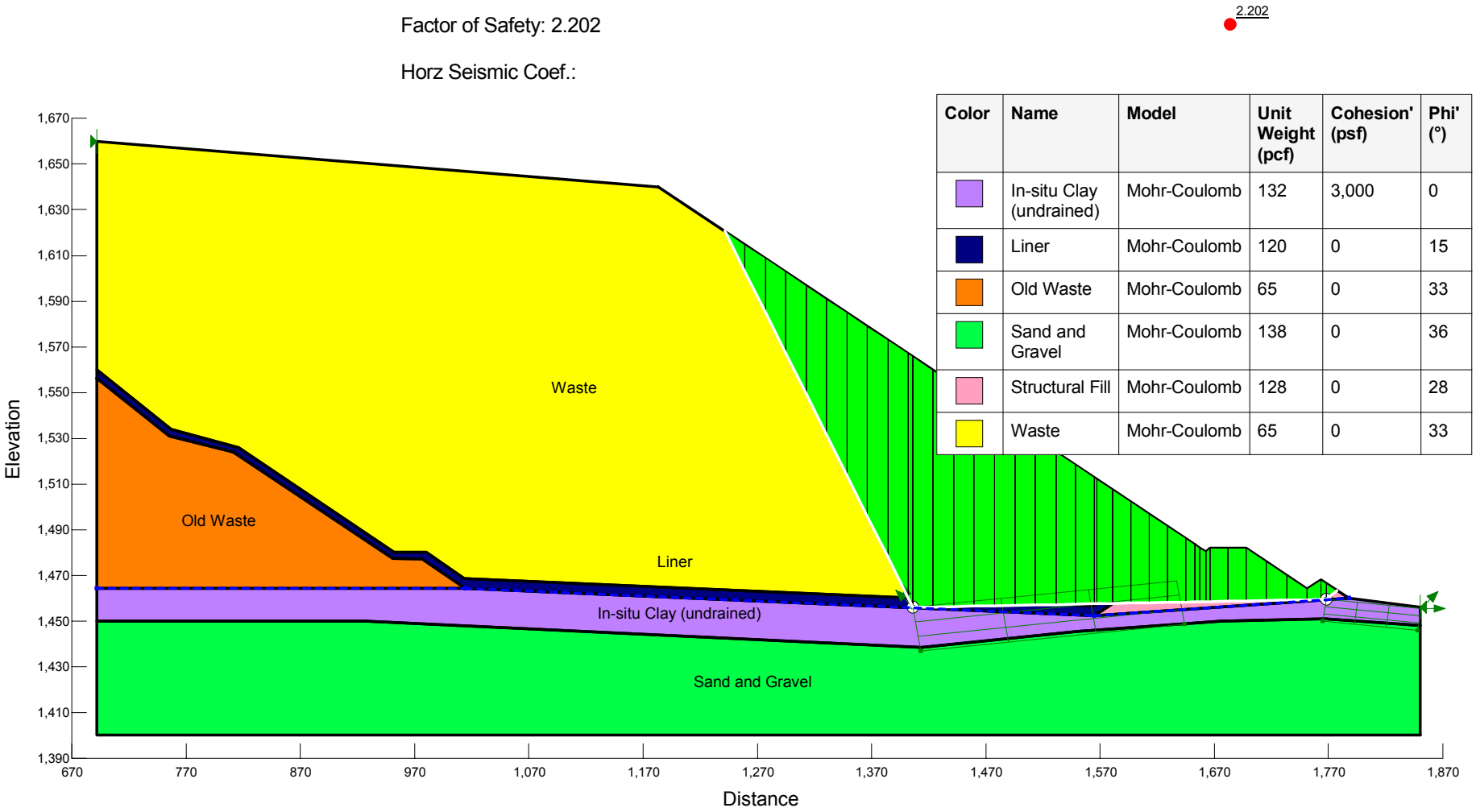
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 2 - Global Stability

Morganstern-Price Analysis

Factor of Safety: 2.202

Horz Seismic Coef.:



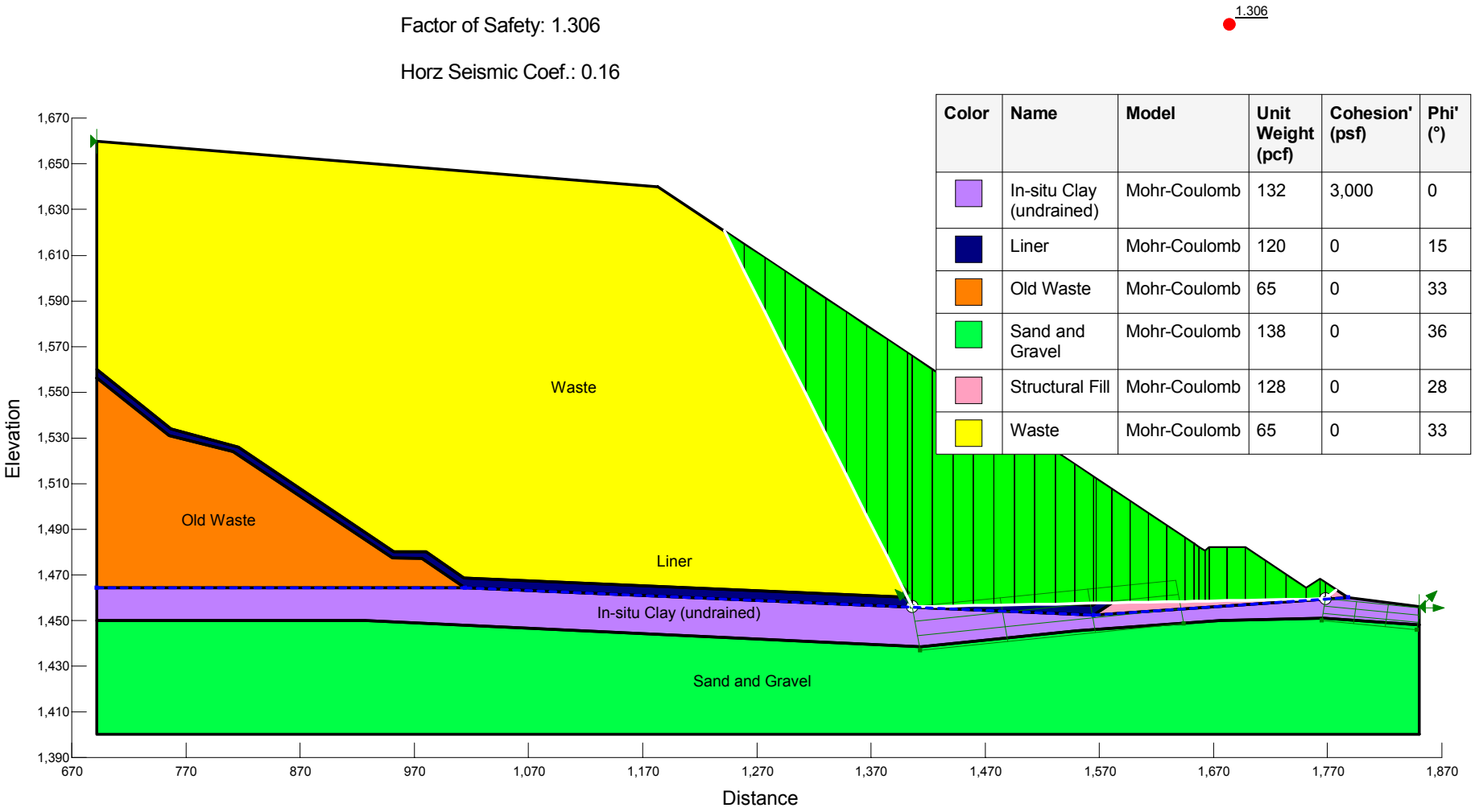
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 2 - Global Stability

Morganstern-Price Analysis

Factor of Safety: 1.306

Horz Seismic Coef.: 0.16



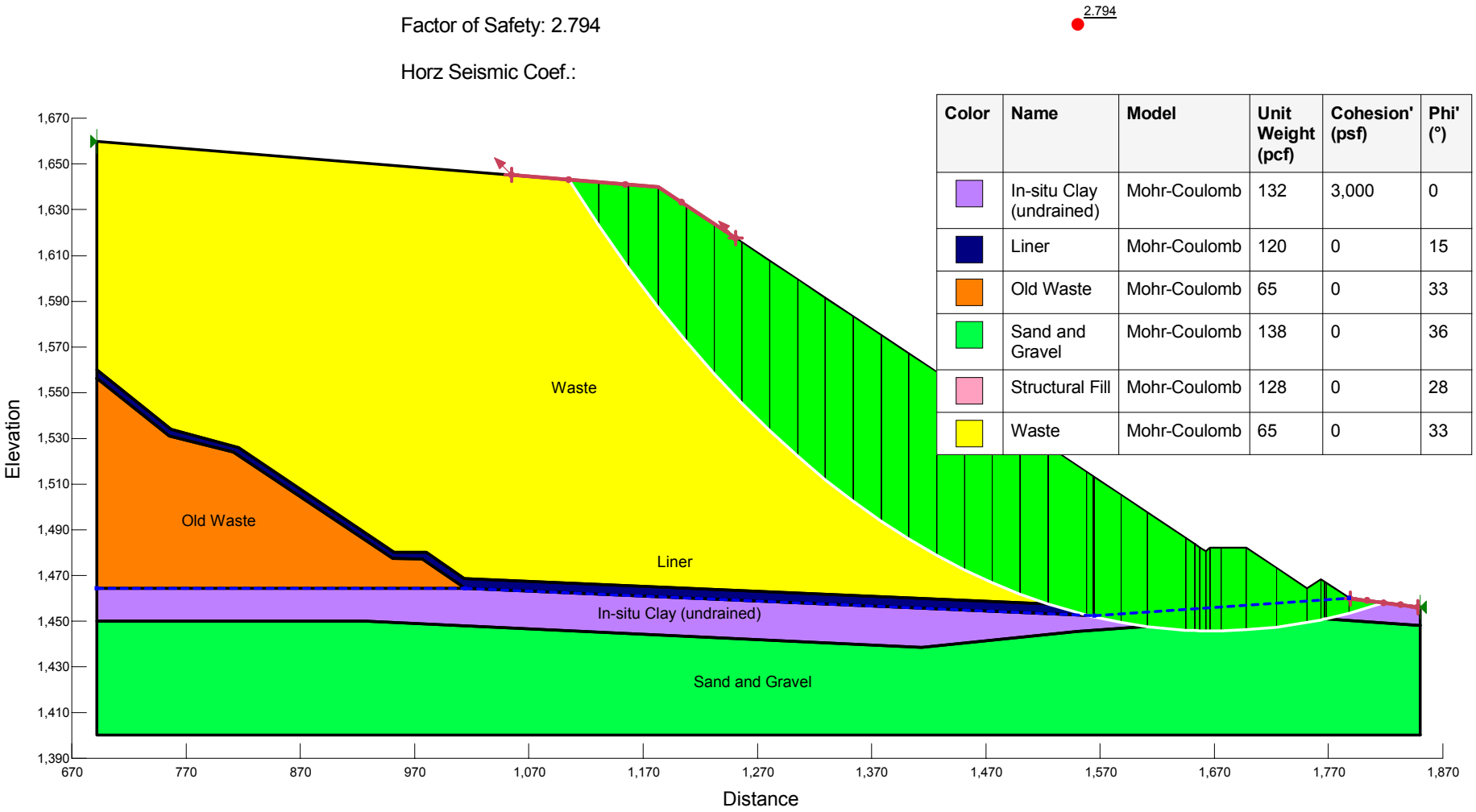
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 2 - Global Stability

Morganstern-Price Analysis

Factor of Safety: 2.794

Horz Seismic Coef.:



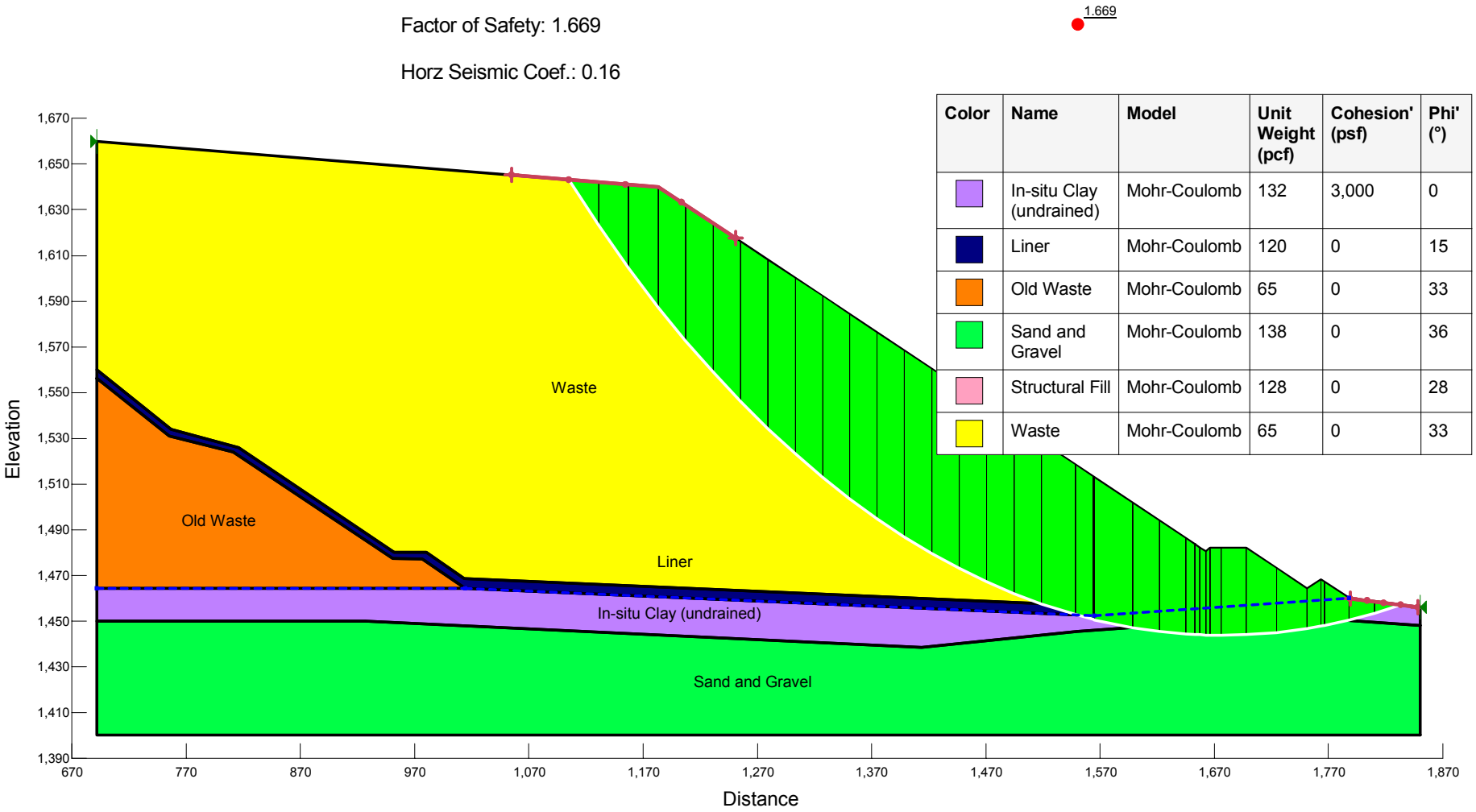
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 2 - Global Stability

Morganstern-Price Analysis

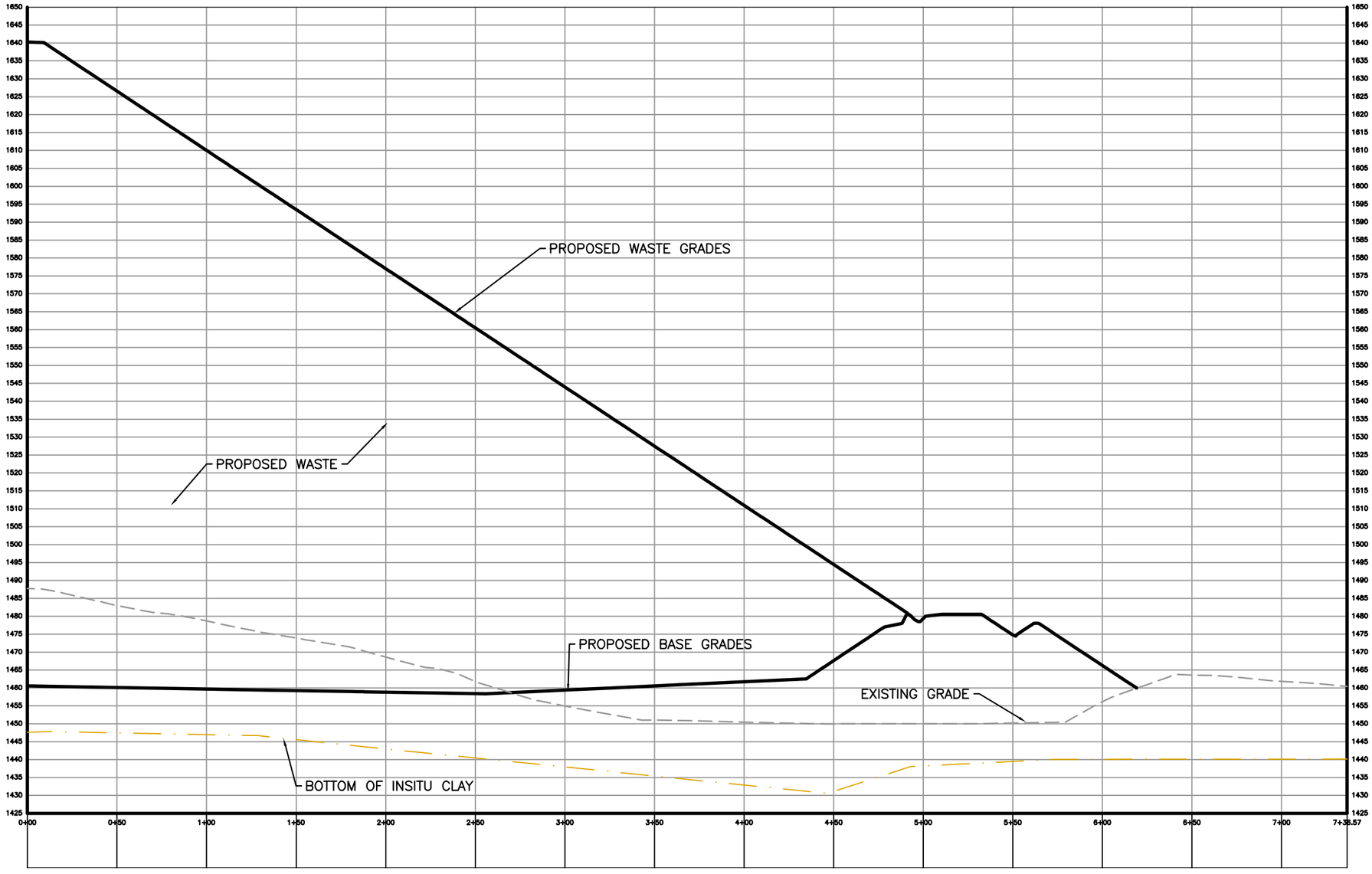
Factor of Safety: 1.669

Horz Seismic Coef.: 0.16



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	Old Waste	Mohr-Coulomb	65	0	33
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

STABILITY SECTION 3



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SARDINIA, ERIE COUNTY, NEW YORK

SETTLEMENT SECTION 3

SHEET NO. 4

PROJECT NO. 190260

File: X:\PROJECTS\WM-CHAFFEE\190260 - SOUTHERN EXPANSION TITLE_Project Drawings\190260-LDK-STABILITY.DWG Layout: SECTION 3 User: bgarrow Feb 24, 2020 - 2:31pm

1" 1/2" 0" 1"

Chaffee Area 7/8 Development
Section 3 - Global Stability

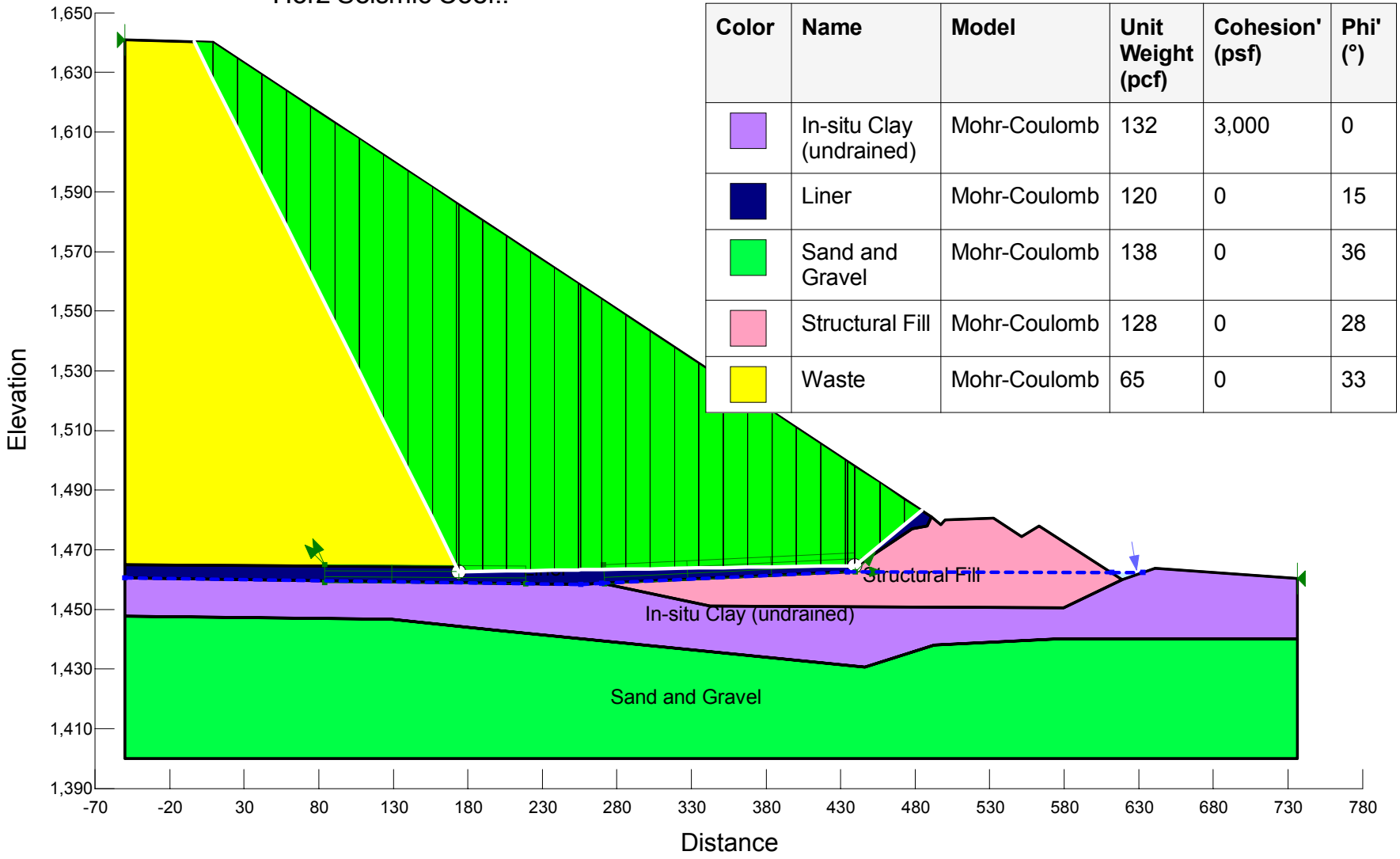
Morganstern-Price Analysis

1.68

Factor of Safety: 1.68

Horz Seismic Coef.:

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33



Chaffee Area 7/8 Development
Section 3 - Global Stability

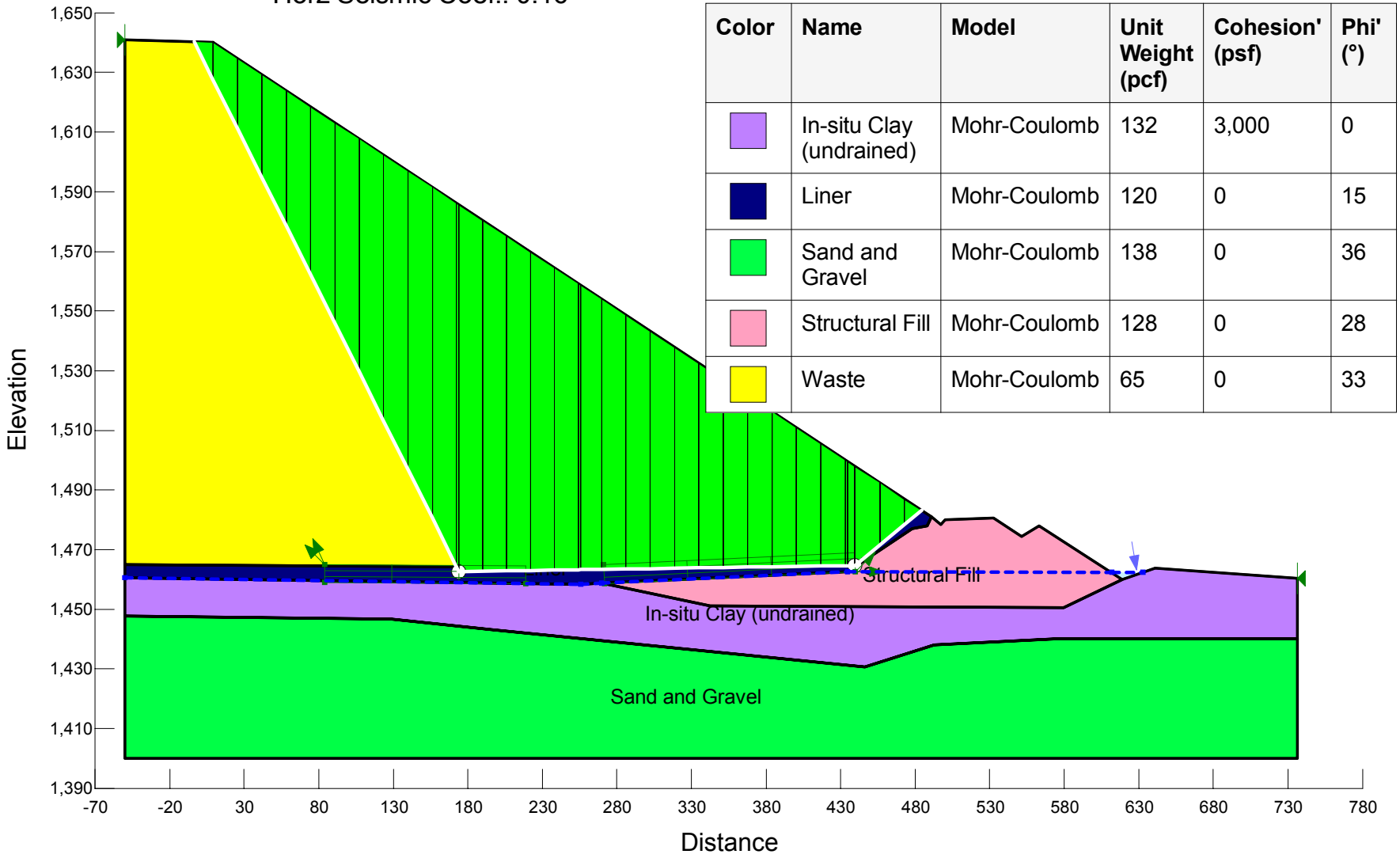
Morganstern-Price Analysis

1.00

Factor of Safety: 1.00

Horz Seismic Coef.: 0.16

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

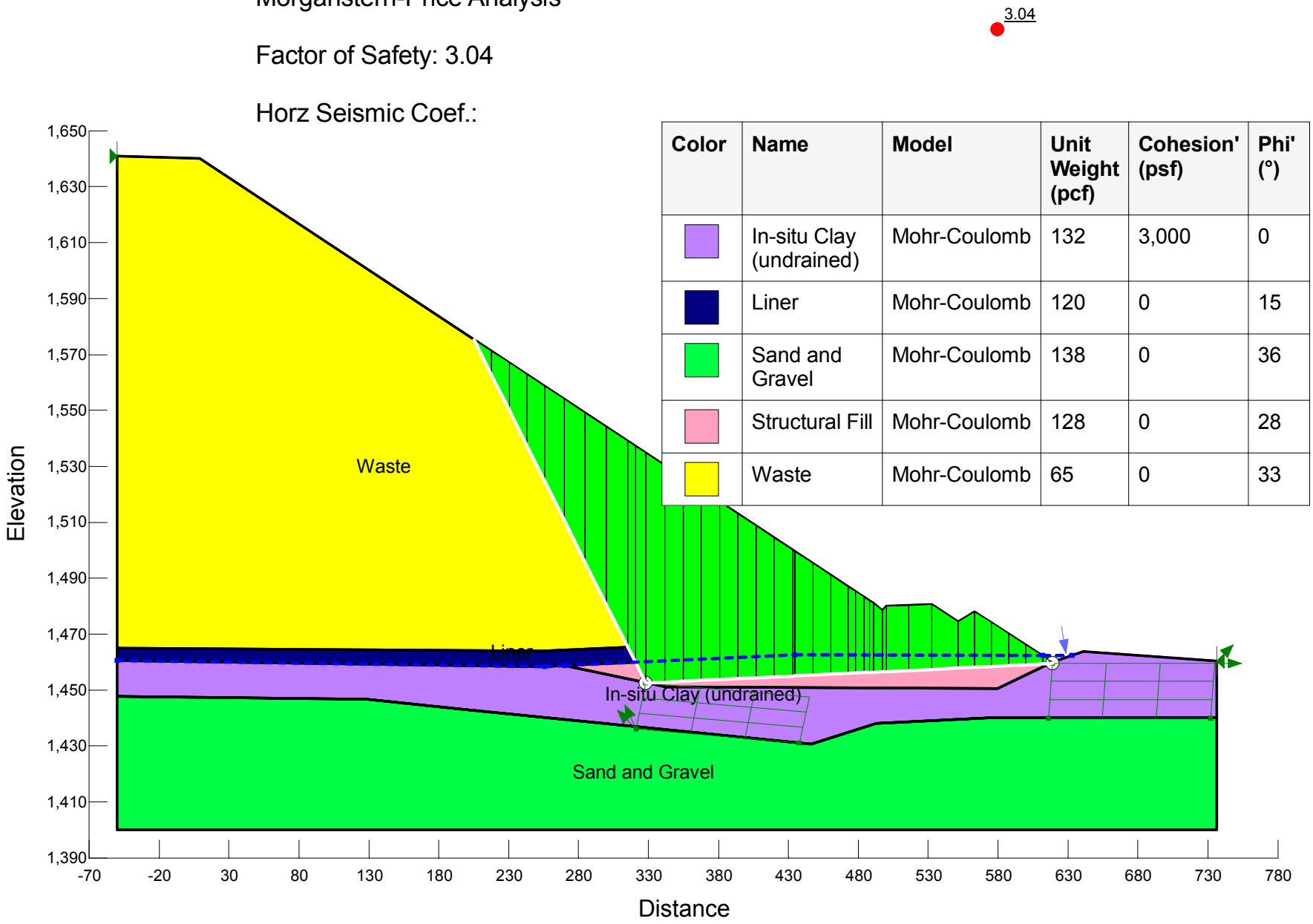


Chaffee Area 7/8 Development
Section 3 - Global Stability

Morganstern-Price Analysis

Factor of Safety: 3.04

Horz Seismic Coef.:



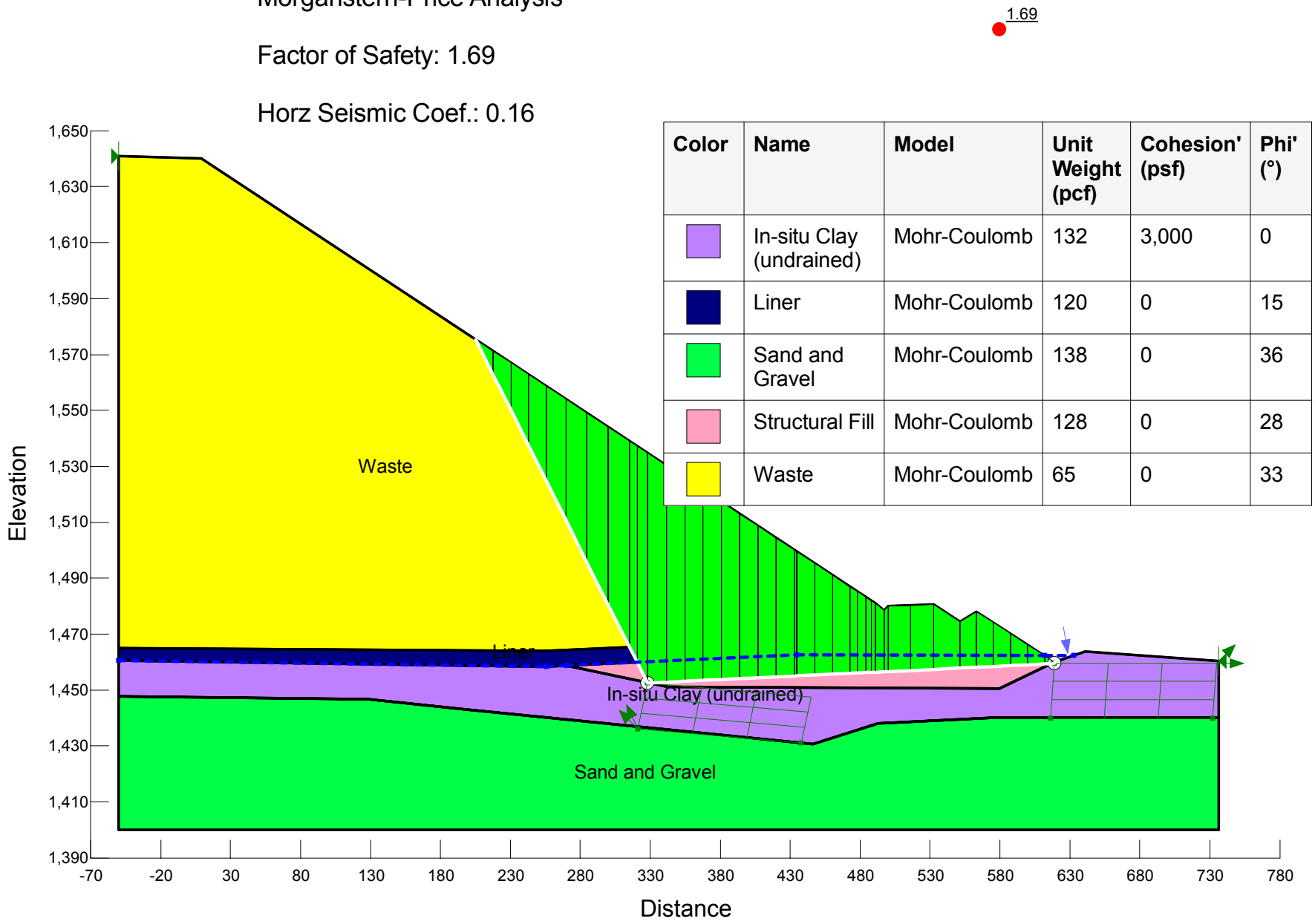
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 3 - Global Stability

Morganstern-Price Analysis

Factor of Safety: 1.69

Horz Seismic Coef.: 0.16



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

Chaffee Area 7/8 Development
Section 3 - Global Stability

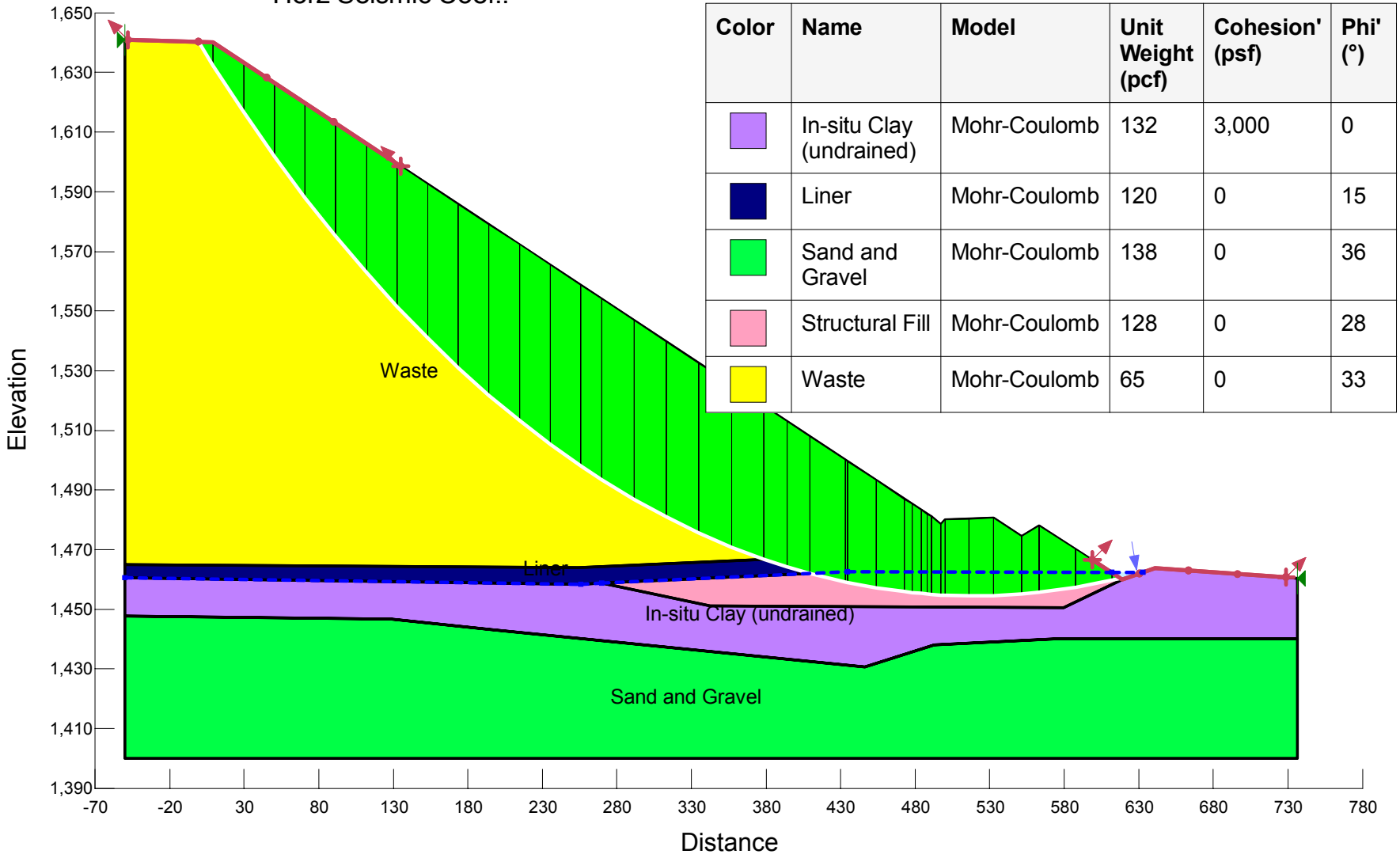
Morganstern-Price Analysis

Factor of Safety: 2.25

Horz Seismic Coef.:

2.25

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

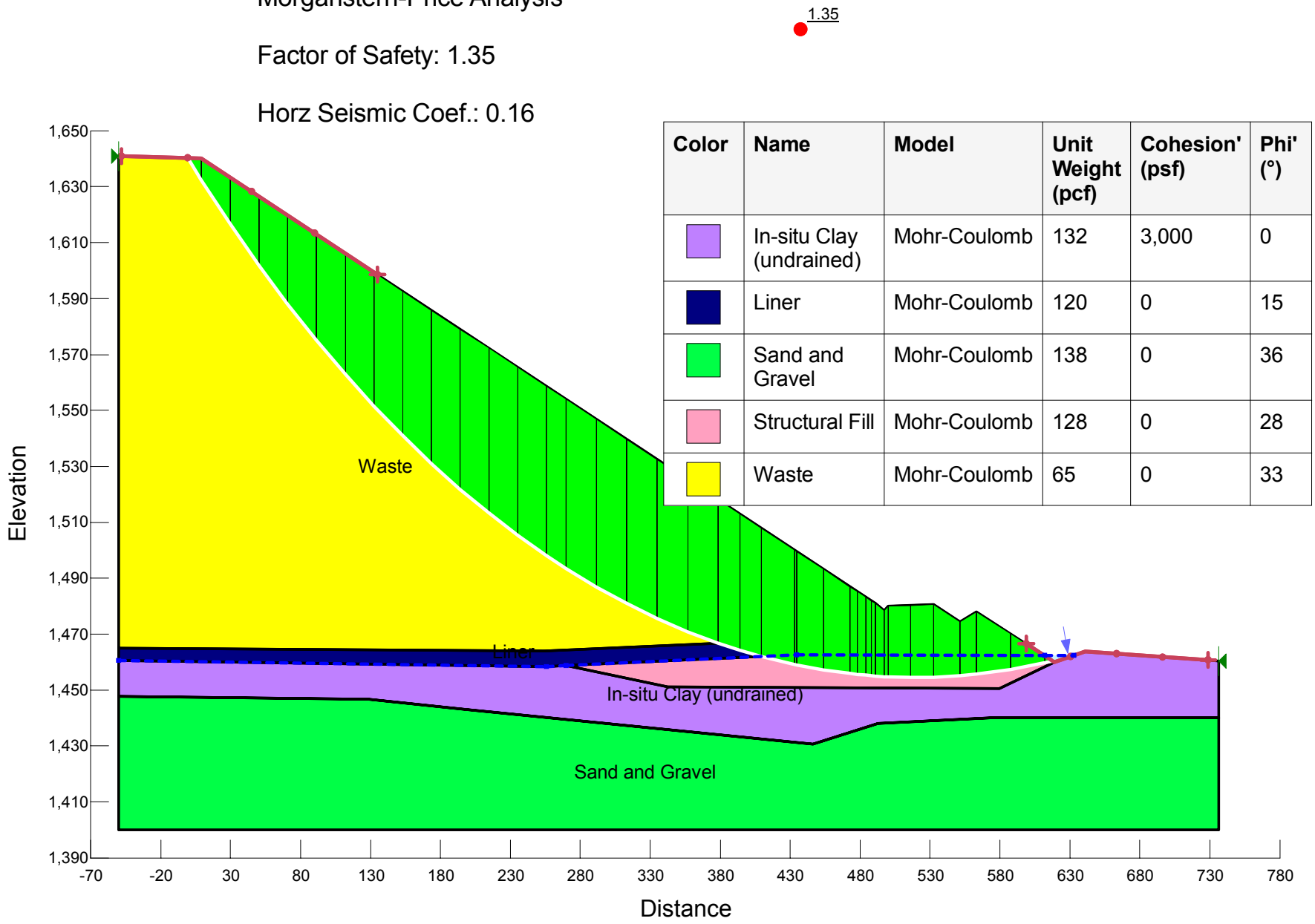


Chaffee Area 7/8 Development
Section 3 - Global Stability

Morganstern-Price Analysis

Factor of Safety: 1.35

Horz Seismic Coef.: 0.16



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	In-situ Clay (undrained)	Mohr-Coulomb	132	3,000	0
	Liner	Mohr-Coulomb	120	0	15
	Sand and Gravel	Mohr-Coulomb	138	0	36
	Structural Fill	Mohr-Coulomb	128	0	28
	Waste	Mohr-Coulomb	65	0	33

B.4 - Baseliner Stability Analysis

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	13-Jul-20	190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7-8 Development	Baseliner Stability Analysis	
PREPARED BY	**CHECKED BY**	
L.Rohr	R. Holmes	

Description and Purpose:

Determine the stability of the baseliner system along the sideslopes.

Design Basis/References/Assumptions:

Use infinite slope stability to determine the factor of safety and minimum friction angles between the interfaces of the baseliner system.
See calculation sheet for additional input parameters and references.

Remarks/Conclusions/Results:

A minimum friction angle of 26.5 degrees is required between geosynthetic to geosynthetic interfaces for a factor of safety of 1.5.A minimum friction angle of 24 degrees is required between geosynthetic to soil drainage layer for a FS greater than 1.3 .
A factor of safety of less than 1.5 for the soil to geomembrane interface is acceptable since this "failure" mode does not impact the baseliner integrity.

Client Name:	Waste Management - Chaffee			Project Name:	Area 7-8 Development						
Subject:	Baseliner Side Slope Stability			Project #:	190260						
Designed by:	L.Rohr	Date:	7/13/2020	Checked by:	R.Holmes	Date:	7/13/2020	Sheet No.	1	of	1

Purpose: Evaluate the stability of the base liner on the sideslope

shaded cell represent values to be input

shaded cells are calculated values

Description: Uses infinite slope stability method which is applicable for relatively long slope lengths (greater than 100 feet)
Addresses potential seepage forces assuming parallel seepage

Method:

$$FS = \frac{[C + \{((\gamma_s \cdot t) - (\gamma_w \cdot h))cos\beta\} \cdot tan\varphi]}{\gamma_s \cdot t \cdot sin\beta(1+n)}$$

FS	factor of safety
C	cohesion at interface
γ_s	density of soil
t	thickness of soil layers over geosynthetic interface
γ_w	density of water (62.4 pcf)
h	depth of water over geosynthetic interface
β	slope angle
ϕ	friction angle at interface
n	maximum ground acceleration

Parameters:

γ_s	135	pcf	
t	2.0	ft	
h	0.5	ft	
β	18.4	degrees	
n	0.00		not in seismic impact zone

Interface 1 - soil against uppermost layer of geosynthetics

C	0	psf
ϕ	24	degrees

interface 2 - weakest internal shear strength of geosynthetics layers (if geomembrane only use interface 1 values)

C	0	psf
ϕ	26.5	degrees

Conclusions:

Factors of Safety

	static (h=0)	saturated	seismic(h=0)
interface 1	1.35	1.20	NA
interface 2	1.50	1.33	NA

for interface 1 where the failure surface is soil sliding over other components:
suggested FS is 1.3 with no liquid, 1.2 with liquid, and 1.1 seismic,
for other interfaces where the failure surface impacts geosynthetic components:
suggested FS is 1.5 with no liquid, 1.3 with liquid and 1.1 seismic

B.5 - Final Cover Stability Calculation

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	21-Apr-21	190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7-8 Development	Final Cover Slope Stability	
PREPARED BY	**CHECKED BY**	
L.Rohr	R. Holmes	

Description and Purpose:

To evaluate the stability of the final cover system as required by 6 NYCRR Part 363-4.3(c)(1)(iv).
Verify that the proposed cover system designs meet the required factor of safety of 1.5 under normal and saturated conditions and confirm that the cover system maintains a factor of safety of 1.25 in the atypical event of a non-functioning drainage system producing a head of 12".
The permeability of the Geocomposite Drain was also verified for constructability.

Design Basis/References/Assumptions:

2 final cover scenarios were evaluated with the potential for each event to occur at the site

- Cover System with GCD Layer maintaining a liquid head the thickness of the GCD (normal saturated condition)
- Cover System with GCD Layer maintaining a liquid head the of 12" (atypical conditions - drainage system not functioning)

Each of the scenarios was evaluated using the infinite slope stability method (See Calculation Sheet)

The friction angle for the final cover interfaces was selected to be 28° to be consistent with historical testing results.

Using the lowest permeability of the final cover soils a loading rate was applied to the GCD to determine its required design transmissivity.

Remarks/Conclusions/Results:

The two scenarios maintained the required factor of safety of 1.5 under normal and saturated conditions and an acceptable factor of safety of 1.25 in the atypical case of a non functioning drainage system resulting in a head build up of 12".

For Final Cover, a peak friction angle of 28° (consistent with historical testing) should be specified to meet the required factors of safety.

The required GCD transmissivity of $1.5*10^{-3}$ m^2/s is achievable with readily available materials.

Client Name:	Waste Management - Chaffee			Project Name:	Area 7-8 Development						
Subject:	Cover Slope Stability			Project #:	190260						
Designed by:	L.Rohr	Date:	4/17/2021	Checked by:	R.Holmes	Date:	4/21/2021	Sheet No.	1	of	2

Purpose: Evaluate the stability of final cover systems

shaded cell represent values to be input

shaded cells are calculated values

Final cover system with geocomposite drainage layer, liquid head limited to thickness of geocomposite

Description: Uses infinite slope stability method which is applicable for relatively long slope lengths (greater than 100 feet)
Addresses potential seepage forces assuming parallel seepage

Method:

$$FS = \frac{[C + \{((\gamma_s \cdot t) - (\gamma_w \cdot h))cos\beta - u\} \cdot tan\varphi]}{\gamma_s \cdot t \cdot sin\beta(1+n)}$$

FS	factor of safety
C	cohesion at interface
γ_s	density of soil
t	thickness of soil layers over geosynthetic interface
γ_w	density of water (62.4 pcf)
h	depth of water over geosynthetic interface
β	slope angle
u	gas pressure
ϕ	friction angle at interface
n	maximum ground acceleration

Parameters:

γ_s	120	pcf	
t	2.5	ft	
h	0.1	ft	
β	18.4	degrees	
u	20	psf	Typical value for landfill with active gas collection system
n	0.00		not in seismic impact zone

Interface 1 - soil against uppermost layer of geosynthetics

C	0	psf
ϕ	28	degrees

interface 2 - weakest internal shear strength of geosynthetics layers (if geomembrane only use interface 1 values)

C	0	psf
ϕ	28	degrees

interface 3 - bottom of lowest geosynthetic layer to subgrade soil

C	0	psf
ϕ	28	degrees

Conclusions:

Factors of Safety

	static (h=0)	saturated	seismic(h=0)	seismic	w/gas*
interface 1	1.60	1.57	1.60	1.57	1.60
interface 2	1.60	1.57	1.60	1.57	1.60
interface 3	1.60	1.60	1.60	1.60	1.49

* gas affects only the bottom layer; seepage forces do not affect the bottom layer

Client Name:	Waste Management - Chaffee			Project Name:	Area 7-8 Development						
Subject:	Cover Slope Stability			Project #:	190260						
Designed by:	L.Rohr	Date:	4/17/2021	Checked by:	R.Holmes	Date:	4/21/2021	Sheet No.	2	of	2

Purpose: Evaluate the stability of final cover systems

shaded cell represent values to be input

shaded cells are calculated values

Final cover system with geocomposite drainage layer, liquid head of 12" used for calculation

Description: Uses infinite slope stability method which is applicable for relatively long slope lengths (greater than 100 feet)
Addresses potential seepage forces assuming parallel seepage

Method:

$$FS = \frac{\left[C + \{((\gamma_s \cdot t) - (\gamma_w \cdot h))cos\beta - u\} \cdot tan\varphi\right]}{\gamma_s \cdot t \cdot sin\beta(1+n)}$$

FS	factor of safety
C	cohesion at interface
γ_s	density of soil
t	thickness of soil layers over geosynthetic interface
γ_w	density of water (62.4 pcf)
h	depth of water over geosynthetic interface
β	slope angle
u	gas pressure
ϕ	friction angle at interface
n	maximum ground acceleration

Parameters:

γ_s	120	pcf	
t	2.5	ft	
h	1.0	ft	
β	18.4	degrees	
u	20	psf	Typical value for landfill with active gas collection system
n	0.00		not in seismic impact zone

Interface 1 - soil against uppermost layer of geosynthetics

C	0	psf
ϕ	28	degrees

interface 2 - weakest internal shear strength of geosynthetics layers (if geomembrane only use interface 1 values)

C	0	psf
ϕ	28	degrees

interface 3 - bottom of lowest geosynthetic layer to subgrade soil

C	0	psf
ϕ	28	degrees

Conclusions:

Factors of Safety

	static (h=0)	saturated	seismic(h=0)	seismic	w/gas*
interface 1	1.60	1.27	1.60	1.27	1.60
interface 2	1.60	1.27	1.60	1.27	1.60
interface 3	1.60	1.60	1.60	1.60	1.49

* gas affects only the bottom layer; seepage forces do not affect the bottom layer

Client Name:	Waste Management - Chaffee			Project Name:	Area 7-8 Development						
Subject:	Final Cover Geocomposite			Project #:	190260						
Designed by:	L.Rohr	Date:	7/13/2020	Checked by:	R.Holmes	Date:	7/13/2020	Sheet No.	1	of	2

Purpose: For design of geocomposite drainage in cover systems
Estimates infiltration into the geocomposite
Computes required geocomposite parameters for specifications
shaded cell represent values to be input
shaded cells are calculated values

Description: Estimates infiltration for final cover drainage using various methods or incorporates values from other model
Calculations required transmissivity given a drainage length
Summarizes required values for geocompositie for long-term performance

STEP 1. Estimate infiltration

How would you like to estimate infiltration into the geocomposite?	saturated flow from overlying layer	
Input infiltration from other source (if applicable)	NA	in/hr

To compute flow from overlying saturated layer
q = ki
q = infiltration
k = permeability of layer with lowest permeability over the geocomposite
i= unit gradient = 1

k =	0.0001	cm/s
infiltration from saturated layer	0.14	in/hr

To compute flow from rational method
q = P- CP
q = infiltration
P = Precipitation
C = runoff coefficient

input precipitation	NA	in/hr
input runoff coefficient	NA	
infiltration using rational method	NA	in/hr

To compute flow from SCS TR-55 method

$$q = P - \left[P - 0.2\left(\frac{1000}{CN} - 10\right)\right]^2 \Big/ \left[P + 0.8\left(\frac{1000}{CN} - 10\right)\right]$$

q = infiltration
P = Precipitation
CN = curve number

input precipitation (P)	NA	in/hr
input type of soil	NA	
input grass cover	NA	
CN value computed for "open spaces"	NA	
infiltration (q) value compugted by TR-55	NA	in/hr

Value to be used for infiltration:	**0.14**	**in/hr**
must have topsoil permeablity no higher than	1.0E-04	cm/s

Client Name:	Waste Management - Chaffee			Project Name:	Area 7-8 Development						
Subject:	Final Cover Geocomposite			Project #:	190260						
Designed by:	L.Rohr	Date:	7/13/2020	Checked by:	R.Holmes	Date:	7/13/2020	Sheet No.	2	of	2

STEP 2: Compute long-term required transmissivity

Using modified Giroud's equation applied to a relatively thin geocomposite

$$\theta = \frac{qL}{sin\beta}$$

θ = transmissivity required
β = slope angle
q = infiltration
L = maximum slope length from drain to drain (typically maximum length from bench to bench)

q =	0.14	in/hr	1.00E-06	$m^3/s / m^2$
L =	150	ft	45.42	m
β =	18.4	degrees	0.321	radians
θ =			1.44E-04	$m^3/s / m^2$

STEP 3: Compute geocomposite values to be specified

Step 2 computed the long-term required value which must be increased to estimate short-term test value

input factor of safety for intrusion of geotextile into geonet	1.2
input factor of safety for creep	1
input factor of safety for chemical clogging	1
input factor of safety for biological clogging	1.5
input overall factor of safety	5.5

$\theta_{100} = \theta * Fs_{in} * FS_{cr} * FS_{cc} * FS_{BC} * FS$

if topsoil permeability is 1.0E-04 cm/s θ_{100} = 1.47E-03 $m^3/s / m^2$

Conclusions:

1.5E-03 $m^3/s / m^2$ should be specified for the actual transmissivity ASTM D 4716 after 100 hours under 500 psf
This assumes a topsoil permeability of 1 x 10-4 cm/s
suggest minimum thickness of 200 mil
no crush strength is required for low load application
flow must be collected at benches/berms spaced every 150 ft

References:

1. Urban Hydrology for Small Waterways, TR 55, US Department of Agriculture, June, 1986
2. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers,"
J.P. Giroud, J.G> Zornberg and A. Zhao, Geosynthetic International, Vol. 7, Nos 4-6, 2000
3. GRI GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite, GRI 2001

B.6 – Seismic Analysis

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management	27-Apr-20	190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Chaffee Area 7/8 Development	Seismic Impact Zone Analysis	
PREPARED BY	**CHECKED BY**	
A. Alvermann / R. Holmes (4/27/20)	C. Eller (4/27/20)	

Description and Purpose:

To determine whether the Chaffee Area 7/8 Development is in a Seismic Impact Zone

Design Basis/References/Assumptions:

References:
-6NYCRR Part 360-4.3
-USGS Unified Hazard Tool (USGS NHSM 2014 Rev 1). https://earthquake.usgs.gov/hazards/interactive/

Remarks/Conclusions/Results:

The analysis indicates that the Chaffee Area 7/8 Development is not in a Seismic Impact Zone.

Chaffee Area 7/8 Development - Seismic Impact Zone Analysis

Objective

The objective of this report is to determine whether the proposed Chaffee Area 7/8 Development is within a Seimic Impact Zone. If it is not within a Seismic Impact Zone, then a stability analysis is not required by Regulation 363-4.3(d).

Seismic Zone Definition (Part 360.2(b)(243)

(243) ***Seismic impact zone*** means an area with a 10 percent or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10g in 250 years (or two percent or greater probability in 50 years) as delineated on a United States Geological Survey (USGS) National Earthquake Hazard Reduction Program (NEHRP) Probabilistic Earthquake Acceleration and Velocity Map for the United States and Puerto Rico, or other equivalent seismic hazard map, or site-specific probabilistic seismic hazard analysis approved by the department.

Seismic Zone Determination

Seismic zones, which represent areas of the United States with the greatest seismic risk, are areas with a peak ground acceleration (PGA) that is greater the 0.10-g (g is a percetage of the earth's gravitational pull). The U.S. Geological Survey (USGS) Earthquake Hazards program (https://www.usgs.gov/natural-hazards/earthquake-hazards/hazard) contains the an online the Unified Hazard Tool (https://earthquake.usgs.gov/hazards/interactive/) which provides ground motion information for loactions across the US based on different type of sites. To assess the ground motion for the Chaffee site, the tool was used to obtain the Peak Ground Acceleration (PGA). To assess the PGA in a manner that is consistent with the NYSDEC Part 360 definition - which is based on the acceleration in lithified material (i.e., rock), a Site Class of B/C was selected when using the Unified Hazard Tool. This Site Class represents the interface between National Earthquake Hazard Reduction Program(NEHRP) classes B and C, i.e, a site with an average shear wave velocity (V_s) of 760 m/sec in the top 30m - or the interface between rock (Class B) and very dense soil soft rock (Class C).

The map analysis and the output Unified Hazard Tool are provided below. The results show:

Unified Hazard Tool = 0.0855-g

Siesmic Impact Zone Conclusion: **Not in an Impact Zone**

Based on this definition the Chaffee Site is **not** in a Seismic impact zone. Calculations from the USGS Unified Tool at the Chaffee Site location, provide a peak ground acceleration (PGA) of 0.0855g which is less than the required 0.10g (see Figure 1). **Therefore a stability analysis is not necessary.**

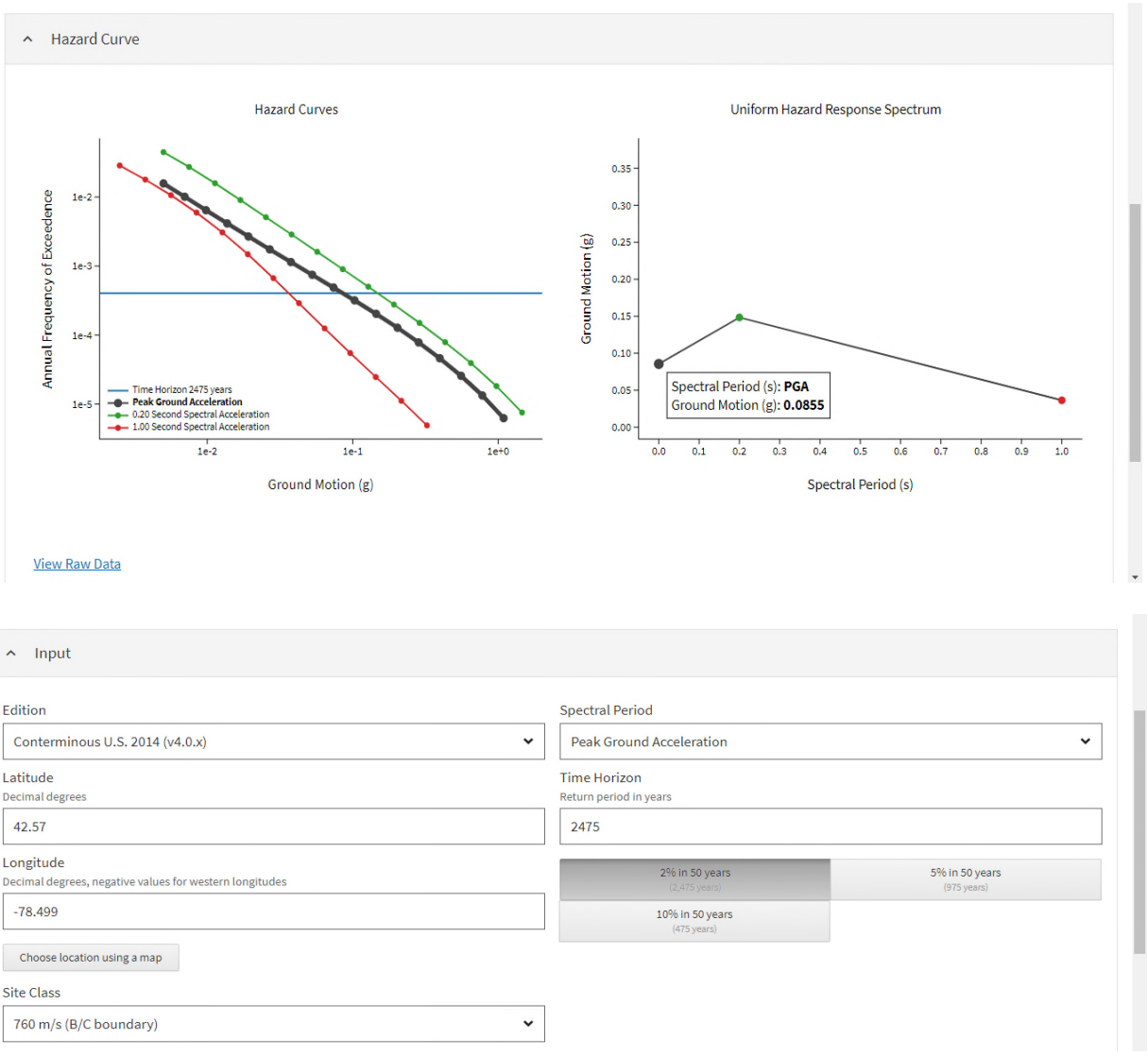


Figure 1: Site B/C Hazard Curve

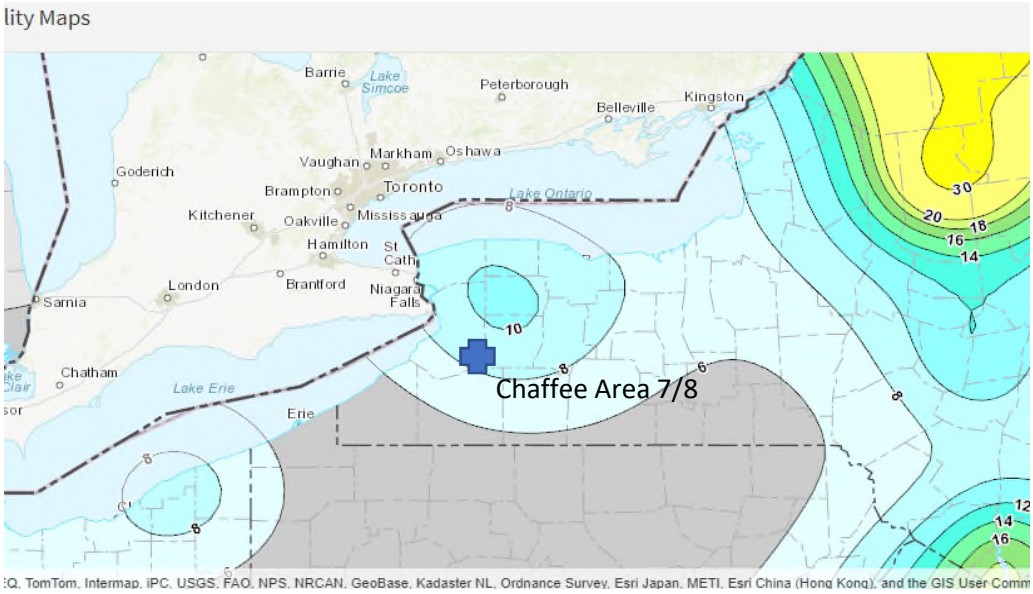


Figure 2: 2014 US PGA Hazard Map (2% at 50 years) at B/C Horizon

B.7 - Settlement Analysis

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	28-Feb-20	190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	Proposed Settlement	
PREPARED BY	**CHECKED BY**	
L. Rohr	C. Eller	

Description and Purpose:

- To evaluate landfill settlement as required in 6 NYCRR Part 363-4.3(b)(1).
- Verify that the proposed cells meet the minimum post-settlement slope requirements under the loading of the proposed Area 7/8 Development (2% post-settlement slope on the liner floor and 1% post-settlement slope for pipes).

Design Basis/References/Assumptions:

- The Cross Sections depicted on Figure 1 (attached) are the selected critical cross-sections for the settlement analysis of the proposed Area 7/8 Development.
- Section 1 (Figure 2) is made up of Points 1-5. Points 1, 2, and 3 are located along the leachate pipe and points 4 and 5 are located on the landfill floor.
- Section 2 (Figure 3) is made up of Points 3 and 6-11. Points 3 and 6 are located on the landfill floor and points 7 through 11 are located on the overliner subgrade above the closed landfill.

- In general, the settlement evaluation consisted of the following steps:

1. Divide the material beneath the liner into layers. The underlying layers for points 1 through 8 consist of recompacted clay, in-situ clay and in-situ sand and gravel with silt and clay lenses. Points 9 through 11 also consider the layer of existing waste within the closed landfill. Soil parameters consistent with the 2005 permit application were used for these layers in the settlement analysis. The settlement parameters used for the existing waste are consistent with the 2012 permit application and are based on typical values for MSW of that age and some site specific settlement information.
2. Estimate the stress increase at the center of each layer. The stress increase due to the landfill is estimated from elastic theory. Stress increases are estimated at different locations and depths beneath the embankment.
3. Estimate the settlement of each layer. The settlement of each layer is estimated using elastic and consolidation theory. (Elastic settlement for sands and low plasticity soils and consolidation settlement for clay-like soils). Secondary consolidation settlement was conservatively analyzed over a 40-year period.
4. Sum the settlement in each layer. The settlement of each layer is added to estimate the total settlement at each point considered in the evaluation.
5. Evaluate the effect on the liner system. The effect on the leachate collection system is evaluated by estimating the slope of the leachate collection pipes and the landfill floor after settlement. The strain in the liner is also estimated to evaluate the effect of the settlement on the liner.

- As required by 6 NYCRR Part 363-4.3(b)(1), a factor of safety of 2.0 was applied to the landfill load. The typical unit weight of waste, 59 pcf, was doubled to a value of 118 pcf for use in the calculation to incorporate the factor of safety of 2.0.
- Subsurface stratigraphy and selected settlement parameters are consistent with historical borings and lab results.

References:

- Poulos and Davis "Elastic Solutions for Soil and Rock Mechanics" 1973.
- Chaffee 2005 Part 360 Application Western Expansion Engineering Report by McMahon and Mann
- Chaffee 2012 Part 360 Application Valley Fill Engineering Report by McMahon and Mann

Remarks/Conclusions/Results:

- As summarized in the attached tables, settlement of the subgrade beneath the leachate collection pipe in Section 1 is estimated to vary from about 2.5 feet to 4.3 feet.
- Post-settlement slopes of the pipes remain greater than 1.0%.
- Settlement of the subgrade beneath Section 2 is estimated to vary from about 3.3 feet to 34 feet.
- Post-settlement slopes of the landfill floor and overliner remain greater than 2.0%

- Proposed LCRS pipes and liner floor layouts meet the minimum required post-settlement slopes.

SETTLEMENT POINT #11

SETTLEMENT POINT #10

SETTLEMENT POINT #9

SETTLEMENT POINT #8

SETTLEMENT POINT #7

SETTLEMENT POINT #6

SETTLEMENT POINT #1

SETTLEMENT POINT #2

SETTLEMENT POINT #5

SETTLEMENT POINT #4

SETTLEMENT POINT #3

Obscured

N

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ROBERT A. HOLMES

N.Y.P.E. Lic. No. 077317 Date

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CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

SETTLEMENT SITE PLAN

SHEET NO. 1

PROJECT NO. 190260

1" 1/2" 0" 1"

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Client Name:	WM Chaffee			Project Name:	Chaffee Area 7/8 Development						
Subject:	Proposed Settlement Section 1			Project #:	190260						
Designed by:	L.Rohr	Date:	2/28/2020	Checked by:	C.Eller	Date:	2/28/2020	Sheet No.	1	of	7

Purpose:
- To evaluate landfill settlement as required in 6 NYCRR Part 363-4.3(b)(1).
- Verify that the proposed cells meet the minimum post-settlement slope requirements under the loading of the proposed Area 7/8 Development (2% post-settlement slope on the liner floor and 1% post-settlement for pipes).

shaded cells represent values to be input

shaded cells represent values to be calculated

Methodology:
- Soil Parameters from the Chaffee 2005 Part 360 Application Western Expansion Engineering Report by McMahon and Mann
- Methodology for Elastic Settlement of sands and low plasticity soils from Giroud and Natissee (1972) via Poulos and Davis "Elastic Solutions for Soil and Rock Mechanics" 1973.
- Methodology for Consolidation Settlement of clay-like soils from Gray (1936) as presented by Poulos and Davis "Elastic Solutions for Soil and Rock Mechanics" 1973.

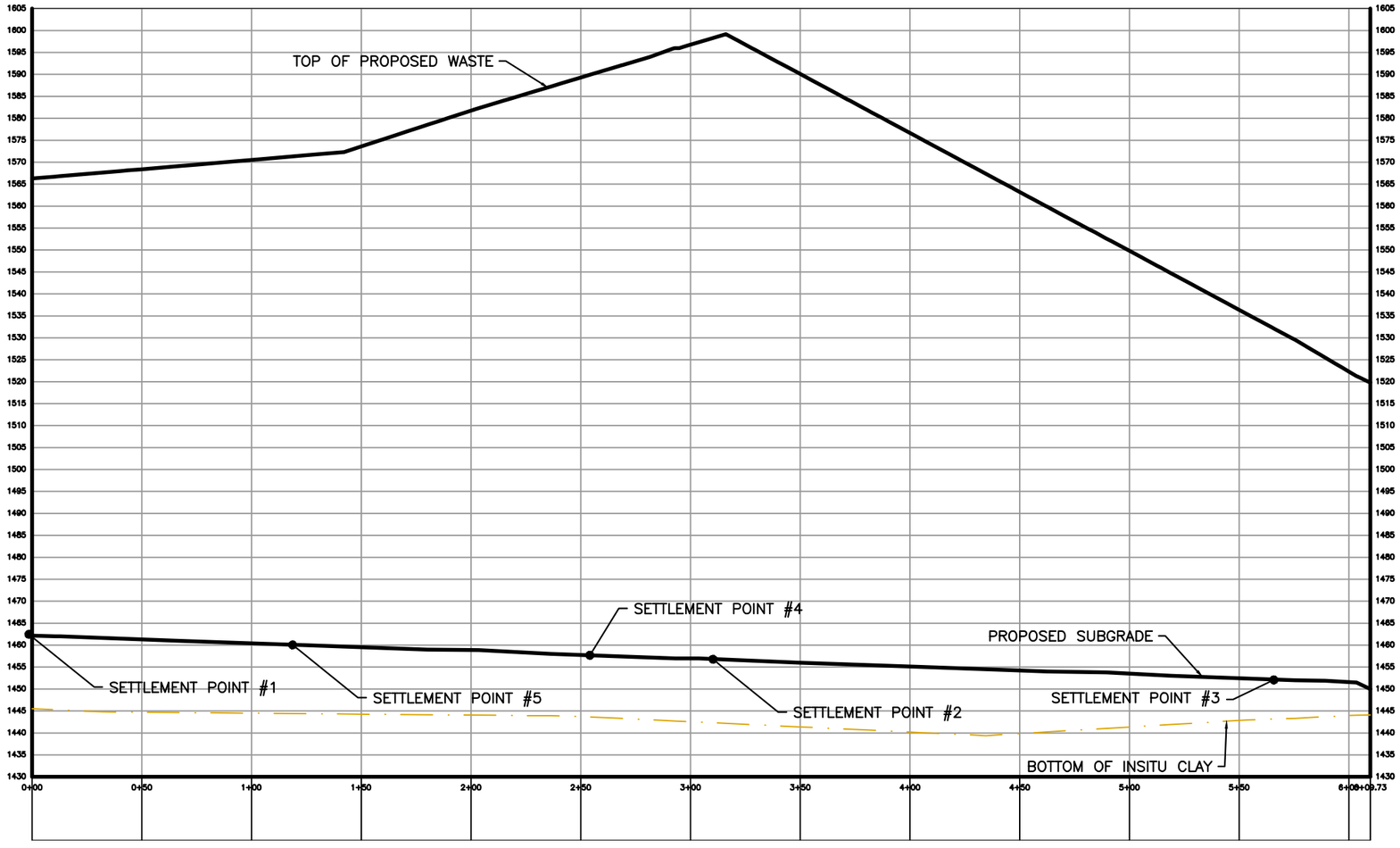
E	Elastic Modulus
v	Poisson's Ratio
P_c	Preconsolidation Pressure
C_c	Compression Index
C_r	Recompression Index
C_α'	Secondary Compression Index
e_o	Initial Void Ratio
γ	Unit Weight

Material Properties:

Recompacted Clay Till			Insitu Clay Till			Underlying Silt and Clay Till			Landfill Elevations and Distances		
γ	132	pcf	γ	132	pcf	γ	138	pcf	Top of Landfill Elev. =	1,608.75	ft
e_o	0.54		e_o	0.59		e_o	0.41		Top of Waste Elev. =	1,604.25	ft
P_c	4,800	psf	P_c	9,000	psf	P_c	4,800	psf	Top of Stone =	1,464.00	ft
C_c	0.10		C_c	0.15		C_r	0.018		Top of Clay =	1,462.00	ft
C_r	0.013		C_r	0.017		C_α'	0.0015		Bottom of Clay =	1,445.26	ft
C_α'	0.0015		C_α'	0.0023		t_1	1.0	years	Top of Rock =	900.00	ft
t_1	1.0	years	t_1	1.0	years	t_2	40.0	years	Depth of Soils =	545.26	ft
t_2	40.0	years	t_2	40.0	years	E	10,400	psi	Depth of Underlying		
E	10,400	psi	E	10,400	psi	E	1,497,600	psf	10 Soil Layers =	54.53	ft
E	1,497,600	psf	E	1,497,600	psf	v	0.5				
v	0.5		v	0.5							

Underlying Sand and Gravel			Waste			Cover Soil			Primary Collection Stone		
γ	135	pcf	γ	59	pcf	γ	125	pcf	γ	130	pcf
E	22,500	psi	max.H	140.25	ft	H	4.5	ft	H	2	ft
E	3,240,000	psf									
v	0.5		Water			Factor of Safety	2				
			γ	62.4	pcf						

SETTLEMENT SECTION 1



NOTE:
POINTS 4 AND 5 ARE SHOWN IN THIS SECTION,
BUT ARE NOT IN THE SAME PLANE AS POINTS 1–3

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ROBERT A. HOLMES

N.Y.P.E. Lic. No. 077317 Date

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CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

SETTLEMENT SECTION 1

SHEET NO. 2
PROJECT NO. 190260

1" 1/2" 0" 1"

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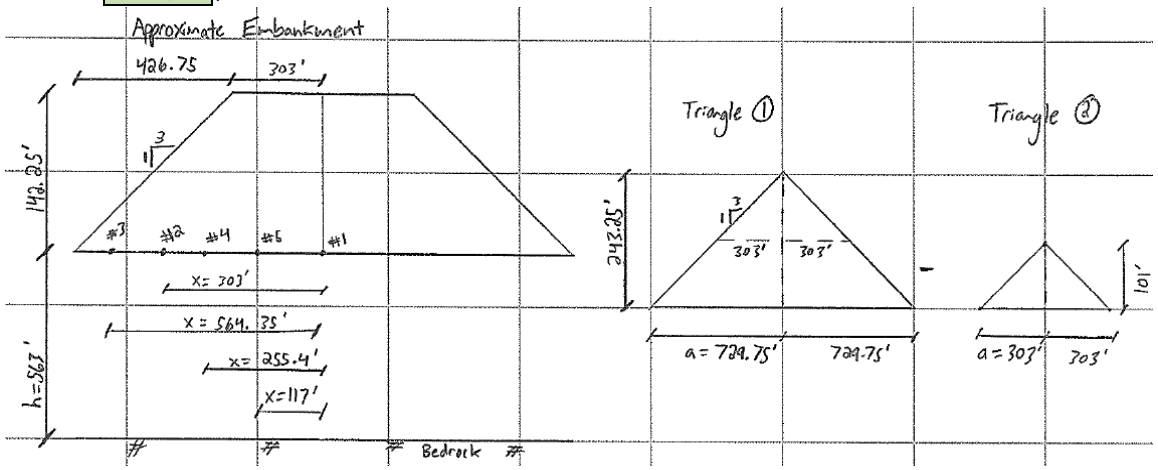
Elastic Settlements:

Landfill Load

P = (γ.cover)(H.cover)+(FS)(γ.waste)(H.waste)+(γ.stone)(H.stone)

P = 17,372 psf



Properties for Triangle #1

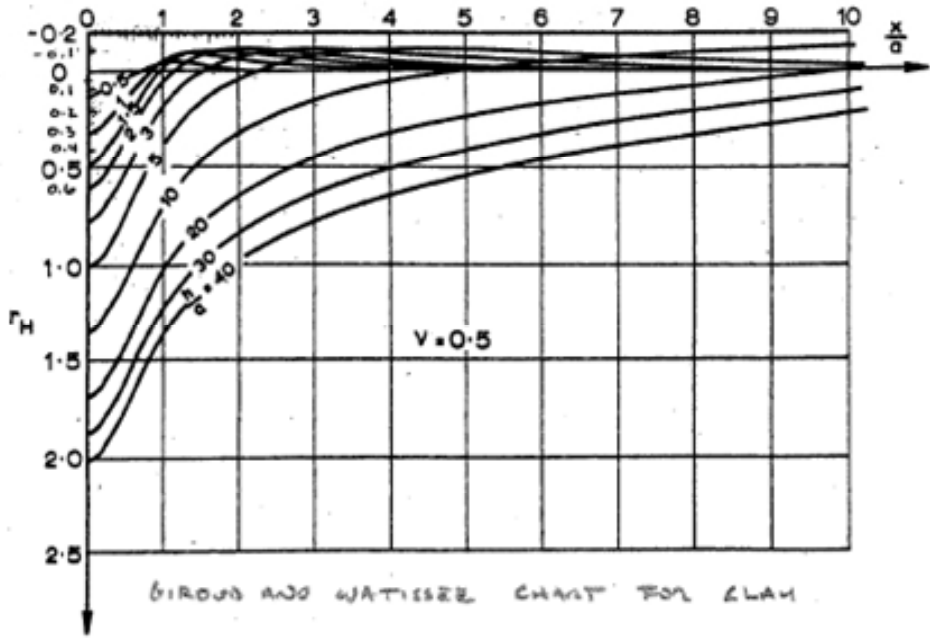
a =	729.75	ft
h =	563.00	ft
Height of Triangle =	243.25	ft
P =	28,759.00	psf
h/a =	0.77	

Properties for Triangle #2

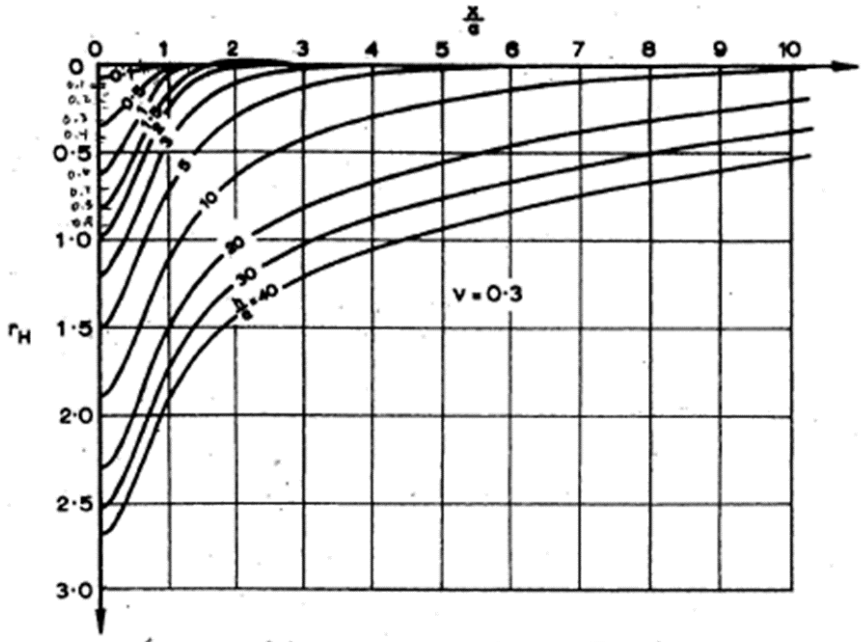
a =	303.00	ft
h =	563.00	ft
Height of Triangle =	101.00	ft
P =	11,918.00	psf
h/a =	1.86	

Settlement Point	x (ft)	x/a for Triangle 1	x/a for Triangle 2	Top of Recompacted Clay	Top of Insitu Clay	Bottom of Insitu Clay	% Clay	% Silt
1	0	0.00	0.00	1462	1459	1445.26	41.79%	58.21%
2	303	0.42	1.00	1456.75	1453.75	1442.21	41.57%	58.43%
3	564.35	0.77	1.86	1452.00	1449	1443.33	40.94%	59.06%
4	255.4	0.35	0.84	1462.00	1459	1446.85	41.62%	58.38%
5	117	0.16	0.39	1463.00	1460	1441.72	42.27%	57.73%

Settlement Point	Elastic Settlement in Clay			Elastic Settlement in Sand			Total Elastic Settlement (ft)
	ρ_h for Triangle 1	ρ_h for Triangle 2	S_{ic} (ft)	ρ_h for Triangle 1	ρ_h for Triangle 2	S_{is} (ft)	
1	0.20	0.55	0.617	0.45	0.95	1.080	1.697
2	0.15	0.10	0.774	0.30	0.25	0.973	1.746
3	0.08	-0.10	0.558	0.20	0.00	0.765	1.323
4	0.15	0.10	0.774	0.35	0.40	1.063	1.838
5	0.20	0.40	0.777	0.45	0.75	1.200	1.977



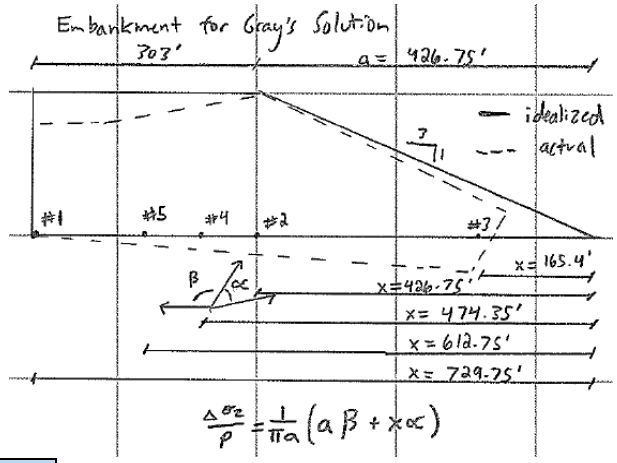
GIROUD AND WATTISSEE CHART FOR CLAY



GIROUD AND WATTISSEE CHART FOR SAND

Stress Distribution Per Gray's Solution

a = 426.75 ft



x = 729.75 ft

Point 1	α (Deg)	α (Rad)	β (Deg)	β (Rad)	σz/P
1	0.17	0.00	179.7	3.14	1.00
2	1.09	0.02	178.1	3.11	1.00
3	4.81	0.08	171.7	3.00	1.00
4	10.32	0.18	162.0	2.83	1.00
5	14.95	0.26	153.2	2.67	0.99
6	18.54	0.32	145.6	2.54	0.98
7	21.10	0.37	139.1	2.43	0.97
8	22.80	0.40	133.7	2.33	0.96
9	23.81	0.42	129.2	2.26	0.94
10	24.30	0.42	125.4	2.19	0.93
11	24.40	0.43	122.3	2.13	0.91
12	24.23	0.42	119.5	2.09	0.89

x = 426.75 ft

Point 2	α (Deg)	α (Rad)	β (Deg)	β (Rad)	σz/P
1	0.08	0.00	179.7	3.14	1.00
2	0.48	0.01	178.3	3.11	0.99
3	2.25	0.04	172.2	3.00	0.97
4	4.90	0.09	162.4	2.84	0.93
5	6.97	0.12	153.6	2.68	0.89
6	8.41	0.15	146.0	2.55	0.86
7	9.26	0.16	139.5	2.44	0.83
8	9.67	0.17	134.1	2.34	0.80
9	9.76	0.17	129.5	2.26	0.77
10	9.64	0.17	125.7	2.19	0.75
11	9.40	0.16	122.5	2.14	0.73
12	9.09	0.16	119.8	2.09	0.72

x = 165.4 ft

Point 3	α (Deg)	α (Rad)	β (Deg)	β (Rad)	σz/P
1	179.15	3.13	0.3	0.01	0.39
2	176.70	3.08	1.3	0.02	0.39
3	159.97	2.79	7.8	0.14	0.39
4	132.37	2.31	19.0	0.33	0.39
5	109.92	1.92	28.9	0.51	0.40
6	92.49	1.61	37.3	0.65	0.41
7	79.07	1.38	44.1	0.77	0.42
8	68.64	1.20	49.6	0.87	0.42
9	60.41	1.05	54.2	0.95	0.43
10	53.80	0.94	57.9	1.01	0.44
11	48.42	0.85	60.9	1.06	0.44
12	43.96	0.77	63.5	1.11	0.45

x = 474.35 ft

Point 4	α (Deg)	α (Rad)	β (Deg)	β (Rad)	σz/P
1	0.10	0.00	179.7	3.14	1.00
2	0.62	0.01	178.3	3.11	0.99
3	2.86	0.05	172.0	3.00	0.97
4	6.20	0.11	162.2	2.83	0.94
5	8.87	0.15	153.4	2.68	0.91
6	10.75	0.19	145.7	2.54	0.88
7	11.92	0.21	139.2	2.43	0.85
8	12.53	0.22	133.8	2.34	0.82
9	12.73	0.22	129.3	2.26	0.80
10	12.65	0.22	125.5	2.19	0.78
11	12.40	0.22	122.3	2.13	0.76
12	12.04	0.21	119.5	2.09	0.74

x = 612.75 ft

Point 5	α (Deg)	α (Rad)	β (Deg)	β (Rad)	σz/P
1	0.14	0.00	179.7	3.14	1.00
2	1.16	0.02	177.7	3.10	1.00
3	4.56	0.08	170.9	2.98	0.99
4	9.20	0.16	161.3	2.82	0.97
5	13.00	0.23	152.7	2.66	0.95
6	15.85	0.28	145.2	2.53	0.93
7	17.79	0.31	138.8	2.42	0.91
8	18.98	0.33	133.5	2.33	0.89
9	19.58	0.34	129.1	2.25	0.87
10	19.77	0.35	125.3	2.19	0.85
11	19.66	0.34	122.2	2.13	0.84
12	19.34	0.34	119.5	2.09	0.82

Consolidation Settlements: Landfill Load

p 17,372 psf

Settlement for Point #1

Elevations

Top of Recompacted Clay =	1462
Top of Insitu Clay =	1459
Bottom of Clay =	1445.26

Layer	P.o (psf)	σz/P	Δσz (psf)	Clay Settlement Primary S.pc (ft)	Clay Settlement Secondary S.pc (ft)
Recompacted Clay	104.4	1.00	17372.00	0.154	0.007
In-situ Clay	686.952	1.00	17371.96	0.556	0.051
1	3177.1134	1.00	17368.73	0.226	0.051
2	7201.1322	1.00	17337.33	0.148	0.051
3	11225.151	0.99	17253.55	0.113	0.051
4	15249.17	0.98	17109.69	0.091	0.051
5	19273.189	0.97	16911.39	0.076	0.051
6	23297.207	0.96	16670.95	0.065	0.051
7	27321.226	0.94	16402.11	0.057	0.051
8	31345.245	0.93	16117.13	0.050	0.051
9	35369.264	0.91	15825.82	0.045	0.051
10	39393.283	0.89	15535.48	0.040	0.051
			Totals	**1.621**	**0.568**

Settlement for Point #2

Elevations

Top of Recompacted Clay =	1456.75
Top of Insitu Clay =	1453.75
Bottom of Clay =	1442.21

Layer	P.o (psf)	σz/P	Δσz (psf)	Clay Settlement Primary S.pc (ft)	Clay Settlement Secondary S.pc (ft)
Recompacted Clay	104.4	1.00	17352.56	0.154	0.007
In-situ Clay	610.392	0.99	17258.38	0.468	0.043
1	3012.7389	0.97	16834.01	0.227	0.051
2	7014.2487	0.93	16150.02	0.144	0.051
3	11015.759	0.89	15501.87	0.106	0.051
4	15017.268	0.86	14902.91	0.083	0.051
5	19018.778	0.83	14360.04	0.068	0.051
6	23020.288	0.80	13874.74	0.057	0.051
7	27021.798	0.77	13444.64	0.049	0.051
8	31023.308	0.75	13065.21	0.042	0.051
9	35024.817	0.73	12730.98	0.037	0.051
10	39026.327	0.72	12436.39	0.033	0.051
			Totals	**1.467**	**0.557**

Settlement for Point #3

Elevations

Top of Recompacted Clay =	1452
Top of Insitu Clay =	1449
Bottom of Clay =	1443.33

Layer	P.o (psf)	σz/P	Δσz (psf)	Clay Settlement Primary S.pc	Clay Settlement Secondary S.pc (ft)
Recompacted Clay	104.40	0.39	6733.05	0.073	0.007
In-situ Clay	406.12	0.39	6733.07	0.075	0.021
1	2608.32	0.39	6737.24	0.154	0.051
2	6618.10	0.39	6788.42	0.085	0.051
3	10627.87	0.40	6904.51	0.060	0.051
4	14637.65	0.41	7056.09	0.047	0.051
5	18647.42	0.42	7212.70	0.039	0.051
6	22657.20	0.42	7358.06	0.034	0.051
7	26666.97	0.43	7486.56	0.030	0.051
8	30676.75	0.44	7597.79	0.027	0.051
9	34686.52	0.44	7693.44	0.024	0.051
10	38696.30	0.45	7775.68	0.022	0.051
			Totals	**0.671**	**0.536**

Settlement for Point #4

Elevations

Top of Recompacted Clay =	1462
Top of Insitu Clay =	1459
Bottom of Clay =	1446.85

Layer	P.o (psf)	σz/P	Δσz (psf)	Clay Settlement Primary S.pc	Clay Settlement Secondary S.pc (ft)
Recompacted Clay	104.40	1.00	17355.62	0.154	0.007
In-situ Clay	631.62	0.99	17272.89	0.492	0.045
1	3072.32	0.97	16908.80	0.227	0.051
2	4328.83	0.94	16321.41	0.189	0.051
3	6511.76	0.91	15754.15	0.149	0.051
4	8694.69	0.88	15216.84	0.123	0.051
5	10877.62	0.85	14716.76	0.104	0.051
6	13060.55	0.82	14257.99	0.089	0.051
7	15243.47	0.80	13841.63	0.078	0.051
8	17426.40	0.78	13466.48	0.069	0.051
9	19609.33	0.76	13129.89	0.062	0.051
10	21792.26	0.74	12828.48	0.056	0.051
			Totals	**1.794**	**0.563**

Settlement for Point #5

	Elevations
Top of Recompacted Clay =	1463
Top of Insitu Clay =	1460
Bottom of Clay =	1441.72

Layer	P.o (psf)	σz/P	Δσz (psf)	Clay Settlement Primary S.pc (ft)	Clay Settlement Secondary S.pc (ft)
Recompacted Clay	104.4	1.00	17364.49	0.154	0.007
In-situ Clay	844.944	1.00	17311.23	0.726	0.067
1	3480.0348	0.99	17128.08	0.214	0.051
2	7477.9284	0.97	16842.00	0.142	0.051
3	11475.822	0.95	16534.39	0.107	0.051
4	15473.716	0.93	16205.69	0.086	0.051
5	19471.609	0.91	15862.64	0.072	0.051
6	23469.503	0.89	15514.38	0.061	0.051
7	27467.396	0.87	15169.48	0.053	0.051
8	31465.29	0.85	14834.70	0.046	0.051
9	35463.184	0.84	14514.62	0.041	0.051
10	39461.077	0.82	14212.02	0.037	0.051
			Totals	**1.739**	**0.581**

Summary of Differential Settlements and Liner Strains

	Point	Top of Recompacted Clay Elevation	Elevation Difference Between Points (ft)	Horizontal Distance Between Points (ft)	Length of Liner Between Points (ft)	Pre-Settlement Slope (%)	Total Elastic Settlement (ft)	Total Consolidation Settlement (ft)	Total Settlement (ft)	Top of Recompacted Clay Elevation Following Settlement	Elevation Difference Between Points (ft)	Post-Settlement Slope (%)	Settled Length of Liner Between Points (ft)	Liner Strain (%)
	1	1462					1.697	2.188	3.886	1458.11				
Points along	1-2		5.25	303	303.05	1.73					5.13	**1.69**	303.04	-0.00066
Pipe Slope	2	1456.75					1.746	2.023	3.770	1452.98				
	2-3		4.75	261.4	261.44	1.82					3.51	**1.34**	261.42	-0.00749
	3	1452					1.323	1.207	2.530	1449.47				
	4	1462					1.838	2.357	4.195	1457.81				
	4-3		10	399.7	399.83	2.50					8.33	**2.09**	399.79	-0.00955
Points along	3	1452					1.323	1.207	2.530	1449.47				
Floor Slope	5	1463					1.977	2.320	4.297	1458.70				
	5-2		6.25	255.4	255.48	2.45					5.72	**2.24**	255.46	-0.00484
	2	1456.75					1.746	2.023	3.770	1452.98				

Conclusion

- Proposed pipes and liner floor layouts for the Area 7/8 Development cells meet the required post-settlement slopes under the proposed loading.
- Post-settlement pipe slopes are greater than 1.0% and post-settlement floor slopes are greater than 2.0%.

Client Name:	WM Chaffee		Project Name:	Chaffee Area 7/8 Development					
Subject:	Proposed Settlement Section 2		Project #:	190260					
Designed by:	L.Rohr	Date:	2/28/2020	Checked by:	C.Eller	Date:	2/28/2020	Sheet No.	1 of 8

Purpose:
- To evaluate landfill settlement as required in 6 NYCRR Part 363-4.3(b)(1).
- Verify that the proposed cells meet the minimum post-settlement slope requirements under the loading of the proposed Area 7/8 Development (2% post-settlement slope on the liner floor and 1% post-settlement for pipes).

shaded cells represent values to be input
shaded cells represent values to be calculated

Methodology:
- Soil Parameters from the Chaffee 2005 Part 360 Application Western Expansion Engineering Report by McMahon and Mann
- Existing Waste Parameters from the Chaffee 2012 Part 360 Application Valley Fill Engineering Report by McMahon and Mann
- Methodology for Elastic Settlement of sands and low plasticity soils from Giroud and Natissee (1972) via Poulos and Davis "Elastic Solutions for Soil and Rock Mechanics" 1973.
- Methodology for Consolidation Settlement of clay-like soils from Gray (1936) as presented by Poulos and Davis "Elastic Solutions for Soil and Rock Mechanics" 1973.

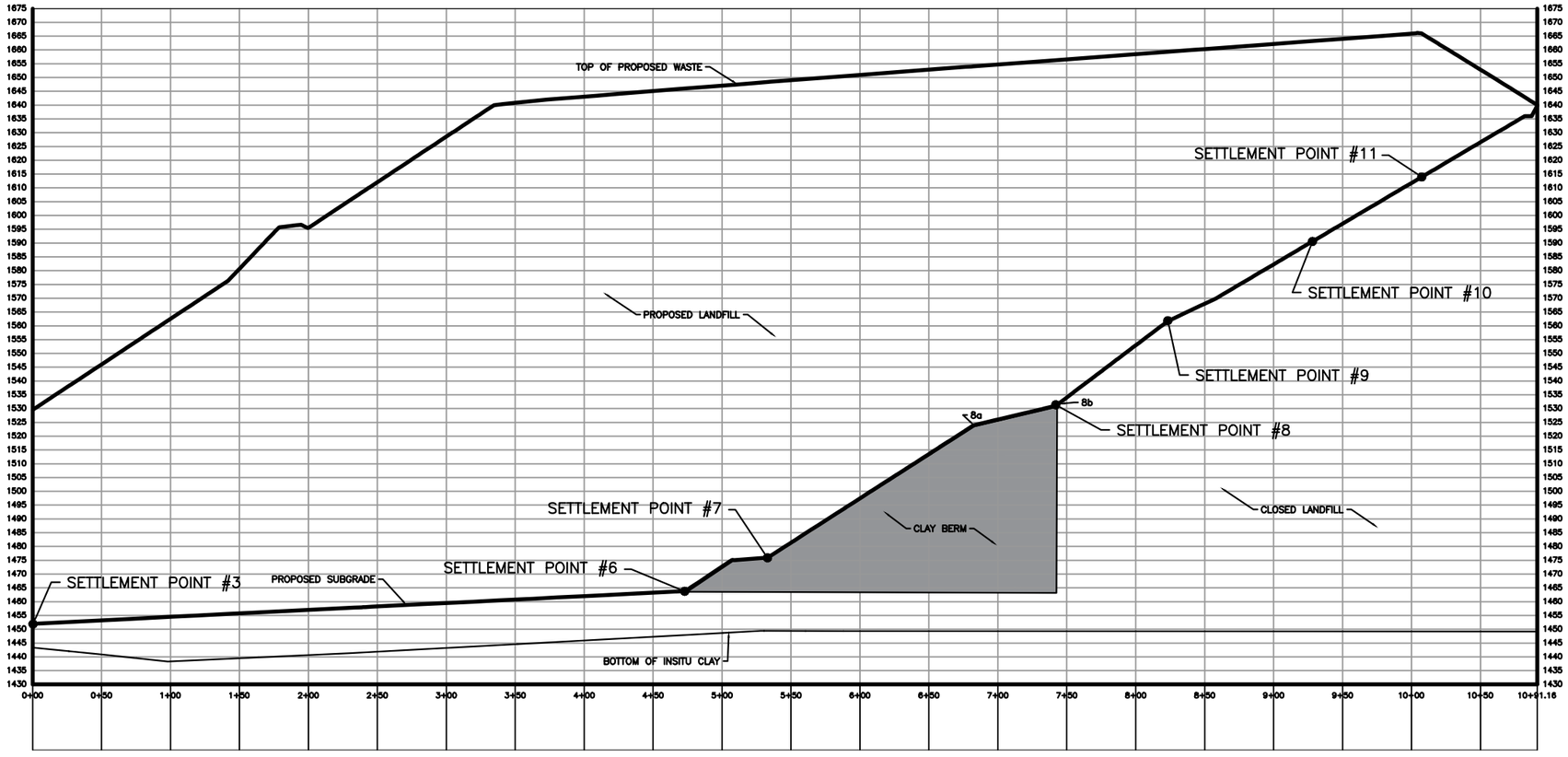
E	Elastic Modulus
v	Poisson's Ratio
P_c	Preconsolidation Pressure
C_c	Compression Index
C_r	Recompression Index
C_α'	Secondary Compression Index
e_o	Initial Void Ratio
γ	Unit Weight

Material Properties:

Recompacted Clay Till			Insitu Clay Till			Underlying Silt and Clay Till			Landfill Elevations and Distances			Existing Waste Properties	
γ	132	pcf	γ	132	pcf	γ	138	pcf	Top of Landfill Elev. =	1,670.50	ft	γ (pcf)	118
e_o	0.54		e_o	0.59		e_o	0.41		Top of Waste Elev. =	1,666.00	ft	C_c	0.35
P_c	4,800	psf	P_c	9,000	psf	P_c	4,800	psf	Top of Stone =	1,468.00	ft	C_α'	0.15
C_c	0.10		C_c	0.15		C_r	0.018		Top of Clay =	1,466.00	ft	t1 (yrs)	20
C_r	0.013		C_r	0.017		C_α'	0.0015		Bottom of Clay =	1,448.00	ft	t2 (yrs)	50
C_α'	0.0015		C_α'	0.0023		t_1	1.0	years	Top of Rock =	900.00	ft		
t_1	1.0	years	t_1	1.0	years	t_2	40.0	years	Depth of Soils =	548.00	ft		
t_2	40.0	years	t_2	40.0	years	E	10,400	psi	Depth of Underlying				
E	10,400	psi	E	10,400	psi	E	1,497,600	psf	10 Soil Layers =	54.80	ft		
E	1,497,600	psf	E	1,497,600	psf	v	0.5						
v	0.5		v	0.5									

Underlying Sand and Gravel			Waste			Cover Soil			Primary Collection Stone		
γ	135	pcf	γ	59	pcf	γ	125	pcf	γ	130	pcf
E	22,500	psi	max.H	198	ft	H	4.5	ft	H	2	ft
E	3,240,000	psf							Landfill Load		
v	0.5		Water			Factor of Safety	2		P =	(γ.cover)(H.cover)+(FS)(γ.waste)(H.waste)+(γ.stone)(H.stone	
			γ	62.4	pcf				P =	24,187	psf

SETTLEMENT SECTION 2



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ROBERT A. HOLMES

N.Y.P.E. Lic. No. 077317 Date

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CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

SETTLEMENT SECTION 2

SHEET NO. 3
PROJECT NO. 190260

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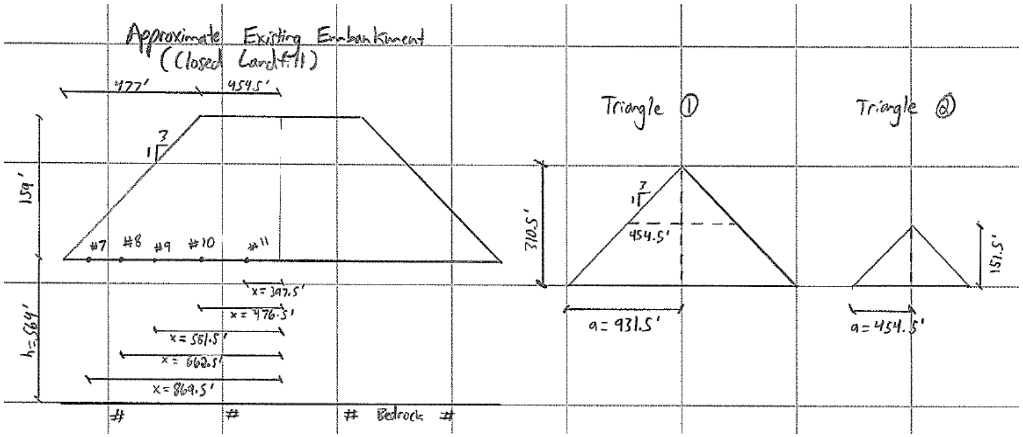
1" 1/2" 0" 1"

Elastic Settlements: For Recompacted Clay

G

Settlement Point	Top of Proposed Cover	Top of Proposed Waste	Top of Leachate Stone	Top of Recompacted Clay	Bottom of Recompacted Clay	$\Delta\sigma_z$ (psf)	Elastic Settlement in Clay S_{irc} (ft)
3	1534	1529.5	1456	1454	1450	9495.5	0.025
6	1670.5	1666	1468	1466	1462	24186.5	0.065
7	1670.5	1666	1479	1477	1462	22888.5	0.229
8	1670.5	1666	1535	1533	1462	16280.5	0.772
9	1670.5	1666	1566	1564	1560	12622.5	0.034
10	1670.5	1666	1595	1593	1589	9200.5	0.025
11	1670.5	1666	1618	1616	1612	6486.5	0.017

Elastic Settlements: Based on Existing Embankment



Properties for Triangle #1

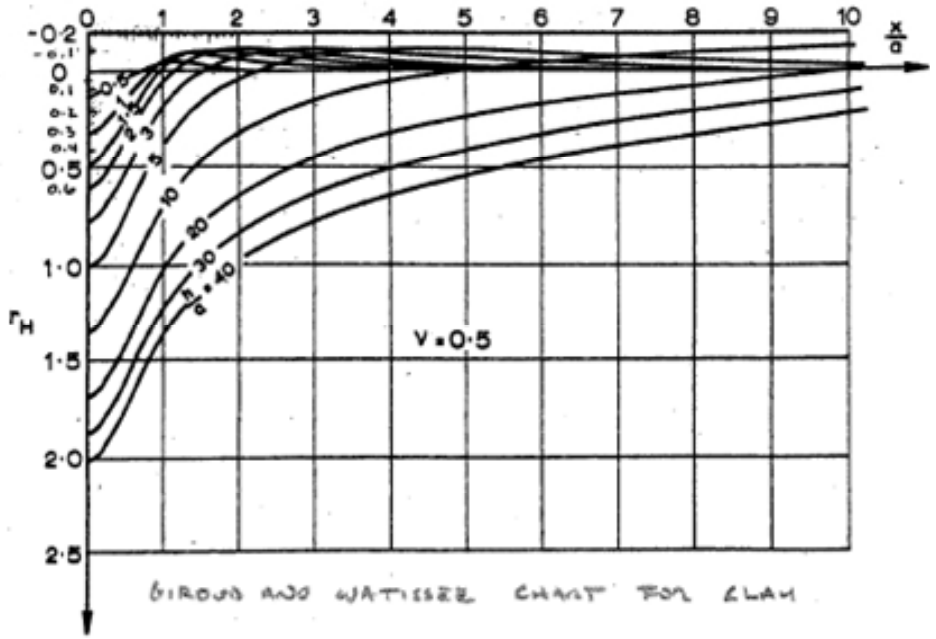
a =	931.50	ft
h =	564.00	ft
Height of Triangle =	310.50	ft
P =	36,694.50	psf
h/a =	0.61	

Properties for Triangle #2

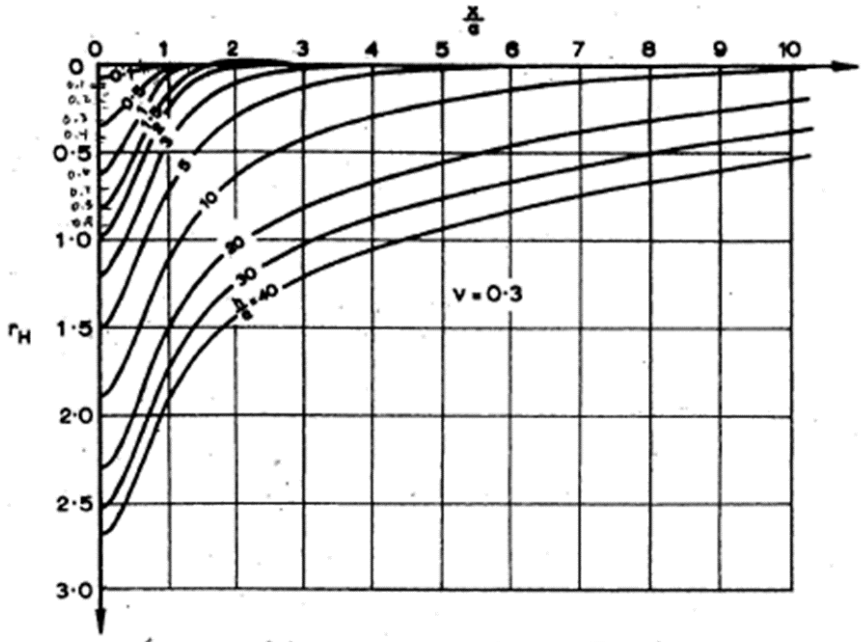
a =	454.50	ft
h =	564.00	ft
Height of Triangle =	151.50	ft
P =	17,932.50	psf
h/a =	1.24	

Settlement Point	x (ft)	x/a for Triangle 1	x/a for Triangle 2	Top of Insitu Clay	Bottom of Insitu Clay	% Clay	% Silt
7	869.5	0.93	1.91	1464	1448	41.70%	58.30%
8	662.5	0.71	1.46	1464	1448	41.70%	58.30%
9	581.5	0.62	1.28	1464	1448	41.70%	58.30%
10	476.5	0.51	1.05	1464	1448	41.70%	58.30%
11	397.5	0.43	0.87	1464	1448	41.70%	58.30%

Settlement Point	Elastic Settlement in Clay			Elastic Settlement in Sand		
	r_h for Triangle 1	r_h for Triangle 2	S_{ic} (ft)	r_h for Triangle 1	r_h for Triangle 2	S_{is} (ft)
7	0.00	-0.10	0.227	0.10	0.00	0.615
8	0.05	-0.10	0.703	0.15	0.00	0.923
9	0.08	-0.05	0.875	0.20	0.05	1.157
10	0.09	-0.05	0.970	0.25	0.15	1.318
11	0.10	0.05	0.838	0.25	0.30	1.098

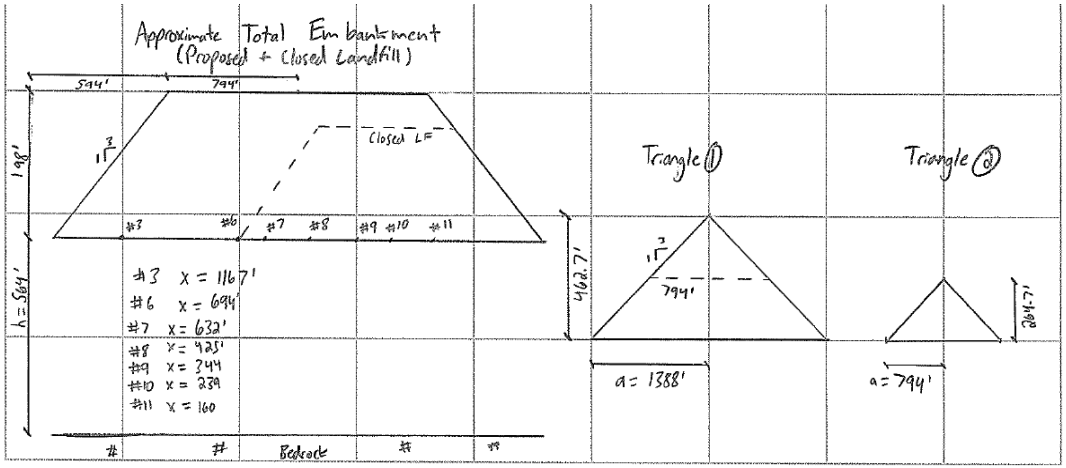


GIROUD AND WATTISSEE CHART FOR CLAY



GIROUD AND WATTISSEE CHART FOR SAND

Elastic Settlements: Based on Existing and Proposed Embankment



Properties for Triangle #1		
a =	1,388.00	ft
h =	564.00	ft
Height of Triangle =	462.67	ft
P =	54,650.17	psf
h/a =	0.41	

Properties for Triangle #2		
a =	794.00	ft
h =	564.00	ft
Height of Triangle =	264.70	ft
P =	31,290.10	psf
h/a =	0.71	

Settlement Point	x (ft)	x/a for Triangle 1	x/a for Triangle 2	Top of Insitu Clay	Bottom of Insitu Clay	% Clay	% Silt
3	1167	0.84	1.47	1452	1443.00	40.98%	59.02%
6	694	0.50	0.87	1464	1448.00	41.70%	58.30%
7	632	0.46	0.80	1464	1448.00	41.70%	58.30%
8	425	0.31	0.54	1464	1448.00	41.70%	58.30%
9	344	0.25	0.43	1464	1448.00	41.70%	58.30%
10	239	0.17	0.30	1464	1448.00	41.70%	58.30%
11	160	0.12	0.20	1464	1448.00	41.70%	58.30%

Settlement Point	Elastic Settlement in Clay			Elastic Settlement in Sand		
	r_h for Triangle 1	r_h for Triangle 2	S_{ic} (ft)	r_h for Triangle 1	r_h for Triangle 2	S_{is} (ft)
3	0.00	-0.10	0.680	0.08	0.00	1.105
6	0.05	0.04	0.779	0.15	0.15	1.377
7	0.06	0.06	0.852	0.20	0.20	1.836
8	0.08	0.10	0.998	0.22	0.25	1.885
9	0.09	0.11	1.140	0.23	0.28	1.888
10	0.10	0.13	1.213	0.25	0.30	2.071
11	0.11	0.15	1.286	0.28	0.31	2.436

Elastic Settlements: Total

	A	B	C = (B-A)	D	E	F = (E-D)	G	H = (C+F+G)
Settlement Point	Existing S_{ic} (ft)	Existing and Proposed	Total S_{ic} (ft)	Existing S_{is} (ft)	Existing and Proposed S_{is} (ft)	Total S_{is} (ft)	Recompacted Clay S_{irc} (ft)	Total Elastic Settlement (ft)
3	NA	0.68	0.68	NA	1.11	1.11	0.025	**1.811**
6	NA	0.78	0.78	NA	1.38	1.38	0.065	**2.221**
7	0.23	0.85	0.63	0.62	1.84	1.22	0.229	**2.075**
8	0.70	1.00	0.30	0.92	1.89	0.96	0.772	**2.030**
9	0.87	1.14	0.27	1.16	1.89	0.73	0.034	**1.030**
10	0.97	1.21	0.24	1.32	2.07	0.75	0.025	**1.021**
11	0.84	1.29	0.45	1.10	2.44	1.34	0.017	**1.803**

Consolidation Settlements: For Recompacted Clay

Settlement Point	Top of Proposed Cover	Top of Proposed Waste	Top of Leachate Stone	Top of Recompacted Clay	Bottom of Recompacted Clay	P_o (psf)	$\Delta\sigma_z$ (psf)	Clay Settlement Primary S_{PC} (ft)	Clay Settlement Secondary S_{SC} (ft)
3	1534	1529.5	1456	1454	1450	139.20	9495.5	0.132	0.009
6	1670.5	1666	1468	1466	1462	139.20	24186.5	0.239	0.009
7	1670.5	1666	1479	1477	1462	522.00	22888.5	0.806	0.035
8	1670.5	1666	1535	1533	1462	2470.80	16280.5	2.956	0.166
9	1670.5	1666	1566	1564	1560	139.20	12622.5	0.164	0.009
10	1670.5	1666	1595	1593	1589	139.20	9200.5	0.129	0.009
11	1670.5	1666	1618	1616	1612	139.20	6486.5	0.089	0.009

Stress Distribution Per Gray's Solution: Based on Existing Embankment

x = 62 ft

Point 7	α (Rad)	β (Rad)	σz/P
1	2.99	0.02	0.13
2	2.43	0.10	0.13
3	1.90	0.23	0.15
4	1.60	0.35	0.18
5	1.40	0.46	0.21
6	1.24	0.56	0.23
7	1.11	0.65	0.25
8	1.00	0.73	0.27
9	0.92	0.80	0.29
10	0.84	0.86	0.31
11	0.77	0.91	0.32

a = 477.00 ft

Landfill Load

P = (γ.cover)(H.cover)+(FS)(γ.waste)(H.waste)+(γ.stone)(H.stone)

P = 24,187 psf

x = 269 ft

Point 8	α (Rad)	β (Rad)	σz/P
1	3.07	0.04	0.56
2	2.78	0.21	0.56
3	2.35	0.44	0.56
4	1.99	0.63	0.56
5	1.70	0.78	0.55
6	1.47	0.90	0.55
7	1.28	0.99	0.55
8	1.14	1.06	0.54
9	1.02	1.12	0.54
10	0.92	1.16	0.53
11	0.83	1.20	0.53

x = 455 ft

Point 10	α (Rad)	β (Rad)	σz/P
1	2.78	0.35	0.95
2	1.94	1.10	0.94
3	1.58	1.35	0.91
4	1.39	1.43	0.88
5	1.25	1.47	0.85
6	1.13	1.49	0.82
7	1.03	1.50	0.79
8	0.94	1.51	0.77
9	0.87	1.52	0.75
10	0.80	1.53	0.73
11	0.74	1.53	0.71

x = 350 ft

Point 9	α (Rad)	β (Rad)	σz/P
1	3.06	0.06	0.73
2	2.69	0.33	0.73
3	2.21	0.66	0.73
4	1.85	0.88	0.71
5	1.58	1.02	0.70
6	1.38	1.12	0.68
7	1.21	1.19	0.66
8	1.08	1.24	0.65
9	0.98	1.28	0.64
10	0.89	1.31	0.62
11	0.81	1.34	0.62

x = 534 ft

Point 11	α (Rad)	β (Rad)	σz/P
1	0.00	3.12	1.00
2	0.01	3.05	0.97
3	0.03	2.93	0.94
4	0.05	2.82	0.91
5	0.06	2.71	0.88
6	0.07	2.62	0.86
7	0.07	2.53	0.83
8	0.08	2.46	0.81
9	0.08	2.39	0.79
10	0.08	2.33	0.77
11	0.08	2.27	0.75

Stress Distribution Per Gray's Solution: Based on Existing and Proposed Embankment

x = 221 ft

a = 594.00 ft

Landfill Load

P = (γ.cover)(H.cover)+(FS)(γ.waste)(H.waste)+(γ.stone)(H.stone)

P = 24,187 psf

Point 3	α (Rad)	β (Rad)	σz/P
1	3.11	0.01	0.37
2	2.88	0.10	0.37
3	2.52	0.24	0.37
4	2.19	0.37	0.38
5	1.92	0.49	0.38
6	1.69	0.60	0.39
7	1.50	0.69	0.40
8	1.35	0.77	0.40
9	1.22	0.84	0.41
10	1.11	0.90	0.42
11	1.02	0.95	0.42

x = 694 ft

Point 6	α (Rad)	β (Rad)	σz/P
1	0.00	3.13	1.00
2	-0.01	3.09	0.98
3	-0.02	3.02	0.95
4	-0.03	2.95	0.93
5	-0.03	2.89	0.91
6	-0.04	2.82	0.88
7	-0.05	2.76	0.86
8	-0.05	2.70	0.84
9	-0.06	2.65	0.82
10	-0.06	2.60	0.80
11	-0.06	2.55	0.79

x = 756 ft

Point 7	α (Rad)	β (Rad)	σz/P
1	0.00	3.13	1.00
2	0.00	3.09	0.98
3	-0.01	3.02	0.96
4	-0.01	2.95	0.94
5	-0.01	2.89	0.91
6	-0.01	2.82	0.89
7	-0.02	2.76	0.87
8	-0.02	2.70	0.85
9	-0.02	2.65	0.83
10	-0.02	2.60	0.82
11	-0.02	2.55	0.80

x = 963 ft

Point 8	α (Rad)	β (Rad)	σz/P
1	0.00	3.13	1.00
2	0.01	3.09	0.99
3	0.02	3.02	0.97
4	0.03	2.95	0.96
5	0.04	2.89	0.94
6	0.05	2.82	0.93
7	0.06	2.76	0.91
8	0.07	2.70	0.90
9	0.08	2.65	0.88
10	0.08	2.60	0.87
11	0.09	2.55	0.86

x = 1044 ft

Point 9	α (Rad)	β (Rad)	σz/P
1	0.00	3.13	1.00
2	0.01	3.09	0.99
3	0.03	3.02	0.98
4	0.04	2.95	0.96
5	0.06	2.89	0.95
6	0.07	2.82	0.94
7	0.09	2.76	0.93
8	0.10	2.70	0.91
9	0.11	2.65	0.90
10	0.11	2.60	0.89
11	0.12	2.55	0.88

x = 1149 ft

Point 10	α (Rad)	β (Rad)	σz/P
1	0.00	3.13	1.00
2	0.02	3.09	0.99
3	0.04	3.02	0.98
4	0.06	2.95	0.98
5	0.08	2.89	0.97
6	0.09	2.82	0.96
7	0.11	2.76	0.95
8	0.13	2.70	0.94
9	0.14	2.65	0.93
10	0.15	2.60	0.92
11	0.16	2.55	0.91

x = 1228 ft

Point 11	α (Rad)	β (Rad)	σz/P
1	0.00	3.13	1.00
2	0.02	3.09	1.00
3	0.04	3.02	0.99
4	0.07	2.95	0.98
5	0.09	2.89	0.98
6	0.11	2.82	0.97
7	0.13	2.76	0.96
8	0.14	2.70	0.96
9	0.16	2.65	0.95
10	0.17	2.60	0.94
11	0.18	2.55	0.93

Consolidation Settlements: Landfill Load

p 24,187 psf

Settlement for Point #3

Layer	P_o (psf)	Existing Embankment σ_z/P	Existing Embankment $\Delta\sigma_z$ (psf)	Total Embankment σ_z/P	Total Embankment $\Delta\sigma_z$ (psf)	Proposed Embankment $\Delta\sigma_z$ (psf)	Clay Settlement Primary S_{pc} (ft)	Clay Settlement Secondary S_{sc} (ft)
In-situ Clay	313.2	NA	NA	0.37	8998.69	8998.69	0.153	0.033
1	2630.07	NA	NA	0.37	9001.34	9001.34	0.179	0.051
2	6637.41	NA	NA	0.37	9036.06	9036.06	0.103	0.051
3	10644.75	NA	NA	0.38	9127.34	9127.34	0.075	0.051
4	14652.09	NA	NA	0.38	9268.40	9268.40	0.059	0.051
5	18659.43	NA	NA	0.39	9438.41	9438.41	0.049	0.051
6	22666.77	NA	NA	0.40	9617.87	9617.87	0.043	0.051
7	26674.11	NA	NA	0.40	9793.76	9793.76	0.038	0.051
8	30681.45	NA	NA	0.41	9959.01	9959.01	0.034	0.051
9	34688.79	NA	NA	0.42	10110.59	10110.59	0.031	0.051
10	38696.13	NA	NA	0.42	10247.82	10247.82	0.028	0.051
						Totals	**0.791**	**0.541**

Settlement for Point #6

Layer	P_o (psf)	Existing Embankment σ_z/P	Existing Embankment $\Delta\sigma_z$ (psf)	Total Embankment σ_z/P	Total Embankment $\Delta\sigma_z$ (psf)	Proposed Embankment $\Delta\sigma_z$ (psf)	Clay Settlement Primary S_{pc} (ft)	Clay Settlement Secondary S_{sc} (ft)
In-situ Clay	556.8	NA	NA	1.00	24095.88	24095.88	0.867	0.059
1	2648.52	NA	NA	0.98	23695.50	23695.50	0.279	0.051
2	6692.76	NA	NA	0.95	23081.62	23081.62	0.181	0.051
3	10737	NA	NA	0.93	22481.42	22481.42	0.137	0.051
4	14781.24	NA	NA	0.91	21901.40	21901.40	0.110	0.051
5	18825.48	NA	NA	0.88	21346.70	21346.70	0.092	0.051
6	22869.72	NA	NA	0.86	20821.05	20821.05	0.079	0.051
7	26913.96	NA	NA	0.84	20326.70	20326.70	0.068	0.051
8	30958.2	NA	NA	0.82	19864.66	19864.66	0.060	0.051
9	35002.44	NA	NA	0.80	19434.87	19434.87	0.054	0.051
10	39046.68	NA	NA	0.79	19036.49	19036.49	0.048	0.051
						Totals	**1.977**	**0.572**

Settlement for Point #7

Layer	P_o (psf)	Existing Embankment σ_z/P	Existing Embankment $\Delta\sigma_z$ (psf)	Total Embankment σ_z/P	Total Embankment $\Delta\sigma_z$ (psf)	Proposed Embankment $\Delta\sigma_z$ (psf)	Clay Settlement Primary S_{pc} (ft)	Clay Settlement Secondary S_{sc} (ft)
In-situ Clay	556.8	0.13	3144.43	1.00	24103.97	20959.54	0.778	0.059
1	2648.52	0.13	3230.54	0.98	23739.27	20508.73	0.264	0.051
2	6692.76	0.15	3691.74	0.96	23179.19	19487.45	0.166	0.051
3	10737	0.18	4323.01	0.94	22629.60	18306.60	0.121	0.051
4	14781.24	0.21	4971.46	0.91	22095.58	17124.12	0.094	0.051
5	18825.48	0.23	5582.75	0.89	21581.36	15998.61	0.075	0.051
6	22869.72	0.25	6138.23	0.87	21090.16	14951.92	0.061	0.051
7	26913.96	0.27	6633.92	0.85	20624.17	13990.26	0.051	0.051
8	30958.2	0.29	7072.30	0.83	20184.66	13112.36	0.043	0.051
9	35002.44	0.31	7458.63	0.82	19772.05	12313.42	0.037	0.051
10	39046.68	0.32	7798.97	0.80	19386.10	11587.13	0.032	0.051
						Totals	**1.720**	**0.572**

Settlement for Point #8

Layer	P_o (psf)	Existing Embankment σ_z/P	Existing Embankment $\Delta\sigma_z$ (psf)	Total Embankment σ_z/P	Total Embankment $\Delta\sigma_z$ (psf)	Proposed Embankment $\Delta\sigma_z$ (psf)	Clay Settlement Primary S_{pc} (ft)	Clay Settlement Secondary S_{sc} (ft)
In-situ Clay	556.8	0.56	13639.74	1.00	24131.00	10491.26	0.341	0.059
1	2648.52	0.56	13635.84	0.99	23885.53	10249.69	0.192	0.051
2	6692.76	0.56	13600.88	0.97	23506.63	9905.75	0.110	0.051
3	10737	0.56	13523.62	0.96	23130.34	9606.72	0.078	0.051
4	14781.24	0.55	13419.14	0.94	22758.10	9338.95	0.060	0.051
5	18825.48	0.55	13306.54	0.93	22391.33	9084.79	0.048	0.051
6	22869.72	0.55	13198.15	0.91	22031.41	8833.26	0.040	0.051
7	26913.96	0.54	13099.54	0.90	21679.62	8580.08	0.034	0.051
8	30958.2	0.54	13012.25	0.88	21337.11	8324.86	0.029	0.051
9	35002.44	0.53	12935.90	0.87	21004.87	8068.97	0.025	0.051
10	39046.68	0.53	12869.34	0.86	20683.72	7814.38	0.022	0.051
						Totals	**0.979**	**0.572**

Settlement for Point #9

Layer	P_o (psf)	Existing Embankment σ_z/P	Existing Embankment $\Delta\sigma_z$ (psf)	Total Embankment σ_z/P	Total Embankment $\Delta\sigma_z$ (psf)	Proposed Embankment $\Delta\sigma_z$ (psf)	Clay Settlement Primary S_{pc} (ft)	Clay Settlement Secondary S_{sc} (ft)
In-situ Clay	556.8	0.73	17746.76	1.00	24141.58	6394.82	0.188	0.059
1	2648.52	0.73	17724.96	0.99	23942.80	6217.84	0.147	0.051
2	6692.76	0.73	17550.86	0.98	23635.16	6084.31	0.079	0.051
3	10737	0.71	17218.58	0.96	23327.76	6109.18	0.055	0.051
4	14781.24	0.70	16815.56	0.95	23020.90	6205.34	0.043	0.051
5	18825.48	0.68	16407.17	0.94	22715.04	6307.87	0.035	0.051
6	22869.72	0.66	16025.51	0.93	22410.85	6385.34	0.030	0.051
7	26913.96	0.65	15682.36	0.91	22109.16	6426.80	0.026	0.051
8	30958.2	0.64	15379.41	0.90	21810.89	6431.48	0.023	0.051
9	35002.44	0.62	15113.97	0.89	21517.02	6403.05	0.020	0.051
10	39046.68	0.62	14881.78	0.88	21228.52	6346.74	0.018	0.051
						Totals	**0.663**	**0.572**

Settlement for Point #10

Layer	P_o (psf)	Existing Embankment σ_z/P	Existing Embankment $\Delta\sigma_z$ (psf)	Total Embankment σ_z/P	Total Embankment $\Delta\sigma_z$ (psf)	Proposed Embankment $\Delta\sigma_z$ (psf)	Clay Settlement Primary S_{pc} (ft)	Clay Settlement Secondary S_{sc} (ft)
In-situ Clay	556.8	0.95	23065.71	1.00	24155.29	1089.57	0.081	0.059
1	2648.52	0.94	22763.78	0.99	24017.06	1253.27	0.047	0.051
2	6692.76	0.91	21989.47	0.98	23801.98	1812.51	0.029	0.051
3	10737	0.88	21195.83	0.98	23584.41	2388.58	0.024	0.051
4	14781.24	0.85	20445.13	0.97	23363.30	2918.17	0.022	0.051
5	18825.48	0.82	19755.04	0.96	23138.02	3382.98	0.020	0.051
6	22869.72	0.79	19131.10	0.95	22908.33	3777.24	0.019	0.051
7	26913.96	0.77	18572.67	0.94	22674.47	4101.80	0.017	0.051
8	30958.2	0.75	18075.77	0.93	22437.02	4361.25	0.016	0.051
9	35002.44	0.73	17634.76	0.92	22196.85	4562.09	0.015	0.051
10	39046.68	0.71	17243.48	0.91	21955.01	4711.53	0.014	0.051
						Totals	**0.304**	**0.572**

Settlement for Point #11

Layer	P_o (psf)	Existing Embankment σ_z/P	Existing Embankment $\Delta\sigma_z$ (psf)	Total Embankment σ_z/P	Total Embankment $\Delta\sigma_z$ (psf)	Proposed Embankment $\Delta\sigma_z$ (psf)	Clay Settlement Primary S_{pc} (ft)	Clay Settlement Secondary S_{sc} (ft)
In-situ Clay	556.8	1.00	24073.58	1.00	24165.60	92.02	0.011	0.059
1	2648.52	0.97	23575.14	1.00	24072.94	497.79	0.021	0.051
2	6692.76	0.94	22814.82	0.99	23927.59	1112.77	0.019	0.051
3	10737	0.91	22080.24	0.98	23777.89	1697.66	0.018	0.051
4	14781.24	0.88	21382.51	0.98	23621.87	2239.36	0.017	0.051
5	18825.48	0.86	20729.42	0.97	23458.09	2728.68	0.016	0.051
6	22869.72	0.83	20125.27	0.96	23285.73	3160.46	0.016	0.051
7	26913.96	0.81	19571.41	0.96	23104.54	3533.13	0.015	0.051
8	30958.2	0.79	19066.88	0.95	22914.84	3847.95	0.014	0.051
9	35002.44	0.77	18609.21	0.94	22717.38	4108.17	0.013	0.051
10	39046.68	0.75	18194.98	0.93	22513.23	4318.25	0.013	0.051
						Totals	**0.174**	**0.572**

Waste Settlements

Settlement Point	Top of Proposed Cover	Top of Proposed Waste	Top of Leachate Stone	Top of Clay Liner	Bottom of Clay Liner	Bottom of Barrier Protection	Bottom of Exisitng Waste	P_o (psf)	$\Delta\sigma_z$ (psf)	Primary S_{PW} (ft)	Secondary S_{SW} (ft)
9	1670.5	1666	1566	1564	1562	1560	1464	2932.8	12882.5	25.10	5.85
10	1670.5	1666	1595	1593	1591	1589	1464	3739.0	9460.5	24.35	7.58
11	1670.5	1666	1618	1616	1614	1612	1464	4378.4	6746.5	21.26	8.95

Summary of Differential Settlements and Liner Strains

Point	Top of Recompacted Clay Elevation	Elevation Difference Between Points (ft)	Horizontal Distance Between Points (ft)	Length of Liner Between Points (ft)	Pre-Settlement Slope (%)	Total Elastic Settlement (ft)	Total Consolidation Settlement (ft)	Total Waste Settlement (ft)	Total Settlement (ft)	Top of Recompacted Clay Elevation Following Settlement	Elevation Difference Between Points (ft)	Post-Settlement Slope (%)	Settled Length of Liner Between Points (ft)	Liner Strain (%)
3	1454					1.811	1.474	0	3.285	1450.72				
3-6		12	473	473.15	2.54						10.27	**2.17**	473.11	-0.00862
6	1466					2.221	2.797	0	5.017	1460.98				
7	1477					2.075	3.132	0	5.207	1471.79				
7-8a		49	155	162.56	31.61						47.51	**30.65**	162.12	-0.27323
8a	1526					2.030	4.672	0	6.702	1519.30				
8a-8b		7	62	62.39	11.29						7.00	**11.29**	62.39	0
8b	1533					2.030	4.672	0	6.702	1526.30				
8-9		31	82	87.66	37.80						4.31	**5.26**	82.11	-6.33186
9	1564					1.030	1.408	30.95	33.388	1530.61				
9-10		29	105	108.93	27.62						28.42	**27.07**	108.78	-0.13953
10	1593					1.021	1.013	31.93	33.965	1559.04				
10-11		23	79	82.28	29.11						24.10	**30.51**	82.60	0.382945
11	1616					1.803	0.844	30.22	32.862	1583.14				

Conclusion

- Proposed pipes and liner floor layouts for the Area 7/8 Development cells meet the required post-settlement slopes under the proposed loading.
- Post-settlement pipe slopes are greater than 1.0% and post-settlement floor slopes are greater than 2.0%.

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	26-Feb-20	190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	Existing Conditions Settlement	
PREPARED BY	**CHECKED BY**	
L. Rohr	C. Eller	

Description and Purpose:

- To evaluate landfill settlement as required in 6 NYCRR Part 363-4.3(b)(1).
- Verify that the existing cells meet the minimum post-settlement slope requirements under the loading of the proposed Area 7/8 Development (2% post-settlement slope on the liner floor and 1% post-settlement slope for pipes).

Design Basis/References/Assumptions:

- The Cross Section depicted on Figure 1 (attached) is the selected critical cross-sections for the settlement analysis of the existing landfill cells. This cross section represents the cross-section previously analyzed as part of the 2005 permit with the additional loading from the proposed Area 7/8 Development.
- Points 1, 2, and 3 are located along the leachate pipe and points 4 and 5 are located on the landfill subgrade. The starting elevations of these points was taken from the landfill as-built drawings.

- In general, the settlement evaluation consisted of the following steps:

1. Divide the material beneath the liner into layers. The underlying layers consist of recompacted clay, in-situ clay and in-situ sand and gravel with silt and clay lenses. Soil parameters consistent with the 2005 and 2012 permit applications were used for these layers in the settlement analysis.
2. Estimate the stress increase at the center of each layer. The stress increase due to the landfill is estimated from elastic theory. The applied load is considered an embankment and for this analysis includes the orginally permitted fill plus the proposed vertical overfill. Stress increases are estimated at different locations and depths beneath the embankment.
3. Estimate the settlement of each layer. The settlement of each layer is estimated using elastic and consolidation theory. (Elastic settlement for sands and low plasticity soils and consolidation settlement for clay-like soils). Secondary consolidation settlement was conservatively analyzed over a 40-year period.
4. Sum the settlement in each layer. The settlement of each layer is added to estimate the total settlement at each point considered in the evaluation.
5. Evaluate the effect on the liner system. The effect on the leachate collection system is evaluated by estimating the slope of the leachate collection pipes and the landfill floor after settlement. The strain in the liner is also estimated to evaluate the effect of the settlement on the liner.

- As required by 6 NYCRR Part 363-4.3(b)(1), a factor of safety of 2.0 was applied to the landfill load. The typical unit weight of waste, 59 pcf, was doubled to a value of 118 pcf for use in the calculation to incorporate the factor of safety of 2.0.
- Subsurface stratigraphy and selected settlement parameters are consistent with historical borings and lab results.

References:

- Poulos and Davis "Elastic Solutions for Soil and Rock Mechanics" 1973.
- Chaffee 2005 Part 360 Application Western Expansion Engineering Report by McMahon and Mann

Remarks/Conclusions/Results:

- As summarized in the attached tables, settlement of the subgrade beneath the leachate collection pipe in Section 1 is estimated to vary from about 1.9 feet to 6.5 feet.
- Post-settlement slopes of the pipes remain greater than 1.0%.
- Post-settlement slopes of the landfill floor remain greater than 2.0%

- Existing LCRS pipes and liner floor layouts meet the minimum required post-settlement slopes for the existing cells.

Client Name:	WM Chaffee			Project Name:	Chaffee Area 7/8 Development						
Subject:	Existing Cell Settlement			Project #:	190260						
Designed by:	L.Rohr	Date:	2/19/2020	Checked by:	C.Eller	Date:	2/26/2020	Sheet No.	1	of	7

Purpose:
- To evaluate landfill settlement as required in 6 NYCRR Part 363-4.3(b)(1).
- Verify that the existing Western Expansion cells meet the minimum post-settlement slope requirements under the loading of the proposed Area 7/8 Development (2% post-settlement slope on the liner floor and 1% post-settlement for pipes).

shaded cells represent values to be input
shaded cells represent values to be calculated

Methodology:
- Soil Parameters from the Chaffee 2005 Part 360 Application Western Expansion Engineering Report by McMahon and Mann
- Methodology for Elastic Settlement of sands and low plasticity soils from Giroud and Natissee (1972) via Poulos and Davis "Elastic Solutions for Soil and Rock Mechanics" 1973.
- Methodology for Consolidation Settlement of clay-like soils from Gray (1936) as presented by Poulos and Davis "Elastic Solutions for Soil and Rock Mechanics" 1973.

E	Elastic Modulus
v	Poisson's Ratio
P_c	Preconsolidation Pressure
C_c	Compression Index
C_r	Recompression Index
C_{α}'	Secondary Compression Index
e_o	Initial Void Ratio
γ	Unit Weight

Material Properties:

Recompacted Clay Till			Insitu Clay Till			Underlying Silt and Clay Till		
γ	132	pcf	γ	132	pcf	γ	138	pcf
e_o	0.54		e_o	0.59		e_o	0.41	
P_c	4,800	psf	P_c	9,000	psf	C_r	0.018	
C_c	0.10		C_c	0.15		C_{α}'	0.0015	
C_r	0.013		C_r	0.017		t_1	1.0	years
C_{α}'	0.0015		C_{α}'	0.0023		t_2	40.0	years
t_1	1.0	years	t_1	1.0	years	E	10,400	psi
t_2	40.0	years	t_2	40.0	years	E	1,497,600	psf
E	10,400	psi	E	10,400	psi	v	0.5	
E	1,497,600	psf	E	1,497,600	psf			
v	0.5		v	0.5				

Landfill Elevations and Distances		
Top of Landfill Elev. =	1,690.25	ft
Top of Waste Elev. =	1,685.75	ft
Top of Stone =	1,483.50	ft
Top of Clay =	1,481.50	ft
Bottom of Clay =	1,449.00	ft
Top of Rock =	900.00	ft
Depth of Soils =	549.00	ft
Depth of Underlying 10 Soil Layers =	54.90	ft

Underlying Sand and Gravel			Waste			Cover Soil			Primary Collection Stone		
γ	135	pcf	γ	59	pcf	γ	125	pcf	γ	130	pcf
E	22,500	psi	max.H	202.25	ft	H	4.5	ft	H	2	ft
E	3,240,000	psf									
v	0.5		Water			Factor of Safety	2				
			γ	62.4	pcf						

PROPOSED ACCESS ROAD

CELL 4

CELL 2

CELL 3

CELL 1

EXISTING LANDFILL

LEGEND

----1470----	TOP OF PRIMARY LEACHATE COLLECTION LAYER CONTOURS
——1650——	TOP OF PROPOSED COVER CONTOURS
1 ●	DENOTES LOCATION OF SETTLEMENT EVALUATION

NOTE: DRAWING NOT TO SCALE

NOTE:
UNAUTHORIZED ALTERATION OR ADDITION TO ANY SURVEY, DRAWING, DESIGN, SPECIFICATION, PLAN, OR REPORT IS A VIOLATION OF SECTION 7209 PROVISION 2 OF THE NEW YORK STATE EDUCATION LAW.

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CHAFFEE FACILITY
WESTERN EXPANSION
ERIE COUNTY
NEW YORK

SETTLEMENT PLAN VIEW

DWG. NO. 00016-171a

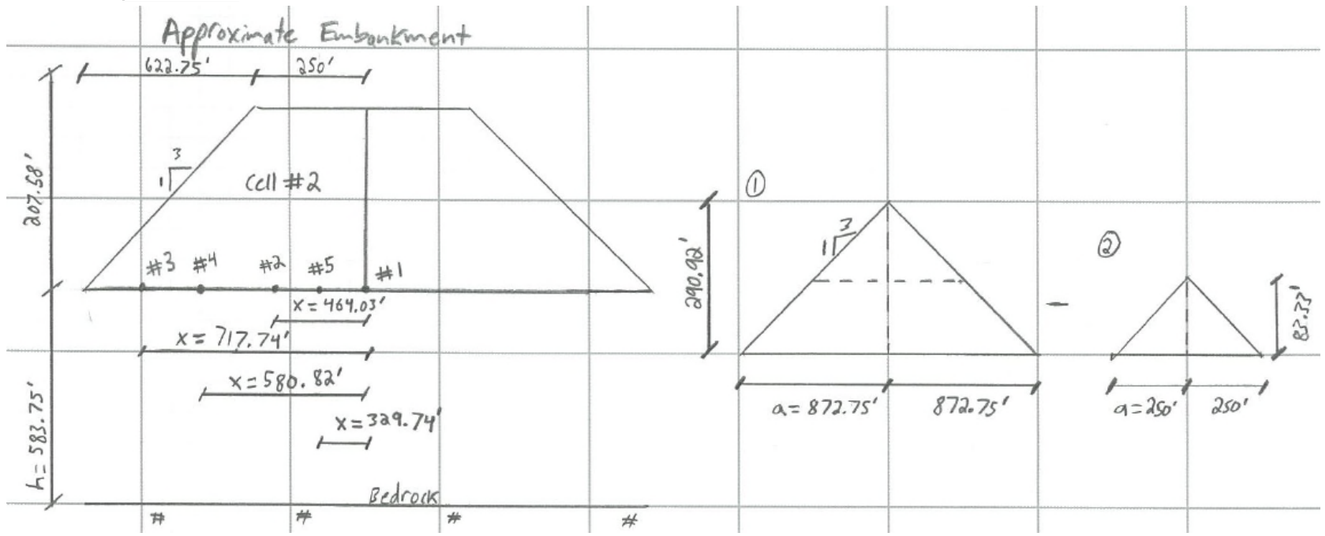
FIGURE 1

Elastic Settlements:

Landfill Load

P = (γ.cover)(H.cover)+(FS)(γ.waste)(H.waste)+(γ.stone)(H.stone)

P = 24,688 psf



Properties for Triangle #1		Properties for Triangle #2	
a =	872.75 ft	a =	250.00 ft
h =	583.75 ft	h =	583.75 ft
Height of Triangle =	290.92 ft	Height of Triangle =	83.33 ft
P =	34,383.67 psf	P =	9,833.33 psf
h/a =	0.67	h/a =	2.34

Settlement Point	x (ft)	x/a for Triangle 1	x/a for Triangle 2	Top of Recompacted Clay	Top of Insitu Clay	Bottom of Insitu Clay	% Clay	% Sand
1	0	0.00	0.00	1481.5	1478.5	1449.00	43.35%	56.65%
2	464.03	0.53	1.86	1473.5	1470.5	1445.30	42.95%	57.05%
3	717.74	0.82	2.87	1469.00	1466.00	1442.20	42.83%	57.17%
4	580.82	0.67	2.32	1475.00	1472.00	1445.30	43.10%	56.90%
5	329.74	0.38	1.32	1479.00	1476.00	1446.60	43.36%	56.64%

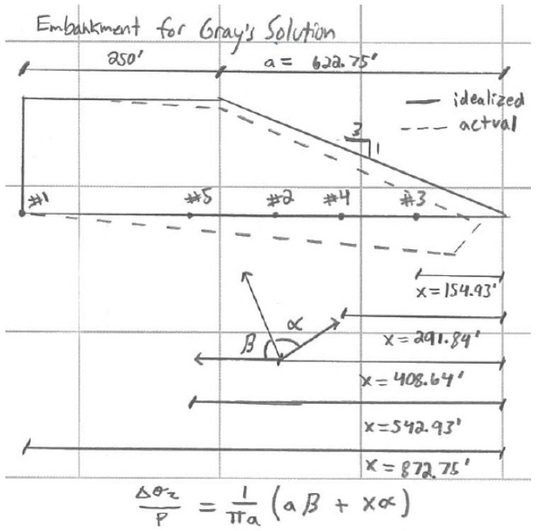
Sic = (P.1/E)*(rh.1) - (P.2/E)*(rh.2)

Settlement Point	Elastic Settlement in Clay			Elastic Settlement in Sand			Total Elastic Settlement (ft)
	rh for Triangle 1	rh for Triangle 2	Sic (ft)	rh for Triangle 1	rh for Triangle 2	Sis (ft)	
1	0.20	0.65	1.275	0.42	1.05	1.752	3.027
2	0.05	-0.05	0.466	0.20	0.10	1.013	1.480
3	0.00	-0.10	0.070	0.10	0.00	0.530	0.600
4	0.05	-0.10	0.503	0.15	0.00	0.791	1.293
5	0.10	0.00	0.869	0.25	0.25	1.204	2.073

* Note: Based on historical borings and lab data it is assumed that the underlying soils contain 40% clay and 60% sand. This is used to determine the total % clay and sand for the total soil depth.

Stress Distribution Per Gray's Solution

a = 622.75 ft



x = 872.75 ft

Point 1	α (Deg)	α (Rad)	β (Deg)	β (Rad)	σz/P
1	0.25	0.00	179.7	3.14	1.00
2	2.90	0.05	175.9	3.07	1.00
3	9.56	0.17	166.5	2.91	1.00
4	17.18	0.30	155.3	2.71	1.00
5	23.17	0.40	145.8	2.55	0.99
6	27.51	0.48	138.1	2.41	0.98
7	30.43	0.53	131.8	2.30	0.97
8	32.25	0.56	126.8	2.21	0.96
9	33.25	0.58	122.7	2.14	0.94
10	33.65	0.59	119.4	2.08	0.93
11	33.63	0.59	116.6	2.04	0.91
12	33.31	0.58	114.3	1.99	0.89

x = 408.64 ft

Point 2	α (Deg)	α (Rad)	β (Deg)	β (Rad)	σz/P
1	179.39	3.13	0.4	0.01	0.66
2	173.65	3.03	4.2	0.07	0.66
3	157.75	2.75	14.5	0.25	0.66
4	137.74	2.40	27.2	0.47	0.65
5	120.53	2.10	37.5	0.66	0.65
6	106.15	1.85	45.7	0.80	0.64
7	94.24	1.64	52.0	0.91	0.63
8	84.36	1.47	56.9	0.99	0.62
9	76.11	1.33	60.8	1.06	0.62
10	69.16	1.21	63.9	1.12	0.61
11	63.26	1.10	66.5	1.16	0.60
12	58.20	1.02	68.6	1.20	0.59

x = 154.93 ft

Point 3	α (Deg)	α (Rad)	β (Deg)	β (Rad)	σz/P
1	179.26	3.13	0.2	0.00	0.25
2	172.68	3.01	1.8	0.03	0.25
3	154.24	2.69	6.6	0.11	0.25
4	132.07	2.31	13.0	0.23	0.25
5	114.52	2.00	19.1	0.33	0.26
6	100.74	1.76	24.8	0.43	0.28
7	89.71	1.57	30.1	0.52	0.29
8	80.70	1.41	34.8	0.61	0.30
9	73.19	1.28	39.0	0.68	0.32
10	66.85	1.17	42.8	0.75	0.33
11	61.43	1.07	46.2	0.81	0.34
12	56.76	0.99	49.2	0.86	0.35

x = 291.84 ft

Point 4	α (Deg)	α (Rad)	β (Deg)	β (Rad)	σz/P
1	179.45	3.13	0.3	0.00	0.47
2	173.96	3.04	2.8	0.05	0.47
3	159.19	2.78	9.8	0.17	0.47
4	140.47	2.45	18.6	0.32	0.47
5	123.72	2.16	26.6	0.47	0.47
6	109.24	1.91	33.7	0.59	0.47
7	96.96	1.69	39.7	0.69	0.47
8	86.63	1.51	44.9	0.78	0.47
9	77.97	1.36	49.3	0.86	0.48
10	70.66	1.23	53.0	0.92	0.48
11	64.47	1.13	56.1	0.98	0.48
12	59.19	1.03	58.9	1.03	0.48

x = 542.93 ft

Point 5	α (Deg)	α (Rad)	β (Deg)	β (Rad)	σz/P
1	178.77	3.12	1.1	0.02	0.87
2	165.63	2.89	12.5	0.22	0.87
3	136.91	2.39	36.8	0.64	0.87
4	113.01	1.97	55.1	0.96	0.85
5	97.98	1.71	64.7	1.13	0.83
6	87.24	1.52	70.4	1.23	0.81
7	78.85	1.38	74.0	1.29	0.79
8	71.95	1.26	76.5	1.34	0.77
9	66.10	1.15	78.4	1.37	0.76
10	61.06	1.07	79.8	1.39	0.74
11	56.65	0.99	80.9	1.41	0.72
12	52.78	0.92	81.8	1.43	0.71

Consolidation Settlements: Landfill Load

p 24,688 psf

Settlement for Point #1

Elevations

Top of Recompacted Clay =	1481.5
Top of Insitu Clay =	1478.5
Bottom of Clay =	1449.00

Layer	P.o (psf)	σz/P	Δσz (psf)	Clay Settlement Primary S.pc (ft)	Clay Settlement Secondary S.pc (ft)
Recompacted Clay	104.4	1.00	24688.00	0.184	0.007
In-situ Clay	1235.4	1.00	24687.66	1.551	0.109
1	4287.81	1.00	24675.17	0.233	0.051
2	8339.43	1.00	24605.56	0.167	0.051
3	12391.05	0.99	24454.13	0.133	0.051
4	16442.67	0.98	24222.78	0.110	0.051
5	20494.29	0.97	23927.68	0.094	0.051
6	24545.91	0.96	23588.13	0.082	0.051
7	28597.53	0.94	23221.36	0.072	0.051
8	32649.15	0.93	22840.96	0.065	0.051
9	36700.77	0.91	22457.02	0.058	0.051
10	40752.39	0.89	22076.77	0.053	0.051
		Totals		**2.801**	**0.629**

Settlement for Point #2

Elevations

Top of Recompacted Clay =	1473.5
Top of Insitu Clay =	1470.5
Bottom of Clay =	1445.30

Layer	P.o (psf)	σz/P	Δσz (psf)	Clay Settlement Primary S.pc (ft)	Clay Settlement Secondary S.pc (ft)
Recompacted Clay	104.4	0.66	16199.93	0.148	0.007
In-situ Clay	1085.76	0.66	16199.67	0.921	0.093
1	3974.877	0.66	16189.12	0.196	0.051
2	7999.191	0.65	16126.26	0.133	0.051
3	12023.505	0.65	15996.39	0.102	0.051
4	16047.819	0.64	15815.35	0.083	0.051
5	20072.133	0.63	15607.62	0.070	0.051
6	24096.447	0.62	15393.25	0.060	0.051
7	28120.761	0.62	15184.99	0.052	0.051
8	32145.075	0.61	14989.61	0.046	0.051
9	36169.389	0.60	14809.98	0.042	0.051
10	40193.703	0.59	14646.69	0.038	0.051
		Totals		**1.891**	**0.610**

Settlement for Point #3

Elevations

Top of Recompacted Clay =	1469
Top of Insitu Clay =	1466
Bottom of Clay =	1442.20

Layer	P.o (psf)	σz/P	Δσz (psf)	Clay Settlement Primary S.pc	Clay Settlement Secondary S.pc (ft)
Recompacted Clay	104.40	0.25	6141.97	0.065	0.007
In-situ Clay	1037.04	0.25	6142.48	0.214	0.088
1	3866.00	0.25	6164.60	0.115	0.051
2	7867.43	0.25	6291.63	0.071	0.051
3	11868.87	0.26	6532.68	0.053	0.051
4	15870.31	0.28	6844.48	0.043	0.051
5	19871.74	0.29	7184.56	0.037	0.051
6	23873.18	0.30	7525.08	0.033	0.051
7	27874.61	0.32	7850.57	0.030	0.051
8	31876.05	0.33	8153.61	0.027	0.051
9	35877.49	0.34	8431.51	0.025	0.051
10	39878.92	0.35	8684.21	0.024	0.051
		Totals		**0.736**	**0.602**

Settlement for Point #4

Elevations

Top of Recompacted Clay =	1475
Top of Insitu Clay =	1472
Bottom of Clay =	1445.30

Layer	P.o (psf)	σz/P	Δσz (psf)	Clay Settlement Primary S.pc	Clay Settlement Secondary S.pc (ft)
Recompacted Clay	104.40	0.47	11569.56	0.119	0.007
In-situ Clay	1137.96	0.47	11569.61	0.634	0.098
1	4079.28	0.47	11571.51	0.163	0.051
2	6285.18	0.47	11582.70	0.126	0.051
3	9097.22	0.47	11606.57	0.099	0.051
4	11909.26	0.47	11641.14	0.082	0.051
5	14721.30	0.47	11682.00	0.071	0.051
6	17533.34	0.47	11725.02	0.062	0.051
7	20345.37	0.48	11767.31	0.055	0.051
8	23157.41	0.48	11807.23	0.050	0.051
9	25969.45	0.48	11844.04	0.045	0.051
10	28781.49	0.48	11877.53	0.042	0.051
		Totals		**1.548**	**0.616**

Settlement for Point #5

	Elevations
Top of Recompacted Clay =	1479
Top of Insitu Clay =	1476
Bottom of Clay =	1446.60

Layer	P.o (psf)	σz/P	Δσz (psf)	Clay Settlement: Primary S.pc (ft)	Clay Settlement: Secondary S.pc (ft)
Recompacted Clay	104.4	0.87	21523.65	0.172	0.007
In-situ Clay	1231.92	0.87	21520.18	1.389	0.108
1	4271.994	0.87	21420.02	0.217	0.051
2	8305.902	0.85	21069.50	0.153	0.051
3	12339.81	0.83	20593.45	0.119	0.051
4	16373.718	0.81	20082.88	0.097	0.051
5	20407.626	0.79	19578.67	0.082	0.051
6	24441.534	0.77	19099.29	0.070	0.051
7	28475.442	0.76	18652.84	0.061	0.051
8	32509.35	0.74	18242.07	0.054	0.051
9	36543.258	0.72	17866.85	0.048	0.051
10	40577.166	0.71	17525.48	0.044	0.051
			Totals	**2.506**	**0.627**

Summary of Differential Settlements and Liner Strains

	Point	Top of Recompacted Clay Elevation	Elevation Difference Between Points (ft)	Horizontal Distance Between Points (ft)	Length of Liner Between Points (ft)	Pre-Settlement Slope (%)	Total Elastic Settlement (ft)	Total Consolidation Settlement (ft)	Total Settlement (ft)	Top of Recompacted Clay Elevation Following Settlement	Elevation Difference Between Points (ft)	Post-Settlement Slope (%)	Settled Length of Liner Between Points (ft)	Liner Strain (%)
	1	1481.5					3.027	3.431	6.458	1475.04				
Points along	1-2		8	464.03	464.10	1.72					5.52	**1.19**	464.06	-0.00778
Pipe Slope	2	1473.5					1.480	2.501	3.981	1469.52				
	2-3		4.5	235.71	235.75	1.91					2.46	**1.04**	235.72	-0.01279
	3	1469					0.600	1.338	1.938	1467.06				
	4	1475					1.293	2.164	3.457	1471.54				
	4-3		6	211.73	211.81	2.83					4.48	**2.12**	211.78	-0.01774
Points along	3	1469					0.600	1.338	1.938	1467.06				
Floor Slope	5	1479					2.073	3.132	5.205	1473.79				
	5-2		5.5	207.67	207.74	2.65					4.28	**2.06**	207.71	-0.01387
	2	1473.5					1.480	2.501	3.981	1469.52				

Conclusion

- Existing pipes and liner floor layouts in the Western Expansion meet the required post-settlement slopes under the proposed additional loading from the Area 7/8 Development.
- Post-settlement pipe slopes are greater than 1.0% and post-settlement floor slopes are greater than 2.0%.

B.8 - Bearing Capacity Calculation

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	13-Jul-20	190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7-8 Development	Bearing Capacity Calculation	
PREPARED BY	**CHECKED BY**	
L.Rohr	R. Holmes	

Description and Purpose:

Verify the factor of safety for the soil bearing capacity of the proposed MSE Berm meets the regulatory minimum of 2.00 set by 6 NYCRR 363-4.3(c)(3)(i)

Design Basis/References/Assumptions:

The proposed MSE Berm has been conservatively modeled as a vertical wall for this analysis.

Reference:

"Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes."
Publication No. FHWA-NHI-10-024, FHWA GEC 011 - Volumer I. November 2009.

Remarks/Conclusions/Results:

The calculated factor of safety for bearing capacity for the proposed MSE Berm is 3.88.
The factor of safety exceeds the minimum required factor of 2.00 set by 6 NYCRR 363-4.3(c)(3)(i)
Additionally, since the calculated factor of safety exceeds 3.00, 6 NYCRR 363-4.3(c)(3)(i)(a) is also satisified and a supplemental settlement analysis is not required.

Client Name:	Waste Management - Chaffee		Project Name:	Area 7-8 Development					
Subject:	MSE Berm Bearing Capacity Check		Project #:	190260					
Designed by:	L.Rohr	Date: 7/13/2020	Checked by:	R.Holmes	Date:	7/13/2020	Sheet No.	1	of 2

cornerstone PLLC

Shaded cells represent values to be input
Shaded cells represent cells to be calculated

Purpose: Evaluate Bearing Capactiy on Foundation of MSE Berm

Reference: "Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes." Publication No. FHWA-NHI-10-024, FHWA GEC 011 - Volumer I. November 2009.

Assumptions: We have conservatively modeled the berm as a vertical wall while the actual embankment has a 2V : 1H slope.

Calculations: * Calculate Bearing Eccentricity to be used in bearing calculation

L =	Length of Berm	30	feet
H =	Height of Berm	25	feet
ϕ_b =	friction angle of retained backfill	40	°
γ_b =	moist unit weight of backfill soil	128	pcf
γ_r =	moist unit weight of reinforced soil	128	pcf
q =	uniform live load surcharge	200	psf
γ_{EH-MAX} =	Horizontal Earth Pressure Load Factor	1.5	
γ_{LS} =	Live Load Surchage Load Factor	1.75	
γ_{EV-MAX} =	Vertical Earth Pressure Load Factor	1.35	

$$K_{ab} = \tan^2\left(45 - \frac{\phi'_b}{2}\right) \quad (4\text{-}1)$$

K_{ab} = Active Coefficient of Earth Pressure 0.22

$$F_1 = \frac{1}{2} K_{ab} \gamma_b H^2 \quad (4\text{-}5)$$

F1 = Retained Backfill Resultant 8698 lbs/ft

$$F_2 = K_{ab} q H \quad (4\text{-}6)$$

F2 = Uniform Surcharge Resultant 1087 lbs/ft

$V1 = \gamma_r * H * L$

V1 = Vertical Resultant of Reinforced Soil 96000 lbs/ft

$$e = \frac{\gamma_{EH-MAX} F_1 \left(H/3\right) + \gamma_{LS} F_{q-LS} \left(H/2\right)}{\gamma_{EV-MIN} V_1} \quad (4\text{-}15)$$

e_b = calculated bearing eccentricity 1.02 feet

Client Name:	Waste Management - Chaffee	Project Name:	Area 7-8 Development		
Subject:	MSE Berm Bearing Capacity Check	Project #:	190260		

Designed by:	L.Rohr	Date:	7/13/2020	Checked by:	R.Holmes	Date:	7/13/2020	Sheet No.	2 of 2

Shaded cells represent values to be input
Shaded cells represent cells to be calculated

Calculations:

L =	Length of Berm	30	feet
H =	Height of Berm	25	feet
q =	uniform live load surcharge	200	psf
$\gamma_{EH\text{-}MAX}$ =	Horizontal Earth Pressure Load Factor	1.5	
γ_{LS} =	Live Load Surchage Load Factor	1.75	
$\gamma_{EV\text{-}MAX}$ =	Vertical Earth Pressure Load Factor	1.35	
c_f =	cohesion of foundation soil	0	psf
γ_f =	unit weight of foundation soil	128	pcf
ϕ_f =	friction angle of foundation soil	28	°
N_c =	dimensionless bearing coefficients	25.8	*From Table 4-6
N_γ =	dimensionless bearing coefficients	16.7	*From Table 4-6
L' =	effective foundation width (L - $2e_b$)	27.96	feet
e_b =	Bearing Eccentricity	1.02	feet
V1 =	Vertical Resultant of Reinforced Soil	96000	lbs/ ft

$$\sigma_{V\text{-}F} = \frac{\gamma_{EV\text{-}MAX} V_1 + \gamma_{LS} q L}{L - 2e_B} \qquad (4\text{-}20)$$

$\sigma_{V\text{-}F}$ = Factored Vertical Stress — 5012 psf

$$q_n = c_f N_c + 0.5 L' \gamma_f N_\gamma \qquad (4\text{-}22)$$

q_n = nominal bearing resistance — 29878 psf

$$q_R = \phi q_n \qquad (4\text{-}23)$$

where:

ϕ = resistance factor, for MSE walls this factor is 0.65 (Table 11.5.6-1, AASHTO {2007})

q_R = Factored Bearing Resistance — 19421 psf

FOS = Factor of Safety for Bearing Capacity = q_R / $\sigma_{V\text{-}F}$ — 3.88

Conclusion: Bearing Capacity is acceptable since q_R is greater than $\sigma_{V\text{-}F}$ with a FOS of 3.88.

U. S. Department of Transportation
Federal Highway Administration

Publication No. FHWA-NHI-10-024
FHWA GEC 011 – Volume I
November 2009

NHI Courses No. 132042 and 132043

Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volume I

Developed following:

AASHTO LRFD Bridge Design Specifications, 4th Edition, 2007, with 2008 and 2009 Interims.

and

AASHTO LRFD Bridge Construction Specifications, 2nd Edition, 2004, with 2006, 2007, 2008, and 2009 Interims.

NATIONAL HIGHWAY INSTITUTE

Table 4-6. Bearing Resistance Factors
(Table 10.6.3.1.2a-1, AASHTO {2007}).

ϕ	N_c	N_q	N_γ	ϕ	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	25.9
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	37.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Note:
N_c (Prandtl, 1921), N_q (Reisnner, 1924), and N_γ (Vesic, 1975).
N_q is embedment term, which is typically not used in MSE wall design.

B.9 - South Borrow Area Sediment Basin Design

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Chaffee Landfill	31-Mar-20	190260
PROJECT / CALCULATION NUMBER	**TITLE**	
	Sediment Basin Design	
PREPARED BY	**CHECKED BY**	
AJA (3/31/20)	RAH (3/31/20)	

Description and Purpose:

The purpose of this calculation is to design a sediment basin that is able to withstand a 10 year 24 hour storm event of 3.18 inches.

Design Basis/References/Assumptions:

Ref #1 HydroCAD
Ref #2 New York State Standards and Specifications for Erosion and Sediment Control

First, the runoff sub catchment was created. The runoff area was determined through the Construction Drawing set of the Chaffee Landfill to be 9.0 acres. A curve number of 94 was assigned to the area to represent the disturbed borrow area cover type. Next the time of concentration (Tc) was calculated. It was determined that 100 feet of sheet flow and 586 feet of shallow concentrated flow was the longest path for a drop of water within the runoff area. For sheet flow a surface description for range with a Manning's Number of 0.13, a 2 year 24 hour rain of 2.22 inches, and a 3:1 land slope were all selected. The Tc for sheet flow was calculated to be 3.4 minutes. For shallow concentrated flow a surface description of short grass pasture was selected which has a velocity factor of 7 ft/sec and the watercourse slope was 3:1. This produced 2.4 minutes for shallow concentrated flow. The total Tc for both flow types was 5.8 minutes.

Second, the detention pond storage was created. Custom Stage Data Storage was chosen for the sediment basin and forebay. The surface area stage type was selected for both as well as the irregular shape option and the areas and perimeters at each elevation based on the Construction Drawings set were input. The sediment basin had an invert elevation of 1,438 feet, an elevation depth of 6 feet, and an approximate 4:1 side slope based on the Construction Drawing set. The forebay had an invert elevation of 1,439 feet, an elevation depth of 5 feet, and an approximate 4:1 side slope based on the construction drawings.

Finally, the outlets were created. These outlets consisted of a culvert, six orifices at two different elevations, and a grate. The culvert is the primary outlet. The orifices and the grate are routed to it. The inlet invert elevation of the culvert was 1442 feet and the outlet invert elevation was 1441.57 feet. The length of the pipe was 29 feet, the diameter of the pipe was 1 foot, and slope of the pipe was 1.5% all according to the Construction Drawing set. A Manning's Number of 0.011 for PVC with a smooth interior, Ke of 0.01, and contraction coefficient of 1 were all selected. The first elevation consisted of two orifices that had an invert elevation of 1,442 feet. The length was 8 inches and the height was 1 inch. The second elevation consisted of four orifices that had an invert elevation of 1,443.5 feet. The length was 8 inches and the height was 1 inch.

Remarks/Conclusions/Results:

The resulting peak discharge for the runoff sub catchment sediment basin was 0.31 cfs. The peak elevation during a 10 year 24 hour storm event was 1442.38 feet. Since the inlet invert of the culvert is 1442 feet and the bar grates elevation is 1444 feet, the water level would be rise above the outlet pipe by 0.38 feet and be below the overflow the bar grate by 1.62 feet. The emergency spillway would still be above the 10 year storm water depth with an elevation of 1446 feet and a freeboard height of 3.62 feet.

According to the New York State Standards and Specifications for Erosion and Sediment Control, the forebay needs to be sized for a volume equal to 1,000 cubic foot per disturbed acre over the course of the life of the project. The total runoff area going into the sedimentation basin and forebay is 9 acres. The forebay in this design is approximately 0.947 acre feet which is equal to 41,251 cubic feet. Therefore, the forebay will have 4,583 cubic feet per acre which satisfies this requirement. The sediment basin needs to be sized for a volume equal to 3,600 cubic foot per disturbed acre over the course of the life of the project. The sediment basin in this design is approximately 2.041 acre feet which is equal to 88,906 cubic feet. Therefore, the sediment basin in this design is approximately 9,878 cubic feet per acre which satisfies this requirement.

Runoff

South Borrow Area Sediment Basin and Forebay

Subcat Reach Pond Link

Routing Diagram for 190260 - Pond Design (3-30-20)
Prepared by Tetra Tech Inc, Printed 4/1/2020
HydroCAD® 10.00-24 s/n 04051 © 2018 HydroCAD Software Solutions LLC

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Runoff Runoff Area=9.000 ac 0.00% Impervious Runoff Depth>2.52"
Flow Length=686' Slope=0.3300 '/' Tc=5.8 min CN=94 Runoff=36.68 cfs 1.892 af

Pond 2P: South Borrow Area Sediment Peak Elev=1,442.38' Storage=1.662 af Inflow=36.68 cfs 1.892 af
Outflow=0.31 cfs 0.229 af

Total Runoff Area = 9.000 ac Runoff Volume = 1.892 af Average Runoff Depth = 2.52"
100.00% Pervious = 9.000 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Runoff

[49] Hint: Tc<2dt may require smaller dt

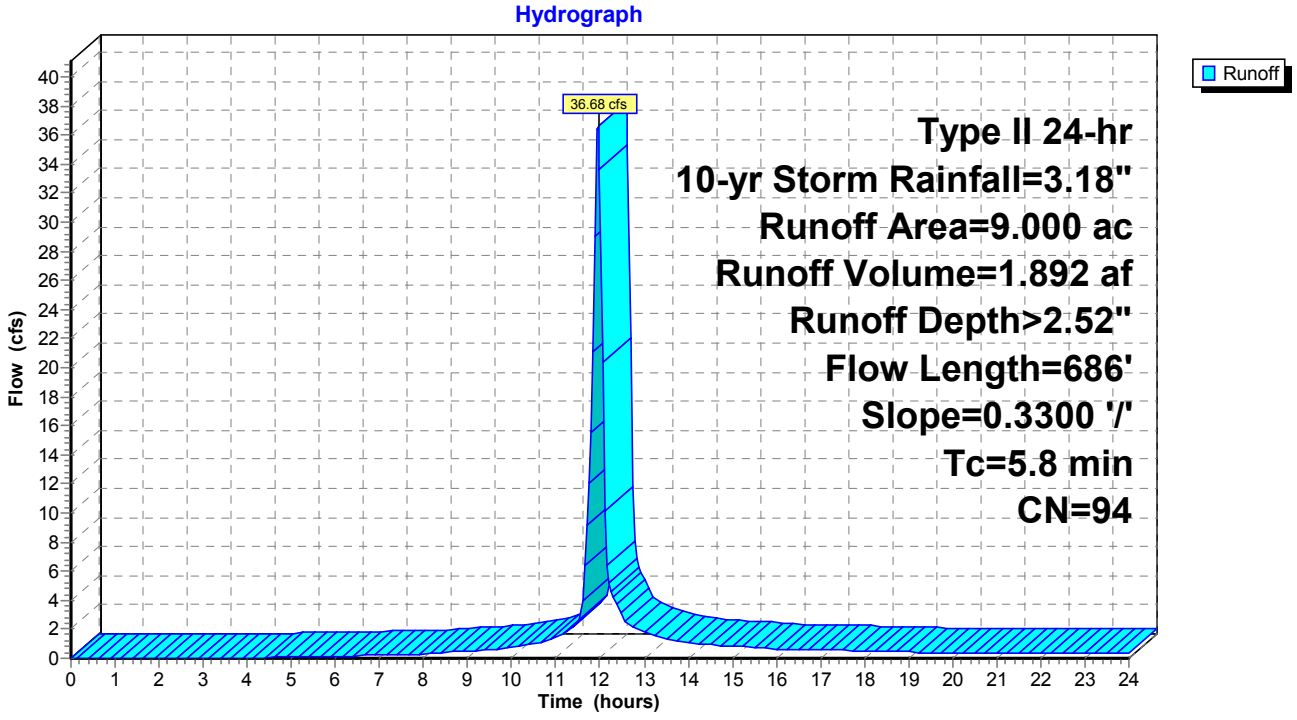
Runoff = 36.68 cfs @ 11.96 hrs, Volume= 1.892 af, Depth> 2.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Storm Rainfall=3.18"

Area (ac)	CN	Description
9.000	94	Fallow, bare soil, HSG D
9.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	100	0.3300	0.49		**Sheet Flow,** Range n= 0.130 P2= 2.22"
2.4	586	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
5.8	686	Total			

Subcatchment 1S: Runoff



Summary for Pond 2P: South Borrow Area Sediment Basin and Forebay

[92] Warning: Device #4 is above defined storage

Inflow Area = 9.000 ac, 0.00% Impervious, Inflow Depth > 2.52" for 10-yr Storm event
Inflow = 36.68 cfs @ 11.96 hrs, Volume= 1.892 af
Outflow = 0.31 cfs @ 23.83 hrs, Volume= 0.229 af, Atten= 99%, Lag= 712.0 min
Primary = 0.31 cfs @ 23.83 hrs, Volume= 0.229 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,442.38' @ 23.83 hrs Surf.Area= 0.705 ac Storage= 1.662 af

Plug-Flow detention time= 614.5 min calculated for 0.229 af (12% of inflow)
Center-of-Mass det. time= 382.4 min (1,165.7 - 783.3)

Volume	Invert	Avail.Storage	Storage Description
#1	1,438.00'	2.041 af	**South Borrow Area Sedimentation Basin (Irregular)** Listed below (Recalc)
#2	1,439.00'	0.947 af	**South Borrow Area Forebay (Irregular)** Listed below (Recalc)
		2.988 af	Total Available Storage

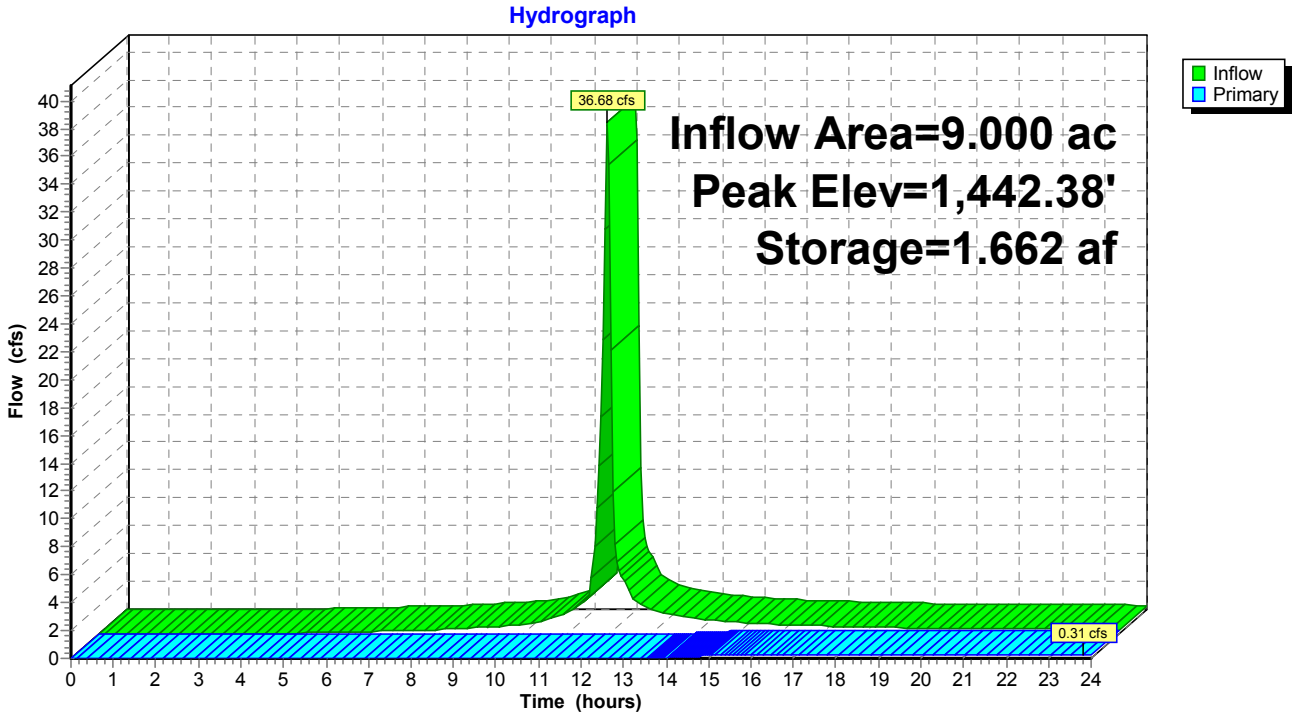
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
1,438.00	0.166	362.7	0.000	0.000	0.166
1,440.00	0.238	429.5	0.402	0.402	0.264
1,442.00	0.434	573.3	0.662	1.064	0.529
1,444.00	0.545	641.3	0.977	2.041	0.682

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
1,439.00	0.066	824.2	0.000	0.000	0.066
1,440.00	0.066	824.2	0.066	0.066	0.085
1,442.00	0.222	893.7	0.273	0.339	0.307
1,444.00	0.394	962.5	0.608	0.947	0.544

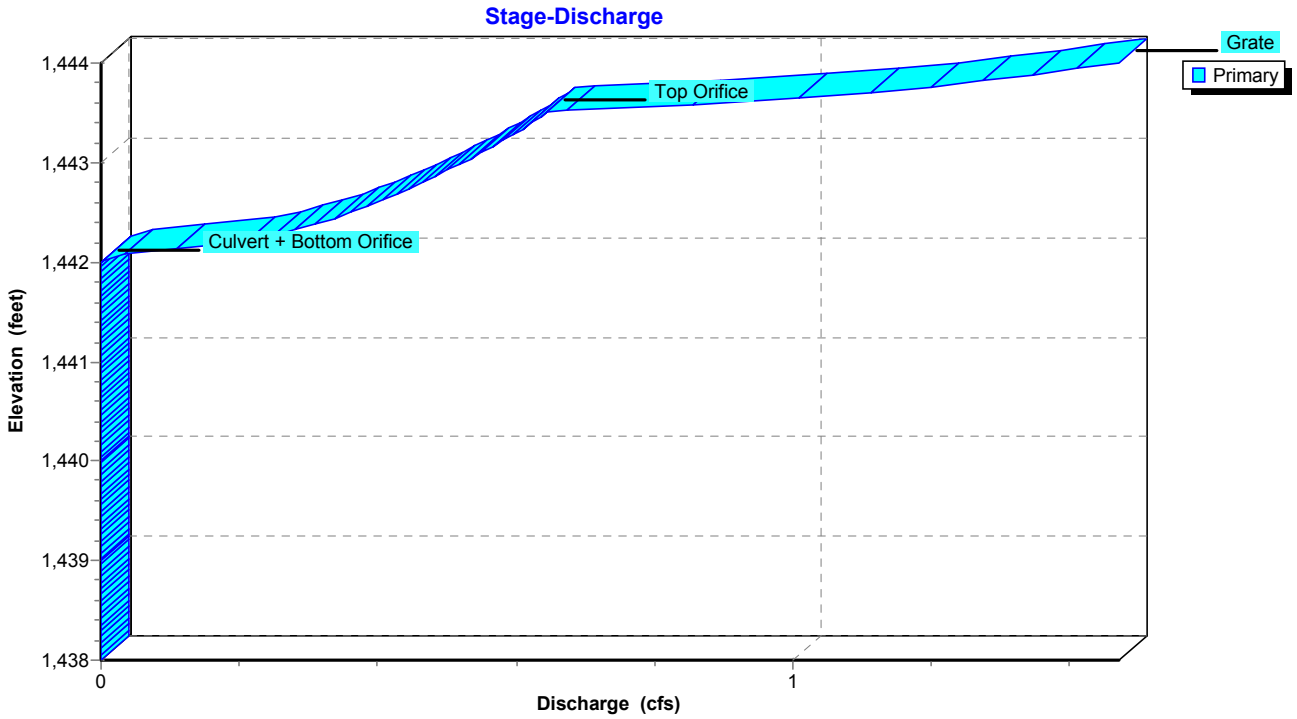
Device	Routing	Invert	Outlet Devices
#1	Primary	1,442.00'	**12.0" Round Culvert** L= 29.0' Ke= 0.010 Inlet / Outlet Invert= 1,442.00' / 1,441.57' S= 0.0148 '/' Cc= 1.000 n= 0.011 PVC, smooth interior, Flow Area= 0.79 sf
#2	Device 1	1,443.50'	**8.0" W x 1.0" H Vert. Top Orifice X 4.00** C= 0.600
#3	Device 1	1,442.00'	**8.0" W x 1.0" H Vert. Bottom Orifice X 2.00** C= 0.600
#4	Device 1	1,444.00'	**36.0" Horiz. Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.31 cfs @ 23.83 hrs HW=1,442.38' (Free Discharge)
└**1=Culvert** (Passes 0.31 cfs of 0.74 cfs potential flow)
  ├**2=Top Orifice** (Controls 0.00 cfs)
  ├**3=Bottom Orifice** (Orifice Controls 0.31 cfs @ 2.80 fps)
  └**4=Grate** (Controls 0.00 cfs)

Pond 2P: South Borrow Area Sediment Basin and Forebay



Pond 2P: South Borrow Area Sediment Basin and Forebay



N

SB5-

SB6-17

SB7-17

RUNOFF AREA
9.0 ACRES

SB9-17

MB-2

MB-3

Pond 4

MB-4

SB8-17

SB10-17

SB11-17

SHALLOW CONCENTRATED FLOW
586 FT.

SHEET FLOW
100 FT.

SOUTH BORROW AREA
PLAN
SCALE: 1"=100'

0 100 200
SCALE IN FEET

NOTES:

1. Existing site contours are based on aerial photography dated February 12, 2001 and November 22, 2001 compiled by Lockwood Mapping Inc. of Rochester, NY. Aero-Metric, dated July 10, 2012 and Quantum Spatial dated June 11, 2018. Additional topography to better reflect the main landfill area 2019 conditions has been incorporated and are based on photogrammetric methods from aerial photography dated 6/8/2019 compiled by Quantum Spatial of Dulles, Virginia. Grid based on NY West NAD83 Coordinate System Vertical datum based on NAVD 1988.
2. Property lines are based on surveys performed by Deborah A. Naybor, PLS, P.C. dated June 2001 and by Gary E. Krull dated March 1994.
3. Survey of delineated wetlands was prepared by Deborah A. Naybor, PLS, P.C. dated August 2001, Wendel Duchscherer Survey dated September 16, 2008 and by Wendel survey dated November 21, 2017.

LEGEND

- EXISTING CONTOURS (SEE NOTE 1 ON FIGURE 3)
- EXISTING STORMWATER BASIN
- EXISTING CULVERT
- EXISTING RIP-RAP
- CLOSED LANDFILL'S CLAY BERM
- PROPERTY LINE (SEE NOTE 2)
- APPROXIMATE CELL BOUNDARIES
- APPROXIMATE BORROW AREA LIMIT
- 100' WETLAND BUFFER
- DELINEATED WETLAND (SEE NOTE 3)
- SILT FENCE

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ROBERT A. HOLMES
N.Y.P.E. Lic. No. 077317 Date

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DATE OF ISSUE MARCH 2020
DRAWN BY DSS
DESIGNED BY
CHECKED BY
APPROVED BY

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CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

BORROW AREA USE PLAN
SOUTH BORROW AREA PLAN AND SECTIONS

FIGURE NO. 1
PROJECT NO. 190260

Plot: XU:\PROJECTS\MA-CHAFFEE\190260 - SOUTHERN EXPANSION TITLE_Project Drawings\BORROW AREA PLANS\190260-SC-03 (SOUTH BORROW AREA PLAN).dwg Layout: SHEET 3 (2) User: andrew.stevenson Mar 09, 2020 - 1:56pm

Extreme Precipitation Tables

Northeast Regional Climate Center

Data represents point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.

Smoothing	Yes
State	New York
Location	
Longitude	78.505 degrees West
Latitude	42.571 degrees North
Elevation	0 feet
Date/Time	Wed, 04 Mar 2020 08:46:06 -0500

Extreme Precipitation Estimates

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.27	0.42	0.52	0.68	0.85	1.04	**1yr**	0.74	0.95	1.18	1.40	1.64	1.90	2.20	**1yr**	1.69	2.11	2.58	3.13	3.60	**1yr**
2yr	0.32	0.50	0.62	0.82	1.03	1.26	**2yr**	0.89	1.15	1.41	1.67	1.93	2.22	2.53	**2yr**	1.96	2.44	2.92	3.48	3.99	**2yr**
5yr	0.38	0.60	0.75	1.00	1.28	1.58	**5yr**	1.11	1.44	1.78	2.08	2.40	2.72	3.10	**5yr**	2.41	2.99	3.53	4.15	4.77	**5yr**
10yr	0.43	0.68	0.86	1.17	1.52	1.88	**10yr**	1.31	1.71	2.11	2.47	2.82	3.18	3.62	**10yr**	2.81	3.48	4.08	4.75	5.46	**10yr**
25yr	0.52	0.82	1.04	1.44	1.90	2.35	**25yr**	1.64	2.14	2.65	3.08	3.50	3.90	4.44	**25yr**	3.45	4.27	4.95	5.67	6.53	**25yr**
50yr	0.58	0.93	1.19	1.67	2.26	2.81	**50yr**	1.95	2.54	3.16	3.66	4.13	4.56	5.18	**50yr**	4.03	4.98	5.72	6.49	7.48	**50yr**
100yr	0.67	1.08	1.39	1.97	2.69	3.34	**100yr**	2.32	3.01	3.76	4.33	4.85	5.33	6.04	**100yr**	4.71	5.81	6.62	7.43	8.57	**100yr**
200yr	0.76	1.24	1.61	2.31	3.19	3.98	**200yr**	2.75	3.57	4.47	5.12	5.71	6.23	7.05	**200yr**	5.51	6.78	7.67	8.50	9.83	**200yr**
500yr	0.92	1.51	1.97	2.86	4.02	5.01	**500yr**	3.47	4.49	5.62	6.40	7.07	7.65	8.66	**500yr**	6.77	8.33	9.31	10.18	11.78	**500yr**

Lower Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.24	0.38	0.46	0.62	0.76	0.80	**1yr**	0.66	0.79	0.88	1.12	1.44	1.72	1.93	**1yr**	1.52	1.86	2.30	2.96	3.30	**1yr**
2yr	0.31	0.48	0.60	0.81	0.99	1.13	**2yr**	0.86	1.11	1.25	1.52	1.81	2.16	2.47	**2yr**	1.91	2.37	2.85	3.38	3.88	**2yr**
5yr	0.35	0.54	0.67	0.92	1.17	1.35	**5yr**	1.01	1.32	1.48	1.79	2.13	2.55	2.90	**5yr**	2.26	2.79	3.32	3.87	4.41	**5yr**
10yr	0.38	0.59	0.73	1.02	1.32	1.52	**10yr**	1.14	1.49	1.65	2.01	2.40	2.88	3.27	**10yr**	2.55	3.15	3.73	4.29	5.01	**10yr**
25yr	0.43	0.65	0.81	1.16	1.53	1.78	**25yr**	1.32	1.74	1.91	2.32	2.75	3.40	3.83	**25yr**	3.01	3.69	4.35	4.93	5.77	**25yr**
50yr	0.47	0.71	0.89	1.27	1.71	2.00	**50yr**	1.48	1.96	2.11	2.60	3.07	3.85	4.33	**50yr**	3.40	4.16	4.90	5.47	6.43	**50yr**
100yr	0.51	0.77	0.96	1.39	1.90	2.25	**100yr**	1.64	2.20	2.34	2.90	3.38	4.36	4.90	**100yr**	3.86	4.71	5.52	6.08	7.18	**100yr**
200yr	0.55	0.82	1.04	1.51	2.11	2.53	**200yr**	1.82	2.48	2.58	3.22	3.71	4.93	5.53	**200yr**	4.36	5.32	6.23	6.79	8.03	**200yr**
500yr	0.61	0.90	1.16	1.68	2.40	2.95	**500yr**	2.07	2.88	2.90	3.66	4.15	5.83	6.53	**500yr**	5.16	6.28	7.33	7.86	9.34	**500yr**

Upper Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.30	0.46	0.56	0.75	0.92	1.08	**1yr**	0.80	1.06	1.19	1.43	1.72	2.14	2.36	**1yr**	1.89	2.27	2.74	3.30	3.80	**1yr**
2yr	0.34	0.52	0.65	0.87	1.08	1.23	**2yr**	0.93	1.21	1.37	1.64	1.97	2.29	2.63	**2yr**	2.02	2.53	3.00	3.60	4.13	**2yr**
5yr	0.42	0.65	0.81	1.11	1.42	1.61	**5yr**	1.22	1.58	1.77	2.15	2.56	2.90	3.32	**5yr**	2.57	3.20	3.73	4.46	5.17	**5yr**
10yr	0.51	0.79	0.98	1.36	1.76	1.99	**10yr**	1.52	1.95	2.18	2.65	3.16	3.48	4.01	**10yr**	3.08	3.85	4.41	5.25	6.00	**10yr**
25yr	0.66	1.01	1.25	1.79	2.35	2.63	**25yr**	2.03	2.57	2.88	3.49	4.18	4.44	5.10	**25yr**	3.93	4.91	5.50	6.52	7.47	**25yr**
50yr	0.80	1.22	1.52	2.19	2.94	3.26	**50yr**	2.54	3.19	3.55	4.33	5.20	5.32	6.13	**50yr**	4.71	5.90	6.50	7.66	8.80	**50yr**
100yr	0.98	1.49	1.86	2.69	3.69	4.05	**100yr**	3.18	3.96	4.41	5.37	6.48	6.40	7.37	**100yr**	5.66	7.09	7.67	9.01	10.38	**100yr**
200yr	1.20	1.81	2.29	3.32	4.63	5.01	**200yr**	4.00	4.90	5.47	6.68	8.11	7.69	8.85	**200yr**	6.80	8.51	9.07	10.61	12.22	**200yr**
500yr	1.59	2.37	3.05	4.43	6.29	6.66	**500yr**	5.43	6.51	7.32	8.95	10.92	9.81	11.26	**500yr**	8.68	10.83	11.29	13.15	15.15	**500yr**

B.10 - Leachate Generation Analysis

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management -Chaffee	15-Apr-20	190260
PROJECT / CALCULATION NUMBER		
Chaffee Area 7/8 Development	Leachate Generation Rate Storage Calculation	
PREPARED BY	**CHECKED BY**	
R. Holmes (4/1/2020)	L. Rohr (4/15/20)	

Description and Purpose:

The objective of this calculation is to leachate generations rates for various analyses and regulatory criteria

Design Basis/References/Assumptions:

1) Various leachate impingement rates are from historical data as opposed to HELP modeling which is consistent with the Valley Fill (2012) application documents - Appendix C.1 - Leachate Generation Quantities, Valley Fill Engineering Report

2) 24-hr, 25-year storm is 3.9 inches (Reference Drainage Calcs this submittal)

3) Disposal Capacity includes 30,000 gallons per day (5 day per week) in Jamestown and 77,000 gallons per day (5 days per week) in Buffalo

4) Cell acreages from the Annual Report for Western Expansion Cell 1-6

5) Cell acreages for Overfill areas taken from Appendix C.1 - Leachate Generation Quantities, Valley Fill Engineering Report

6) Cell acreages from expanded Cell 1, and Cells 7/8 from current design - see attached figure

Calculation Process:

See descriptions throughout calculation

Remarks/Conclusions/Results:

Total 3 month generation rate estimated to be 678,000 gallons which is exceeded by the sites storage and disposal capacity - meeting the regulatory threshold. The estimated additional number of trips required to haul leachate off site is 7 per day.

CALCULATION COVER SHEET

For the Western Expansion, Leachate generation was evaluated using the HELP model. For the subsequent Valley Fill project, operating leachate generation data was used to predict future generation rates for this site.

Similarly, operating data for more recent years was assessed for to determine current conditions and for comparison versus data reviewed for the Valley Fill

Leachate Date for 2015, 2016, 2017 and 2018 was provided by WMNY and is summarized in the following tables. During this period the cells for the western expansion came on line (giving us initial start up data) and operated with waste thicknesses consistent with those anticipated for the Area 7/8 Development and with no final cover installed.

To Date the following can be stated:

- Maximum Generation = 1885 gpad (Cell 4 - Feb 2016)
- Average Generated in Primary = 379 (2016 - for Cell 2- 6 which were fully constructed during this year)

For the maximum monthly generation, the 1885 gpad is consistent with the value determined for the Valley Infill Project which was 1961 gpad - therefore we will use 1885 gpad. For the maximum average rate for the entire western expansion (where Cells were online the entire year) the average was on 521 gpad (2019)

The maximum annual average for a single Cell 4 was 869 gpad in 2019. This is consistent with the value used for the Valley Fill Project of 851 gpad.

It should be noted that the maximum monthly generation in 2019 for Cells 1 and 2 was not considered due to the construction associated with the overfill areas which required liner and waste tie-ins

For the secondary, it is assumed the cells will be operated in accordance with the Part 360 requirements that require less than 20 gpad.

There are several other systems contributing to the main storage tank, including the LPS (Manhole3/4), Tank 5 and the CPS (Condensate Pump Station). The average contribution from each sump, in gallons, over the years 2015 to 2017 is as follows:

	2015	2016	2017	2018	2019	Ann. Average	Daily Average
LPS	81600	71859	59138	42588	29768	56991	160
Tank 5	193960	204244	226253	69477	123230	163433	459
CPS	60389	69582	86973	97420	174103	97693	274

Storage Calcs

Per 363-6.20, the facility must be able to store 3 consecutive months of leachate (assume 91.5 days)

WMNY Current operates two leachate storage tanks with a combined capacity of approximately 810,730 gallons.
Consistent with Valley Fill assumptions, assume 3.5 acres of active cell is open and contributes a 25-yr, 24 hour storm of 3.9 inches, or 106,000 gallons per acre

Maximum monthly rate = 1885 gpad
Maximum average annual rate = 521 gpad

	Cell Area, ac	Assumed Primary Impingement Rate, gpad	Assumed Secondary Impingement Rate, gpad	Daily Volume	3-month volume	Notes
Cell 1	7.3	521	20	3949	361361	use max. annual ave. for the cell or annual ave., whichever is higher
Cell 2	9.7	521	20	5248	480165	use max. annual ave. for the cell or annual ave., whichever is higher
Cell 3	8.3	553	20	4756	435165	use max. annual ave. for the cell or annual ave., whichever is higher
Cell 4	9	869	20	8001	732092	use max. annual ave. for the cell or annual ave., whichever is higher
Cell 5	7	521	20	3787	346511	use max. annual ave. for the cell or annual ave., whichever is higher
Cell 6	11.5	521	20	6222	569267	use max. annual ave. for the cell or annual ave., whichever is higher
Overfill Liner Cell 1	6.8	521	20	3679	336610	future - use average annual - significant waste thickness
Overfill Liner Cell 2	8.8	521	20	4761	435613	future - use average annual - significant waste thickness
Additional Cell 1 Area	2.6	521	20	1407	128704	future - use average annual - significant waste thickness
Cell 7	11.7	521	20	6330	579168	future - use average annual - significant waste thickness
Cell 8	3.5			371000	371000	assume 3.5 acres open and a 25-yr, 24-hr storm occurs 1 time during 90days
Cell 8	3.5		20	70	6405	secondary only for 3.5 acres of open area
Cell 8	11	1885	20	20955	1917383	future - use maximum monthly rate - active area
LPS				160	14648	Daily average between 2015 and 2019
Tank 5				459	42006	Daily average between 2015 and 2020
CPS				274	25109	Daily average between 2015 and 2021
			Estimated Daily Volume(Max) =	441057		gallons
			Total Estimated 3 month generation rate =		6781205	gallons
			Total Estimated 90 day generation rate from Area 7/8 Development =		3002659	gallons
			Estimated additional leachate haul-out trips (5,500 gallon tanker) =		7	

Available Disposal

91.5 days = 13.1 weeks

Jamestown - 30,000 gpd, 5days a week = 13.1*5*30,000 = 1,965,000 gallc	1965000	gallons
Buffalo - 77,000gpd, 5 days a week = 13.1*5*77,000 =	5043500	gallons
Total Disposal Capacity in 90 days =	7008500	
Storage in Tank =	810,730	(per Leachate Calculations in Valley Fill Application Docs)
Total Disposal Capacity in 90 days +Storage =	7,819,230	

Because disposal and storage capacity is greater than 3 month generation rate the requirement is met

2015 Totals

2015 Totals

Date	Cell 2-1 Primary Gallons Removed	Cell Size (acres) 9.7	Cell 3-1 Primary Gallons Removed	Cell Size (acres) 8.3	Cell 4-1 Primary Gallons Removed	Cell Size (acres) 9.0	Cell 5-1 Primary Gallons Removed	Cell Size (acres) 7.0	Cell 6-1 Primary Gallons Removed	Cell Size (acres) 11.5	Cell 6-3 Pore Water Gallons Removed	C.P.S. Gallons Removed	Loadout Building Gallons Removed	Tank 1 Gallons Removed	Tank 2 Gallons Removed	L.P.S Gallons Removed	Tank 5 Gallons Removed	Flare/ Plant Condensate Gallons Removed
January	-	0	126,369	491	101,764	365	116,275	536	118,837	333	-	2,827	523,581	37,781	28,475	6,818	13,249	927
February	-	0	114,183	491	94,837	376	79,854	407	75,555	235	182	2,617	492,507	27,296	27,815	5,008	13,540	-
March	-	0	157,324	611	128,962	462	127,985	590	100,313	281	96	3,967	584,048	45,986	52,210	6,894	15,090	861
April	-	0	112,380	451	40,715	151	51,212	244	149,084	432	16	3,940	633,417	57,670	52,245	8,626	31,782	-
May	-	0	107,898	419	51,614	185	16,234	75	96,314	270	129	4,464	418,568	31,225	22,885	3,809	11,335	2,235
June	-	0	106,566	428	74,674	277	5,164	25	64,992	188	6	4,097	626,026	46,805	21,915	3,778	17,088	1,155
July	-	0	22,718	88	85,474	306	49,302	227	41,938	118	-	4,688	195,308	35,910	29,550	8,833	14,060	-
August	-	0	104,471	406	87,918	315	53,061	245	92,107	258	-	6,315	721,433	37,651	17,915	7,900	7,466	1,203
September	-	0	124,823	501	85,520	317	41,806	199	77,733	225	-	8,399	390,555	34,223	29,295	6,763	4,753	3,869
October	37,578	125	133,430	519	105,886	380	47,456	219	104,980	294	3	7,885	705,156	38,019	20,557	8,722	11,738	6,453
November	141,222	485	148,900	598	161,123	597	49,320	235	24,896	72	12	5,547	621,422	47,205	26,730	6,828	-	1,865
December	300,747	1000	157,702	613	186,274	668	48,378	223	106,625	299	2	5,643	879,894	58,931	27,505	7,621	53,859	1,055
Total	479,547	135	1,416,764	468	1,204,761	367	686,047	269	1,053,374	251	446	60,389	6,791,915	498,702	357,097	81,600	193,960	19,623

Total to Primary (gal) = 4360946

Total Area (ac) = 35.80 (Cells 3 - 6 - Fully Online in 2015)

Average (gpad) = 334

2016 Totals

Date	Cell 2-1 Primary Gallons Removed	Cell Size (Acres) 9.70	Cell 3-1 Primary Gallons Removed	Cell Size (Acres) 8.3	Cell 4-1 Primary Gallons Removed	Cell Size (Acres) 9	Cell 5-1 Primary Gallons Removed	Cell Size (Acres) 7	Cell 6-1 Primary Gallons Removed	Cell Size (Acres) 11.5	Cell 6-3 Pore Water Gallons Removed
January	304,847	1014	143,374	557	215,059	771	46,299	213	96,812	272	-
February	395,912	1458	134,631	579	474,905	1885	52,591	268	86,424	268	38
March	125,256	417	113,972	443	346,826	1243	45,595	210	91,797	257	2
April	80,838	278	77,636	312	248,279	920	30,000	143	83,025	241	-
May	73,448	244	104,859	408	198,921	713	39,834	184	80,495	226	-
June	53,443	184	94,465	379	164,656	610	4,836	23	72,486	210	11
July	46,564	155	86,941	338	161,609	579	880	4	74,558	209	-
August	43,667	145	93,328	363	166,773	598	27,051	125	89,182	250	-
September	51,593	177	79,177	318	157,399	583	21,918	104	78,761	228	3
October	51,966	173	79,859	310	169,194	606	25,915	119	73,879	207	-
November	20,332	70	75,843	305	150,979	559	23,410	111	43,969	127	-
December	16	0	83,330	324	153,083	549	42,735	197	30,561	86	4
Total	1,247,882	352	1,167,415	385	2,607,683	794	361,064	141	901,949	215	58

Total to Primary (gal) = 6,285,993
Total Area (ac) = 45.5
Average (gpad) = 379

2016 Totals

Date	C.P.S. Gallons Removed	Loadout Building Gallons Removed	Tank 1 Gallons Removed	Tank 2 Gallons Removed	L.P.S Gallons Removed	Tank 5 Gallons Removed	Flare/ Plant Condensate Gallons Removed
January	6,488	1,049,524	34,884	18,110	7,446	19,429	664
February	6,973	1,024,034	56,791	30,170	8,377	14,210	-
March	7,080	962,057	65,024	34,199	7,027	16,538	1,123
April	7,102	650,026	56,116	15,630	6,310	15,336	1,000
May	6,994	478,396	26,479	15,075	2,919	12,697	-
June	5,509	328,903	29,797	14,930	4,140	9,543	3,067
July	4,810	250,635	27,532	16,055	4,858	7,589	-
August	5,430	401,338	29,109	15,210	5,441	9,983	2,041
September	5,194	417,204	37,049	6,360	5,135	8,138	3,652
October	7,081	474,110	25,166	14,860	8,451	13,305	4,216
November	6,614	495,148	32,530	24,831	5,830	11,933	3,675
December	307	453,138	46,258	15,948	5,925	65,543	-
Total	69,582	6,984,513	466,735	221,378	71,859	204,244	19,438

2017 Totals

2017 Totals

Date	Cell 1-1 Primary Gallons Removed	Cell Size (Area) 7.3	Cell 2-1 Primary Gallons Removed	Cell Size (Area) 9.7	Cell 3-1 Primary Gallons Removed	Cell Size (Area) 8.3	Cell 4-1 Primary Gallons Removed	Cell Size (Area) 9	Cell 5-1 Primary Gallons Removed	Cell Size (Area) 7	Cell 6-1 Primary Gallons Removed	Cell Size (Area) 11.5	Cell 6-3 Pore Water Gallons Removed	C.P.S. Gallons Removed	Loadout Building Gallons Removed	Tank 1 Gallons Removed	Tank 2 Gallons Removed	L.P.S Gallons Removed	Tank 5 Gallons Removed	Flare/ Plant Condensate Gallons Removed
January	-	0	4	0	89,165	347	144,963	520	59,447	274	1,741	5	-	1	596,269	49,305	20,370	5,837	17,168	1,363
February	-	0	69,109	254	75,981	327	9,754	39	49,409	252	4,832	15	-	1	405,102	43,763	18,282	5,057	45,587	646
March	-	0	75,289	250	73,930	287	202,676	726	38,081	175	27,762	78	-	-	663,696	66,135	42,626	5,137	54,568	-
April	-	0	1	0	80,278	322	205,931	763	42,506	202	35,855	104	-	6,883	523,669	40,207	43,542	6,246	70,417	-
May	-	0	-	0	78,740	306	235,184	843	33,940	156	36,268	102	-	6,192	551,845	72,378	17,775	6,686	5,719	-
June	-	0	46,939	161	71,796	288	216,434	802	22,003	105	48,781	141	-	5,788	398,474	43,763	12,805	3,988	4,119	911
July	-	0	101,766	338	74,101	288	253,369	908	23,751	109	49,447	139	-	5,146	334,595	55,648	18,658	3,633	5,629	1,063
August	-	0	86,923	289	75,159	292	228,404	819	21,483	99	45,662	128	-	58,500	578,849	37,497	11,675	3,894	3,670	1,762
September	-	0	65,613	225	69,145	278	198,963	737	18,709	89	38,930	113	-	-	318,850	24,440	15,135	3,508	3,691	2,704
October	-	0	33,882	113	79,565	309	255,878	917	29,681	137	45,214	127	-	-	386,985	42,257	18,050	4,268	4,856	3,356
November	-	0	-	0	79,437	319	266,502	987	55,288	263	48,670	141	-	-	545,641	70,975	21,540	3,852	5,444	2,028
December	186,789	825	8	0	84,500	328	238,945	856	50,965	235	38,859	109	-	4,462	532,885	53,324	16,435	7,032	5,385	-
Total	186,789	70	479,534	135	931,797	308	2,457,003	748	445,263	174	422,021	101	0	86,973	5,836,860	599,692	256,893	59,138	226,253	13,833

Total to Primary (gal) = 4,735,618
Total Area (ac) = 45.5
Average (gpad) = 285

2018 Totals

2018 Totals

Date	Cell 1-1 Primary Gallons Removed	Cell Size (Area) 7.3	Cell 2-1 Primary Gallons Removed	Cell Size (Area) 9.7	Cell 3-1 Primary Gallons Removed	Cell Size (Area) 8.3	Cell 4-1 Primary Gallons Removed	Cell Size (Area) 9	Cell 5-1 Primary Gallons Removed	Cell Size (Area) 7	Cell 6-1 Primary Gallons Removed	Cell Size (Area) 11.5	Cell 6-3 Pore Water Gallons Removed	C.P.S. Gallons Removed	Loadout Building Gallons Removed	Tank 1 Gallons Removed	Tank 2 Gallons Removed	L.P.S Gallons Removed	Tank 5 Gallons Removed	Flare/ Plant Condensate Gallons Removed
January	262,111	1,158	1	0	115,454	449	247,058	886	61,299	282	52,110	146	-	5,654	1,020,030	67,193	47,805	6,516	5,290	-
February	34,888	171	22,467	83	133,875	576	173,558	689	50,113	256	47,839	149	-	260	1,141,484	69,914	21,795	3,405	6,803	-
March	128,687	569	147,848	492	209,007	812	47,911	172	64,476	297	36,140	101	-	14	850,739	75,096	16,200	4,292	5,607	960
April	163,854	748	339,120	1,165	135,568	544	-	-	64,427	307	31	0	-	10,754	927,552	74,634	21,800	3,590	7,243	-
May	86,826	384	131,482	437	115,509	449	100,937	362	66,621	307	-	-	-	12,518	570,139	68,725	7,765	4,064	3,038	-
June	57,367	262	26	0	110,718	445	156,368	579	37,258	177	-	-	-	8,998	684,144	32,119	14,250	2,534	53	-
July	19,304	85	-	-	128,658	500	188,423	675	37,530	173	-	-	-	10,240	390,417	28,153	7,155	2,644	800	1,186
August	4,001	18	119,273	397	122,272	475	197,226	707	48,438	223	-	-	-	9,125	457,993	41,429	17,810	2,679	-	1,458
September	12,209	56	148,808	511	127,861	513	181,674	673	33,692	160	3,987	12	-	8,405	725,855	41,263	5,275	2,565	-	1,091
October	46,969	208	315,940	1,051	186,018	723	233,405	837	111,185	512	47,267	133	-	10,578	1,198,637	56,246	35,176	4,672	5,275	4,968
November	119,372	545	457,684	1,573	155,463	624	207,898	770	10,962	52	47,084	136	-	10,062	1,321,441	57,281	33,813	2,629	18,392	1,210
December	197,344	872	110,450	367	133,706	520	239,598	859	5,103	24	18,184	51	-	10,812	1,302,174	50,880	38,315	2,968	16,976	-
Total	1,132,932	425	1,793,099	506	1,674,109	553	1,974,056	601	591,104	231	252,642	60	0	97,420	10,590,605	662,933	267,159	42,558	69,477	10,873

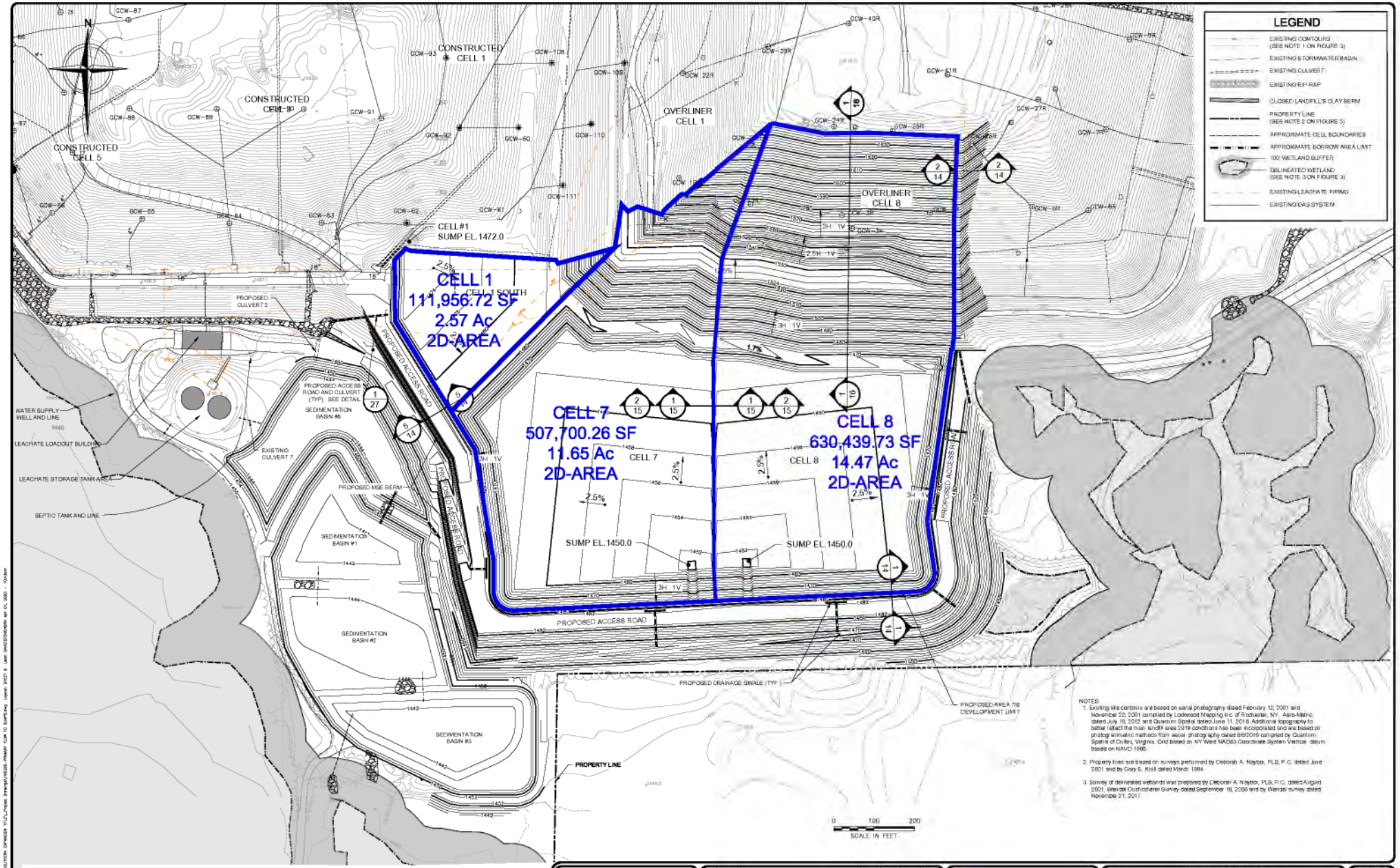
Total to Primary (gal) = 7,417,942
Total Area (ac) = 52.8
Average (gpad) = 385

2019 Totals

2019 Totals

Date	Cell 1-1 Primary Gallons Removed	Cell Size (Area) 7.3	Cell 2-1 Primary Gallons Removed	Cell Size (Area) 9.7	Cell 3-1 Primary Gallons Removed	Cell Size (Area) 8.3	Cell 4-1 Primary Gallons Removed	Cell Size (Area) 9	Cell 5-1 Primary Gallons Removed	Cell Size (Area) 7	Cell 6-1 Primary Gallons Removed	Cell Size (Area) 11.5	Cell 6-3 Pore Water Gallons Removed	C.P.S. Gallons Removed	Loadout Building Gallons Removed	Tank 1 Gallons Removed	Tank 2 Gallons Removed	L.P.S Gallons Removed	Tank 5 Gallons Removed	Flare/ Plant Condensate Gallons Removed
January	142,658	630	14,732	49	126,459	491	279,330	1,001	48,456	223	15,584	44	-	9,159	801,087	43,812	33,180	2,693	13,357	1,430
February	209,770	1,026	33,374	123	127,436	548	326,337	1,295	71,646	366	10,339	32	-	9,376	650,611	49,930	44,530	2,383	11,588	1,000
March	145,599	643	211,771	704	135,903	528	359,147	1,287	124,958	576	437	1	-	8,543	1,000,739	43,599	30,555	2,127	8,473	-
April	150,274	686	877,251	3,015	177,129	711	286,481	1,061	162,625	774	417	1	-	8,896	1,588,600	48,077	24,395	2,715	10,345	-
May	152,166	672	779,809	2,593	140,105	545	242,279	868	24,654	114	8,551	24	-	8,182	1,594,416	53,166	12,775	2,198	5,382	-
June	211,531	966	294,728	1,013	120,034	482	178,332	660	10,620	51	2,869	8	-	8,973	930,603	29,091	7,210	2,159	4,676	838
July	75,951	336	261,366	869	132,006	513	208,782	748	8,410	39	1,561	4	-	25,426	760,993	31,908	18,081	2,451	14,586	1,077
August	164,561	727	267,282	889	109,990	427	173,840	623	15,271	70	2,630	7	-	20,019	787,541	25,467	10,855	2,203	16,485	1,200
September	92,949	424	101,802	350	105,312	423	183,312	679	18,677	89	10,344	30	-	15,724	706,076	32,416	10,915	2,214	17,318	-
October	21,824	96	90,997	303	118,191	459	196,600	705	32,389	149	11,555	32	-	19,530	745,006	10,378	12,510	3,898	5,487	-
November	136,441	623	18,794	65	106,246	427	202,059	748	133,143	634	25,649	74	-	18,446	699,502	26,899	14,450	2,060	6,320	3,761
December	152,990	676	170,316	566	131,505	511	217,010	778	93,737	432	44,307	124	-	21,829	850,906	36,513	26,920	2,667	9,213	976
Total	1,656,714	622	3,122,222	882	1,530,316	505	2,853,509	869	744,586	291	134,243	32	0	174,103	11,116,080	431,256	246,376	29,768	123,230	10,282

Total to Primary (gal) = 10,041,590
Total Area (ac) = 52.8
Average (gpad) = 521



SUBGRADE DEVELOPMENT

PLAN

SCALE: 1"=100' (1/8)

ROBERT A. HOLMES

N.Y.P.E. Lic. No. 077317 Date

REV	DATE	DESCRIPTION	DRN BY	DES BY	CHK BY	APP BY
DAT OF ISSUE MARCH 2020		DRAWN BY: DSS DESIGNED BY:	CHECKED BY: APPROVED BY:			

cornerstone PLLC

PREPARED BY: CORNERSTONE ENGINEERING, GEOLOGY AND LAND SURVEYING, PLLC

CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

PRIMARY FLOW AREAS TO SUMPS

SHEET NO. X

PROJECT NO. 192260

B.11 - HELP Model Analysis

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Chaffee Landfill	17-Jul-20	190260
PROJECT / CALCULATION NUMBER	Leachate Collection - 500 Yr Storm	
PREPARED BY Tyler Brown (7/17/2020)	**CHECKED BY** Rob Holmes (TBD)	

Description and Purpose:

The objective of this calculation is to determine leachate collection volumes during a 500 year storm.

Design Basis/References/Assumptions:

1) Using a HELP model to determine the leachate collection for a 500-yr storm.
2) 24-hr, 500-year storm is 7.65 inches (From the Stormwater Calculations). Precipitiation data was edited to include this peak number.
3) Runoff from the daily cover on the top of the waste is assumed to travel 575 ft at a 2% slope
4) Leachate contained within the gravel drainage layer is assumed to travel 575 ft at a 2.5% slope
5) See output file for layer configuration
6) Assumed 50 ft of waste with 6 inches of daily cover

Calculation Process:

HELP model was used by performing the following inputs:
1) Precipitation data for Buffalo, NY used, based on the available software choices within the HELP model.
2) A manual overide was inserted into the data for a 500-year storm (7.65 inches)
3) Layer information entered for daily cover, waste, drainage layer, membrane etc.
4) Model was run to predict both primary and secondary drainage layer collection in inches.

Remarks/Conclusions/Results:

During a 500-year storm event (7.65 inches) it is expected that 472 cubic feet (3,529 gallons) per acre per day would be collected in the primary drainage layer.

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**                                                                           **
**                                                                           **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                    USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                           **
**                                                                           **
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PRECIPITATION DATA FILE:    C:\CHAF1.D4
TEMPERATURE DATA FILE:      c:\CHAF2.D7
SOLAR RADIATION DATA FILE:  C:\CHAF3.D13
EVAPOTRANSPIRATION DATA:    C:\CHAF4.D11
SOIL AND DESIGN DATA FILE:  C:\CHAFF50.D10
OUTPUT DATA FILE:           C:\CHAFF50.OUT



TIME:  11:34     DATE:   7/17/2020



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     TITLE:  Chaffee Phase IV Expansion

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
           THICKNESS                     =      6.00   INCHES
```

POROSITY	=	0.4530 VOL/VOL
FIELD CAPACITY	=	0.1900 VOL/VOL
WILTING POINT	=	0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4051 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.720000011000E-03 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 1.80
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	600.00 INCHES
POROSITY	=	0.6710 VOL/VOL
FIELD CAPACITY	=	0.2920 VOL/VOL
WILTING POINT	=	0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3014 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02 CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00 INCHES
POROSITY	=	0.3970 VOL/VOL
FIELD CAPACITY	=	0.0320 VOL/VOL
WILTING POINT	=	0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0601 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	1.00000000000 CM/SEC
SLOPE	=	2.50 PERCENT
DRAINAGE LENGTH	=	575.0 FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06 INCHES
POROSITY	=	0.0000 VOL/VOL

```
FIELD CAPACITY              =      0.0000 VOL/VOL
WILTING POINT               =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY         =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD
```

LAYER 5

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            TYPE 3 - BARRIER SOIL LINER
            MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      1.00   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000003000E-08 CM/SEC
```

LAYER 6

```
          TYPE 2 - LATERAL DRAINAGE LAYER
            MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.3970 VOL/VOL
FIELD CAPACITY              =      0.0320 VOL/VOL
WILTING POINT               =      0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0320 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   1.00000000000     CM/SEC
SLOPE                       =      2.50   PERCENT
DRAINAGE LENGTH             =    575.0    FEET
```

LAYER 7

```
          TYPE 4 - FLEXIBLE MEMBRANE LINER
            MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
POROSITY                    =      0.0000 VOL/VOL
```

FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY	=	1.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 8

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 11

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4640 VOL/VOL
FIELD CAPACITY	=	0.3100 VOL/VOL
WILTING POINT	=	0.1870 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4640 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.639999998000E-04 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 575. FEET.

SCS RUNOFF CURVE NUMBER	=	85.20	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.904	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	12.112	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.588	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	196.982	INCHES
TOTAL INITIAL WATER	=	196.982	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
BUFFALO NEW YORK

STATION LATITUDE	=	42.93 DEGREES
MAXIMUM LEAF AREA INDEX	=	1.00
START OF GROWING SEASON (JULIAN DATE)	=	126
END OF GROWING SEASON (JULIAN DATE)	=	285
EVAPORATIVE ZONE DEPTH	=	20.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	12.10 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	72.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR BUFFALO NEW YORK

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.02	2.40	2.97	3.06	2.89	2.72
2.96	4.16	3.37	2.93	3.62	3.42

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR BUFFALO NEW YORK

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
23.50	24.50	33.00	45.40	56.10	66.00
70.70	68.90	62.10	51.50	40.30	28.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR BUFFALO NEW YORK
AND STATION LATITUDE = 42.93 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.44	2.02	4.28	2.94	3.27	2.62
	2.70	3.84	2.92	5.27	13.02	3.68
RUNOFF	1.362	1.004	3.401	0.831	0.000	0.000
	0.017	0.006	0.000	0.071	4.612	1.025
EVAPOTRANSPIRATION	0.346	0.452	0.371	2.892	3.488	2.996
	3.577	4.437	2.056	1.959	1.540	0.493
LATERAL DRAINAGE COLLECTED	3.5868	2.1483	0.0924	0.1308	3.1334	0.5114
FROM LAYER 3	0.0529	0.0274	0.0173	0.0452	0.6868	1.6427
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.470	0.311	0.012	0.018	0.410	0.069
TOP OF LAYER 4	0.007	0.004	0.002	0.006	0.093	0.215
STD. DEVIATION OF DAILY	0.023	0.169	0.006	0.051	0.034	0.115
HEAD ON TOP OF LAYER 4	0.002	0.000	0.000	0.013	0.095	0.176
AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	49.00	177869.969	100.00
RUNOFF	12.328	44751.121	25.16
EVAPOTRANSPIRATION	24.608	89325.914	50.22
DRAINAGE COLLECTED FROM LAYER 3	12.0754	43833.609	24.64
PERC./LEAKAGE THROUGH LAYER 5	0.000011	0.039	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1348		
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.030	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000003	0.009	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	-0.011	-40.711	-0.02
SOIL WATER AT START OF YEAR	196.982	715044.562	
SOIL WATER AT END OF YEAR	196.971	715003.875	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.002	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.32	3.62	3.57	1.88	3.58	1.26
	3.27	7.84	2.04	2.24	1.83	3.85
RUNOFF	0.009	0.040	7.713	0.208	0.002	0.000
	0.032	0.111	0.000	0.000	0.000	0.006
EVAPOTRANSPIRATION	0.453	0.471	0.286	2.376	4.378	1.130
	2.670	6.173	3.082	1.775	1.295	0.503
LATERAL DRAINAGE COLLECTED	3.5850	2.1397	0.0919	0.6940	2.5437	0.1134
FROM LAYER 3	0.0585	0.4800	0.6288	0.0651	0.0380	0.3994
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.469	0.310	0.012	0.094	0.333	0.015
TOP OF LAYER 4	0.008	0.063	0.085	0.009	0.005	0.052
STD. DEVIATION OF DAILY	0.023	0.170	0.006	0.157	0.140	0.007
HEAD ON TOP OF LAYER 4	0.003	0.117	0.097	0.003	0.000	0.065
AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.30	139029.031	100.00
RUNOFF	8.120	29477.227	21.20
EVAPOTRANSPIRATION	24.592	89268.586	64.21
DRAINAGE COLLECTED FROM LAYER 3	10.8373	39339.469	28.30
PERC./LEAKAGE THROUGH LAYER 5	0.000010	0.036	0.00
AVG. HEAD ON TOP OF LAYER 4	0.1213		
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.027	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000002	0.009	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	-5.250	-19056.291	-13.71
SOIL WATER AT START OF YEAR	196.971	715003.875	
SOIL WATER AT END OF YEAR	189.430	687630.812	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	2.291	8316.764	5.98
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	5.13	2.64	1.93	2.02	2.49	1.99
	2.42	4.71	3.23	2.45	2.35	2.34

RUNOFF	0.105	0.443	1.752	6.598	0.008	0.000
	0.033	0.002	0.004	0.000	0.000	0.116
EVAPOTRANSPIRATION	0.470	0.490	0.693	1.581	2.523	2.643
	3.518	4.526	2.762	1.834	1.106	0.446
LATERAL DRAINAGE COLLECTED	0.1086	0.0317	0.0207	0.0138	2.3934	0.4382
FROM LAYER 3	0.0563	0.0535	0.0307	0.0193	0.0132	0.0106
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.014	0.005	0.003	0.002	0.313	0.059
TOP OF LAYER 4	0.007	0.007	0.004	0.003	0.002	0.001
STD. DEVIATION OF DAILY	0.008	0.001	0.000	0.000	0.176	0.074
HEAD ON TOP OF LAYER 4	0.002	0.002	0.001	0.000	0.000	0.000
AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	33.70	122331.047	100.00
RUNOFF	9.060	32889.578	26.89

EVAPOTRANSPIRATION	22.591	82004.594	67.03
DRAINAGE COLLECTED FROM LAYER 3	3.1901	11579.979	9.47
PERC./LEAKAGE THROUGH LAYER 5	0.000005	0.017	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0350		
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.008	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000002	0.009	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	-1.141	-4143.156	-3.39
SOIL WATER AT START OF YEAR	189.430	687630.812	
SOIL WATER AT END OF YEAR	189.400	687523.375	
SNOW WATER AT START OF YEAR	2.291	8316.764	6.80
SNOW WATER AT END OF YEAR	1.179	4281.062	3.50
ANNUAL WATER BUDGET BALANCE	0.0000	0.033	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.32	1.56	1.47	2.98	4.44	2.76
	4.76	1.07	5.39	3.07	5.03	3.92
RUNOFF	0.539	1.312	2.143	2.140	0.001	0.000
	0.072	0.000	0.011	0.000	0.443	0.694
EVAPOTRANSPIRATION	0.405	0.533	0.539	0.329	5.937	3.035
	5.231	2.394	2.747	1.887	1.277	0.523

LATERAL DRAINAGE COLLECTED	0.0086	0.0067	0.0061	0.0051	1.5068	0.9122
FROM LAYER 3	0.0537	0.0288	0.0174	0.2844	0.3798	1.8779
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.001	0.001	0.001	0.197	0.123
TOP OF LAYER 4	0.007	0.004	0.002	0.037	0.051	0.246
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.184	0.161
HEAD ON TOP OF LAYER 4	0.002	0.001	0.000	0.055	0.035	0.160
AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	39.77	144365.047	100.00
RUNOFF	7.354	26696.592	18.49
EVAPOTRANSPIRATION	24.837	90157.094	62.45
DRAINAGE COLLECTED FROM LAYER 3	5.0876	18467.883	12.79
PERC./LEAKAGE THROUGH LAYER 5	0.000006	0.021	0.00

AVG. HEAD ON TOP OF LAYER 4	0.0560		
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.012	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000002	0.009	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	2.491	9043.513	6.26
SOIL WATER AT START OF YEAR	189.400	687523.375	
SOIL WATER AT END OF YEAR	191.604	695521.375	
SNOW WATER AT START OF YEAR	1.179	4281.062	2.97
SNOW WATER AT END OF YEAR	1.467	5326.566	3.69
ANNUAL WATER BUDGET BALANCE	0.0000	-0.053	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.92	0.96	3.53	5.18	1.88	4.20
	3.43	3.51	5.99	2.21	1.76	2.42
RUNOFF	2.458	0.485	2.497	3.908	0.678	0.010
	0.000	0.002	0.346	0.000	0.000	0.007
EVAPOTRANSPIRATION	0.378	0.514	0.423	0.711	3.085	3.767
	4.554	4.021	3.362	1.858	1.439	0.843
LATERAL DRAINAGE COLLECTED	1.3084	0.0513	0.0273	0.0168	1.0471	2.2183
FROM LAYER 3	0.1057	0.0389	0.0209	0.0176	0.4301	0.4280
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.171	0.007	0.004	0.002	0.137	0.300
TOP OF LAYER 4	0.014	0.005	0.003	0.002	0.058	0.056
STD. DEVIATION OF DAILY	0.187	0.002	0.001	0.000	0.191	0.167
HEAD ON TOP OF LAYER 4	0.005	0.001	0.000	0.000	0.082	0.046
AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 7	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.99	137903.703	100.00
RUNOFF	10.390	37717.508	27.35
EVAPOTRANSPIRATION	24.954	90584.570	65.69
DRAINAGE COLLECTED FROM LAYER 3	5.7104	20728.826	15.03
PERC./LEAKAGE THROUGH LAYER 5	0.000006	0.023	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0634		
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.014	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000002	0.009	0.00

AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	-3.065	-11127.249	-8.07
SOIL WATER AT START OF YEAR	191.604	695521.375	
SOIL WATER AT END OF YEAR	189.918	689401.312	
SNOW WATER AT START OF YEAR	1.467	5326.566	3.86
SNOW WATER AT END OF YEAR	0.088	319.403	0.23
ANNUAL WATER BUDGET BALANCE	0.0000	0.025	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.43	2.16	2.96	3.00	3.13	2.57
	3.32	4.19	3.91	3.05	4.80	3.24
STD. DEVIATIONS	1.02	1.02	1.20	1.32	0.99	1.09
	0.91	2.45	1.69	1.29	4.79	0.79
RUNOFF						
TOTALS	0.894	0.656	3.501	2.737	0.138	0.002
	0.031	0.024	0.072	0.014	1.011	0.370
STD. DEVIATIONS	1.024	0.501	2.432	2.582	0.302	0.005
	0.027	0.049	0.153	0.032	2.022	0.465
EVAPOTRANSPIRATION						
TOTALS	0.410	0.492	0.462	1.578	3.882	2.714
	3.910	4.310	2.802	1.862	1.331	0.561

STD. DEVIATIONS	0.052	0.032	0.158	1.081	1.333	0.975
	0.995	1.350	0.488	0.068	0.166	0.160

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	1.7195	0.8755	0.0477	0.1721	2.1249	0.8387
	0.0654	0.1257	0.1430	0.0863	0.3096	0.8717
STD. DEVIATIONS	1.7789	1.1581	0.0413	0.2963	0.8379	0.8219
	0.0226	0.1983	0.2716	0.1125	0.2843	0.8319

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 8

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.2252	0.1269	0.0062	0.0233	0.2783	0.1135
	0.0086	0.0165	0.0194	0.0113	0.0419	0.1142
STD. DEVIATIONS	0.2330	0.1679	0.0054	0.0401	0.1097	0.1112
	0.0030	0.0260	0.0368	0.0147	0.0385	0.1089

DAILY AVERAGE HEAD ON TOP OF LAYER 7

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	39.75 (5.643)	144299.8	100.00
RUNOFF	9.451 (1.9672)	34306.40	23.774
EVAPOTRANSPIRATION	24.316 (0.9767)	88268.16	61.170
LATERAL DRAINAGE COLLECTED FROM LAYER 3	7.38015 (3.85998)	26789.955	18.56549
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00001 (0.00000)	0.027	0.00002
AVERAGE HEAD ON TOP OF LAYER 4	0.082 (0.043)		
LATERAL DRAINAGE COLLECTED FROM LAYER 6	0.00000 (0.00000)	0.018	0.00001
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.00000 (0.00000)	0.009	0.00001
AVERAGE HEAD ON TOP OF LAYER 7	0.000 (0.000)		
CHANGE IN WATER STORAGE	-1.395 (2.9467)	-5064.78	-3.510

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	7.65	27769.500
RUNOFF	4.611	16737.0469
DRAINAGE COLLECTED FROM LAYER 3	0.12999	471.84903
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00036
AVERAGE HEAD ON TOP OF LAYER 4	0.528	
MAXIMUM HEAD ON TOP OF LAYER 4	1.029	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	14.2 FEET	
DRAINAGE COLLECTED FROM LAYER 6	0.00000	0.00033
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 7	0.000	
MAXIMUM HEAD ON TOP OF LAYER 7	0.070	
LOCATION OF MAXIMUM HEAD IN LAYER 6 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	7.57	27477.4961

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4477
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0794

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	1.6168	0.2695
2	174.9032	0.2915
3	1.1276	0.0470
4	0.0000	0.0000
5	0.7500	0.7500
6	0.3840	0.0320
7	0.0000	0.0000
8	11.1360	0.4640
SNOW WATER	0.088	

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B.12 – Stormwater Calculations

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	29-Apr-20	208-190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	Pre-Development Drainage Calculations	
PREPARED BY	**CHECKED BY**	
KLS 9/23/2019	LR 4/29/2020	

Description and Purpose:

Determine the pre-development discharge to Hosmer Brook for the 1-Year, 10-Year and 100-Year storm events. Since the stormwater from the Area 7/8 Development will all drain to Hosmer Brook, pre-development discharge calculations are only included for the drainage area that discharges to Hosmer Brook.

Design Basis/References/Assumptions:

Appendix E.1 Pre-Development Runoff and Design Criteria of the Engineering Report for the 6 NYCRR Part 360 Solid Waste Management Permit Modification Application prepared by McMahon & Mann Consulting Engineers, P.C., February 2005.
New York State Stormwater Management Design manual, January 2015.
New York State Standards and Specifications for Erosion and Sediment Control, November 2016.
HydroCAD Stormwater Modeling, Version 10.00-24.

Remarks/Conclusions/Results:

Storm Event	Hosmer Brook Discharge (cfs)
1-Year	70.75
10-Year	191.22
100-Year	418.96

Note:
1. Precipitation data obtained from the Northeast Regional Climate Center (NRCC) for the Extreme Precipitation in New York & New England.
2. Pre-Development areas and cover types remained the same as the Appendix E.1 Pre-Development Runoff and Design Criteria of the Engineering Report for the 6 NYCRR Part 360 Solid Waste Management Permit Modification Application prepared by McMahon & Mann Consulting Engineers, P.C., February 2005.

6 NYCRR Part 360 Solid Waste Management Permit Modification Application
Engineering Report
Prepared by McMahon & Mann Consulting Engineers, P.C.
February 2005

Appendix E.1 Pre-Development Runoff And Design Criteria

The pre-existing landfill runoff conditions and post-existing landfill conditions were presented in calculations by the CID Group, Inc. shown in the "Final Stormwater Management and Sediment and Erosion Control Plan", Appendices A and B dated May 1997 and revised in October 1997. MMCE has subsequently estimated pre-existing landfill runoff conditions for both the 1-year and 10-year storm events using the same input as presented in the above mentioned calculations. This will allow the outflow from the proposed expansion to be compared with the predevelopment flows

The following section summarizes the pre-existing landfill and post existing landfill stormwater runoff calculations. This is followed by a description of the proposed landfill stormwater operations.

Pre-existing Landfill conditions: The site was divided into four drainage basins (see attached figure – sheet 4 of 5). The peak flow calculated by CID Group from each area is summarized below.

Drainage Area	Q peak–1 yr. (CFS)	Q peak–10 yr. (CFS)	Q peak–25 yr. (CFS)	Q peak–100 yr. (CFS)
A	29	71	83	111
B1	94	238	280	378
B2	5	18	20	29
C	32	78	92	123

Post-existing landfill conditions: The site was divided into areas F1 – F14 (see attached figure – sheet 5 of 5). The following table lists the original drainage areas and the corresponding post existing landfill drainage areas that flow to the same outfall.

Original Drainage Area	Post-Existing Landfill Areas	Outfall Location
A	F9	Wetland AR-11
B1	F4, F5, F6, F7, F12, F13, F14	Hosmer Brook
B2	F1, F2, F3, F8	Tributary to Hosmer Brook (southeast of existing landfill)
C	F10, F11	Hand Road drainage structures

The drainage from F4, F5, F6, F7, F12, F13, and F14 was directed to sedimentation basins #1, #2, and #3 (see sheet 5 of 5 for location). The drainage from F1, F2, F3, and F8 was directed to sedimentation basin #4 (see sheet 5 of 5 for location). The calculations prepared by CID Group indicated that sedimentation basins #1, #2, #3, and #4 were of sufficient size to limit flow to below the pre-development discharge flows. Area F9 is smaller than drainage area A and areas F10 and F11 area smaller than drainage area C. As such the post development flows from these areas were also less than the pre-development flow.

For the proposed expansion, the conditions in the drainage areas flowing to basins #1, #2 and #3 will be modified. This area will be larger and include the area previously flowing to basins #1, #2, and #3 and most of the area previously in F10 and F11. The existing pond volumes and outlet devices vary from those described in the 1997 documentation. Also a new pond has been proposed upstream of sedimentation basins #1, #2, and #3 (designated basin #5). This upstream basin will be lined with low permeable soil and will be equipped with a valve on the inlet and outlet to contain impacted stormwater if required. In that case stormwater will be allowed to flow into existing basins #1, #2, and #3. These proposed changes in the surface water management system require evaluation as part of the Western Expansion design.

The purpose of these calculations is to recalculate the flows from the modified areas and design the new upstream basin to contain the flows from the expansion area.

During operation, basins will operate as follows:

- Expansion areas will flow into new basin #5.
- Existing landfill areas will flow into existing basins #1 - #3.
- Basin #5 will discharge into basins #1 - #3 through a controlled riser and spillway; water can be diverted directly into basins #1 - #3 if necessary.

If a spill occurs the basins will operate as follows:

- Expansion area stormwater will flow into basin #5; basin inlet and outlet will be closed until water can be tested, treated and disposed if required.
- Storm events during this containment period will be diverted into basins #1 - #3.
- Existing landfill areas will flow into existing basins #1 - #3.

Basin design criteria are described below:

For basin #5

1. Provide ½ yr. of sediment storage within the basin based on an approximate disturbed area for a normal construction season (30 acres).
2. Based on the remaining storage after sediment buildup, check that the basin can adequately retain and discharge the 25-yr. storm through the riser and spillway, maintaining 1.0' of freeboard to the basin banks.

3. Based on the remaining storage after sediment buildup, check that the basin can adequately retain and discharge the 100-yr. storm through the riser and spillway, maintaining no overtopping of the basin banks.

For existing basins #1 - #3

The basins have been resized to provide pretreatment and treatment water quality volumes, extended detention for the 1-year, 24 hour storm, and control of the 10-year, 25-year and 100-year, 24 hour storms.

1. Check the capacity and outlet sizing based on the outflow from basin #5 combined with existing landfill flows. This flow will not control the basins design.

2. Check the capacity and outlet for the condition when basin #5 has been closed due to a spill and all stormwater has to be diverted to basins #1 - #3. Check this for the following:

    a. Pretreatment of 100% of the water quality volume in the forebay area,

    b. Treatment of 100% of the water quality volume in the permanent pool areas,

    c. Provide channel protection by providing 12 to 24-hours of extended detention of the 1-year, 24-hour storm,

    d. Check that the basin can adequately retain and discharge the 10-yr. storm through the riser, with a peak outflow less than the predevelopment flow,

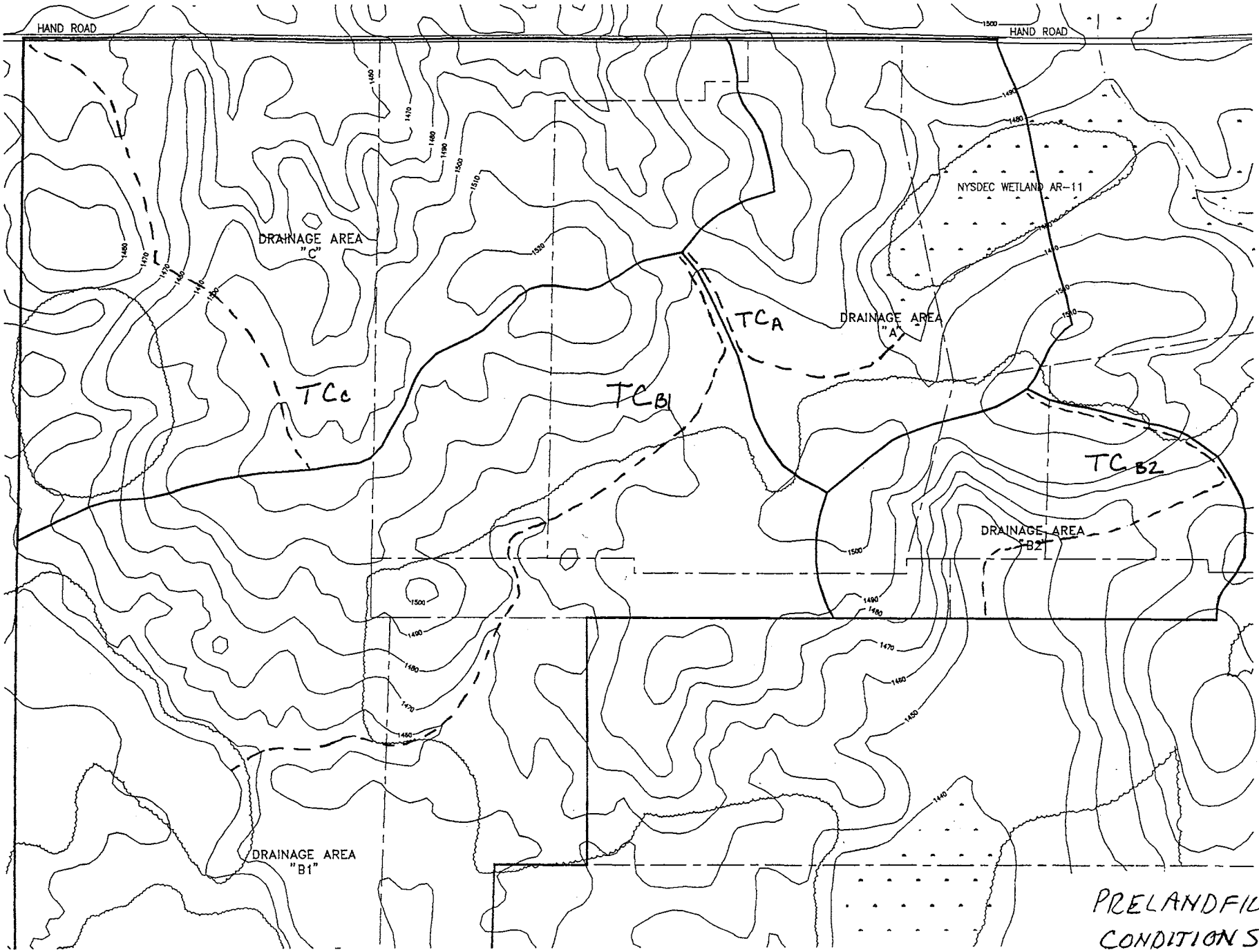
    e. Check that the basin can adequately retain and discharge the 25-yr. storm through the riser and spillway, maintaining 1.0' of freeboard to the basin banks with a peak outflow less than the predevelopment flow,

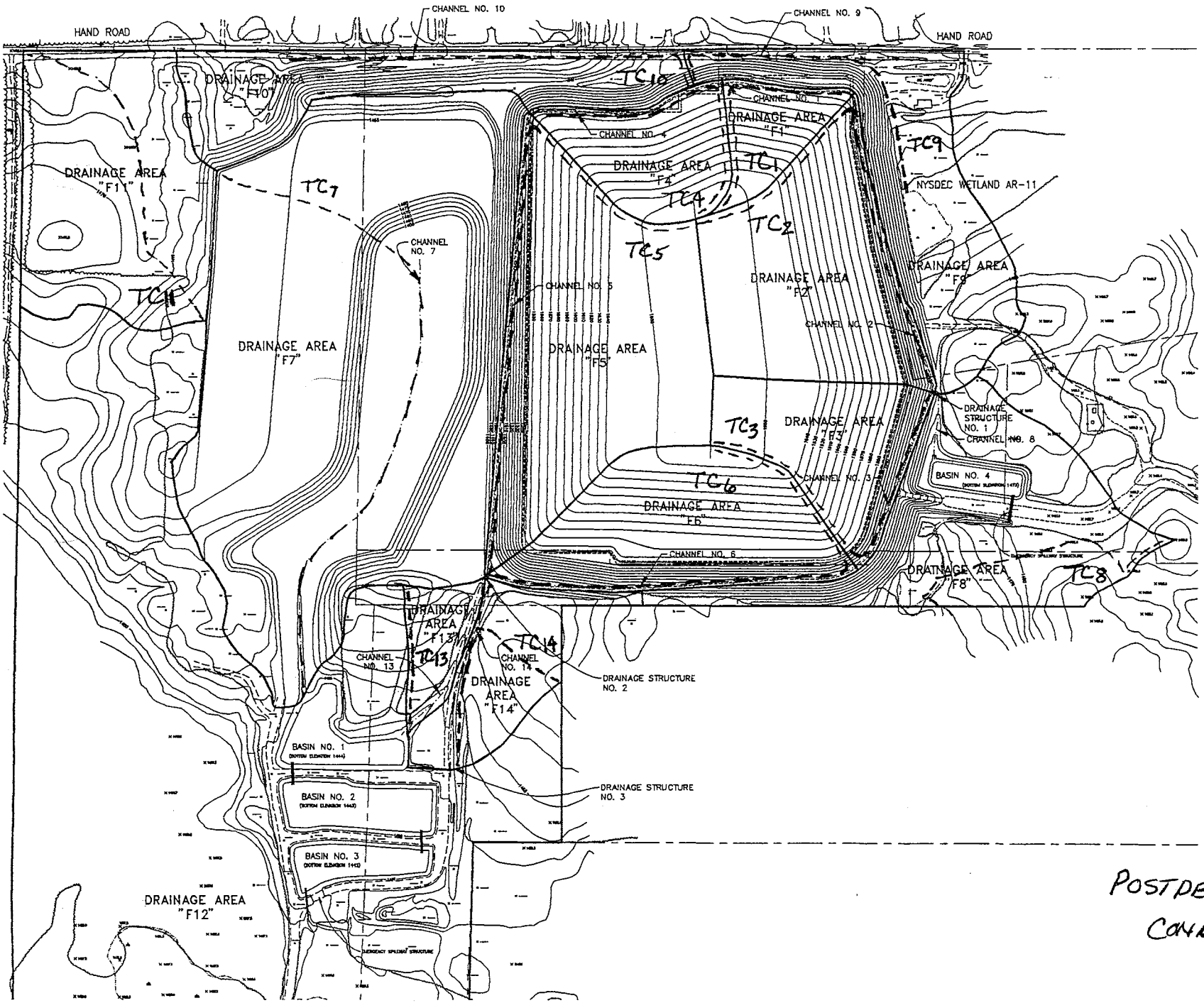
    f. Check that the basin can adequately retain and discharge the 100-yr. storm through the riser and spillway, maintaining no overtopping of the basin banks with a peak outflow less than the predevelopment flow.

Channel and culvert design will be as follows:

1. Design all proposed channels and culverts for both the 25-yr. and 100-yr. storms, providing adequate freeboard and required revetments.

2. Check existing channels and culverts for both the 25-yr. and 100-yr. storms; when an increase in peak flow has occurred, ensure adequate freeboard and revetments.


HAND ROAD
HAND ROAD
NYSDEC WETLAND AR-11
DRAINAGE AREA "C"
DRAINAGE AREA "A"
DRAINAGE AREA "B2"
DRAINAGE AREA "B1"
TCc
TCB1
TCA
TCB2
NORTH
NO SCALE
PRELANDFILL CONDITIONS



NORTH

NO SCALE

POSTDEVELOPMENT CONDITIONS

ESTIMATE 1-YEAR PRE-EXISTING LANDFILL RUNOFF

- USE INFORMATION PRESENTED IN "FINAL STORMWATER MANAGEMENT AND SEDIMENT AND EROSION CONTROL PLAN"

- APPENDIX A PRESENTS 24-HOUR, 25 YEAR AND 24-HOUR, 100 YEAR STORMWATER ANALYSIS INCLUDING AREAS, SURFACE CONDITIONS, AND TIMES OF CONCENTRATION

- USING THIS DATA, AND TR55 ESTIMATE PEAK FLOWS FOR THE FOUR DRAINAGE AREAS (SEE ATTACHED PAGES)

	Q_1 (CFS)
A	29
B1	94
B2	5
C	32

ESTIMATE 10-YEAR PRE-EXISTING LANDFILL RUNOFF

- USE THE SAME INFORMATION AS STATED ABOVE AND TR55 TO ESTIMATE PEAK FLOWS FOR THE FOUR DRAINAGE AREAS (SEE ATTACHED PAGES)

	Q_{10} (CFS)
A	71
B1	238
B2	18
C	78

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : Chaffee Western Expansion User: AJN Date:
County : Erie State: NY Checked: ____ Date: _____
Subtitle: Prelandfill 24-Hour, 1-Year Stormwater Analysis
Subarea : A

COVER DESCRIPTION			Hydrologic Soil Group A	B	C	D
			Acres (CN)			
CULTIVATED AGRICULTURAL LANDS						
Fallow	Crop residue (CR)	good	-	-	-	20(90)
OTHER AGRICULTURAL LANDS						
Brush - brush, weed, grass mix		good	-	-	-	5.1(73)
Woods		good	-	-	-	8(77)
Total Area (by Hydrologic Soil Group)						33.1 ====

SUBAREA: A TOTAL DRAINAGE AREA: 33.1 Acres WEIGHTED CURVE NUMBER: 84

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : Chaffee Western Expansion User: AJN Date:
County : Erie State: NY Checked: ____ Date: _____
Subtitle: Prelandfill 24-Hour, 1-Year Stormwater Analysis
Subarea : B1

COVER DESCRIPTION			Hydrologic Soil Group A	B	C	D
			Acres (CN)			
CULTIVATED AGRICULTURAL LANDS						
Fallow	Crop residue (CR)	good	-	-	-	71.7(90)
OTHER AGRICULTURAL LANDS						
Brush - brush, weed, grass mix		good	-	-	-	23(73)
Woods		good	-	-	-	53.6(77)
Total Area (by Hydrologic Soil Group)						148. ====

SUBAREA: B1 TOTAL DRAINAGE AREA: 148.3 Acres WEIGHTED CURVE NUMBER: 83

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : Chaffee Western Expansion User: AJN Date:
County : Erie State: NY Checked: ____ Date: _____
Subtitle: Prelandfill 24-Hour, 1-Year Stormwater Analysis
Subarea : B2

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
		Acres (CN)			
OTHER AGRICULTURAL LANDS					
Woods	good	-	-	-	21.2(77)
Total Area (by Hydrologic Soil Group)					21.2

SUBAREA: B2 TOTAL DRAINAGE AREA: 21.2 Acres WEIGHTED CURVE NUMBER: 77

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : Chaffee Western Expansion User: AJN Date:
County : Erie State: NY Checked: ____ Date: _____
Subtitle: Prelandfill 24-Hour, 1-Year Stormwater Analysis
Subarea : C

COVER DESCRIPTION			Hydrologic Soil Group A	B	C	D
			Acres (CN)			
CULTIVATED AGRICULTURAL LANDS						
Fallow	Crop residue (CR)	good	-	-	-	42(90)
OTHER AGRICULTURAL LANDS						
Brush - brush, weed, grass mix		good	-	-	-	20.3(73)
Woods		good	-	-	-	7.2(77)
Total Area (by Hydrologic Soil Group)						69.5

SUBAREA: C TOTAL DRAINAGE AREA: 69.5 Acres WEIGHTED CURVE NUMBER: 84

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : Chaffee Western Expansion User: AJN Date:

County : Erie State: NY Checked: ____ Date: _____

Subtitle: Prelandfill 24-Hour, 1-Year Stormwater Analysis

---------- Subarea #1 - A ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.5	300	.0239	C					0.199
Shallow Concent'd		745	.0239	U					0.083
								Time of Concentration =	0.28*
									=====

---------- Subarea #2 - B1 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.5	300	.0249	C					0.196
Shallow Concent'd		3115	.0249	U					0.340
								Time of Concentration =	0.54*
									=====

---------- Subarea #3 - B2 ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.5	300	.032	H					0.808
Shallow Concent'd		1524	.032	U					0.147
								Time of Concentration =	0.95*
									=====

---------- Subarea #4 - C ----------

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.5	300	.032	H					0.808
Shallow Concent'd		1595	.032	U					0.154
								Time of Concentration =	0.96*
									=====

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense	--- Shallow Concentrated ---
B Fallow (No Res.)	G Grass, Burmuda	--- Surface Codes ---
C Cultivated < 20 % Res.	H Woods, Light	P Paved
D Cultivated > 20 % Res.	I Woods, Dense	U Unpaved
E Grass-Range, Short	J Range, Natural	

* - Generated for use by TABULAR method

TABULAR HYDROGRAPH METHOD Version 2.00

Project : Chaffee Western Expansion User: AJN Date:
County : Erie State: NY Checked: ____ Date: _____
Subtitle: Prelandfill 24-Hour, 1-Year Stormwater Analysis

Total watershed area: 0.425 sq mi Rainfall type: II Frequency: 1 years

	Subareas			
	A	B1	B2	C
Area(sq mi)	0.05*	0.23*	0.03*	0.11*
Rainfall(in)	2.1	2.1	2.1	2.1
Curve number	84*	83*	77*	84*
Runoff(in)	0.82	0.76	0.50	0.82
Tc (hrs)	0.28*	0.54*	0.95*	0.96*
(Used)	0.30	0.50	1.00	1.00
TimeToOutlet	0.00	0.00	0.00	0.00
Ia/P	0.18	0.20	0.28	0.18
(Used)	0.10	0.10	0.30	0.10

Time	Total	Subarea Contribution to Total Flow (cfs)			
(hr)	Flow	A	B1	B2	C
11.0	5	1	3	0	1
11.3	6	1	4	0	1
11.6	10	2	6	0	2
11.9	18	5	10	0	3
12.0	30	10	17	0	3
12.1	53	19	30	0	4
12.2	90	29P	55	0	6
12.3	123	29	83	1	10
12.4	129P	19	94P	1	15
12.5	124	12	90	2	20
12.6	108	8	71	3	26
12.7	92	6	53	4	29
12.8	82	5	40	5P	32P
13.0	61	3	25	5	28
13.2	45	3	17	4	21
13.4	33	2	13	3	15
13.6	27	2	11	2	12
13.8	22	2	9	2	9
14.0	19	2	8	2	7
14.3	16	2	7	1	6
14.6	12	1	6	1	4
15.0	12	1	6	1	4
15.5	10	1	5	1	3
16.0	10	1	5	1	3
16.5	8	1	4	1	2
17.0	8	1	4	1	2
17.5	8	1	4	1	2
18.0	6	1	3	0	2
19.0	6	1	3	0	2
20.0	4	1	2	0	1
22.0	4	1	2	0	1
26.0	0	0	0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : Chaffee Western Expansion User: AJN Date:
County : Erie State: NY Checked: ____ Date: _____
Subtitle: Prelandfill 24-Hour, 10-Year Stormwater Analysis
Subarea : A

COVER DESCRIPTION			Hydrologic Soil Group A	B	C	D
			Acres (CN)			
CULTIVATED AGRICULTURAL LANDS						
Fallow	Crop residue (CR)	good	-	-	-	20(90)
OTHER AGRICULTURAL LANDS						
Brush - brush, weed, grass mix		good	-	-	-	5.1(73)
Woods		good	-	-	-	8(77)
Total Area (by Hydrologic Soil Group)						33.1 ====

SUBAREA: A TOTAL DRAINAGE AREA: 33.1 Acres WEIGHTED CURVE NUMBER: 84

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : Chaffee Western Expansion User: AJN Date:
County : Erie State: NY Checked: ____ Date: _____
Subtitle: Prelandfill 24-Hour, 10-Year Stormwater Analysis
Subarea : B1

COVER DESCRIPTION			Hydrologic Soil Group A	B	C	D
			Acres (CN)			
CULTIVATED AGRICULTURAL LANDS						
Fallow	Crop residue (CR)	good	-	-	-	71.7(90)
OTHER AGRICULTURAL LANDS						
Brush - brush, weed, grass mix		good	-	-	-	23(73)
Woods		good	-	-	-	53.6(77)
Total Area (by Hydrologic Soil Group)						148.

SUBAREA: B1 TOTAL DRAINAGE AREA: 148.3 Acres WEIGHTED CURVE NUMBER: 83

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : Chaffee Western Expansion User: AJN Date:
County : Erie State: NY Checked: ____ Date: _____
Subtitle: Prelandfill 24-Hour, 10-Year Stormwater Analysis
Subarea : B2

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
		Acres (CN)			
OTHER AGRICULTURAL LANDS					
Woods	good	-	-	-	21.2(77)
Total Area (by Hydrologic Soil Group)					21.2

SUBAREA: B2 TOTAL DRAINAGE AREA: 21.2 Acres WEIGHTED CURVE NUMBER: 77

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

Project : Chaffee Western Expansion User: AJN Date:
County : Erie State: NY Checked: ____ Date: _____
Subtitle: Prelandfill 24-Hour, 10-Year Stormwater Analysis
Subarea : C

COVER DESCRIPTION			Hydrologic Soil Group A	B	C	D
			Acres (CN)			
CULTIVATED AGRICULTURAL LANDS						
Fallow	Crop residue (CR)	good	-	-	-	42(90)
OTHER AGRICULTURAL LANDS						
Brush - brush, weed, grass mix		good	-	-	-	20.3(73)
Woods		good	-	-	-	7.2(77)
Total Area (by Hydrologic Soil Group)						69.5 ====

SUBAREA: C TOTAL DRAINAGE AREA: 69.5 Acres WEIGHTED CURVE NUMBER: 84

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

Project : Chaffee Western Expansion User: AJN Date:
County : Erie State: NY Checked: ____ Date: _____
Subtitle: Prelandfill 24-Hour, 10-Year Stormwater Analysis

Subarea #1 - A

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.5	300	.0239	C					0.199
Shallow Concent'd		745	.0239	U					0.083
								Time of Concentration =	0.28*

Subarea #2 - B1

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.5	300	.0249	C					0.196
Shallow Concent'd		3115	.0249	U					0.340
								Time of Concentration =	0.54*

Subarea #3 - B2

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.5	300	.032	H					0.808
Shallow Concent'd		1524	.032	U					0.147
								Time of Concentration =	0.95*

Subarea #4 - C

Flow Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
Sheet	2.5	300	.032	H					0.808
Shallow Concent'd		1595	.032	U					0.154
								Time of Concentration =	0.96*

--- Sheet Flow Surface Codes ---

A Smooth Surface	F Grass, Dense	--- Shallow Concentrated ---
B Fallow (No Res.)	G Grass, Burmuda	--- Surface Codes ---
C Cultivated < 20 % Res.	H Woods, Light	P Paved
D Cultivated > 20 % Res.	I Woods, Dense	U Unpaved
E Grass-Range, Short	J Range, Natural	

* - Generated for use by TABULAR method

TABULAR HYDROGRAPH METHOD Version 2.00

Project : Chaffee Western Expansion User: AJN Date:
County : Erie State: NY Checked: ____ Date: _____
Subtitle: Prelandfill 24-Hour, 10-Year Stormwater Analysis

Total watershed area: 0.425 sq mi Rainfall type: II Frequency: 10 years

	Subareas			
	A	B1	B2	C
Area(sq mi)	0.05*	0.23*	0.03*	0.11*
Rainfall(in)	3.6	3.6	3.6	3.6
Curve number	84*	83*	77*	84*
Runoff(in)	2.02	1.94	1.51	2.02
Tc (hrs)	0.28*	0.54*	0.95*	0.96*
(Used)	0.30	0.50	1.00	1.00
TimeToOutlet	0.00	0.00	0.00	0.00
Ia/P	0.11	0.11	0.17	0.11
(Used)	0.10	0.10	0.10	0.10

Time	Total	Subarea Contribution to Total Flow (cfs)			
(hr)	Flow	A	B1	B2	C
11.0	13	2	8	1	2
11.3	17	3	10	1	3
11.6	23	4	14	1	4
11.9	45	12	26	1	6
12.0	77	25	42	2	8
12.1	136	47	77	2	10
12.2	230	71P	139	4	16
12.3	312	71	210	6	25
12.4	331P	48	238P	8	37
12.5	321	30	228	12	51
12.6	279	21	181	14	63
12.7	237	15	134	16	72
12.8	210	12	102	18P	78P
13.0	156	8	63	16	69
13.2	114	7	43	12	52
13.4	86	6	33	9	38
13.6	68	5	27	7	29
13.8	57	5	24	5	23
14.0	47	4	21	4	18
14.3	39	4	18	3	14
14.6	32	3	16	2	11
15.0	28	3	14	2	9
15.5	25	3	13	2	7
16.0	22	3	12	1	6
16.5	19	2	10	1	6
17.0	17	2	9	1	5
17.5	17	2	9	1	5
18.0	16	2	9	1	4
19.0	14	2	7	1	4
20.0	11	1	6	1	3
22.0	10	1	5	1	3
26.0	0	0	0	0	0

P - Peak Flow * - value(s) provided from TR-55 system routines

Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Drainage Calculations
Storm Event Extreme Precipitation Data

Northeast Regional Climate Center Extreme Precipitation estimates (inches)

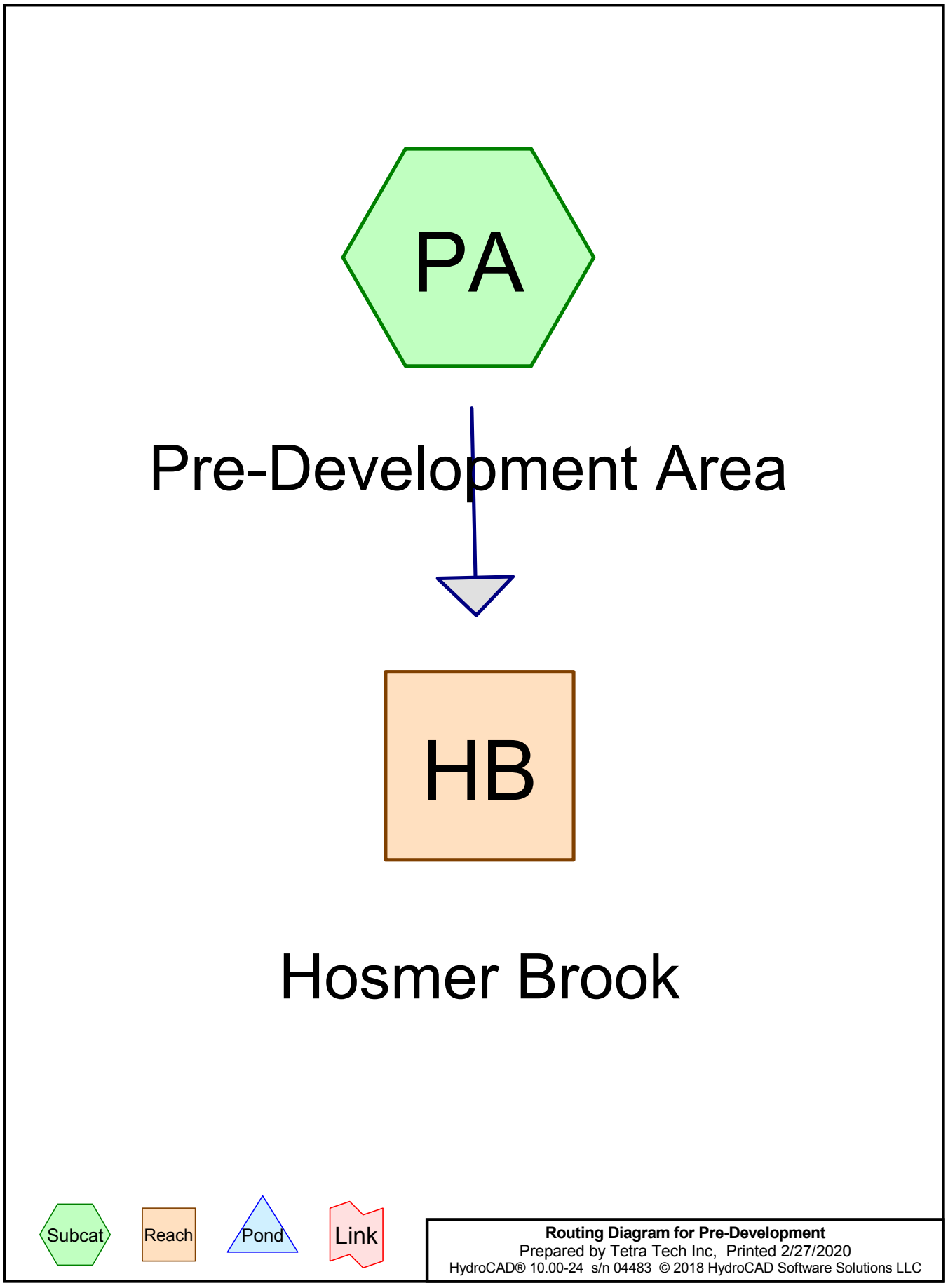
Point Estimates	Smoothed
Data series	Partial duration series
State	New York
Location	
Lon (dd)	-78.487
Lat (dd)	42.581
Elev (feet)	0

MEAN PRECIPITATION FREQUENCY ESTIMATES

Freq (yr)	5-min	10-min	15-min	30-min	60-min	120-min	3-hr	6-hr	12-hr	24-hr	2-day	4-day	7-day	10-day
1	0.27	0.42	0.52	0.68	0.85	1.04	1.17	1.39	1.64	1.9	2.19	2.57	3.13	3.59
2	0.32	0.5	0.62	0.82	1.03	1.26	1.41	1.67	1.93	2.22	2.53	2.91	3.48	3.98
5	0.38	0.6	0.75	1.01	1.29	1.58	1.78	2.08	2.39	2.72	3.1	3.53	4.15	4.76
10	0.43	0.68	0.86	1.17	1.52	1.88	2.11	2.47	2.82	3.18	3.62	4.08	4.74	5.45
25	0.52	0.82	1.04	1.44	1.91	2.36	2.65	3.08	3.5	3.9	4.44	4.94	5.67	6.52
50	0.58	0.93	1.2	1.68	2.27	2.82	3.17	3.66	4.13	4.55	5.18	5.72	6.49	7.47
100	0.67	1.08	1.4	1.98	2.7	3.35	3.77	4.33	4.85	5.32	6.04	6.62	7.43	8.56
200	0.76	1.25	1.62	2.32	3.21	4	4.48	5.13	5.7	6.21	7.06	7.67	8.52	9.82
500	0.92	1.52	1.98	2.88	4.04	5.04	5.64	6.41	7.07	7.64	8.67	9.31	10.2	11.78

Notes:

1. Extreme precipitation estimates obtained from the Northeast Regional Climate Center.
2. Date/time data acessed: Tue Jul 02 07:11:48 EDT 2019



Routing Diagram for Pre-Development
Prepared by Tetra Tech Inc, Printed 2/27/2020
HydroCAD® 10.00-24 s/n 04483 © 2018 HydroCAD Software Solutions LLC

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PA: Pre-Development Area Runoff Area=148.300 ac 0.00% Impervious Runoff Depth>0.56"
Flow Length=3,415' Slope=0.0249 '/' Tc=32.9 min CN=83 Runoff=70.75 cfs 6.917 af

Reach HB: Hosmer Brook Inflow=70.75 cfs 6.917 af
Outflow=70.75 cfs 6.917 af

Summary for Subcatchment PA: Pre-Development Area

Runoff = 70.75 cfs @ 12.30 hrs, Volume= 6.917 af, Depth> 0.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

Area (ac)	CN	Description
71.700	90	Fallow, crop residue, Good, HSG D
23.000	73	Brush, Good, HSG D
53.600	77	Woods, Good, HSG D
148.300	83	Weighted Average
148.300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	300	0.0249	0.40		**Sheet Flow,** Cultivated: Residue<=20% n= 0.060 P2= 2.22"
20.4	3,115	0.0249	2.54		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
32.9	3,415	Total			

Summary for Reach HB: Hosmer Brook

Inflow Area = 148.300 ac, 0.00% Impervious, Inflow Depth > 0.56" for 1 Year Storm event
Inflow = 70.75 cfs @ 12.30 hrs, Volume= 6.917 af
Outflow = 70.75 cfs @ 12.30 hrs, Volume= 6.917 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PA: Pre-Development Area Runoff Area=148.300 ac 0.00% Impervious Runoff Depth>1.45"
Flow Length=3,415' Slope=0.0249 '/' Tc=32.9 min CN=83 Runoff=191.22 cfs 17.939 af

Reach HB: Hosmer Brook Inflow=191.22 cfs 17.939 af
Outflow=191.22 cfs 17.939 af

Summary for Subcatchment PA: Pre-Development Area

Runoff = 191.22 cfs @ 12.28 hrs, Volume= 17.939 af, Depth> 1.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

Area (ac)	CN	Description
71.700	90	Fallow, crop residue, Good, HSG D
23.000	73	Brush, Good, HSG D
53.600	77	Woods, Good, HSG D
148.300	83	Weighted Average
148.300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	300	0.0249	0.40		**Sheet Flow,** Cultivated: Residue<=20% n= 0.060 P2= 2.22"
20.4	3,115	0.0249	2.54		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
32.9	3,415	Total			

Summary for Reach HB: Hosmer Brook

Inflow Area = 148.300 ac, 0.00% Impervious, Inflow Depth > 1.45" for 10 Year Storm event
Inflow = 191.22 cfs @ 12.28 hrs, Volume= 17.939 af
Outflow = 191.22 cfs @ 12.28 hrs, Volume= 17.939 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PA: Pre-Development Area Runoff Area=148.300 ac 0.00% Impervious Runoff Depth>3.20"
Flow Length=3,415' Slope=0.0249 '/' Tc=32.9 min CN=83 Runoff=418.96 cfs 39.554 af

Reach HB: Hosmer Brook Inflow=418.96 cfs 39.554 af
Outflow=418.96 cfs 39.554 af

Summary for Subcatchment PA: Pre-Development Area

Runoff = 418.96 cfs @ 12.27 hrs, Volume= 39.554 af, Depth> 3.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

Area (ac)	CN	Description
71.700	90	Fallow, crop residue, Good, HSG D
23.000	73	Brush, Good, HSG D
53.600	77	Woods, Good, HSG D
148.300	83	Weighted Average
148.300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	300	0.0249	0.40		**Sheet Flow,** Cultivated: Residue<=20% n= 0.060 P2= 2.22"
20.4	3,115	0.0249	2.54		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
32.9	3,415	Total			

Summary for Reach HB: Hosmer Brook

Inflow Area = 148.300 ac, 0.00% Impervious, Inflow Depth > 3.20" for 100 Year Storm event
Inflow = 418.96 cfs @ 12.27 hrs, Volume= 39.554 af
Outflow = 418.96 cfs @ 12.27 hrs, Volume= 39.554 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	18-May-20	208-190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	Post-Development Drainage Calculations	
PREPARED BY	**CHECKED BY**	
KLS 5/4/2020	LR 5/18/2020	

Description and Purpose:

Determine the post-development discharge from Basins #1, #2 and #3 to Hosmer Brook for the 1-Year, 10-Year and 100-Year storm events. Determine if the Stream Channel Protection Volume, Overbank Flood Control and Extreme Flood Control requirements are met.

Design Basis/References/Assumptions:

Appendix E Surface Water Management Calculations of the Engineering Report for the 6 NYCRR Part 360 Solid Waste Management Permit Modification Application prepared by McMahon & Mann Consulting Engineers, P.C., December 2012.
New York State Stormwater Management Design Manual, January 2015.
New York State Standards and Specifications for Erosion and Sediment Control, November 2016.
HydroCAD Stormwater Modeling, Version 10.00-24.

Remarks/Conclusions/Results:

Storm Event	Hosmer Brook Discharge (cfs)
1-Year	15.09
10-Year	40.84
100-Year	95.13

Post-development discharge rates to Hosmer Brook are less than the calculated pre-development discharge rates, requirements for Stream Channel Protection Volume, Overbank Flood Control and Extreme Flood Control have been met.

LEGEND

- EXISTING CONTOURS (SEE NOTE 1 ON FIGURE 3)
- EXISTING SURFACE WATER
- EXISTING STORMWATER BASIN
- EXISTING CULVERT
- EXISTING RIP-RAP
- EXISTING DRAINAGE CHANNELS
- EXISTING RIP-RAP LINED DOWNCHUTE CHANNELS
- CLOSED LANDFILL'S CLAY BERM
- PROPERTY LINE (SEE NOTE 2 ON FIGURE 3)
- APPROXIMATE CELL BOUNDARIES

VERTICAL LANDFILL EXPANSION

SEDIMENTATION BASIN #5

SEDIMENTATION BASIN #1

SEDIMENTATION BASIN #2

SEDIMENTATION BASIN #3

PROPOSED MSE WALLS

WATER SUPPLY WELL AND LINE

LEACHATE LOADOUT BUILDING

LEACHATE STORAGE TANK AREA

SEPTIC TANK AND LINE

LEACHATE COLLECTION SUMP #2

LEACHATE STORAGE TANK #2 AND LOADOUT PAD

PROPOSED SOUTHERN LANDFILL EXPANSION LIMIT

PROPERT

0 150 300

SCALE IN FEET

NOTES:

1. Existing site contours are based on aerial photography dated February 12, 2001 and November 22, 2001 compiled by Lockwood Mapping Inc. of Rochester, NY, Aero-Metric, dated July 10, 2012 and Quantum Spatial dated July 3, 2015 and June 8, 2017.
2. Property lines are based on surveys performed by Deborah A. Naybor, PLS, P.C. dated June 2001 and by Gary E. Krull dated March 1994.
3. Survey of delineated wetlands was prepared by Deborah A. Naybor, PLS, P.C. dated August 2001, Wendel Duchscherer Survey dated September 16, 2008 and by Wendel survey dated November 21, 2017.

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	DATE OF ISSUE MARCH 2020	DRAWN BY DSS / DESIGNED BY	CHECKED BY / APPROVED BY			

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CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

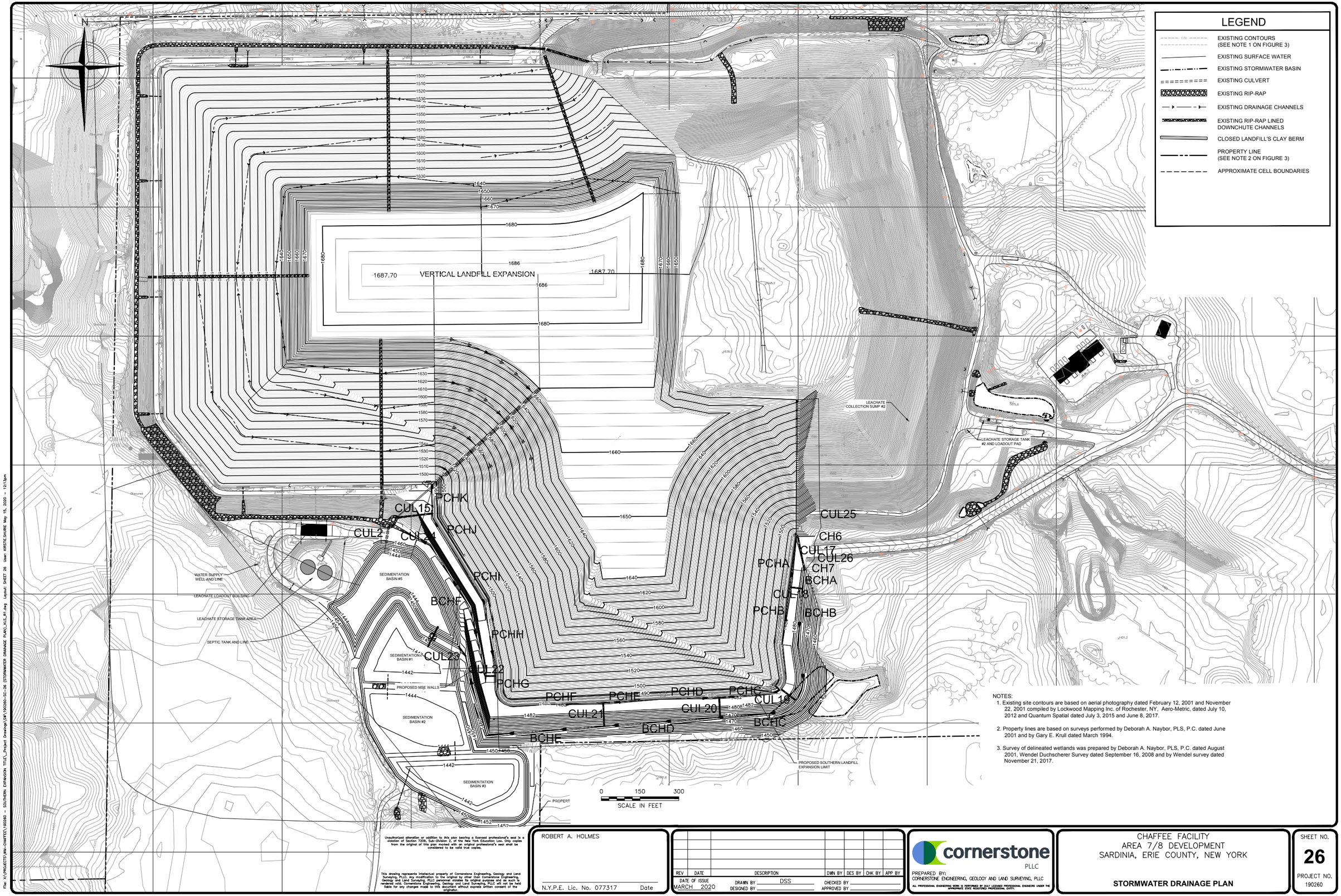
STORMWATER DRAINAGE PLAN

SHEET NO. **26**

PROJECT NO. 190260

1" 1/2" 0" 1"

File: X:\PROJECTS\WM-CHAFFEE\190260 - SOUTHERN EXPANSION TITLE_Project Drawings\CAD\190260-SC-26 (STORMWATER DRAINAGE PLAN)_ACS_A1.dwg Layout: SHEET 26 User: KRISTE.SHORE May 15, 2020 - 12:11pm



NOTES:

1. Existing site contours are based on aerial photography dated February 12, 2001 and November 22, 2001 compiled by Lockwood Mapping Inc. of Rochester, NY, Aero-Metric, dated July 10, 2012 and Quantum Spatial dated July 3, 2015 and June 8, 2017.
2. Property lines are based on surveys performed by Deborah A. Naybor, PLS, P.C. dated June 2001 and by Gary E. Krull dated March 1994.
3. Survey of delineated wetlands was prepared by Deborah A. Naybor, PLS, P.C. dated August 2001, Wendel Duchscherer Survey dated September 16, 2008 and by Wendel survey dated November 21, 2017.

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REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY
	DATE OF ISSUE MARCH 2020	DRAWN BY DSS DESIGNED BY	CHECKED BY APPROVED BY			

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CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

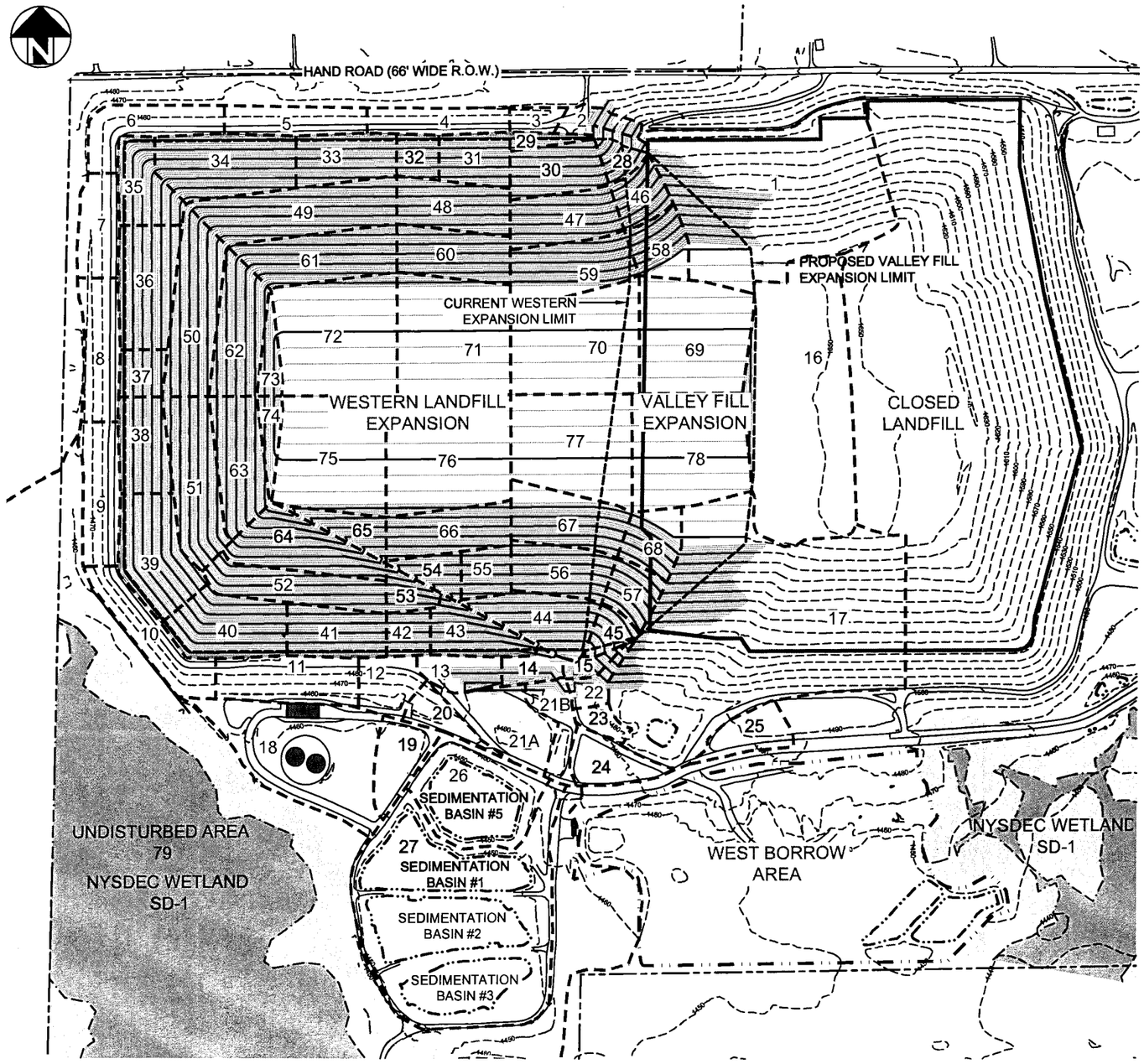
STORMWATER DRAINAGE PLAN

SHEET NO. **26**

PROJECT NO. 190260

1" 1/2" 0" 1"

File: X:\PROJECTS\WM-CHAFFEE\190260 - SOUTHERN EXPANSION TITLE_Project Drawings\DWG\190260-SC-26 (STORMWATER DRAINAGE PLAN)_ACS_A1.dwg Layout: SHEET 26 User: KRISTIE.SHORE May 15, 2020 - 12:13pm



DRAINAGE AREA PLAN

SCALE: 1" = 400'

400' 0 200' 400'

SCALE: 1" = 400'

LEGEND

- EXISTING CONTOURS (SEE NOTE 1)
- PROPOSED CONTOURS
- CLOSED LANDFILL'S CLAY BERM
- PROPERTY LINE (SEE NOTE 2)
- 100' WETLAND BUFFER
- DELINEATED WETLAND (SEE NOTE 3)
- DRAINAGE AREA BOUNDARY
- 3 DRAINAGE AREA DESIGNATION

NOTES:

1. Existing site contours are based on aerial photography dated June 30, 2011 compiled by Aero Metric of Dulles, Virginia.
2. Property lines are based on surveys performed by Deborah A. Naybor, PLS, P.C. dated June 2001 and by Gary E. Krull dated March 1994.
3. Survey of delineated wetlands was prepared by Deborah A. Naybor, PLS, P.C. dated August 2001 and by Wendel Duchscherer Survey dated September 16, 2008.

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CHAFFEE FACILITY
VALLEY FILL EXPANSION
ERIE COUNTY NEW YORK

POST DEVELOPMENT DRAINAGE AREAS

DWG. NO. 00016-531 | FIGURE 2

Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Post-Development Drainage Calculations
Drainage Areas

Drainage Area				Sheet Flow				Shallow Concentrated Flow			Channel Flow						
Reach Number	Area (sf)	Area (ac)	Surface Condition	Length (ft)	Slope (%)	P_2 (in)	Surface Condition	Length (ft)	Slope (%)	Surface Condition	Length (ft)	Slope (%)	Bottom Width (ft)	Left Side Slope (run)	Right Side Slope (run)	Depth (ft)	Surface Condition
Same Areas from Valley Fill Design																	
1	309,031	7.09	Grass	100	33%	2.5	Short Grass	304	33%	Short Grass	707	3%	2	2	2	1.0	Rip Rap
2	17,031	0.39	Grass	100	33%	2.5	Short Grass	0			Into CUL1						
3	12,681	0.29	Grass	45	1%	2.5	Smooth Surface	0			Into CH1a						
				21	33%	2.5	Short Grass										
4	36,469	0.84	Grass	33	1%	2.5	Smooth Surface	0			Into CH1b						
				28	33%	2.5	Short Grass										
5	39,423	0.91	Grass	35	1%	2.5	Smooth Surface	0			Into CH1d						
				33	33%	2.5	Short Grass										
6	51,457	1.18	Grass	36	1%	2.5	Smooth Surface	0			Into CH1e						
				38	33%	2.5	Short Grass										
7	40,492	0.93	Grass	36	1%	2.5	Smooth Surface	0			Into CH1f						
				47	33%	2.5	Short Grass										
8	52,508	1.21	Grass	36	1%	2.5	Smooth Surface	0			Into CH1g						
				52	33%	2.5	Short Grass										
9	53,327	1.22	Grass	36	1%	2.5	Smooth Surface	0			Into CH1i						
				59	33%	2.5	Short Grass										
10	56,707	1.30	Grass	32	1%	2.5	Smooth Surface	1	33%	Short Grass	Into CH1j						
				68	33%	2.5	Short Grass										
11	64,217	1.47	Grass	32	1%	2.5	Smooth Surface	11	33%	Short Grass	Into CH2a						
				68	33%	2.5	Short Grass										
12	32,357	0.74	Grass	32	1%	2.5	Smooth Surface	21	33%	Short Grass	Into CH2b						
				68	33%	2.5	Short Grass										
20	22,282	0.51	Grass	100	2%	2.5	Short Grass	130	2%	Short Grass	Into CUL15						
28	19,201	0.44	Grass	100	33%	2.5	Short Grass	83	33%	Short Grass	Into DC2d						
29	9,939	0.23	Grass	19	33%	2.5	Short Grass	0			238	1%	1.6	2	2	1.0	Grass
30	44,923	1.03	Grass	100	33%	2.5	Short Grass	53	33%	Short Grass	269	4%	0	3	3	1.5	Grass
31	35,811	0.82	Grass	100	33%	2.5	Short Grass	41	33%	Short Grass	225	1%	1.6	2	2	1.0	Grass
32	18,017	0.41	Grass	100	33%	2.5	Short Grass	41	33%	Short Grass	133	1%	1.6	2	2	0.5	Grass
33	47,473	1.09	Grass	100	33%	2.5	Short Grass	63	33%	Short Grass	225	1%	1.6	2	2	1.0	Grass
34	82,684	1.90	Grass	100	33%	2.5	Short Grass	63	33%	Short Grass	225	1%	1.6	2	2	1.0	Grass
35	43,693	1.00	Grass	100	33%	2.5	Short Grass	98	33%	Short Grass	164	1%	1.6	2	2	1.0	Grass
36	69,648	1.60	Grass	100	33%	2.5	Short Grass	98	33%	Short Grass	164	1%	1.6	2	2	1.0	Grass
37	21,353	0.49	Grass	100	33%	2.5	Short Grass	50	33%	Short Grass	148	1%	1.6	2	2	0.5	Grass
38	47,365	1.09	Grass	100	33%	2.5	Short Grass	69	33%	Short Grass	225	1%	1.6	2	2	1.0	Grass
39	74,592	1.71	Grass	100	33%	2.5	Short Grass	98	33%	Short Grass	227	1%	1.6	2	2	1.0	Grass
40	68,641	1.58	Grass	100	33%	2.5	Short Grass	98	33%	Short Grass	229	1%	1.6	2	2	1.0	Grass
41	48,000	1.10	Grass	100	33%	2.5	Short Grass	67	33%	Short Grass	225	1%	1.6	2	2	1.0	Grass
46	26,521	0.61	Grass	100	33%	2.5	Short Grass	61	33%	Short Grass	88	4%	0	3	3	1.5	Grass
47	52,705	1.21	Grass	100	33%	2.5	Short Grass	56	33%	Short Grass	318	4%	0	3	3	1.5	Grass
48	54,019	1.24	Grass	100	33%	2.5	Short Grass	51	33%	Short Grass	360	4%	0	3	3	1.5	Grass
49	91,405	2.10	Grass	100	33%	2.5	Short Grass	51	33%	Short Grass	518	4%	0	3	3	1.5	Grass
50	81,531	1.87	Grass	100	33%	2.5	Short Grass	91	33%	Short Grass	608	4%	0	3	3	1.5	Grass
51	77,602	1.78	Grass	100	33%	2.5	Short Grass	36	33%	Short Grass	582	4%	0	3	3	1.5	Grass
52	58,718	1.35	Grass	93	33%	2.5	Short Grass	0			622	4%	0	3	3	1.5	Grass
58	32,792	0.75	Grass	100	4%	2.5	Short Grass	20	4%	Short Grass	129	4%	0	3	3	1.5	Grass
								124	33%	Short Grass							
59	65,108	1.49	Grass	80	4%	2.5	Short Grass	92	33%	Short Grass	367	4%	0	3	3	1.5	Grass
				20	33%	2.5	Short Grass										
60	54,019	1.24	Grass	100	33%	2.5	Short Grass	51	33%	Short Grass	360	4%	0	3	3	1.5	Grass
61	71,026	1.63	Grass	100	33%	2.5	Short Grass	51	33%	Short Grass	382	4%	0	3	3	1.5	Grass
62	61,153	1.40	Grass	100	33%	2.5	Short Grass	91	33%	Short Grass	472	4%	0	3	3	1.5	Grass
63	60,504	1.39	Grass	100	33%	2.5	Short Grass	73	33%	Short Grass	463	4%	0	3	3	1.5	Grass
Modified Areas from Valley Fill Design																	
13	N/A																
14	N/A																
15	N/A																
16A	105,043	2.41	Grass	100	4%	2.5	Short Grass	151	4%	Short Grass	435	0.5%	0	25	3	3.0	Grass
								137	33%	Short Grass							
16B	334,391	7.68	Grass	100	4%	2.5	Short Grass	151	4%	Short Grass	526	0.5%	0	3	25	3.0	Grass
								237	33%	Short Grass	459	3%	0	3	3	1.5	Grass
17	77,124	1.77	Grass	32	33%	2.5	Short Grass	0			528	4%	0	3	3	1.5	Grass
18	116,799	2.68	Grass	100	2%	2.5	Short Grass	320	3%	Short Grass	107	8%	0	2	2	1.0	Grass
19	N/A																
21A	N/A																
21B	N/A																
22	N/A																
23	N/A																
24	N/A																
25	N/A																
26	138,227	3.17	Basin	0				0			Into Basin 5						
27	324,396	7.45	Basin	0				0			Into Basin 1,2,3						
42	29,378	0.67	Grass	100	33%	2.5	Short Grass	44	33%	Short Grass	201	1%	0	2	2	1.5	Grass
43	N/A																
44	19,787	0.45	Grass	100	33%	2.5	Short Grass	68	33%	Short Grass	54	4%	0	3	3	1.5	Grass
45	30,237	0.69	Grass	100	33%	2.5	Short Grass	65	33%	Short Grass	149	4%	0	3	3	1.5	Grass
53	34,303	0.79	Grass	100	33%	2.5	Short Grass	63	33%	Short Grass	209	4%	0	3	3	1.5	Grass
54	N/A																
55	N/A																
56	40,941	0.94	Grass	100	33%	2.5	Short Grass	68	33%	Short Grass	187	4%	0	3	3	1.5	Grass
57	40,026	0.92	Grass	100	33%	2.5	Short Grass	61	33%	Short Grass	219	4%	0	3	3	1.5	Grass
64	89,809	2.06	Grass	100	33%	2.5	Short Grass	107	33%	Short Grass	538	4%	0	3	3	1.5	Grass
65	N/A																
66	28,475	0.65	Grass	100	33%	2.5	Short Grass	37	33%	Short Grass	209	4%	0	3	3	1.5	Grass
67	61,430	1.41	Grass	100	33%	2.5	Short Grass	57	33%	Short Grass	323	4%	0	3	3	1.5	Grass
68	137,890	3.17	Grass	30	33%	2.5	Short Grass	0			602	4%	0	3	3	1.5	Grass
69	35,160	0.81	Grass	100	4%	2.5	Short Grass	47	33%	Short Grass	370	4%	0	3	3	1.5	Grass
70	145,786	3.35	Grass	100	4%	2.5	Short Grass	161	4%	Short Grass	422	4%	0	3	3	1.5	Grass
71	130,226	2.99	Grass	100	4%	2.5	Short Grass	157	4%	Short Grass	360	4%	0	3	3	1.5	Grass
								86	33%	Short Grass							
72	88,619	2.03	Grass	10	33%	2.5	Short Grass	0			402	4%	0	3	3	1.5	Grass
73	63,671	1.46	Grass	10	33%	2.5	Short Grass	0			336	4%	0	3	3	1.5	Grass
74	64,300	1.48	Grass	10	33%	2.5	Short Grass	0			342	4%	0	3	3	1.5	Grass
75	74,098	1.70	Grass	10	33%	2.5	Short Grass	0			368	4%	0	3	3	1.5	Grass
76	76,679	1.76	Grass	100	4%	2.5	Short Grass	163	4%	Short Grass	209	4%	0	3	3	1.5	Grass
								94	33%	Short Grass							
77	131,201	3.01	Grass	100	4%	2.5	Short Grass	145	4%	Short Grass	452	1%	0	3	25	1.5	Grass
78	142,440	3.27	Grass	100	4%	2.5	Short Grass	345	4%	Short Grass	Into DC6a						
79	4,866,899	111.73	Woods	100	3.6%	2.5	Woods	1,496	4%	Woodland	Into Hosmer Brook						
								1,985	0%	Woodland							
Additional Areas																	
79R	214,975	4.94	Grass	100	4%	2.5	Short Grass	535	4%		313	4%	0	3	3	1.5	Grass

Drainage Area				Sheet Flow				Shallow Concentrated Flow			Channel Flow						
Reach Number	Area (sf)	Area (ac)	Surface Condition	Length (ft)	Slope (%)	P_2 (in)	Surface Condition	Length (ft)	Slope (%)	Surface Condition	Length (ft)	Slope (%)	Bottom Width (ft)	Left Side Slope (run)	Right Side Slope (run)	Depth (ft)	Surface Condition
80	76,856	1.76	Grass	28	33%	2.5	Short Grass	0			397	4%	0	3	3	1.5	Grass
81	61,274	1.41	Grass	100	33%	2.5	Short Grass	41	33%	Short Grass	357	4%	0	3	3	1.5	Grass
82	54,442	1.25	Grass	57	33%	2.5	Short Grass	0			263	4%	0	3	3	1.5	Grass
83	60,848	1.40	Grass	100	33%	2.5	Short Grass	16	33%	Short Grass	399	4%	0	3	3	1.5	Grass
84	18,630	0.43	Grass	61	33%	2.5	Short Grass	0			Into PCHa						
85	52,194	1.20	Grass	100	33%	2.5	Short Grass	91	33%	Short Grass	Into PCHb						
86	14,701	0.34	Grass	10	33%	2.5	Short Grass	0			Into PCHc						
87	11,389	0.26	Grass	75	33%	2.5	Short Grass	0			Into PCHk						
88	2,228	0.05	Grass	65	33%	2.5	Short Grass	0			Into PCHk						
89	41,788	0.96	Grass	73	33%	2.5	Short Grass	0			322	4%	0	3	3	1.5	Grass
90	51,317	1.18	Grass	100	33%	2.5	Short Grass	54	33%	Short Grass	342	4%	0	3	3	1.5	Grass
91	45,282	1.04	Grass	100	33%	2.5	Short Grass	27	33%	Short Grass	359	4%	0	3	3	1.5	Grass
92	10,584	0.24	Grass	43	33%	2.5	Short Grass	0			Into PCHj						
93	6,232	0.14	Grass	43	33%	2.5	Short Grass	0			Into PCHi						
94	38,910	0.89	Grass	41	33%	2.5	Short Grass	0			284	4%	0.0	3	3	1.5	Grass
95	74,924	1.72	Grass	49	33%	2.5	Short Grass	0			664	4%	0.0	3	3	1.5	Grass
96	101,683	2.33	Grass	47	33%	2.5	Short Grass	0			1,004	4%	0.0	3	3	1.5	Grass
97	14,080	0.32	Grass	21	33%	2.5	Short Grass	0			Into PCHh						
98	6,183	0.14	Grass	78	33%	2.5	Short Grass	0			Into PCHg						
99	33,575	0.77	Grass	78	33%	2.5	Short Grass	0			Into PCHf						
100	29,119	0.67	Grass	100	33%	2.5	Short Grass	40	33%	Short Grass	Into PCHe						
101	35,863	0.82	Grass	100	33%	2.5	Short Grass	40	33%	Short Grass	Into PCHd						
102	3,351	0.08	Grass	36	1%	2.5	Road	0			Into BCHa						
				12	33%	2.5	Short Grass										
103	25,624	0.59	Grass	36	1%	2.5	Road	0			Into BCHb						
				13	33%	2.5	Short Grass										
104	21,132	0.49	Grass	36	1%	2.5	Road	0			Into BCHc						
				37	33%	2.5	Short Grass										
105	38,526	0.88	Grass	36	1%	2.5	Road	0			Into BCHd						
				41	33%	2.5	Short Grass										
106	59,555	1.37	Grass	36	1%	2.5	Road	0			Into BCHe						
				55	33%	2.5	Short Grass										
107	52,005	1.19	Grass	36	1%	2.5	Road	0			Into BCHf						
				3	33%	2.5	Short Grass										
108	40,837	0.94	Grass	100	33%	2.5	Short Grass	84	33%	Short Grass	308	4%	0	3	3	1.5	Grass
109	41,747	0.96	Grass	100	33%	2.5	Short Grass	95	33%	Short Grass	118	4%	0	3	3	1.5	Grass
110	19,094	0.44	Grass	100	33%	2.5	Short Grass	104	33%	Short Grass	42	4%	0	3	3	1.5	Grass
111	1,561	0.04	Grass	66	33%	2.5	Short Grass	0			Into CUL17						
TOTAL	10,994,265.22	242.31															

Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Pre-Development Drainage Calculations
Downchutes, Channels and Culverts

Culvert Number	Description	Channel Geometry								Culvert Geometery									
		Length (ft)	Slope (%)	Bottom Width (ft)	Left Side Slope (run)	Right Side Slope (run)	Depth (ft)	Surface Condition	Mannings 'n'	Number of Culverts	Length (ft)	Inlet Elevation (ft)	Outlet Elevation (ft)	Diameter (in)	Width (ft)	Height (ft)	Material	Mannings 'n'	Entrance Type
Same from Valley Fill Design																			
DC1	stone lined downchute	174	33%	8	2	2	1.0	Rip Rap	0.035										
DC2a	stone lined downchute	150	33%	10	2	2	1.0	Rip Rap	0.035										
DC2b	stone lined downchute	150	33%	10	2	2	1.0	Rip Rap	0.035										
DC2c	stone lined downchute	164	33%	10	2	2	1.0	Rip Rap	0.035										
DC2d	stone lined downchute	63	8%	10	3	3	2.0	Rip Rap	0.035										
CUL1	Culvert 1									2	122	1483	1480	36	0	0	Smooth HDPE	0.013	Mitered
CH1a	Channel 1	130	0.5%	0	3	3	4.0	Rip Rap Bottom, Grass Sides	0.035										
CUL5a	Culvert 5									1	61	1482	1480	18	0	0	Smooth HDPE	0.013	Drop Inlet
CH1b	Channel 1	358	0.5%	0	3	3	4.0	Rip Rap Bottom, Grass Sides	0.035										
CH1c	Channel 1	92	0.5%	0	3	3	4.0	Rip Rap Bottom, Grass Sides	0.035										
DC3a	stone lined downchute	151	33%	10	2	2	1.0	Rip Rap	0.035										
DC3b	stone lined downchute	151	33%	10	2	2	1.0	Rip Rap	0.035										
DC3c	stone lined downchute	131	33%	10	2	2	1.0	Rip Rap	0.035										
DCCUL3	2 downchute culverts									2	56	1484	1480	30	0	0	Smooth HDPE	0.013	Mitered
CH1d	Channel 1	450	0.5%	0	3	3	4.0	Rip Rap Bottom, Grass Sides	0.035										
CUL5b	Culvert 5									1	54	1482	1480	18	0	0	Smooth HDPE	0.013	Drop Inlet
CH1e	Channel 1	595	0.5%	0	3	3	4.0	Rip Rap Bottom, Grass Sides	0.035										
CUL5c	Culvert 5									1	55	1482	1480	18	0	0	Smooth HDPE	0.013	Drop Inlet
CH1f	Channel 1	328	0.5%	0	3	3	4.0	Rip Rap Bottom, Grass Sides	0.035										
CUL5d	Culvert 5									1	60	1482	1479	18	0	0	Smooth HDPE	0.013	Drop Inlet
CH1g	Channel 1	373	0.5%	0	3	3	4.0	Rip Rap Bottom, Grass Sides	0.035										
CUL5e	Culvert 5									1	60	1482	1479	18	0	0	Smooth HDPE	0.013	Drop Inlet
CH1h	Channel 1	78	0.5%	0	3	3	4.0	Rip Rap Bottom, Grass Sides	0.035										
DC4a	stone lined downchute	151	33%	10	2	2	1.0	Rip Rap	0.035										
DC4b	stone lined downchute	151	33%	10	2	2	1.0	Rip Rap	0.035										
DC4c	stone lined downchute	140	33%	10	2	2	1.0	Rip Rap	0.035										
DCCUL4	2 downchute culverts									2	53	1484	1479	30	0	0	Smooth HDPE	0.013	Mitered
CH1i	Channel 1	452	0.5%	0	3	3	4.0	Rip Rap Bottom, Grass Sides	0.035										
CUL5f	Culvert 5									1	56	1482	1479	18	0	0	Smooth HDPE	0.013	Drop Inlet
CH1j	Channel 1	613	0.5%	0	3	3	4.0	Rip Rap Bottom, Grass Sides	0.035										
CUL5g	Culvert 5									1	60	1482	1478	18	0	0	Smooth HDPE	0.013	Drop Inlet
CH2a	Channel 2	450	0.7%	0	3	3	4.0	Rip Rap Bottom, Grass Sides	0.035										
CUL5h	Culvert 5									1	60	1482	1478	18	0	0	Smooth HDPE	0.013	Drop Inlet
CH2b	Channel 2	117	3.5%	0	3	3	4.0	Rip Rap Bottom, Grass Sides	0.035										
DCCUL5	2 downchute culverts									2	50	1484	1481	30	0	0	Smooth HDPE	0.013	Mitered
CUL5i	Culvert 5									1	60	1482	1478	18	0	0	Smooth HDPE	0.013	Drop Inlet
HB	Hosmer Brook	30	0.4%	27	3	3	1.0	Rip Rap	0.035										
Modified from Valley Fill Design																			
DC5a	stone lined downchute	137	33%	12	2	2	1.0	Rip Rap	0.035			1630	1584.79						
DC5b	stone lined downchute	62	33%	12	2	2	1.0	Rip Rap	0.035			1584.79	1564.33						
DC5c	stone lined downchute	103	33%	12	2	2	1.0	Rip Rap	0.035			1564.33	1530.34						
DC5d	stone lined downchute	130	33%	12	2	2	1.0	Rip Rap	0.035			1530.34	1487						
DC6a	stone lined downchute	31	33%	12	2	2	1.0	Rip Rap	0.035			1670.23	1660						
DC6b	stone lined downchute	150	33%	12	2	2	1.0	Rip Rap	0.035			1660	1610.5						
DC6c	stone lined downchute	151	33%	12	2	2	1.0	Rip Rap	0.035			1610.5	1560.67						
DC6d	stone lined downchute	149	33%	12	2	2	1.0	Rip Rap	0.035			1560.67	1511.5						
Cul2	Culvert 2	70								1		1455.42	1454		7	6	Concrete	0.011	Headwall
CH5										N/A									
CH3c										N/A									
Cul4										N/A									
CH3b										N/A									
CUL5j										N/A									
CH3a										N/A									
Cul3										N/A									
Cul6										N/A									
Cul7	Culvert 7									1	89	1448	1445	18	0	0	Smooth HDPE	0.013	Drop Inlet with Storage
CH4										N/A									
EXCH4										N/A									
EXCH5										N/A									
Cul8										N/A									
Cul9										N/A									
Cul10										N/A									
Cul11										N/A									
Cul12										N/A									
Cul13										N/A									
Cul14										N/A									
Cul15	Culvert 15									1	50	1460	1455.42	60	0	0	Smooth HDPE	0.013	Mitered
Additional Downchutes, Channels and Culverts																			
DC6d	stone lined downchute	149	33%	12	2	2	1.0	Rip Rap	0.035			1560.67	1511.5						
DC6e	stone lined downchute	85	33%	12	2	2	1.0	Rip Rap	0.035			1511.5	1483.45						
DC1a	stone lined downchute	164	33%	12	2	2	1.0	Rip Rap	0.035			1611.51	1557.39						
DC1b	stone lined downchute	165	33%	12	2	2	1.0	Rip Rap	0.035			1557.39	1502.94						
DC1c	stone lined downchute	67	33%	12	2	2	1.0	Rip Rap	0.035			1502.94	1480.83						
RCHa	stone lined road channel	314	16%	0	3	3	1.5	Rip Rap	0.035			1618	1567						
RCHb	stone lined road channel	312	16%	0	3	3	1.5	Rip Rap	0.035			1567	1517						
RCHc	stone lined road channel	191	16%	0	3	3	1.5	Rip Rap	0.035			1517	1486						
PCHa	perimeter channel	197	1%	2	3	3	2.0	Rip Rap Bottom, Grass Sides	0.035			1479.97	1478.00						
PCHb	perimeter channel	403	1%	2	3	3	2.0	Rip Rap Bottom, Grass Sides	0.035			1482.03	1478.00						
PCHc	perimeter channel	209	1%	2	3	3	2.0	Rip Rap Bottom, Grass Sides	0.035			1482.09	1480.00						
PCHd	perimeter channel	225	1%	2	3	3	2.0	Rip Rap Bottom, Grass Sides	0.035			1482.25	1480.00						
PCHe	perimeter channel	225	1%	2	3	3	2.0	Rip Rap Bottom, Grass Sides	0.035			1482.25	1480.00						
PCHf	perimeter channel	380	1%	2	3	3	2.0	Rip Rap Bottom, Grass Sides	0.035			1483.80	1480.00						

Culvert Number	Description	Channel Geometry								Culvert Geometery									
		Length (ft)	Slope (%)	Bottom Width (ft)	Left Side Slope (run)	Right Side Slope (run)	Depth (ft)	Surface Condition	Mannings 'n'	Number of Culverts	Length (ft)	Inlet Elevation (ft)	Outlet Elevation (ft)	Diameter (in)	Width (ft)	Height (ft)	Material	Mannings 'n'	Entrance Type
PCHg	perimeter channel	124	1%	2	3	3	2.0	Rip Rap Bottom, Grass Sides	0.035			1482.30	1481.00						
PCHh	perimeter channel	292	1%	2	3	3	2.0	Rip Rap Bottom, Grass Sides	0.035			1482.92	1480.00						
PCHi	perimeter channel	192	1%	2	3	3	2.0	Rip Rap Bottom, Grass Sides	0.035			1484.85	1482.92						
PCHj	perimeter channel	206	1%	2	3	3	2.0	Rip Rap Bottom, Grass Sides	0.035			1485.86	1483.80						
PCHk	perimeter channel	101	1%	2	3	3	2.0	Rip Rap Bottom, Grass Sides	0.035			1483.80	1482.79						
Cul16	Culvert 16									1	202	1470	1443	48	0	0	Corrugated HDPE	0.013	Mitered
Cul17	Culvert 17									1	136	1480	1476	48	0	0	Corrugated HDPE	0.013	Mitered
Cul18	Culvert 18									1	48	1478	1475	24	0	0	Corrugated HDPE	0.013	Mitered
Cul19	Culvert 19									1	69	1482	1471	36	0	0	Corrugated HDPE	0.013	Mitered
Cul20	Culvert 20									1	72	1480	1468	24	0	0	Corrugated HDPE	0.013	Mitered
Cul21	Culvert 21									1	89	1480	1464	24	0	0	Corrugated HDPE	0.013	Mitered
Cul22	Culvert 22									1	45	1480	1479	60	0	0	Corrugated HDPE	0.013	Mitered
Cul23	Culvert 23									1	49	1454	1452	60	0	0	Corrugated HDPE	0.013	Mitered
Cul24	Culvert 24									1	177	1483.45	1461	48	0	0	Corrugated HDPE	0.013	Mitered
BCHa	berm channel	70	1%	0	3	3	4.0	Rip Rap	0.035			1476	1475						
BCHb	berm channel	442	1%	0	3	3	4.0	Rip Rap	0.035			1475	1471						
BCHc	berm channel	309	1%	0	3	3	4.0	Rip Rap	0.035			1471	1468						
BCHd	berm channel	451	1%	0	3	3	4.0	Rip Rap	0.035			1468	1464						
BCHe	berm channel	772	1%	0	3	3	4.0	Rip Rap	0.035			1464	1454						
BCHf	berm channel	701	3%	0	3	3	4.0	Rip Rap	0.035			1479	1460						
DC7a	stone lined downchute	152	33%	12	2	2	1.0	Rip Rap	0.035			1584	1533.84						
DC7b	stone lined downchute	127	33%	12	2	2	1.0	Rip Rap	0.035			1533.84	1491.93						
DC7c	stone lined downchute	21	33%	12	2	2	1.0	Rip Rap	0.035			1491.93	1485						

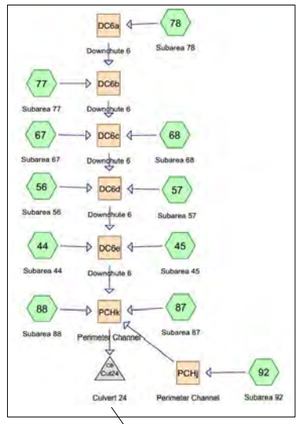
Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Sedimentation Basin Calculations
Basin # 5 Storage

Elevation (ft)	Area (sf)	Incremental Volume (cf)	Cumulative Volume (cf)	Cumulative Volume (gal)	Notes
1444	53,356	0	0	0	Bottom of Basin
1446	65,054	118,410	118,410	885,769	
1448	73,763	138,817	257,227	1,924,195	
1450	82,901	156,665	413,892	3,096,128	Overflow Pipe Elevation @ 1451
1452	89,234	172,136	586,028	4,383,791	Emergency Spillway Elevation
1454	101,595	190,830	776,857	5,811,295	Top of Basin Berm

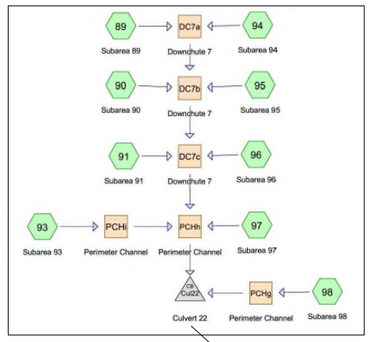
Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Sedimentation Basin Calculations
Basin # 1, 2, 3 Storage

Elevation (ft)	Area (sf)	Incremental Volume (cf)	Cumulative Volume (cf)	Cumulative Volume (gal)	Notes
1441	40,344	0	0	0	Bottom of Basin
1442	65,526	41,794	41,794	312,641	
1444	160,382	142,587	225,693	1,688,302	
1446	258,186	231,822	426,428	3,189,901	Overflow Pipe Elevation @ 1447
1448	272,450	530,636	762,458	5,703,581	Emergency Spillway Elevation
1450	296,591	569,041	1,099,676	8,226,152	Top of Basin Berm

SEGMENT 4



SEGMENT 7



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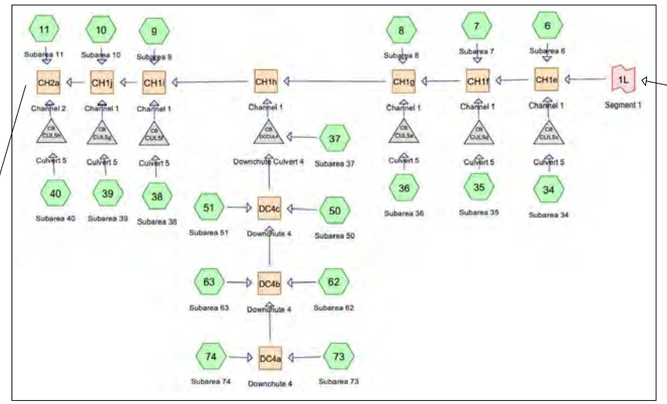

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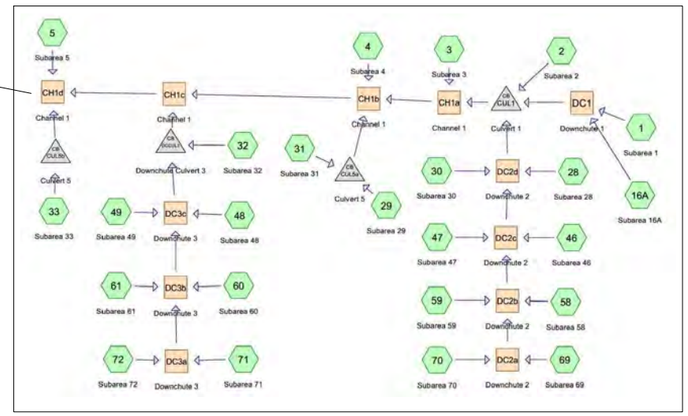

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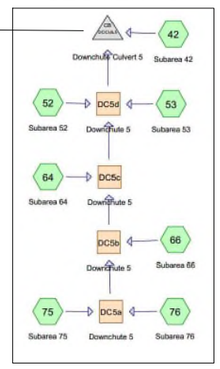

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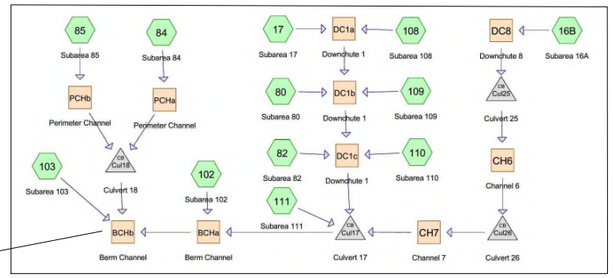

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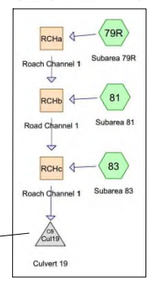
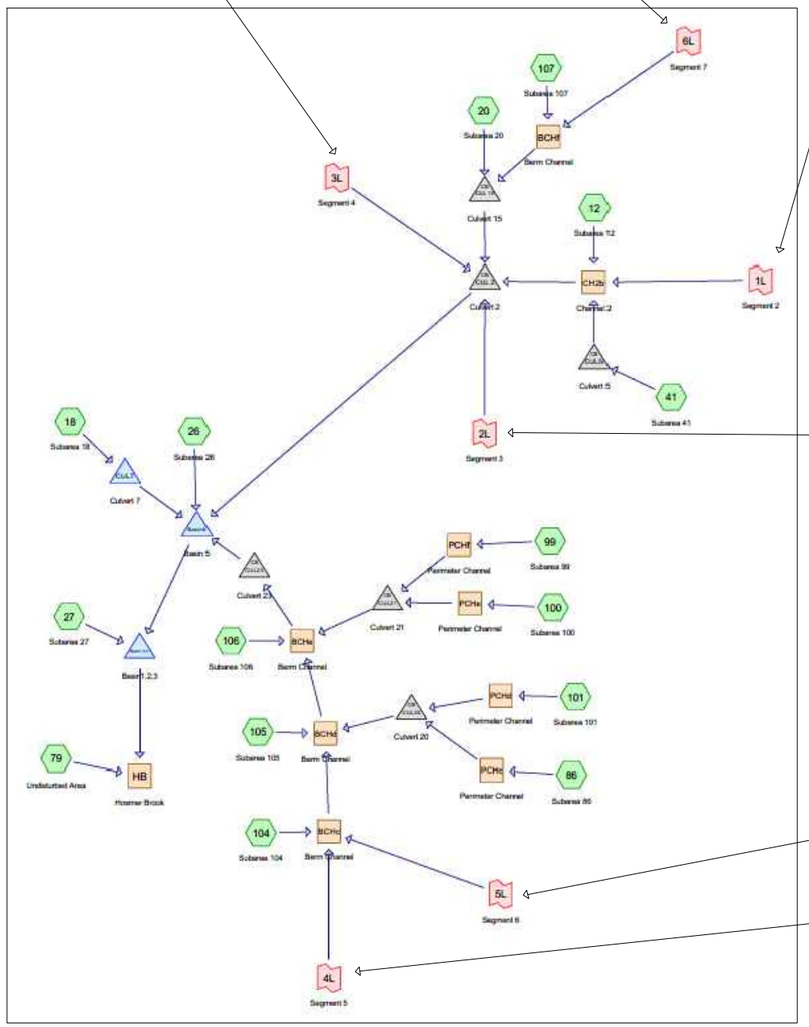


SEGMENT COMBINATION



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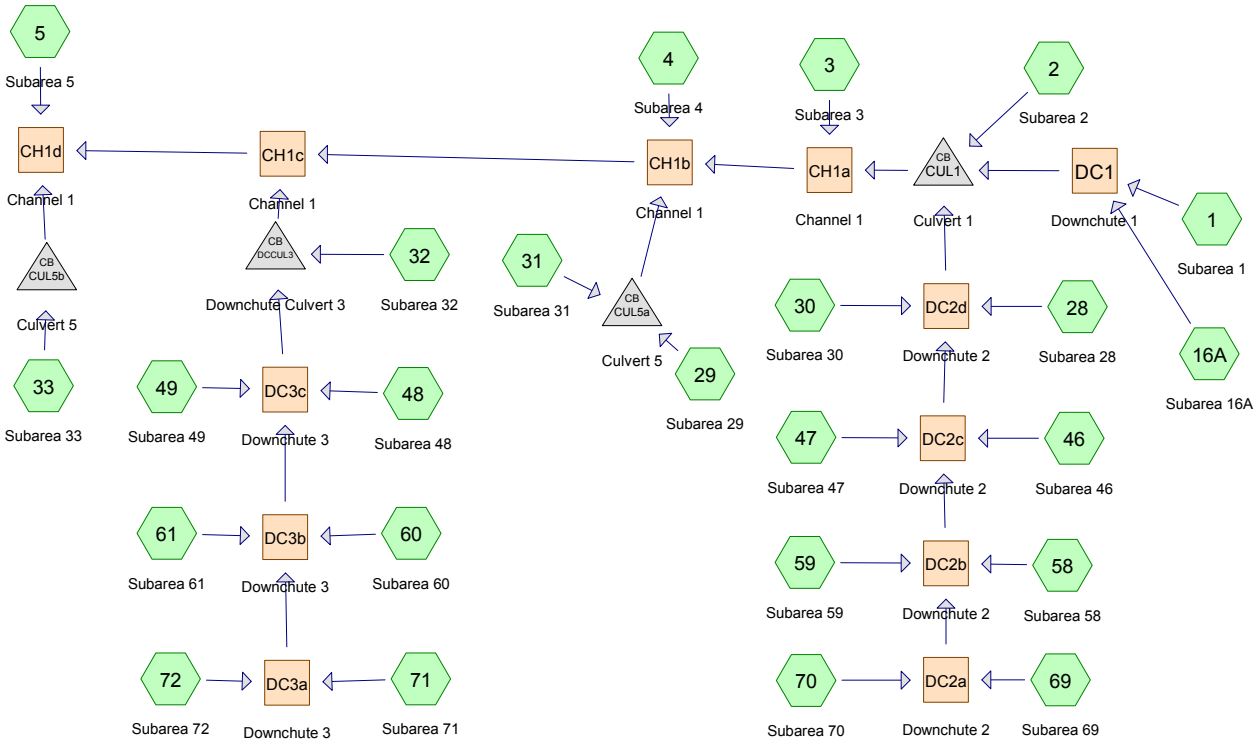
CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

STORMWATER DRAINAGE SYSTEM MODEL

SHEET NO.
1
PROJECT NO.
190260

1" 1/2" 0" 1"



Subcat Reach Pond Link

Routing Diagram for Southern Expansion Segment 1
Prepared by Tetra Tech Inc, Printed 5/4/2020
HydroCAD® 10.00-24 s/n 04483 © 2018 HydroCAD Software Solutions LLC

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=309,031 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=1,111' Tc=7.1 min CN=80 Runoff=5.90 cfs 12,942 cf

Subcatchment 2: Subarea 2 Runoff Area=17,031 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=174' Slope=0.3300 '/' Tc=3.9 min CN=80 Runoff=0.37 cfs 713 cf

Subcatchment 3: Subarea 3 Runoff Area=12,681 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=66' Tc=2.0 min CN=80 Runoff=0.30 cfs 531 cf

Subcatchment 4: Subarea 4 Runoff Area=36,469 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=61' Tc=2.0 min CN=80 Runoff=0.86 cfs 1,527 cf

Subcatchment 5: Subarea 5 Runoff Area=39,423 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=68' Tc=2.3 min CN=80 Runoff=0.92 cfs 1,651 cf

Subcatchment 16A: Subarea 16A Runoff Area=105,043 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=823' Tc=12.7 min CN=80 Runoff=1.58 cfs 4,399 cf

Subcatchment 28: Subarea 28 Runoff Area=19,201 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=183' Slope=0.3300 '/' Tc=3.9 min CN=80 Runoff=0.42 cfs 804 cf

Subcatchment 29: Subarea 29 Runoff Area=9,939 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=257' Tc=2.1 min CN=80 Runoff=0.23 cfs 416 cf

Subcatchment 30: Subarea 30 Runoff Area=44,923 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=422' Tc=4.4 min CN=80 Runoff=0.96 cfs 1,881 cf

Subcatchment 31: Subarea 31 Runoff Area=35,811 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=366' Tc=4.9 min CN=80 Runoff=0.75 cfs 1,500 cf

Subcatchment 32: Subarea 32 Runoff Area=18,017 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=274' Tc=4.7 min CN=80 Runoff=0.38 cfs 755 cf

Subcatchment 33: Subarea 33 Runoff Area=47,473 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=388' Tc=5.0 min CN=80 Runoff=0.99 cfs 1,988 cf

Subcatchment 46: Subarea 46 Runoff Area=26,521 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=249' Tc=4.1 min CN=80 Runoff=0.58 cfs 1,111 cf

Subcatchment 47: Subarea 47 Runoff Area=52,705 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=474' Tc=4.5 min CN=80 Runoff=1.12 cfs 2,207 cf

Subcatchment 48: Subarea 48 Runoff Area=54,019 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=511' Tc=4.6 min CN=80 Runoff=1.15 cfs 2,262 cf

Subcatchment 49: Subarea 49 Runoff Area=91,405 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=669' Tc=4.9 min CN=80 Runoff=1.92 cfs 3,828 cf

Subcatchment 58: Subarea 58 Runoff Area=32,792 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=373' Tc=9.4 min CN=80 Runoff=0.57 cfs 1,373 cf

Subcatchment 59: Subarea 59 Runoff Area=65,108 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=559' Tc=9.2 min CN=80 Runoff=1.13 cfs 2,727 cf

Subcatchment 60: Subarea 60 Runoff Area=54,019 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=511' Tc=4.6 min CN=80 Runoff=1.15 cfs 2,262 cf

Subcatchment 61: Subarea 61 Runoff Area=71,026 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=533' Tc=4.6 min CN=80 Runoff=1.51 cfs 2,975 cf

Subcatchment 69: Subarea 69 Runoff Area=35,160 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=517' Tc=9.4 min CN=80 Runoff=0.61 cfs 1,473 cf

Subcatchment 70: Subarea 70 Runoff Area=145,786 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=683' Slope=0.0400 '/' Tc=11.2 min CN=80 Runoff=2.33 cfs 6,106 cf

Subcatchment 71: Subarea 71 Runoff Area=130,226 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=703' Tc=11.5 min CN=80 Runoff=2.06 cfs 5,454 cf

Subcatchment 72: Subarea 72 Runoff Area=88,619 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=412' Slope=0.0400 '/' Tc=2.1 min CN=80 Runoff=2.09 cfs 3,711 cf

Reach CH1a: Channel 1 Avg. Flow Depth=1.43' Max Vel=2.31 fps Inflow=14.23 cfs 36,268 cf
n=0.035 L=130.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=14.09 cfs 36,268 cf

Reach CH1b: Channel 1 Avg. Flow Depth=1.43' Max Vel=2.32 fps Inflow=15.12 cfs 39,711 cf
n=0.035 L=358.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=14.25 cfs 39,711 cf

Reach CH1c: Channel 1 Avg. Flow Depth=1.67' Max Vel=2.57 fps Inflow=21.68 cfs 60,958 cf
n=0.035 L=92.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=21.61 cfs 60,958 cf

Reach CH1d: Channel 1 Avg. Flow Depth=1.66' Max Vel=2.56 fps Inflow=22.82 cfs 64,597 cf
n=0.035 L=450.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=21.25 cfs 64,597 cf

Reach DC1: Downchute 1 Avg. Flow Depth=0.14' Max Vel=6.33 fps Inflow=7.21 cfs 17,342 cf
n=0.035 L=174.0' S=0.3300 '/' Capacity=210.50 cfs Outflow=7.19 cfs 17,342 cf

Reach DC2a: Downchute 2 Avg. Flow Depth=0.07' Max Vel=4.10 fps Inflow=2.93 cfs 7,578 cf
n=0.035 L=150.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=2.92 cfs 7,578 cf

Reach DC2b: Downchute 2 Avg. Flow Depth=0.09' Max Vel=4.89 fps Inflow=4.58 cfs 11,678 cf
n=0.035 L=150.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=4.57 cfs 11,678 cf

Reach DC2c: Downchute 2 Avg. Flow Depth=0.10' Max Vel=5.30 fps Inflow=5.61 cfs 14,996 cf
n=0.035 L=164.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=5.60 cfs 14,996 cf

Reach DC2d: Downchute 2 Avg. Flow Depth=0.16' Max Vel=4.01 fps Inflow=6.64 cfs 17,682 cf
n=0.035 L=63.0' S=0.1119 '/' Capacity=572.26 cfs Outflow=6.63 cfs 17,682 cf

Reach DC3a: Downchute 3 Avg. Flow Depth=0.07' Max Vel=4.25 fps Inflow=3.20 cfs 9,165 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=3.19 cfs 9,165 cf

Reach DC3b: Downchute 3 Avg. Flow Depth=0.11' Max Vel=5.38 fps Inflow=5.84 cfs 14,402 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=5.83 cfs 14,402 cf

Reach DC3c: Downchute 3 Avg. Flow Depth=0.14' Max Vel=6.33 fps Inflow=8.89 cfs 20,493 cf
n=0.035 L=131.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=8.88 cfs 20,493 cf

Pond CUL1: Culvert 1 Peak Elev=1,484.07' Inflow=14.10 cfs 35,737 cf
36.0" Round Culvert x 2.00 n=0.013 L=122.0' S=0.0246 '/' Outflow=14.10 cfs 35,737 cf

Pond CUL5a: Culvert 5 Peak Elev=1,482.49' Inflow=0.95 cfs 1,916 cf
18.0" Round Culvert n=0.013 L=61.0' S=0.0328 '/' Outflow=0.95 cfs 1,916 cf

Pond CUL5b: Culvert 5 Peak Elev=1,482.50' Inflow=0.99 cfs 1,988 cf
18.0" Round Culvert n=0.013 L=54.0' S=0.0370 '/' Outflow=0.99 cfs 1,988 cf

Pond DCCUL3: Downchute Culvert 3 Peak Elev=1,484.91' Inflow=9.26 cfs 21,247 cf
30.0" Round Culvert x 2.00 n=0.013 L=56.0' S=0.0714 '/' Outflow=9.26 cfs 21,247 cf

Summary for Subcatchment 1: Subarea 1

Runoff = 5.90 cfs @ 12.00 hrs, Volume= 12,942 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	309,031	80	
	309,031		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.3	304	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.2	707	0.0300	5.34	21.34	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=1.00' Z= 2.0 '/' Top.W=6.00' n= 0.035
7.1	1,111	Total			

Summary for Subcatchment 2: Subarea 2

Runoff = 0.37 cfs @ 11.96 hrs, Volume= 713 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	17,031	80	
	17,031		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	74	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	174	Total			

Summary for Subcatchment 3: Subarea 3

Runoff = 0.30 cfs @ 11.93 hrs, Volume= 531 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	12,681	80	
	12,681		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	45	0.0100	0.79		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.0	21	0.3300	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.0	66	Total			

Summary for Subcatchment 4: Subarea 4

Runoff = 0.86 cfs @ 11.93 hrs, Volume= 1,527 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	36,469	80	
	36,469		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	33	0.0100	0.74		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.3	28	0.3300	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.0	61	Total			

Summary for Subcatchment 5: Subarea 5

Runoff = 0.92 cfs @ 11.93 hrs, Volume= 1,651 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	39,423	80	
	39,423		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	35	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.5	33	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.3	68	Total			

Summary for Subcatchment 16A: Subarea 16A

Runoff = 1.58 cfs @ 12.06 hrs, Volume= 4,399 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	105,043	80	Landfill
	105,043		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.8	151	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	137	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	435	0.0050	3.92	493.54	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=3.00' Z= 25.0 & 3.0 '/' Top.W=84.00' n= 0.035 Earth, dense weeds
12.7	823	Total			

Summary for Subcatchment 28: Subarea 28

Runoff = 0.42 cfs @ 11.96 hrs, Volume= 804 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	19,201	80	
	19,201		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	83	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	183	Total			

Summary for Subcatchment 29: Subarea 29

Runoff = 0.23 cfs @ 11.93 hrs, Volume= 416 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	9,939	80	
	9,939		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	19	0.3300	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.1	238	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
2.1	257	Total			

Summary for Subcatchment 30: Subarea 30

Runoff = 0.96 cfs @ 11.96 hrs, Volume= 1,881 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	44,923	80	
	44,923		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	53	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	269	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.4	422	Total			

Summary for Subcatchment 31: Subarea 31

Runoff = 0.75 cfs @ 11.97 hrs, Volume= 1,500 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	35,811	80	
	35,811		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	41	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
4.9	366	Total			

Summary for Subcatchment 32: Subarea 32

Runoff = 0.38 cfs @ 11.97 hrs, Volume= 755 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	18,017	80	
	18,017		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	41	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	133	0.0100	2.41	3.13	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=0.50' Z= 2.0 '/' Top.W=3.60' n= 0.030
4.7	274	Total			

Summary for Subcatchment 33: Subarea 33

Runoff = 0.99 cfs @ 11.97 hrs, Volume= 1,988 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	47,473	80	
	47,473		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	63	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.0	388	Total			

Summary for Subcatchment 46: Subarea 46

Runoff = 0.58 cfs @ 11.96 hrs, Volume= 1,111 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	26,521	80	
	26,521		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	61	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	88	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.1	249	Total			

Summary for Subcatchment 47: Subarea 47

Runoff = 1.12 cfs @ 11.96 hrs, Volume= 2,207 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	52,705	80	
	52,705		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	56	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	318	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.5	474	Total			

Summary for Subcatchment 48: Subarea 48

Runoff = 1.15 cfs @ 11.97 hrs, Volume= 2,262 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	54,019	80	
	54,019		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	51	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	360	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	511	Total			

Summary for Subcatchment 49: Subarea 49

Runoff = 1.92 cfs @ 11.97 hrs, Volume= 3,828 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	91,405	80	
	91,405		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	51	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	518	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.9	669	Total			

Summary for Subcatchment 58: Subarea 58

Runoff = 0.57 cfs @ 12.02 hrs, Volume= 1,373 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	32,792	80	
	32,792		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	20	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	124	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	129	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
9.4	373	Total			

Summary for Subcatchment 59: Subarea 59

Runoff = 1.13 cfs @ 12.02 hrs, Volume= 2,727 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	65,108	80	
	65,108		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0	80	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.0	20	0.3300	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	92	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	367	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
9.2	559	Total			

Summary for Subcatchment 60: Subarea 60

Runoff = 1.15 cfs @ 11.97 hrs, Volume= 2,262 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	54,019	80	
	54,019		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	51	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	360	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	511	Total			

Summary for Subcatchment 61: Subarea 61

Runoff = 1.51 cfs @ 11.97 hrs, Volume= 2,975 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	71,026	80	
	71,026		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	51	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	382	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	533	Total			

Summary for Subcatchment 69: Subarea 69

Runoff = 0.61 cfs @ 12.02 hrs, Volume= 1,473 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	35,160	80	
	35,160		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	47	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	370	0.0400	8.14	256.49	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 & 25.0 '/' Top.W=42.00' n= 0.030
9.4	517	Total			

Summary for Subcatchment 70: Subarea 70

Runoff = 2.33 cfs @ 12.04 hrs, Volume= 6,106 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	145,786	80	
	145,786		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.9	161	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	422	0.0400	8.14	256.49	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 & 25.0 '/' Top.W=42.00' n= 0.030
11.2	683	Total			

Summary for Subcatchment 71: Subarea 71

Runoff = 2.06 cfs @ 12.05 hrs, Volume= 5,454 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	130,226	80	
	130,226		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.9	157	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	86	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	360	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
11.5	703	Total			

Summary for Subcatchment 72: Subarea 72

Runoff = 2.09 cfs @ 11.93 hrs, Volume= 3,711 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	88,619	80	
	88,619		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	10	0.0400	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.8	402	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.1	412	Total			

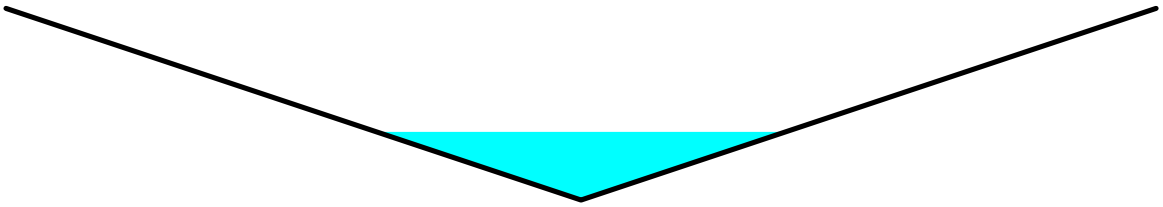
Summary for Reach CH1a: Channel 1

Inflow Area = 865,982 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 14.23 cfs @ 12.00 hrs, Volume= 36,268 cf
Outflow = 14.09 cfs @ 12.02 hrs, Volume= 36,268 cf, Atten= 1%, Lag= 0.7 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.31 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 0.94 fps, Avg. Travel Time= 2.3 min

Peak Storage= 792 cf @ 12.02 hrs
Average Depth at Peak Storage= 1.43'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 130.0' Slope= 0.0050 '/'
Inlet Invert= 1,480.00', Outlet Invert= 1,479.35'



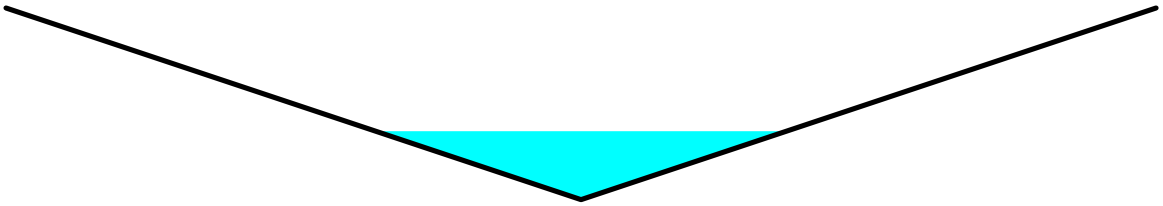
Summary for Reach CH1b: Channel 1

Inflow Area = 948,201 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 15.12 cfs @ 12.01 hrs, Volume= 39,711 cf
Outflow = 14.25 cfs @ 12.04 hrs, Volume= 39,711 cf, Atten= 6%, Lag= 1.9 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.32 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 0.89 fps, Avg. Travel Time= 6.7 min

Peak Storage= 2,200 cf @ 12.04 hrs
Average Depth at Peak Storage= 1.43'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 358.0' Slope= 0.0050 '/'
Inlet Invert= 1,479.35', Outlet Invert= 1,477.56'



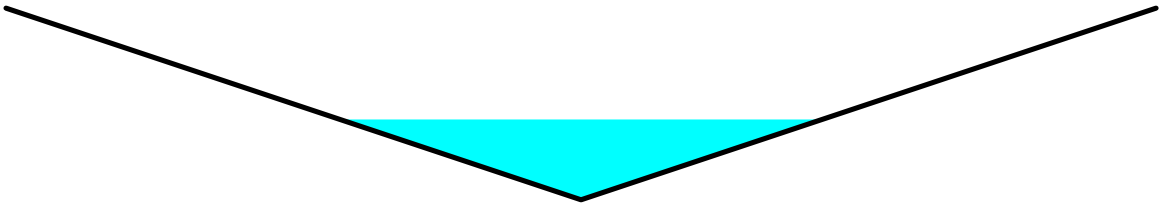
Summary for Reach CH1c: Channel 1

Inflow Area = 1,455,532 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 21.68 cfs @ 12.01 hrs, Volume= 60,958 cf
Outflow = 21.61 cfs @ 12.01 hrs, Volume= 60,958 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.57 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 1.6 min

Peak Storage= 773 cf @ 12.01 hrs
Average Depth at Peak Storage= 1.67'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 92.0' Slope= 0.0050 '/'
Inlet Invert= 1,477.56', Outlet Invert= 1,477.10'



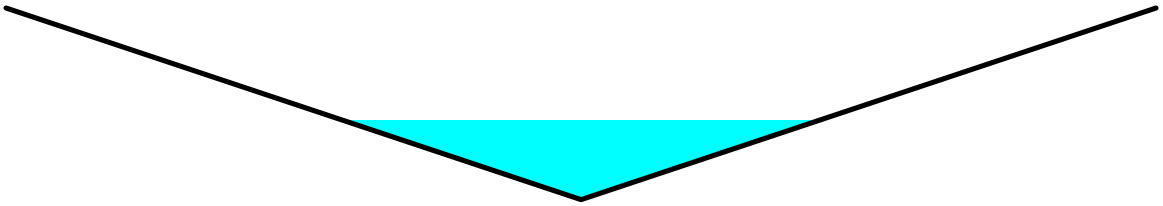
Summary for Reach CH1d: Channel 1

Inflow Area = 1,542,428 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 22.82 cfs @ 12.01 hrs, Volume= 64,597 cf
Outflow = 21.25 cfs @ 12.05 hrs, Volume= 64,597 cf, Atten= 7%, Lag= 2.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.56 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 0.94 fps, Avg. Travel Time= 8.0 min

Peak Storage= 3,731 cf @ 12.05 hrs
Average Depth at Peak Storage= 1.66'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 450.0' Slope= 0.0050 '/'
Inlet Invert= 1,477.10', Outlet Invert= 1,474.85'



Summary for Reach DC1: Downchute 1

Inflow Area = 414,074 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 7.21 cfs @ 12.00 hrs, Volume= 17,342 cf
Outflow = 7.19 cfs @ 12.01 hrs, Volume= 17,342 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.33 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.73 fps, Avg. Travel Time= 1.7 min

Peak Storage= 198 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.00' Flow Area= 10.0 sf, Capacity= 210.50 cfs

8.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 12.00'
Length= 174.0' Slope= 0.3300 '/'
Inlet Invert= 1,540.42', Outlet Invert= 1,483.00'

‡

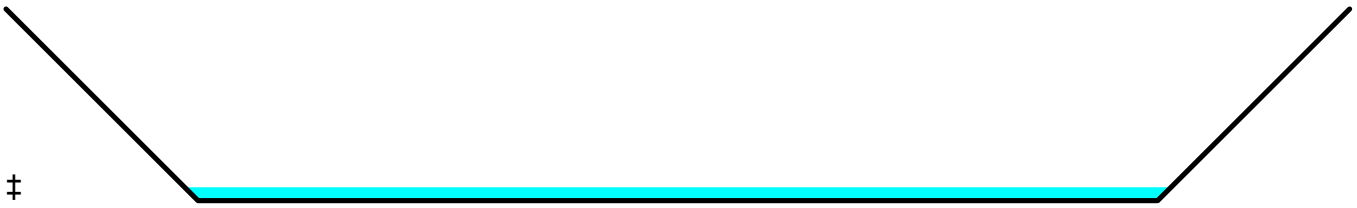
Summary for Reach DC2a: Downchute 2

Inflow Area = 180,946 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 2.93 cfs @ 12.04 hrs, Volume= 7,578 cf
Outflow = 2.92 cfs @ 12.04 hrs, Volume= 7,578 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.10 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.29 fps, Avg. Travel Time= 1.9 min

Peak Storage= 107 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.07'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 150.0' Slope= 0.3300 '/'
Inlet Invert= 1,643.17', Outlet Invert= 1,593.67'



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Summary for Reach DC2b: Downchute 2

Inflow Area = 278,846 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 4.58 cfs @ 12.03 hrs, Volume= 11,678 cf
Outflow = 4.57 cfs @ 12.04 hrs, Volume= 11,678 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.89 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.40 fps, Avg. Travel Time= 1.8 min

Peak Storage= 140 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.09'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 150.0' Slope= 0.3300 '/'
Inlet Invert= 1,593.67', Outlet Invert= 1,544.17'

‡

Summary for Reach DC2c: Downchute 2

Inflow Area = 358,072 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 5.61 cfs @ 12.01 hrs, Volume= 14,996 cf
Outflow = 5.60 cfs @ 12.02 hrs, Volume= 14,996 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.30 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.51 fps, Avg. Travel Time= 1.8 min

Peak Storage= 173 cf @ 12.02 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 164.0' Slope= 0.3300 '/'
Inlet Invert= 1,544.17', Outlet Invert= 1,490.05'

‡

Summary for Reach DC2d: Downchute 2

Inflow Area = 422,196 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 6.64 cfs @ 12.00 hrs, Volume= 17,682 cf
Outflow = 6.63 cfs @ 12.01 hrs, Volume= 17,682 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.01 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.23 fps, Avg. Travel Time= 0.9 min

Peak Storage= 104 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 572.26 cfs

10.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 63.0' Slope= 0.1119 '/'
Inlet Invert= 1,490.05', Outlet Invert= 1,483.00'

‡

Summary for Reach DC3a: Downchute 3

Inflow Area = 218,845 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 3.20 cfs @ 11.95 hrs, Volume= 9,165 cf
Outflow = 3.19 cfs @ 11.96 hrs, Volume= 9,165 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.25 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.33 fps, Avg. Travel Time= 1.9 min

Peak Storage= 113 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.07'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,626.89', Outlet Invert= 1,577.06'

‡

Summary for Reach DC3b: Downchute 3

Inflow Area = 343,890 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 5.84 cfs @ 11.96 hrs, Volume= 14,402 cf
Outflow = 5.83 cfs @ 11.97 hrs, Volume= 14,402 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.38 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.49 fps, Avg. Travel Time= 1.7 min

Peak Storage= 164 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.11'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,577.06', Outlet Invert= 1,527.23'

‡

Summary for Reach DC3c: Downchute 3

Inflow Area = 489,314 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 8.89 cfs @ 11.97 hrs, Volume= 20,493 cf
Outflow = 8.88 cfs @ 11.97 hrs, Volume= 20,493 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.33 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.70 fps, Avg. Travel Time= 1.3 min

Peak Storage= 184 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 131.0' Slope= 0.3300 '/'
Inlet Invert= 1,527.23', Outlet Invert= 1,484.00'

‡

Summary for Pond CUL1: Culvert 1

Inflow Area = 853,301 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 14.10 cfs @ 12.01 hrs, Volume= 35,737 cf
Outflow = 14.10 cfs @ 12.01 hrs, Volume= 35,737 cf, Atten= 0%, Lag= 0.0 min
Primary = 14.10 cfs @ 12.01 hrs, Volume= 35,737 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,484.07' @ 12.01 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,483.00'	**36.0" Round Culvert X 2.00** L= 122.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,483.00' / 1,480.00' S= 0.0246 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=14.07 cfs @ 12.01 hrs HW=1,484.07' TW=1,481.42' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 14.07 cfs @ 3.11 fps)

Summary for Pond CUL5a: Culvert 5

Inflow Area = 45,750 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 0.95 cfs @ 11.96 hrs, Volume= 1,916 cf
Outflow = 0.95 cfs @ 11.96 hrs, Volume= 1,916 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.95 cfs @ 11.96 hrs, Volume= 1,916 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.49' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 61.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,480.00' S= 0.0328 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=0.95 cfs @ 11.96 hrs HW=1,482.49' TW=1,480.59' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.95 cfs @ 1.88 fps)

Summary for Pond CUL5b: Culvert 5

Inflow Area = 47,473 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 0.99 cfs @ 11.97 hrs, Volume= 1,988 cf
Outflow = 0.99 cfs @ 11.97 hrs, Volume= 1,988 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.99 cfs @ 11.97 hrs, Volume= 1,988 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.50' @ 11.97 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 54.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,480.00' S= 0.0370 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=0.99 cfs @ 11.97 hrs HW=1,482.50' TW=1,478.57' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.99 cfs @ 1.91 fps)

Summary for Pond DCCUL3: Downchute Culvert 3

Inflow Area = 507,331 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 9.26 cfs @ 11.97 hrs, Volume= 21,247 cf
Outflow = 9.26 cfs @ 11.97 hrs, Volume= 21,247 cf, Atten= 0%, Lag= 0.0 min
Primary = 9.26 cfs @ 11.97 hrs, Volume= 21,247 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,484.91' @ 11.97 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,484.00'	**30.0" Round Culvert X 2.00** L= 56.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,484.00' / 1,480.00' S= 0.0714 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=9.25 cfs @ 11.97 hrs HW=1,484.91' TW=1,479.16' (Dynamic Tailwater)
1=Culvert (Inlet Controls 9.25 cfs @ 2.87 fps)

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=309,031 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=1,111' Tc=7.1 min CN=80 Runoff=16.91 cfs 35,708 cf

Subcatchment 2: Subarea 2 Runoff Area=17,031 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=174' Slope=0.3300 '/' Tc=3.9 min CN=80 Runoff=1.05 cfs 1,968 cf

Subcatchment 3: Subarea 3 Runoff Area=12,681 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=66' Tc=2.0 min CN=80 Runoff=0.84 cfs 1,465 cf

Subcatchment 4: Subarea 4 Runoff Area=36,469 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=61' Tc=2.0 min CN=80 Runoff=2.42 cfs 4,214 cf

Subcatchment 5: Subarea 5 Runoff Area=39,423 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=68' Tc=2.3 min CN=80 Runoff=2.59 cfs 4,555 cf

Subcatchment 16A: Subarea 16A Runoff Area=105,043 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=823' Tc=12.7 min CN=80 Runoff=4.67 cfs 12,137 cf

Subcatchment 28: Subarea 28 Runoff Area=19,201 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=183' Slope=0.3300 '/' Tc=3.9 min CN=80 Runoff=1.19 cfs 2,219 cf

Subcatchment 29: Subarea 29 Runoff Area=9,939 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=257' Tc=2.1 min CN=80 Runoff=0.66 cfs 1,148 cf

Subcatchment 30: Subarea 30 Runoff Area=44,923 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=422' Tc=4.4 min CN=80 Runoff=2.72 cfs 5,191 cf

Subcatchment 31: Subarea 31 Runoff Area=35,811 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=366' Tc=4.9 min CN=80 Runoff=2.13 cfs 4,138 cf

Subcatchment 32: Subarea 32 Runoff Area=18,017 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=274' Tc=4.7 min CN=80 Runoff=1.08 cfs 2,082 cf

Subcatchment 33: Subarea 33 Runoff Area=47,473 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=388' Tc=5.0 min CN=80 Runoff=2.81 cfs 5,485 cf

Subcatchment 46: Subarea 46 Runoff Area=26,521 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=249' Tc=4.1 min CN=80 Runoff=1.63 cfs 3,064 cf

Subcatchment 47: Subarea 47 Runoff Area=52,705 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=474' Tc=4.5 min CN=80 Runoff=3.18 cfs 6,090 cf

Subcatchment 48: Subarea 48 Runoff Area=54,019 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=511' Tc=4.6 min CN=80 Runoff=3.25 cfs 6,242 cf

Subcatchment 49: Subarea 49 Runoff Area=91,405 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=669' Tc=4.9 min CN=80 Runoff=5.44 cfs 10,562 cf

Subcatchment 58: Subarea 58 Runoff Area=32,792 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=373' Tc=9.4 min CN=80 Runoff=1.64 cfs 3,789 cf

Subcatchment 59: Subarea 59 Runoff Area=65,108 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=559' Tc=9.2 min CN=80 Runoff=3.29 cfs 7,523 cf

Subcatchment 60: Subarea 60 Runoff Area=54,019 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=511' Tc=4.6 min CN=80 Runoff=3.25 cfs 6,242 cf

Subcatchment 61: Subarea 61 Runoff Area=71,026 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=533' Tc=4.6 min CN=80 Runoff=4.27 cfs 8,207 cf

Subcatchment 69: Subarea 69 Runoff Area=35,160 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=517' Tc=9.4 min CN=80 Runoff=1.76 cfs 4,063 cf

Subcatchment 70: Subarea 70 Runoff Area=145,786 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=683' Slope=0.0400 '/' Tc=11.2 min CN=80 Runoff=6.84 cfs 16,845 cf

Subcatchment 71: Subarea 71 Runoff Area=130,226 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=703' Tc=11.5 min CN=80 Runoff=6.04 cfs 15,047 cf

Subcatchment 72: Subarea 72 Runoff Area=88,619 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=412' Slope=0.0400 '/' Tc=2.1 min CN=80 Runoff=5.85 cfs 10,240 cf

Reach CH1a: Channel 1 Avg. Flow Depth=2.14' Max Vel=3.03 fps Inflow=41.93 cfs 100,062 cf
n=0.035 L=130.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=41.73 cfs 100,062 cf

Reach CH1b: Channel 1 Avg. Flow Depth=2.18' Max Vel=3.07 fps Inflow=45.09 cfs 109,562 cf
n=0.035 L=358.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=43.65 cfs 109,562 cf

Reach CH1c: Channel 1 Avg. Flow Depth=2.56' Max Vel=3.41 fps Inflow=66.96 cfs 168,182 cf
n=0.035 L=92.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=66.84 cfs 168,182 cf

Reach CH1d: Channel 1 Avg. Flow Depth=2.57' Max Vel=3.43 fps Inflow=70.84 cfs 178,223 cf
n=0.035 L=450.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=68.11 cfs 178,223 cf

Reach DC1: Downchute 1 Avg. Flow Depth=0.26' Max Vel=9.45 fps Inflow=20.91 cfs 47,845 cf
n=0.035 L=174.0' S=0.3300 '/' Capacity=210.50 cfs Outflow=20.90 cfs 47,845 cf

Reach DC2a: Downchute 2 Avg. Flow Depth=0.13' Max Vel=6.24 fps Inflow=8.57 cfs 20,908 cf
n=0.035 L=150.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=8.56 cfs 20,908 cf

Reach DC2b: Downchute 2 Avg. Flow Depth=0.17' Max Vel=7.42 fps Inflow=13.42 cfs 32,220 cf
n=0.035 L=150.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=13.41 cfs 32,220 cf

Reach DC2c: Downchute 2 Avg. Flow Depth=0.20' Max Vel=8.05 fps Inflow=16.66 cfs 41,374 cf
n=0.035 L=164.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=16.65 cfs 41,374 cf

Reach DC2d: Downchute 2 Avg. Flow Depth=0.30' Max Vel=6.02 fps Inflow=19.81 cfs 48,783 cf
n=0.035 L=63.0' S=0.1119 '/' Capacity=572.26 cfs Outflow=19.81 cfs 48,783 cf

Reach DC3a: Downchute 3 Avg. Flow Depth=0.14' Max Vel=6.52 fps Inflow=9.60 cfs 25,287 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=9.59 cfs 25,287 cf

Reach DC3b: Downchute 3 Avg. Flow Depth=0.20' Max Vel=8.13 fps Inflow=17.06 cfs 39,735 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=17.04 cfs 39,735 cf

Reach DC3c: Downchute 3 Avg. Flow Depth=0.26' Max Vel=9.49 fps Inflow=25.72 cfs 56,539 cf
n=0.035 L=131.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=25.71 cfs 56,539 cf

Pond CUL1: Culvert 1 Peak Elev=1,484.97' Inflow=41.50 cfs 98,596 cf
36.0" Round Culvert x 2.00 n=0.013 L=122.0' S=0.0246 '/' Outflow=41.50 cfs 98,596 cf

Pond CUL5a: Culvert 5 Peak Elev=1,482.88' Inflow=2.69 cfs 5,286 cf
18.0" Round Culvert n=0.013 L=61.0' S=0.0328 '/' Outflow=2.69 cfs 5,286 cf

Pond CUL5b: Culvert 5 Peak Elev=1,482.90' Inflow=2.81 cfs 5,485 cf
18.0" Round Culvert n=0.013 L=54.0' S=0.0370 '/' Outflow=2.81 cfs 5,485 cf

Pond DCCUL3: Downchute Culvert 3 Peak Elev=1,485.66' Inflow=26.79 cfs 58,621 cf
30.0" Round Culvert x 2.00 n=0.013 L=56.0' S=0.0714 '/' Outflow=26.79 cfs 58,621 cf

Summary for Subcatchment 1: Subarea 1

Runoff = 16.91 cfs @ 11.99 hrs, Volume= 35,708 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	309,031	80	
	309,031		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.3	304	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.2	707	0.0300	5.34	21.34	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=1.00' Z= 2.0 '/' Top.W=6.00' n= 0.035
7.1	1,111	Total			

Summary for Subcatchment 2: Subarea 2

Runoff = 1.05 cfs @ 11.95 hrs, Volume= 1,968 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	17,031	80	
	17,031		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	74	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	174	Total			

Summary for Subcatchment 3: Subarea 3

Runoff = 0.84 cfs @ 11.93 hrs, Volume= 1,465 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	12,681	80	
	12,681		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	45	0.0100	0.79		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.0	21	0.3300	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.0	66	Total			

Summary for Subcatchment 4: Subarea 4

Runoff = 2.42 cfs @ 11.93 hrs, Volume= 4,214 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	36,469	80	
	36,469		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	33	0.0100	0.74		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.3	28	0.3300	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.0	61	Total			

Summary for Subcatchment 5: Subarea 5

Runoff = 2.59 cfs @ 11.93 hrs, Volume= 4,555 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	39,423	80	
	39,423		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	35	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.5	33	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.3	68	Total			

Summary for Subcatchment 16A: Subarea 16A

Runoff = 4.67 cfs @ 12.05 hrs, Volume= 12,137 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	105,043	80	Landfill
	105,043		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.8	151	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	137	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	435	0.0050	3.92	493.54	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=3.00' Z= 25.0 & 3.0 '/' Top.W=84.00' n= 0.035 Earth, dense weeds
12.7	823	Total			

Summary for Subcatchment 28: Subarea 28

Runoff = 1.19 cfs @ 11.95 hrs, Volume= 2,219 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	19,201	80	
	19,201		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	83	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	183	Total			

Summary for Subcatchment 29: Subarea 29

Runoff = 0.66 cfs @ 11.93 hrs, Volume= 1,148 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	9,939	80	
	9,939		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	19	0.3300	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.1	238	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
2.1	257	Total			

Summary for Subcatchment 30: Subarea 30

Runoff = 2.72 cfs @ 11.96 hrs, Volume= 5,191 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	44,923	80	
	44,923		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	53	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	269	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.4	422	Total			

Summary for Subcatchment 31: Subarea 31

Runoff = 2.13 cfs @ 11.96 hrs, Volume= 4,138 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	35,811	80	
	35,811		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	41	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
4.9	366	Total			

Summary for Subcatchment 32: Subarea 32

Runoff = 1.08 cfs @ 11.96 hrs, Volume= 2,082 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	18,017	80	
	18,017		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	41	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	133	0.0100	2.41	3.13	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=0.50' Z= 2.0 '/' Top.W=3.60' n= 0.030
4.7	274	Total			

Summary for Subcatchment 33: Subarea 33

Runoff = 2.81 cfs @ 11.96 hrs, Volume= 5,485 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	47,473	80	
	47,473		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	63	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.0	388	Total			

Summary for Subcatchment 46: Subarea 46

Runoff = 1.63 cfs @ 11.95 hrs, Volume= 3,064 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	26,521	80	
	26,521		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	61	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	88	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.1	249	Total			

Summary for Subcatchment 47: Subarea 47

Runoff = 3.18 cfs @ 11.96 hrs, Volume= 6,090 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	52,705	80	
	52,705		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	56	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	318	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.5	474	Total			

Summary for Subcatchment 48: Subarea 48

Runoff = 3.25 cfs @ 11.96 hrs, Volume= 6,242 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	54,019	80	
	54,019		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	51	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	360	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	511	Total			

Summary for Subcatchment 49: Subarea 49

Runoff = 5.44 cfs @ 11.96 hrs, Volume= 10,562 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	91,405	80	
	91,405		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	51	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	518	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.9	669	Total			

Summary for Subcatchment 58: Subarea 58

Runoff = 1.64 cfs @ 12.01 hrs, Volume= 3,789 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	32,792	80	
	32,792		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	20	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	124	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	129	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
9.4	373	Total			

Summary for Subcatchment 59: Subarea 59

Runoff = 3.29 cfs @ 12.01 hrs, Volume= 7,523 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	65,108	80	
	65,108		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0	80	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.0	20	0.3300	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	92	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	367	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
9.2	559	Total			

Summary for Subcatchment 60: Subarea 60

Runoff = 3.25 cfs @ 11.96 hrs, Volume= 6,242 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	54,019	80	
	54,019		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	51	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	360	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	511	Total			

Summary for Subcatchment 61: Subarea 61

Runoff = 4.27 cfs @ 11.96 hrs, Volume= 8,207 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	71,026	80	
	71,026		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	51	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	382	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	533	Total			

Summary for Subcatchment 69: Subarea 69

Runoff = 1.76 cfs @ 12.01 hrs, Volume= 4,063 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	35,160	80	
	35,160		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	47	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	370	0.0400	8.14	256.49	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 & 25.0 '/' Top.W=42.00' n= 0.030
9.4	517	Total			

Summary for Subcatchment 70: Subarea 70

Runoff = 6.84 cfs @ 12.03 hrs, Volume= 16,845 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	145,786	80	
	145,786		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.9	161	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	422	0.0400	8.14	256.49	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 & 25.0 '/' Top.W=42.00' n= 0.030
11.2	683	Total			

Summary for Subcatchment 71: Subarea 71

Runoff = 6.04 cfs @ 12.04 hrs, Volume= 15,047 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	130,226	80	
	130,226		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.9	157	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	86	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	360	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
11.5	703	Total			

Summary for Subcatchment 72: Subarea 72

Runoff = 5.85 cfs @ 11.93 hrs, Volume= 10,240 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	88,619	80	
	88,619		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	10	0.0400	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.8	402	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.1	412	Total			

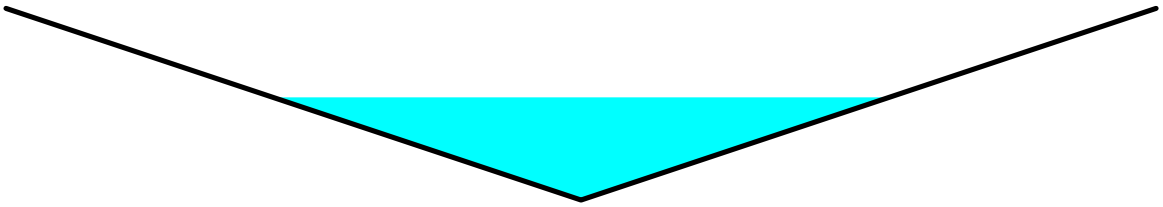
Summary for Reach CH1a: Channel 1

Inflow Area = 865,982 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 41.93 cfs @ 11.99 hrs, Volume= 100,062 cf
Outflow = 41.73 cfs @ 12.00 hrs, Volume= 100,062 cf, Atten= 0%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.03 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.13 fps, Avg. Travel Time= 1.9 min

Peak Storage= 1,788 cf @ 12.00 hrs
Average Depth at Peak Storage= 2.14'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 130.0' Slope= 0.0050 '/'
Inlet Invert= 1,480.00', Outlet Invert= 1,479.35'



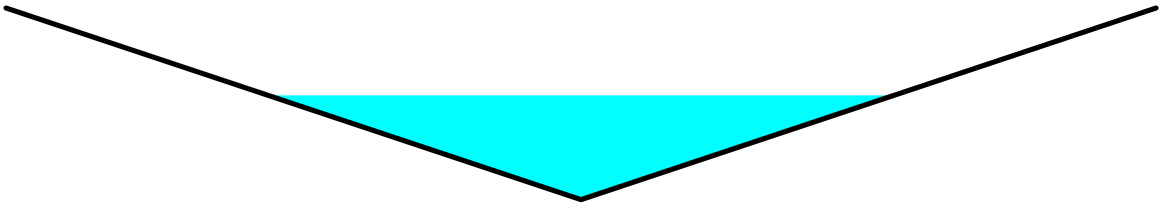
Summary for Reach CH1b: Channel 1

Inflow Area = 948,201 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 45.09 cfs @ 11.99 hrs, Volume= 109,562 cf
Outflow = 43.65 cfs @ 12.02 hrs, Volume= 109,562 cf, Atten= 3%, Lag= 1.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.07 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 1.07 fps, Avg. Travel Time= 5.6 min

Peak Storage= 5,093 cf @ 12.02 hrs
Average Depth at Peak Storage= 2.18'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 358.0' Slope= 0.0050 '/'
Inlet Invert= 1,479.35', Outlet Invert= 1,477.56'



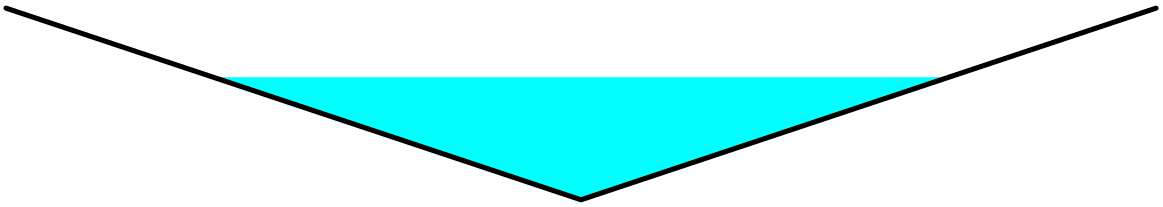
Summary for Reach CH1c: Channel 1

Inflow Area = 1,455,532 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 66.96 cfs @ 11.99 hrs, Volume= 168,182 cf
Outflow = 66.84 cfs @ 12.00 hrs, Volume= 168,182 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.41 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.18 fps, Avg. Travel Time= 1.3 min

Peak Storage= 1,802 cf @ 12.00 hrs
Average Depth at Peak Storage= 2.56'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 92.0' Slope= 0.0050 '/'
Inlet Invert= 1,477.56', Outlet Invert= 1,477.10'



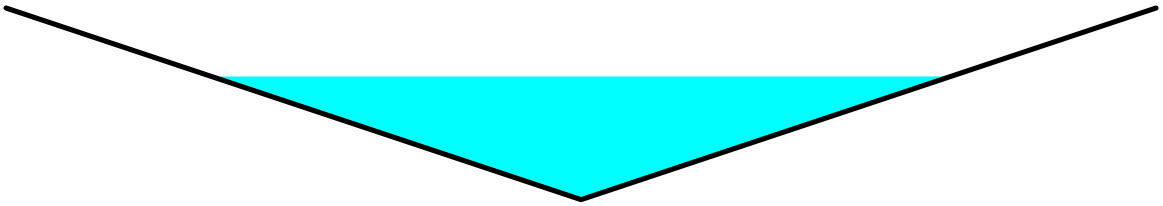
Summary for Reach CH1d: Channel 1

Inflow Area = 1,542,428 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 70.84 cfs @ 11.99 hrs, Volume= 178,223 cf
Outflow = 68.11 cfs @ 12.02 hrs, Volume= 178,223 cf, Atten= 4%, Lag= 1.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.43 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 1.13 fps, Avg. Travel Time= 6.6 min

Peak Storage= 8,938 cf @ 12.02 hrs
Average Depth at Peak Storage= 2.57'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 450.0' Slope= 0.0050 '/'
Inlet Invert= 1,477.10', Outlet Invert= 1,474.85'



Summary for Reach DC1: Downchute 1

Inflow Area = 414,074 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 20.91 cfs @ 12.00 hrs, Volume= 47,845 cf
Outflow = 20.90 cfs @ 12.00 hrs, Volume= 47,845 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 9.45 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.29 fps, Avg. Travel Time= 1.3 min

Peak Storage= 385 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 1.00' Flow Area= 10.0 sf, Capacity= 210.50 cfs

8.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 12.00'
Length= 174.0' Slope= 0.3300 '/'
Inlet Invert= 1,540.42', Outlet Invert= 1,483.00'

‡

Summary for Reach DC2a: Downchute 2

Inflow Area = 180,946 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 8.57 cfs @ 12.03 hrs, Volume= 20,908 cf
Outflow = 8.56 cfs @ 12.03 hrs, Volume= 20,908 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.24 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.58 fps, Avg. Travel Time= 1.6 min

Peak Storage= 206 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 150.0' Slope= 0.3300 '/'
Inlet Invert= 1,643.17', Outlet Invert= 1,593.67'

‡

Summary for Reach DC2b: Downchute 2

Inflow Area = 278,846 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 13.42 cfs @ 12.02 hrs, Volume= 32,220 cf
Outflow = 13.41 cfs @ 12.03 hrs, Volume= 32,220 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 7.42 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.85 fps, Avg. Travel Time= 1.4 min

Peak Storage= 271 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 150.0' Slope= 0.3300 '/'
Inlet Invert= 1,593.67', Outlet Invert= 1,544.17'

‡

Summary for Reach DC2c: Downchute 2

Inflow Area = 358,072 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 16.66 cfs @ 12.00 hrs, Volume= 41,374 cf
Outflow = 16.65 cfs @ 12.01 hrs, Volume= 41,374 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 8.05 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.01 fps, Avg. Travel Time= 1.4 min

Peak Storage= 339 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.20'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 164.0' Slope= 0.3300 '/'
Inlet Invert= 1,544.17', Outlet Invert= 1,490.05'

‡

Summary for Reach DC2d: Downchute 2

Inflow Area = 422,196 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 19.81 cfs @ 11.99 hrs, Volume= 48,783 cf
Outflow = 19.81 cfs @ 11.99 hrs, Volume= 48,783 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.02 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.57 fps, Avg. Travel Time= 0.7 min

Peak Storage= 207 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 572.26 cfs

10.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 63.0' Slope= 0.1119 '/'
Inlet Invert= 1,490.05', Outlet Invert= 1,483.00'

‡

Summary for Reach DC3a: Downchute 3

Inflow Area = 218,845 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 9.60 cfs @ 11.94 hrs, Volume= 25,287 cf
Outflow = 9.59 cfs @ 11.95 hrs, Volume= 25,287 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.52 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.69 fps, Avg. Travel Time= 1.5 min

Peak Storage= 222 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,626.89', Outlet Invert= 1,577.06'

‡

Summary for Reach DC3b: Downchute 3

Inflow Area = 343,890 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 17.06 cfs @ 11.95 hrs, Volume= 39,735 cf
Outflow = 17.04 cfs @ 11.96 hrs, Volume= 39,735 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 8.13 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.99 fps, Avg. Travel Time= 1.3 min

Peak Storage= 317 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.20'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,577.06', Outlet Invert= 1,527.23'

‡

Summary for Reach DC3c: Downchute 3

Inflow Area = 489,314 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 25.72 cfs @ 11.96 hrs, Volume= 56,539 cf
Outflow = 25.71 cfs @ 11.96 hrs, Volume= 56,539 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 9.49 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.24 fps, Avg. Travel Time= 1.0 min

Peak Storage= 355 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 131.0' Slope= 0.3300 '/'
Inlet Invert= 1,527.23', Outlet Invert= 1,484.00'

‡

Summary for Pond CUL1: Culvert 1

Inflow Area = 853,301 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 41.50 cfs @ 11.99 hrs, Volume= 98,596 cf
Outflow = 41.50 cfs @ 11.99 hrs, Volume= 98,596 cf, Atten= 0%, Lag= 0.0 min
Primary = 41.50 cfs @ 11.99 hrs, Volume= 98,596 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,484.97' @ 11.99 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,483.00'	**36.0" Round Culvert X 2.00** L= 122.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,483.00' / 1,480.00' S= 0.0246 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=41.43 cfs @ 11.99 hrs HW=1,484.97' TW=1,482.14' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 41.43 cfs @ 4.21 fps)

Summary for Pond CUL5a: Culvert 5

Inflow Area = 45,750 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 2.69 cfs @ 11.95 hrs, Volume= 5,286 cf
Outflow = 2.69 cfs @ 11.95 hrs, Volume= 5,286 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.69 cfs @ 11.95 hrs, Volume= 5,286 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.88' @ 11.95 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 61.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,480.00' S= 0.0328 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=2.69 cfs @ 11.95 hrs HW=1,482.87' TW=1,481.35' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.69 cfs @ 2.51 fps)

Summary for Pond CUL5b: Culvert 5

Inflow Area = 47,473 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 2.81 cfs @ 11.96 hrs, Volume= 5,485 cf
Outflow = 2.81 cfs @ 11.96 hrs, Volume= 5,485 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.81 cfs @ 11.96 hrs, Volume= 5,485 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.90' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 54.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,480.00' S= 0.0370 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=2.81 cfs @ 11.96 hrs HW=1,482.90' TW=1,479.52' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.81 cfs @ 2.55 fps)

Summary for Pond DCCUL3: Downchute Culvert 3

Inflow Area = 507,331 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 26.79 cfs @ 11.96 hrs, Volume= 58,621 cf
Outflow = 26.79 cfs @ 11.96 hrs, Volume= 58,621 cf, Atten= 0%, Lag= 0.0 min
Primary = 26.79 cfs @ 11.96 hrs, Volume= 58,621 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,485.66' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,484.00'	**30.0" Round Culvert X 2.00** L= 56.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,484.00' / 1,480.00' S= 0.0714 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=26.76 cfs @ 11.96 hrs HW=1,485.66' TW=1,480.05' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 26.76 cfs @ 3.87 fps)

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Subarea 1 Runoff Area=309,031 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=1,111' Tc=7.1 min CN=80 Runoff=38.12 cfs 81,734 cf

Subcatchment 2: Subarea 2 Runoff Area=17,031 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=174' Slope=0.3300 '/' Tc=3.9 min CN=80 Runoff=2.35 cfs 4,504 cf

Subcatchment 3: Subarea 3 Runoff Area=12,681 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=66' Tc=2.0 min CN=80 Runoff=1.87 cfs 3,354 cf

Subcatchment 4: Subarea 4 Runoff Area=36,469 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=61' Tc=2.0 min CN=80 Runoff=5.37 cfs 9,646 cf

Subcatchment 5: Subarea 5 Runoff Area=39,423 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=68' Tc=2.3 min CN=80 Runoff=5.75 cfs 10,427 cf

Subcatchment 16A: Subarea 16A Runoff Area=105,043 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=823' Tc=12.7 min CN=80 Runoff=10.67 cfs 27,782 cf

Subcatchment 28: Subarea 28 Runoff Area=19,201 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=183' Slope=0.3300 '/' Tc=3.9 min CN=80 Runoff=2.65 cfs 5,078 cf

Subcatchment 29: Subarea 29 Runoff Area=9,939 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=257' Tc=2.1 min CN=80 Runoff=1.46 cfs 2,629 cf

Subcatchment 30: Subarea 30 Runoff Area=44,923 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=422' Tc=4.4 min CN=80 Runoff=6.10 cfs 11,881 cf

Subcatchment 31: Subarea 31 Runoff Area=35,811 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=366' Tc=4.9 min CN=80 Runoff=4.77 cfs 9,471 cf

Subcatchment 32: Subarea 32 Runoff Area=18,017 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=274' Tc=4.7 min CN=80 Runoff=2.42 cfs 4,765 cf

Subcatchment 33: Subarea 33 Runoff Area=47,473 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=388' Tc=5.0 min CN=80 Runoff=6.31 cfs 12,556 cf

Subcatchment 46: Subarea 46 Runoff Area=26,521 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=249' Tc=4.1 min CN=80 Runoff=3.64 cfs 7,014 cf

Subcatchment 47: Subarea 47 Runoff Area=52,705 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=474' Tc=4.5 min CN=80 Runoff=7.13 cfs 13,940 cf

Subcatchment 48: Subarea 48 Runoff Area=54,019 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=511' Tc=4.6 min CN=80 Runoff=7.28 cfs 14,287 cf

Subcatchment 49: Subarea 49 Runoff Area=91,405 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=669' Tc=4.9 min CN=80 Runoff=12.19 cfs 24,175 cf

Subcatchment 58: Subarea 58 Runoff Area=32,792 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=373' Tc=9.4 min CN=80 Runoff=3.73 cfs 8,673 cf

Subcatchment 59: Subarea 59 Runoff Area=65,108 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=559' Tc=9.2 min CN=80 Runoff=7.46 cfs 17,220 cf

Subcatchment 60: Subarea 60 Runoff Area=54,019 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=511' Tc=4.6 min CN=80 Runoff=7.28 cfs 14,287 cf

Subcatchment 61: Subarea 61 Runoff Area=71,026 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=533' Tc=4.6 min CN=80 Runoff=9.57 cfs 18,785 cf

Subcatchment 69: Subarea 69 Runoff Area=35,160 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=517' Tc=9.4 min CN=80 Runoff=4.00 cfs 9,299 cf

Subcatchment 70: Subarea 70 Runoff Area=145,786 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=683' Slope=0.0400 '/' Tc=11.2 min CN=80 Runoff=15.58 cfs 38,558 cf

Subcatchment 71: Subarea 71 Runoff Area=130,226 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=703' Tc=11.5 min CN=80 Runoff=13.77 cfs 34,443 cf

Subcatchment 72: Subarea 72 Runoff Area=88,619 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=412' Slope=0.0400 '/' Tc=2.1 min CN=80 Runoff=13.02 cfs 23,438 cf

Reach CH1a: Channel 1 Avg. Flow Depth=2.92' Max Vel=3.73 fps Inflow=95.67 cfs 229,040 cf
n=0.035 L=130.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=95.38 cfs 229,040 cf

Reach CH1b: Channel 1 Avg. Flow Depth=2.99' Max Vel=3.78 fps Inflow=103.35 cfs 250,785 cf
n=0.035 L=358.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=101.23 cfs 250,785 cf

Reach CH1c: Channel 1 Avg. Flow Depth=3.51' Max Vel=4.22 fps Inflow=155.77 cfs 384,967 cf
n=0.035 L=92.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=155.59 cfs 384,967 cf

Reach CH1d: Channel 1 Avg. Flow Depth=3.55' Max Vel=4.25 fps Inflow=165.12 cfs 407,950 cf
n=0.035 L=450.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=160.94 cfs 407,950 cf

Reach DC1: Downchute 1 Avg. Flow Depth=0.42' Max Vel=12.72 fps Inflow=47.38 cfs 109,517 cf
n=0.035 L=174.0' S=0.3300 '/' Capacity=210.50 cfs Outflow=47.37 cfs 109,517 cf

Reach DC2a: Downchute 2 Avg. Flow Depth=0.22' Max Vel=8.55 fps Inflow=19.50 cfs 47,858 cf
n=0.035 L=150.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=19.49 cfs 47,858 cf

Reach DC2b: Downchute 2 Avg. Flow Depth=0.29' Max Vel=10.12 fps Inflow=30.52 cfs 73,751 cf
n=0.035 L=150.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=30.52 cfs 73,751 cf

Reach DC2c: Downchute 2 Avg. Flow Depth=0.33' Max Vel=11.00 fps Inflow=38.15 cfs 94,705 cf
n=0.035 L=164.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=38.13 cfs 94,705 cf

Reach DC2d: Downchute 2 Avg. Flow Depth=0.49' Max Vel=8.08 fps Inflow=45.46 cfs 111,665 cf
n=0.035 L=63.0' S=0.1119 '/' Capacity=572.26 cfs Outflow=45.46 cfs 111,665 cf

Reach DC3a: Downchute 3 Avg. Flow Depth=0.24' Max Vel=8.97 fps Inflow=22.11 cfs 57,881 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=22.11 cfs 57,881 cf

Reach DC3b: Downchute 3 Avg. Flow Depth=0.33' Max Vel=11.06 fps Inflow=38.78 cfs 90,954 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=38.77 cfs 90,954 cf

Reach DC3c: Downchute 3 Avg. Flow Depth=0.42' Max Vel=12.83 fps Inflow=58.19 cfs 129,416 cf
n=0.035 L=131.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=58.16 cfs 129,416 cf

Pond CUL1: Culvert 1 Peak Elev=1,486.98' Inflow=94.63 cfs 225,686 cf
36.0" Round Culvert x 2.00 n=0.013 L=122.0' S=0.0246 '/' Outflow=94.63 cfs 225,686 cf

Pond CUL5a: Culvert 5 Peak Elev=1,483.56' Inflow=6.04 cfs 12,100 cf
18.0" Round Culvert n=0.013 L=61.0' S=0.0328 '/' Outflow=6.04 cfs 12,100 cf

Pond CUL5b: Culvert 5 Peak Elev=1,483.63' Inflow=6.31 cfs 12,556 cf
18.0" Round Culvert n=0.013 L=54.0' S=0.0370 '/' Outflow=6.31 cfs 12,556 cf

Pond DCCUL3: Downchute Culvert 3 Peak Elev=1,487.36' Inflow=60.58 cfs 134,182 cf
30.0" Round Culvert x 2.00 n=0.013 L=56.0' S=0.0714 '/' Outflow=60.58 cfs 134,182 cf

Summary for Subcatchment 1: Subarea 1

Runoff = 38.12 cfs @ 11.98 hrs, Volume= 81,734 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	309,031	80	
	309,031		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.3	304	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.2	707	0.0300	5.34	21.34	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=1.00' Z= 2.0 '/' Top.W=6.00' n= 0.035
7.1	1,111	Total			

Summary for Subcatchment 2: Subarea 2

Runoff = 2.35 cfs @ 11.95 hrs, Volume= 4,504 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	17,031	80	
	17,031		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	74	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	174	Total			

Summary for Subcatchment 3: Subarea 3

Runoff = 1.87 cfs @ 11.92 hrs, Volume= 3,354 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	12,681	80	
	12,681		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	45	0.0100	0.79		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.0	21	0.3300	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.0	66	Total			

Summary for Subcatchment 4: Subarea 4

Runoff = 5.37 cfs @ 11.92 hrs, Volume= 9,646 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	36,469	80	
	36,469		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	33	0.0100	0.74		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.3	28	0.3300	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.0	61	Total			

Summary for Subcatchment 5: Subarea 5

Runoff = 5.75 cfs @ 11.93 hrs, Volume= 10,427 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	39,423	80	
	39,423		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	35	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.5	33	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.3	68	Total			

Summary for Subcatchment 16A: Subarea 16A

Runoff = 10.67 cfs @ 12.04 hrs, Volume= 27,782 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	105,043	80	Landfill
	105,043		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.8	151	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	137	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	435	0.0050	3.92	493.54	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=3.00' Z= 25.0 & 3.0 '/' Top.W=84.00' n= 0.035 Earth, dense weeds
12.7	823	Total			

Summary for Subcatchment 28: Subarea 28

Runoff = 2.65 cfs @ 11.95 hrs, Volume= 5,078 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	19,201	80	
	19,201		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	83	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.9	183	Total			

Summary for Subcatchment 29: Subarea 29

Runoff = 1.46 cfs @ 11.93 hrs, Volume= 2,629 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	9,939	80	
	9,939		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	19	0.3300	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.1	238	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
2.1	257	Total			

Summary for Subcatchment 30: Subarea 30

Runoff = 6.10 cfs @ 11.95 hrs, Volume= 11,881 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	44,923	80	
	44,923		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	53	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.6	269	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.4	422	Total			

Summary for Subcatchment 31: Subarea 31

Runoff = 4.77 cfs @ 11.96 hrs, Volume= 9,471 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	35,811	80	
	35,811		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	41	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
4.9	366	Total			

Summary for Subcatchment 32: Subarea 32

Runoff = 2.42 cfs @ 11.96 hrs, Volume= 4,765 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	18,017	80	
	18,017		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	41	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	133	0.0100	2.41	3.13	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=0.50' Z= 2.0 '/' Top.W=3.60' n= 0.030
4.7	274	Total			

Summary for Subcatchment 33: Subarea 33

Runoff = 6.31 cfs @ 11.96 hrs, Volume= 12,556 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	47,473	80	
	47,473		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	63	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.0	388	Total			

Summary for Subcatchment 46: Subarea 46

Runoff = 3.64 cfs @ 11.95 hrs, Volume= 7,014 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	26,521	80	
	26,521		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	61	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	88	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.1	249	Total			

Summary for Subcatchment 47: Subarea 47

Runoff = 7.13 cfs @ 11.95 hrs, Volume= 13,940 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	52,705	80	
	52,705		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	56	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	318	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.5	474	Total			

Summary for Subcatchment 48: Subarea 48

Runoff = 7.28 cfs @ 11.96 hrs, Volume= 14,287 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	54,019	80	
	54,019		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	51	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	360	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	511	Total			

Summary for Subcatchment 49: Subarea 49

Runoff = 12.19 cfs @ 11.96 hrs, Volume= 24,175 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	91,405	80	
	91,405		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	51	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	518	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.9	669	Total			

Summary for Subcatchment 58: Subarea 58

Runoff = 3.73 cfs @ 12.01 hrs, Volume= 8,673 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	32,792	80	
	32,792		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	20	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	124	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	129	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
9.4	373	Total			

Summary for Subcatchment 59: Subarea 59

Runoff = 7.46 cfs @ 12.01 hrs, Volume= 17,220 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	65,108	80	
	65,108		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0	80	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.0	20	0.3300	0.33		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	92	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	367	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
9.2	559	Total			

Summary for Subcatchment 60: Subarea 60

Runoff = 7.28 cfs @ 11.96 hrs, Volume= 14,287 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	54,019	80	
	54,019		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	51	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	360	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	511	Total			

Summary for Subcatchment 61: Subarea 61

Runoff = 9.57 cfs @ 11.96 hrs, Volume= 18,785 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	71,026	80	
	71,026		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	51	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	382	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	533	Total			

Summary for Subcatchment 69: Subarea 69

Runoff = 4.00 cfs @ 12.01 hrs, Volume= 9,299 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	35,160	80	
	35,160		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	47	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	370	0.0400	8.14	256.49	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 & 25.0 '/' Top.W=42.00' n= 0.030
9.4	517	Total			

Summary for Subcatchment 70: Subarea 70

Runoff = 15.58 cfs @ 12.03 hrs, Volume= 38,558 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	145,786	80	
	145,786		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.9	161	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	422	0.0400	8.14	256.49	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 & 25.0 '/' Top.W=42.00' n= 0.030
11.2	683	Total			

Summary for Subcatchment 71: Subarea 71

Runoff = 13.77 cfs @ 12.03 hrs, Volume= 34,443 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	130,226	80	
	130,226		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.9	157	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	86	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	360	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
11.5	703	Total			

Summary for Subcatchment 72: Subarea 72

Runoff = 13.02 cfs @ 11.93 hrs, Volume= 23,438 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	88,619	80	
	88,619		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	10	0.0400	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.8	402	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.1	412	Total			

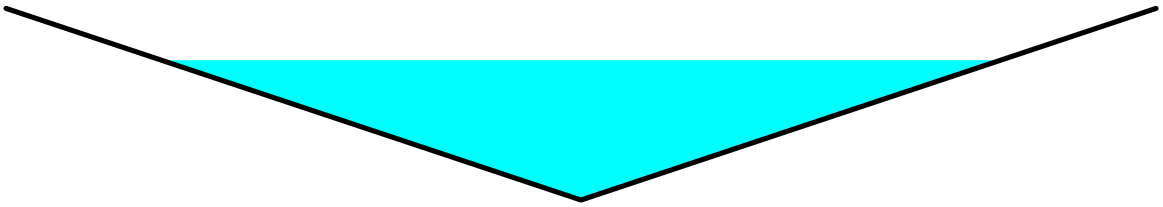
Summary for Reach CH1a: Channel 1

Inflow Area = 865,982 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 95.67 cfs @ 11.99 hrs, Volume= 229,040 cf
Outflow = 95.38 cfs @ 11.99 hrs, Volume= 229,040 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.73 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.31 fps, Avg. Travel Time= 1.7 min

Peak Storage= 3,324 cf @ 11.99 hrs
Average Depth at Peak Storage= 2.92'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 130.0' Slope= 0.0050 '/'
Inlet Invert= 1,480.00', Outlet Invert= 1,479.35'



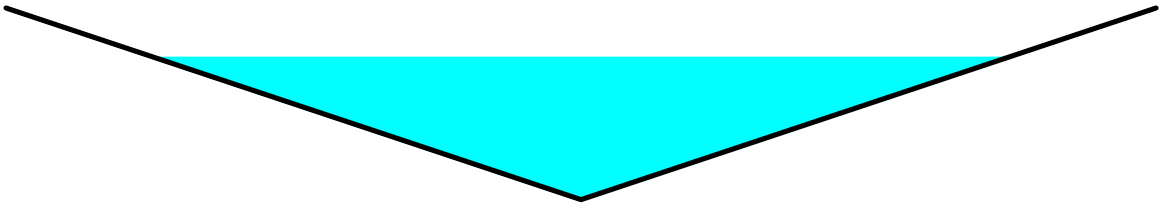
Summary for Reach CH1b: Channel 1

Inflow Area = 948,201 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 103.35 cfs @ 11.99 hrs, Volume= 250,785 cf
Outflow = 101.23 cfs @ 12.01 hrs, Volume= 250,785 cf, Atten= 2%, Lag= 1.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.78 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.25 fps, Avg. Travel Time= 4.8 min

Peak Storage= 9,572 cf @ 12.01 hrs
Average Depth at Peak Storage= 2.99'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 358.0' Slope= 0.0050 '/'
Inlet Invert= 1,479.35', Outlet Invert= 1,477.56'



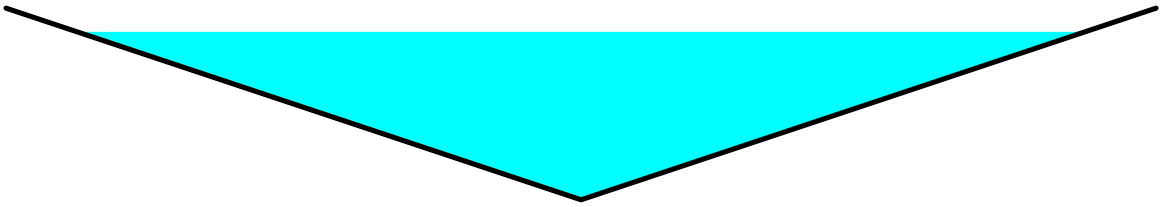
Summary for Reach CH1c: Channel 1

Inflow Area = 1,455,532 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 155.77 cfs @ 11.98 hrs, Volume= 384,967 cf
Outflow = 155.59 cfs @ 11.99 hrs, Volume= 384,967 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.22 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 1.1 min

Peak Storage= 3,396 cf @ 11.99 hrs
Average Depth at Peak Storage= 3.51'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 92.0' Slope= 0.0050 '/'
Inlet Invert= 1,477.56', Outlet Invert= 1,477.10'



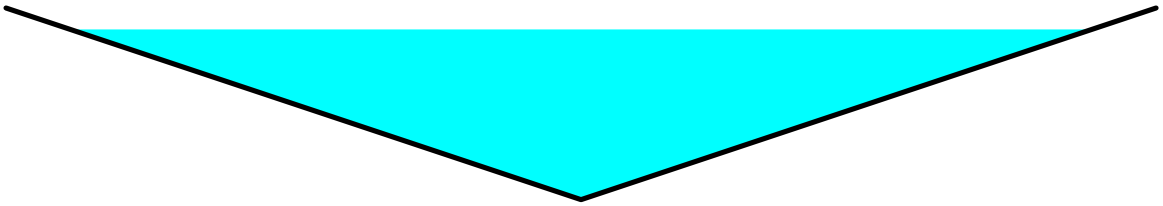
Summary for Reach CH1d: Channel 1

Inflow Area = 1,542,428 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 165.12 cfs @ 11.98 hrs, Volume= 407,950 cf
Outflow = 160.94 cfs @ 12.00 hrs, Volume= 407,950 cf, Atten= 3%, Lag= 1.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.25 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 1.33 fps, Avg. Travel Time= 5.6 min

Peak Storage= 17,036 cf @ 12.00 hrs
Average Depth at Peak Storage= 3.55'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 450.0' Slope= 0.0050 '/'
Inlet Invert= 1,477.10', Outlet Invert= 1,474.85'



Summary for Reach DC1: Downchute 1

Inflow Area = 414,074 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 47.38 cfs @ 11.99 hrs, Volume= 109,517 cf
Outflow = 47.37 cfs @ 11.99 hrs, Volume= 109,517 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 12.72 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.87 fps, Avg. Travel Time= 1.0 min

Peak Storage= 648 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 1.00' Flow Area= 10.0 sf, Capacity= 210.50 cfs

8.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 12.00'
Length= 174.0' Slope= 0.3300 '/'
Inlet Invert= 1,540.42', Outlet Invert= 1,483.00'

‡

Summary for Reach DC2a: Downchute 2

Inflow Area = 180,946 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 19.50 cfs @ 12.02 hrs, Volume= 47,858 cf
Outflow = 19.49 cfs @ 12.03 hrs, Volume= 47,858 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 8.55 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.97 fps, Avg. Travel Time= 1.3 min

Peak Storage= 342 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 150.0' Slope= 0.3300 '/'
Inlet Invert= 1,643.17', Outlet Invert= 1,593.67'

‡

Summary for Reach DC2b: Downchute 2

Inflow Area = 278,846 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 30.52 cfs @ 12.02 hrs, Volume= 73,751 cf
Outflow = 30.52 cfs @ 12.02 hrs, Volume= 73,751 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 10.12 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.29 fps, Avg. Travel Time= 1.1 min

Peak Storage= 452 cf @ 12.02 hrs
Average Depth at Peak Storage= 0.29'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 150.0' Slope= 0.3300 '/'
Inlet Invert= 1,593.67', Outlet Invert= 1,544.17'

‡

Summary for Reach DC2c: Downchute 2

Inflow Area = 358,072 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 38.15 cfs @ 12.00 hrs, Volume= 94,705 cf
Outflow = 38.13 cfs @ 12.00 hrs, Volume= 94,705 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 11.00 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.51 fps, Avg. Travel Time= 1.1 min

Peak Storage= 569 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 164.0' Slope= 0.3300 '/'
Inlet Invert= 1,544.17', Outlet Invert= 1,490.05'

‡

Summary for Reach DC2d: Downchute 2

Inflow Area = 422,196 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 45.46 cfs @ 11.98 hrs, Volume= 111,665 cf
Outflow = 45.46 cfs @ 11.99 hrs, Volume= 111,665 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 8.08 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.94 fps, Avg. Travel Time= 0.5 min

Peak Storage= 354 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 2.00' Flow Area= 32.0 sf, Capacity= 572.26 cfs

10.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 63.0' Slope= 0.1119 '/'
Inlet Invert= 1,490.05', Outlet Invert= 1,483.00'

‡

Summary for Reach DC3a: Downchute 3

Inflow Area = 218,845 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 22.11 cfs @ 11.94 hrs, Volume= 57,881 cf
Outflow = 22.11 cfs @ 11.94 hrs, Volume= 57,881 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 8.97 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.10 fps, Avg. Travel Time= 1.2 min

Peak Storage= 372 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,626.89', Outlet Invert= 1,577.06'

‡

Summary for Reach DC3b: Downchute 3

Inflow Area = 343,890 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 38.78 cfs @ 11.95 hrs, Volume= 90,954 cf
Outflow = 38.77 cfs @ 11.95 hrs, Volume= 90,954 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 11.06 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.47 fps, Avg. Travel Time= 1.0 min

Peak Storage= 529 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,577.06', Outlet Invert= 1,527.23'

‡

Summary for Reach DC3c: Downchute 3

Inflow Area = 489,314 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 58.19 cfs @ 11.95 hrs, Volume= 129,416 cf
Outflow = 58.16 cfs @ 11.96 hrs, Volume= 129,416 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 12.83 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.81 fps, Avg. Travel Time= 0.8 min

Peak Storage= 594 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 131.0' Slope= 0.3300 '/'
Inlet Invert= 1,527.23', Outlet Invert= 1,484.00'

‡

Summary for Pond CUL1: Culvert 1

Inflow Area = 853,301 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 94.63 cfs @ 11.99 hrs, Volume= 225,686 cf
Outflow = 94.63 cfs @ 11.99 hrs, Volume= 225,686 cf, Atten= 0%, Lag= 0.0 min
Primary = 94.63 cfs @ 11.99 hrs, Volume= 225,686 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,486.98' @ 11.99 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,483.00'	**36.0" Round Culvert X 2.00** L= 122.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,483.00' / 1,480.00' S= 0.0246 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=94.57 cfs @ 11.99 hrs HW=1,486.98' TW=1,482.92' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 94.57 cfs @ 6.69 fps)

Summary for Pond CUL5a: Culvert 5

Inflow Area = 45,750 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 6.04 cfs @ 11.95 hrs, Volume= 12,100 cf
Outflow = 6.04 cfs @ 11.95 hrs, Volume= 12,100 cf, Atten= 0%, Lag= 0.0 min
Primary = 6.04 cfs @ 11.95 hrs, Volume= 12,100 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,483.56' @ 11.95 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 61.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,480.00' S= 0.0328 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=6.04 cfs @ 11.95 hrs HW=1,483.56' TW=1,482.15' (Dynamic Tailwater)
1=Culvert (Inlet Controls 6.04 cfs @ 3.42 fps)

Summary for Pond CUL5b: Culvert 5

Inflow Area = 47,473 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 6.31 cfs @ 11.96 hrs, Volume= 12,556 cf
Outflow = 6.31 cfs @ 11.96 hrs, Volume= 12,556 cf, Atten= 0%, Lag= 0.0 min
Primary = 6.31 cfs @ 11.96 hrs, Volume= 12,556 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,483.63' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 54.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,480.00' S= 0.0370 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=6.30 cfs @ 11.96 hrs HW=1,483.63' TW=1,480.52' (Dynamic Tailwater)
1=Culvert (Inlet Controls 6.30 cfs @ 3.57 fps)

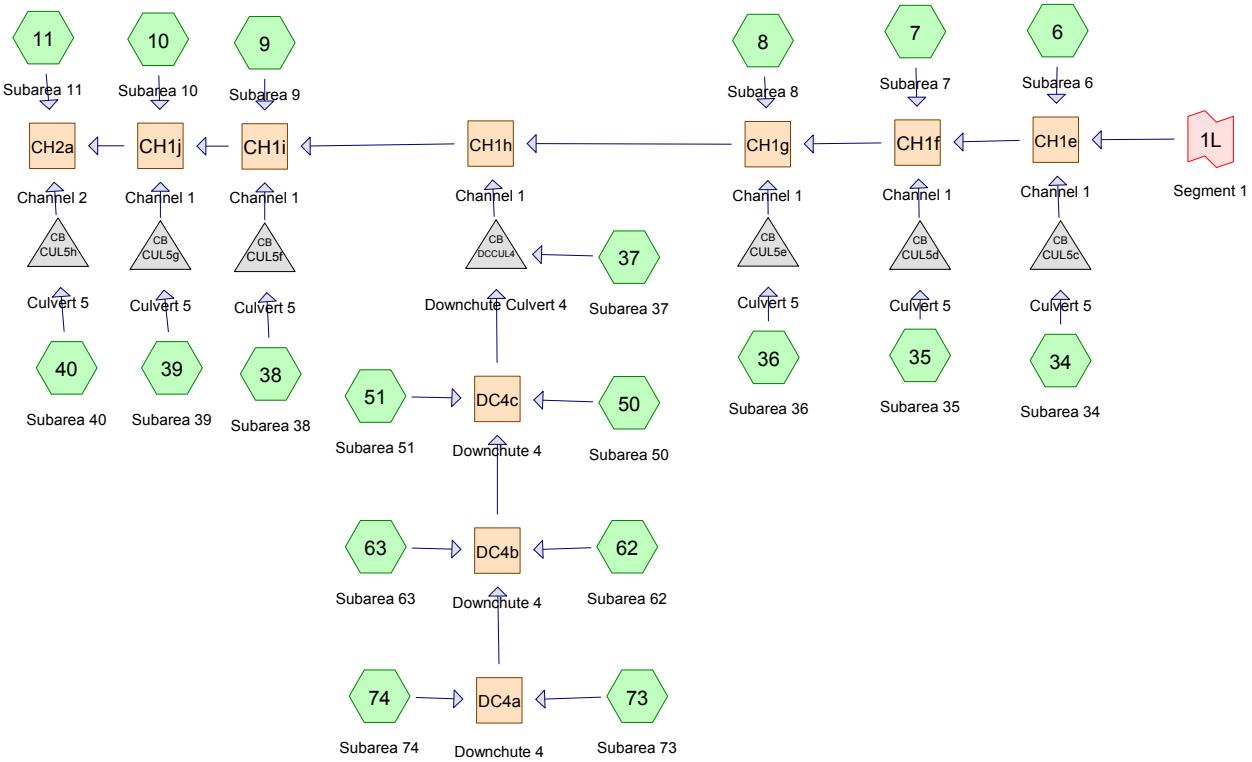
Summary for Pond DCCUL3: Downchute Culvert 3

Inflow Area = 507,331 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 60.58 cfs @ 11.96 hrs, Volume= 134,182 cf
Outflow = 60.58 cfs @ 11.96 hrs, Volume= 134,182 cf, Atten= 0%, Lag= 0.0 min
Primary = 60.58 cfs @ 11.96 hrs, Volume= 134,182 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,487.36' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,484.00'	**30.0" Round Culvert X 2.00** L= 56.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,484.00' / 1,480.00' S= 0.0714 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=60.47 cfs @ 11.96 hrs HW=1,487.35' TW=1,481.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 60.47 cfs @ 6.16 fps)



Subcat Reach Pond Link

Routing Diagram for Southern Expansion Segment 2
Prepared by Tetra Tech Inc, Printed 5/4/2020
HydroCAD® 10.00-24 s/n 04483 © 2018 HydroCAD Software Solutions LLC

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 6: Subarea 6 Runoff Area=51,457 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=74' Tc=2.5 min CN=80 Runoff=1.19 cfs 2,155 cf

Subcatchment 7: Subarea 7 Runoff Area=40,492 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=83' Tc=2.8 min CN=80 Runoff=0.93 cfs 1,696 cf

Subcatchment 8: Subarea 8 Runoff Area=52,508 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=88' Tc=2.9 min CN=80 Runoff=1.20 cfs 2,199 cf

Subcatchment 9: Subarea 9 Runoff Area=53,327 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=95' Tc=3.2 min CN=80 Runoff=1.20 cfs 2,233 cf

Subcatchment 10: Subarea 10 Runoff Area=56,707 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=101' Tc=3.4 min CN=80 Runoff=1.27 cfs 2,375 cf

Subcatchment 11: Subarea 11 Runoff Area=64,217 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=111' Tc=3.4 min CN=80 Runoff=1.43 cfs 2,689 cf

Subcatchment 34: Subarea 34 Runoff Area=82,684 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=388' Tc=5.0 min CN=80 Runoff=1.73 cfs 3,463 cf

Subcatchment 35: Subarea 35 Runoff Area=43,693 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=362' Tc=4.8 min CN=80 Runoff=0.92 cfs 1,830 cf

Subcatchment 36: Subarea 36 Runoff Area=69,648 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=362' Tc=4.8 min CN=80 Runoff=1.47 cfs 2,917 cf

Subcatchment 37: Subarea 37 Runoff Area=21,353 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=298' Tc=4.8 min CN=80 Runoff=0.45 cfs 894 cf

Subcatchment 38: Subarea 38 Runoff Area=47,365 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=394' Tc=5.0 min CN=80 Runoff=0.99 cfs 1,984 cf

Subcatchment 39: Subarea 39 Runoff Area=74,592 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=425' Tc=5.1 min CN=80 Runoff=1.55 cfs 3,124 cf

Subcatchment 40: Subarea 40 Runoff Area=68,641 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=427' Tc=5.1 min CN=80 Runoff=1.43 cfs 2,875 cf

Subcatchment 50: Subarea 50 Runoff Area=81,531 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=799' Tc=5.3 min CN=80 Runoff=1.68 cfs 3,415 cf

Subcatchment 51: Subarea 51 Runoff Area=77,602 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=718' Tc=4.9 min CN=80 Runoff=1.63 cfs 3,250 cf

Subcatchment 62: Subarea 62 Runoff Area=61,153 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=663' Tc=5.0 min CN=80 Runoff=1.28 cfs 2,561 cf

Subcatchment 63: Subarea 63 Runoff Area=60,504 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=636' Tc=4.9 min CN=80 Runoff=1.27 cfs 2,534 cf

Subcatchment 73: Subarea 73 Runoff Area=63,671 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=346' Tc=1.3 min CN=80 Runoff=1.55 cfs 2,667 cf

Subcatchment 74: Subarea 74 Runoff Area=64,300 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=352' Tc=1.3 min CN=80 Runoff=1.56 cfs 2,693 cf

Reach CH1e: Channel 1 Avg. Flow Depth=1.64' Max Vel=2.54 fps Inflow=22.52 cfs 70,215 cf
n=0.035 L=595.0' S=0.0050 '/' Capacity=220.67 cfs Outflow=20.48 cfs 70,215 cf

Reach CH1f: Channel 1 Avg. Flow Depth=1.64' Max Vel=2.54 fps Inflow=20.87 cfs 73,741 cf
n=0.035 L=328.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=20.39 cfs 73,741 cf

Reach CH1g: Channel 1 Avg. Flow Depth=1.64' Max Vel=2.53 fps Inflow=20.88 cfs 78,857 cf
n=0.035 L=373.0' S=0.0050 '/' Capacity=220.56 cfs Outflow=20.36 cfs 78,857 cf

Reach CH1h: Channel 1 Avg. Flow Depth=1.68' Max Vel=2.59 fps Inflow=22.04 cfs 96,870 cf
n=0.035 L=78.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=22.02 cfs 96,870 cf

Reach CH1i: Channel 1 Avg. Flow Depth=1.68' Max Vel=2.58 fps Inflow=22.38 cfs 101,087 cf
n=0.035 L=452.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=21.99 cfs 101,087 cf

Reach CH1j: Channel 1 Avg. Flow Depth=1.68' Max Vel=2.58 fps Inflow=22.43 cfs 106,586 cf
n=0.035 L=613.0' S=0.0050 '/' Capacity=220.68 cfs Outflow=21.85 cfs 106,586 cf

Reach CH2a: Channel 2 Avg. Flow Depth=1.58' Max Vel=2.93 fps Inflow=22.27 cfs 112,150 cf
n=0.035 L=450.0' S=0.0070 '/' Capacity=261.32 cfs Outflow=22.03 cfs 112,150 cf

Reach DC4a: Downchute 4 Avg. Flow Depth=0.07' Max Vel=4.19 fps Inflow=3.11 cfs 5,359 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=3.07 cfs 5,359 cf

Reach DC4b: Downchute 4 Avg. Flow Depth=0.10' Max Vel=5.15 fps Inflow=5.25 cfs 10,455 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=5.23 cfs 10,455 cf

Reach DC4c: Downchute 4 Avg. Flow Depth=0.13' Max Vel=6.19 fps Inflow=8.39 cfs 17,119 cf
n=0.035 L=140.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=8.38 cfs 17,119 cf

Pond CUL5c: Culvert 5 Peak Elev=1,482.68' Inflow=1.73 cfs 3,463 cf
18.0" Round Culvert n=0.013 L=55.0' S=0.0364 '/' Outflow=1.73 cfs 3,463 cf

Pond CUL5d: Culvert 5 Peak Elev=1,482.48' Inflow=0.92 cfs 1,830 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0500 '/' Outflow=0.92 cfs 1,830 cf

Pond CUL5e: Culvert 5 Peak Elev=1,482.62' Inflow=1.47 cfs 2,917 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0500 '/' Outflow=1.47 cfs 2,917 cf

Pond CUL5f: Culvert 5 Peak Elev=1,482.50' Inflow=0.99 cfs 1,984 cf
18.0" Round Culvert n=0.013 L=56.0' S=0.0536 '/' Outflow=0.99 cfs 1,984 cf

Pond CUL5g: Culvert 5 Peak Elev=1,482.64' Inflow=1.55 cfs 3,124 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0667 '/' Outflow=1.55 cfs 3,124 cf

Pond CUL5h: Culvert 5 Peak Elev=1,482.61' Inflow=1.43 cfs 2,875 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0667 '/' Outflow=1.43 cfs 2,875 cf

Pond DCCUL4: Downchute Culvert 4 Peak Elev=1,484.89' Inflow=8.82 cfs 18,013 cf
30.0" Round Culvert x 2.00 n=0.013 L=53.0' S=0.0943 '/' Outflow=8.82 cfs 18,013 cf

Link 1 Year Storm Outflow Imported from Southern Expansion Segment 1~Reach CH1d.hce Inflow=21.25 cfs 64,597 cf
Area= 1,542,428 sf Primary=21.25 cfs 64,597 cf

Summary for Subcatchment 6: Subarea 6

Runoff = 1.19 cfs @ 11.94 hrs, Volume= 2,155 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	51,457	80	
	51,457		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.7	38	0.3300	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.5	74	Total			

Summary for Subcatchment 7: Subarea 7

Runoff = 0.93 cfs @ 11.94 hrs, Volume= 1,696 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	40,492	80	
	40,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.0	47	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.8	83	Total			

Summary for Subcatchment 8: Subarea 8

Runoff = 1.20 cfs @ 11.94 hrs, Volume= 2,199 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	52,508	80	
	52,508		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.1	52	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.9	88	Total			

Summary for Subcatchment 9: Subarea 9

Runoff = 1.20 cfs @ 11.95 hrs, Volume= 2,233 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	53,327	80	
	53,327		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.4	59	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
3.2	95	Total			

Summary for Subcatchment 10: Subarea 10

Runoff = 1.27 cfs @ 11.95 hrs, Volume= 2,375 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	56,707	80	
	56,707		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	32	0.0100	0.73		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.7	68	0.3300	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.0	1	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.4	101	Total			

Summary for Subcatchment 11: Subarea 11

Runoff = 1.43 cfs @ 11.95 hrs, Volume= 2,689 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	64,217	80	
	64,217		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	32	0.0100	0.73		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.7	68	0.3300	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.0	11	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.4	111	Total			

Summary for Subcatchment 34: Subarea 34

Runoff = 1.73 cfs @ 11.97 hrs, Volume= 3,463 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	82,684	80	
	82,684		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	63	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.0	388	Total			

Summary for Subcatchment 35: Subarea 35

Runoff = 0.92 cfs @ 11.97 hrs, Volume= 1,830 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	43,693	80	
	43,693		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	98	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	164	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
4.8	362	Total			

Summary for Subcatchment 36: Subarea 36

Runoff = 1.47 cfs @ 11.97 hrs, Volume= 2,917 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	69,648	80	
	69,648		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	98	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	164	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
4.8	362	Total			

Summary for Subcatchment 37: Subarea 37

Runoff = 0.45 cfs @ 11.97 hrs, Volume= 894 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	21,353	80	
	21,353		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	50	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	148	0.0100	2.41	3.13	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=0.50' Z= 2.0 '/' Top.W=3.60' n= 0.030
4.8	298	Total			

Summary for Subcatchment 38: Subarea 38

Runoff = 0.99 cfs @ 11.97 hrs, Volume= 1,984 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	47,365	80	
	47,365		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	69	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.0	394	Total			

Summary for Subcatchment 39: Subarea 39

Runoff = 1.55 cfs @ 11.97 hrs, Volume= 3,124 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	74,592	80	
	74,592		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	98	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	227	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.1	425	Total			

Summary for Subcatchment 40: Subarea 40

Runoff = 1.43 cfs @ 11.97 hrs, Volume= 2,875 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	68,641	80	
	68,641		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	98	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	229	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.1	427	Total			

Summary for Subcatchment 50: Subarea 50

Runoff = 1.68 cfs @ 11.97 hrs, Volume= 3,415 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	81,531	80	
	81,531		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	91	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.3	608	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
5.3	799	Total			

Summary for Subcatchment 51: Subarea 51

Runoff = 1.63 cfs @ 11.97 hrs, Volume= 3,250 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	77,602	80	
	77,602		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.1	36	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	582	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.9	718	Total			

Summary for Subcatchment 62: Subarea 62

Runoff = 1.28 cfs @ 11.97 hrs, Volume= 2,561 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	61,153	80	
	61,153		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	91	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	472	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
5.0	663	Total			

Summary for Subcatchment 63: Subarea 63

Runoff = 1.27 cfs @ 11.97 hrs, Volume= 2,534 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	60,504	80	
	60,504		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	73	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	463	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.9	636	Total			

Summary for Subcatchment 73: Subarea 73

Runoff = 1.55 cfs @ 11.92 hrs, Volume= 2,667 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	63,671	80	
	63,671		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	10	0.3300	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.7	336	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
1.3	346	Total			

Summary for Subcatchment 74: Subarea 74

Runoff = 1.56 cfs @ 11.92 hrs, Volume= 2,693 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	64,300	80	
	64,300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	10	0.3300	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.7	342	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
1.3	352	Total			

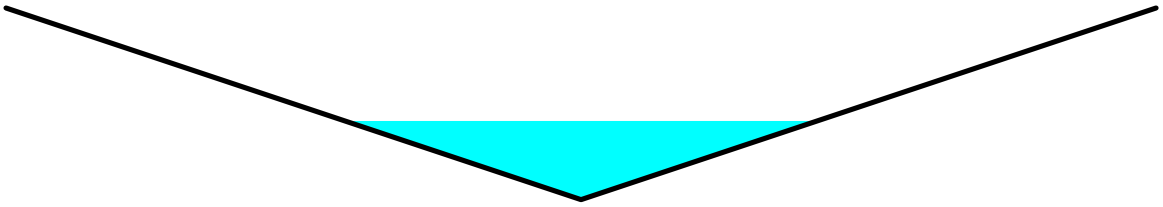
Summary for Reach CH1e: Channel 1

Inflow Area = 1,676,569 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 22.52 cfs @ 12.04 hrs, Volume= 70,215 cf
Outflow = 20.48 cfs @ 12.09 hrs, Volume= 70,215 cf, Atten= 9%, Lag= 3.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.54 fps, Min. Travel Time= 3.9 min
Avg. Velocity = 0.90 fps, Avg. Travel Time= 11.0 min

Peak Storage= 4,802 cf @ 12.09 hrs
Average Depth at Peak Storage= 1.64'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.67 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 595.0' Slope= 0.0050 '/'
Inlet Invert= 1,474.85', Outlet Invert= 1,471.88'



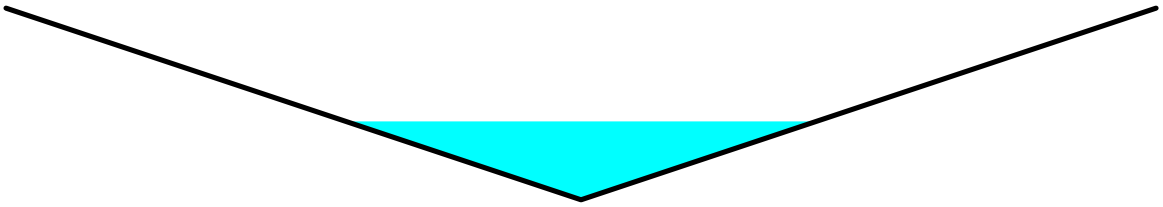
Summary for Reach CH1f: Channel 1

Inflow Area = 1,760,754 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 20.87 cfs @ 12.09 hrs, Volume= 73,741 cf
Outflow = 20.39 cfs @ 12.12 hrs, Volume= 73,741 cf, Atten= 2%, Lag= 1.8 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.54 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.90 fps, Avg. Travel Time= 6.1 min

Peak Storage= 2,637 cf @ 12.12 hrs
Average Depth at Peak Storage= 1.64'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 328.0' Slope= 0.0050 '/'
Inlet Invert= 1,471.88', Outlet Invert= 1,470.24'



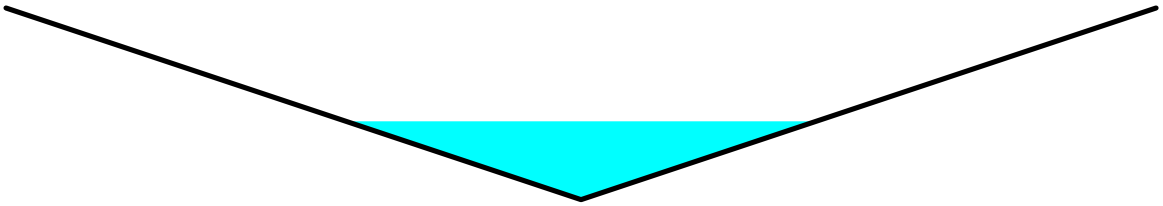
Summary for Reach CH1g: Channel 1

Inflow Area = 1,882,910 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 20.88 cfs @ 12.11 hrs, Volume= 78,857 cf
Outflow = 20.36 cfs @ 12.15 hrs, Volume= 78,857 cf, Atten= 3%, Lag= 2.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.53 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 0.89 fps, Avg. Travel Time= 7.0 min

Peak Storage= 2,998 cf @ 12.15 hrs
Average Depth at Peak Storage= 1.64'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.56 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 373.0' Slope= 0.0050 '/'
Inlet Invert= 1,470.24', Outlet Invert= 1,468.38'



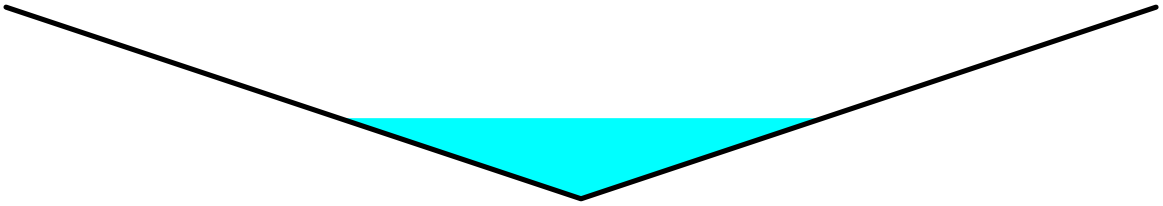
Summary for Reach CH1h: Channel 1

Inflow Area = 2,313,024 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 22.04 cfs @ 12.14 hrs, Volume= 96,870 cf
Outflow = 22.02 cfs @ 12.15 hrs, Volume= 96,870 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.59 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 0.94 fps, Avg. Travel Time= 1.4 min

Peak Storage= 664 cf @ 12.15 hrs
Average Depth at Peak Storage= 1.68'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 78.0' Slope= 0.0050 '/'
Inlet Invert= 1,468.38', Outlet Invert= 1,467.99'



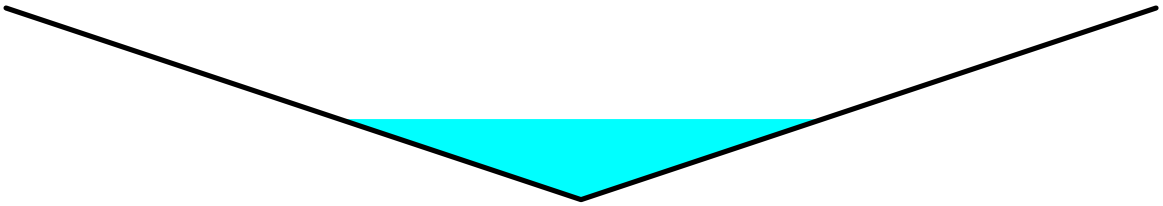
Summary for Reach CH1i: Channel 1

Inflow Area = 2,413,716 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 22.38 cfs @ 12.14 hrs, Volume= 101,087 cf
Outflow = 21.99 cfs @ 12.18 hrs, Volume= 101,087 cf, Atten= 2%, Lag= 1.9 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.58 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 0.92 fps, Avg. Travel Time= 8.2 min

Peak Storage= 3,845 cf @ 12.18 hrs
Average Depth at Peak Storage= 1.68'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 452.0' Slope= 0.0050 '/'
Inlet Invert= 1,467.99', Outlet Invert= 1,465.73'



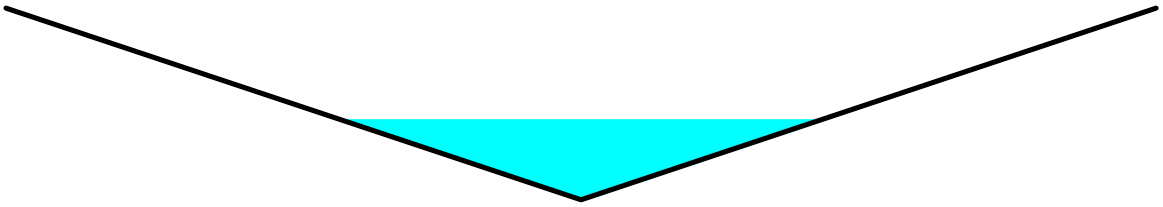
Summary for Reach CH1j: Channel 1

Inflow Area = 2,545,015 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 22.43 cfs @ 12.17 hrs, Volume= 106,586 cf
Outflow = 21.85 cfs @ 12.22 hrs, Volume= 106,586 cf, Atten= 3%, Lag= 2.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.58 fps, Min. Travel Time= 4.0 min
Avg. Velocity = 0.90 fps, Avg. Travel Time= 11.4 min

Peak Storage= 5,194 cf @ 12.22 hrs
Average Depth at Peak Storage= 1.68'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.68 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 613.0' Slope= 0.0050 '/'
Inlet Invert= 1,465.73', Outlet Invert= 1,462.67'



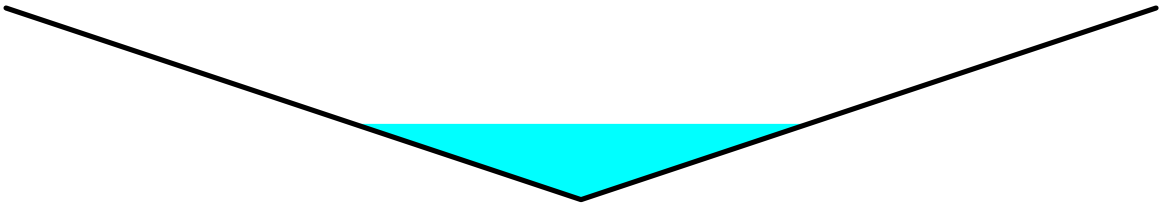
Summary for Reach CH2a: Channel 2

Inflow Area = 2,677,873 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 22.27 cfs @ 12.22 hrs, Volume= 112,150 cf
Outflow = 22.03 cfs @ 12.25 hrs, Volume= 112,150 cf, Atten= 1%, Lag= 1.8 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.93 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 1.02 fps, Avg. Travel Time= 7.3 min

Peak Storage= 3,379 cf @ 12.25 hrs
Average Depth at Peak Storage= 1.58'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 261.32 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 450.0' Slope= 0.0070 '/'
Inlet Invert= 1,462.67', Outlet Invert= 1,459.52'



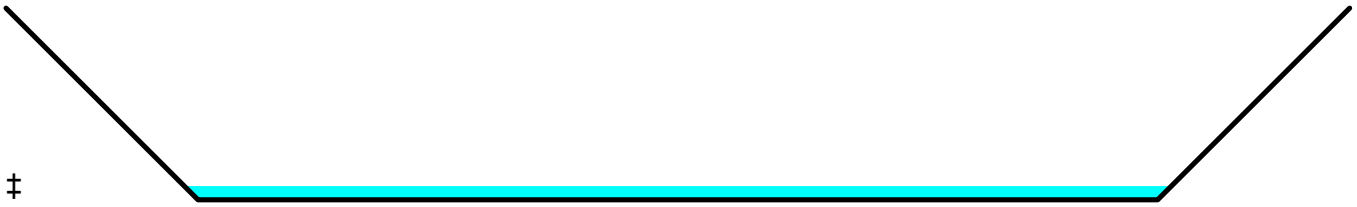
Summary for Reach DC4a: Downchute 4

Inflow Area = 127,971 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 3.11 cfs @ 11.92 hrs, Volume= 5,359 cf
Outflow = 3.07 cfs @ 11.93 hrs, Volume= 5,359 cf, Atten= 1%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.19 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.23 fps, Avg. Travel Time= 2.1 min

Peak Storage= 111 cf @ 11.93 hrs
Average Depth at Peak Storage= 0.07'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,629.86', Outlet Invert= 1,580.03'



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Summary for Reach DC4b: Downchute 4

Inflow Area = 249,628 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 5.25 cfs @ 11.94 hrs, Volume= 10,455 cf
Outflow = 5.23 cfs @ 11.95 hrs, Volume= 10,455 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.15 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 1.8 min

Peak Storage= 153 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,580.03', Outlet Invert= 1,530.20'

‡

Summary for Reach DC4c: Downchute 4

Inflow Area = 408,761 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 8.39 cfs @ 11.96 hrs, Volume= 17,119 cf
Outflow = 8.38 cfs @ 11.96 hrs, Volume= 17,119 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.19 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.59 fps, Avg. Travel Time= 1.5 min

Peak Storage= 189 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 140.0' Slope= 0.3300 '/'
Inlet Invert= 1,530.20', Outlet Invert= 1,484.00'

‡

Summary for Pond CUL5c: Culvert 5

Inflow Area = 82,684 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 1.73 cfs @ 11.97 hrs, Volume= 3,463 cf
Outflow = 1.73 cfs @ 11.97 hrs, Volume= 3,463 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.73 cfs @ 11.97 hrs, Volume= 3,463 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 1,482.68' @ 11.97 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 55.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,480.00' S= 0.0364 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=1.73 cfs @ 11.97 hrs HW=1,482.68' TW=1,476.13' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 1.73 cfs @ 2.22 fps)

Summary for Pond CUL5d: Culvert 5

Inflow Area = 43,693 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 0.92 cfs @ 11.97 hrs, Volume= 1,830 cf
Outflow = 0.92 cfs @ 11.97 hrs, Volume= 1,830 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.92 cfs @ 11.97 hrs, Volume= 1,830 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.48' @ 11.97 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,479.00' S= 0.0500 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=0.92 cfs @ 11.97 hrs HW=1,482.48' TW=1,473.05' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 0.92 cfs @ 1.87 fps)

Summary for Pond CUL5e: Culvert 5

Inflow Area = 69,648 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 1.47 cfs @ 11.97 hrs, Volume= 2,917 cf
Outflow = 1.47 cfs @ 11.97 hrs, Volume= 2,917 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.47 cfs @ 11.97 hrs, Volume= 2,917 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.62' @ 11.97 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,479.00' S= 0.0500 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=1.46 cfs @ 11.97 hrs HW=1,482.62' TW=1,471.35' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 1.46 cfs @ 2.12 fps)

Summary for Pond CUL5f: Culvert 5

Inflow Area = 47,365 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 0.99 cfs @ 11.97 hrs, Volume= 1,984 cf
Outflow = 0.99 cfs @ 11.97 hrs, Volume= 1,984 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.99 cfs @ 11.97 hrs, Volume= 1,984 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.50' @ 11.97 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 56.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,479.00' S= 0.0536 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=0.99 cfs @ 11.97 hrs HW=1,482.50' TW=1,469.37' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.99 cfs @ 1.90 fps)

Summary for Pond CUL5g: Culvert 5

Inflow Area = 74,592 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 1.55 cfs @ 11.97 hrs, Volume= 3,124 cf
Outflow = 1.55 cfs @ 11.97 hrs, Volume= 3,124 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.55 cfs @ 11.97 hrs, Volume= 3,124 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.64' @ 11.97 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,478.00' S= 0.0667 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=1.55 cfs @ 11.97 hrs HW=1,482.64' TW=1,466.94' (Dynamic Tailwater)
1=Culvert (Inlet Controls 1.55 cfs @ 2.15 fps)

Summary for Pond CUL5h: Culvert 5

Inflow Area = 68,641 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 1.43 cfs @ 11.97 hrs, Volume= 2,875 cf
Outflow = 1.43 cfs @ 11.97 hrs, Volume= 2,875 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.43 cfs @ 11.97 hrs, Volume= 2,875 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.61' @ 11.97 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,478.00' S= 0.0667 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=1.42 cfs @ 11.97 hrs HW=1,482.61' TW=1,463.74' (Dynamic Tailwater)
1=Culvert (Inlet Controls 1.42 cfs @ 2.10 fps)

Summary for Pond DCCUL4: Downchute Culvert 4

Inflow Area = 430,114 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 8.82 cfs @ 11.96 hrs, Volume= 18,013 cf
Outflow = 8.82 cfs @ 11.96 hrs, Volume= 18,013 cf, Atten= 0%, Lag= 0.0 min
Primary = 8.82 cfs @ 11.96 hrs, Volume= 18,013 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,484.89' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,484.00'	**30.0" Round Culvert X 2.00** L= 53.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,484.00' / 1,479.00' S= 0.0943 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=8.82 cfs @ 11.96 hrs HW=1,484.89' TW=1,469.83' (Dynamic Tailwater)
1=Culvert (Inlet Controls 8.82 cfs @ 2.83 fps)

Summary for Link 1L: Segment 1

Inflow Area = 1,542,428 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 21.25 cfs @ 12.05 hrs, Volume= 64,597 cf
Primary = 21.25 cfs @ 12.05 hrs, Volume= 64,597 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

1 Year Storm Outflow Imported from Southern Expansion Segment 1~Reach CH1d.hce

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 6: Subarea 6 Runoff Area=51,457 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=74' Tc=2.5 min CN=80 Runoff=3.35 cfs 5,946 cf

Subcatchment 7: Subarea 7 Runoff Area=40,492 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=83' Tc=2.8 min CN=80 Runoff=2.61 cfs 4,679 cf

Subcatchment 8: Subarea 8 Runoff Area=52,508 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=88' Tc=2.9 min CN=80 Runoff=3.37 cfs 6,067 cf

Subcatchment 9: Subarea 9 Runoff Area=53,327 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=95' Tc=3.2 min CN=80 Runoff=3.38 cfs 6,162 cf

Subcatchment 10: Subarea 10 Runoff Area=56,707 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=101' Tc=3.4 min CN=80 Runoff=3.57 cfs 6,552 cf

Subcatchment 11: Subarea 11 Runoff Area=64,217 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=111' Tc=3.4 min CN=80 Runoff=4.04 cfs 7,420 cf

Subcatchment 34: Subarea 34 Runoff Area=82,684 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=388' Tc=5.0 min CN=80 Runoff=4.90 cfs 9,554 cf

Subcatchment 35: Subarea 35 Runoff Area=43,693 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=362' Tc=4.8 min CN=80 Runoff=2.61 cfs 5,049 cf

Subcatchment 36: Subarea 36 Runoff Area=69,648 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=362' Tc=4.8 min CN=80 Runoff=4.16 cfs 8,048 cf

Subcatchment 37: Subarea 37 Runoff Area=21,353 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=298' Tc=4.8 min CN=80 Runoff=1.28 cfs 2,467 cf

Subcatchment 38: Subarea 38 Runoff Area=47,365 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=394' Tc=5.0 min CN=80 Runoff=2.81 cfs 5,473 cf

Subcatchment 39: Subarea 39 Runoff Area=74,592 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=425' Tc=5.1 min CN=80 Runoff=4.41 cfs 8,619 cf

Subcatchment 40: Subarea 40 Runoff Area=68,641 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=427' Tc=5.1 min CN=80 Runoff=4.05 cfs 7,931 cf

Subcatchment 50: Subarea 50 Runoff Area=81,531 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=799' Tc=5.3 min CN=80 Runoff=4.78 cfs 9,421 cf

Subcatchment 51: Subarea 51 Runoff Area=77,602 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=718' Tc=4.9 min CN=80 Runoff=4.62 cfs 8,967 cf

Subcatchment 62: Subarea 62 Runoff Area=61,153 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=663' Tc=5.0 min CN=80 Runoff=3.63 cfs 7,066 cf

Subcatchment 63: Subarea 63 Runoff Area=60,504 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=636' Tc=4.9 min CN=80 Runoff=3.60 cfs 6,991 cf

Subcatchment 73: Subarea 73 Runoff Area=63,671 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=346' Tc=1.3 min CN=80 Runoff=4.32 cfs 7,357 cf

Subcatchment 74: Subarea 74 Runoff Area=64,300 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=352' Tc=1.3 min CN=80 Runoff=4.37 cfs 7,430 cf

Reach CH1e: Channel 1 Avg. Flow Depth=2.59' Max Vel=3.44 fps Inflow=73.26 cfs 193,722 cf
n=0.035 L=595.0' S=0.0050 '/' Capacity=220.67 cfs Outflow=69.07 cfs 193,722 cf

Reach CH1f: Channel 1 Avg. Flow Depth=2.60' Max Vel=3.45 fps Inflow=71.01 cfs 203,450 cf
n=0.035 L=328.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=69.90 cfs 203,450 cf

Reach CH1g: Channel 1 Avg. Flow Depth=2.62' Max Vel=3.46 fps Inflow=72.22 cfs 217,565 cf
n=0.035 L=373.0' S=0.0050 '/' Capacity=220.56 cfs Outflow=71.05 cfs 217,565 cf

Reach CH1h: Channel 1 Avg. Flow Depth=2.74' Max Vel=3.57 fps Inflow=80.42 cfs 267,263 cf
n=0.035 L=78.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=80.39 cfs 267,263 cf

Reach CH1i: Channel 1 Avg. Flow Depth=2.76' Max Vel=3.59 fps Inflow=83.41 cfs 278,898 cf
n=0.035 L=452.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=81.89 cfs 278,898 cf

Reach CH1j: Channel 1 Avg. Flow Depth=2.77' Max Vel=3.60 fps Inflow=85.05 cfs 294,069 cf
n=0.035 L=613.0' S=0.0050 '/' Capacity=220.68 cfs Outflow=82.53 cfs 294,069 cf

Reach CH2a: Channel 2 Avg. Flow Depth=2.61' Max Vel=4.09 fps Inflow=84.38 cfs 309,420 cf
n=0.035 L=450.0' S=0.0070 '/' Capacity=261.32 cfs Outflow=83.67 cfs 309,420 cf

Reach DC4a: Downchute 4 Avg. Flow Depth=0.13' Max Vel=6.26 fps Inflow=8.69 cfs 14,787 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=8.64 cfs 14,787 cf

Reach DC4b: Downchute 4 Avg. Flow Depth=0.19' Max Vel=7.72 fps Inflow=14.95 cfs 28,844 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=14.94 cfs 28,844 cf

Reach DC4c: Downchute 4 Avg. Flow Depth=0.25' Max Vel=9.21 fps Inflow=23.75 cfs 47,231 cf
n=0.035 L=140.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=23.74 cfs 47,231 cf

Pond CUL5c: Culvert 5 Peak Elev=1,483.28' Inflow=4.90 cfs 9,554 cf
18.0" Round Culvert n=0.013 L=55.0' S=0.0364 '/' Outflow=4.90 cfs 9,554 cf

Pond CUL5d: Culvert 5 Peak Elev=1,482.86' Inflow=2.61 cfs 5,049 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0500 '/' Outflow=2.61 cfs 5,049 cf

Pond CUL5e: Culvert 5 Peak Elev=1,483.14' Inflow=4.16 cfs 8,048 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0500 '/' Outflow=4.16 cfs 8,048 cf

Pond CUL5f: Culvert 5 Peak Elev=1,482.90' Inflow=2.81 cfs 5,473 cf
18.0" Round Culvert n=0.013 L=56.0' S=0.0536 '/' Outflow=2.81 cfs 5,473 cf

Pond CUL5g: Culvert 5 Peak Elev=1,483.19' Inflow=4.41 cfs 8,619 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0667 '/' Outflow=4.41 cfs 8,619 cf

Pond CUL5h: Culvert 5 Peak Elev=1,483.13' Inflow=4.05 cfs 7,931 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0667 '/' Outflow=4.05 cfs 7,931 cf

Pond DCCUL4: Downchute Culvert 4 Peak Elev=1,485.59' Inflow=24.99 cfs 49,698 cf
30.0" Round Culvert x 2.00 n=0.013 L=53.0' S=0.0943 '/' Outflow=24.99 cfs 49,698 cf

Link 3 10 Year Storm Outflow Imported from Southern Expansion Segment 1~Reach CH1d.hce Inflow=68.11 cfs 178,223 cf
Area= 1,542,428 sf Primary=68.11 cfs 178,223 cf

Summary for Subcatchment 6: Subarea 6

Runoff = 3.35 cfs @ 11.93 hrs, Volume= 5,946 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	51,457	80	
	51,457		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.7	38	0.3300	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.5	74	Total			

Summary for Subcatchment 7: Subarea 7

Runoff = 2.61 cfs @ 11.94 hrs, Volume= 4,679 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	40,492	80	
	40,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.0	47	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.8	83	Total			

Summary for Subcatchment 8: Subarea 8

Runoff = 3.37 cfs @ 11.94 hrs, Volume= 6,067 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	52,508	80	
	52,508		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.1	52	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.9	88	Total			

Summary for Subcatchment 9: Subarea 9

Runoff = 3.38 cfs @ 11.94 hrs, Volume= 6,162 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	53,327	80	
	53,327		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.4	59	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
3.2	95	Total			

Summary for Subcatchment 10: Subarea 10

Runoff = 3.57 cfs @ 11.94 hrs, Volume= 6,552 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	56,707	80	
	56,707		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	32	0.0100	0.73		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.7	68	0.3300	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.0	1	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.4	101	Total			

Summary for Subcatchment 11: Subarea 11

Runoff = 4.04 cfs @ 11.94 hrs, Volume= 7,420 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	64,217	80	
	64,217		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	32	0.0100	0.73		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.7	68	0.3300	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.0	11	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.4	111	Total			

Summary for Subcatchment 34: Subarea 34

Runoff = 4.90 cfs @ 11.96 hrs, Volume= 9,554 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	82,684	80	
	82,684		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	63	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.0	388	Total			

Summary for Subcatchment 35: Subarea 35

Runoff = 2.61 cfs @ 11.96 hrs, Volume= 5,049 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	43,693	80	
	43,693		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	98	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	164	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
4.8	362	Total			

Summary for Subcatchment 36: Subarea 36

Runoff = 4.16 cfs @ 11.96 hrs, Volume= 8,048 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	69,648	80	
	69,648		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	98	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	164	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
4.8	362	Total			

Summary for Subcatchment 37: Subarea 37

Runoff = 1.28 cfs @ 11.96 hrs, Volume= 2,467 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	21,353	80	
	21,353		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	50	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	148	0.0100	2.41	3.13	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=0.50' Z= 2.0 '/' Top.W=3.60' n= 0.030
4.8	298	Total			

Summary for Subcatchment 38: Subarea 38

Runoff = 2.81 cfs @ 11.96 hrs, Volume= 5,473 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	47,365	80	
	47,365		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	69	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.0	394	Total			

Summary for Subcatchment 39: Subarea 39

Runoff = 4.41 cfs @ 11.97 hrs, Volume= 8,619 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	74,592	80	
	74,592		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	98	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	227	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.1	425	Total			

Summary for Subcatchment 40: Subarea 40

Runoff = 4.05 cfs @ 11.97 hrs, Volume= 7,931 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	68,641	80	
	68,641		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	98	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	229	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.1	427	Total			

Summary for Subcatchment 50: Subarea 50

Runoff = 4.78 cfs @ 11.97 hrs, Volume= 9,421 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	81,531	80	
	81,531		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	91	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.3	608	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
5.3	799	Total			

Summary for Subcatchment 51: Subarea 51

Runoff = 4.62 cfs @ 11.96 hrs, Volume= 8,967 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	77,602	80	
	77,602		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.1	36	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	582	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.9	718	Total			

Summary for Subcatchment 62: Subarea 62

Runoff = 3.63 cfs @ 11.96 hrs, Volume= 7,066 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	61,153	80	
	61,153		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	91	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	472	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
5.0	663	Total			

Summary for Subcatchment 63: Subarea 63

Runoff = 3.60 cfs @ 11.96 hrs, Volume= 6,991 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	60,504	80	
	60,504		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	73	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	463	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.9	636	Total			

Summary for Subcatchment 73: Subarea 73

Runoff = 4.32 cfs @ 11.92 hrs, Volume= 7,357 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	63,671	80	
	63,671		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	10	0.3300	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.7	336	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
1.3	346	Total			

Summary for Subcatchment 74: Subarea 74

Runoff = 4.37 cfs @ 11.92 hrs, Volume= 7,430 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	64,300	80	
	64,300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	10	0.3300	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.7	342	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
1.3	352	Total			

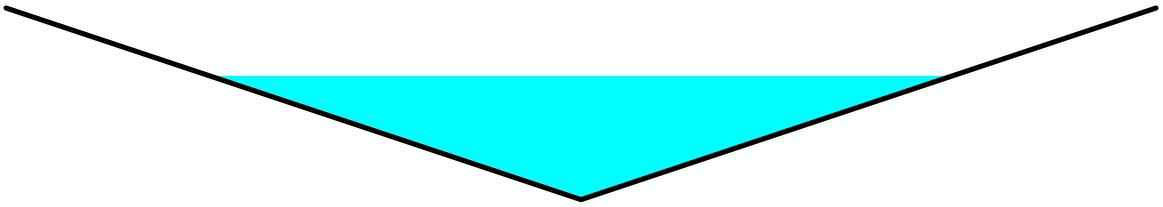
Summary for Reach CH1e: Channel 1

Inflow Area = 1,676,569 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 73.26 cfs @ 12.01 hrs, Volume= 193,722 cf
Outflow = 69.07 cfs @ 12.04 hrs, Volume= 193,722 cf, Atten= 6%, Lag= 2.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.44 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 1.08 fps, Avg. Travel Time= 9.2 min

Peak Storage= 11,951 cf @ 12.04 hrs
Average Depth at Peak Storage= 2.59'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.67 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 595.0' Slope= 0.0050 '/'
Inlet Invert= 1,474.85', Outlet Invert= 1,471.88'



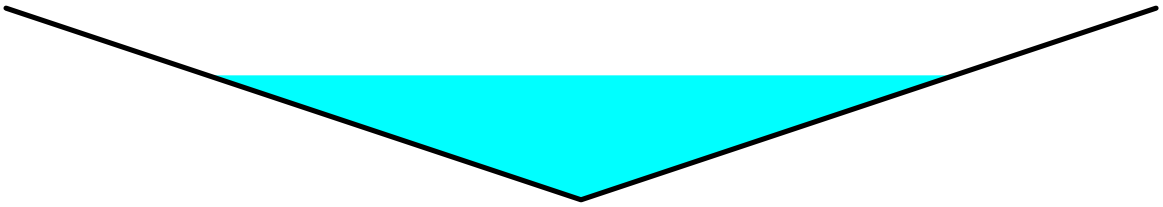
Summary for Reach CH1f: Channel 1

Inflow Area = 1,760,754 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 71.01 cfs @ 12.04 hrs, Volume= 203,450 cf
Outflow = 69.90 cfs @ 12.06 hrs, Volume= 203,450 cf, Atten= 2%, Lag= 1.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.45 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.07 fps, Avg. Travel Time= 5.1 min

Peak Storage= 6,644 cf @ 12.06 hrs
Average Depth at Peak Storage= 2.60'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 328.0' Slope= 0.0050 '/'
Inlet Invert= 1,471.88', Outlet Invert= 1,470.24'



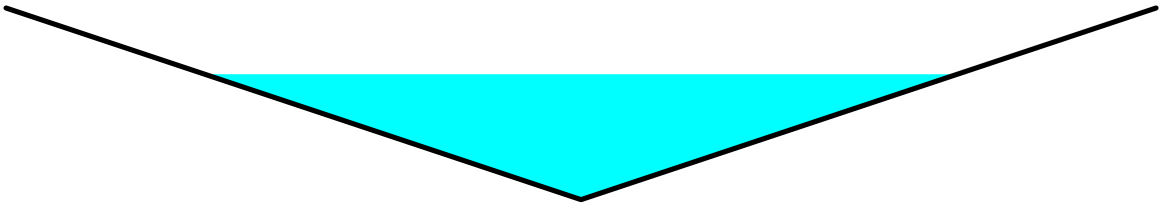
Summary for Reach CH1g: Channel 1

Inflow Area = 1,882,910 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 72.22 cfs @ 12.05 hrs, Volume= 217,565 cf
Outflow = 71.05 cfs @ 12.07 hrs, Volume= 217,565 cf, Atten= 2%, Lag= 1.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.46 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 1.07 fps, Avg. Travel Time= 5.8 min

Peak Storage= 7,655 cf @ 12.07 hrs
Average Depth at Peak Storage= 2.62'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.56 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 373.0' Slope= 0.0050 '/'
Inlet Invert= 1,470.24', Outlet Invert= 1,468.38'



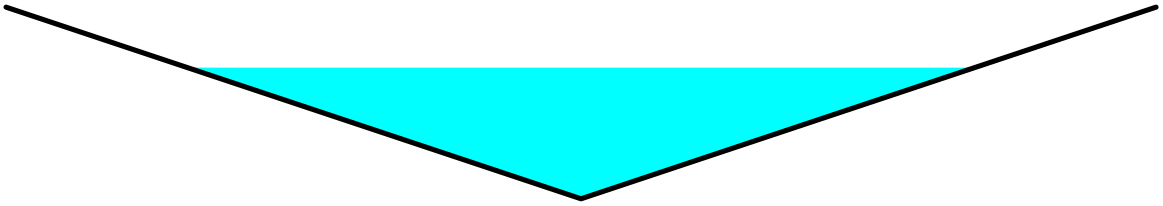
Summary for Reach CH1h: Channel 1

Inflow Area = 2,313,024 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 80.42 cfs @ 12.03 hrs, Volume= 267,263 cf
Outflow = 80.39 cfs @ 12.04 hrs, Volume= 267,263 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.57 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.12 fps, Avg. Travel Time= 1.2 min

Peak Storage= 1,755 cf @ 12.04 hrs
Average Depth at Peak Storage= 2.74'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 78.0' Slope= 0.0050 '/'
Inlet Invert= 1,468.38', Outlet Invert= 1,467.99'



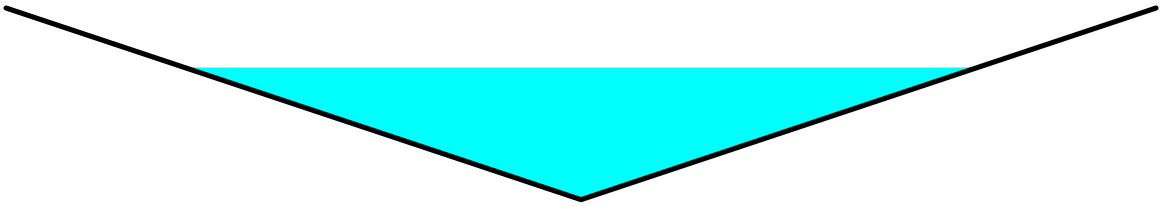
Summary for Reach CH1i: Channel 1

Inflow Area = 2,413,716 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 83.41 cfs @ 12.02 hrs, Volume= 278,898 cf
Outflow = 81.89 cfs @ 12.06 hrs, Volume= 278,898 cf, Atten= 2%, Lag= 2.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.59 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 1.10 fps, Avg. Travel Time= 6.8 min

Peak Storage= 10,309 cf @ 12.06 hrs
Average Depth at Peak Storage= 2.76'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 452.0' Slope= 0.0050 '/'
Inlet Invert= 1,467.99', Outlet Invert= 1,465.73'



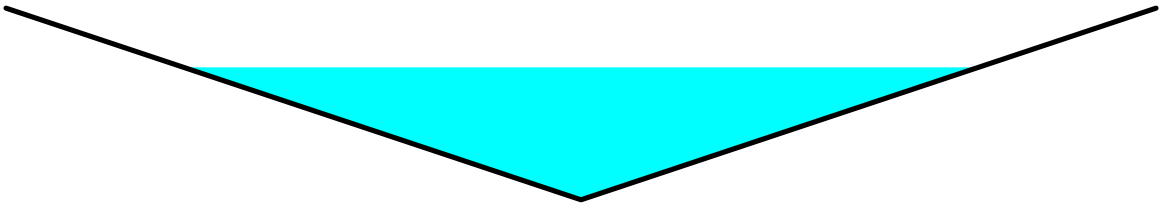
Summary for Reach CH1j: Channel 1

Inflow Area = 2,545,015 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 85.05 cfs @ 12.04 hrs, Volume= 294,069 cf
Outflow = 82.53 cfs @ 12.09 hrs, Volume= 294,069 cf, Atten= 3%, Lag= 2.9 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.60 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 1.07 fps, Avg. Travel Time= 9.5 min

Peak Storage= 14,072 cf @ 12.09 hrs
Average Depth at Peak Storage= 2.77'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.68 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 613.0' Slope= 0.0050 '/'
Inlet Invert= 1,465.73', Outlet Invert= 1,462.67'



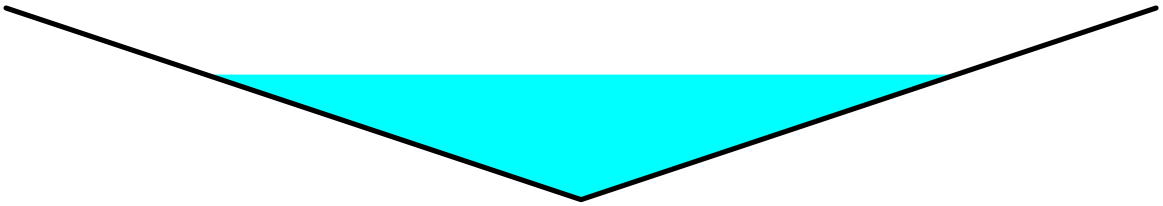
Summary for Reach CH2a: Channel 2

Inflow Area = 2,677,873 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 84.38 cfs @ 12.08 hrs, Volume= 309,420 cf
Outflow = 83.67 cfs @ 12.10 hrs, Volume= 309,420 cf, Atten= 1%, Lag= 1.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.09 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 1.22 fps, Avg. Travel Time= 6.1 min

Peak Storage= 9,193 cf @ 12.10 hrs
Average Depth at Peak Storage= 2.61'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 261.32 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 450.0' Slope= 0.0070 '/'
Inlet Invert= 1,462.67', Outlet Invert= 1,459.52'



Summary for Reach DC4a: Downchute 4

Inflow Area = 127,971 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 8.69 cfs @ 11.92 hrs, Volume= 14,787 cf
Outflow = 8.64 cfs @ 11.92 hrs, Volume= 14,787 cf, Atten= 1%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.26 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.42 fps, Avg. Travel Time= 1.8 min

Peak Storage= 208 cf @ 11.92 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,629.86', Outlet Invert= 1,580.03'

‡

Summary for Reach DC4b: Downchute 4

Inflow Area = 249,628 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 14.95 cfs @ 11.93 hrs, Volume= 28,844 cf
Outflow = 14.94 cfs @ 11.93 hrs, Volume= 28,844 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 7.72 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.78 fps, Avg. Travel Time= 1.4 min

Peak Storage= 292 cf @ 11.93 hrs
Average Depth at Peak Storage= 0.19'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,580.03', Outlet Invert= 1,530.20'

‡

Summary for Reach DC4c: Downchute 4

Inflow Area = 408,761 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 23.75 cfs @ 11.95 hrs, Volume= 47,231 cf
Outflow = 23.74 cfs @ 11.95 hrs, Volume= 47,231 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 9.21 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.12 fps, Avg. Travel Time= 1.1 min

Peak Storage= 361 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.25'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 140.0' Slope= 0.3300 '/'
Inlet Invert= 1,530.20', Outlet Invert= 1,484.00'

‡

Summary for Pond CUL5c: Culvert 5

Inflow Area = 82,684 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 4.90 cfs @ 11.96 hrs, Volume= 9,554 cf
Outflow = 4.90 cfs @ 11.96 hrs, Volume= 9,554 cf, Atten= 0%, Lag= 0.0 min
Primary = 4.90 cfs @ 11.96 hrs, Volume= 9,554 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 1,483.28' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 55.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,480.00' S= 0.0364 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=4.89 cfs @ 11.96 hrs HW=1,483.28' TW=1,477.16' (Dynamic Tailwater)
1=Culvert (Inlet Controls 4.89 cfs @ 3.04 fps)

Summary for Pond CUL5d: Culvert 5

Inflow Area = 43,693 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 2.61 cfs @ 11.96 hrs, Volume= 5,049 cf
Outflow = 2.61 cfs @ 11.96 hrs, Volume= 5,049 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.61 cfs @ 11.96 hrs, Volume= 5,049 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.86' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,479.00' S= 0.0500 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=2.61 cfs @ 11.96 hrs HW=1,482.86' TW=1,474.11' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.61 cfs @ 2.49 fps)

Summary for Pond CUL5e: Culvert 5

Inflow Area = 69,648 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 4.16 cfs @ 11.96 hrs, Volume= 8,048 cf
Outflow = 4.16 cfs @ 11.96 hrs, Volume= 8,048 cf, Atten= 0%, Lag= 0.0 min
Primary = 4.16 cfs @ 11.96 hrs, Volume= 8,048 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,483.14' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,479.00' S= 0.0500 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=4.15 cfs @ 11.96 hrs HW=1,483.14' TW=1,472.44' (Dynamic Tailwater)
1=Culvert (Inlet Controls 4.15 cfs @ 2.87 fps)

Summary for Pond CUL5f: Culvert 5

Inflow Area = 47,365 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 2.81 cfs @ 11.96 hrs, Volume= 5,473 cf
Outflow = 2.81 cfs @ 11.96 hrs, Volume= 5,473 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.81 cfs @ 11.96 hrs, Volume= 5,473 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.90' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 56.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,479.00' S= 0.0536 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=2.80 cfs @ 11.96 hrs HW=1,482.90' TW=1,470.49' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.80 cfs @ 2.54 fps)

Summary for Pond CUL5g: Culvert 5

Inflow Area = 74,592 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 4.41 cfs @ 11.97 hrs, Volume= 8,619 cf
Outflow = 4.41 cfs @ 11.97 hrs, Volume= 8,619 cf, Atten= 0%, Lag= 0.0 min
Primary = 4.41 cfs @ 11.97 hrs, Volume= 8,619 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,483.19' @ 11.97 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,478.00' S= 0.0667 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=4.39 cfs @ 11.97 hrs HW=1,483.19' TW=1,468.09' (Dynamic Tailwater)
1=Culvert (Inlet Controls 4.39 cfs @ 2.93 fps)

Summary for Pond CUL5h: Culvert 5

Inflow Area = 68,641 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 4.05 cfs @ 11.97 hrs, Volume= 7,931 cf
Outflow = 4.05 cfs @ 11.97 hrs, Volume= 7,931 cf, Atten= 0%, Lag= 0.0 min
Primary = 4.05 cfs @ 11.97 hrs, Volume= 7,931 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,483.13' @ 11.97 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,478.00' S= 0.0667 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=4.04 cfs @ 11.97 hrs HW=1,483.12' TW=1,464.84' (Dynamic Tailwater)
1=Culvert (Inlet Controls 4.04 cfs @ 2.85 fps)

Summary for Pond DCCUL4: Downchute Culvert 4

Inflow Area = 430,114 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 24.99 cfs @ 11.95 hrs, Volume= 49,698 cf
Outflow = 24.99 cfs @ 11.95 hrs, Volume= 49,698 cf, Atten= 0%, Lag= 0.0 min
Primary = 24.99 cfs @ 11.95 hrs, Volume= 49,698 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,485.59' @ 11.95 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,484.00'	**30.0" Round Culvert X 2.00** L= 53.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,484.00' / 1,479.00' S= 0.0943 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=24.99 cfs @ 11.95 hrs HW=1,485.59' TW=1,470.89' (Dynamic Tailwater)
1=Culvert (Inlet Controls 24.99 cfs @ 3.79 fps)

Summary for Link 1L: Segment 1

Inflow Area = 1,542,428 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 68.11 cfs @ 12.02 hrs, Volume= 178,223 cf
Primary = 68.11 cfs @ 12.02 hrs, Volume= 178,223 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

10 Year Storm Outflow Imported from Southern Expansion Segment 1~Reach CH1d.hce

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 6: Subarea 6 Runoff Area=51,457 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=74' Tc=2.5 min CN=80 Runoff=7.46 cfs 13,610 cf

Subcatchment 7: Subarea 7 Runoff Area=40,492 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=83' Tc=2.8 min CN=80 Runoff=5.81 cfs 10,710 cf

Subcatchment 8: Subarea 8 Runoff Area=52,508 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=88' Tc=2.9 min CN=80 Runoff=7.51 cfs 13,888 cf

Subcatchment 9: Subarea 9 Runoff Area=53,327 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=95' Tc=3.2 min CN=80 Runoff=7.55 cfs 14,104 cf

Subcatchment 10: Subarea 10 Runoff Area=56,707 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=101' Tc=3.4 min CN=80 Runoff=7.97 cfs 14,998 cf

Subcatchment 11: Subarea 11 Runoff Area=64,217 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=111' Tc=3.4 min CN=80 Runoff=9.02 cfs 16,984 cf

Subcatchment 34: Subarea 34 Runoff Area=82,684 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=388' Tc=5.0 min CN=80 Runoff=10.99 cfs 21,869 cf

Subcatchment 35: Subarea 35 Runoff Area=43,693 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=362' Tc=4.8 min CN=80 Runoff=5.85 cfs 11,556 cf

Subcatchment 36: Subarea 36 Runoff Area=69,648 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=362' Tc=4.8 min CN=80 Runoff=9.32 cfs 18,421 cf

Subcatchment 37: Subarea 37 Runoff Area=21,353 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=298' Tc=4.8 min CN=80 Runoff=2.86 cfs 5,648 cf

Subcatchment 38: Subarea 38 Runoff Area=47,365 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=394' Tc=5.0 min CN=80 Runoff=6.29 cfs 12,527 cf

Subcatchment 39: Subarea 39 Runoff Area=74,592 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=425' Tc=5.1 min CN=80 Runoff=9.88 cfs 19,728 cf

Subcatchment 40: Subarea 40 Runoff Area=68,641 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=427' Tc=5.1 min CN=80 Runoff=9.09 cfs 18,155 cf

Subcatchment 50: Subarea 50 Runoff Area=81,531 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=799' Tc=5.3 min CN=80 Runoff=10.72 cfs 21,564 cf

Subcatchment 51: Subarea 51 Runoff Area=77,602 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=718' Tc=4.9 min CN=80 Runoff=10.35 cfs 20,525 cf

Subcatchment 62: Subarea 62 Runoff Area=61,153 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=663' Tc=5.0 min CN=80 Runoff=8.12 cfs 16,174 cf

Subcatchment 63: Subarea 63 Runoff Area=60,504 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=636' Tc=4.9 min CN=80 Runoff=8.07 cfs 16,002 cf

Subcatchment 73: Subarea 73 Runoff Area=63,671 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=346' Tc=1.3 min CN=80 Runoff=9.60 cfs 16,840 cf

Subcatchment 74: Subarea 74 Runoff Area=64,300 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=352' Tc=1.3 min CN=80 Runoff=9.69 cfs 17,006 cf

Reach CH1e: Channel 1 Avg. Flow Depth=3.61' Max Vel=4.29 fps Inflow=174.15 cfs 443,428 cf
n=0.035 L=595.0' S=0.0050 '/' Capacity=220.67 cfs Outflow=167.36 cfs 443,428 cf

Reach CH1f: Channel 1 Avg. Flow Depth=3.64' Max Vel=4.32 fps Inflow=173.41 cfs 465,694 cf
n=0.035 L=328.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=171.41 cfs 465,694 cf

Reach CH1g: Channel 1 Avg. Flow Depth=3.68' Max Vel=4.35 fps Inflow=179.34 cfs 498,002 cf
n=0.035 L=373.0' S=0.0050 '/' Capacity=220.56 cfs Outflow=176.97 cfs 498,002 cf

Reach CH1h: Channel 1 Avg. Flow Depth=3.91' Max Vel=4.53 fps Inflow=207.83 cfs 611,761 cf
n=0.035 L=78.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=207.74 cfs 611,761 cf

Reach CH1i: Channel 1 Avg. Flow Depth=3.95' Max Vel=4.56 fps Inflow=216.61 cfs 638,393 cf
n=0.035 L=452.0' S=0.0050 '/' Capacity=220.86 cfs Outflow=213.15 cfs 638,393 cf

Reach CH1j: Channel 1 Avg. Flow Depth=3.98' Max Vel=4.58 fps Inflow=223.46 cfs 673,119 cf
n=0.035 L=613.0' S=0.0050 '/' Capacity=220.68 cfs Outflow=217.39 cfs 673,119 cf

Reach CH2a: Channel 2 Avg. Flow Depth=3.77' Max Vel=5.23 fps Inflow=224.66 cfs 708,258 cf
n=0.035 L=450.0' S=0.0070 '/' Capacity=261.32 cfs Outflow=222.45 cfs 708,258 cf

Reach DC4a: Downchute 4 Avg. Flow Depth=0.22' Max Vel=8.51 fps Inflow=19.29 cfs 33,846 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=19.23 cfs 33,846 cf

Reach DC4b: Downchute 4 Avg. Flow Depth=0.30' Max Vel=10.48 fps Inflow=33.53 cfs 66,023 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=33.53 cfs 66,023 cf

Reach DC4c: Downchute 4 Avg. Flow Depth=0.40' Max Vel=12.42 fps Inflow=53.20 cfs 108,111 cf
n=0.035 L=140.0' S=0.3300 '/' Capacity=258.32 cfs Outflow=53.20 cfs 108,111 cf

Pond CUL5c: Culvert 5 Peak Elev=1,485.42' Inflow=10.99 cfs 21,869 cf
18.0" Round Culvert n=0.013 L=55.0' S=0.0364 '/' Outflow=10.99 cfs 21,869 cf

Pond CUL5d: Culvert 5 Peak Elev=1,483.51' Inflow=5.85 cfs 11,556 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0500 '/' Outflow=5.85 cfs 11,556 cf

Pond CUL5e: Culvert 5 Peak Elev=1,484.67' Inflow=9.32 cfs 18,421 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0500 '/' Outflow=9.32 cfs 18,421 cf

Pond CUL5f: Culvert 5 Peak Elev=1,483.63' Inflow=6.29 cfs 12,527 cf
18.0" Round Culvert n=0.013 L=56.0' S=0.0536 '/' Outflow=6.29 cfs 12,527 cf

Pond CUL5g: Culvert 5 Peak Elev=1,484.91' Inflow=9.88 cfs 19,728 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0667 '/' Outflow=9.88 cfs 19,728 cf

Pond CUL5h: Culvert 5 Peak Elev=1,484.58' Inflow=9.09 cfs 18,155 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0667 '/' Outflow=9.09 cfs 18,155 cf

Pond DCCUL4: Downchute Culvert 4 Peak Elev=1,487.05' Inflow=55.99 cfs 113,759 cf
30.0" Round Culvert x 2.00 n=0.013 L=53.0' S=0.0943 '/' Outflow=55.99 cfs 113,759 cf

Link 100 Year Storm Outflow Imported from Southern Expansion Segment 1~Reach CH1d.hce Inflow=160.94 cfs 407,950 cf
Area= 1,542,428 sf Primary=160.94 cfs 407,950 cf

Summary for Subcatchment 6: Subarea 6

Runoff = 7.46 cfs @ 11.93 hrs, Volume= 13,610 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	51,457	80	
	51,457		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.7	38	0.3300	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.5	74	Total			

Summary for Subcatchment 7: Subarea 7

Runoff = 5.81 cfs @ 11.93 hrs, Volume= 10,710 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	40,492	80	
	40,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.0	47	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.8	83	Total			

Summary for Subcatchment 8: Subarea 8

Runoff = 7.51 cfs @ 11.94 hrs, Volume= 13,888 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	52,508	80	
	52,508		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.1	52	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.9	88	Total			

Summary for Subcatchment 9: Subarea 9

Runoff = 7.55 cfs @ 11.94 hrs, Volume= 14,104 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	53,327	80	
	53,327		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.4	59	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
3.2	95	Total			

Summary for Subcatchment 10: Subarea 10

Runoff = 7.97 cfs @ 11.94 hrs, Volume= 14,998 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	56,707	80	
	56,707		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	32	0.0100	0.73		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.7	68	0.3300	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.0	1	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.4	101	Total			

Summary for Subcatchment 11: Subarea 11

Runoff = 9.02 cfs @ 11.94 hrs, Volume= 16,984 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	64,217	80	
	64,217		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	32	0.0100	0.73		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.7	68	0.3300	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.0	11	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.4	111	Total			

Summary for Subcatchment 34: Subarea 34

Runoff = 10.99 cfs @ 11.96 hrs, Volume= 21,869 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	82,684	80	
	82,684		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	63	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.0	388	Total			

Summary for Subcatchment 35: Subarea 35

Runoff = 5.85 cfs @ 11.96 hrs, Volume= 11,556 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	43,693	80	
	43,693		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	98	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	164	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
4.8	362	Total			

Summary for Subcatchment 36: Subarea 36

Runoff = 9.32 cfs @ 11.96 hrs, Volume= 18,421 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	69,648	80	
	69,648		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	98	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	164	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
4.8	362	Total			

Summary for Subcatchment 37: Subarea 37

Runoff = 2.86 cfs @ 11.96 hrs, Volume= 5,648 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	21,353	80	
	21,353		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	50	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	148	0.0100	2.41	3.13	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=0.50' Z= 2.0 '/' Top.W=3.60' n= 0.030
4.8	298	Total			

Summary for Subcatchment 38: Subarea 38

Runoff = 6.29 cfs @ 11.96 hrs, Volume= 12,527 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	47,365	80	
	47,365		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	69	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.0	394	Total			

Summary for Subcatchment 39: Subarea 39

Runoff = 9.88 cfs @ 11.96 hrs, Volume= 19,728 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	74,592	80	
	74,592		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	98	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	227	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.1	425	Total			

Summary for Subcatchment 40: Subarea 40

Runoff = 9.09 cfs @ 11.96 hrs, Volume= 18,155 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	68,641	80	
	68,641		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	98	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	229	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.1	427	Total			

Summary for Subcatchment 50: Subarea 50

Runoff = 10.72 cfs @ 11.96 hrs, Volume= 21,564 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	81,531	80	
	81,531		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	91	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.3	608	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
5.3	799	Total			

Summary for Subcatchment 51: Subarea 51

Runoff = 10.35 cfs @ 11.96 hrs, Volume= 20,525 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	77,602	80	
	77,602		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.1	36	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.2	582	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.9	718	Total			

Summary for Subcatchment 62: Subarea 62

Runoff = 8.12 cfs @ 11.96 hrs, Volume= 16,174 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	61,153	80	
	61,153		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	91	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	472	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
5.0	663	Total			

Summary for Subcatchment 63: Subarea 63

Runoff = 8.07 cfs @ 11.96 hrs, Volume= 16,002 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	60,504	80	
	60,504		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	73	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	463	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.9	636	Total			

Summary for Subcatchment 73: Subarea 73

Runoff = 9.60 cfs @ 11.92 hrs, Volume= 16,840 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	63,671	80	
	63,671		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	10	0.3300	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.7	336	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
1.3	346	Total			

Summary for Subcatchment 74: Subarea 74

Runoff = 9.69 cfs @ 11.92 hrs, Volume= 17,006 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	64,300	80	
	64,300		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	10	0.3300	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.7	342	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
1.3	352	Total			

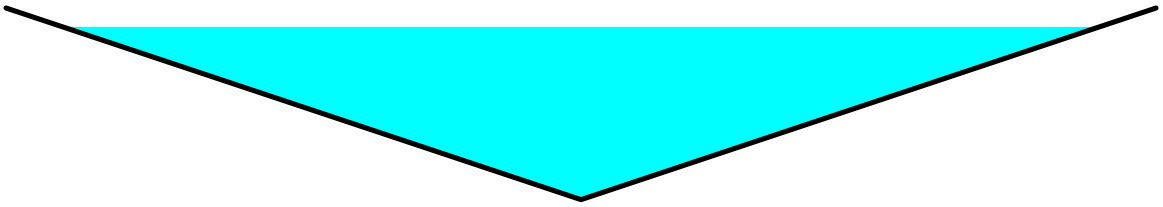
Summary for Reach CH1e: Channel 1

Inflow Area = 1,676,569 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 174.15 cfs @ 12.00 hrs, Volume= 443,428 cf
Outflow = 167.36 cfs @ 12.02 hrs, Volume= 443,428 cf, Atten= 4%, Lag= 1.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.29 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 1.28 fps, Avg. Travel Time= 7.8 min

Peak Storage= 23,210 cf @ 12.02 hrs
Average Depth at Peak Storage= 3.61'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.67 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 595.0' Slope= 0.0050 '/'
Inlet Invert= 1,474.85', Outlet Invert= 1,471.88'



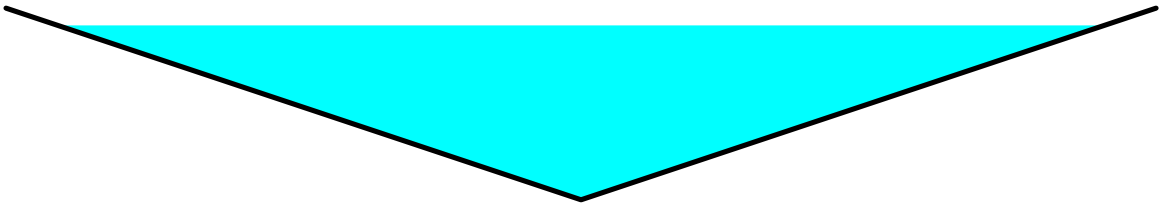
Summary for Reach CH1f: Channel 1

Inflow Area = 1,760,754 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 173.41 cfs @ 12.02 hrs, Volume= 465,694 cf
Outflow = 171.41 cfs @ 12.03 hrs, Volume= 465,694 cf, Atten= 1%, Lag= 1.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.32 fps, Min. Travel Time= 1.3 min
Avg. Velocity = 1.27 fps, Avg. Travel Time= 4.3 min

Peak Storage= 13,019 cf @ 12.03 hrs
Average Depth at Peak Storage= 3.64'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 328.0' Slope= 0.0050 '/'
Inlet Invert= 1,471.88', Outlet Invert= 1,470.24'



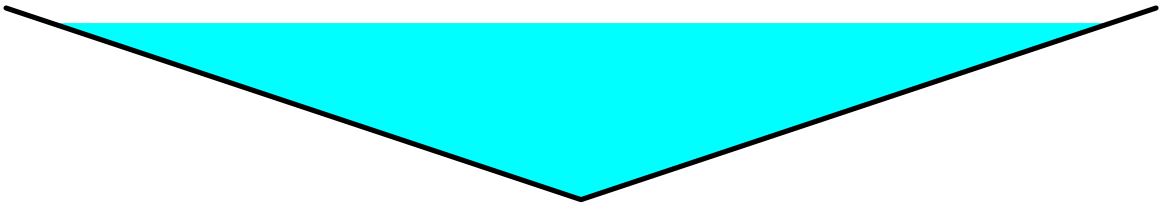
Summary for Reach CH1g: Channel 1

Inflow Area = 1,882,910 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 179.34 cfs @ 12.02 hrs, Volume= 498,002 cf
Outflow = 176.97 cfs @ 12.04 hrs, Volume= 498,002 cf, Atten= 1%, Lag= 1.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.35 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 1.26 fps, Avg. Travel Time= 4.9 min

Peak Storage= 15,178 cf @ 12.04 hrs
Average Depth at Peak Storage= 3.68'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.56 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 373.0' Slope= 0.0050 '/'
Inlet Invert= 1,470.24', Outlet Invert= 1,468.38'



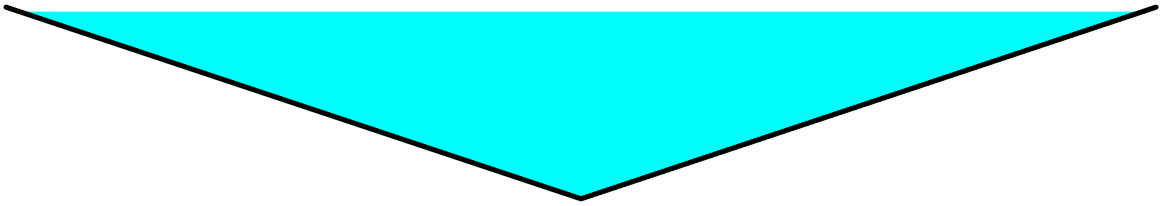
Summary for Reach CH1h: Channel 1

Inflow Area = 2,313,024 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 207.83 cfs @ 12.01 hrs, Volume= 611,761 cf
Outflow = 207.74 cfs @ 12.01 hrs, Volume= 611,761 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.53 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.33 fps, Avg. Travel Time= 1.0 min

Peak Storage= 3,576 cf @ 12.01 hrs
Average Depth at Peak Storage= 3.91'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 78.0' Slope= 0.0050 '/'
Inlet Invert= 1,468.38', Outlet Invert= 1,467.99'



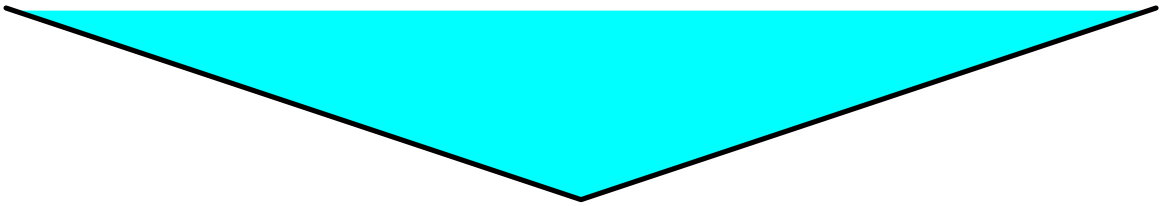
Summary for Reach CH1i: Channel 1

Inflow Area = 2,413,716 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 216.61 cfs @ 12.01 hrs, Volume= 638,393 cf
Outflow = 213.15 cfs @ 12.03 hrs, Volume= 638,393 cf, Atten= 2%, Lag= 1.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.56 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 1.31 fps, Avg. Travel Time= 5.8 min

Peak Storage= 21,126 cf @ 12.03 hrs
Average Depth at Peak Storage= 3.95'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.86 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 452.0' Slope= 0.0050 '/'
Inlet Invert= 1,467.99', Outlet Invert= 1,465.73'



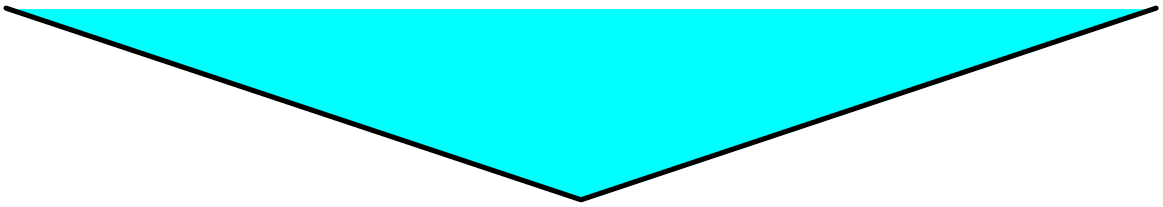
Summary for Reach CH1j: Channel 1

Inflow Area = 2,545,015 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 223.46 cfs @ 12.02 hrs, Volume= 673,119 cf
Outflow = 217.39 cfs @ 12.05 hrs, Volume= 673,119 cf, Atten= 3%, Lag= 1.8 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.58 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 1.27 fps, Avg. Travel Time= 8.0 min

Peak Storage= 29,094 cf @ 12.05 hrs
Average Depth at Peak Storage= 3.98'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 220.68 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 613.0' Slope= 0.0050 '/'
Inlet Invert= 1,465.73', Outlet Invert= 1,462.67'



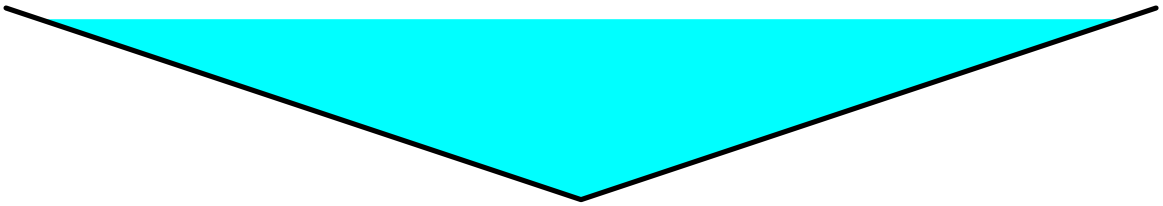
Summary for Reach CH2a: Channel 2

Inflow Area = 2,677,873 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 224.66 cfs @ 12.04 hrs, Volume= 708,258 cf
Outflow = 222.45 cfs @ 12.06 hrs, Volume= 708,258 cf, Atten= 1%, Lag= 1.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.23 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 1.45 fps, Avg. Travel Time= 5.2 min

Peak Storage= 19,142 cf @ 12.06 hrs
Average Depth at Peak Storage= 3.77'
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 261.32 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 450.0' Slope= 0.0070 '/'
Inlet Invert= 1,462.67', Outlet Invert= 1,459.52'



Summary for Reach DC4a: Downchute 4

Inflow Area = 127,971 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 19.29 cfs @ 11.92 hrs, Volume= 33,846 cf
Outflow = 19.23 cfs @ 11.92 hrs, Volume= 33,846 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 8.51 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.75 fps, Avg. Travel Time= 1.4 min

Peak Storage= 341 cf @ 11.92 hrs
Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,629.86', Outlet Invert= 1,580.03'

‡

Summary for Reach DC4b: Downchute 4

Inflow Area = 249,628 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 33.53 cfs @ 11.93 hrs, Volume= 66,023 cf
Outflow = 33.53 cfs @ 11.93 hrs, Volume= 66,023 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 10.48 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.21 fps, Avg. Travel Time= 1.1 min

Peak Storage= 483 cf @ 11.93 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,580.03', Outlet Invert= 1,530.20'

‡

Summary for Reach DC4c: Downchute 4

Inflow Area = 408,761 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 53.20 cfs @ 11.94 hrs, Volume= 108,111 cf
Outflow = 53.20 cfs @ 11.94 hrs, Volume= 108,111 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 12.42 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.65 fps, Avg. Travel Time= 0.9 min

Peak Storage= 599 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 1.00' Flow Area= 12.0 sf, Capacity= 258.32 cfs

10.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 140.0' Slope= 0.3300 '/'
Inlet Invert= 1,530.20', Outlet Invert= 1,484.00'

‡

Summary for Pond CUL5c: Culvert 5

Inflow Area = 82,684 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 10.99 cfs @ 11.96 hrs, Volume= 21,869 cf
Outflow = 10.99 cfs @ 11.96 hrs, Volume= 21,869 cf, Atten= 0%, Lag= 0.0 min
Primary = 10.99 cfs @ 11.96 hrs, Volume= 21,869 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 1,485.42' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 55.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,480.00' S= 0.0364 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=10.98 cfs @ 11.96 hrs HW=1,485.42' TW=1,478.20' (Dynamic Tailwater)
1=Culvert (Inlet Controls 10.98 cfs @ 6.21 fps)

Summary for Pond CUL5d: Culvert 5

Inflow Area = 43,693 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 5.85 cfs @ 11.96 hrs, Volume= 11,556 cf
Outflow = 5.85 cfs @ 11.96 hrs, Volume= 11,556 cf, Atten= 0%, Lag= 0.0 min
Primary = 5.85 cfs @ 11.96 hrs, Volume= 11,556 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,483.51' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,479.00' S= 0.0500 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=5.84 cfs @ 11.96 hrs HW=1,483.50' TW=1,475.18' (Dynamic Tailwater)
1=Culvert (Inlet Controls 5.84 cfs @ 3.30 fps)

Summary for Pond CUL5e: Culvert 5

Inflow Area = 69,648 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 9.32 cfs @ 11.96 hrs, Volume= 18,421 cf
Outflow = 9.32 cfs @ 11.96 hrs, Volume= 18,421 cf, Atten= 0%, Lag= 0.0 min
Primary = 9.32 cfs @ 11.96 hrs, Volume= 18,421 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,484.67' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,479.00' S= 0.0500 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=9.30 cfs @ 11.96 hrs HW=1,484.67' TW=1,473.54' (Dynamic Tailwater)
1=Culvert (Inlet Controls 9.30 cfs @ 5.27 fps)

Summary for Pond CUL5f: Culvert 5

Inflow Area = 47,365 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 6.29 cfs @ 11.96 hrs, Volume= 12,527 cf
Outflow = 6.29 cfs @ 11.96 hrs, Volume= 12,527 cf, Atten= 0%, Lag= 0.0 min
Primary = 6.29 cfs @ 11.96 hrs, Volume= 12,527 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,483.63' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 56.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,479.00' S= 0.0536 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=6.29 cfs @ 11.96 hrs HW=1,483.63' TW=1,471.69' (Dynamic Tailwater)
1=Culvert (Inlet Controls 6.29 cfs @ 3.56 fps)

Summary for Pond CUL5g: Culvert 5

Inflow Area = 74,592 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 9.88 cfs @ 11.96 hrs, Volume= 19,728 cf
Outflow = 9.88 cfs @ 11.96 hrs, Volume= 19,728 cf, Atten= 0%, Lag= 0.0 min
Primary = 9.88 cfs @ 11.96 hrs, Volume= 19,728 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,484.91' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,478.00' S= 0.0667 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=9.86 cfs @ 11.96 hrs HW=1,484.91' TW=1,469.32' (Dynamic Tailwater)
1=Culvert (Inlet Controls 9.86 cfs @ 5.58 fps)

Summary for Pond CUL5h: Culvert 5

Inflow Area = 68,641 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 9.09 cfs @ 11.96 hrs, Volume= 18,155 cf
Outflow = 9.09 cfs @ 11.96 hrs, Volume= 18,155 cf, Atten= 0%, Lag= 0.0 min
Primary = 9.09 cfs @ 11.96 hrs, Volume= 18,155 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,484.58' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,478.00' S= 0.0667 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=9.07 cfs @ 11.96 hrs HW=1,484.57' TW=1,466.01' (Dynamic Tailwater)
1=Culvert (Inlet Controls 9.07 cfs @ 5.14 fps)

Summary for Pond DCCUL4: Downchute Culvert 4

Inflow Area = 430,114 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 55.99 cfs @ 11.94 hrs, Volume= 113,759 cf
Outflow = 55.99 cfs @ 11.94 hrs, Volume= 113,759 cf, Atten= 0%, Lag= 0.0 min
Primary = 55.99 cfs @ 11.94 hrs, Volume= 113,759 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,487.05' @ 11.94 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,484.00'	**30.0" Round Culvert X 2.00** L= 53.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,484.00' / 1,479.00' S= 0.0943 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

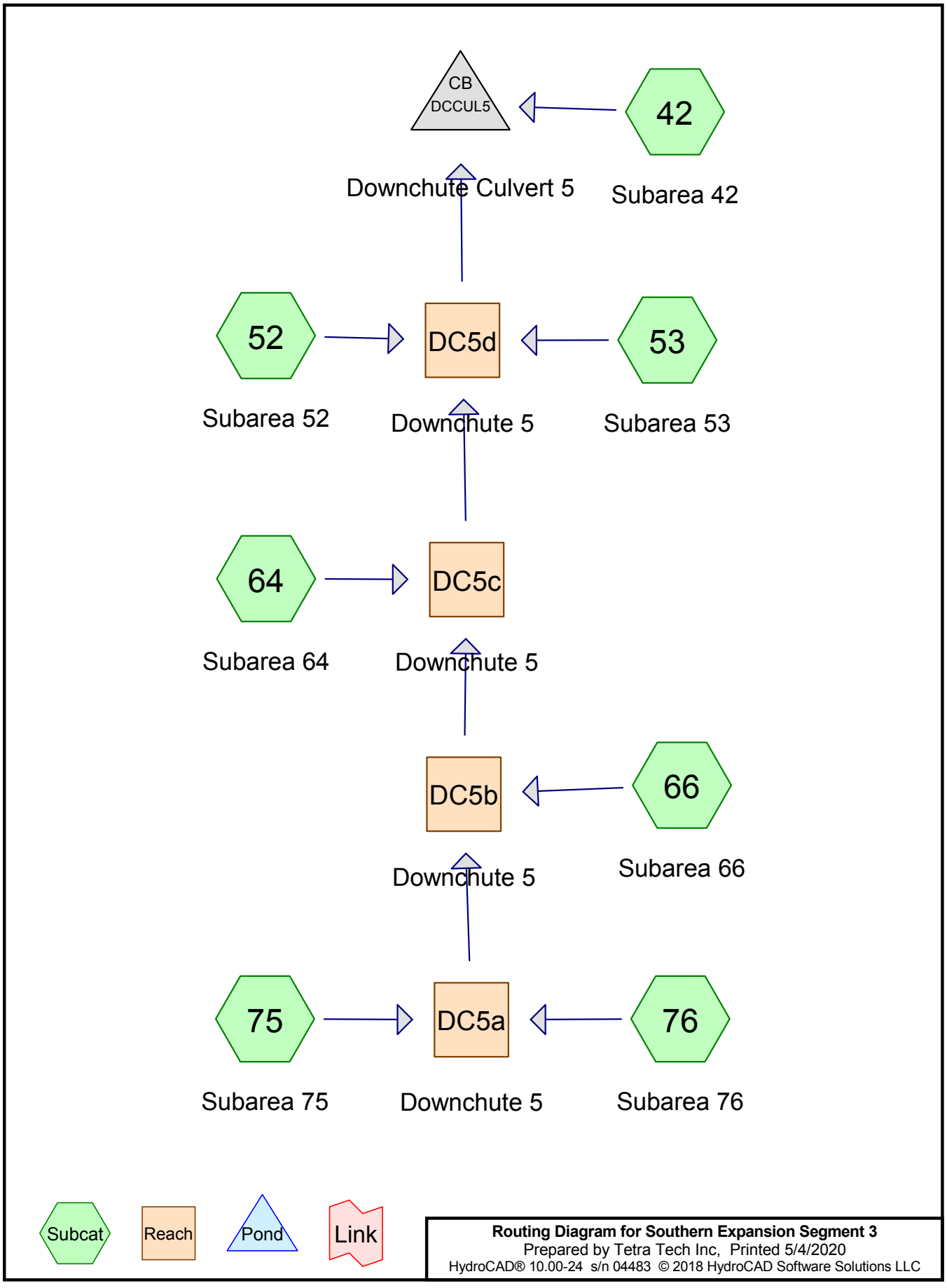
Primary OutFlow Max=55.88 cfs @ 11.94 hrs HW=1,487.04' TW=1,472.02' (Dynamic Tailwater)
1=Culvert (Inlet Controls 55.88 cfs @ 5.69 fps)

Summary for Link 1L: Segment 1

Inflow Area = 1,542,428 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 160.94 cfs @ 12.00 hrs, Volume= 407,950 cf
Primary = 160.94 cfs @ 12.00 hrs, Volume= 407,950 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

100 Year Storm Outflow Imported from Southern Expansion Segment 1~Reach CH1d.hce



Routing Diagram for Southern Expansion Segment 3
Prepared by Tetra Tech Inc, Printed 5/4/2020
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Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 42: Subarea 42 Runoff Area=29,378 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=345' Tc=5.2 min CN=80 Runoff=0.61 cfs 1,230 cf

Subcatchment 52: Subarea 52 Runoff Area=58,718 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=715' Tc=4.7 min CN=80 Runoff=1.24 cfs 2,459 cf

Subcatchment 53: Subarea 53 Runoff Area=34,303 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=372' Tc=6.5 min CN=80 Runoff=0.67 cfs 1,437 cf

Subcatchment 64: Subarea 64 Runoff Area=89,809 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=745' Tc=5.1 min CN=80 Runoff=1.87 cfs 3,761 cf

Subcatchment 66: Subarea 66 Runoff Area=28,475 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=346' Tc=4.2 min CN=80 Runoff=0.61 cfs 1,193 cf

Subcatchment 75: Subarea 75 Runoff Area=74,098 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=378' Tc=1.4 min CN=80 Runoff=1.79 cfs 3,103 cf

Subcatchment 76: Subarea 76 Runoff Area=76,679 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=566' Tc=11.1 min CN=80 Runoff=1.23 cfs 3,211 cf

Reach DC5a: Downchute 5 Avg. Flow Depth=0.06' Max Vel=3.53 fps Inflow=2.38 cfs 6,315 cf
n=0.035 L=137.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=2.37 cfs 6,315 cf

Reach DC5b: Downchute 5 Avg. Flow Depth=0.06' Max Vel=3.85 fps Inflow=2.95 cfs 7,507 cf
n=0.035 L=62.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=2.95 cfs 7,507 cf

Reach DC5c: Downchute 5 Avg. Flow Depth=0.08' Max Vel=4.63 fps Inflow=4.74 cfs 11,268 cf
n=0.035 L=103.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=4.74 cfs 11,268 cf

Reach DC5d: Downchute 5 Avg. Flow Depth=0.10' Max Vel=5.28 fps Inflow=6.61 cfs 15,164 cf
n=0.035 L=122.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=6.61 cfs 15,164 cf

Pond DCCUL5: Downchute Culvert 5 Peak Elev=1,484.80' Inflow=7.21 cfs 16,394 cf
30.0" Round Culvert x 2.00 n=0.013 L=50.0' S=0.0600 '/' Outflow=7.21 cfs 16,394 cf

Summary for Subcatchment 42: Subarea 42

Runoff = 0.61 cfs @ 11.97 hrs, Volume= 1,230 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	29,378	80	
	29,378		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	44	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	201	0.0100	2.41	3.13	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=0.50' Z= 2.0 '/' Top.W=3.60' n= 0.030
5.2	345	Total			

Summary for Subcatchment 52: Subarea 52

Runoff = 1.24 cfs @ 11.97 hrs, Volume= 2,459 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	58,718	80	
	58,718		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	93	0.3300	0.45		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.3	622	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.7	715	Total			

Summary for Subcatchment 53: Subarea 53

Runoff = 0.67 cfs @ 11.99 hrs, Volume= 1,437 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	34,303	80	
	34,303		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.5	63	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	209	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
6.5	372	Total			

Summary for Subcatchment 64: Subarea 64

Runoff = 1.87 cfs @ 11.97 hrs, Volume= 3,761 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	89,809	80	
	89,809		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	107	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	538	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
5.1	745	Total			

Summary for Subcatchment 66: Subarea 66

Runoff = 0.61 cfs @ 11.96 hrs, Volume= 1,193 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	28,475	80	
	28,475		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	37	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	209	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.2	346	Total			

Summary for Subcatchment 75: Subarea 75

Runoff = 1.79 cfs @ 11.92 hrs, Volume= 3,103 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	74,098	80	
	74,098		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	10	0.3300	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.8	368	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
1.4	378	Total			

Summary for Subcatchment 76: Subarea 76

Runoff = 1.23 cfs @ 12.04 hrs, Volume= 3,211 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	76,679	80	
	76,679		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.9	163	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	94	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	209	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
11.1	566	Total			

Summary for Reach DC5a: Downchute 5

Inflow Area = 150,777 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 2.38 cfs @ 11.93 hrs, Volume= 6,315 cf
Outflow = 2.37 cfs @ 11.94 hrs, Volume= 6,315 cf, Atten= 1%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.53 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.23 fps, Avg. Travel Time= 1.9 min

Peak Storage= 92 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.06'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 137.0' Slope= 0.3300 '/'
Inlet Invert= 1,630.00', Outlet Invert= 1,584.79'

‡

Summary for Reach DC5b: Downchute 5

Inflow Area = 179,252 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 2.95 cfs @ 11.94 hrs, Volume= 7,507 cf
Outflow = 2.95 cfs @ 11.95 hrs, Volume= 7,507 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.85 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.25 fps, Avg. Travel Time= 0.8 min

Peak Storage= 48 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.06'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 62.0' Slope= 0.3300 '/'
Inlet Invert= 1,584.79', Outlet Invert= 1,564.33'

‡

Summary for Reach DC5c: Downchute 5

Inflow Area = 269,061 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 4.74 cfs @ 11.96 hrs, Volume= 11,268 cf
Outflow = 4.74 cfs @ 11.96 hrs, Volume= 11,268 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.63 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.33 fps, Avg. Travel Time= 1.3 min

Peak Storage= 105 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 103.0' Slope= 0.3300 '/'
Inlet Invert= 1,564.33', Outlet Invert= 1,530.34'

‡

Summary for Reach DC5d: Downchute 5

Inflow Area = 362,082 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 6.61 cfs @ 11.97 hrs, Volume= 15,164 cf
Outflow = 6.61 cfs @ 11.97 hrs, Volume= 15,164 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.28 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.43 fps, Avg. Travel Time= 1.4 min

Peak Storage= 153 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 122.0' Slope= 0.3300 '/'
Inlet Invert= 1,530.34', Outlet Invert= 1,490.08'

‡

Summary for Pond DCCUL5: Downchute Culvert 5

Inflow Area = 391,460 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 7.21 cfs @ 11.97 hrs, Volume= 16,394 cf
Outflow = 7.21 cfs @ 11.97 hrs, Volume= 16,394 cf, Atten= 0%, Lag= 0.0 min
Primary = 7.21 cfs @ 11.97 hrs, Volume= 16,394 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,484.80' @ 11.97 hrs
Flood Elev= 1,486.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,484.00'	**30.0" Round Culvert X 2.00** L= 50.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,484.00' / 1,481.00' S= 0.0600 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=7.21 cfs @ 11.97 hrs HW=1,484.80' (Free Discharge)
↑**1=Culvert** (Inlet Controls 7.21 cfs @ 2.68 fps)

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 42: Subarea 42 Runoff Area=29,378 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=345' Tc=5.2 min CN=80 Runoff=1.73 cfs 3,395 cf

Subcatchment 52: Subarea 52 Runoff Area=58,718 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=715' Tc=4.7 min CN=80 Runoff=3.52 cfs 6,785 cf

Subcatchment 53: Subarea 53 Runoff Area=34,303 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=372' Tc=6.5 min CN=80 Runoff=1.92 cfs 3,964 cf

Subcatchment 64: Subarea 64 Runoff Area=89,809 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=745' Tc=5.1 min CN=80 Runoff=5.30 cfs 10,377 cf

Subcatchment 66: Subarea 66 Runoff Area=28,475 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=346' Tc=4.2 min CN=80 Runoff=1.74 cfs 3,290 cf

Subcatchment 75: Subarea 75 Runoff Area=74,098 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=378' Tc=1.4 min CN=80 Runoff=5.02 cfs 8,562 cf

Subcatchment 76: Subarea 76 Runoff Area=76,679 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=566' Tc=11.1 min CN=80 Runoff=3.61 cfs 8,860 cf

Reach DC5a: Downchute 5 Avg. Flow Depth=0.11' Max Vel=5.42 fps Inflow=7.09 cfs 17,422 cf
n=0.035 L=137.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=7.08 cfs 17,422 cf

Reach DC5b: Downchute 5 Avg. Flow Depth=0.12' Max Vel=5.87 fps Inflow=8.72 cfs 20,712 cf
n=0.035 L=62.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=8.71 cfs 20,712 cf

Reach DC5c: Downchute 5 Avg. Flow Depth=0.16' Max Vel=7.01 fps Inflow=13.74 cfs 31,089 cf
n=0.035 L=103.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=13.74 cfs 31,089 cf

Reach DC5d: Downchute 5 Avg. Flow Depth=0.19' Max Vel=7.95 fps Inflow=19.05 cfs 41,837 cf
n=0.035 L=122.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=19.04 cfs 41,837 cf

Pond DCCUL5: Downchute Culvert 5 Peak Elev=1,485.43' Inflow=20.76 cfs 45,232 cf
30.0" Round Culvert x 2.00 n=0.013 L=50.0' S=0.0600 '/' Outflow=20.76 cfs 45,232 cf

Summary for Subcatchment 42: Subarea 42

Runoff = 1.73 cfs @ 11.97 hrs, Volume= 3,395 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	29,378	80	
	29,378		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	44	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	201	0.0100	2.41	3.13	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=0.50' Z= 2.0 '/' Top.W=3.60' n= 0.030
5.2	345	Total			

Summary for Subcatchment 52: Subarea 52

Runoff = 3.52 cfs @ 11.96 hrs, Volume= 6,785 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	58,718	80	
	58,718		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	93	0.3300	0.45		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.3	622	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.7	715	Total			

Summary for Subcatchment 53: Subarea 53

Runoff = 1.92 cfs @ 11.98 hrs, Volume= 3,964 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	34,303	80	
	34,303		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.5	63	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	209	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
6.5	372	Total			

Summary for Subcatchment 64: Subarea 64

Runoff = 5.30 cfs @ 11.97 hrs, Volume= 10,377 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	89,809	80	
	89,809		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	107	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	538	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
5.1	745	Total			

Summary for Subcatchment 66: Subarea 66

Runoff = 1.74 cfs @ 11.95 hrs, Volume= 3,290 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	28,475	80	
	28,475		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	37	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	209	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.2	346	Total			

Summary for Subcatchment 75: Subarea 75

Runoff = 5.02 cfs @ 11.92 hrs, Volume= 8,562 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	74,098	80	
	74,098		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	10	0.3300	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.8	368	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
1.4	378	Total			

Summary for Subcatchment 76: Subarea 76

Runoff = 3.61 cfs @ 12.03 hrs, Volume= 8,860 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	76,679	80	
	76,679		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.9	163	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	94	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	209	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
11.1	566	Total			

Summary for Reach DC5a: Downchute 5

Inflow Area = 150,777 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 7.09 cfs @ 11.93 hrs, Volume= 17,422 cf
Outflow = 7.08 cfs @ 11.93 hrs, Volume= 17,422 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.42 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.42 fps, Avg. Travel Time= 1.6 min

Peak Storage= 179 cf @ 11.93 hrs
Average Depth at Peak Storage= 0.11'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 137.0' Slope= 0.3300 '/'
Inlet Invert= 1,630.00', Outlet Invert= 1,584.79'

‡

Summary for Reach DC5b: Downchute 5

Inflow Area = 179,252 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 8.72 cfs @ 11.93 hrs, Volume= 20,712 cf
Outflow = 8.71 cfs @ 11.94 hrs, Volume= 20,712 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.87 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.48 fps, Avg. Travel Time= 0.7 min

Peak Storage= 92 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.12'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 62.0' Slope= 0.3300 '/'
Inlet Invert= 1,584.79', Outlet Invert= 1,564.33'

‡

Summary for Reach DC5c: Downchute 5

Inflow Area = 269,061 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 13.74 cfs @ 11.95 hrs, Volume= 31,089 cf
Outflow = 13.74 cfs @ 11.95 hrs, Volume= 31,089 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 7.01 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.71 fps, Avg. Travel Time= 1.0 min

Peak Storage= 202 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 103.0' Slope= 0.3300 '/'
Inlet Invert= 1,564.33', Outlet Invert= 1,530.34'

‡

Summary for Reach DC5d: Downchute 5

Inflow Area = 362,082 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 19.05 cfs @ 11.96 hrs, Volume= 41,837 cf
Outflow = 19.04 cfs @ 11.96 hrs, Volume= 41,837 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 7.95 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.90 fps, Avg. Travel Time= 1.1 min

Peak Storage= 292 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.19'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 122.0' Slope= 0.3300 '/'
Inlet Invert= 1,530.34', Outlet Invert= 1,490.08'

‡

Summary for Pond DCCUL5: Downchute Culvert 5

Inflow Area = 391,460 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 20.76 cfs @ 11.96 hrs, Volume= 45,232 cf
Outflow = 20.76 cfs @ 11.96 hrs, Volume= 45,232 cf, Atten= 0%, Lag= 0.0 min
Primary = 20.76 cfs @ 11.96 hrs, Volume= 45,232 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,485.43' @ 11.96 hrs
Flood Elev= 1,486.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,484.00'	**30.0" Round Culvert X 2.00** L= 50.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,484.00' / 1,481.00' S= 0.0600 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=20.76 cfs @ 11.96 hrs HW=1,485.43' (Free Discharge)
1=Culvert (Inlet Controls 20.76 cfs @ 3.59 fps)

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 42: Subarea 42 Runoff Area=29,378 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=345' Tc=5.2 min CN=80 Runoff=3.87 cfs 7,770 cf

Subcatchment 52: Subarea 52 Runoff Area=58,718 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=715' Tc=4.7 min CN=80 Runoff=7.88 cfs 15,530 cf

Subcatchment 53: Subarea 53 Runoff Area=34,303 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=372' Tc=6.5 min CN=80 Runoff=4.32 cfs 9,073 cf

Subcatchment 64: Subarea 64 Runoff Area=89,809 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=745' Tc=5.1 min CN=80 Runoff=11.89 cfs 23,753 cf

Subcatchment 66: Subarea 66 Runoff Area=28,475 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=346' Tc=4.2 min CN=80 Runoff=3.89 cfs 7,531 cf

Subcatchment 75: Subarea 75 Runoff Area=74,098 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=378' Tc=1.4 min CN=80 Runoff=11.14 cfs 19,598 cf

Subcatchment 76: Subarea 76 Runoff Area=76,679 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=566' Tc=11.1 min CN=80 Runoff=8.22 cfs 20,280 cf

Reach DC5a: Downchute 5 Avg. Flow Depth=0.18' Max Vel=7.47 fps Inflow=16.27 cfs 39,878 cf
n=0.035 L=137.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=16.22 cfs 39,878 cf

Reach DC5b: Downchute 5 Avg. Flow Depth=0.20' Max Vel=8.09 fps Inflow=19.90 cfs 47,410 cf
n=0.035 L=62.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=19.91 cfs 47,410 cf

Reach DC5c: Downchute 5 Avg. Flow Depth=0.26' Max Vel=9.59 fps Inflow=31.13 cfs 71,163 cf
n=0.035 L=103.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=31.12 cfs 71,163 cf

Reach DC5d: Downchute 5 Avg. Flow Depth=0.31' Max Vel=10.83 fps Inflow=43.00 cfs 95,765 cf
n=0.035 L=122.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=42.98 cfs 95,765 cf

Pond DCCUL5: Downchute Culvert 5 Peak Elev=1,486.51' Inflow=46.83 cfs 103,535 cf
30.0" Round Culvert x 2.00 n=0.013 L=50.0' S=0.0600 '/' Outflow=46.83 cfs 103,535 cf

Summary for Subcatchment 42: Subarea 42

Runoff = 3.87 cfs @ 11.96 hrs, Volume= 7,770 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	29,378	80	
	29,378		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	44	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.4	201	0.0100	2.41	3.13	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=0.50' Z= 2.0 '/' Top.W=3.60' n= 0.030
5.2	345	Total			

Summary for Subcatchment 52: Subarea 52

Runoff = 7.88 cfs @ 11.96 hrs, Volume= 15,530 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	58,718	80	
	58,718		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	93	0.3300	0.45		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.3	622	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.7	715	Total			

Summary for Subcatchment 53: Subarea 53

Runoff = 4.32 cfs @ 11.98 hrs, Volume= 9,073 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	34,303	80	
	34,303		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.5	63	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	209	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
6.5	372	Total			

Summary for Subcatchment 64: Subarea 64

Runoff = 11.89 cfs @ 11.96 hrs, Volume= 23,753 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	89,809	80	
	89,809		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	107	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	538	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
5.1	745	Total			

Summary for Subcatchment 66: Subarea 66

Runoff = 3.89 cfs @ 11.95 hrs, Volume= 7,531 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	28,475	80	
	28,475		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	37	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	209	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.2	346	Total			

Summary for Subcatchment 75: Subarea 75

Runoff = 11.14 cfs @ 11.92 hrs, Volume= 19,598 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	74,098	80	
	74,098		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	10	0.3300	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.8	368	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
1.4	378	Total			

Summary for Subcatchment 76: Subarea 76

Runoff = 8.22 cfs @ 12.03 hrs, Volume= 20,280 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	76,679	80	
	76,679		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.9	163	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	94	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	209	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
11.1	566	Total			

Summary for Reach DC5a: Downchute 5

Inflow Area = 150,777 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 16.27 cfs @ 11.92 hrs, Volume= 39,878 cf
Outflow = 16.22 cfs @ 11.93 hrs, Volume= 39,878 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 7.47 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.74 fps, Avg. Travel Time= 1.3 min

Peak Storage= 297 cf @ 11.93 hrs
Average Depth at Peak Storage= 0.18'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 137.0' Slope= 0.3300 '/'
Inlet Invert= 1,630.00', Outlet Invert= 1,584.79'

‡

Summary for Reach DC5b: Downchute 5

Inflow Area = 179,252 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 19.90 cfs @ 11.93 hrs, Volume= 47,410 cf
Outflow = 19.91 cfs @ 11.93 hrs, Volume= 47,410 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 8.09 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.84 fps, Avg. Travel Time= 0.6 min

Peak Storage= 153 cf @ 11.93 hrs
Average Depth at Peak Storage= 0.20'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 62.0' Slope= 0.3300 '/'
Inlet Invert= 1,584.79', Outlet Invert= 1,564.33'

‡

Summary for Reach DC5c: Downchute 5

Inflow Area = 269,061 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 31.13 cfs @ 11.94 hrs, Volume= 71,163 cf
Outflow = 31.12 cfs @ 11.95 hrs, Volume= 71,163 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 9.59 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.12 fps, Avg. Travel Time= 0.8 min

Peak Storage= 334 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 103.0' Slope= 0.3300 '/'
Inlet Invert= 1,564.33', Outlet Invert= 1,530.34'

‡

Summary for Reach DC5d: Downchute 5

Inflow Area = 362,082 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 43.00 cfs @ 11.95 hrs, Volume= 95,765 cf
Outflow = 42.98 cfs @ 11.95 hrs, Volume= 95,765 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 10.83 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.36 fps, Avg. Travel Time= 0.9 min

Peak Storage= 484 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.31'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 122.0' Slope= 0.3300 '/'
Inlet Invert= 1,530.34', Outlet Invert= 1,490.08'

‡

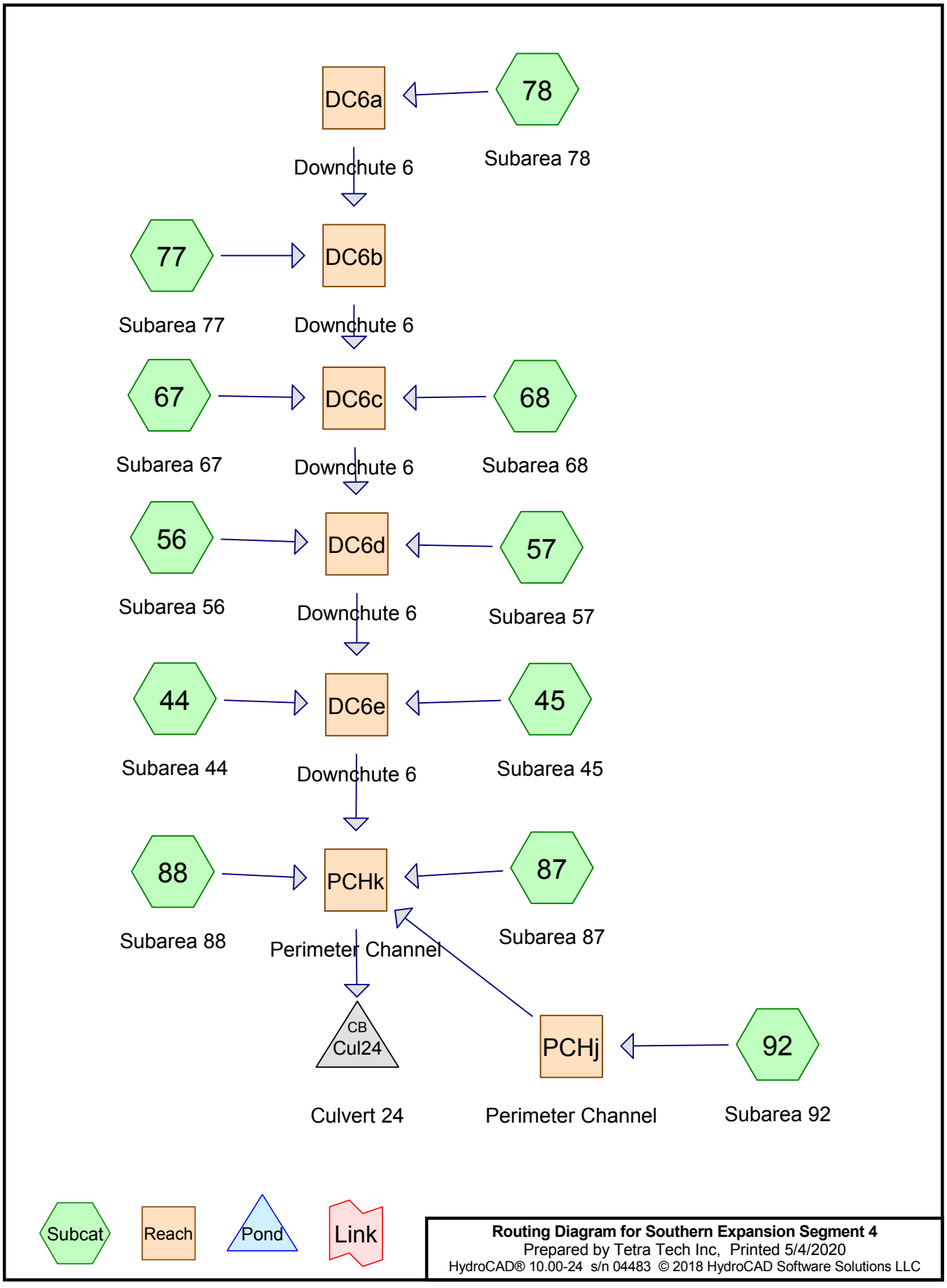
Summary for Pond DCCUL5: Downchute Culvert 5

Inflow Area = 391,460 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 46.83 cfs @ 11.95 hrs, Volume= 103,535 cf
Outflow = 46.83 cfs @ 11.95 hrs, Volume= 103,535 cf, Atten= 0%, Lag= 0.0 min
Primary = 46.83 cfs @ 11.95 hrs, Volume= 103,535 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,486.51' @ 11.95 hrs
Flood Elev= 1,486.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,484.00'	**30.0" Round Culvert X 2.00** L= 50.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,484.00' / 1,481.00' S= 0.0600 '/' Cc= 0.900 n= 0.013, Flow Area= 4.91 sf

Primary OutFlow Max=46.75 cfs @ 11.95 hrs HW=1,486.51' (Free Discharge)
1=Culvert (Inlet Controls 46.75 cfs @ 4.76 fps)



Routing Diagram for Southern Expansion Segment 4
Prepared by Tetra Tech Inc, Printed 5/4/2020
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Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 44: Subarea 44 Runoff Area=19,787 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=222' Tc=4.0 min CN=80 Runoff=0.43 cfs 829 cf

Subcatchment 45: Subarea 45 Runoff Area=30,237 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=314' Tc=4.2 min CN=80 Runoff=0.65 cfs 1,266 cf

Subcatchment 56: Subarea 56 Runoff Area=40,941 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=355' Tc=4.3 min CN=80 Runoff=0.88 cfs 1,715 cf

Subcatchment 57: Subarea 57 Runoff Area=40,026 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=380' Tc=4.4 min CN=80 Runoff=0.86 cfs 1,676 cf

Subcatchment 67: Subarea 67 Runoff Area=61,430 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=480' Tc=4.5 min CN=80 Runoff=1.31 cfs 2,573 cf

Subcatchment 68: Subarea 68 Runoff Area=137,890 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=632' Tc=2.7 min CN=80 Runoff=3.17 cfs 5,775 cf

Subcatchment 77: Subarea 77 Runoff Area=131,201 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=697' Tc=12.0 min CN=80 Runoff=2.03 cfs 5,495 cf

Subcatchment 78: Subarea 78 Runoff Area=142,440 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=445' Slope=0.0400 '/' Tc=12.5 min CN=80 Runoff=2.16 cfs 5,965 cf

Subcatchment 87: Subarea 87 Runoff Area=11,389 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=75' Slope=0.3300 '/' Tc=2.9 min CN=80 Runoff=0.26 cfs 477 cf

Subcatchment 88: Subarea 88 Runoff Area=2,228 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=65' Slope=0.3300 '/' Tc=2.6 min CN=80 Runoff=0.05 cfs 93 cf

Subcatchment 92: Subarea 92 Runoff Area=10,584 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=43' Slope=0.3300 '/' Tc=1.8 min CN=80 Runoff=0.25 cfs 443 cf

Reach DC6a: Downchute 6 Avg. Flow Depth=0.05' Max Vel=3.41 fps Inflow=2.16 cfs 5,965 cf
n=0.035 L=31.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=2.16 cfs 5,965 cf

Reach DC6b: Downchute 6 Avg. Flow Depth=0.08' Max Vel=4.41 fps Inflow=4.19 cfs 11,460 cf
n=0.035 L=150.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=4.18 cfs 11,460 cf

Reach DC6c: Downchute 6 Avg. Flow Depth=0.10' Max Vel=5.31 fps Inflow=6.73 cfs 19,808 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=6.73 cfs 19,808 cf

Reach DC6d: Downchute 6 Avg. Flow Depth=0.12' Max Vel=5.80 fps Inflow=8.44 cfs 23,199 cf
n=0.035 L=149.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=8.43 cfs 23,199 cf

Reach DC6e: Downchute 6 Avg. Flow Depth=0.13' Max Vel=6.07 fps Inflow=9.49 cfs 25,294 cf
n=0.035 L=85.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=9.49 cfs 25,294 cf

Reach PCHj: Perimeter Channel Avg. Flow Depth=0.10' Max Vel=0.86 fps Inflow=0.25 cfs 443 cf
n=0.035 L=206.0' S=0.0100 '/' Capacity=71.87 cfs Outflow=0.21 cfs 443 cf

Reach PCHk: Perimeter Channel Avg. Flow Depth=0.82' Max Vel=2.71 fps Inflow=9.96 cfs 26,307 cf
n=0.035 L=101.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=9.91 cfs 26,307 cf

Pond Cul24: Culvert 24 Peak Elev=1,483.17' Inflow=9.91 cfs 26,307 cf
48.0" Round Culvert n=0.013 L=138.0' S=0.1522 '/' Outflow=9.91 cfs 26,307 cf

Summary for Subcatchment 44: Subarea 44

Runoff = 0.43 cfs @ 11.96 hrs, Volume= 829 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	19,787	80	
	19,787		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	68	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	54	0.0400	6.77	45.68	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035
4.0	222	Total			

Summary for Subcatchment 45: Subarea 45

Runoff = 0.65 cfs @ 11.96 hrs, Volume= 1,266 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	30,237	80	
	30,237		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	65	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	149	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.2	314	Total			

Summary for Subcatchment 56: Subarea 56

Runoff = 0.88 cfs @ 11.96 hrs, Volume= 1,715 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	40,941	80	
	40,941		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	68	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	187	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.3	355	Total			

Summary for Subcatchment 57: Subarea 57

Runoff = 0.86 cfs @ 11.96 hrs, Volume= 1,676 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	40,026	80	
	40,026		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	61	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	219	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.4	380	Total			

Summary for Subcatchment 67: Subarea 67

Runoff = 1.31 cfs @ 11.96 hrs, Volume= 2,573 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	61,430	80	
	61,430		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	57	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	323	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.5	480	Total			

Summary for Subcatchment 68: Subarea 68

Runoff = 3.17 cfs @ 11.94 hrs, Volume= 5,775 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	137,890	80	
	137,890		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	30	0.3300	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.3	602	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.7	632	Total			

Summary for Subcatchment 77: Subarea 77

Runoff = 2.03 cfs @ 12.05 hrs, Volume= 5,495 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	131,201	80	
	131,201		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.7	145	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	452	0.0100	4.07	128.24	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 & 25.0 '/' Top.W=42.00' n= 0.030
12.0	697	Total			

Summary for Subcatchment 78: Subarea 78

Runoff = 2.16 cfs @ 12.06 hrs, Volume= 5,965 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	142,440	80	
	142,440		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
4.1	345	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
12.5	445	Total			

Summary for Subcatchment 87: Subarea 87

Runoff = 0.26 cfs @ 11.94 hrs, Volume= 477 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	11,389	80	
	11,389		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	75	0.3300	0.44		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 88: Subarea 88

Runoff = 0.05 cfs @ 11.94 hrs, Volume= 93 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	2,228	80	
	2,228		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.6	65	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 92: Subarea 92

Runoff = 0.25 cfs @ 11.93 hrs, Volume= 443 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	10,584	80	
	10,584		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	43	0.3300	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Reach DC6a: Downchute 6

Inflow Area = 142,440 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 2.16 cfs @ 12.06 hrs, Volume= 5,965 cf
Outflow = 2.16 cfs @ 12.06 hrs, Volume= 5,965 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.41 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.22 fps, Avg. Travel Time= 0.4 min

Peak Storage= 20 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.05'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 31.0' Slope= 0.3300 '/'
Inlet Invert= 1,670.23', Outlet Invert= 1,660.00'

‡

Summary for Reach DC6b: Downchute 6

Inflow Area = 273,641 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 4.19 cfs @ 12.06 hrs, Volume= 11,460 cf
Outflow = 4.18 cfs @ 12.06 hrs, Volume= 11,460 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.41 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.34 fps, Avg. Travel Time= 1.9 min

Peak Storage= 142 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 150.0' Slope= 0.3300 '/'
Inlet Invert= 1,660.00', Outlet Invert= 1,610.50'

‡

Summary for Reach DC6c: Downchute 6

Inflow Area = 472,961 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 6.73 cfs @ 11.97 hrs, Volume= 19,808 cf
Outflow = 6.73 cfs @ 11.98 hrs, Volume= 19,808 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.31 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.56 fps, Avg. Travel Time= 1.6 min

Peak Storage= 191 cf @ 11.98 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,610.50', Outlet Invert= 1,560.67'

‡

Summary for Reach DC6d: Downchute 6

Inflow Area = 553,928 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 8.44 cfs @ 11.97 hrs, Volume= 23,199 cf
Outflow = 8.43 cfs @ 11.97 hrs, Volume= 23,199 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.80 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.66 fps, Avg. Travel Time= 1.5 min

Peak Storage= 217 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.12'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 149.0' Slope= 0.3300 '/'
Inlet Invert= 1,560.67', Outlet Invert= 1,511.50'

‡

Summary for Reach DC6e: Downchute 6

Inflow Area = 603,952 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 9.49 cfs @ 11.97 hrs, Volume= 25,294 cf
Outflow = 9.49 cfs @ 11.97 hrs, Volume= 25,294 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.07 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.71 fps, Avg. Travel Time= 0.8 min

Peak Storage= 133 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 85.0' Slope= 0.3300 '/'
Inlet Invert= 1,511.50', Outlet Invert= 1,483.45'

‡

Summary for Reach PCHj: Perimeter Channel

Inflow Area = 10,584 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 0.25 cfs @ 11.93 hrs, Volume= 443 cf
Outflow = 0.21 cfs @ 11.96 hrs, Volume= 443 cf, Atten= 17%, Lag= 2.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 0.86 fps, Min. Travel Time= 4.0 min
Avg. Velocity = 0.32 fps, Avg. Travel Time= 10.7 min

Peak Storage= 50 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.10'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 71.87 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 71.87 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 206.0' Slope= 0.0100 '/'
Inlet Invert= 1,485.85', Outlet Invert= 1,483.80'

Summary for Reach PCHk: Perimeter Channel

Inflow Area = 628,153 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 9.96 cfs @ 11.97 hrs, Volume= 26,307 cf
Outflow = 9.91 cfs @ 11.98 hrs, Volume= 26,307 cf, Atten= 1%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.71 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 0.99 fps, Avg. Travel Time= 1.7 min

Peak Storage= 370 cf @ 11.98 hrs
Average Depth at Peak Storage= 0.82'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 101.0' Slope= 0.0100 '/'
Inlet Invert= 1,483.80', Outlet Invert= 1,482.79'

Summary for Pond Cul24: Culvert 24

Inflow Area = 628,153 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 9.91 cfs @ 11.98 hrs, Volume= 26,307 cf
Outflow = 9.91 cfs @ 11.98 hrs, Volume= 26,307 cf, Atten= 0%, Lag= 0.0 min
Primary = 9.91 cfs @ 11.98 hrs, Volume= 26,307 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,483.17' @ 11.98 hrs
Flood Elev= 1,486.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**48.0" Round Culvert** L= 138.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,482.00' / 1,461.00' S= 0.1522 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 12.57 sf

Primary OutFlow Max=9.90 cfs @ 11.98 hrs HW=1,483.17' (Free Discharge)
1=Culvert (Inlet Controls 9.90 cfs @ 3.25 fps)

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 44: Subarea 44 Runoff Area=19,787 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=222' Tc=4.0 min CN=80 Runoff=1.22 cfs 2,286 cf

Subcatchment 45: Subarea 45 Runoff Area=30,237 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=314' Tc=4.2 min CN=80 Runoff=1.85 cfs 3,494 cf

Subcatchment 56: Subarea 56 Runoff Area=40,941 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=355' Tc=4.3 min CN=80 Runoff=2.49 cfs 4,731 cf

Subcatchment 57: Subarea 57 Runoff Area=40,026 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=380' Tc=4.4 min CN=80 Runoff=2.43 cfs 4,625 cf

Subcatchment 67: Subarea 67 Runoff Area=61,430 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=480' Tc=4.5 min CN=80 Runoff=3.71 cfs 7,098 cf

Subcatchment 68: Subarea 68 Runoff Area=137,890 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=632' Tc=2.7 min CN=80 Runoff=8.91 cfs 15,933 cf

Subcatchment 77: Subarea 77 Runoff Area=131,201 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=697' Tc=12.0 min CN=80 Runoff=5.98 cfs 15,160 cf

Subcatchment 78: Subarea 78 Runoff Area=142,440 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=445' Slope=0.0400 '/' Tc=12.5 min CN=80 Runoff=6.37 cfs 16,459 cf

Subcatchment 87: Subarea 87 Runoff Area=11,389 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=75' Slope=0.3300 '/' Tc=2.9 min CN=80 Runoff=0.73 cfs 1,316 cf

Subcatchment 88: Subarea 88 Runoff Area=2,228 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=65' Slope=0.3300 '/' Tc=2.6 min CN=80 Runoff=0.14 cfs 257 cf

Subcatchment 92: Subarea 92 Runoff Area=10,584 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=43' Slope=0.3300 '/' Tc=1.8 min CN=80 Runoff=0.71 cfs 1,223 cf

Reach DC6a: Downchute 6 Avg. Flow Depth=0.10' Max Vel=5.20 fps Inflow=6.37 cfs 16,459 cf
n=0.035 L=31.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=6.37 cfs 16,459 cf

Reach DC6b: Downchute 6 Avg. Flow Depth=0.15' Max Vel=6.73 fps Inflow=12.35 cfs 31,618 cf
n=0.035 L=150.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=12.34 cfs 31,618 cf

Reach DC6c: Downchute 6 Avg. Flow Depth=0.20' Max Vel=8.16 fps Inflow=20.38 cfs 54,649 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=20.38 cfs 54,649 cf

Reach DC6d: Downchute 6 Avg. Flow Depth=0.23' Max Vel=8.85 fps Inflow=25.27 cfs 64,005 cf
n=0.035 L=149.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=25.26 cfs 64,005 cf

Reach DC6e: Downchute 6 Avg. Flow Depth=0.24' Max Vel=9.24 fps Inflow=28.28 cfs 69,785 cf
n=0.035 L=85.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=28.28 cfs 69,785 cf

Reach PCHj: Perimeter Channel Avg. Flow Depth=0.20' Max Vel=1.24 fps Inflow=0.71 cfs 1,223 cf
n=0.035 L=206.0' S=0.0100 '/' Capacity=71.87 cfs Outflow=0.64 cfs 1,223 cf

Reach PCHk: Perimeter Channel Avg. Flow Depth=1.36' Max Vel=3.59 fps Inflow=29.69 cfs 72,581 cf
n=0.035 L=101.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=29.60 cfs 72,581 cf

Pond Cul24: Culvert 24 Peak Elev=1,484.12' Inflow=29.60 cfs 72,581 cf
48.0" Round Culvert n=0.013 L=138.0' S=0.1522 '/' Outflow=29.60 cfs 72,581 cf

Summary for Subcatchment 44: Subarea 44

Runoff = 1.22 cfs @ 11.95 hrs, Volume= 2,286 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	19,787	80	
	19,787		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	68	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	54	0.0400	6.77	45.68	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035
4.0	222	Total			

Summary for Subcatchment 45: Subarea 45

Runoff = 1.85 cfs @ 11.95 hrs, Volume= 3,494 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	30,237	80	
	30,237		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	65	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	149	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.2	314	Total			

Summary for Subcatchment 56: Subarea 56

Runoff = 2.49 cfs @ 11.96 hrs, Volume= 4,731 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	40,941	80	
	40,941		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	68	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	187	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.3	355	Total			

Summary for Subcatchment 57: Subarea 57

Runoff = 2.43 cfs @ 11.96 hrs, Volume= 4,625 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	40,026	80	
	40,026		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	61	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	219	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.4	380	Total			

Summary for Subcatchment 67: Subarea 67

Runoff = 3.71 cfs @ 11.96 hrs, Volume= 7,098 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	61,430	80	
	61,430		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	57	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	323	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.5	480	Total			

Summary for Subcatchment 68: Subarea 68

Runoff = 8.91 cfs @ 11.94 hrs, Volume= 15,933 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	137,890	80	
	137,890		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	30	0.3300	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.3	602	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.7	632	Total			

Summary for Subcatchment 77: Subarea 77

Runoff = 5.98 cfs @ 12.04 hrs, Volume= 15,160 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	131,201	80	
	131,201		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.7	145	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	452	0.0100	4.07	128.24	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 & 25.0 '/' Top.W=42.00' n= 0.030
12.0	697	Total			

Summary for Subcatchment 78: Subarea 78

Runoff = 6.37 cfs @ 12.05 hrs, Volume= 16,459 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	142,440	80	
	142,440		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
4.1	345	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
12.5	445	Total			

Summary for Subcatchment 87: Subarea 87

Runoff = 0.73 cfs @ 11.94 hrs, Volume= 1,316 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	11,389	80	
	11,389		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	75	0.3300	0.44		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 88: Subarea 88

Runoff = 0.14 cfs @ 11.93 hrs, Volume= 257 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	2,228	80	
	2,228		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.6	65	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 92: Subarea 92

Runoff = 0.71 cfs @ 11.92 hrs, Volume= 1,223 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	10,584	80	
	10,584		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	43	0.3300	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Reach DC6a: Downchute 6

Inflow Area = 142,440 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 6.37 cfs @ 12.05 hrs, Volume= 16,459 cf
Outflow = 6.37 cfs @ 12.05 hrs, Volume= 16,459 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.20 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.40 fps, Avg. Travel Time= 0.4 min

Peak Storage= 38 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 31.0' Slope= 0.3300 '/'
Inlet Invert= 1,670.23', Outlet Invert= 1,660.00'

Summary for Reach DC6b: Downchute 6

Inflow Area = 273,641 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 12.35 cfs @ 12.04 hrs, Volume= 31,618 cf
Outflow = 12.34 cfs @ 12.05 hrs, Volume= 31,618 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.73 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.72 fps, Avg. Travel Time= 1.5 min

Peak Storage= 275 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.15'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 150.0' Slope= 0.3300 '/'
Inlet Invert= 1,660.00', Outlet Invert= 1,610.50'

Summary for Reach DC6c: Downchute 6

Inflow Area = 472,961 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 20.38 cfs @ 11.96 hrs, Volume= 54,649 cf
Outflow = 20.38 cfs @ 11.96 hrs, Volume= 54,649 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 8.16 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.08 fps, Avg. Travel Time= 1.2 min

Peak Storage= 377 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.20'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,610.50', Outlet Invert= 1,560.67'

‡

Summary for Reach DC6d: Downchute 6

Inflow Area = 553,928 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 25.27 cfs @ 11.96 hrs, Volume= 64,005 cf
Outflow = 25.26 cfs @ 11.96 hrs, Volume= 64,005 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 8.85 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.20 fps, Avg. Travel Time= 1.1 min

Peak Storage= 425 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.23'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 149.0' Slope= 0.3300 '/'
Inlet Invert= 1,560.67', Outlet Invert= 1,511.50'

‡

Summary for Reach DC6e: Downchute 6

Inflow Area = 603,952 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 28.28 cfs @ 11.96 hrs, Volume= 69,785 cf
Outflow = 28.28 cfs @ 11.96 hrs, Volume= 69,785 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 9.24 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.27 fps, Avg. Travel Time= 0.6 min

Peak Storage= 260 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 85.0' Slope= 0.3300 '/'
Inlet Invert= 1,511.50', Outlet Invert= 1,483.45'

‡

Summary for Reach PCHj: Perimeter Channel

Inflow Area = 10,584 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 0.71 cfs @ 11.92 hrs, Volume= 1,223 cf
Outflow = 0.64 cfs @ 11.95 hrs, Volume= 1,223 cf, Atten= 10%, Lag= 1.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.24 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 0.35 fps, Avg. Travel Time= 9.7 min

Peak Storage= 106 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.20'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 71.87 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 71.87 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 206.0' Slope= 0.0100 '/'
Inlet Invert= 1,485.85', Outlet Invert= 1,483.80'

Summary for Reach PCHk: Perimeter Channel

Inflow Area = 628,153 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 29.69 cfs @ 11.96 hrs, Volume= 72,581 cf
Outflow = 29.60 cfs @ 11.97 hrs, Volume= 72,581 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.59 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.24 fps, Avg. Travel Time= 1.4 min

Peak Storage= 832 cf @ 11.97 hrs
Average Depth at Peak Storage= 1.36'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 101.0' Slope= 0.0100 '/'
Inlet Invert= 1,483.80', Outlet Invert= 1,482.79'

Summary for Pond Cul24: Culvert 24

Inflow Area = 628,153 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 29.60 cfs @ 11.97 hrs, Volume= 72,581 cf
Outflow = 29.60 cfs @ 11.97 hrs, Volume= 72,581 cf, Atten= 0%, Lag= 0.0 min
Primary = 29.60 cfs @ 11.97 hrs, Volume= 72,581 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,484.12' @ 11.97 hrs
Flood Elev= 1,486.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**48.0" Round Culvert** L= 138.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,482.00' / 1,461.00' S= 0.1522 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 12.57 sf

Primary OutFlow Max=29.58 cfs @ 11.97 hrs HW=1,484.12' (Free Discharge)
1=Culvert (Inlet Controls 29.58 cfs @ 4.37 fps)

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 44: Subarea 44 Runoff Area=19,787 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=222' Tc=4.0 min CN=80 Runoff=2.72 cfs 5,233 cf

Subcatchment 45: Subarea 45 Runoff Area=30,237 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=314' Tc=4.2 min CN=80 Runoff=4.13 cfs 7,997 cf

Subcatchment 56: Subarea 56 Runoff Area=40,941 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=355' Tc=4.3 min CN=80 Runoff=5.57 cfs 10,828 cf

Subcatchment 57: Subarea 57 Runoff Area=40,026 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=380' Tc=4.4 min CN=80 Runoff=5.43 cfs 10,586 cf

Subcatchment 67: Subarea 67 Runoff Area=61,430 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=480' Tc=4.5 min CN=80 Runoff=8.31 cfs 16,247 cf

Subcatchment 68: Subarea 68 Runoff Area=137,890 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=632' Tc=2.7 min CN=80 Runoff=19.85 cfs 36,470 cf

Subcatchment 77: Subarea 77 Runoff Area=131,201 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=697' Tc=12.0 min CN=80 Runoff=13.65 cfs 34,701 cf

Subcatchment 78: Subarea 78 Runoff Area=142,440 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=445' Slope=0.0400 '/' Tc=12.5 min CN=80 Runoff=14.57 cfs 37,673 cf

Subcatchment 87: Subarea 87 Runoff Area=11,389 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=75' Slope=0.3300 '/' Tc=2.9 min CN=80 Runoff=1.63 cfs 3,012 cf

Subcatchment 88: Subarea 88 Runoff Area=2,228 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=65' Slope=0.3300 '/' Tc=2.6 min CN=80 Runoff=0.32 cfs 589 cf

Subcatchment 92: Subarea 92 Runoff Area=10,584 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=43' Slope=0.3300 '/' Tc=1.8 min CN=80 Runoff=1.57 cfs 2,799 cf

Reach DC6a: Downchute 6 Avg. Flow Depth=0.16' Max Vel=7.17 fps Inflow=14.57 cfs 37,673 cf
n=0.035 L=31.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=14.57 cfs 37,673 cf

Reach DC6b: Downchute 6 Avg. Flow Depth=0.24' Max Vel=9.24 fps Inflow=28.21 cfs 72,374 cf
n=0.035 L=150.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=28.19 cfs 72,374 cf

Reach DC6c: Downchute 6 Avg. Flow Depth=0.33' Max Vel=11.21 fps Inflow=47.08 cfs 125,091 cf
n=0.035 L=151.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=47.07 cfs 125,091 cf

Reach DC6d: Downchute 6 Avg. Flow Depth=0.38' Max Vel=12.12 fps Inflow=58.04 cfs 146,506 cf
n=0.035 L=149.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=58.03 cfs 146,506 cf

Reach DC6e: Downchute 6 Avg. Flow Depth=0.40' Max Vel=12.62 fps Inflow=64.83 cfs 159,737 cf
n=0.035 L=85.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=64.83 cfs 159,737 cf

Reach PCHj: Perimeter Channel Avg. Flow Depth=0.31' Max Vel=1.59 fps Inflow=1.57 cfs 2,799 cf
n=0.035 L=206.0' S=0.0100 '/' Capacity=71.87 cfs Outflow=1.46 cfs 2,799 cf

Reach PCHk: Perimeter Channel Avg. Flow Depth=1.95' Max Vel=4.44 fps Inflow=68.02 cfs 166,137 cf
n=0.035 L=101.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=67.92 cfs 166,137 cf

Pond Cul24: Culvert 24 Peak Elev=1,485.60' Inflow=67.92 cfs 166,137 cf
48.0" Round Culvert n=0.013 L=138.0' S=0.1522 '/' Outflow=67.92 cfs 166,137 cf

Summary for Subcatchment 44: Subarea 44

Runoff = 2.72 cfs @ 11.95 hrs, Volume= 5,233 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	19,787	80	
	19,787		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	68	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	54	0.0400	6.77	45.68	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035
4.0	222	Total			

Summary for Subcatchment 45: Subarea 45

Runoff = 4.13 cfs @ 11.95 hrs, Volume= 7,997 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	30,237	80	
	30,237		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	65	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.3	149	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.2	314	Total			

Summary for Subcatchment 56: Subarea 56

Runoff = 5.57 cfs @ 11.95 hrs, Volume= 10,828 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	40,941	80	
	40,941		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	68	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.4	187	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.3	355	Total			

Summary for Subcatchment 57: Subarea 57

Runoff = 5.43 cfs @ 11.95 hrs, Volume= 10,586 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	40,026	80	
	40,026		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	61	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.5	219	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.4	380	Total			

Summary for Subcatchment 67: Subarea 67

Runoff = 8.31 cfs @ 11.95 hrs, Volume= 16,247 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	61,430	80	
	61,430		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	57	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	323	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.5	480	Total			

Summary for Subcatchment 68: Subarea 68

Runoff = 19.85 cfs @ 11.93 hrs, Volume= 36,470 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	137,890	80	
	137,890		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	30	0.3300	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.3	602	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.7	632	Total			

Summary for Subcatchment 77: Subarea 77

Runoff = 13.65 cfs @ 12.04 hrs, Volume= 34,701 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	131,201	80	
	131,201		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.7	145	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.9	452	0.0100	4.07	128.24	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 & 25.0 '/' Top.W=42.00' n= 0.030
12.0	697	Total			

Summary for Subcatchment 78: Subarea 78

Runoff = 14.57 cfs @ 12.04 hrs, Volume= 37,673 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	142,440	80	
	142,440		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
4.1	345	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
12.5	445	Total			

Summary for Subcatchment 87: Subarea 87

Runoff = 1.63 cfs @ 11.94 hrs, Volume= 3,012 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	11,389	80	
	11,389		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	75	0.3300	0.44		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 88: Subarea 88

Runoff = 0.32 cfs @ 11.93 hrs, Volume= 589 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	2,228	80	
	2,228		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.6	65	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 92: Subarea 92

Runoff = 1.57 cfs @ 11.92 hrs, Volume= 2,799 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	10,584	80	
	10,584		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	43	0.3300	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Reach DC6a: Downchute 6

Inflow Area = 142,440 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 14.57 cfs @ 12.04 hrs, Volume= 37,673 cf
Outflow = 14.57 cfs @ 12.04 hrs, Volume= 37,673 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 7.17 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.70 fps, Avg. Travel Time= 0.3 min

Peak Storage= 63 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 31.0' Slope= 0.3300 '/'
Inlet Invert= 1,670.23', Outlet Invert= 1,660.00'

Summary for Reach DC6b: Downchute 6

Inflow Area = 273,641 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 28.21 cfs @ 12.04 hrs, Volume= 72,374 cf
Outflow = 28.19 cfs @ 12.04 hrs, Volume= 72,374 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 9.24 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.14 fps, Avg. Travel Time= 1.2 min

Peak Storage= 458 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 150.0' Slope= 0.3300 '/'
Inlet Invert= 1,660.00', Outlet Invert= 1,610.50'

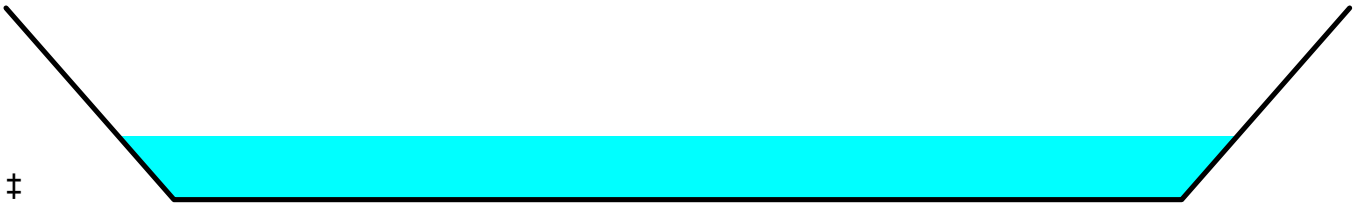
Summary for Reach DC6c: Downchute 6

Inflow Area = 472,961 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 47.08 cfs @ 11.96 hrs, Volume= 125,091 cf
Outflow = 47.07 cfs @ 11.96 hrs, Volume= 125,091 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 11.21 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.60 fps, Avg. Travel Time= 1.0 min

Peak Storage= 634 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 151.0' Slope= 0.3300 '/'
Inlet Invert= 1,610.50', Outlet Invert= 1,560.67'



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Summary for Reach DC6d: Downchute 6

Inflow Area = 553,928 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 58.04 cfs @ 11.96 hrs, Volume= 146,506 cf
Outflow = 58.03 cfs @ 11.96 hrs, Volume= 146,506 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 12.12 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.75 fps, Avg. Travel Time= 0.9 min

Peak Storage= 714 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 149.0' Slope= 0.3300 '/'
Inlet Invert= 1,560.67', Outlet Invert= 1,511.50'

‡

Summary for Reach DC6e: Downchute 6

Inflow Area = 603,952 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 64.83 cfs @ 11.96 hrs, Volume= 159,737 cf
Outflow = 64.83 cfs @ 11.96 hrs, Volume= 159,737 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 12.62 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.84 fps, Avg. Travel Time= 0.5 min

Peak Storage= 437 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 85.0' Slope= 0.3300 '/'
Inlet Invert= 1,511.50', Outlet Invert= 1,483.45'

‡

Summary for Reach PCHj: Perimeter Channel

Inflow Area = 10,584 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 1.57 cfs @ 11.92 hrs, Volume= 2,799 cf
Outflow = 1.46 cfs @ 11.94 hrs, Volume= 2,799 cf, Atten= 7%, Lag= 1.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.59 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.41 fps, Avg. Travel Time= 8.4 min

Peak Storage= 189 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.31'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 71.87 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 71.87 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 206.0' Slope= 0.0100 '/'
Inlet Invert= 1,485.85', Outlet Invert= 1,483.80'

Summary for Reach PCHk: Perimeter Channel

Inflow Area = 628,153 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 68.02 cfs @ 11.96 hrs, Volume= 166,137 cf
Outflow = 67.92 cfs @ 11.96 hrs, Volume= 166,137 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.44 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.47 fps, Avg. Travel Time= 1.1 min

Peak Storage= 1,546 cf @ 11.96 hrs
Average Depth at Peak Storage= 1.95'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 101.0' Slope= 0.0100 '/'
Inlet Invert= 1,483.80', Outlet Invert= 1,482.79'

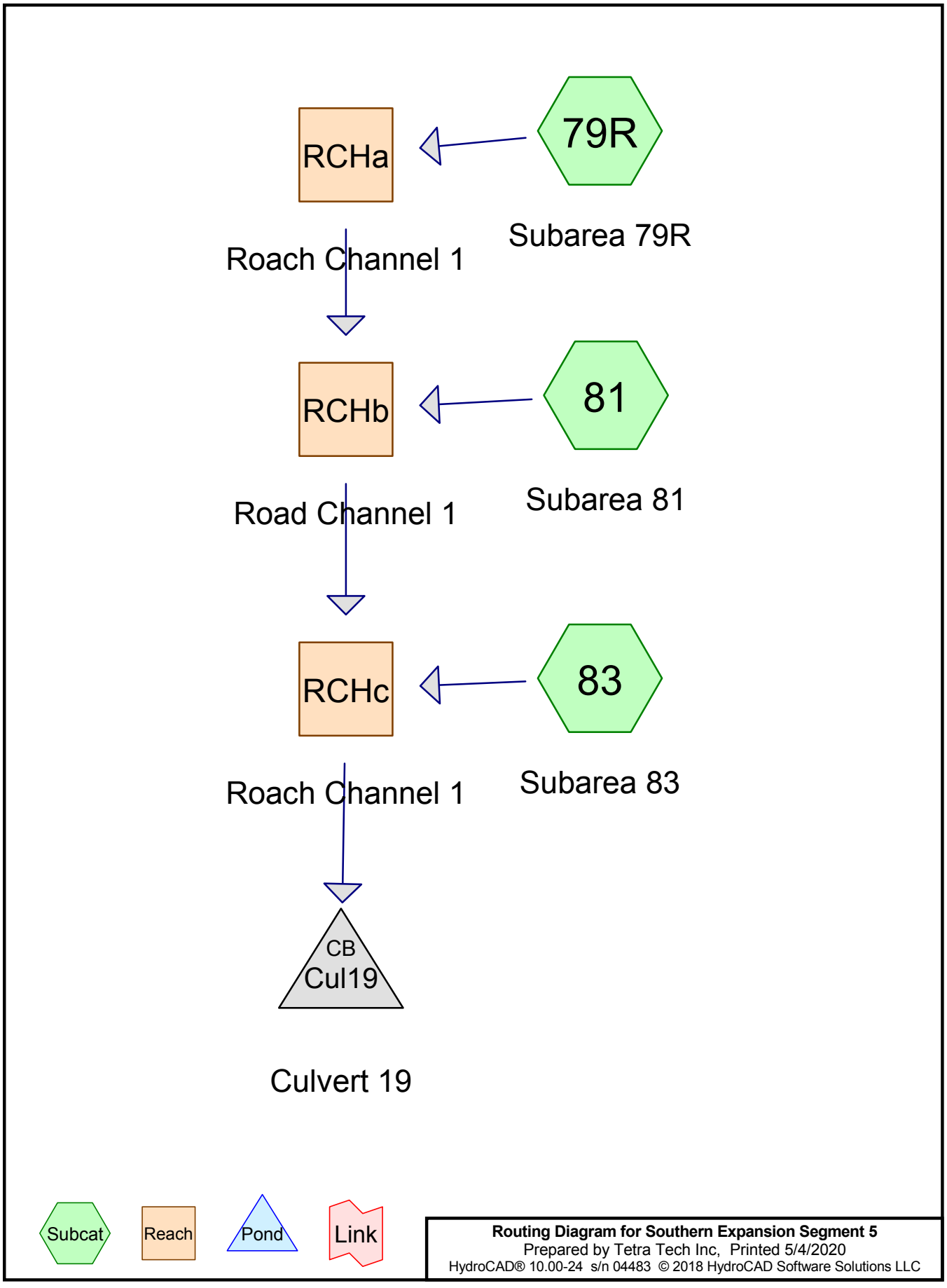
Summary for Pond Cul24: Culvert 24

Inflow Area = 628,153 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 67.92 cfs @ 11.96 hrs, Volume= 166,137 cf
Outflow = 67.92 cfs @ 11.96 hrs, Volume= 166,137 cf, Atten= 0%, Lag= 0.0 min
Primary = 67.92 cfs @ 11.96 hrs, Volume= 166,137 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,485.60' @ 11.96 hrs
Flood Elev= 1,486.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**48.0" Round Culvert** L= 138.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,482.00' / 1,461.00' S= 0.1522 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 12.57 sf

Primary OutFlow Max=67.83 cfs @ 11.96 hrs HW=1,485.60' (Free Discharge)
1=Culvert (Inlet Controls 67.83 cfs @ 5.70 fps)



Routing Diagram for Southern Expansion Segment 5
Prepared by Tetra Tech Inc, Printed 5/4/2020
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Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 79R: Subarea 79R Runoff Area=214,975 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=948' Slope=0.0400 '/' Tc=15.5 min CN=80 Runoff=2.91 cfs 9,003 cf

Subcatchment 81: Subarea 81 Runoff Area=61,274 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=498' Tc=4.6 min CN=80 Runoff=1.30 cfs 2,566 cf

Subcatchment 83: Subarea 83 Runoff Area=60,848 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=515' Tc=4.5 min CN=80 Runoff=1.30 cfs 2,548 cf

Reach RCHa: Roach Channel 1 Avg. Flow Depth=0.41' Max Vel=5.74 fps Inflow=2.91 cfs 9,003 cf
n=0.035 L=314.0' S=0.1624 '/' Capacity=92.05 cfs Outflow=2.89 cfs 9,003 cf

Reach RCHb: Road Channel 1 Avg. Flow Depth=0.43' Max Vel=5.85 fps Inflow=3.19 cfs 11,569 cf
n=0.035 L=312.0' S=0.1603 '/' Capacity=91.44 cfs Outflow=3.19 cfs 11,569 cf

Reach RCHc: Roach Channel 1 Avg. Flow Depth=0.46' Max Vel=6.21 fps Inflow=3.98 cfs 14,118 cf
n=0.035 L=191.0' S=0.1623 '/' Capacity=92.02 cfs Outflow=3.97 cfs 14,118 cf

Pond Cul19: Culvert 19 Peak Elev=1,482.79' Inflow=3.97 cfs 14,118 cf
36.0" Round Culvert n=0.013 L=69.0' S=0.1594 '/' Outflow=3.97 cfs 14,118 cf

Summary for Subcatchment 79R: Subarea 79R

Runoff = 2.91 cfs @ 12.09 hrs, Volume= 9,003 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	214,975	80	
	214,975		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
6.4	535	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	313	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
15.5	948	Total			

Summary for Subcatchment 81: Subarea 81

Runoff = 1.30 cfs @ 11.97 hrs, Volume= 2,566 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	61,274	80	
	61,274		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	41	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	357	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	498	Total			

Summary for Subcatchment 83: Subarea 83

Runoff = 1.30 cfs @ 11.96 hrs, Volume= 2,548 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	60,848	80	
	60,848		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.1	16	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	399	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.5	515	Total			

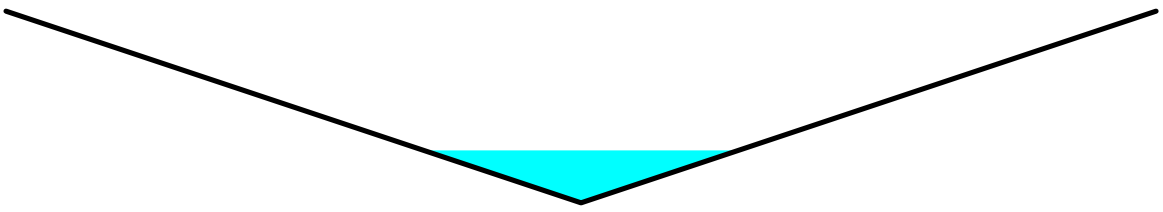
Summary for Reach RCHa: Roach Channel 1

Inflow Area = 214,975 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 2.91 cfs @ 12.09 hrs, Volume= 9,003 cf
Outflow = 2.89 cfs @ 12.10 hrs, Volume= 9,003 cf, Atten= 0%, Lag= 0.7 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.74 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 2.53 fps, Avg. Travel Time= 2.1 min

Peak Storage= 158 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.41'
Defined Flood Depth= 1.50' Flow Area= 6.8 sf, Capacity= 92.05 cfs
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 92.05 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 314.0' Slope= 0.1624 '/'
Inlet Invert= 1,618.00', Outlet Invert= 1,567.00'



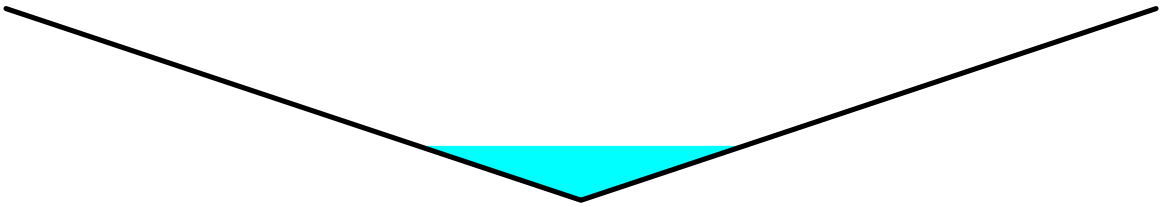
Summary for Reach RCHb: Road Channel 1

Inflow Area = 276,249 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 3.19 cfs @ 12.09 hrs, Volume= 11,569 cf
Outflow = 3.19 cfs @ 12.10 hrs, Volume= 11,569 cf, Atten= 0%, Lag= 0.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.85 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 2.65 fps, Avg. Travel Time= 2.0 min

Peak Storage= 170 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.43'
Defined Flood Depth= 1.50' Flow Area= 6.8 sf, Capacity= 91.44 cfs
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 91.44 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 312.0' Slope= 0.1603 '/'
Inlet Invert= 1,567.00', Outlet Invert= 1,517.00'



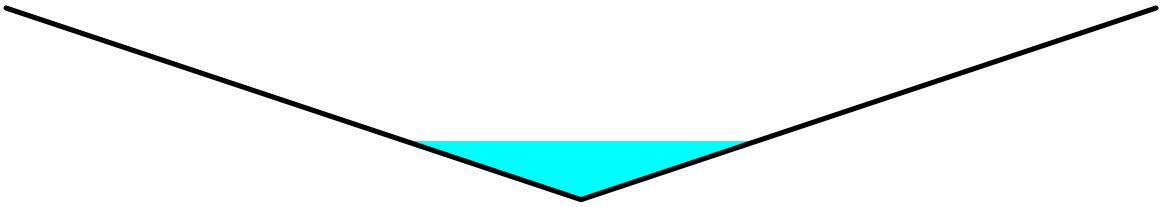
Summary for Reach RCHc: Roach Channel 1

Inflow Area = 337,097 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 3.98 cfs @ 12.00 hrs, Volume= 14,118 cf
Outflow = 3.97 cfs @ 12.01 hrs, Volume= 14,118 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.21 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 2.78 fps, Avg. Travel Time= 1.1 min

Peak Storage= 122 cf @ 12.01 hrs
Average Depth at Peak Storage= 0.46'
Defined Flood Depth= 1.50' Flow Area= 6.8 sf, Capacity= 92.02 cfs
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 92.02 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 191.0' Slope= 0.1623 '/'
Inlet Invert= 1,517.00', Outlet Invert= 1,486.00'



Summary for Pond Cul19: Culvert 19

Inflow Area = 337,097 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 3.97 cfs @ 12.01 hrs, Volume= 14,118 cf
Outflow = 3.97 cfs @ 12.01 hrs, Volume= 14,118 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.97 cfs @ 12.01 hrs, Volume= 14,118 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.79' @ 12.01 hrs
Flood Elev= 1,485.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**36.0" Round Culvert** L= 69.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,482.00' / 1,471.00' S= 0.1594 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=3.97 cfs @ 12.01 hrs HW=1,482.79' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 3.97 cfs @ 2.67 fps)

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 79R: Subarea 79R Runoff Area=214,975 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=948' Slope=0.0400 '/' Tc=15.5 min CN=80 Runoff=8.67 cfs 24,840 cf

Subcatchment 81: Subarea 81 Runoff Area=61,274 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=498' Tc=4.6 min CN=80 Runoff=3.69 cfs 7,080 cf

Subcatchment 83: Subarea 83 Runoff Area=60,848 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=515' Tc=4.5 min CN=80 Runoff=3.68 cfs 7,031 cf

Reach RCHa: Roach Channel 1 Avg. Flow Depth=0.62' Max Vel=7.55 fps Inflow=8.67 cfs 24,840 cf
n=0.035 L=314.0' S=0.1624 '/' Capacity=92.05 cfs Outflow=8.65 cfs 24,840 cf

Reach RCHb: Road Channel 1 Avg. Flow Depth=0.65' Max Vel=7.73 fps Inflow=9.70 cfs 31,920 cf
n=0.035 L=312.0' S=0.1603 '/' Capacity=91.44 cfs Outflow=9.69 cfs 31,920 cf

Reach RCHc: Roach Channel 1 Avg. Flow Depth=0.71' Max Vel=8.26 fps Inflow=12.44 cfs 38,951 cf
n=0.035 L=191.0' S=0.1623 '/' Capacity=92.02 cfs Outflow=12.43 cfs 38,951 cf

Pond Cul19: Culvert 19 Peak Elev=1,483.46' Inflow=12.43 cfs 38,951 cf
36.0" Round Culvert n=0.013 L=69.0' S=0.1594 '/' Outflow=12.43 cfs 38,951 cf

Summary for Subcatchment 79R: Subarea 79R

Runoff = 8.67 cfs @ 12.08 hrs, Volume= 24,840 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	214,975	80	
	214,975		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
6.4	535	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	313	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
15.5	948	Total			

Summary for Subcatchment 81: Subarea 81

Runoff = 3.69 cfs @ 11.96 hrs, Volume= 7,080 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	61,274	80	
	61,274		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	41	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	357	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	498	Total			

Summary for Subcatchment 83: Subarea 83

Runoff = 3.68 cfs @ 11.96 hrs, Volume= 7,031 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	60,848	80	
	60,848		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.1	16	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	399	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.5	515	Total			

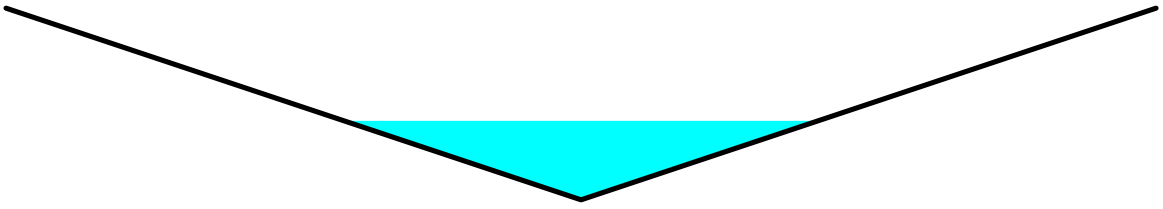
Summary for Reach RCHa: Roach Channel 1

Inflow Area = 214,975 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 8.67 cfs @ 12.08 hrs, Volume= 24,840 cf
Outflow = 8.65 cfs @ 12.09 hrs, Volume= 24,840 cf, Atten= 0%, Lag= 0.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 7.55 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 3.02 fps, Avg. Travel Time= 1.7 min

Peak Storage= 360 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.62'
Defined Flood Depth= 1.50' Flow Area= 6.8 sf, Capacity= 92.05 cfs
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 92.05 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 314.0' Slope= 0.1624 '/'
Inlet Invert= 1,618.00', Outlet Invert= 1,567.00'



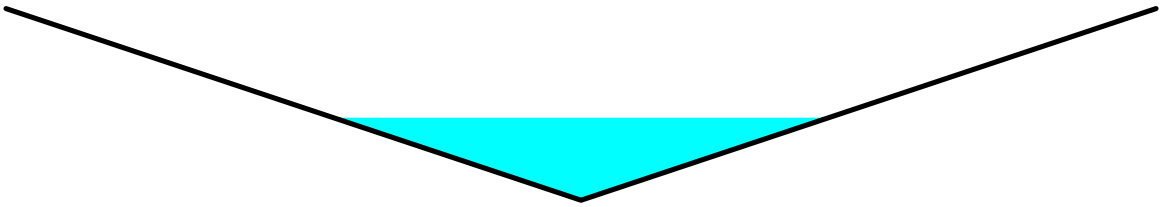
Summary for Reach RCHb: Road Channel 1

Inflow Area = 276,249 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 9.70 cfs @ 12.03 hrs, Volume= 31,920 cf
Outflow = 9.69 cfs @ 12.04 hrs, Volume= 31,920 cf, Atten= 0%, Lag= 0.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 7.73 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 3.16 fps, Avg. Travel Time= 1.6 min

Peak Storage= 391 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.65'
Defined Flood Depth= 1.50' Flow Area= 6.8 sf, Capacity= 91.44 cfs
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 91.44 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 312.0' Slope= 0.1603 '/'
Inlet Invert= 1,567.00', Outlet Invert= 1,517.00'



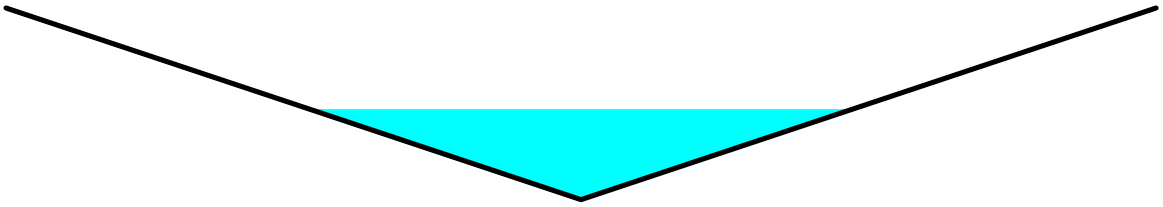
Summary for Reach RCHc: Roach Channel 1

Inflow Area = 337,097 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 12.44 cfs @ 11.99 hrs, Volume= 38,951 cf
Outflow = 12.43 cfs @ 11.99 hrs, Volume= 38,951 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 8.26 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 3.32 fps, Avg. Travel Time= 1.0 min

Peak Storage= 287 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.71'
Defined Flood Depth= 1.50' Flow Area= 6.8 sf, Capacity= 92.02 cfs
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 92.02 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 191.0' Slope= 0.1623 '/'
Inlet Invert= 1,517.00', Outlet Invert= 1,486.00'



Summary for Pond Cul19: Culvert 19

Inflow Area = 337,097 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 12.43 cfs @ 11.99 hrs, Volume= 38,951 cf
Outflow = 12.43 cfs @ 11.99 hrs, Volume= 38,951 cf, Atten= 0%, Lag= 0.0 min
Primary = 12.43 cfs @ 11.99 hrs, Volume= 38,951 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,483.46' @ 11.99 hrs
Flood Elev= 1,485.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**36.0" Round Culvert** L= 69.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,482.00' / 1,471.00' S= 0.1594 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=12.41 cfs @ 11.99 hrs HW=1,483.46' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 12.41 cfs @ 3.63 fps)

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 79R: Subarea 79R Runoff Area=214,975 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=948' Slope=0.0400 '/' Tc=15.5 min CN=80 Runoff=19.94 cfs 56,858 cf

Subcatchment 81: Subarea 81 Runoff Area=61,274 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=498' Tc=4.6 min CN=80 Runoff=8.26 cfs 16,206 cf

Subcatchment 83: Subarea 83 Runoff Area=60,848 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=515' Tc=4.5 min CN=80 Runoff=8.23 cfs 16,093 cf

Reach RCHa: Roach Channel 1 Avg. Flow Depth=0.84' Max Vel=9.30 fps Inflow=19.94 cfs 56,858 cf
n=0.035 L=314.0' S=0.1624 '/' Capacity=92.05 cfs Outflow=19.90 cfs 56,858 cf

Reach RCHb: Road Channel 1 Avg. Flow Depth=0.89' Max Vel=9.56 fps Inflow=22.71 cfs 73,064 cf
n=0.035 L=312.0' S=0.1603 '/' Capacity=91.44 cfs Outflow=22.68 cfs 73,064 cf

Reach RCHc: Roach Channel 1 Avg. Flow Depth=0.97' Max Vel=10.23 fps Inflow=29.17 cfs 89,157 cf
n=0.035 L=191.0' S=0.1623 '/' Capacity=92.02 cfs Outflow=29.14 cfs 89,157 cf

Pond Cul19: Culvert 19 Peak Elev=1,484.45' Inflow=29.14 cfs 89,157 cf
36.0" Round Culvert n=0.013 L=69.0' S=0.1594 '/' Outflow=29.14 cfs 89,157 cf

Summary for Subcatchment 79R: Subarea 79R

Runoff = 19.94 cfs @ 12.07 hrs, Volume= 56,858 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	214,975	80	
	214,975		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
6.4	535	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	313	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
15.5	948	Total			

Summary for Subcatchment 81: Subarea 81

Runoff = 8.26 cfs @ 11.96 hrs, Volume= 16,206 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	61,274	80	
	61,274		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	41	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	357	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	498	Total			

Summary for Subcatchment 83: Subarea 83

Runoff = 8.23 cfs @ 11.95 hrs, Volume= 16,093 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	60,848	80	
	60,848		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.1	16	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	399	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.5	515	Total			

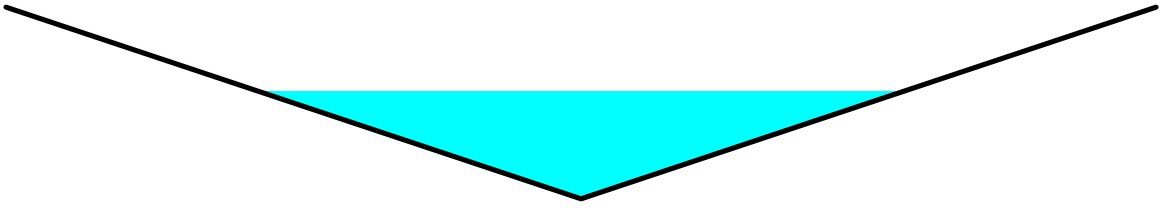
Summary for Reach RCHa: Roach Channel 1

Inflow Area = 214,975 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 19.94 cfs @ 12.07 hrs, Volume= 56,858 cf
Outflow = 19.90 cfs @ 12.08 hrs, Volume= 56,858 cf, Atten= 0%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 9.30 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 3.49 fps, Avg. Travel Time= 1.5 min

Peak Storage= 672 cf @ 12.08 hrs
Average Depth at Peak Storage= 0.84'
Defined Flood Depth= 1.50' Flow Area= 6.8 sf, Capacity= 92.05 cfs
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 92.05 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 314.0' Slope= 0.1624 '/'
Inlet Invert= 1,618.00', Outlet Invert= 1,567.00'



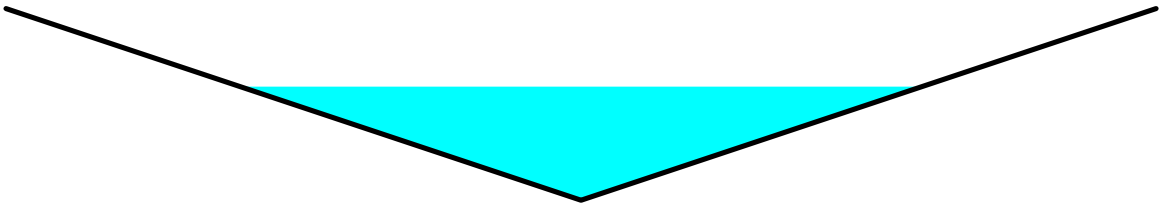
Summary for Reach RCHb: Road Channel 1

Inflow Area = 276,249 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 22.71 cfs @ 12.02 hrs, Volume= 73,064 cf
Outflow = 22.68 cfs @ 12.03 hrs, Volume= 73,064 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 9.56 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 3.66 fps, Avg. Travel Time= 1.4 min

Peak Storage= 740 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.89'
Defined Flood Depth= 1.50' Flow Area= 6.8 sf, Capacity= 91.44 cfs
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 91.44 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 312.0' Slope= 0.1603 '/'
Inlet Invert= 1,567.00', Outlet Invert= 1,517.00'



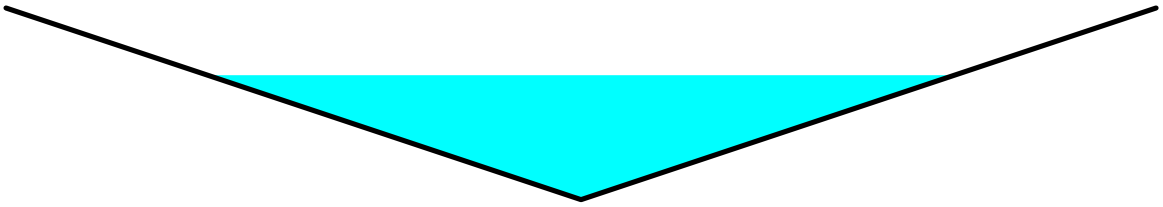
Summary for Reach RCHc: Roach Channel 1

Inflow Area = 337,097 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 29.17 cfs @ 11.98 hrs, Volume= 89,157 cf
Outflow = 29.14 cfs @ 11.99 hrs, Volume= 89,157 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 10.23 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 3.85 fps, Avg. Travel Time= 0.8 min

Peak Storage= 544 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.97'
Defined Flood Depth= 1.50' Flow Area= 6.8 sf, Capacity= 92.02 cfs
Bank-Full Depth= 1.50' Flow Area= 6.8 sf, Capacity= 92.02 cfs

0.00' x 1.50' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 9.00'
Length= 191.0' Slope= 0.1623 '/'
Inlet Invert= 1,517.00', Outlet Invert= 1,486.00'



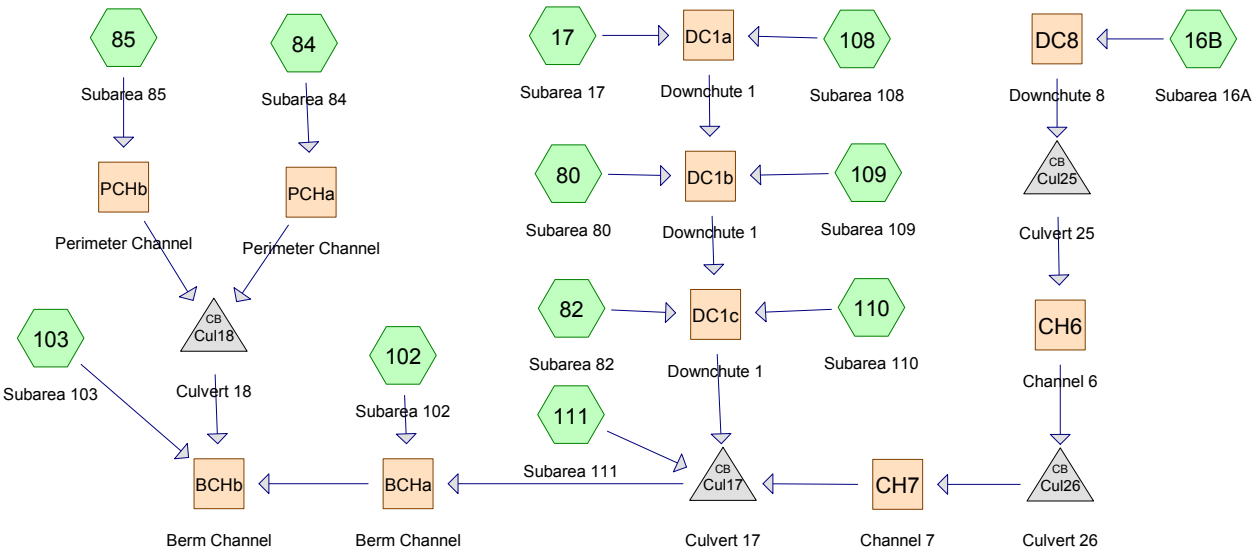
Summary for Pond Cul19: Culvert 19

Inflow Area = 337,097 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 29.14 cfs @ 11.99 hrs, Volume= 89,157 cf
Outflow = 29.14 cfs @ 11.99 hrs, Volume= 89,157 cf, Atten= 0%, Lag= 0.0 min
Primary = 29.14 cfs @ 11.99 hrs, Volume= 89,157 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,484.45' @ 11.99 hrs
Flood Elev= 1,485.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**36.0" Round Culvert** L= 69.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,482.00' / 1,471.00' S= 0.1594 '/' Cc= 0.900 n= 0.013, Flow Area= 7.07 sf

Primary OutFlow Max=29.13 cfs @ 11.99 hrs HW=1,484.45' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 29.13 cfs @ 4.71 fps)



Subcat Reach Pond Link

Routing Diagram for Southern Expansion Segment 6
Prepared by Tetra Tech Inc, Printed 5/5/2020
HydroCAD® 10.00-24 s/n 04483 © 2018 HydroCAD Software Solutions LLC

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 16B: Subarea 16A Runoff Area=334,391 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=1,473' Tc=14.7 min CN=80 Runoff=4.66 cfs 14,004 cf

Subcatchment 17: Subarea 17 Runoff Area=77,124 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=560' Tc=2.6 min CN=80 Runoff=1.78 cfs 3,230 cf

Subcatchment 80: Subarea 80 Runoff Area=76,856 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=425' Tc=2.1 min CN=80 Runoff=1.81 cfs 3,219 cf

Subcatchment 82: Subarea 82 Runoff Area=54,442 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=320' Tc=2.9 min CN=80 Runoff=1.24 cfs 2,280 cf

Subcatchment 84: Subarea 84 Runoff Area=18,630 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=61' Slope=0.3300 '/' Tc=2.4 min CN=80 Runoff=0.43 cfs 780 cf

Subcatchment 85: Subarea 85 Runoff Area=52,194 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=191' Slope=0.3300 '/' Tc=4.0 min CN=80 Runoff=1.14 cfs 2,186 cf

Subcatchment 102: Subarea 102 Runoff Area=3,351 sf 0.00% Impervious Runoff Depth=0.77"
Flow Length=48' Tc=1.5 min CN=86 Runoff=0.13 cfs 216 cf

Subcatchment 103: Subarea 103 Runoff Area=25,624 sf 0.00% Impervious Runoff Depth=0.77"
Flow Length=49' Tc=1.5 min CN=86 Runoff=0.97 cfs 1,653 cf

Subcatchment 108: Subarea 108 Runoff Area=40,837 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=492' Tc=4.6 min CN=80 Runoff=0.87 cfs 1,710 cf

Subcatchment 109: Subarea 109 Runoff Area=41,747 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=313' Tc=4.2 min CN=80 Runoff=0.90 cfs 1,748 cf

Subcatchment 110: Subarea 110 Runoff Area=19,094 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=246' Tc=4.1 min CN=80 Runoff=0.41 cfs 800 cf

Subcatchment 111: Subarea 111 Runoff Area=1,561 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=66' Slope=0.3300 '/' Tc=2.6 min CN=80 Runoff=0.04 cfs 65 cf

Reach BCHa: Berm Channel Avg. Flow Depth=0.97' Max Vel=3.02 fps Inflow=8.54 cfs 27,273 cf
n=0.035 L=70.0' S=0.0143 '/' Capacity=373.32 cfs Outflow=8.53 cfs 27,273 cf

Reach BCHb: Berm Channel Avg. Flow Depth=1.10' Max Vel=2.62 fps Inflow=10.41 cfs 31,892 cf
n=0.035 L=442.0' S=0.0090 '/' Capacity=297.13 cfs Outflow=9.55 cfs 31,892 cf

Reach CH6: Channel 6 Avg. Flow Depth=0.26' Max Vel=6.24 fps Inflow=4.61 cfs 14,004 cf
n=0.035 L=109.0' S=0.1835 '/' Capacity=64.73 cfs Outflow=4.61 cfs 14,004 cf

Reach CH7: Channel 7 Avg. Flow Depth=0.86' Max Vel=2.09 fps Inflow=4.61 cfs 14,004 cf
n=0.035 L=62.0' S=0.0081 '/' Capacity=44.17 cfs Outflow=4.60 cfs 14,004 cf

Reach DC1a: Downchute 1 Avg. Flow Depth=0.06' Max Vel=3.64 fps Inflow=2.59 cfs 4,940 cf
n=0.035 L=164.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=2.57 cfs 4,940 cf

Reach DC1b: Downchute 1 Avg. Flow Depth=0.09' Max Vel=4.78 fps Inflow=5.16 cfs 9,907 cf
n=0.035 L=165.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=5.14 cfs 9,907 cf

Reach DC1c: Downchute 1 Avg. Flow Depth=0.10' Max Vel=5.33 fps Inflow=6.78 cfs 12,987 cf
n=0.035 L=67.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=6.77 cfs 12,987 cf

Reach DC8: Downchute 8 Avg. Flow Depth=0.08' Max Vel=4.46 fps Inflow=4.66 cfs 14,004 cf
n=0.035 L=427.0' S=0.3021 '/' Capacity=293.14 cfs Outflow=4.61 cfs 14,004 cf

Reach PCHa: Perimeter Channel Avg. Flow Depth=0.15' Max Vel=1.05 fps Inflow=0.43 cfs 780 cf
n=0.035 L=197.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=0.38 cfs 780 cf

Reach PCHb: Perimeter Channel Avg. Flow Depth=0.24' Max Vel=1.39 fps Inflow=1.14 cfs 2,186 cf
n=0.035 L=403.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=0.92 cfs 2,186 cf

Pond Cul17: Culvert 17 Peak Elev=1,481.07' Inflow=8.45 cfs 27,057 cf
48.0" Round Culvert n=0.013 L=136.0' S=0.0294 '/' Outflow=8.45 cfs 27,057 cf

Pond Cul18: Culvert 18 Peak Elev=1,478.49' Inflow=1.26 cfs 2,966 cf
24.0" Round Culvert n=0.013 L=48.0' S=0.0625 '/' Outflow=1.26 cfs 2,966 cf

Pond Cul25: Culvert 25 Peak Elev=1,500.85' Inflow=4.61 cfs 14,004 cf
36.0" Round Culvert n=0.013 L=31.0' S=0.0968 '/' Outflow=4.61 cfs 14,004 cf

Pond Cul26: Culvert 26 Peak Elev=1,477.93' Inflow=4.61 cfs 14,004 cf
36.0" Round Culvert n=0.013 L=63.0' S=0.0079 '/' Outflow=4.61 cfs 14,004 cf

Summary for Subcatchment 16B: Subarea 16A

Runoff = 4.66 cfs @ 12.08 hrs, Volume= 14,004 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	334,391	80	
	334,391		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.8	151	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	237	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.2	526	0.0050	3.92	493.54	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=3.00' Z= 3.0 & 25.0 '/' Top.W=84.00' n= 0.035 Earth, dense weeds
1.3	459	0.0300	5.86	39.56	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035 Earth, dense weeds
14.7	1,473	Total			

Summary for Subcatchment 17: Subarea 17

Runoff = 1.78 cfs @ 11.94 hrs, Volume= 3,230 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	77,124	80	
	77,124		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	32	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.1	528	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.6	560	Total			

Summary for Subcatchment 80: Subarea 80

Runoff = 1.81 cfs @ 11.93 hrs, Volume= 3,219 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	76,856	80	
	76,856		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	28	0.3300	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.8	397	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.1	425	Total			

Summary for Subcatchment 82: Subarea 82

Runoff = 1.24 cfs @ 11.94 hrs, Volume= 2,280 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	54,442	80	
	54,442		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	57	0.3300	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.6	263	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.9	320	Total			

Summary for Subcatchment 84: Subarea 84

Runoff = 0.43 cfs @ 11.94 hrs, Volume= 780 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	18,630	80	
	18,630		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	61	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 85: Subarea 85

Runoff = 1.14 cfs @ 11.96 hrs, Volume= 2,186 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	52,194	80	
	52,194		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	91	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.0	191	Total			

Summary for Subcatchment 102: Subarea 102

Runoff = 0.13 cfs @ 11.92 hrs, Volume= 216 cf, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
	3,351	86	<50% Grass cover, Poor, HSG C
	3,351		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
0.7	12	0.3300	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.5	48	Total			

Summary for Subcatchment 103: Subarea 103

Runoff = 0.97 cfs @ 11.92 hrs, Volume= 1,653 cf, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	25,624	86	
	25,624		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
0.7	13	0.3300	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.5	49	Total			

Summary for Subcatchment 108: Subarea 108

Runoff = 0.87 cfs @ 11.97 hrs, Volume= 1,710 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	40,837	80	
	40,837		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	84	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	308	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	492	Total			

Summary for Subcatchment 109: Subarea 109

Runoff = 0.90 cfs @ 11.96 hrs, Volume= 1,748 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	41,747	80	
	41,747		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	95	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	118	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.2	313	Total			

Summary for Subcatchment 110: Subarea 110

Runoff = 0.41 cfs @ 11.96 hrs, Volume= 800 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	19,094	80	
	19,094		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	104	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	42	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.1	246	Total			

Summary for Subcatchment 111: Subarea 111

Runoff = 0.04 cfs @ 11.94 hrs, Volume= 65 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	1,561	80	
	1,561		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.6	66	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

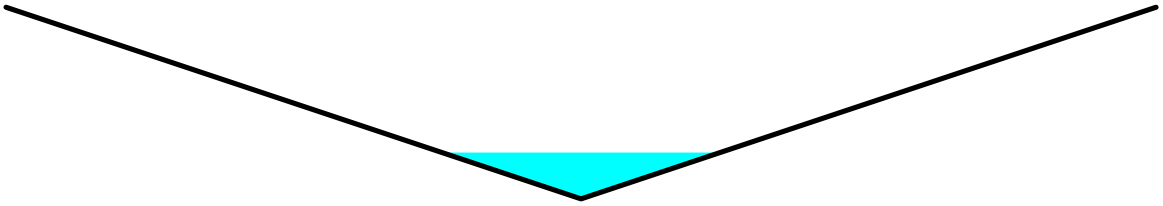
Summary for Reach BCHa: Berm Channel

Inflow Area = 649,403 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 8.54 cfs @ 11.96 hrs, Volume= 27,273 cf
Outflow = 8.53 cfs @ 11.97 hrs, Volume= 27,273 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.02 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.23 fps, Avg. Travel Time= 1.0 min

Peak Storage= 197 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.97'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 373.32 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 373.32 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 70.0' Slope= 0.0143 '/'
Inlet Invert= 1,476.00', Outlet Invert= 1,475.00'



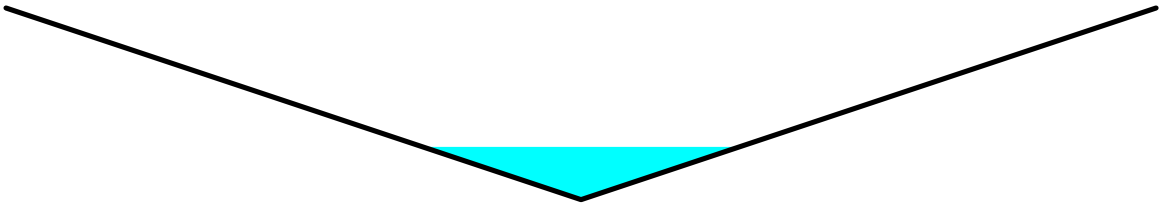
Summary for Reach BCHb: Berm Channel

Inflow Area = 745,851 sf, 0.00% Impervious, Inflow Depth = 0.51" for 1 Year Storm event
Inflow = 10.41 cfs @ 11.97 hrs, Volume= 31,892 cf
Outflow = 9.55 cfs @ 12.00 hrs, Volume= 31,892 cf, Atten= 8%, Lag= 2.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.62 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 1.00 fps, Avg. Travel Time= 7.4 min

Peak Storage= 1,611 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.10'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 297.13 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 297.13 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 442.0' Slope= 0.0090 '/'
Inlet Invert= 1,475.00', Outlet Invert= 1,471.00'



Summary for Reach CH6: Channel 6

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 4.61 cfs @ 12.10 hrs, Volume= 14,004 cf
Outflow = 4.61 cfs @ 12.10 hrs, Volume= 14,004 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.24 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.09 fps, Avg. Travel Time= 0.9 min

Peak Storage= 80 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.26'
Defined Flood Depth= 2.00' Flow Area= 13.0 sf, Capacity= 203.67 cfs
Bank-Full Depth= 1.00' Flow Area= 5.0 sf, Capacity= 64.73 cfs

2.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 8.00'
Length= 109.0' Slope= 0.1835 '/'
Inlet Invert= 1,497.00', Outlet Invert= 1,477.00'

‡

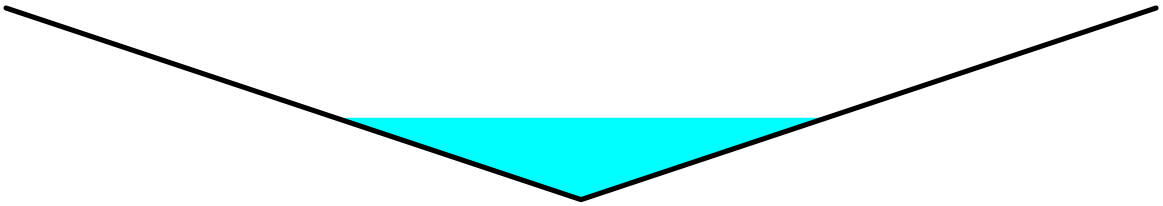
Summary for Reach CH7: Channel 7

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 4.61 cfs @ 12.10 hrs, Volume= 14,004 cf
Outflow = 4.60 cfs @ 12.11 hrs, Volume= 14,004 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.09 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 0.89 fps, Avg. Travel Time= 1.2 min

Peak Storage= 136 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.86'
Defined Flood Depth= 2.00' Flow Area= 12.0 sf, Capacity= 44.17 cfs
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 44.17 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 62.0' Slope= 0.0081 '/'
Inlet Invert= 1,476.50', Outlet Invert= 1,476.00'



Summary for Reach DC1a: Downchute 1

Inflow Area = 117,961 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 2.59 cfs @ 11.95 hrs, Volume= 4,940 cf
Outflow = 2.57 cfs @ 11.95 hrs, Volume= 4,940 cf, Atten= 1%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.64 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.20 fps, Avg. Travel Time= 2.3 min

Peak Storage= 116 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.06'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 164.0' Slope= 0.3300 '/'
Inlet Invert= 1,611.51', Outlet Invert= 1,557.39'

‡

Summary for Reach DC1b: Downchute 1

Inflow Area = 236,564 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 5.16 cfs @ 11.95 hrs, Volume= 9,907 cf
Outflow = 5.14 cfs @ 11.95 hrs, Volume= 9,907 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.78 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.30 fps, Avg. Travel Time= 2.1 min

Peak Storage= 177 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.09'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 165.0' Slope= 0.3300 '/'
Inlet Invert= 1,557.39', Outlet Invert= 1,502.94'

‡

Summary for Reach DC1c: Downchute 1

Inflow Area = 310,100 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 6.78 cfs @ 11.95 hrs, Volume= 12,987 cf
Outflow = 6.77 cfs @ 11.95 hrs, Volume= 12,987 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.33 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 0.8 min

Peak Storage= 85 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 67.0' Slope= 0.3300 '/'
Inlet Invert= 1,502.94', Outlet Invert= 1,480.83'

‡

Summary for Reach DC8: Downchute 8

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 4.66 cfs @ 12.08 hrs, Volume= 14,004 cf
Outflow = 4.61 cfs @ 12.10 hrs, Volume= 14,004 cf, Atten= 1%, Lag= 1.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.46 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.36 fps, Avg. Travel Time= 5.2 min

Peak Storage= 441 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.08'
Defined Flood Depth= 1.00' Flow Area= 14.0 sf, Capacity= 293.14 cfs
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 293.14 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 427.0' Slope= 0.3021 '/'
Inlet Invert= 1,629.00', Outlet Invert= 1,500.00'

‡

Summary for Reach PCHa: Perimeter Channel

Inflow Area = 18,630 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 0.43 cfs @ 11.94 hrs, Volume= 780 cf
Outflow = 0.38 cfs @ 11.96 hrs, Volume= 780 cf, Atten= 12%, Lag= 1.7 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.05 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 0.34 fps, Avg. Travel Time= 9.7 min

Peak Storage= 71 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.15'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 197.0' Slope= 0.0100 '/'
Inlet Invert= 1,479.97', Outlet Invert= 1,478.00'

Summary for Reach PCHb: Perimeter Channel

Inflow Area = 52,194 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 1.14 cfs @ 11.96 hrs, Volume= 2,186 cf
Outflow = 0.92 cfs @ 12.00 hrs, Volume= 2,186 cf, Atten= 19%, Lag= 2.5 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.39 fps, Min. Travel Time= 4.8 min
Avg. Velocity = 0.43 fps, Avg. Travel Time= 15.8 min

Peak Storage= 266 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.24'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 403.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.03', Outlet Invert= 1,478.00'

Summary for Pond Cul17: Culvert 17

Inflow Area = 646,052 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 8.45 cfs @ 11.97 hrs, Volume= 27,057 cf
Outflow = 8.45 cfs @ 11.97 hrs, Volume= 27,057 cf, Atten= 0%, Lag= 0.0 min
Primary = 8.45 cfs @ 11.97 hrs, Volume= 27,057 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,481.07' @ 11.97 hrs
Flood Elev= 1,484.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,480.00'	**48.0" Round Culvert** L= 136.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,480.00' / 1,476.00' S= 0.0294 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 12.57 sf

Primary OutFlow Max=8.43 cfs @ 11.97 hrs HW=1,481.07' TW=1,476.97' (Dynamic Tailwater)
1=Culvert (Inlet Controls 8.43 cfs @ 3.11 fps)

Summary for Pond Cul18: Culvert 18

Inflow Area = 70,824 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 1.26 cfs @ 11.99 hrs, Volume= 2,966 cf
Outflow = 1.26 cfs @ 11.99 hrs, Volume= 2,966 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.26 cfs @ 11.99 hrs, Volume= 2,966 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 1,478.49' @ 11.99 hrs
Flood Elev= 1,480.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,478.00'	**24.0" Round Culvert** L= 48.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,478.00' / 1,475.00' S= 0.0625 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=1.26 cfs @ 11.99 hrs HW=1,478.49' TW=1,476.10' (Dynamic Tailwater)
1=Culvert (Inlet Controls 1.26 cfs @ 2.11 fps)

Summary for Pond Cul25: Culvert 25

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 4.61 cfs @ 12.10 hrs, Volume= 14,004 cf
Outflow = 4.61 cfs @ 12.10 hrs, Volume= 14,004 cf, Atten= 0%, Lag= 0.0 min
Primary = 4.61 cfs @ 12.10 hrs, Volume= 14,004 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,500.85' @ 12.10 hrs
Flood Elev= 1,503.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,500.00'	**36.0" Round Culvert** L= 31.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,500.00' / 1,497.00' S= 0.0968 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf

Primary OutFlow Max=4.61 cfs @ 12.10 hrs HW=1,500.85' TW=1,497.26' (Dynamic Tailwater)
1=Culvert (Inlet Controls 4.61 cfs @ 2.78 fps)

Summary for Pond Cul26: Culvert 26

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 4.61 cfs @ 12.10 hrs, Volume= 14,004 cf
Outflow = 4.61 cfs @ 12.10 hrs, Volume= 14,004 cf, Atten= 0%, Lag= 0.0 min
Primary = 4.61 cfs @ 12.10 hrs, Volume= 14,004 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,477.93' @ 12.10 hrs
Flood Elev= 1,480.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,477.00'	**36.0" Round Culvert** L= 63.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,477.00' / 1,476.50' S= 0.0079 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf

Primary OutFlow Max=4.60 cfs @ 12.10 hrs HW=1,477.93' TW=1,477.36' (Dynamic Tailwater)
1=Culvert (Outlet Controls 4.60 cfs @ 3.69 fps)

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 16B: Subarea 16A Runoff Area=334,391 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=1,473' Tc=14.7 min CN=80 Runoff=13.88 cfs 38,638 cf

Subcatchment 17: Subarea 17 Runoff Area=77,124 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=560' Tc=2.6 min CN=80 Runoff=5.00 cfs 8,911 cf

Subcatchment 80: Subarea 80 Runoff Area=76,856 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=425' Tc=2.1 min CN=80 Runoff=5.08 cfs 8,880 cf

Subcatchment 82: Subarea 82 Runoff Area=54,442 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=320' Tc=2.9 min CN=80 Runoff=3.49 cfs 6,291 cf

Subcatchment 84: Subarea 84 Runoff Area=18,630 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=61' Slope=0.3300 '/' Tc=2.4 min CN=80 Runoff=1.22 cfs 2,153 cf

Subcatchment 85: Subarea 85 Runoff Area=52,194 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=191' Slope=0.3300 '/' Tc=4.0 min CN=80 Runoff=3.21 cfs 6,031 cf

Subcatchment 102: Subarea 102 Runoff Area=3,351 sf 0.00% Impervious Runoff Depth=1.82"
Flow Length=48' Tc=1.5 min CN=86 Runoff=0.29 cfs 508 cf

Subcatchment 103: Subarea 103 Runoff Area=25,624 sf 0.00% Impervious Runoff Depth=1.82"
Flow Length=49' Tc=1.5 min CN=86 Runoff=2.21 cfs 3,881 cf

Subcatchment 108: Subarea 108 Runoff Area=40,837 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=492' Tc=4.6 min CN=80 Runoff=2.46 cfs 4,719 cf

Subcatchment 109: Subarea 109 Runoff Area=41,747 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=313' Tc=4.2 min CN=80 Runoff=2.55 cfs 4,824 cf

Subcatchment 110: Subarea 110 Runoff Area=19,094 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=246' Tc=4.1 min CN=80 Runoff=1.17 cfs 2,206 cf

Subcatchment 111: Subarea 111 Runoff Area=1,561 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=66' Slope=0.3300 '/' Tc=2.6 min CN=80 Runoff=0.10 cfs 180 cf

Reach BCHa: Berm Channel Avg. Flow Depth=1.48' Max Vel=4.01 fps Inflow=26.42 cfs 75,157 cf
n=0.035 L=70.0' S=0.0143 '/' Capacity=373.32 cfs Outflow=26.40 cfs 75,157 cf

Reach BCHb: Berm Channel Avg. Flow Depth=1.70' Max Vel=3.50 fps Inflow=31.88 cfs 87,222 cf
n=0.035 L=442.0' S=0.0090 '/' Capacity=297.13 cfs Outflow=30.42 cfs 87,222 cf

Reach CH6: Channel 6 Avg. Flow Depth=0.47' Max Vel=8.56 fps Inflow=13.80 cfs 38,638 cf
n=0.035 L=109.0' S=0.1835 '/' Capacity=64.73 cfs Outflow=13.80 cfs 38,638 cf

Reach CH7: Channel 7 Avg. Flow Depth=1.29' Max Vel=2.75 fps Inflow=13.80 cfs 38,638 cf
n=0.035 L=62.0' S=0.0081 '/' Capacity=44.17 cfs Outflow=13.78 cfs 38,638 cf

Reach DC1a: Downchute 1 Avg. Flow Depth=0.11' Max Vel=5.48 fps Inflow=7.33 cfs 13,630 cf
n=0.035 L=164.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=7.30 cfs 13,630 cf

Reach DC1b: Downchute 1 Avg. Flow Depth=0.17' Max Vel=7.19 fps Inflow=14.69 cfs 27,334 cf
n=0.035 L=165.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=14.66 cfs 27,334 cf

Reach DC1c: Downchute 1 Avg. Flow Depth=0.19' Max Vel=7.99 fps Inflow=19.29 cfs 35,831 cf
n=0.035 L=67.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=19.29 cfs 35,831 cf

Reach DC8: Downchute 8 Avg. Flow Depth=0.16' Max Vel=6.84 fps Inflow=13.88 cfs 38,638 cf
n=0.035 L=427.0' S=0.3021 '/' Capacity=293.14 cfs Outflow=13.80 cfs 38,638 cf

Reach PCHa: Perimeter Channel Avg. Flow Depth=0.27' Max Vel=1.48 fps Inflow=1.22 cfs 2,153 cf
n=0.035 L=197.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=1.13 cfs 2,153 cf

Reach PCHb: Perimeter Channel Avg. Flow Depth=0.44' Max Vel=1.93 fps Inflow=3.21 cfs 6,031 cf
n=0.035 L=403.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=2.85 cfs 6,031 cf

Pond Cul17: Culvert 17 Peak Elev=1,481.98' Inflow=26.19 cfs 74,649 cf
48.0" Round Culvert n=0.013 L=136.0' S=0.0294 '/' Outflow=26.19 cfs 74,649 cf

Pond Cul18: Culvert 18 Peak Elev=1,478.90' Inflow=3.90 cfs 8,183 cf
24.0" Round Culvert n=0.013 L=48.0' S=0.0625 '/' Outflow=3.90 cfs 8,183 cf

Pond Cul25: Culvert 25 Peak Elev=1,501.55' Inflow=13.80 cfs 38,638 cf
36.0" Round Culvert n=0.013 L=31.0' S=0.0968 '/' Outflow=13.80 cfs 38,638 cf

Pond Cul26: Culvert 26 Peak Elev=1,478.66' Inflow=13.80 cfs 38,638 cf
36.0" Round Culvert n=0.013 L=63.0' S=0.0079 '/' Outflow=13.80 cfs 38,638 cf

Summary for Subcatchment 16B: Subarea 16A

Runoff = 13.88 cfs @ 12.07 hrs, Volume= 38,638 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	334,391	80	
	334,391		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.8	151	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	237	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.2	526	0.0050	3.92	493.54	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=3.00' Z= 3.0 & 25.0 '/' Top.W=84.00' n= 0.035 Earth, dense weeds
1.3	459	0.0300	5.86	39.56	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035 Earth, dense weeds
14.7	1,473	Total			

Summary for Subcatchment 17: Subarea 17

Runoff = 5.00 cfs @ 11.93 hrs, Volume= 8,911 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	77,124	80	
	77,124		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	32	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.1	528	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.6	560	Total			

Summary for Subcatchment 80: Subarea 80

Runoff = 5.08 cfs @ 11.93 hrs, Volume= 8,880 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	76,856	80	
	76,856		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	28	0.3300	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.8	397	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.1	425	Total			

Summary for Subcatchment 82: Subarea 82

Runoff = 3.49 cfs @ 11.94 hrs, Volume= 6,291 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	54,442	80	
	54,442		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	57	0.3300	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.6	263	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.9	320	Total			

Summary for Subcatchment 84: Subarea 84

Runoff = 1.22 cfs @ 11.93 hrs, Volume= 2,153 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	18,630	80	
	18,630		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	61	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 85: Subarea 85

Runoff = 3.21 cfs @ 11.95 hrs, Volume= 6,031 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	52,194	80	
	52,194		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	91	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.0	191	Total			

Summary for Subcatchment 102: Subarea 102

Runoff = 0.29 cfs @ 11.92 hrs, Volume= 508 cf, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
	3,351	86	<50% Grass cover, Poor, HSG C
	3,351		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
0.7	12	0.3300	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.5	48	Total			

Summary for Subcatchment 103: Subarea 103

Runoff = 2.21 cfs @ 11.92 hrs, Volume= 3,881 cf, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	25,624	86	
	25,624		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
0.7	13	0.3300	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.5	49	Total			

Summary for Subcatchment 108: Subarea 108

Runoff = 2.46 cfs @ 11.96 hrs, Volume= 4,719 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	40,837	80	
	40,837		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	84	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	308	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	492	Total			

Summary for Subcatchment 109: Subarea 109

Runoff = 2.55 cfs @ 11.95 hrs, Volume= 4,824 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	41,747	80	
	41,747		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	95	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	118	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.2	313	Total			

Summary for Subcatchment 110: Subarea 110

Runoff = 1.17 cfs @ 11.95 hrs, Volume= 2,206 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	19,094	80	
	19,094		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	104	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	42	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.1	246	Total			

Summary for Subcatchment 111: Subarea 111

Runoff = 0.10 cfs @ 11.93 hrs, Volume= 180 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	1,561	80	
	1,561		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.6	66	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

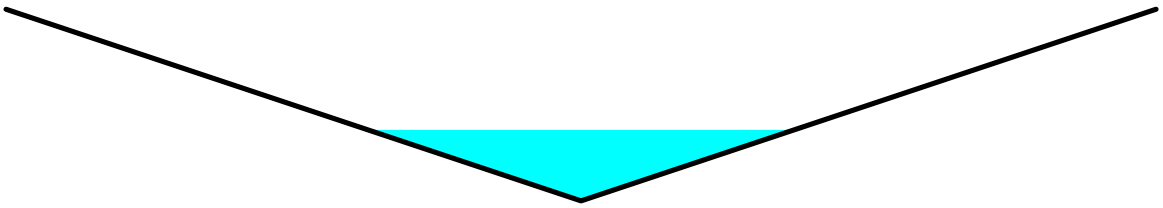
Summary for Reach BCHa: Berm Channel

Inflow Area = 649,403 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 26.42 cfs @ 11.96 hrs, Volume= 75,157 cf
Outflow = 26.40 cfs @ 11.96 hrs, Volume= 75,157 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.01 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.43 fps, Avg. Travel Time= 0.8 min

Peak Storage= 461 cf @ 11.96 hrs
Average Depth at Peak Storage= 1.48'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 373.32 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 373.32 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 70.0' Slope= 0.0143 '/'
Inlet Invert= 1,476.00', Outlet Invert= 1,475.00'



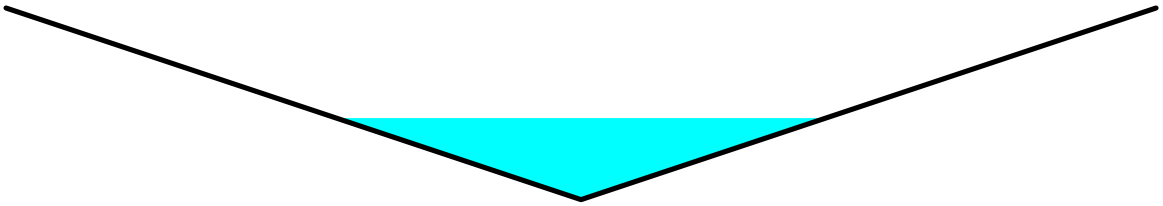
Summary for Reach BCHb: Berm Channel

Inflow Area = 745,851 sf, 0.00% Impervious, Inflow Depth = 1.40" for 10 Year Storm event
Inflow = 31.88 cfs @ 11.96 hrs, Volume= 87,222 cf
Outflow = 30.42 cfs @ 11.98 hrs, Volume= 87,222 cf, Atten= 5%, Lag= 1.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.50 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 1.17 fps, Avg. Travel Time= 6.3 min

Peak Storage= 3,839 cf @ 11.98 hrs
Average Depth at Peak Storage= 1.70'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 297.13 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 297.13 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 442.0' Slope= 0.0090 '/'
Inlet Invert= 1,475.00', Outlet Invert= 1,471.00'



Summary for Reach CH6: Channel 6

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 13.80 cfs @ 12.08 hrs, Volume= 38,638 cf
Outflow = 13.80 cfs @ 12.08 hrs, Volume= 38,638 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 8.56 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.70 fps, Avg. Travel Time= 0.7 min

Peak Storage= 176 cf @ 12.08 hrs
Average Depth at Peak Storage= 0.47'
Defined Flood Depth= 2.00' Flow Area= 13.0 sf, Capacity= 203.67 cfs
Bank-Full Depth= 1.00' Flow Area= 5.0 sf, Capacity= 64.73 cfs

2.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 8.00'
Length= 109.0' Slope= 0.1835 '/'
Inlet Invert= 1,497.00', Outlet Invert= 1,477.00'

‡

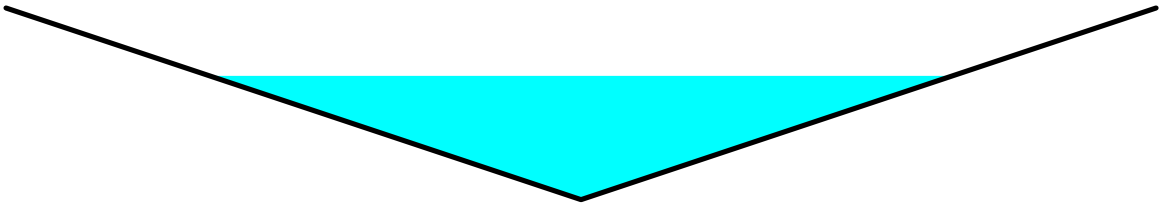
Summary for Reach CH7: Channel 7

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 13.80 cfs @ 12.08 hrs, Volume= 38,638 cf
Outflow = 13.78 cfs @ 12.09 hrs, Volume= 38,638 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.75 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.07 fps, Avg. Travel Time= 1.0 min

Peak Storage= 311 cf @ 12.09 hrs
Average Depth at Peak Storage= 1.29'
Defined Flood Depth= 2.00' Flow Area= 12.0 sf, Capacity= 44.17 cfs
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 44.17 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 62.0' Slope= 0.0081 '/'
Inlet Invert= 1,476.50', Outlet Invert= 1,476.00'



Summary for Reach DC1a: Downchute 1

Inflow Area = 117,961 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 7.33 cfs @ 11.94 hrs, Volume= 13,630 cf
Outflow = 7.30 cfs @ 11.95 hrs, Volume= 13,630 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.48 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.34 fps, Avg. Travel Time= 2.0 min

Peak Storage= 218 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.11'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 164.0' Slope= 0.3300 '/'
Inlet Invert= 1,611.51', Outlet Invert= 1,557.39'

‡

Summary for Reach DC1b: Downchute 1

Inflow Area = 236,564 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 14.69 cfs @ 11.94 hrs, Volume= 27,334 cf
Outflow = 14.66 cfs @ 11.94 hrs, Volume= 27,334 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 7.19 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.63 fps, Avg. Travel Time= 1.7 min

Peak Storage= 336 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 165.0' Slope= 0.3300 '/'
Inlet Invert= 1,557.39', Outlet Invert= 1,502.94'

‡

Summary for Reach DC1c: Downchute 1

Inflow Area = 310,100 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 19.29 cfs @ 11.94 hrs, Volume= 35,831 cf
Outflow = 19.29 cfs @ 11.94 hrs, Volume= 35,831 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 7.99 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.80 fps, Avg. Travel Time= 0.6 min

Peak Storage= 162 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.19'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 67.0' Slope= 0.3300 '/'
Inlet Invert= 1,502.94', Outlet Invert= 1,480.83'

‡

Summary for Reach DC8: Downchute 8

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 13.88 cfs @ 12.07 hrs, Volume= 38,638 cf
Outflow = 13.80 cfs @ 12.08 hrs, Volume= 38,638 cf, Atten= 1%, Lag= 0.7 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.84 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.78 fps, Avg. Travel Time= 4.0 min

Peak Storage= 862 cf @ 12.08 hrs
Average Depth at Peak Storage= 0.16'
Defined Flood Depth= 1.00' Flow Area= 14.0 sf, Capacity= 293.14 cfs
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 293.14 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 427.0' Slope= 0.3021 '/'
Inlet Invert= 1,629.00', Outlet Invert= 1,500.00'

‡

Summary for Reach PCHa: Perimeter Channel

Inflow Area = 18,630 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 1.22 cfs @ 11.93 hrs, Volume= 2,153 cf
Outflow = 1.13 cfs @ 11.95 hrs, Volume= 2,153 cf, Atten= 7%, Lag= 1.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.48 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.40 fps, Avg. Travel Time= 8.2 min

Peak Storage= 151 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.27'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 197.0' Slope= 0.0100 '/'
Inlet Invert= 1,479.97', Outlet Invert= 1,478.00'

Summary for Reach PCHb: Perimeter Channel

Inflow Area = 52,194 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 3.21 cfs @ 11.95 hrs, Volume= 6,031 cf
Outflow = 2.85 cfs @ 11.98 hrs, Volume= 6,031 cf, Atten= 11%, Lag= 1.9 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.93 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 0.54 fps, Avg. Travel Time= 12.4 min

Peak Storage= 594 cf @ 11.98 hrs
Average Depth at Peak Storage= 0.44'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 403.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.03', Outlet Invert= 1,478.00'

Summary for Pond Cul17: Culvert 17

Inflow Area = 646,052 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 26.19 cfs @ 11.96 hrs, Volume= 74,649 cf
Outflow = 26.19 cfs @ 11.96 hrs, Volume= 74,649 cf, Atten= 0%, Lag= 0.0 min
Primary = 26.19 cfs @ 11.96 hrs, Volume= 74,649 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,481.98' @ 11.96 hrs
Flood Elev= 1,484.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,480.00'	**48.0" Round Culvert** L= 136.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,480.00' / 1,476.00' S= 0.0294 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 12.57 sf

Primary OutFlow Max=26.15 cfs @ 11.96 hrs HW=1,481.98' TW=1,477.48' (Dynamic Tailwater)
1=Culvert (Inlet Controls 26.15 cfs @ 4.22 fps)

Summary for Pond Cul18: Culvert 18

Inflow Area = 70,824 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 3.90 cfs @ 11.97 hrs, Volume= 8,183 cf
Outflow = 3.90 cfs @ 11.97 hrs, Volume= 8,183 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.90 cfs @ 11.97 hrs, Volume= 8,183 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 1,478.90' @ 11.97 hrs
Flood Elev= 1,480.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,478.00'	**24.0" Round Culvert** L= 48.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,478.00' / 1,475.00' S= 0.0625 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=3.89 cfs @ 11.97 hrs HW=1,478.90' TW=1,476.70' (Dynamic Tailwater)
1=Culvert (Inlet Controls 3.89 cfs @ 2.85 fps)

Summary for Pond Cul25: Culvert 25

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 13.80 cfs @ 12.08 hrs, Volume= 38,638 cf
Outflow = 13.80 cfs @ 12.08 hrs, Volume= 38,638 cf, Atten= 0%, Lag= 0.0 min
Primary = 13.80 cfs @ 12.08 hrs, Volume= 38,638 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,501.55' @ 12.08 hrs
Flood Elev= 1,503.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,500.00'	**36.0" Round Culvert** L= 31.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,500.00' / 1,497.00' S= 0.0968 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf

Primary OutFlow Max=13.79 cfs @ 12.08 hrs HW=1,501.55' TW=1,497.47' (Dynamic Tailwater)
1=Culvert (Inlet Controls 13.79 cfs @ 3.74 fps)

Summary for Pond Cul26: Culvert 26

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 13.80 cfs @ 12.08 hrs, Volume= 38,638 cf
Outflow = 13.80 cfs @ 12.08 hrs, Volume= 38,638 cf, Atten= 0%, Lag= 0.0 min
Primary = 13.80 cfs @ 12.08 hrs, Volume= 38,638 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,478.66' @ 12.09 hrs
Flood Elev= 1,480.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,477.00'	**36.0" Round Culvert** L= 63.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,477.00' / 1,476.50' S= 0.0079 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf

Primary OutFlow Max=13.78 cfs @ 12.08 hrs HW=1,478.66' TW=1,477.79' (Dynamic Tailwater)
1=Culvert (Outlet Controls 13.78 cfs @ 4.98 fps)

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 16B: Subarea 16A Runoff Area=334,391 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=1,473' Tc=14.7 min CN=80 Runoff=31.83 cfs 88,442 cf

Subcatchment 17: Subarea 17 Runoff Area=77,124 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=560' Tc=2.6 min CN=80 Runoff=11.14 cfs 20,398 cf

Subcatchment 80: Subarea 80 Runoff Area=76,856 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=425' Tc=2.1 min CN=80 Runoff=11.29 cfs 20,327 cf

Subcatchment 82: Subarea 82 Runoff Area=54,442 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=320' Tc=2.9 min CN=80 Runoff=7.78 cfs 14,399 cf

Subcatchment 84: Subarea 84 Runoff Area=18,630 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=61' Slope=0.3300 '/' Tc=2.4 min CN=80 Runoff=2.71 cfs 4,927 cf

Subcatchment 85: Subarea 85 Runoff Area=52,194 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=191' Slope=0.3300 '/' Tc=4.0 min CN=80 Runoff=7.18 cfs 13,805 cf

Subcatchment 102: Subarea 102 Runoff Area=3,351 sf 0.00% Impervious Runoff Depth>3.77"
Flow Length=48' Tc=1.5 min CN=86 Runoff=0.57 cfs 1,052 cf

Subcatchment 103: Subarea 103 Runoff Area=25,624 sf 0.00% Impervious Runoff Depth>3.77"
Flow Length=49' Tc=1.5 min CN=86 Runoff=4.39 cfs 8,043 cf

Subcatchment 108: Subarea 108 Runoff Area=40,837 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=492' Tc=4.6 min CN=80 Runoff=5.50 cfs 10,801 cf

Subcatchment 109: Subarea 109 Runoff Area=41,747 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=313' Tc=4.2 min CN=80 Runoff=5.70 cfs 11,041 cf

Subcatchment 110: Subarea 110 Runoff Area=19,094 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=246' Tc=4.1 min CN=80 Runoff=2.62 cfs 5,050 cf

Subcatchment 111: Subarea 111 Runoff Area=1,561 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=66' Slope=0.3300 '/' Tc=2.6 min CN=80 Runoff=0.23 cfs 413 cf

Reach BCHa: Berm Channel Avg. Flow Depth=2.03' Max Vel=4.95 fps Inflow=61.49 cfs 171,923 cf
n=0.035 L=70.0' S=0.0143 '/' Capacity=373.32 cfs Outflow=61.46 cfs 171,923 cf

Reach BCHb: Berm Channel Avg. Flow Depth=2.34' Max Vel=4.34 fps Inflow=73.82 cfs 198,698 cf
n=0.035 L=442.0' S=0.0090 '/' Capacity=297.13 cfs Outflow=71.52 cfs 198,698 cf

Reach CH6: Channel 6 Avg. Flow Depth=0.71' Max Vel=10.74 fps Inflow=31.73 cfs 88,442 cf
n=0.035 L=109.0' S=0.1835 '/' Capacity=64.73 cfs Outflow=31.72 cfs 88,442 cf

Reach CH7: Channel 7 Avg. Flow Depth=1.77' Max Vel=3.39 fps Inflow=31.72 cfs 88,442 cf
n=0.035 L=62.0' S=0.0081 '/' Capacity=44.17 cfs Outflow=31.70 cfs 88,442 cf

Reach DC1a: Downchute 1 Avg. Flow Depth=0.18' Max Vel=7.50 fps Inflow=16.39 cfs 31,199 cf
n=0.035 L=164.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=16.36 cfs 31,199 cf

Reach DC1b: Downchute 1 Avg. Flow Depth=0.27' Max Vel=9.79 fps Inflow=32.90 cfs 62,568 cf
n=0.035 L=165.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=32.87 cfs 62,568 cf

Reach DC1c: Downchute 1 Avg. Flow Depth=0.32' Max Vel=10.86 fps Inflow=43.22 cfs 82,017 cf
n=0.035 L=67.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=43.22 cfs 82,017 cf

Reach DC8: Downchute 8 Avg. Flow Depth=0.27' Max Vel=9.40 fps Inflow=31.83 cfs 88,442 cf
n=0.035 L=427.0' S=0.3021 '/' Capacity=293.14 cfs Outflow=31.73 cfs 88,442 cf

Reach PCHa: Perimeter Channel Avg. Flow Depth=0.42' Max Vel=1.88 fps Inflow=2.71 cfs 4,927 cf
n=0.035 L=197.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=2.58 cfs 4,927 cf

Reach PCHb: Perimeter Channel Avg. Flow Depth=0.68' Max Vel=2.43 fps Inflow=7.18 cfs 13,805 cf
n=0.035 L=403.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=6.62 cfs 13,805 cf

Pond Cul17: Culvert 17 Peak Elev=1,483.32' Inflow=61.03 cfs 170,871 cf
48.0" Round Culvert n=0.013 L=136.0' S=0.0294 '/' Outflow=61.03 cfs 170,871 cf

Pond Cul18: Culvert 18 Peak Elev=1,479.47' Inflow=9.03 cfs 18,732 cf
24.0" Round Culvert n=0.013 L=48.0' S=0.0625 '/' Outflow=9.03 cfs 18,732 cf

Pond Cul25: Culvert 25 Peak Elev=1,502.61' Inflow=31.73 cfs 88,442 cf
36.0" Round Culvert n=0.013 L=31.0' S=0.0968 '/' Outflow=31.73 cfs 88,442 cf

Pond Cul26: Culvert 26 Peak Elev=1,479.76' Inflow=31.72 cfs 88,442 cf
36.0" Round Culvert n=0.013 L=63.0' S=0.0079 '/' Outflow=31.72 cfs 88,442 cf

Summary for Subcatchment 16B: Subarea 16A

Runoff = 31.83 cfs @ 12.07 hrs, Volume= 88,442 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	334,391	80	
	334,391		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0400	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.8	151	0.0400	1.40		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.0	237	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
2.2	526	0.0050	3.92	493.54	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=3.00' Z= 3.0 & 25.0 '/' Top.W=84.00' n= 0.035 Earth, dense weeds
1.3	459	0.0300	5.86	39.56	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035 Earth, dense weeds
14.7	1,473	Total			

Summary for Subcatchment 17: Subarea 17

Runoff = 11.14 cfs @ 11.93 hrs, Volume= 20,398 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	77,124	80	
	77,124		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	32	0.3300	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.1	528	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.6	560	Total			

Summary for Subcatchment 80: Subarea 80

Runoff = 11.29 cfs @ 11.93 hrs, Volume= 20,327 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	76,856	80	
	76,856		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	28	0.3300	0.36		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.8	397	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.1	425	Total			

Summary for Subcatchment 82: Subarea 82

Runoff = 7.78 cfs @ 11.94 hrs, Volume= 14,399 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	54,442	80	
	54,442		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	57	0.3300	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.6	263	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
2.9	320	Total			

Summary for Subcatchment 84: Subarea 84

Runoff = 2.71 cfs @ 11.93 hrs, Volume= 4,927 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	18,630	80	
	18,630		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	61	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 85: Subarea 85

Runoff = 7.18 cfs @ 11.95 hrs, Volume= 13,805 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	52,194	80	
	52,194		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	91	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.0	191	Total			

Summary for Subcatchment 102: Subarea 102

Runoff = 0.57 cfs @ 11.92 hrs, Volume= 1,052 cf, Depth> 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
	3,351	86	<50% Grass cover, Poor, HSG C
	3,351		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
0.7	12	0.3300	0.30		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.5	48	Total			

Summary for Subcatchment 103: Subarea 103

Runoff = 4.39 cfs @ 11.92 hrs, Volume= 8,043 cf, Depth> 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	25,624	86	
	25,624		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
0.7	13	0.3300	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.5	49	Total			

Summary for Subcatchment 108: Subarea 108

Runoff = 5.50 cfs @ 11.96 hrs, Volume= 10,801 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	40,837	80	
	40,837		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	84	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	308	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.6	492	Total			

Summary for Subcatchment 109: Subarea 109

Runoff = 5.70 cfs @ 11.95 hrs, Volume= 11,041 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	41,747	80	
	41,747		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	95	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.2	118	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.2	313	Total			

Summary for Subcatchment 110: Subarea 110

Runoff = 2.62 cfs @ 11.95 hrs, Volume= 5,050 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	19,094	80	
	19,094		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.4	104	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	42	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.1	246	Total			

Summary for Subcatchment 111: Subarea 111

Runoff = 0.23 cfs @ 11.93 hrs, Volume= 413 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	1,561	80	
	1,561		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.6	66	0.3300	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

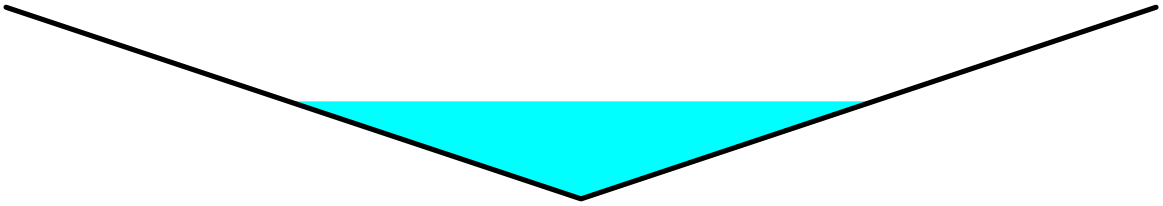
Summary for Reach BCHa: Berm Channel

Inflow Area = 649,403 sf, 0.00% Impervious, Inflow Depth = 3.18" for 100 Year Storm event
Inflow = 61.49 cfs @ 11.95 hrs, Volume= 171,923 cf
Outflow = 61.46 cfs @ 11.95 hrs, Volume= 171,923 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.95 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.69 fps, Avg. Travel Time= 0.7 min

Peak Storage= 868 cf @ 11.95 hrs
Average Depth at Peak Storage= 2.03'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 373.32 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 373.32 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 70.0' Slope= 0.0143 '/'
Inlet Invert= 1,476.00', Outlet Invert= 1,475.00'



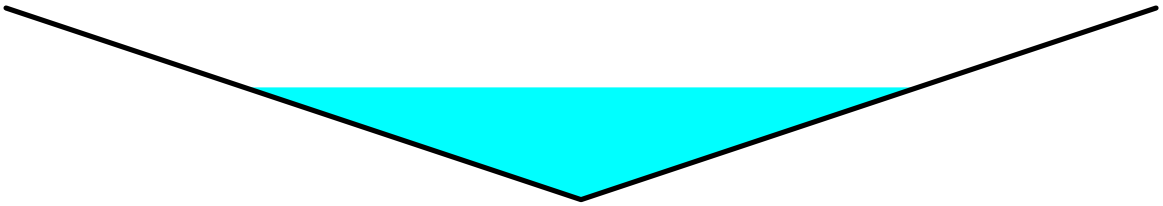
Summary for Reach BCHb: Berm Channel

Inflow Area = 745,851 sf, 0.00% Impervious, Inflow Depth = 3.20" for 100 Year Storm event
Inflow = 73.82 cfs @ 11.95 hrs, Volume= 198,698 cf
Outflow = 71.52 cfs @ 11.97 hrs, Volume= 198,698 cf, Atten= 3%, Lag= 1.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.34 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 5.3 min

Peak Storage= 7,291 cf @ 11.97 hrs
Average Depth at Peak Storage= 2.34'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 297.13 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 297.13 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 442.0' Slope= 0.0090 '/'
Inlet Invert= 1,475.00', Outlet Invert= 1,471.00'



Summary for Reach CH6: Channel 6

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 31.73 cfs @ 12.07 hrs, Volume= 88,442 cf
Outflow = 31.72 cfs @ 12.08 hrs, Volume= 88,442 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 10.74 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 3.29 fps, Avg. Travel Time= 0.6 min

Peak Storage= 322 cf @ 12.08 hrs
Average Depth at Peak Storage= 0.71'
Defined Flood Depth= 2.00' Flow Area= 13.0 sf, Capacity= 203.67 cfs
Bank-Full Depth= 1.00' Flow Area= 5.0 sf, Capacity= 64.73 cfs

2.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 8.00'
Length= 109.0' Slope= 0.1835 '/'
Inlet Invert= 1,497.00', Outlet Invert= 1,477.00'

‡

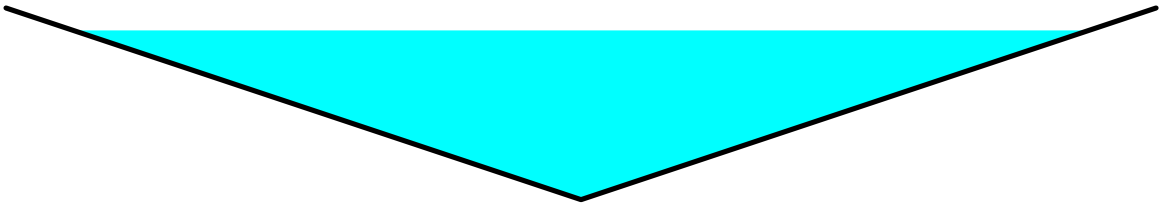
Summary for Reach CH7: Channel 7

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 31.72 cfs @ 12.08 hrs, Volume= 88,442 cf
Outflow = 31.70 cfs @ 12.08 hrs, Volume= 88,442 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.39 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.24 fps, Avg. Travel Time= 0.8 min

Peak Storage= 580 cf @ 12.08 hrs
Average Depth at Peak Storage= 1.77'
Defined Flood Depth= 2.00' Flow Area= 12.0 sf, Capacity= 44.17 cfs
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 44.17 cfs

0.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 12.00'
Length= 62.0' Slope= 0.0081 '/'
Inlet Invert= 1,476.50', Outlet Invert= 1,476.00'



Summary for Reach DC1a: Downchute 1

Inflow Area = 117,961 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 16.39 cfs @ 11.94 hrs, Volume= 31,199 cf
Outflow = 16.36 cfs @ 11.94 hrs, Volume= 31,199 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 7.50 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.59 fps, Avg. Travel Time= 1.7 min

Peak Storage= 358 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.18'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 164.0' Slope= 0.3300 '/'
Inlet Invert= 1,611.51', Outlet Invert= 1,557.39'

‡

Summary for Reach DC1b: Downchute 1

Inflow Area = 236,564 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 32.90 cfs @ 11.94 hrs, Volume= 62,568 cf
Outflow = 32.87 cfs @ 11.94 hrs, Volume= 62,568 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 9.79 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.03 fps, Avg. Travel Time= 1.4 min

Peak Storage= 554 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 165.0' Slope= 0.3300 '/'
Inlet Invert= 1,557.39', Outlet Invert= 1,502.94'

‡

Summary for Reach DC1c: Downchute 1

Inflow Area = 310,100 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 43.22 cfs @ 11.94 hrs, Volume= 82,017 cf
Outflow = 43.22 cfs @ 11.94 hrs, Volume= 82,017 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 10.86 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.23 fps, Avg. Travel Time= 0.5 min

Peak Storage= 267 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 67.0' Slope= 0.3300 '/'
Inlet Invert= 1,502.94', Outlet Invert= 1,480.83'

‡

Summary for Reach DC8: Downchute 8

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 31.83 cfs @ 12.07 hrs, Volume= 88,442 cf
Outflow = 31.73 cfs @ 12.07 hrs, Volume= 88,442 cf, Atten= 0%, Lag= 0.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 9.40 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 2.20 fps, Avg. Travel Time= 3.2 min

Peak Storage= 1,441 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.27'
Defined Flood Depth= 1.00' Flow Area= 14.0 sf, Capacity= 293.14 cfs
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 293.14 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 427.0' Slope= 0.3021 '/'
Inlet Invert= 1,629.00', Outlet Invert= 1,500.00'

‡

Summary for Reach PCHa: Perimeter Channel

Inflow Area = 18,630 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 2.71 cfs @ 11.93 hrs, Volume= 4,927 cf
Outflow = 2.58 cfs @ 11.95 hrs, Volume= 4,927 cf, Atten= 5%, Lag= 1.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.88 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 0.49 fps, Avg. Travel Time= 6.7 min

Peak Storage= 270 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.42'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 197.0' Slope= 0.0100 '/'
Inlet Invert= 1,479.97', Outlet Invert= 1,478.00'

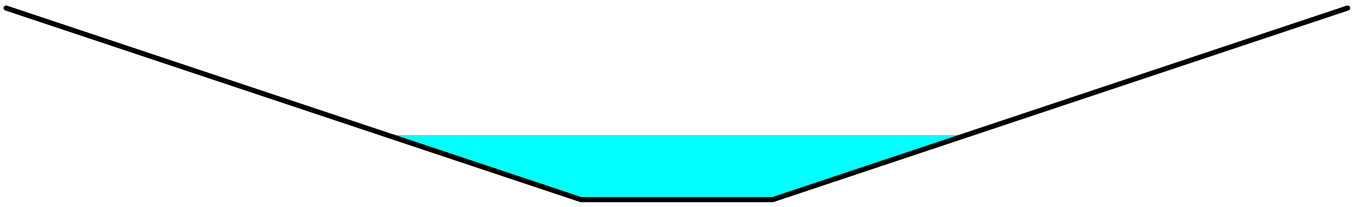
Summary for Reach PCHb: Perimeter Channel

Inflow Area = 52,194 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 7.18 cfs @ 11.95 hrs, Volume= 13,805 cf
Outflow = 6.62 cfs @ 11.97 hrs, Volume= 13,805 cf, Atten= 8%, Lag= 1.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.43 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 0.66 fps, Avg. Travel Time= 10.3 min

Peak Storage= 1,096 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.68'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 403.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.03', Outlet Invert= 1,478.00'



Summary for Pond Cul17: Culvert 17

Inflow Area = 646,052 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 61.03 cfs @ 11.95 hrs, Volume= 170,871 cf
Outflow = 61.03 cfs @ 11.95 hrs, Volume= 170,871 cf, Atten= 0%, Lag= 0.0 min
Primary = 61.03 cfs @ 11.95 hrs, Volume= 170,871 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,483.32' @ 11.95 hrs
Flood Elev= 1,484.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,480.00'	**48.0" Round Culvert** L= 136.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,480.00' / 1,476.00' S= 0.0294 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 12.57 sf

Primary OutFlow Max=60.99 cfs @ 11.95 hrs HW=1,483.32' TW=1,478.03' (Dynamic Tailwater)
1=Culvert (Inlet Controls 60.99 cfs @ 5.47 fps)

Summary for Pond Cul18: Culvert 18

Inflow Area = 70,824 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 9.03 cfs @ 11.96 hrs, Volume= 18,732 cf
Outflow = 9.03 cfs @ 11.96 hrs, Volume= 18,732 cf, Atten= 0%, Lag= 0.0 min
Primary = 9.03 cfs @ 11.96 hrs, Volume= 18,732 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 1,479.47' @ 11.96 hrs
Flood Elev= 1,480.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,478.00'	**24.0" Round Culvert** L= 48.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,478.00' / 1,475.00' S= 0.0625 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=9.01 cfs @ 11.96 hrs HW=1,479.47' TW=1,477.34' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 9.01 cfs @ 3.64 fps)

Summary for Pond Cul25: Culvert 25

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 31.73 cfs @ 12.07 hrs, Volume= 88,442 cf
Outflow = 31.73 cfs @ 12.07 hrs, Volume= 88,442 cf, Atten= 0%, Lag= 0.0 min
Primary = 31.73 cfs @ 12.07 hrs, Volume= 88,442 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,502.61' @ 12.07 hrs
Flood Elev= 1,503.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,500.00'	**36.0" Round Culvert** L= 31.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,500.00' / 1,497.00' S= 0.0968 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf

Primary OutFlow Max=31.70 cfs @ 12.07 hrs HW=1,502.61' TW=1,497.71' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 31.70 cfs @ 4.85 fps)

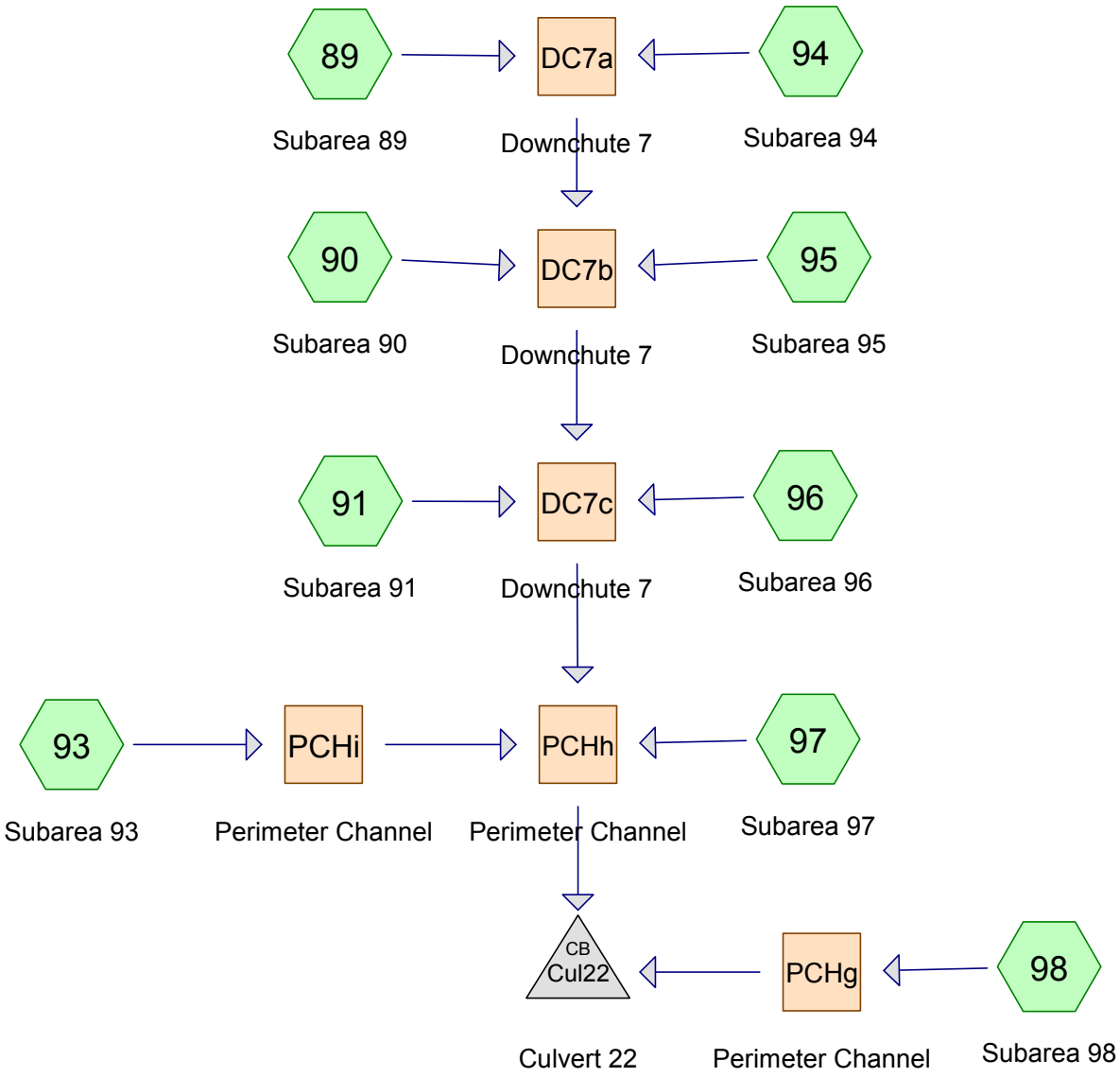
Summary for Pond Cul26: Culvert 26

Inflow Area = 334,391 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 31.72 cfs @ 12.08 hrs, Volume= 88,442 cf
Outflow = 31.72 cfs @ 12.08 hrs, Volume= 88,442 cf, Atten= 0%, Lag= 0.0 min
Primary = 31.72 cfs @ 12.08 hrs, Volume= 88,442 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,479.76' @ 12.08 hrs
Flood Elev= 1,480.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,477.00'	**36.0" Round Culvert** L= 63.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,477.00' / 1,476.50' S= 0.0079 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 7.07 sf

Primary OutFlow Max=31.69 cfs @ 12.08 hrs HW=1,479.76' TW=1,478.27' (Dynamic Tailwater)
↑**1=Culvert** (Barrel Controls 31.69 cfs @ 6.09 fps)



Subcat Reach Pond Link

Routing Diagram for Southern Expansion Segment 7
Prepared by Tetra Tech Inc, Printed 5/4/2020
HydroCAD® 10.00-24 s/n 04483 © 2018 HydroCAD Software Solutions LLC

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 89: Subarea 89 Runoff Area=41,788 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=395' Tc=3.6 min CN=80 Runoff=0.93 cfs 1,750 cf

Subcatchment 90: Subarea 90 Runoff Area=51,317 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=496' Tc=4.6 min CN=80 Runoff=1.09 cfs 2,149 cf

Subcatchment 91: Subarea 91 Runoff Area=45,282 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=486' Tc=4.6 min CN=80 Runoff=0.96 cfs 1,896 cf

Subcatchment 93: Subarea 93 Runoff Area=6,232 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=43' Slope=0.3300 '/' Tc=1.8 min CN=80 Runoff=0.15 cfs 261 cf

Subcatchment 94: Subarea 94 Runoff Area=38,910 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=325' Slope=0.0400 '/' Tc=4.7 min CN=80 Runoff=0.82 cfs 1,630 cf

Subcatchment 95: Subarea 95 Runoff Area=74,924 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=713' Tc=3.4 min CN=80 Runoff=1.67 cfs 3,138 cf

Subcatchment 96: Subarea 96 Runoff Area=101,683 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=1,051' Tc=4.1 min CN=80 Runoff=2.20 cfs 4,259 cf

Subcatchment 97: Subarea 97 Runoff Area=14,080 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=21' Slope=0.3300 '/' Tc=1.0 min CN=80 Runoff=0.34 cfs 590 cf

Subcatchment 98: Subarea 98 Runoff Area=6,183 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=78' Slope=0.3300 '/' Tc=3.0 min CN=80 Runoff=0.14 cfs 259 cf

Reach DC7a: Downchute 7 Avg. Flow Depth=0.05' Max Vel=3.12 fps Inflow=1.74 cfs 3,380 cf
n=0.035 L=152.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=1.72 cfs 3,380 cf

Reach DC7b: Downchute 7 Avg. Flow Depth=0.08' Max Vel=4.51 fps Inflow=4.44 cfs 8,667 cf
n=0.035 L=127.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=4.43 cfs 8,667 cf

Reach DC7c: Downchute 7 Avg. Flow Depth=0.11' Max Vel=5.57 fps Inflow=7.59 cfs 14,822 cf
n=0.035 L=21.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=7.59 cfs 14,822 cf

Reach PCHg: Perimeter Channel Avg. Flow Depth=0.08' Max Vel=0.74 fps Inflow=0.14 cfs 259 cf
n=0.035 L=124.0' S=0.0105 '/' Capacity=73.77 cfs Outflow=0.13 cfs 259 cf

Reach PCHh: Perimeter Channel Avg. Flow Depth=0.72' Max Vel=2.52 fps Inflow=7.95 cfs 15,672 cf
n=0.035 L=292.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=7.51 cfs 15,672 cf

Reach PCHi: Perimeter Channel Avg. Flow Depth=0.08' Max Vel=0.71 fps Inflow=0.15 cfs 261 cf
n=0.035 L=192.0' S=0.0101 '/' Capacity=72.23 cfs Outflow=0.12 cfs 261 cf

Pond Cul22: Culvert 22 Peak Elev=1,480.95' Inflow=7.64 cfs 15,931 cf
60.0" Round Culvert n=0.013 L=45.0' S=0.0222 '/' Outflow=7.64 cfs 15,931 cf

Summary for Subcatchment 89: Subarea 89

Runoff = 0.93 cfs @ 11.95 hrs, Volume= 1,750 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	41,788	80	
	41,788		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	73	0.3300	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.8	322	0.0400	6.77	45.68	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035
3.6	395	Total			

Summary for Subcatchment 90: Subarea 90

Runoff = 1.09 cfs @ 11.97 hrs, Volume= 2,149 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	51,317	80	
	51,317		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	54	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	342	0.0400	6.77	45.68	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035
4.6	496	Total			

Summary for Subcatchment 91: Subarea 91

Runoff = 0.96 cfs @ 11.97 hrs, Volume= 1,896 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	45,282	80	
	45,282		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.1	27	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	359	0.0400	6.77	45.68	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035
4.6	486	Total			

Summary for Subcatchment 93: Subarea 93

Runoff = 0.15 cfs @ 11.93 hrs, Volume= 261 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	6,232	80	
	6,232		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	43	0.3300	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 94: Subarea 94

Runoff = 0.82 cfs @ 11.97 hrs, Volume= 1,630 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	38,910	80	
	38,910		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	41	0.0400	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.6	284	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.7	325	Total			

Summary for Subcatchment 95: Subarea 95

Runoff = 1.67 cfs @ 11.95 hrs, Volume= 3,138 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	74,924	80	
	74,924		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	49	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.4	664	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
3.4	713	Total			

Summary for Subcatchment 96: Subarea 96

Runoff = 2.20 cfs @ 11.96 hrs, Volume= 4,259 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	101,683	80	
	101,683		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	47	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.1	1,004	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.1	1,051	Total			

Summary for Subcatchment 97: Subarea 97

Runoff = 0.34 cfs @ 11.92 hrs, Volume= 590 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	14,080	80	
	14,080		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	21	0.3300	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 98: Subarea 98

Runoff = 0.14 cfs @ 11.94 hrs, Volume= 259 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	6,183	80	
	6,183		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	78	0.3300	0.44		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Reach DC7a: Downchute 7

Inflow Area = 80,698 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 1.74 cfs @ 11.96 hrs, Volume= 3,380 cf
Outflow = 1.72 cfs @ 11.97 hrs, Volume= 3,380 cf, Atten= 1%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.12 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.17 fps, Avg. Travel Time= 2.2 min

Peak Storage= 84 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.05'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 152.0' Slope= 0.3300 '/'
Inlet Invert= 1,584.00', Outlet Invert= 1,533.84'

‡

Summary for Reach DC7b: Downchute 7

Inflow Area = 206,939 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 4.44 cfs @ 11.96 hrs, Volume= 8,667 cf
Outflow = 4.43 cfs @ 11.96 hrs, Volume= 8,667 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.51 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.27 fps, Avg. Travel Time= 1.7 min

Peak Storage= 125 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 127.0' Slope= 0.3300 '/'
Inlet Invert= 1,533.84', Outlet Invert= 1,491.93'

‡

Summary for Reach DC7c: Downchute 7

Inflow Area = 353,904 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 7.59 cfs @ 11.96 hrs, Volume= 14,822 cf
Outflow = 7.59 cfs @ 11.96 hrs, Volume= 14,822 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.57 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.43 fps, Avg. Travel Time= 0.2 min

Peak Storage= 29 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.11'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 21.0' Slope= 0.3300 '/'
Inlet Invert= 1,491.93', Outlet Invert= 1,485.00'

‡

Summary for Reach PCHg: Perimeter Channel

Inflow Area = 6,183 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 0.14 cfs @ 11.94 hrs, Volume= 259 cf
Outflow = 0.13 cfs @ 11.97 hrs, Volume= 259 cf, Atten= 10%, Lag= 1.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 0.74 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 0.32 fps, Avg. Travel Time= 6.4 min

Peak Storage= 21 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.08'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 73.77 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 73.77 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 124.0' Slope= 0.0105 '/'
Inlet Invert= 1,482.30', Outlet Invert= 1,481.00'

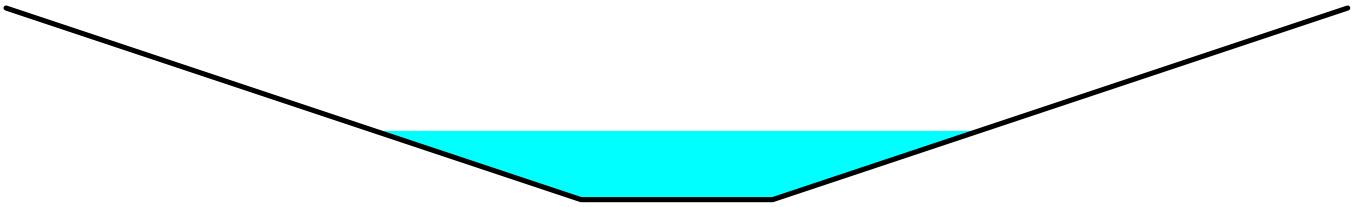
Summary for Reach PCHh: Perimeter Channel

Inflow Area = 374,216 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 7.95 cfs @ 11.96 hrs, Volume= 15,672 cf
Outflow = 7.51 cfs @ 11.98 hrs, Volume= 15,672 cf, Atten= 6%, Lag= 1.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.52 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 0.80 fps, Avg. Travel Time= 6.0 min

Peak Storage= 872 cf @ 11.98 hrs
Average Depth at Peak Storage= 0.72'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 292.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.92', Outlet Invert= 1,480.00'



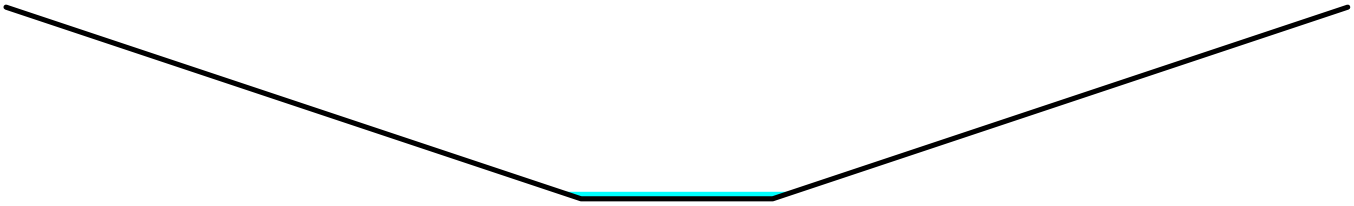
Summary for Reach PCHi: Perimeter Channel

Inflow Area = 6,232 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 0.15 cfs @ 11.93 hrs, Volume= 261 cf
Outflow = 0.12 cfs @ 11.96 hrs, Volume= 261 cf, Atten= 20%, Lag= 2.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 0.71 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 0.32 fps, Avg. Travel Time= 10.1 min

Peak Storage= 32 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.08'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.23 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.23 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 192.0' Slope= 0.0101 '/'
Inlet Invert= 1,484.85', Outlet Invert= 1,482.92'



Summary for Pond Cul22: Culvert 22

Inflow Area = 380,399 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 7.64 cfs @ 11.98 hrs, Volume= 15,931 cf
Outflow = 7.64 cfs @ 11.98 hrs, Volume= 15,931 cf, Atten= 0%, Lag= 0.0 min
Primary = 7.64 cfs @ 11.98 hrs, Volume= 15,931 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,480.95' @ 11.98 hrs
Flood Elev= 1,485.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,480.00'	**60.0" Round Culvert** L= 45.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,480.00' / 1,479.00' S= 0.0222 '/' Cc= 0.900 n= 0.013, Flow Area= 19.63 sf

Primary OutFlow Max=7.62 cfs @ 11.98 hrs HW=1,480.95' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 7.62 cfs @ 2.93 fps)

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 89: Subarea 89 Runoff Area=41,788 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=395' Tc=3.6 min CN=80 Runoff=2.61 cfs 4,828 cf

Subcatchment 90: Subarea 90 Runoff Area=51,317 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=496' Tc=4.6 min CN=80 Runoff=3.09 cfs 5,930 cf

Subcatchment 91: Subarea 91 Runoff Area=45,282 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=486' Tc=4.6 min CN=80 Runoff=2.73 cfs 5,232 cf

Subcatchment 93: Subarea 93 Runoff Area=6,232 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=43' Slope=0.3300 '/' Tc=1.8 min CN=80 Runoff=0.42 cfs 720 cf

Subcatchment 94: Subarea 94 Runoff Area=38,910 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=325' Slope=0.0400 '/' Tc=4.7 min CN=80 Runoff=2.33 cfs 4,496 cf

Subcatchment 95: Subarea 95 Runoff Area=74,924 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=713' Tc=3.4 min CN=80 Runoff=4.72 cfs 8,657 cf

Subcatchment 96: Subarea 96 Runoff Area=101,683 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=1,051' Tc=4.1 min CN=80 Runoff=6.24 cfs 11,749 cf

Subcatchment 97: Subarea 97 Runoff Area=14,080 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=21' Slope=0.3300 '/' Tc=1.0 min CN=80 Runoff=0.96 cfs 1,627 cf

Subcatchment 98: Subarea 98 Runoff Area=6,183 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=78' Slope=0.3300 '/' Tc=3.0 min CN=80 Runoff=0.40 cfs 714 cf

Reach DC7a: Downchute 7 Avg. Flow Depth=0.09' Max Vel=4.69 fps Inflow=4.92 cfs 9,324 cf
n=0.035 L=152.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=4.90 cfs 9,324 cf

Reach DC7b: Downchute 7 Avg. Flow Depth=0.15' Max Vel=6.78 fps Inflow=12.62 cfs 23,911 cf
n=0.035 L=127.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=12.61 cfs 23,911 cf

Reach DC7c: Downchute 7 Avg. Flow Depth=0.21' Max Vel=8.33 fps Inflow=21.56 cfs 40,893 cf
n=0.035 L=21.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=21.56 cfs 40,893 cf

Reach PCHg: Perimeter Channel Avg. Flow Depth=0.14' Max Vel=1.06 fps Inflow=0.40 cfs 714 cf
n=0.035 L=124.0' S=0.0105 '/' Capacity=73.77 cfs Outflow=0.38 cfs 714 cf

Reach PCHh: Perimeter Channel Avg. Flow Depth=1.19' Max Vel=3.33 fps Inflow=22.62 cfs 43,240 cf
n=0.035 L=292.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=21.92 cfs 43,240 cf

Reach PCHi: Perimeter Channel Avg. Flow Depth=0.15' Max Vel=1.04 fps Inflow=0.42 cfs 720 cf
n=0.035 L=192.0' S=0.0101 '/' Capacity=72.23 cfs Outflow=0.37 cfs 720 cf

Pond Cul22: Culvert 22 Peak Elev=1,481.67' Inflow=22.28 cfs 43,954 cf
60.0" Round Culvert n=0.013 L=45.0' S=0.0222 '/' Outflow=22.28 cfs 43,954 cf

Summary for Subcatchment 89: Subarea 89

Runoff = 2.61 cfs @ 11.95 hrs, Volume= 4,828 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	41,788	80	
	41,788		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	73	0.3300	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.8	322	0.0400	6.77	45.68	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035
3.6	395	Total			

Summary for Subcatchment 90: Subarea 90

Runoff = 3.09 cfs @ 11.96 hrs, Volume= 5,930 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	51,317	80	
	51,317		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	54	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	342	0.0400	6.77	45.68	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035
4.6	496	Total			

Summary for Subcatchment 91: Subarea 91

Runoff = 2.73 cfs @ 11.96 hrs, Volume= 5,232 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	45,282	80	
	45,282		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.1	27	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	359	0.0400	6.77	45.68	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035
4.6	486	Total			

Summary for Subcatchment 93: Subarea 93

Runoff = 0.42 cfs @ 11.92 hrs, Volume= 720 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	6,232	80	
	6,232		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	43	0.3300	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 94: Subarea 94

Runoff = 2.33 cfs @ 11.96 hrs, Volume= 4,496 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	38,910	80	
	38,910		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	41	0.0400	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.6	284	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.7	325	Total			

Summary for Subcatchment 95: Subarea 95

Runoff = 4.72 cfs @ 11.94 hrs, Volume= 8,657 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	74,924	80	
	74,924		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	49	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.4	664	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
3.4	713	Total			

Summary for Subcatchment 96: Subarea 96

Runoff = 6.24 cfs @ 11.95 hrs, Volume= 11,749 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	101,683	80	
	101,683		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	47	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.1	1,004	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.1	1,051	Total			

Summary for Subcatchment 97: Subarea 97

Runoff = 0.96 cfs @ 11.91 hrs, Volume= 1,627 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	14,080	80	
	14,080		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	21	0.3300	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 98: Subarea 98

Runoff = 0.40 cfs @ 11.94 hrs, Volume= 714 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	6,183	80	
	6,183		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	78	0.3300	0.44		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Reach DC7a: Downchute 7

Inflow Area = 80,698 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 4.92 cfs @ 11.95 hrs, Volume= 9,324 cf
Outflow = 4.90 cfs @ 11.96 hrs, Volume= 9,324 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.69 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.26 fps, Avg. Travel Time= 2.0 min

Peak Storage= 159 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.09'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 152.0' Slope= 0.3300 '/'
Inlet Invert= 1,584.00', Outlet Invert= 1,533.84'

‡

Summary for Reach DC7b: Downchute 7

Inflow Area = 206,939 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 12.62 cfs @ 11.95 hrs, Volume= 23,911 cf
Outflow = 12.61 cfs @ 11.96 hrs, Volume= 23,911 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.78 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.55 fps, Avg. Travel Time= 1.4 min

Peak Storage= 236 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.15'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 127.0' Slope= 0.3300 '/'
Inlet Invert= 1,533.84', Outlet Invert= 1,491.93'

‡

Summary for Reach DC7c: Downchute 7

Inflow Area = 353,904 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 21.56 cfs @ 11.96 hrs, Volume= 40,893 cf
Outflow = 21.56 cfs @ 11.96 hrs, Volume= 40,893 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 8.33 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 1.89 fps, Avg. Travel Time= 0.2 min

Peak Storage= 54 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.21'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 21.0' Slope= 0.3300 '/'
Inlet Invert= 1,491.93', Outlet Invert= 1,485.00'

‡

Summary for Reach PCHg: Perimeter Channel

Inflow Area = 6,183 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 0.40 cfs @ 11.94 hrs, Volume= 714 cf
Outflow = 0.38 cfs @ 11.96 hrs, Volume= 714 cf, Atten= 5%, Lag= 1.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.06 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 0.34 fps, Avg. Travel Time= 6.1 min

Peak Storage= 44 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.14'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 73.77 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 73.77 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 124.0' Slope= 0.0105 '/'
Inlet Invert= 1,482.30', Outlet Invert= 1,481.00'

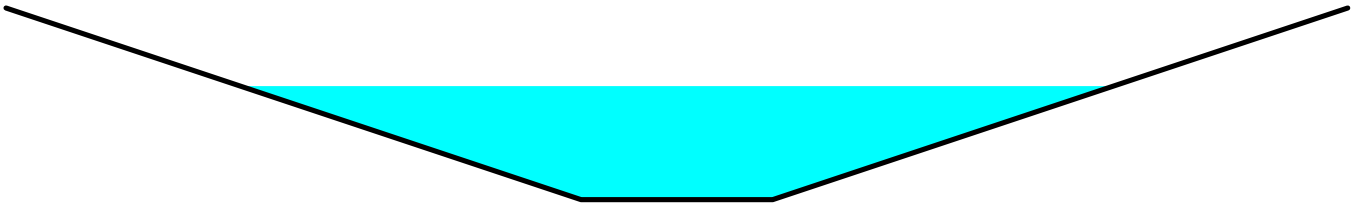
Summary for Reach PCHh: Perimeter Channel

Inflow Area = 374,216 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 22.62 cfs @ 11.95 hrs, Volume= 43,240 cf
Outflow = 21.92 cfs @ 11.97 hrs, Volume= 43,240 cf, Atten= 3%, Lag= 1.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.33 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 1.02 fps, Avg. Travel Time= 4.8 min

Peak Storage= 1,924 cf @ 11.97 hrs
Average Depth at Peak Storage= 1.19'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 292.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.92', Outlet Invert= 1,480.00'



Summary for Reach PCHi: Perimeter Channel

Inflow Area = 6,232 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 0.42 cfs @ 11.92 hrs, Volume= 720 cf
Outflow = 0.37 cfs @ 11.95 hrs, Volume= 720 cf, Atten= 11%, Lag= 1.5 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.04 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 0.33 fps, Avg. Travel Time= 9.6 min

Peak Storage= 68 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.15'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.23 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.23 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 192.0' Slope= 0.0101 '/'
Inlet Invert= 1,484.85', Outlet Invert= 1,482.92'

Summary for Pond Cul22: Culvert 22

Inflow Area = 380,399 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 22.28 cfs @ 11.97 hrs, Volume= 43,954 cf
Outflow = 22.28 cfs @ 11.97 hrs, Volume= 43,954 cf, Atten= 0%, Lag= 0.0 min
Primary = 22.28 cfs @ 11.97 hrs, Volume= 43,954 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,481.67' @ 11.97 hrs
Flood Elev= 1,485.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,480.00'	**60.0" Round Culvert** L= 45.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,480.00' / 1,479.00' S= 0.0222 '/' Cc= 0.900 n= 0.013, Flow Area= 19.63 sf

Primary OutFlow Max=22.27 cfs @ 11.97 hrs HW=1,481.67' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 22.27 cfs @ 3.88 fps)

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 89: Subarea 89 Runoff Area=41,788 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=395' Tc=3.6 min CN=80 Runoff=5.83 cfs 11,052 cf

Subcatchment 90: Subarea 90 Runoff Area=51,317 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=496' Tc=4.6 min CN=80 Runoff=6.91 cfs 13,573 cf

Subcatchment 91: Subarea 91 Runoff Area=45,282 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=486' Tc=4.6 min CN=80 Runoff=6.10 cfs 11,976 cf

Subcatchment 93: Subarea 93 Runoff Area=6,232 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=43' Slope=0.3300 '/' Tc=1.8 min CN=80 Runoff=0.92 cfs 1,648 cf

Subcatchment 94: Subarea 94 Runoff Area=38,910 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=325' Slope=0.0400 '/' Tc=4.7 min CN=80 Runoff=5.22 cfs 10,291 cf

Subcatchment 95: Subarea 95 Runoff Area=74,924 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=713' Tc=3.4 min CN=80 Runoff=10.53 cfs 19,816 cf

Subcatchment 96: Subarea 96 Runoff Area=101,683 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=1,051' Tc=4.1 min CN=80 Runoff=13.94 cfs 26,894 cf

Subcatchment 97: Subarea 97 Runoff Area=14,080 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=21' Slope=0.3300 '/' Tc=1.0 min CN=80 Runoff=2.14 cfs 3,724 cf

Subcatchment 98: Subarea 98 Runoff Area=6,183 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=78' Slope=0.3300 '/' Tc=3.0 min CN=80 Runoff=0.88 cfs 1,635 cf

Reach DC7a: Downchute 7 Avg. Flow Depth=0.14' Max Vel=6.43 fps Inflow=11.00 cfs 21,343 cf
n=0.035 L=152.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=10.98 cfs 21,343 cf

Reach DC7b: Downchute 7 Avg. Flow Depth=0.24' Max Vel=9.25 fps Inflow=28.28 cfs 54,732 cf
n=0.035 L=127.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=28.26 cfs 54,732 cf

Reach DC7c: Downchute 7 Avg. Flow Depth=0.34' Max Vel=11.31 fps Inflow=48.28 cfs 93,602 cf
n=0.035 L=21.0' S=0.3300 '/' Capacity=306.38 cfs Outflow=48.28 cfs 93,602 cf

Reach PCHg: Perimeter Channel Avg. Flow Depth=0.23' Max Vel=1.38 fps Inflow=0.88 cfs 1,635 cf
n=0.035 L=124.0' S=0.0105 '/' Capacity=73.77 cfs Outflow=0.85 cfs 1,635 cf

Reach PCHh: Perimeter Channel Avg. Flow Depth=1.70' Max Vel=4.10 fps Inflow=50.70 cfs 98,975 cf
n=0.035 L=292.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=49.65 cfs 98,975 cf

Reach PCHi: Perimeter Channel Avg. Flow Depth=0.23' Max Vel=1.36 fps Inflow=0.92 cfs 1,648 cf
n=0.035 L=192.0' S=0.0101 '/' Capacity=72.23 cfs Outflow=0.86 cfs 1,648 cf

Pond Cul22: Culvert 22 Peak Elev=1,482.62' Inflow=50.49 cfs 100,610 cf
60.0" Round Culvert n=0.013 L=45.0' S=0.0222 '/' Outflow=50.49 cfs 100,610 cf

Summary for Subcatchment 89: Subarea 89

Runoff = 5.83 cfs @ 11.94 hrs, Volume= 11,052 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	41,788	80	
	41,788		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	73	0.3300	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.8	322	0.0400	6.77	45.68	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035
3.6	395	Total			

Summary for Subcatchment 90: Subarea 90

Runoff = 6.91 cfs @ 11.96 hrs, Volume= 13,573 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	51,317	80	
	51,317		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	54	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	342	0.0400	6.77	45.68	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035
4.6	496	Total			

Summary for Subcatchment 91: Subarea 91

Runoff = 6.10 cfs @ 11.96 hrs, Volume= 11,976 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	45,282	80	
	45,282		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.1	27	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.9	359	0.0400	6.77	45.68	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.035
4.6	486	Total			

Summary for Subcatchment 93: Subarea 93

Runoff = 0.92 cfs @ 11.92 hrs, Volume= 1,648 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	6,232	80	
	6,232		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	43	0.3300	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 94: Subarea 94

Runoff = 5.22 cfs @ 11.96 hrs, Volume= 10,291 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	38,910	80	
	38,910		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	41	0.0400	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.6	284	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.7	325	Total			

Summary for Subcatchment 95: Subarea 95

Runoff = 10.53 cfs @ 11.94 hrs, Volume= 19,816 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	74,924	80	
	74,924		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	49	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.4	664	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
3.4	713	Total			

Summary for Subcatchment 96: Subarea 96

Runoff = 13.94 cfs @ 11.95 hrs, Volume= 26,894 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	101,683	80	
	101,683		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	47	0.3300	0.40		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.1	1,004	0.0400	7.90	53.29	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.50' Z= 3.0 '/' Top.W=9.00' n= 0.030
4.1	1,051	Total			

Summary for Subcatchment 97: Subarea 97

Runoff = 2.14 cfs @ 11.91 hrs, Volume= 3,724 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	14,080	80	
	14,080		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	21	0.3300	0.34		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 98: Subarea 98

Runoff = 0.88 cfs @ 11.94 hrs, Volume= 1,635 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	6,183	80	
	6,183		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	78	0.3300	0.44		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Reach DC7a: Downchute 7

Inflow Area = 80,698 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 11.00 cfs @ 11.95 hrs, Volume= 21,343 cf
Outflow = 10.98 cfs @ 11.95 hrs, Volume= 21,343 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.43 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.43 fps, Avg. Travel Time= 1.8 min

Peak Storage= 260 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 152.0' Slope= 0.3300 '/'
Inlet Invert= 1,584.00', Outlet Invert= 1,533.84'

‡

Summary for Reach DC7b: Downchute 7

Inflow Area = 206,939 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 28.28 cfs @ 11.95 hrs, Volume= 54,732 cf
Outflow = 28.26 cfs @ 11.95 hrs, Volume= 54,732 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 9.25 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.94 fps, Avg. Travel Time= 1.1 min

Peak Storage= 388 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 127.0' Slope= 0.3300 '/'
Inlet Invert= 1,533.84', Outlet Invert= 1,491.93'

‡

Summary for Reach DC7c: Downchute 7

Inflow Area = 353,904 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 48.28 cfs @ 11.95 hrs, Volume= 93,602 cf
Outflow = 48.28 cfs @ 11.95 hrs, Volume= 93,602 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 11.31 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 2.35 fps, Avg. Travel Time= 0.1 min

Peak Storage= 90 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 1.00' Flow Area= 14.0 sf, Capacity= 306.38 cfs

12.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 21.0' Slope= 0.3300 '/'
Inlet Invert= 1,491.93', Outlet Invert= 1,485.00'

‡

Summary for Reach PCHg: Perimeter Channel

Inflow Area = 6,183 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 0.88 cfs @ 11.94 hrs, Volume= 1,635 cf
Outflow = 0.85 cfs @ 11.95 hrs, Volume= 1,635 cf, Atten= 3%, Lag= 0.9 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.38 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 0.37 fps, Avg. Travel Time= 5.6 min

Peak Storage= 77 cf @ 11.95 hrs
Average Depth at Peak Storage= 0.23'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 73.77 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 73.77 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 124.0' Slope= 0.0105 '/'
Inlet Invert= 1,482.30', Outlet Invert= 1,481.00'

Summary for Reach PCHh: Perimeter Channel

Inflow Area = 374,216 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 50.70 cfs @ 11.95 hrs, Volume= 98,975 cf
Outflow = 49.65 cfs @ 11.96 hrs, Volume= 98,975 cf, Atten= 2%, Lag= 0.8 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.10 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.22 fps, Avg. Travel Time= 4.0 min

Peak Storage= 3,538 cf @ 11.96 hrs
Average Depth at Peak Storage= 1.70'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 292.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.92', Outlet Invert= 1,480.00'

Summary for Reach PCHi: Perimeter Channel

Inflow Area = 6,232 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 0.92 cfs @ 11.92 hrs, Volume= 1,648 cf
Outflow = 0.86 cfs @ 11.94 hrs, Volume= 1,648 cf, Atten= 7%, Lag= 1.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.36 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.36 fps, Avg. Travel Time= 8.8 min

Peak Storage= 121 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.23'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.23 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.23 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 192.0' Slope= 0.0101 '/'
Inlet Invert= 1,484.85', Outlet Invert= 1,482.92'

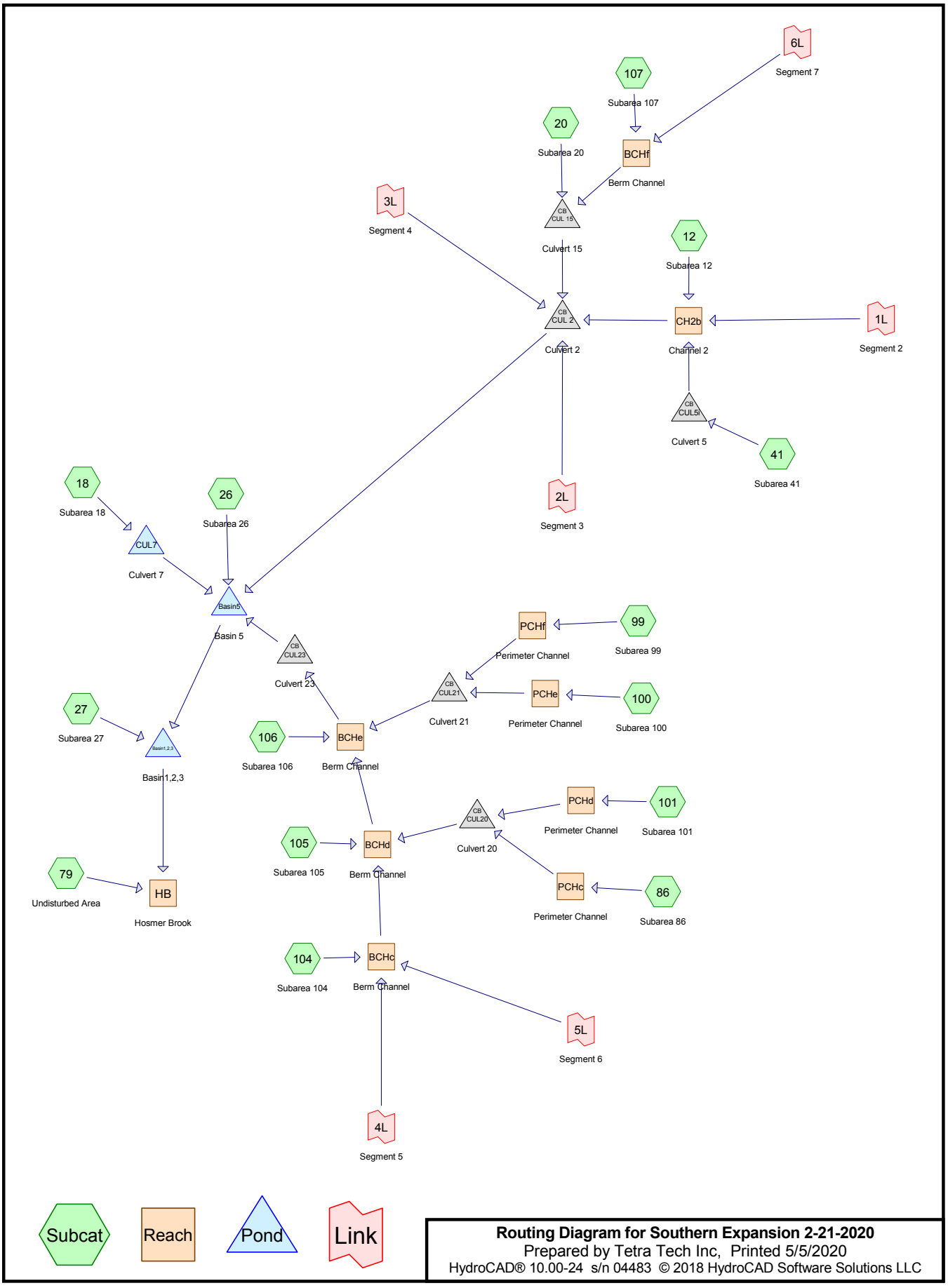
Summary for Pond Cul22: Culvert 22

Inflow Area = 380,399 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 50.49 cfs @ 11.96 hrs, Volume= 100,610 cf
Outflow = 50.49 cfs @ 11.96 hrs, Volume= 100,610 cf, Atten= 0%, Lag= 0.0 min
Primary = 50.49 cfs @ 11.96 hrs, Volume= 100,610 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.62' @ 11.96 hrs
Flood Elev= 1,485.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,480.00'	**60.0" Round Culvert**
			L= 45.0' CPP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 1,480.00' / 1,479.00' S= 0.0222 '/' Cc= 0.900
			n= 0.013, Flow Area= 19.63 sf

Primary OutFlow Max=50.38 cfs @ 11.96 hrs HW=1,482.61' (Free Discharge)
└**1=Culvert** (Inlet Controls 50.38 cfs @ 4.86 fps)



Routing Diagram for Southern Expansion 2-21-2020

Prepared by Tetra Tech Inc, Printed 5/5/2020

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Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 12: Subarea 12 Runoff Area=32,357 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=121' Tc=3.5 min CN=80 Runoff=0.72 cfs 1,355 cf

Subcatchment 18: Subarea 18 Runoff Area=116,799 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=527' Tc=16.2 min CN=80 Runoff=1.54 cfs 4,892 cf

Subcatchment 20: Subarea 20 Runoff Area=22,282 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=230' Slope=0.0200 '/' Tc=13.3 min CN=80 Runoff=0.33 cfs 933 cf

Subcatchment 26: Subarea 26 Runoff Area=138,227 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=315' Tc=0.3 min CN=80 Runoff=3.45 cfs 5,789 cf

Subcatchment 27: Subarea 27 Runoff Area=324,396 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=859' Tc=0.9 min CN=80 Runoff=7.98 cfs 13,586 cf

Subcatchment 41: Subarea 41 Runoff Area=48,000 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=392' Tc=5.0 min CN=80 Runoff=1.00 cfs 2,010 cf

Subcatchment 79: Undisturbed Area Runoff Area=4,866,899 sf 0.00% Impervious Runoff Depth=0.63"
Flow Length=3,581' Tc=177.8 min CN=83 Runoff=15.09 cfs 254,582 cf

Subcatchment 86: Subarea 86 Runoff Area=14,701 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=10' Slope=0.3300 '/' Tc=0.6 min CN=80 Runoff=0.37 cfs 616 cf

Subcatchment 99: Subarea 99 Runoff Area=33,575 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=78' Slope=0.3300 '/' Tc=3.0 min CN=80 Runoff=0.76 cfs 1,406 cf

Subcatchment 100: Subarea 100 Runoff Area=29,119 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=140' Slope=0.3300 '/' Tc=3.8 min CN=80 Runoff=0.64 cfs 1,220 cf

Subcatchment 101: Subarea 101 Runoff Area=35,863 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=140' Slope=0.3300 '/' Tc=3.8 min CN=80 Runoff=0.79 cfs 1,502 cf

Subcatchment 104: Subarea 104 Runoff Area=21,132 sf 0.00% Impervious Runoff Depth=0.77"
Flow Length=73' Tc=2.4 min CN=86 Runoff=0.77 cfs 1,363 cf

Subcatchment 105: Subarea 105 Runoff Area=38,526 sf 0.00% Impervious Runoff Depth=0.77"
Flow Length=77' Tc=2.6 min CN=86 Runoff=1.40 cfs 2,485 cf

Subcatchment 106: Subarea 106 Runoff Area=59,555 sf 0.00% Impervious Runoff Depth=0.77"
Flow Length=91' Tc=3.0 min CN=86 Runoff=2.13 cfs 3,842 cf

Subcatchment 107: Subarea 107 Runoff Area=52,005 sf 0.00% Impervious Runoff Depth=0.77"
Flow Length=39' Tc=1.0 min CN=86 Runoff=1.99 cfs 3,355 cf

Reach BCHc: Berm Channel Avg. Flow Depth=1.24' Max Vel=2.93 fps Inflow=13.92 cfs 47,373 cf
n=0.035 L=309.0' S=0.0097 '/' Capacity=307.76 cfs Outflow=13.51 cfs 47,373 cf

Reach BCHd: Berm Channel Avg. Flow Depth=1.28' Max Vel=2.86 fps Inflow=14.87 cfs 51,976 cf
n=0.035 L=451.0' S=0.0089 '/' Capacity=294.15 cfs Outflow=14.04 cfs 51,976 cf

Reach BCHe: Berm Channel Avg. Flow Depth=1.20' Max Vel=3.32 fps Inflow=15.58 cfs 58,443 cf
n=0.035 L=772.0' S=0.0130 '/' Capacity=355.48 cfs Outflow=14.30 cfs 58,443 cf

Reach BCHf: Berm Channel Avg. Flow Depth=0.83' Max Vel=3.81 fps Inflow=8.66 cfs 19,286 cf
n=0.035 L=701.0' S=0.0278 '/' Capacity=520.94 cfs Outflow=7.87 cfs 19,286 cf

Reach CH2b: Channel 2 Avg. Flow Depth=1.17' Max Vel=5.38 fps Inflow=22.28 cfs 115,516 cf
n=0.035 L=117.0' S=0.0350 '/' Capacity=584.69 cfs Outflow=22.27 cfs 115,516 cf

Reach HB: Hosmer Brook Avg. Flow Depth=0.20' Max Vel=2.75 fps Inflow=15.09 cfs 254,582 cf
n=0.035 L=30.0' S=0.0373 '/' Capacity=229.45 cfs Outflow=15.09 cfs 254,582 cf

Reach PCHc: Perimeter Channel Avg. Flow Depth=0.13' Max Vel=0.98 fps Inflow=0.37 cfs 616 cf
n=0.035 L=209.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=0.30 cfs 616 cf

Reach PCHd: Perimeter Channel Avg. Flow Depth=0.21' Max Vel=1.28 fps Inflow=0.79 cfs 1,502 cf
n=0.035 L=225.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=0.71 cfs 1,502 cf

Reach PCHe: Perimeter Channel Avg. Flow Depth=0.19' Max Vel=1.20 fps Inflow=0.64 cfs 1,220 cf
n=0.035 L=225.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=0.57 cfs 1,220 cf

Reach PCHf: Perimeter Channel Avg. Flow Depth=0.19' Max Vel=1.21 fps Inflow=0.76 cfs 1,406 cf
n=0.035 L=380.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=0.59 cfs 1,406 cf

Pond Basin1,2,3: Basin1,2,3 Peak Elev=1,443.18' Storage=142,736 cf Inflow=7.98 cfs 142,736 cf
Outflow=0.00 cfs 0 cf

Pond Basin5: Basin 5 Peak Elev=1,446.73' Storage=168,735 cf Inflow=50.24 cfs 247,560 cf
Outflow=2.50 cfs 129,150 cf

Pond CUL 15: Culvert 15 Peak Elev=1,460.98' Inflow=8.14 cfs 20,219 cf
60.0" Round Culvert n=0.013 L=50.0' S=0.0916 '/' Outflow=8.14 cfs 20,219 cf

Pond CUL 2: Culvert 2 Peak Elev=1,456.68' Inflow=36.21 cfs 178,436 cf
96.0" x 72.0" Box Culvert n=0.011 L=70.0' S=0.0203 '/' Outflow=36.21 cfs 178,436 cf

Pond CUL20: Culvert 20 Peak Elev=1,480.43' Inflow=0.97 cfs 2,118 cf
24.0" Round Culvert n=0.013 L=72.0' S=0.1667 '/' Outflow=0.97 cfs 2,118 cf

Pond CUL21: Culvert 21 Peak Elev=1,480.47' Inflow=1.16 cfs 2,626 cf
24.0" Round Culvert n=0.013 L=89.0' S=0.1798 '/' Outflow=1.16 cfs 2,626 cf

Pond CUL23: Culvert 23 Peak Elev=1,455.32' Inflow=14.30 cfs 58,443 cf
60.0" Round Culvert n=0.013 L=49.0' S=0.0408 '/' Outflow=14.30 cfs 58,443 cf

Pond CUL5i: Culvert 5 Peak Elev=1,482.51' Inflow=1.00 cfs 2,010 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0667 '/' Outflow=1.00 cfs 2,010 cf

Pond CUL7: Culvert 7 Peak Elev=1,448.64' Storage=50 cf Inflow=1.54 cfs 4,892 cf
18.0" Round Culvert n=0.013 L=313.0' S=0.0096 '/' Outflow=1.54 cfs 4,892 cf

Link 1 Year Storm Outflow Imported from Southern Expansion Segment 2~Reach CH2a.hce Inflow=22.03 cfs 112,150 cf
Area= 2,677,873 sf Primary=22.03 cfs 112,150 cf

Link Year Storm Primary Outflow Imported from Southern Expansion Segment 3~Pond DCCUL5.hce Inflow=7.21 cfs 16,394 cf
Area= 391,460 sf Primary=7.21 cfs 16,394 cf

Link 1 Year Storm Primary Outflow Imported from Southern Expansion Segment 4~Pond Cul24.hce Inflow=9.91 cfs 26,307 cf
Area= 628,153 sf Primary=9.91 cfs 26,307 cf

Link 1 Year Storm Primary Outflow Imported from Southern Expansion Segment 5~Pond Cul19.hce Inflow=3.97 cfs 14,118 cf
Area= 337,097 sf Primary=3.97 cfs 14,118 cf

Link 1 Year Storm Outflow Imported from Southern Expansion Segment 6~Reach BCHb.hce Inflow=9.55 cfs 31,892 cf
Area= 745,851 sf Primary=9.55 cfs 31,892 cf

Link 1 Year Storm Primary Outflow Imported from Southern Expansion Segment 7~Pond Cul22.hce Inflow=7.64 cfs 15,931 cf
Area= 380,399 sf Primary=7.64 cfs 15,931 cf

Summary for Subcatchment 12: Subarea 12

Runoff = 0.72 cfs @ 11.95 hrs, Volume= 1,355 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	32,357	80	
	32,357		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	32	0.0100	0.73		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.7	68	0.3300	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.1	21	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.5	121	Total			

Summary for Subcatchment 18: Subarea 18

Runoff = 1.54 cfs @ 12.10 hrs, Volume= 4,892 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	116,799	80	
	116,799		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	100	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
4.4	320	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	107	0.0080	2.59	5.18	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 2.0 '/' Top.W=4.00' n= 0.030
16.2	527	Total			

Summary for Subcatchment 20: Subarea 20

Runoff = 0.33 cfs @ 12.07 hrs, Volume= 933 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	22,282	80	
	22,282		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	100	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.2	130	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.3	230	Total			

Summary for Subcatchment 26: Subarea 26

Runoff = 3.45 cfs @ 11.91 hrs, Volume= 5,789 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	138,227	80	
	138,227		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	315		16.05		**Lake or Reservoir,** Mean Depth= 8.00'

Summary for Subcatchment 27: Subarea 27

Runoff = 7.98 cfs @ 11.91 hrs, Volume= 13,586 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	324,396	80	
	324,396		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	859		16.05		**Lake or Reservoir,** Mean Depth= 8.00'

Summary for Subcatchment 41: Subarea 41

Runoff = 1.00 cfs @ 11.97 hrs, Volume= 2,010 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	48,000	80	
	48,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	67	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.0	392	Total			

Summary for Subcatchment 79: Undisturbed Area

Runoff = 15.09 cfs @ 14.42 hrs, Volume= 254,582 cf, Depth= 0.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	4,866,899	83	
	4,866,899		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.2	100	0.0360	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.50"
26.3	1,496	0.0360	0.95		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
132.3	1,985	0.0025	0.25		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
177.8	3,581	Total			

Summary for Subcatchment 86: Subarea 86

Runoff = 0.37 cfs @ 11.91 hrs, Volume= 616 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	14,701	80	
	14,701		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	10	0.3300	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 99: Subarea 99

Runoff = 0.76 cfs @ 11.94 hrs, Volume= 1,406 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	33,575	80	
	33,575		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	78	0.3300	0.44		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 100: Subarea 100

Runoff = 0.64 cfs @ 11.95 hrs, Volume= 1,220 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	29,119	80	
	29,119		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	40	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.8	140	Total			

Summary for Subcatchment 101: Subarea 101

Runoff = 0.79 cfs @ 11.95 hrs, Volume= 1,502 cf, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	35,863	80	
	35,863		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	40	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.8	140	Total			

Summary for Subcatchment 104: Subarea 104

Runoff = 0.77 cfs @ 11.93 hrs, Volume= 1,363 cf, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	21,132	86	
	21,132		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.6	37	0.3300	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.4	73	Total			

Summary for Subcatchment 105: Subarea 105

Runoff = 1.40 cfs @ 11.93 hrs, Volume= 2,485 cf, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	38,526	86	
	38,526		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.8	41	0.3300	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.6	77	Total			

Summary for Subcatchment 106: Subarea 106

Runoff = 2.13 cfs @ 11.94 hrs, Volume= 3,842 cf, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	59,555	86	
	59,555		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.2	55	0.3300	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
3.0	91	Total			

Summary for Subcatchment 107: Subarea 107

Runoff = 1.99 cfs @ 11.91 hrs, Volume= 3,355 cf, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 1 Year Storm Rainfall=1.90"

	Area (sf)	CN	Description
*	52,005	86	
	52,005		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
0.2	3	0.3300	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.0	39	Total			

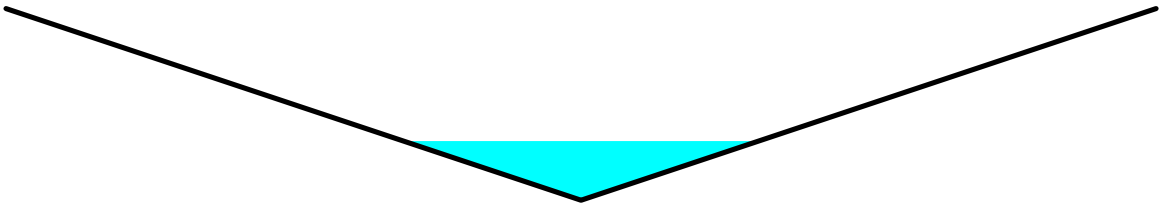
Summary for Reach BCHc: Berm Channel

Inflow Area = 1,104,080 sf, 0.00% Impervious, Inflow Depth = 0.51" for 1 Year Storm event
Inflow = 13.92 cfs @ 12.00 hrs, Volume= 47,373 cf
Outflow = 13.51 cfs @ 12.02 hrs, Volume= 47,373 cf, Atten= 3%, Lag= 1.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.93 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 1.11 fps, Avg. Travel Time= 4.6 min

Peak Storage= 1,422 cf @ 12.02 hrs
Average Depth at Peak Storage= 1.24'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 307.76 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 307.76 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 309.0' Slope= 0.0097 '/'
Inlet Invert= 1,471.00', Outlet Invert= 1,468.00'



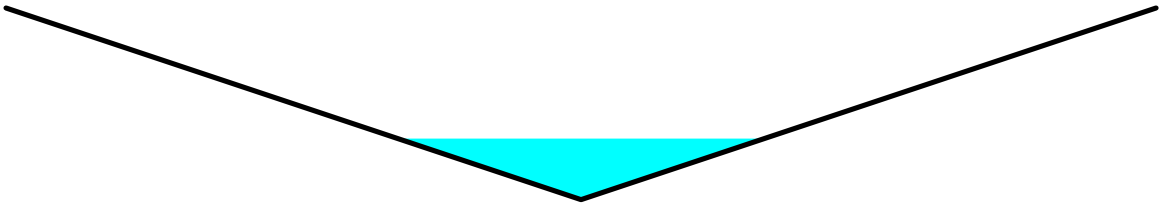
Summary for Reach BCHd: Berm Channel

Inflow Area = 1,193,170 sf, 0.00% Impervious, Inflow Depth = 0.52" for 1 Year Storm event
Inflow = 14.87 cfs @ 12.01 hrs, Volume= 51,976 cf
Outflow = 14.04 cfs @ 12.05 hrs, Volume= 51,976 cf, Atten= 6%, Lag= 2.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.86 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 1.07 fps, Avg. Travel Time= 7.0 min

Peak Storage= 2,211 cf @ 12.05 hrs
Average Depth at Peak Storage= 1.28'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 294.15 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 294.15 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 451.0' Slope= 0.0089 '/'
Inlet Invert= 1,468.00', Outlet Invert= 1,464.00'



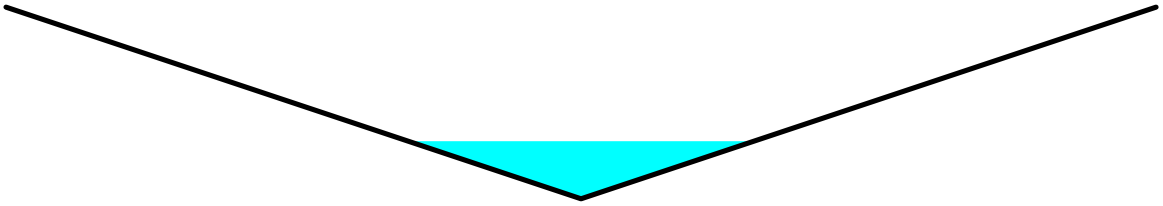
Summary for Reach BCHe: Berm Channel

Inflow Area = 1,315,419 sf, 0.00% Impervious, Inflow Depth = 0.53" for 1 Year Storm event
Inflow = 15.58 cfs @ 12.03 hrs, Volume= 58,443 cf
Outflow = 14.30 cfs @ 12.09 hrs, Volume= 58,443 cf, Atten= 8%, Lag= 3.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.32 fps, Min. Travel Time= 3.9 min
Avg. Velocity = 1.23 fps, Avg. Travel Time= 10.4 min

Peak Storage= 3,329 cf @ 12.09 hrs
Average Depth at Peak Storage= 1.20'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 355.48 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 355.48 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 772.0' Slope= 0.0130 '/'
Inlet Invert= 1,464.00', Outlet Invert= 1,454.00'



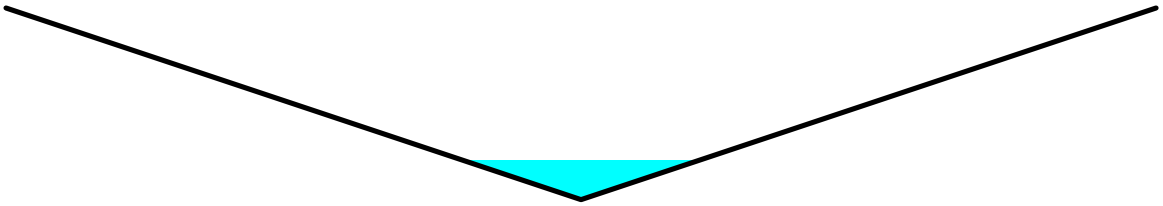
Summary for Reach BCHf: Berm Channel

Inflow Area = 432,404 sf, 0.00% Impervious, Inflow Depth = 0.54" for 1 Year Storm event
Inflow = 8.66 cfs @ 11.97 hrs, Volume= 19,286 cf
Outflow = 7.87 cfs @ 12.00 hrs, Volume= 19,286 cf, Atten= 9%, Lag= 1.9 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.81 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 1.40 fps, Avg. Travel Time= 8.4 min

Peak Storage= 1,450 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.83'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 520.94 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 520.94 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 701.0' Slope= 0.0278 '/'
Inlet Invert= 1,479.50', Outlet Invert= 1,460.00'



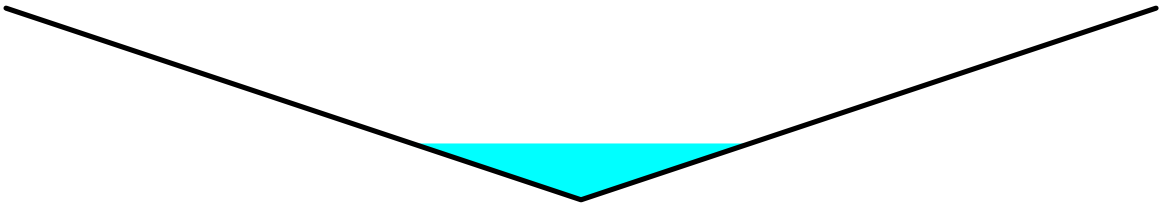
Summary for Reach CH2b: Channel 2

Inflow Area = 2,758,230 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 22.28 cfs @ 12.25 hrs, Volume= 115,516 cf
Outflow = 22.27 cfs @ 12.25 hrs, Volume= 115,516 cf, Atten= 0%, Lag= 0.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.38 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.97 fps, Avg. Travel Time= 1.0 min

Peak Storage= 484 cf @ 12.25 hrs
Average Depth at Peak Storage= 1.17'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 584.69 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 584.69 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 117.0' Slope= 0.0350 '/'
Inlet Invert= 1,459.52', Outlet Invert= 1,455.42'



Summary for Reach HB: Hosmer Brook

Inflow Area = 10,994,269 sf, 0.00% Impervious, Inflow Depth = 0.28" for 1 Year Storm event
Inflow = 15.09 cfs @ 14.42 hrs, Volume= 254,582 cf
Outflow = 15.09 cfs @ 14.42 hrs, Volume= 254,582 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.75 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.19 fps, Avg. Travel Time= 0.4 min

Peak Storage= 165 cf @ 14.42 hrs
Average Depth at Peak Storage= 0.20'
Bank-Full Depth= 1.00' Flow Area= 30.0 sf, Capacity= 229.45 cfs

27.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 33.00'
Length= 30.0' Slope= 0.0373 '/'
Inlet Invert= 1,439.83', Outlet Invert= 1,438.71'

‡

Summary for Reach PCHc: Perimeter Channel

Inflow Area = 14,701 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 0.37 cfs @ 11.91 hrs, Volume= 616 cf
Outflow = 0.30 cfs @ 11.94 hrs, Volume= 616 cf, Atten= 18%, Lag= 1.8 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 0.98 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 0.33 fps, Avg. Travel Time= 10.5 min

Peak Storage= 65 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.13'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 209.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.09', Outlet Invert= 1,480.00'

Summary for Reach PCHd: Perimeter Channel

Inflow Area = 35,863 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 0.79 cfs @ 11.95 hrs, Volume= 1,502 cf
Outflow = 0.71 cfs @ 11.98 hrs, Volume= 1,502 cf, Atten= 10%, Lag= 1.7 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.28 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 0.38 fps, Avg. Travel Time= 9.8 min

Peak Storage= 124 cf @ 11.98 hrs
Average Depth at Peak Storage= 0.21'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 225.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.25', Outlet Invert= 1,480.00'

Summary for Reach PCHe: Perimeter Channel

Inflow Area = 29,119 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 0.64 cfs @ 11.95 hrs, Volume= 1,220 cf
Outflow = 0.57 cfs @ 11.99 hrs, Volume= 1,220 cf, Atten= 11%, Lag= 1.8 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.20 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 0.37 fps, Avg. Travel Time= 10.3 min

Peak Storage= 107 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.19'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 225.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.25', Outlet Invert= 1,480.00'

Summary for Reach PCHf: Perimeter Channel

Inflow Area = 33,575 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 0.76 cfs @ 11.94 hrs, Volume= 1,406 cf
Outflow = 0.59 cfs @ 11.99 hrs, Volume= 1,406 cf, Atten= 22%, Lag= 2.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.21 fps, Min. Travel Time= 5.2 min
Avg. Velocity = 0.37 fps, Avg. Travel Time= 16.9 min

Peak Storage= 186 cf @ 11.99 hrs
Average Depth at Peak Storage= 0.19'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 380.0' Slope= 0.0100 '/'
Inlet Invert= 1,483.80', Outlet Invert= 1,480.00'

Summary for Pond Basin1,2,3: Basin1,2,3

Inflow Area = 6,127,370 sf, 0.00% Impervious, Inflow Depth = 0.28" for 1 Year Storm event
Inflow = 7.98 cfs @ 11.91 hrs, Volume= 142,736 cf
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0 cf, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,443.18' @ 120.00 hrs Surf.Area= 0 sf Storage= 142,736 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	1,441.00'	1,099,676 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
1,441.00	0
1,442.00	41,794
1,443.00	124,900
1,444.00	225,693
1,445.00	337,193
1,446.00	426,428
1,448.00	762,458
1,450.00	1,099,676

Device	Routing	Invert	Outlet Devices
#1	Primary	1,441.00'	**Special & User-Defined** Elev. (feet) 1,441.00 1,441.10 1,441.20 1,441.30 1,441.40 1,441.50 1,441.60 1,441.70 1,441.80 1,441.90 1,442.00 1,442.10 1,442.20 1,442.30 1,442.40 1,442.50 1,442.60 1,442.70 1,442.80 1,442.90 1,443.00 1,443.10 1,443.20 1,443.30 1,443.40 1,443.50 1,443.60 1,443.70 1,443.80 1,443.90 1,444.00 1,444.10 1,444.20 1,444.30 1,444.40 1,444.50 1,444.60 1,444.70 1,444.80 1,444.90 1,445.00 1,445.10 1,445.20 1,445.30 1,445.40 1,445.50 1,445.60 1,445.70 1,445.80 1,445.90 1,446.00 1,446.10 1,446.20 1,446.30 1,446.40 1,446.50 1,446.60 1,446.70 1,446.80 1,446.90 1,447.00 1,447.10 1,447.20 1,447.30 1,447.40 1,447.50 1,447.60 1,447.70 1,447.80 1,447.90 1,448.00 1,448.10 1,448.20 1,448.30 1,448.40 1,448.50 1,448.60 1,448.70 1,448.80 1,448.90 1,449.00 1,449.10 1,449.20 1,449.30 1,449.40 1,449.50 1,449.60 1,449.70 1,449.80 1,449.90 1,450.00 Disch. (cfs) 0.000 0.120 0.160 0.200 0.330 0.410 0.470 0.600 0.710 0.800 0.880 1.070 1.180 1.270 1.460 1.590 1.710 1.880 2.040 2.180 2.300 2.530 2.680 2.820 3.040 3.210 3.360 3.570 3.770 3.940 4.100 4.360 4.540 4.710 4.870 5.020 5.170 5.270 5.310 5.340 5.380 6.550 8.670 11.400 14.630 18.280 22.320 26.710 32.280 38.350 43.980 50.760 58.050 66.530 75.440 85.260 95.490 105.710 116.480 127.020 137.580

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=1,441.00' TW=1,439.83' (Dynamic Tailwater)
↑—**1=Special & User-Defined** (Controls 0.00 cfs)

Summary for Pond Basin5: Basin 5

Inflow Area = 5,802,974 sf, 0.00% Impervious, Inflow Depth = 0.51" for 1 Year Storm event
Inflow = 50.24 cfs @ 12.03 hrs, Volume= 247,560 cf
Outflow = 2.50 cfs @ 18.68 hrs, Volume= 129,150 cf, Atten= 95%, Lag= 399.0 min
Primary = 2.50 cfs @ 18.68 hrs, Volume= 129,150 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,446.73' @ 18.68 hrs Surf.Area= 68,211 sf Storage= 168,735 cf

Plug-Flow detention time= 640.9 min calculated for 129,150 cf (52% of inflow)

Center-of-Mass det. time= 490.6 min (1,381.4 - 890.8)

Volume	Invert	Avail.Storage	Storage Description
#1	1,444.00'	776,855 cf	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,444.00	53,356	0	0
1,446.00	65,054	118,410	118,410
1,448.00	73,763	138,817	257,227
1,450.00	82,901	156,664	413,891
1,452.00	89,234	172,135	586,026
1,454.00	101,595	190,829	776,855

Device	Routing	Invert	Outlet Devices
#1	Primary	1,444.00'	**Special & User-Defined** Elev. (feet) 1,444.00 1,444.20 1,444.40 1,444.60 1,444.80 1,445.00 1,445.20 1,445.40 1,445.60 1,445.80 1,446.00 1,446.20 1,446.40 1,446.60 1,446.80 1,447.00 1,447.20 1,447.40 1,447.60 1,447.80 1,448.00 1,448.20 1,448.40 1,448.60 1,448.80 1,449.00 1,449.20 1,449.40 1,449.60 1,449.80 1,450.00 1,450.20 1,450.40 1,450.60 1,450.80 1,451.00 1,451.20 1,451.40 1,451.60 1,451.80 1,452.00 1,452.20 1,452.40 1,452.60 1,452.80 1,453.00 1,453.20 1,453.40 1,453.60 1,453.80 1,454.00 Disch. (cfs) 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.660 1.310 1.900 2.860 3.520 4.710 5.830 6.830 8.170 9.190 10.720 12.150 13.460 15.090 16.390 18.180 19.870 21.420 23.290 24.820 26.840 28.380 29.770 31.070 32.300 37.160 45.070 54.990 66.560 79.590 97.170 111.170 120.000 130.230 143.900 159.070 177.540 198.670 220.730 242.880

Primary OutFlow Max=2.50 cfs @ 18.68 hrs HW=1,446.73' TW=1,442.09' (Dynamic Tailwater)
↑—**1=Special & User-Defined** (Custom Controls 2.50 cfs)

Summary for Pond CUL 15: Culvert 15

Inflow Area = 454,686 sf, 0.00% Impervious, Inflow Depth = 0.53" for 1 Year Storm event
Inflow = 8.14 cfs @ 12.00 hrs, Volume= 20,219 cf
Outflow = 8.14 cfs @ 12.00 hrs, Volume= 20,219 cf, Atten= 0%, Lag= 0.0 min
Primary = 8.14 cfs @ 12.00 hrs, Volume= 20,219 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,460.98' @ 12.00 hrs
Flood Elev= 1,464.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,460.00'	**60.0" Round Culvert** L= 50.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,460.00' / 1,455.42' S= 0.0916 '/' Cc= 0.900 n= 0.013, Flow Area= 19.63 sf

Primary OutFlow Max=8.13 cfs @ 12.00 hrs HW=1,460.98' TW=1,456.68' (Dynamic Tailwater)
1=Culvert (Inlet Controls 8.13 cfs @ 2.98 fps)

Summary for Pond CUL 2: Culvert 2

Inflow Area = 4,232,529 sf, 0.00% Impervious, Inflow Depth = 0.51" for 1 Year Storm event
Inflow = 36.21 cfs @ 12.01 hrs, Volume= 178,436 cf
Outflow = 36.21 cfs @ 12.01 hrs, Volume= 178,436 cf, Atten= 0%, Lag= 0.0 min
Primary = 36.21 cfs @ 12.01 hrs, Volume= 178,436 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,456.68' @ 12.01 hrs
Flood Elev= 1,461.52'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,455.42'	**96.0" W x 72.0" H Box Culvert** L= 70.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 1,455.42' / 1,454.00' S= 0.0203 '/' Cc= 0.900 n= 0.011, Flow Area= 48.00 sf

Primary OutFlow Max=36.21 cfs @ 12.01 hrs HW=1,456.68' TW=1,444.39' (Dynamic Tailwater)
1=Culvert (Inlet Controls 36.21 cfs @ 3.60 fps)

Summary for Pond CUL20: Culvert 20

Inflow Area = 50,564 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 0.97 cfs @ 11.97 hrs, Volume= 2,118 cf
Outflow = 0.97 cfs @ 11.97 hrs, Volume= 2,118 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.97 cfs @ 11.97 hrs, Volume= 2,118 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,480.43' @ 11.97 hrs
Flood Elev= 1,482.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,480.00'	**24.0" Round Culvert** L= 72.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,480.00' / 1,468.00' S= 0.1667 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=0.97 cfs @ 11.97 hrs HW=1,480.43' TW=1,469.14' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.97 cfs @ 1.96 fps)

Summary for Pond CUL21: Culvert 21

Inflow Area = 62,694 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 1.16 cfs @ 11.99 hrs, Volume= 2,626 cf
Outflow = 1.16 cfs @ 11.99 hrs, Volume= 2,626 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.16 cfs @ 11.99 hrs, Volume= 2,626 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,480.47' @ 11.99 hrs
Flood Elev= 1,482.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,480.00'	**24.0" Round Culvert** L= 89.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,480.00' / 1,464.00' S= 0.1798 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=1.16 cfs @ 11.99 hrs HW=1,480.47' TW=1,465.04' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 1.16 cfs @ 2.06 fps)

Summary for Pond CUL23: Culvert 23

Inflow Area = 1,315,419 sf, 0.00% Impervious, Inflow Depth = 0.53" for 1 Year Storm event
Inflow = 14.30 cfs @ 12.09 hrs, Volume= 58,443 cf
Outflow = 14.30 cfs @ 12.09 hrs, Volume= 58,443 cf, Atten= 0%, Lag= 0.0 min
Primary = 14.30 cfs @ 12.09 hrs, Volume= 58,443 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,455.32' @ 12.09 hrs
Flood Elev= 1,459.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,454.00'	**60.0" Round Culvert** L= 49.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,454.00' / 1,452.00' S= 0.0408 '/' Cc= 0.900 n= 0.013, Flow Area= 19.63 sf

Primary OutFlow Max=14.30 cfs @ 12.09 hrs HW=1,455.32' TW=1,444.62' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 14.30 cfs @ 3.45 fps)

Summary for Pond CUL5i: Culvert 5

Inflow Area = 48,000 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 1.00 cfs @ 11.97 hrs, Volume= 2,010 cf
Outflow = 1.00 cfs @ 11.97 hrs, Volume= 2,010 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.00 cfs @ 11.97 hrs, Volume= 2,010 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.51' @ 11.97 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,478.00' S= 0.0667 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=1.00 cfs @ 11.97 hrs HW=1,482.51' TW=1,460.35' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 1.00 cfs @ 1.91 fps)

Summary for Pond CUL7: Culvert 7

Inflow Area = 116,799 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 1.54 cfs @ 12.10 hrs, Volume= 4,892 cf
Outflow = 1.54 cfs @ 12.11 hrs, Volume= 4,892 cf, Atten= 0%, Lag= 0.5 min
Primary = 1.54 cfs @ 12.11 hrs, Volume= 4,892 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,448.64' @ 12.11 hrs Surf.Area= 156 sf Storage= 50 cf
Flood Elev= 1,454.00' Surf.Area= 22,611 sf Storage= 40,759 cf

Plug-Flow detention time= 0.5 min calculated for 4,891 cf (100% of inflow)
Center-of-Mass det. time= 0.5 min (881.3 - 880.7)

Volume	Invert	Avail.Storage	Storage Description
#1	1,448.00'	40,759 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,448.00	0	0	0
1,450.00	489	489	489
1,452.00	8,585	9,074	9,563
1,454.00	22,611	31,196	40,759

Device	Routing	Invert	Outlet Devices
#1	Primary	1,448.00'	**18.0" Round Culvert** L= 313.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,448.00' / 1,445.00' S= 0.0096 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=1.53 cfs @ 12.11 hrs HW=1,448.64' TW=1,444.69' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 1.53 cfs @ 2.15 fps)

Summary for Link 1L: Segment 2

Inflow Area = 2,677,873 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 22.03 cfs @ 12.25 hrs, Volume= 112,150 cf
Primary = 22.03 cfs @ 12.25 hrs, Volume= 112,150 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

1 Year Storm Outflow Imported from Southern Expansion Segment 2~Reach CH2a.hce

Summary for Link 2L: Segment 3

Inflow Area = 391,460 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 7.21 cfs @ 11.97 hrs, Volume= 16,394 cf
Primary = 7.21 cfs @ 11.97 hrs, Volume= 16,394 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

1 Year Storm Primary Outflow Imported from Southern Expansion Segment 3~Pond DCCUL5.hce

Summary for Link 3L: Segment 4

Inflow Area = 628,153 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 9.91 cfs @ 11.98 hrs, Volume= 26,307 cf
Primary = 9.91 cfs @ 11.98 hrs, Volume= 26,307 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

1 Year Storm Primary Outflow Imported from Southern Expansion Segment 4~Pond Cul24.hce

Summary for Link 4L: Segment 5

Inflow Area = 337,097 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 3.97 cfs @ 12.01 hrs, Volume= 14,118 cf
Primary = 3.97 cfs @ 12.01 hrs, Volume= 14,118 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

1 Year Storm Primary Outflow Imported from Southern Expansion Segment 5~Pond Cul19.hce

Summary for Link 5L: Segment 6

Inflow Area = 745,851 sf, 0.00% Impervious, Inflow Depth = 0.51" for 1 Year Storm event
Inflow = 9.55 cfs @ 12.00 hrs, Volume= 31,892 cf
Primary = 9.55 cfs @ 12.00 hrs, Volume= 31,892 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

1 Year Storm Outflow Imported from Southern Expansion Segment 6~Reach BCHb.hce

Summary for Link 6L: Segment 7

Inflow Area = 380,399 sf, 0.00% Impervious, Inflow Depth = 0.50" for 1 Year Storm event
Inflow = 7.64 cfs @ 11.98 hrs, Volume= 15,931 cf
Primary = 7.64 cfs @ 11.98 hrs, Volume= 15,931 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

1 Year Storm Primary Outflow Imported from Southern Expansion Segment 7~Pond Cul22.hce

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 12: Subarea 12 Runoff Area=32,357 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=121' Tc=3.5 min CN=80 Runoff=2.03 cfs 3,739 cf

Subcatchment 18: Subarea 18 Runoff Area=116,799 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=527' Tc=16.2 min CN=80 Runoff=4.60 cfs 13,496 cf

Subcatchment 20: Subarea 20 Runoff Area=22,282 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=230' Slope=0.0200 '/' Tc=13.3 min CN=80 Runoff=0.97 cfs 2,575 cf

Subcatchment 26: Subarea 26 Runoff Area=138,227 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=315' Tc=0.3 min CN=80 Runoff=9.61 cfs 15,972 cf

Subcatchment 27: Subarea 27 Runoff Area=324,396 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=859' Tc=0.9 min CN=80 Runoff=22.33 cfs 37,483 cf

Subcatchment 41: Subarea 41 Runoff Area=48,000 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=392' Tc=5.0 min CN=80 Runoff=2.85 cfs 5,546 cf

Subcatchment 79: Undisturbed Area Runoff Area=4,866,899 sf 0.00% Impervious Runoff Depth=1.59"
Flow Length=3,581' Tc=177.8 min CN=83 Runoff=40.84 cfs 645,992 cf

Subcatchment 86: Subarea 86 Runoff Area=14,701 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=10' Slope=0.3300 '/' Tc=0.6 min CN=80 Runoff=1.02 cfs 1,699 cf

Subcatchment 99: Subarea 99 Runoff Area=33,575 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=78' Slope=0.3300 '/' Tc=3.0 min CN=80 Runoff=2.15 cfs 3,879 cf

Subcatchment 100: Subarea 100 Runoff Area=29,119 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=140' Slope=0.3300 '/' Tc=3.8 min CN=80 Runoff=1.81 cfs 3,365 cf

Subcatchment 101: Subarea 101 Runoff Area=35,863 sf 0.00% Impervious Runoff Depth=1.39"
Flow Length=140' Slope=0.3300 '/' Tc=3.8 min CN=80 Runoff=2.22 cfs 4,144 cf

Subcatchment 104: Subarea 104 Runoff Area=21,132 sf 0.00% Impervious Runoff Depth=1.82"
Flow Length=73' Tc=2.4 min CN=86 Runoff=1.77 cfs 3,201 cf

Subcatchment 105: Subarea 105 Runoff Area=38,526 sf 0.00% Impervious Runoff Depth=1.82"
Flow Length=77' Tc=2.6 min CN=86 Runoff=3.21 cfs 5,836 cf

Subcatchment 106: Subarea 106 Runoff Area=59,555 sf 0.00% Impervious Runoff Depth=1.82"
Flow Length=91' Tc=3.0 min CN=86 Runoff=4.89 cfs 9,021 cf

Subcatchment 107: Subarea 107 Runoff Area=52,005 sf 0.00% Impervious Runoff Depth=1.82"
Flow Length=39' Tc=1.0 min CN=86 Runoff=4.56 cfs 7,878 cf

Reach BCHc: Berm Channel Avg. Flow Depth=1.92' Max Vel=3.93 fps Inflow=43.94 cfs 129,374 cf
n=0.035 L=309.0' S=0.0097 '/' Capacity=307.76 cfs Outflow=43.22 cfs 129,374 cf

Reach BCHd: Berm Channel Avg. Flow Depth=2.00' Max Vel=3.85 fps Inflow=47.60 cfs 141,052 cf
n=0.035 L=451.0' S=0.0089 '/' Capacity=294.15 cfs Outflow=46.04 cfs 141,052 cf

Reach BCHe: Berm Channel Avg. Flow Depth=1.90' Max Vel=4.51 fps Inflow=51.68 cfs 157,317 cf
n=0.035 L=772.0' S=0.0130 '/' Capacity=355.48 cfs Outflow=48.70 cfs 157,317 cf

Reach BCHf: Berm Channel Avg. Flow Depth=1.26' Max Vel=5.01 fps Inflow=25.02 cfs 51,832 cf
n=0.035 L=701.0' S=0.0278 '/' Capacity=520.94 cfs Outflow=23.70 cfs 51,832 cf

Reach CH2b: Channel 2 Avg. Flow Depth=1.94' Max Vel=7.51 fps Inflow=84.60 cfs 318,705 cf
n=0.035 L=117.0' S=0.0350 '/' Capacity=584.69 cfs Outflow=84.59 cfs 318,705 cf

Reach HB: Hosmer Brook Avg. Flow Depth=0.36' Max Vel=4.04 fps Inflow=40.84 cfs 996,169 cf
n=0.035 L=30.0' S=0.0373 '/' Capacity=229.45 cfs Outflow=40.84 cfs 996,159 cf

Reach PCHc: Perimeter Channel Avg. Flow Depth=0.24' Max Vel=1.39 fps Inflow=1.02 cfs 1,699 cf
n=0.035 L=209.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=0.91 cfs 1,699 cf

Reach PCHd: Perimeter Channel Avg. Flow Depth=0.38' Max Vel=1.77 fps Inflow=2.22 cfs 4,144 cf
n=0.035 L=225.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=2.10 cfs 4,144 cf

Reach PCHe: Perimeter Channel Avg. Flow Depth=0.34' Max Vel=1.67 fps Inflow=1.81 cfs 3,365 cf
n=0.035 L=225.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=1.69 cfs 3,365 cf

Reach PCHf: Perimeter Channel Avg. Flow Depth=0.35' Max Vel=1.71 fps Inflow=2.15 cfs 3,879 cf
n=0.035 L=380.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=1.86 cfs 3,879 cf

Pond Basin1,2,3: Basin1,2,3 Peak Elev=1,446.24' Storage=466,400 cf Inflow=22.33 cfs 596,782 cf
Outflow=2.73 cfs 350,177 cf

Pond Basin5: Basin 5 Peak Elev=1,449.18' Storage=349,757 cf Inflow=190.53 cfs 677,709 cf
Outflow=18.01 cfs 559,299 cf

Pond CUL 15: Culvert 15 Peak Elev=1,461.76' Inflow=24.48 cfs 54,406 cf
60.0" Round Culvert n=0.013 L=50.0' S=0.0916 '/' Outflow=24.48 cfs 54,406 cf

Pond CUL 2: Culvert 2 Peak Elev=1,458.49' Inflow=138.42 cfs 490,925 cf
96.0" x 72.0" Box Culvert n=0.011 L=70.0' S=0.0203 '/' Outflow=138.42 cfs 490,925 cf

Pond CUL20: Culvert 20 Peak Elev=1,480.76' Inflow=2.87 cfs 5,843 cf
24.0" Round Culvert n=0.013 L=72.0' S=0.1667 '/' Outflow=2.87 cfs 5,843 cf

Pond CUL21: Culvert 21 Peak Elev=1,480.85' Inflow=3.56 cfs 7,244 cf
24.0" Round Culvert n=0.013 L=89.0' S=0.1798 '/' Outflow=3.56 cfs 7,244 cf

Pond CUL23: Culvert 23 Peak Elev=1,456.56' Inflow=48.70 cfs 157,317 cf
60.0" Round Culvert n=0.013 L=49.0' S=0.0408 '/' Outflow=48.70 cfs 157,317 cf

Pond CUL5i: Culvert 5 Peak Elev=1,482.90' Inflow=2.85 cfs 5,546 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0667 '/' Outflow=2.85 cfs 5,546 cf

Pond CUL7: Culvert 7 Peak Elev=1,449.22' Storage=182 cf Inflow=4.60 cfs 13,496 cf
18.0" Round Culvert n=0.013 L=313.0' S=0.0096 '/' Outflow=4.57 cfs 13,496 cf

Link 10 Year Storm Outflow Imported from Southern Expansion Segment 2~Reach CH2a.hce Inflow=83.67 cfs 309,420 cf
Area= 2,677,873 sf Primary=83.67 cfs 309,420 cf

Link Year Storm Primary Outflow Imported from Southern Expansion Segment 3~Pond DCCUL5.hce Inflow=20.76 cfs 45,232 cf
Area= 391,460 sf Primary=20.76 cfs 45,232 cf

Link 10 Year Storm Primary Outflow Imported from Southern Expansion Segment 4~Pond Cul24.hce Inflow=29.60 cfs 72,581 cf
Area= 628,153 sf Primary=29.60 cfs 72,581 cf

Link 10 Year Storm Primary Outflow Imported from Southern Expansion Segment 5~Pond Cul19.hce Inflow=12.43 cfs 38,951 cf
Area= 337,097 sf Primary=12.43 cfs 38,951 cf

Link 10 Year Storm Outflow Imported from Southern Expansion Segment 6~Reach BCHb.hce Inflow=30.42 cfs 87,222 cf
Area= 745,851 sf Primary=30.42 cfs 87,222 cf

Link 10 Year Storm Primary Outflow Imported from Southern Expansion Segment 7~Pond Cul22.hce Inflow=22.28 cfs 43,954 cf
Area= 380,399 sf Primary=22.28 cfs 43,954 cf

Summary for Subcatchment 12: Subarea 12

Runoff = 2.03 cfs @ 11.95 hrs, Volume= 3,739 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	32,357	80	
	32,357		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	32	0.0100	0.73		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.7	68	0.3300	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.1	21	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.5	121	Total			

Summary for Subcatchment 18: Subarea 18

Runoff = 4.60 cfs @ 12.09 hrs, Volume= 13,496 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	116,799	80	
	116,799		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	100	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
4.4	320	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	107	0.0080	2.59	5.18	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 2.0 '/' Top.W=4.00' n= 0.030
16.2	527	Total			

Summary for Subcatchment 20: Subarea 20

Runoff = 0.97 cfs @ 12.06 hrs, Volume= 2,575 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	22,282	80	
	22,282		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	100	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.2	130	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.3	230	Total			

Summary for Subcatchment 26: Subarea 26

Runoff = 9.61 cfs @ 11.90 hrs, Volume= 15,972 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	138,227	80	
	138,227		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	315		16.05		**Lake or Reservoir,** Mean Depth= 8.00'

Summary for Subcatchment 27: Subarea 27

Runoff = 22.33 cfs @ 11.91 hrs, Volume= 37,483 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	324,396	80	
	324,396		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	859		16.05		**Lake or Reservoir,** Mean Depth= 8.00'

Summary for Subcatchment 41: Subarea 41

Runoff = 2.85 cfs @ 11.96 hrs, Volume= 5,546 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	48,000	80	
	48,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	67	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.0	392	Total			

Summary for Subcatchment 79: Undisturbed Area

Runoff = 40.84 cfs @ 14.23 hrs, Volume= 645,992 cf, Depth= 1.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	4,866,899	83	
	4,866,899		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.2	100	0.0360	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.50"
26.3	1,496	0.0360	0.95		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
132.3	1,985	0.0025	0.25		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
177.8	3,581	Total			

Summary for Subcatchment 86: Subarea 86

Runoff = 1.02 cfs @ 11.91 hrs, Volume= 1,699 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	14,701	80	
	14,701		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	10	0.3300	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 99: Subarea 99

Runoff = 2.15 cfs @ 11.94 hrs, Volume= 3,879 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	33,575	80	
	33,575		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	78	0.3300	0.44		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 100: Subarea 100

Runoff = 1.81 cfs @ 11.95 hrs, Volume= 3,365 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	29,119	80	
	29,119		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	40	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.8	140	Total			

Summary for Subcatchment 101: Subarea 101

Runoff = 2.22 cfs @ 11.95 hrs, Volume= 4,144 cf, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	35,863	80	
	35,863		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	40	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.8	140	Total			

Summary for Subcatchment 104: Subarea 104

Runoff = 1.77 cfs @ 11.93 hrs, Volume= 3,201 cf, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	21,132	86	
	21,132		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.6	37	0.3300	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.4	73	Total			

Summary for Subcatchment 105: Subarea 105

Runoff = 3.21 cfs @ 11.93 hrs, Volume= 5,836 cf, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	38,526	86	
	38,526		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.8	41	0.3300	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.6	77	Total			

Summary for Subcatchment 106: Subarea 106

Runoff = 4.89 cfs @ 11.94 hrs, Volume= 9,021 cf, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	59,555	86	
	59,555		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.2	55	0.3300	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
3.0	91	Total			

Summary for Subcatchment 107: Subarea 107

Runoff = 4.56 cfs @ 11.91 hrs, Volume= 7,878 cf, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 10 Year Storm Rainfall=3.18"

	Area (sf)	CN	Description
*	52,005	86	
	52,005		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
0.2	3	0.3300	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.0	39	Total			

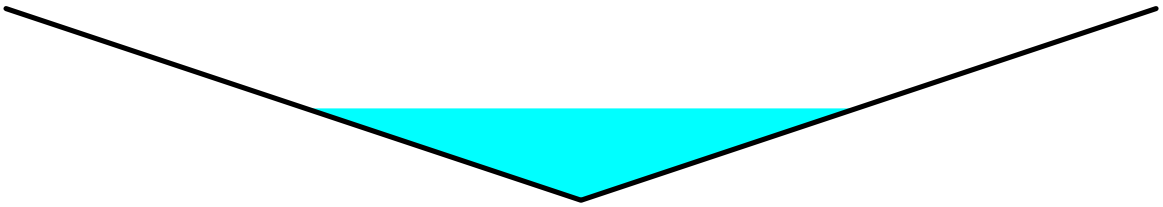
Summary for Reach BCHc: Berm Channel

Inflow Area = 1,104,080 sf, 0.00% Impervious, Inflow Depth = 1.41" for 10 Year Storm event
Inflow = 43.94 cfs @ 11.98 hrs, Volume= 129,374 cf
Outflow = 43.22 cfs @ 12.00 hrs, Volume= 129,374 cf, Atten= 2%, Lag= 1.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.93 fps, Min. Travel Time= 1.3 min
Avg. Velocity = 1.31 fps, Avg. Travel Time= 3.9 min

Peak Storage= 3,403 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.92'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 307.76 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 307.76 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 309.0' Slope= 0.0097 '/'
Inlet Invert= 1,471.00', Outlet Invert= 1,468.00'



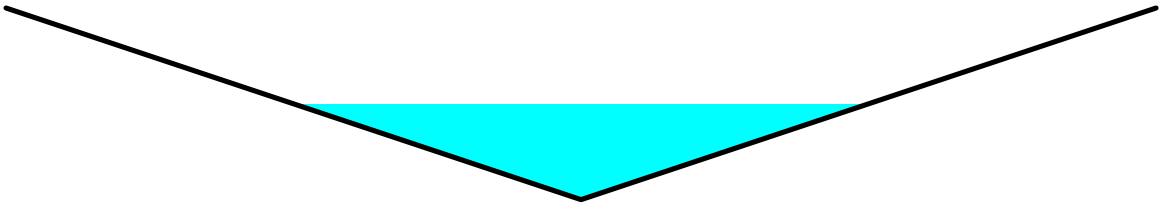
Summary for Reach BCHd: Berm Channel

Inflow Area = 1,193,170 sf, 0.00% Impervious, Inflow Depth = 1.42" for 10 Year Storm event
Inflow = 47.60 cfs @ 11.99 hrs, Volume= 141,052 cf
Outflow = 46.04 cfs @ 12.02 hrs, Volume= 141,052 cf, Atten= 3%, Lag= 1.5 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 3.85 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 1.26 fps, Avg. Travel Time= 6.0 min

Peak Storage= 5,387 cf @ 12.02 hrs
Average Depth at Peak Storage= 2.00'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 294.15 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 294.15 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 451.0' Slope= 0.0089 '/'
Inlet Invert= 1,468.00', Outlet Invert= 1,464.00'



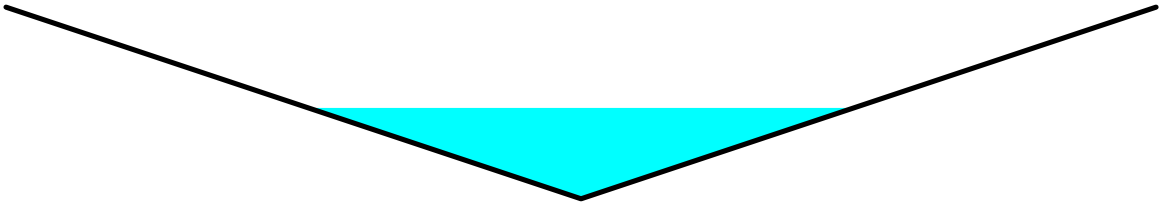
Summary for Reach BCHe: Berm Channel

Inflow Area = 1,315,419 sf, 0.00% Impervious, Inflow Depth = 1.44" for 10 Year Storm event
Inflow = 51.68 cfs @ 12.00 hrs, Volume= 157,317 cf
Outflow = 48.70 cfs @ 12.04 hrs, Volume= 157,317 cf, Atten= 6%, Lag= 2.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.51 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 1.45 fps, Avg. Travel Time= 8.9 min

Peak Storage= 8,344 cf @ 12.04 hrs
Average Depth at Peak Storage= 1.90'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 355.48 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 355.48 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 772.0' Slope= 0.0130 '/'
Inlet Invert= 1,464.00', Outlet Invert= 1,454.00'



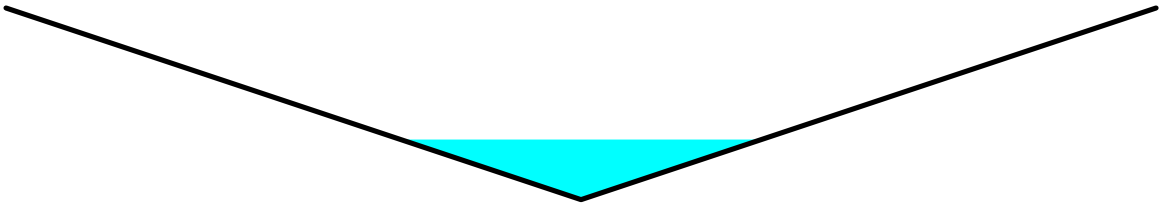
Summary for Reach BCHf: Berm Channel

Inflow Area = 432,404 sf, 0.00% Impervious, Inflow Depth = 1.44" for 10 Year Storm event
Inflow = 25.02 cfs @ 11.96 hrs, Volume= 51,832 cf
Outflow = 23.70 cfs @ 11.99 hrs, Volume= 51,832 cf, Atten= 5%, Lag= 1.4 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.01 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 1.63 fps, Avg. Travel Time= 7.2 min

Peak Storage= 3,314 cf @ 11.99 hrs
Average Depth at Peak Storage= 1.26'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 520.94 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 520.94 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 701.0' Slope= 0.0278 '/'
Inlet Invert= 1,479.50', Outlet Invert= 1,460.00'



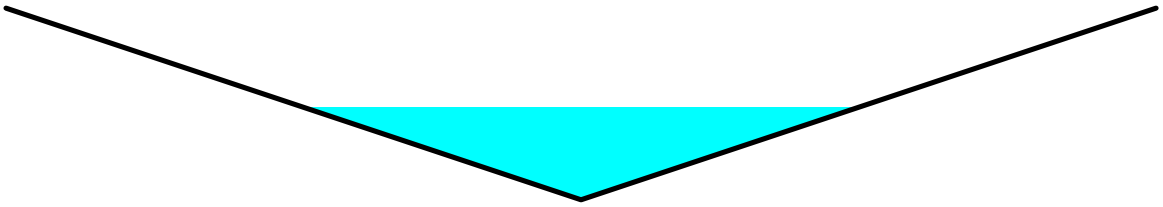
Summary for Reach CH2b: Channel 2

Inflow Area = 2,758,230 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 84.60 cfs @ 12.10 hrs, Volume= 318,705 cf
Outflow = 84.59 cfs @ 12.10 hrs, Volume= 318,705 cf, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 7.51 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.34 fps, Avg. Travel Time= 0.8 min

Peak Storage= 1,317 cf @ 12.10 hrs
Average Depth at Peak Storage= 1.94'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 584.69 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 584.69 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 117.0' Slope= 0.0350 '/'
Inlet Invert= 1,459.52', Outlet Invert= 1,455.42'



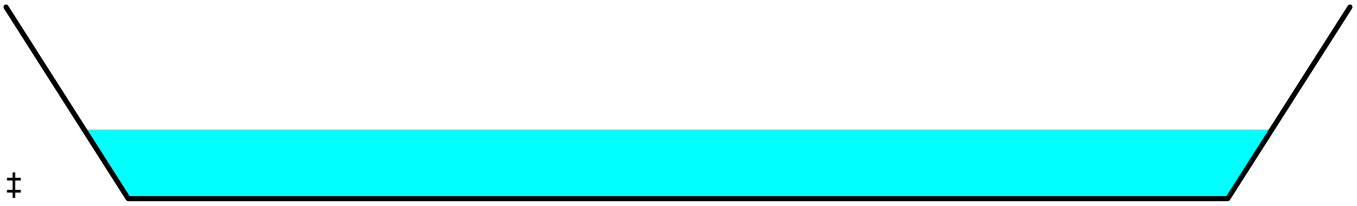
Summary for Reach HB: Hosmer Brook

Inflow Area = 10,994,269 sf, 0.00% Impervious, Inflow Depth > 1.09" for 10 Year Storm event
Inflow = 40.84 cfs @ 14.23 hrs, Volume= 996,169 cf
Outflow = 40.84 cfs @ 14.23 hrs, Volume= 996,159 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.04 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.02 fps, Avg. Travel Time= 0.5 min

Peak Storage= 303 cf @ 14.23 hrs
Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 1.00' Flow Area= 30.0 sf, Capacity= 229.45 cfs

27.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 33.00'
Length= 30.0' Slope= 0.0373 '/'
Inlet Invert= 1,439.83', Outlet Invert= 1,438.71'



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Summary for Reach PCHc: Perimeter Channel

Inflow Area = 14,701 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 1.02 cfs @ 11.91 hrs, Volume= 1,699 cf
Outflow = 0.91 cfs @ 11.93 hrs, Volume= 1,699 cf, Atten= 11%, Lag= 1.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.39 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 0.38 fps, Avg. Travel Time= 9.2 min

Peak Storage= 137 cf @ 11.93 hrs
Average Depth at Peak Storage= 0.24'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 209.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.09', Outlet Invert= 1,480.00'

Summary for Reach PCHd: Perimeter Channel

Inflow Area = 35,863 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 2.22 cfs @ 11.95 hrs, Volume= 4,144 cf
Outflow = 2.10 cfs @ 11.97 hrs, Volume= 4,144 cf, Atten= 6%, Lag= 1.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.77 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 0.49 fps, Avg. Travel Time= 7.6 min

Peak Storage= 266 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.38'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 225.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.25', Outlet Invert= 1,480.00'

Summary for Reach PCHe: Perimeter Channel

Inflow Area = 29,119 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 1.81 cfs @ 11.95 hrs, Volume= 3,365 cf
Outflow = 1.69 cfs @ 11.97 hrs, Volume= 3,365 cf, Atten= 6%, Lag= 1.3 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.67 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.46 fps, Avg. Travel Time= 8.1 min

Peak Storage= 229 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.34'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 225.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.25', Outlet Invert= 1,480.00'

Summary for Reach PCHf: Perimeter Channel

Inflow Area = 33,575 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 2.15 cfs @ 11.94 hrs, Volume= 3,879 cf
Outflow = 1.86 cfs @ 11.97 hrs, Volume= 3,879 cf, Atten= 13%, Lag= 1.9 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.71 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 0.48 fps, Avg. Travel Time= 13.3 min

Peak Storage= 413 cf @ 11.97 hrs
Average Depth at Peak Storage= 0.35'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 380.0' Slope= 0.0100 '/'
Inlet Invert= 1,483.80', Outlet Invert= 1,480.00'

Summary for Pond Basin1,2,3: Basin1,2,3

Inflow Area = 6,127,370 sf, 0.00% Impervious, Inflow Depth = 1.17" for 10 Year Storm event
Inflow = 22.33 cfs @ 11.91 hrs, Volume= 596,782 cf
Outflow = 2.73 cfs @ 27.08 hrs, Volume= 350,177 cf, Atten= 88%, Lag= 910.1 min
Primary = 2.73 cfs @ 27.08 hrs, Volume= 350,177 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,446.24' @ 27.08 hrs Surf.Area= 0 sf Storage= 466,400 cf

Plug-Flow detention time= 1,811.5 min calculated for 350,177 cf (59% of inflow)
Center-of-Mass det. time= 1,576.5 min (2,698.3 - 1,121.8)

Volume	Invert	Avail.Storage	Storage Description
#1	1,441.00'	1,099,676 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
1,441.00	0
1,442.00	41,794
1,443.00	124,900
1,444.00	225,693
1,445.00	337,193
1,446.00	426,428
1,448.00	762,458
1,450.00	1,099,676

Device	Routing	Invert	Outlet Devices
#1	Primary	1,441.00'	**Special & User-Defined** Elev. (feet) 1,441.00 1,441.10 1,441.20 1,441.30 1,441.40 1,441.50 1,441.60 1,441.70 1,441.80 1,441.90 1,442.00 1,442.10 1,442.20 1,442.30 1,442.40 1,442.50 1,442.60 1,442.70 1,442.80 1,442.90 1,443.00 1,443.10 1,443.20 1,443.30 1,443.40 1,443.50 1,443.60 1,443.70 1,443.80 1,443.90 1,444.00 1,444.10 1,444.20 1,444.30 1,444.40 1,444.50 1,444.60 1,444.70 1,444.80 1,444.90 1,445.00 1,445.10 1,445.20 1,445.30 1,445.40 1,445.50 1,445.60 1,445.70 1,445.80 1,445.90 1,446.00 1,446.10 1,446.20 1,446.30 1,446.40 1,446.50 1,446.60 1,446.70 1,446.80 1,446.90 1,447.00 1,447.10 1,447.20 1,447.30 1,447.40 1,447.50 1,447.60 1,447.70 1,447.80 1,447.90 1,448.00 1,448.10 1,448.20 1,448.30 1,448.40 1,448.50 1,448.60 1,448.70 1,448.80 1,448.90 1,449.00 1,449.10 1,449.20 1,449.30 1,449.40 1,449.50 1,449.60 1,449.70 1,449.80 1,449.90 1,450.00 Disch. (cfs) 0.000 0.120 0.160 0.200 0.330 0.410 0.470 0.600 0.710 0.800 0.880 1.070 1.180 1.270 1.460 1.590 1.710 1.880 2.040 2.180 2.300 2.530 2.680 2.820 3.040 3.210 3.360 3.570 3.770 3.940 4.100 4.360 4.540 4.710 4.870 5.020 5.170 5.270 5.310 5.340 5.380 6.550 8.670 11.400 14.630 18.280 22.320 26.710 32.280 38.350 43.980 50.760 58.050 66.530 75.440 85.260 95.490 105.710 116.480 127.020 137.580

Primary OutFlow Max=2.73 cfs @ 27.08 hrs HW=1,446.24' TW=1,439.92' (Dynamic Tailwater)
↑—**1=Special & User-Defined** (Custom Controls 2.73 cfs)

Summary for Pond Basin5: Basin 5

Inflow Area = 5,802,974 sf, 0.00% Impervious, Inflow Depth = 1.40" for 10 Year Storm event
Inflow = 190.53 cfs @ 12.02 hrs, Volume= 677,709 cf
Outflow = 18.01 cfs @ 13.36 hrs, Volume= 559,299 cf, Atten= 91%, Lag= 80.3 min
Primary = 18.01 cfs @ 13.36 hrs, Volume= 559,299 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,449.18' @ 13.36 hrs Surf.Area= 79,160 sf Storage= 349,757 cf

Plug-Flow detention time= 366.3 min calculated for 559,299 cf (83% of inflow)

Center-of-Mass det. time= 286.1 min (1,141.0 - 854.9)

Volume	Invert	Avail.Storage	Storage Description
#1	1,444.00'	776,855 cf	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,444.00	53,356	0	0
1,446.00	65,054	118,410	118,410
1,448.00	73,763	138,817	257,227
1,450.00	82,901	156,664	413,891
1,452.00	89,234	172,135	586,026
1,454.00	101,595	190,829	776,855

Device	Routing	Invert	Outlet Devices
#1	Primary	1,444.00'	**Special & User-Defined** Elev. (feet) 1,444.00 1,444.20 1,444.40 1,444.60 1,444.80 1,445.00 1,445.20 1,445.40 1,445.60 1,445.80 1,446.00 1,446.20 1,446.40 1,446.60 1,446.80 1,447.00 1,447.20 1,447.40 1,447.60 1,447.80 1,448.00 1,448.20 1,448.40 1,448.60 1,448.80 1,449.00 1,449.20 1,449.40 1,449.60 1,449.80 1,450.00 1,450.20 1,450.40 1,450.60 1,450.80 1,451.00 1,451.20 1,451.40 1,451.60 1,451.80 1,452.00 1,452.20 1,452.40 1,452.60 1,452.80 1,453.00 1,453.20 1,453.40 1,453.60 1,453.80 1,454.00 Disch. (cfs) 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.660 1.310 1.900 2.860 3.520 4.710 5.830 6.830 8.170 9.190 10.720 12.150 13.460 15.090 16.390 18.180 19.870 21.420 23.290 24.820 26.840 28.380 29.770 31.070 32.300 37.160 45.070 54.990 66.560 79.590 97.170 111.170 120.000 130.230 143.900 159.070 177.540 198.670 220.730 242.880

Primary OutFlow Max=18.01 cfs @ 13.36 hrs HW=1,449.18' TW=1,442.61' (Dynamic Tailwater)
↑—**1=Special & User-Defined** (Custom Controls 18.01 cfs)

Summary for Pond CUL 15: Culvert 15

Inflow Area = 454,686 sf, 0.00% Impervious, Inflow Depth = 1.44" for 10 Year Storm event
Inflow = 24.48 cfs @ 11.99 hrs, Volume= 54,406 cf
Outflow = 24.48 cfs @ 11.99 hrs, Volume= 54,406 cf, Atten= 0%, Lag= 0.0 min
Primary = 24.48 cfs @ 11.99 hrs, Volume= 54,406 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,461.76' @ 11.99 hrs
Flood Elev= 1,464.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,460.00'	**60.0" Round Culvert** L= 50.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,460.00' / 1,455.42' S= 0.0916 '/' Cc= 0.900 n= 0.013, Flow Area= 19.63 sf

Primary OutFlow Max=24.44 cfs @ 11.99 hrs HW=1,461.75' TW=1,458.45' (Dynamic Tailwater)
1=Culvert (Inlet Controls 24.44 cfs @ 3.98 fps)

Summary for Pond CUL 2: Culvert 2

Inflow Area = 4,232,529 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 138.42 cfs @ 12.01 hrs, Volume= 490,925 cf
Outflow = 138.42 cfs @ 12.01 hrs, Volume= 490,925 cf, Atten= 0%, Lag= 0.0 min
Primary = 138.42 cfs @ 12.01 hrs, Volume= 490,925 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,458.49' @ 12.01 hrs
Flood Elev= 1,461.52'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,455.42'	**96.0" W x 72.0" H Box Culvert** L= 70.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 1,455.42' / 1,454.00' S= 0.0203 '/' Cc= 0.900 n= 0.011, Flow Area= 48.00 sf

Primary OutFlow Max=138.31 cfs @ 12.01 hrs HW=1,458.49' TW=1,446.10' (Dynamic Tailwater)
1=Culvert (Inlet Controls 138.31 cfs @ 5.63 fps)

Summary for Pond CUL20: Culvert 20

Inflow Area = 50,564 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 2.87 cfs @ 11.96 hrs, Volume= 5,843 cf
Outflow = 2.87 cfs @ 11.96 hrs, Volume= 5,843 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.87 cfs @ 11.96 hrs, Volume= 5,843 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,480.76' @ 11.96 hrs
Flood Elev= 1,482.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,480.00'	**24.0" Round Culvert** L= 72.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,480.00' / 1,468.00' S= 0.1667 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=2.87 cfs @ 11.96 hrs HW=1,480.76' TW=1,469.86' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.87 cfs @ 2.62 fps)

Summary for Pond CUL21: Culvert 21

Inflow Area = 62,694 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 3.56 cfs @ 11.97 hrs, Volume= 7,244 cf
Outflow = 3.56 cfs @ 11.97 hrs, Volume= 7,244 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.56 cfs @ 11.97 hrs, Volume= 7,244 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,480.85' @ 11.97 hrs
Flood Elev= 1,482.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,480.00'	**24.0" Round Culvert** L= 89.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,480.00' / 1,464.00' S= 0.1798 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=3.55 cfs @ 11.97 hrs HW=1,480.85' TW=1,465.75' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 3.55 cfs @ 2.78 fps)

Summary for Pond CUL23: Culvert 23

Inflow Area = 1,315,419 sf, 0.00% Impervious, Inflow Depth = 1.44" for 10 Year Storm event
Inflow = 48.70 cfs @ 12.04 hrs, Volume= 157,317 cf
Outflow = 48.70 cfs @ 12.04 hrs, Volume= 157,317 cf, Atten= 0%, Lag= 0.0 min
Primary = 48.70 cfs @ 12.04 hrs, Volume= 157,317 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,456.56' @ 12.04 hrs
Flood Elev= 1,459.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,454.00'	**60.0" Round Culvert** L= 49.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,454.00' / 1,452.00' S= 0.0408 '/' Cc= 0.900 n= 0.013, Flow Area= 19.63 sf

Primary OutFlow Max=48.67 cfs @ 12.04 hrs HW=1,456.56' TW=1,446.40' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 48.67 cfs @ 4.81 fps)

Summary for Pond CUL5i: Culvert 5

Inflow Area = 48,000 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 2.85 cfs @ 11.96 hrs, Volume= 5,546 cf
Outflow = 2.85 cfs @ 11.96 hrs, Volume= 5,546 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.85 cfs @ 11.96 hrs, Volume= 5,546 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,482.90' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert** L= 60.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,482.00' / 1,478.00' S= 0.0667 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=2.84 cfs @ 11.96 hrs HW=1,482.90' TW=1,461.15' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 2.84 cfs @ 2.55 fps)

Summary for Pond CUL7: Culvert 7

Inflow Area = 116,799 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 4.60 cfs @ 12.09 hrs, Volume= 13,496 cf
Outflow = 4.57 cfs @ 12.10 hrs, Volume= 13,496 cf, Atten= 1%, Lag= 1.1 min
Primary = 4.57 cfs @ 12.10 hrs, Volume= 13,496 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,449.22' @ 12.10 hrs Surf.Area= 298 sf Storage= 182 cf
Flood Elev= 1,454.00' Surf.Area= 22,611 sf Storage= 40,759 cf

Plug-Flow detention time= 2.6 min calculated for 13,495 cf (100% of inflow)
Center-of-Mass det. time= 2.6 min (851.9 - 849.3)

Volume	Invert	Avail.Storage	Storage Description
#1	1,448.00'	40,759 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,448.00	0	0	0
1,450.00	489	489	489
1,452.00	8,585	9,074	9,563
1,454.00	22,611	31,196	40,759

Device	Routing	Invert	Outlet Devices
#1	Primary	1,448.00'	**18.0" Round Culvert** L= 313.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,448.00' / 1,445.00' S= 0.0096 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=4.57 cfs @ 12.10 hrs HW=1,449.22' TW=1,447.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 4.57 cfs @ 2.97 fps)

Summary for Link 1L: Segment 2

Inflow Area = 2,677,873 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 83.67 cfs @ 12.10 hrs, Volume= 309,420 cf
Primary = 83.67 cfs @ 12.10 hrs, Volume= 309,420 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

10 Year Storm Outflow Imported from Southern Expansion Segment 2~Reach CH2a.hce

Summary for Link 2L: Segment 3

Inflow Area = 391,460 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 20.76 cfs @ 11.96 hrs, Volume= 45,232 cf
Primary = 20.76 cfs @ 11.96 hrs, Volume= 45,232 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

10 Year Storm Primary Outflow Imported from Southern Expansion Segment 3~Pond DCCUL5.hce

Summary for Link 3L: Segment 4

Inflow Area = 628,153 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 29.60 cfs @ 11.97 hrs, Volume= 72,581 cf
Primary = 29.60 cfs @ 11.97 hrs, Volume= 72,581 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

10 Year Storm Primary Outflow Imported from Southern Expansion Segment 4~Pond Cul24.hce

Summary for Link 4L: Segment 5

Inflow Area = 337,097 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 12.43 cfs @ 11.99 hrs, Volume= 38,951 cf
Primary = 12.43 cfs @ 11.99 hrs, Volume= 38,951 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

10 Year Storm Primary Outflow Imported from Southern Expansion Segment 5~Pond Cul19.hce

Summary for Link 5L: Segment 6

Inflow Area = 745,851 sf, 0.00% Impervious, Inflow Depth = 1.40" for 10 Year Storm event
Inflow = 30.42 cfs @ 11.98 hrs, Volume= 87,222 cf
Primary = 30.42 cfs @ 11.98 hrs, Volume= 87,222 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

10 Year Storm Outflow Imported from Southern Expansion Segment 6~Reach BCHb.hce

Summary for Link 6L: Segment 7

Inflow Area = 380,399 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10 Year Storm event
Inflow = 22.28 cfs @ 11.97 hrs, Volume= 43,954 cf
Primary = 22.28 cfs @ 11.97 hrs, Volume= 43,954 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

10 Year Storm Primary Outflow Imported from Southern Expansion Segment 7~Pond Cul22.hce

Time span=5.00-120.00 hrs, dt=0.01 hrs, 11501 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 12: Subarea 12 Runoff Area=32,357 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=121' Tc=3.5 min CN=80 Runoff=4.53 cfs 8,558 cf

Subcatchment 18: Subarea 18 Runoff Area=116,799 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=527' Tc=16.2 min CN=80 Runoff=10.61 cfs 30,892 cf

Subcatchment 20: Subarea 20 Runoff Area=22,282 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=230' Slope=0.0200 '/' Tc=13.3 min CN=80 Runoff=2.22 cfs 5,893 cf

Subcatchment 26: Subarea 26 Runoff Area=138,227 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=315' Tc=0.3 min CN=80 Runoff=21.30 cfs 36,559 cf

Subcatchment 27: Subarea 27 Runoff Area=324,396 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=859' Tc=0.9 min CN=80 Runoff=49.53 cfs 85,798 cf

Subcatchment 41: Subarea 41 Runoff Area=48,000 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=392' Tc=5.0 min CN=80 Runoff=6.38 cfs 12,695 cf

Subcatchment 79: Undisturbed Area Runoff Area=4,866,899 sf 0.00% Impervious Runoff Depth=3.47"
Flow Length=3,581' Tc=177.8 min CN=83 Runoff=90.33 cfs 1,405,332 cf

Subcatchment 86: Subarea 86 Runoff Area=14,701 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=10' Slope=0.3300 '/' Tc=0.6 min CN=80 Runoff=2.27 cfs 3,888 cf

Subcatchment 99: Subarea 99 Runoff Area=33,575 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=78' Slope=0.3300 '/' Tc=3.0 min CN=80 Runoff=4.78 cfs 8,880 cf

Subcatchment 100: Subarea 100 Runoff Area=29,119 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=140' Slope=0.3300 '/' Tc=3.8 min CN=80 Runoff=4.04 cfs 7,702 cf

Subcatchment 101: Subarea 101 Runoff Area=35,863 sf 0.00% Impervious Runoff Depth=3.17"
Flow Length=140' Slope=0.3300 '/' Tc=3.8 min CN=80 Runoff=4.97 cfs 9,485 cf

Subcatchment 104: Subarea 104 Runoff Area=21,132 sf 0.00% Impervious Runoff Depth>3.77"
Flow Length=73' Tc=2.4 min CN=86 Runoff=3.52 cfs 6,633 cf

Subcatchment 105: Subarea 105 Runoff Area=38,526 sf 0.00% Impervious Runoff Depth>3.77"
Flow Length=77' Tc=2.6 min CN=86 Runoff=6.38 cfs 12,093 cf

Subcatchment 106: Subarea 106 Runoff Area=59,555 sf 0.00% Impervious Runoff Depth>3.77"
Flow Length=91' Tc=3.0 min CN=86 Runoff=9.73 cfs 18,694 cf

Subcatchment 107: Subarea 107 Runoff Area=52,005 sf 0.00% Impervious Runoff Depth>3.77"
Flow Length=39' Tc=1.0 min CN=86 Runoff=9.04 cfs 16,324 cf

Reach BCHc: Berm Channel Avg. Flow Depth=2.64' Max Vel=4.86 fps Inflow=102.95 cfs 294,488 cf
n=0.035 L=309.0' S=0.0097 '/' Capacity=307.76 cfs Outflow=101.83 cfs 294,488 cf

Reach BCHd: Berm Channel Avg. Flow Depth=2.76' Max Vel=4.79 fps Inflow=112.00 cfs 319,955 cf
n=0.035 L=451.0' S=0.0089 '/' Capacity=294.15 cfs Outflow=109.56 cfs 319,955 cf

Reach BCHe: Berm Channel Avg. Flow Depth=2.65' Max Vel=5.62 fps Inflow=123.17 cfs 355,230 cf
n=0.035 L=772.0' S=0.0130 '/' Capacity=355.48 cfs Outflow=118.23 cfs 355,230 cf

Reach BCHf: Berm Channel Avg. Flow Depth=1.71' Max Vel=6.17 fps Inflow=56.36 cfs 116,934 cf
n=0.035 L=701.0' S=0.0278 '/' Capacity=520.94 cfs Outflow=54.34 cfs 116,934 cf

Reach CH2b: Channel 2 Avg. Flow Depth=2.80' Max Vel=9.60 fps Inflow=226.15 cfs 729,512 cf
n=0.035 L=117.0' S=0.0350 '/' Capacity=584.69 cfs Outflow=226.12 cfs 729,512 cf

Reach HB: Hosmer Brook Avg. Flow Depth=0.60' Max Vel=5.55 fps Inflow=95.18 cfs 2,658,963 cf
n=0.035 L=30.0' S=0.0373 '/' Capacity=229.45 cfs Outflow=95.18 cfs 2,658,951 cf

Reach PCHc: Perimeter Channel Avg. Flow Depth=0.38' Max Vel=1.77 fps Inflow=2.27 cfs 3,888 cf
n=0.035 L=209.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=2.09 cfs 3,888 cf

Reach PCHd: Perimeter Channel Avg. Flow Depth=0.58' Max Vel=2.23 fps Inflow=4.97 cfs 9,485 cf
n=0.035 L=225.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=4.78 cfs 9,485 cf

Reach PCHe: Perimeter Channel Avg. Flow Depth=0.52' Max Vel=2.10 fps Inflow=4.04 cfs 7,702 cf
n=0.035 L=225.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=3.87 cfs 7,702 cf

Reach PCHf: Perimeter Channel Avg. Flow Depth=0.55' Max Vel=2.17 fps Inflow=4.78 cfs 8,880 cf
n=0.035 L=380.0' S=0.0100 '/' Capacity=72.05 cfs Outflow=4.34 cfs 8,880 cf

Pond Basin1,2,3: Basin1,2,3 Peak Elev=1,448.57' Storage=858,832 cf Inflow=144.35 cfs 1,512,156 cf
Outflow=21.17 cfs 1,253,631 cf

Pond Basin5: Basin 5 Peak Elev=1,452.95' Storage=676,632 cf Inflow=485.08 cfs 1,544,768 cf
Outflow=140.46 cfs 1,426,358 cf

Pond CUL 15: Culvert 15 Peak Elev=1,462.78' Inflow=56.11 cfs 122,827 cf
60.0" Round Culvert n=0.013 L=50.0' S=0.0916 '/' Outflow=56.11 cfs 122,827 cf

Pond CUL 2: Culvert 2 Peak Elev=1,461.25' Inflow=361.35 cfs 1,122,011 cf
96.0" x 72.0" Box Culvert n=0.011 L=70.0' S=0.0203 '/' Outflow=361.35 cfs 1,122,011 cf

Pond CUL20: Culvert 20 Peak Elev=1,481.21' Inflow=6.55 cfs 13,373 cf
24.0" Round Culvert n=0.013 L=72.0' S=0.1667 '/' Outflow=6.55 cfs 13,373 cf

Pond CUL21: Culvert 21 Peak Elev=1,481.39' Inflow=8.21 cfs 16,582 cf
24.0" Round Culvert n=0.013 L=89.0' S=0.1798 '/' Outflow=8.21 cfs 16,582 cf

Pond CUL23: Culvert 23 Peak Elev=1,458.49' Inflow=118.23 cfs 355,230 cf
60.0" Round Culvert n=0.013 L=49.0' S=0.0408 '/' Outflow=118.23 cfs 355,230 cf

Pond CUL5i: Culvert 5 Peak Elev=1,483.65' Inflow=6.38 cfs 12,695 cf
18.0" Round Culvert n=0.013 L=60.0' S=0.0667 '/' Outflow=6.38 cfs 12,695 cf

Pond CUL7: Culvert 7 Peak Elev=1,452.34' Storage=12,859 cf Inflow=10.61 cfs 30,892 cf
18.0" Round Culvert n=0.013 L=313.0' S=0.0096 '/' Outflow=4.91 cfs 30,892 cf

100 Year Storm Outflow Imported from Southern Expansion Segment 2~Reach CH2a.hce Inflow=222.45 cfs 708,258 cf
Link Area= 2,677,873 sf Primary=222.45 cfs 708,258 cf

ear Storm Primary Outflow Imported from Southern Expansion Segment 3~Pond DCCUL5.hce Inflow=46.83 cfs 103,535 cf
Link Area= 391,460 sf Primary=46.83 cfs 103,535 cf

0 Year Storm Primary Outflow Imported from Southern Expansion Segment 4~Pond Cul24.hce Inflow=67.92 cfs 166,137 cf
Link Area= 628,153 sf Primary=67.92 cfs 166,137 cf

00 Year Storm Primary Outflow Imported from Southern Expansion Segment 5~Pond Cul19.hce Inflow=29.14 cfs 89,157 cf
Link Area= 337,097 sf Primary=29.14 cfs 89,157 cf

100 Year Storm Outflow Imported from Southern Expansion Segment 6~Reach BCHb.hce Inflow=71.52 cfs 198,698 cf
Link Area= 745,851 sf Primary=71.52 cfs 198,698 cf

0 Year Storm Primary Outflow Imported from Southern Expansion Segment 7~Pond Cul22.hce Inflow=50.49 cfs 100,610 cf
Link Area= 380,399 sf Primary=50.49 cfs 100,610 cf

Summary for Subcatchment 12: Subarea 12

Runoff = 4.53 cfs @ 11.94 hrs, Volume= 8,558 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	32,357	80	
	32,357		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	32	0.0100	0.73		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.7	68	0.3300	0.43		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.1	21	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.5	121	Total			

Summary for Subcatchment 18: Subarea 18

Runoff = 10.61 cfs @ 12.08 hrs, Volume= 30,892 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	116,799	80	
	116,799		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	100	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
4.4	320	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	107	0.0080	2.59	5.18	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 2.0 '/' Top.W=4.00' n= 0.030
16.2	527	Total			

Summary for Subcatchment 20: Subarea 20

Runoff = 2.22 cfs @ 12.05 hrs, Volume= 5,893 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	22,282	80	
	22,282		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	100	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.2	130	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.3	230	Total			

Summary for Subcatchment 26: Subarea 26

Runoff = 21.30 cfs @ 11.90 hrs, Volume= 36,559 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	138,227	80	
	138,227		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	315		16.05		**Lake or Reservoir,** Mean Depth= 8.00'

Summary for Subcatchment 27: Subarea 27

Runoff = 49.53 cfs @ 11.91 hrs, Volume= 85,798 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	324,396	80	
	324,396		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	859		16.05		**Lake or Reservoir,** Mean Depth= 8.00'

Summary for Subcatchment 41: Subarea 41

Runoff = 6.38 cfs @ 11.96 hrs, Volume= 12,695 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	48,000	80	
	48,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.3	67	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.1	225	0.0100	3.50	12.58	**Trap/Vee/Rect Channel Flow,** Bot.W=1.60' D=1.00' Z= 2.0 '/' Top.W=5.60' n= 0.030
5.0	392	Total			

Summary for Subcatchment 79: Undisturbed Area

Runoff = 90.33 cfs @ 14.21 hrs, Volume= 1,405,332 cf, Depth= 3.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	4,866,899	83	
	4,866,899		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
19.2	100	0.0360	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.50"
26.3	1,496	0.0360	0.95		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
132.3	1,985	0.0025	0.25		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
177.8	3,581	Total			

Summary for Subcatchment 86: Subarea 86

Runoff = 2.27 cfs @ 11.91 hrs, Volume= 3,888 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	14,701	80	
	14,701		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	10	0.3300	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 99: Subarea 99

Runoff = 4.78 cfs @ 11.94 hrs, Volume= 8,880 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	33,575	80	
	33,575		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	78	0.3300	0.44		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"

Summary for Subcatchment 100: Subarea 100

Runoff = 4.04 cfs @ 11.95 hrs, Volume= 7,702 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	29,119	80	
	29,119		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	40	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.8	140	Total			

Summary for Subcatchment 101: Subarea 101

Runoff = 4.97 cfs @ 11.95 hrs, Volume= 9,485 cf, Depth= 3.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	35,863	80	
	35,863		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.3300	0.46		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
0.2	40	0.3300	4.02		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.8	140	Total			

Summary for Subcatchment 104: Subarea 104

Runoff = 3.52 cfs @ 11.93 hrs, Volume= 6,633 cf, Depth> 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	21,132	86	
	21,132		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.6	37	0.3300	0.38		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.4	73	Total			

Summary for Subcatchment 105: Subarea 105

Runoff = 6.38 cfs @ 11.93 hrs, Volume= 12,093 cf, Depth> 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	38,526	86	
	38,526		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
1.8	41	0.3300	0.39		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
2.6	77	Total			

Summary for Subcatchment 106: Subarea 106

Runoff = 9.73 cfs @ 11.94 hrs, Volume= 18,694 cf, Depth> 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	59,555	86	
	59,555		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
2.2	55	0.3300	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
3.0	91	Total			

Summary for Subcatchment 107: Subarea 107

Runoff = 9.04 cfs @ 11.91 hrs, Volume= 16,324 cf, Depth> 3.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 100 Year Storm Rainfall=5.32"

	Area (sf)	CN	Description
*	52,005	86	
	52,005		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	36	0.0100	0.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
0.2	3	0.3300	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.50"
1.0	39	Total			

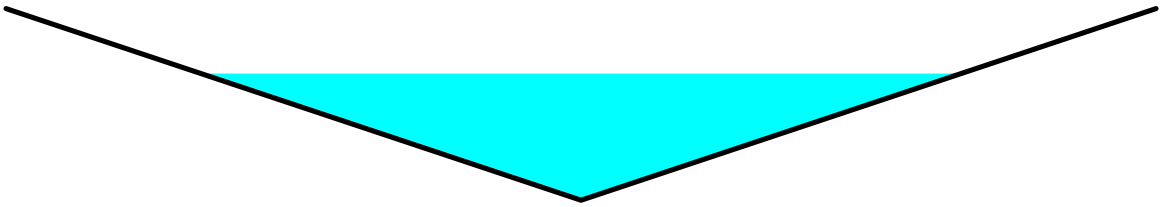
Summary for Reach BCHc: Berm Channel

Inflow Area = 1,104,080 sf, 0.00% Impervious, Inflow Depth = 3.20" for 100 Year Storm event
Inflow = 102.95 cfs @ 11.97 hrs, Volume= 294,488 cf
Outflow = 101.83 cfs @ 11.99 hrs, Volume= 294,488 cf, Atten= 1%, Lag= 0.8 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.86 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 1.55 fps, Avg. Travel Time= 3.3 min

Peak Storage= 6,471 cf @ 11.99 hrs
Average Depth at Peak Storage= 2.64'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 307.76 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 307.76 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 309.0' Slope= 0.0097 '/'
Inlet Invert= 1,471.00', Outlet Invert= 1,468.00'



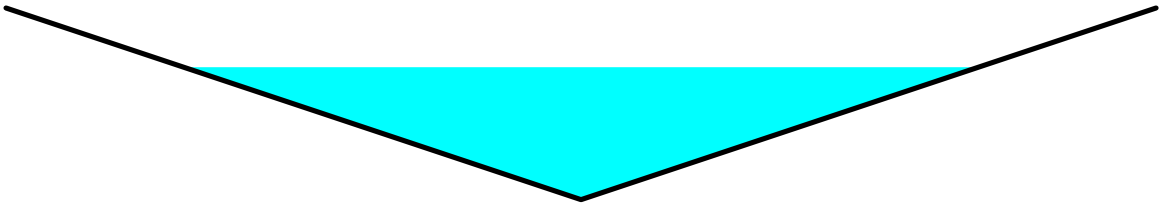
Summary for Reach BCHd: Berm Channel

Inflow Area = 1,193,170 sf, 0.00% Impervious, Inflow Depth = 3.22" for 100 Year Storm event
Inflow = 112.00 cfs @ 11.98 hrs, Volume= 319,955 cf
Outflow = 109.56 cfs @ 12.00 hrs, Volume= 319,955 cf, Atten= 2%, Lag= 1.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 4.79 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.49 fps, Avg. Travel Time= 5.0 min

Peak Storage= 10,321 cf @ 12.00 hrs
Average Depth at Peak Storage= 2.76'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 294.15 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 294.15 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 451.0' Slope= 0.0089 '/'
Inlet Invert= 1,468.00', Outlet Invert= 1,464.00'



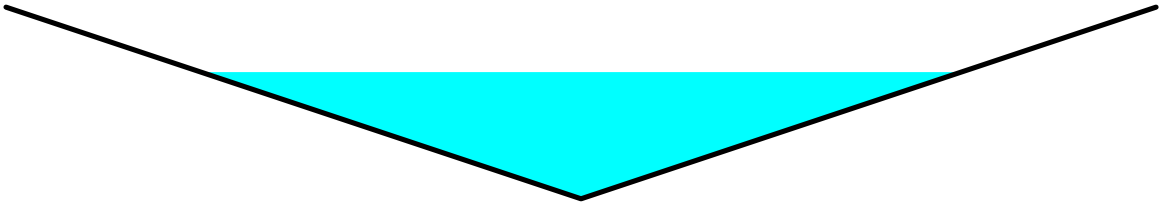
Summary for Reach BCHe: Berm Channel

Inflow Area = 1,315,419 sf, 0.00% Impervious, Inflow Depth = 3.24" for 100 Year Storm event
Inflow = 123.17 cfs @ 11.99 hrs, Volume= 355,230 cf
Outflow = 118.23 cfs @ 12.02 hrs, Volume= 355,230 cf, Atten= 4%, Lag= 1.6 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.62 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 1.71 fps, Avg. Travel Time= 7.5 min

Peak Storage= 16,228 cf @ 12.02 hrs
Average Depth at Peak Storage= 2.65'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 355.48 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 355.48 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 772.0' Slope= 0.0130 '/'
Inlet Invert= 1,464.00', Outlet Invert= 1,454.00'



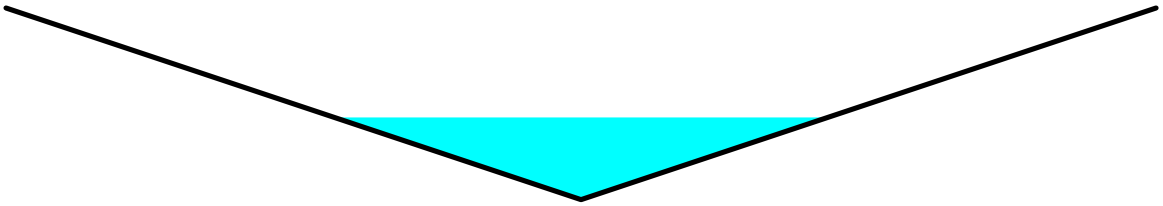
Summary for Reach BCHf: Berm Channel

Inflow Area = 432,404 sf, 0.00% Impervious, Inflow Depth = 3.25" for 100 Year Storm event
Inflow = 56.36 cfs @ 11.96 hrs, Volume= 116,934 cf
Outflow = 54.34 cfs @ 11.97 hrs, Volume= 116,934 cf, Atten= 4%, Lag= 1.2 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 6.17 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 1.91 fps, Avg. Travel Time= 6.1 min

Peak Storage= 6,175 cf @ 11.97 hrs
Average Depth at Peak Storage= 1.71'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 520.94 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 520.94 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 701.0' Slope= 0.0278 '/'
Inlet Invert= 1,479.50', Outlet Invert= 1,460.00'



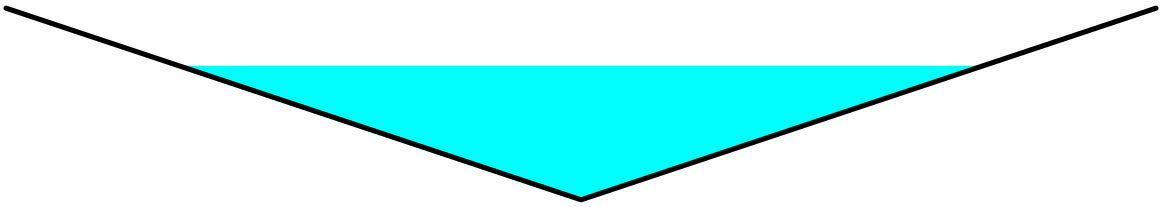
Summary for Reach CH2b: Channel 2

Inflow Area = 2,758,230 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 226.15 cfs @ 12.05 hrs, Volume= 729,512 cf
Outflow = 226.12 cfs @ 12.05 hrs, Volume= 729,512 cf, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 9.60 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.76 fps, Avg. Travel Time= 0.7 min

Peak Storage= 2,754 cf @ 12.05 hrs
Average Depth at Peak Storage= 2.80'
Defined Flood Depth= 4.00' Flow Area= 48.0 sf, Capacity= 584.69 cfs
Bank-Full Depth= 4.00' Flow Area= 48.0 sf, Capacity= 584.69 cfs

0.00' x 4.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 24.00'
Length= 117.0' Slope= 0.0350 '/'
Inlet Invert= 1,459.52', Outlet Invert= 1,455.42'



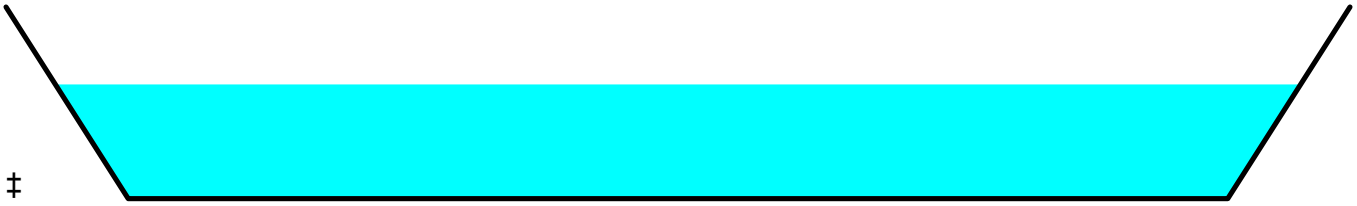
Summary for Reach HB: Hosmer Brook

Inflow Area = 10,994,269 sf, 0.00% Impervious, Inflow Depth > 2.90" for 100 Year Storm event
Inflow = 95.18 cfs @ 14.22 hrs, Volume= 2,658,963 cf
Outflow = 95.18 cfs @ 14.22 hrs, Volume= 2,658,951 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 5.55 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.41 fps, Avg. Travel Time= 0.4 min

Peak Storage= 514 cf @ 14.22 hrs
Average Depth at Peak Storage= 0.60'
Bank-Full Depth= 1.00' Flow Area= 30.0 sf, Capacity= 229.45 cfs

27.00' x 1.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 33.00'
Length= 30.0' Slope= 0.0373 '/'
Inlet Invert= 1,439.83', Outlet Invert= 1,438.71'



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Summary for Reach PCHc: Perimeter Channel

Inflow Area = 14,701 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 2.27 cfs @ 11.91 hrs, Volume= 3,888 cf
Outflow = 2.09 cfs @ 11.92 hrs, Volume= 3,888 cf, Atten= 8%, Lag= 0.9 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 1.77 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.46 fps, Avg. Travel Time= 7.7 min

Peak Storage= 247 cf @ 11.92 hrs
Average Depth at Peak Storage= 0.38'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 209.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.09', Outlet Invert= 1,480.00'

Summary for Reach PCHd: Perimeter Channel

Inflow Area = 35,863 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 4.97 cfs @ 11.95 hrs, Volume= 9,485 cf
Outflow = 4.78 cfs @ 11.96 hrs, Volume= 9,485 cf, Atten= 4%, Lag= 1.0 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.23 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 0.60 fps, Avg. Travel Time= 6.3 min

Peak Storage= 483 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.58'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 225.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.25', Outlet Invert= 1,480.00'

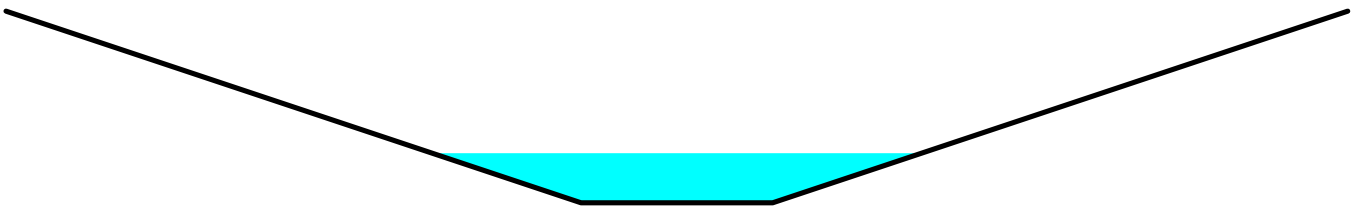
Summary for Reach PCHe: Perimeter Channel

Inflow Area = 29,119 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 4.04 cfs @ 11.95 hrs, Volume= 7,702 cf
Outflow = 3.87 cfs @ 11.96 hrs, Volume= 7,702 cf, Atten= 4%, Lag= 1.1 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.10 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 0.56 fps, Avg. Travel Time= 6.7 min

Peak Storage= 414 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.52'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 225.0' Slope= 0.0100 '/'
Inlet Invert= 1,482.25', Outlet Invert= 1,480.00'



Summary for Reach PCHf: Perimeter Channel

Inflow Area = 33,575 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 4.78 cfs @ 11.94 hrs, Volume= 8,880 cf
Outflow = 4.34 cfs @ 11.96 hrs, Volume= 8,880 cf, Atten= 9%, Lag= 1.5 min

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Max. Velocity= 2.17 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 0.57 fps, Avg. Travel Time= 11.1 min

Peak Storage= 760 cf @ 11.96 hrs
Average Depth at Peak Storage= 0.55'
Defined Flood Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 72.05 cfs

2.00' x 2.00' deep channel, n= 0.035
Side Slope Z-value= 3.0 '/' Top Width= 14.00'
Length= 380.0' Slope= 0.0100 '/'
Inlet Invert= 1,483.80', Outlet Invert= 1,480.00'

Summary for Pond Basin1,2,3: Basin1,2,3

Inflow Area = 6,127,370 sf, 0.00% Impervious, Inflow Depth = 2.96" for 100 Year Storm event
Inflow = 144.35 cfs @ 12.37 hrs, Volume= 1,512,156 cf
Outflow = 21.17 cfs @ 17.79 hrs, Volume= 1,253,631 cf, Atten= 85%, Lag= 325.6 min
Primary = 21.17 cfs @ 17.79 hrs, Volume= 1,253,631 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,448.57' @ 17.79 hrs Surf.Area= 0 sf Storage= 858,832 cf

Plug-Flow detention time= 1,178.0 min calculated for 1,253,522 cf (83% of inflow)
Center-of-Mass det. time= 1,058.6 min (2,066.5 - 1,007.9)

Volume	Invert	Avail.Storage	Storage Description
#1	1,441.00'	1,099,676 cf	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (cubic-feet)
1,441.00	0
1,442.00	41,794
1,443.00	124,900
1,444.00	225,693
1,445.00	337,193
1,446.00	426,428
1,448.00	762,458
1,450.00	1,099,676

Device	Routing	Invert	Outlet Devices
#1	Primary	1,441.00'	**Special & User-Defined** Elev. (feet) 1,441.00 1,441.10 1,441.20 1,441.30 1,441.40 1,441.50 1,441.60 1,441.70 1,441.80 1,441.90 1,442.00 1,442.10 1,442.20 1,442.30 1,442.40 1,442.50 1,442.60 1,442.70 1,442.80 1,442.90 1,443.00 1,443.10 1,443.20 1,443.30 1,443.40 1,443.50 1,443.60 1,443.70 1,443.80 1,443.90 1,444.00 1,444.10 1,444.20 1,444.30 1,444.40 1,444.50 1,444.60 1,444.70 1,444.80 1,444.90 1,445.00 1,445.10 1,445.20 1,445.30 1,445.40 1,445.50 1,445.60 1,445.70 1,445.80 1,445.90 1,446.00 1,446.10 1,446.20 1,446.30 1,446.40 1,446.50 1,446.60 1,446.70 1,446.80 1,446.90 1,447.00 1,447.10 1,447.20 1,447.30 1,447.40 1,447.50 1,447.60 1,447.70 1,447.80 1,447.90 1,448.00 1,448.10 1,448.20 1,448.30 1,448.40 1,448.50 1,448.60 1,448.70 1,448.80 1,448.90 1,449.00 1,449.10 1,449.20 1,449.30 1,449.40 1,449.50 1,449.60 1,449.70 1,449.80 1,449.90 1,450.00 Disch. (cfs) 0.000 0.120 0.160 0.200 0.330 0.410 0.470 0.600 0.710 0.800 0.880 1.070 1.180 1.270 1.460 1.590 1.710 1.880 2.040 2.180 2.300 2.530 2.680 2.820 3.040 3.210 3.360 3.570 3.770 3.940 4.100 4.360 4.540 4.710 4.870 5.020 5.170 5.270 5.310 5.340 5.380 6.550 8.670 11.400 14.630 18.280 22.320 26.710 32.280 38.350 43.980 50.760 58.050 66.530 75.440 85.260 95.490 105.710 116.480 127.020 137.580

Primary OutFlow Max=21.17 cfs @ 17.79 hrs HW=1,448.57' TW=1,440.20' (Dynamic Tailwater)
↑—**1=Special & User-Defined** (Custom Controls 21.17 cfs)

Summary for Pond Basin5: Basin 5

Inflow Area = 5,802,974 sf, 0.00% Impervious, Inflow Depth = 3.19" for 100 Year Storm event
Inflow = 485.08 cfs @ 12.00 hrs, Volume= 1,544,768 cf
Outflow = 140.46 cfs @ 12.37 hrs, Volume= 1,426,358 cf, Atten= 71%, Lag= 22.4 min
Primary = 140.46 cfs @ 12.37 hrs, Volume= 1,426,358 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,452.95' @ 12.37 hrs Surf.Area= 95,103 sf Storage= 676,632 cf

Plug-Flow detention time= 232.0 min calculated for 1,426,234 cf (92% of inflow)

Center-of-Mass det. time= 190.3 min (1,019.7 - 829.5)

Volume	Invert	Avail.Storage	Storage Description
#1	1,444.00'	776,855 cf	**Custom Stage Data (Prismatic)** Listed below

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,444.00	53,356	0	0
1,446.00	65,054	118,410	118,410
1,448.00	73,763	138,817	257,227
1,450.00	82,901	156,664	413,891
1,452.00	89,234	172,135	586,026
1,454.00	101,595	190,829	776,855

Device	Routing	Invert	Outlet Devices
#1	Primary	1,444.00'	**Special & User-Defined** Elev. (feet) 1,444.00 1,444.20 1,444.40 1,444.60 1,444.80 1,445.00 1,445.20 1,445.40 1,445.60 1,445.80 1,446.00 1,446.20 1,446.40 1,446.60 1,446.80 1,447.00 1,447.20 1,447.40 1,447.60 1,447.80 1,448.00 1,448.20 1,448.40 1,448.60 1,448.80 1,449.00 1,449.20 1,449.40 1,449.60 1,449.80 1,450.00 1,450.20 1,450.40 1,450.60 1,450.80 1,451.00 1,451.20 1,451.40 1,451.60 1,451.80 1,452.00 1,452.20 1,452.40 1,452.60 1,452.80 1,453.00 1,453.20 1,453.40 1,453.60 1,453.80 1,454.00 Disch. (cfs) 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.660 1.310 1.900 2.860 3.520 4.710 5.830 6.830 8.170 9.190 10.720 12.150 13.460 15.090 16.390 18.180 19.870 21.420 23.290 24.820 26.840 28.380 29.770 31.070 32.300 37.160 45.070 54.990 66.560 79.590 97.170 111.170 120.000 130.230 143.900 159.070 177.540 198.670 220.730 242.880

Primary OutFlow Max=140.44 cfs @ 12.37 hrs HW=1,452.95' TW=1,443.62' (Dynamic Tailwater)
↑—**1=Special & User-Defined** (Custom Controls 140.44 cfs)

Summary for Pond CUL 15: Culvert 15

Inflow Area = 454,686 sf, 0.00% Impervious, Inflow Depth = 3.24" for 100 Year Storm event
Inflow = 56.11 cfs @ 11.98 hrs, Volume= 122,827 cf
Outflow = 56.11 cfs @ 11.98 hrs, Volume= 122,827 cf, Atten= 0%, Lag= 0.0 min
Primary = 56.11 cfs @ 11.98 hrs, Volume= 122,827 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,462.78' @ 11.98 hrs
Flood Elev= 1,464.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,460.00'	**60.0" Round Culvert** L= 50.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,460.00' / 1,455.42' S= 0.0916 '/' Cc= 0.900 n= 0.013, Flow Area= 19.63 sf

Primary OutFlow Max=56.00 cfs @ 11.98 hrs HW=1,462.78' TW=1,461.15' (Dynamic Tailwater)
1=Culvert (Inlet Controls 56.00 cfs @ 5.00 fps)

Summary for Pond CUL 2: Culvert 2

Inflow Area = 4,232,529 sf, 0.00% Impervious, Inflow Depth = 3.18" for 100 Year Storm event
Inflow = 361.35 cfs @ 12.00 hrs, Volume= 1,122,011 cf
Outflow = 361.35 cfs @ 12.00 hrs, Volume= 1,122,011 cf, Atten= 0%, Lag= 0.0 min
Primary = 361.35 cfs @ 12.00 hrs, Volume= 1,122,011 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,461.25' @ 12.00 hrs
Flood Elev= 1,461.52'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,455.42'	**96.0" W x 72.0" H Box Culvert** L= 70.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 1,455.42' / 1,454.00' S= 0.0203 '/' Cc= 0.900 n= 0.011, Flow Area= 48.00 sf

Primary OutFlow Max=361.31 cfs @ 12.00 hrs HW=1,461.25' TW=1,449.86' (Dynamic Tailwater)
1=Culvert (Inlet Controls 361.31 cfs @ 7.75 fps)

Summary for Pond CUL20: Culvert 20

Inflow Area = 50,564 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 6.55 cfs @ 11.95 hrs, Volume= 13,373 cf
Outflow = 6.55 cfs @ 11.95 hrs, Volume= 13,373 cf, Atten= 0%, Lag= 0.0 min
Primary = 6.55 cfs @ 11.95 hrs, Volume= 13,373 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,481.21' @ 11.95 hrs
Flood Elev= 1,482.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,480.00'	**24.0" Round Culvert** L= 72.0' CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 1,480.00' / 1,468.00' S= 0.1667 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=6.55 cfs @ 11.95 hrs HW=1,481.21' TW=1,470.61' (Dynamic Tailwater)
1=Culvert (Inlet Controls 6.55 cfs @ 3.30 fps)

Summary for Pond CUL21: Culvert 21

Inflow Area = 62,694 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 8.21 cfs @ 11.96 hrs, Volume= 16,582 cf
Outflow = 8.21 cfs @ 11.96 hrs, Volume= 16,582 cf, Atten= 0%, Lag= 0.0 min
Primary = 8.21 cfs @ 11.96 hrs, Volume= 16,582 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,481.39' @ 11.96 hrs
Flood Elev= 1,482.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,480.00'	**24.0" Round Culvert**
			L= 89.0' CMP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 1,480.00' / 1,464.00' S= 0.1798 '/' Cc= 0.900
			n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=8.19 cfs @ 11.96 hrs HW=1,481.38' TW=1,466.50' (Dynamic Tailwater)
1=Culvert (Inlet Controls 8.19 cfs @ 3.53 fps)

Summary for Pond CUL23: Culvert 23

Inflow Area = 1,315,419 sf, 0.00% Impervious, Inflow Depth = 3.24" for 100 Year Storm event
Inflow = 118.23 cfs @ 12.02 hrs, Volume= 355,230 cf
Outflow = 118.23 cfs @ 12.02 hrs, Volume= 355,230 cf, Atten= 0%, Lag= 0.0 min
Primary = 118.23 cfs @ 12.02 hrs, Volume= 355,230 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,458.49' @ 12.02 hrs
Flood Elev= 1,459.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,454.00'	**60.0" Round Culvert**
			L= 49.0' CPP, mitered to conform to fill, Ke= 0.700
			Inlet / Outlet Invert= 1,454.00' / 1,452.00' S= 0.0408 '/' Cc= 0.900
			n= 0.013, Flow Area= 19.63 sf

Primary OutFlow Max=118.11 cfs @ 12.02 hrs HW=1,458.48' TW=1,450.20' (Dynamic Tailwater)
1=Culvert (Inlet Controls 118.11 cfs @ 6.36 fps)

Summary for Pond CUL5i: Culvert 5

Inflow Area = 48,000 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 6.38 cfs @ 11.96 hrs, Volume= 12,695 cf
Outflow = 6.38 cfs @ 11.96 hrs, Volume= 12,695 cf, Atten= 0%, Lag= 0.0 min
Primary = 6.38 cfs @ 11.96 hrs, Volume= 12,695 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,483.65' @ 11.96 hrs
Flood Elev= 1,487.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	1,482.00'	**18.0" Round Culvert**
			L= 60.0' CPP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 1,482.00' / 1,478.00' S= 0.0667 '/' Cc= 0.900
			n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=6.37 cfs @ 11.96 hrs HW=1,483.65' TW=1,462.02' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 6.37 cfs @ 3.61 fps)

Summary for Pond CUL7: Culvert 7

Inflow Area = 116,799 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 10.61 cfs @ 12.08 hrs, Volume= 30,892 cf
Outflow = 4.91 cfs @ 11.96 hrs, Volume= 30,892 cf, Atten= 54%, Lag= 0.0 min
Primary = 4.91 cfs @ 11.96 hrs, Volume= 30,967 cf

Routing by Dyn-Stor-Ind method, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 1,452.34' @ 12.80 hrs Surf.Area= 10,951 sf Storage= 12,859 cf
Flood Elev= 1,454.00' Surf.Area= 22,611 sf Storage= 40,759 cf

Plug-Flow detention time= 47.4 min calculated for 30,889 cf (100% of inflow)
Center-of-Mass det. time= 47.4 min (872.9 - 825.5)

Volume	Invert	Avail.Storage	Storage Description
#1	1,448.00'	40,759 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,448.00	0	0	0
1,450.00	489	489	489
1,452.00	8,585	9,074	9,563
1,454.00	22,611	31,196	40,759

Device	Routing	Invert	Outlet Devices
#1	Primary	1,448.00'	**18.0" Round Culvert** L= 313.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 1,448.00' / 1,445.00' S= 0.0096 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=4.89 cfs @ 11.96 hrs HW=1,449.80' TW=1,448.95' (Dynamic Tailwater)
↑**1=Culvert** (Outlet Controls 4.89 cfs @ 2.92 fps)

Summary for Link 1L: Segment 2

Inflow Area = 2,677,873 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 222.45 cfs @ 12.06 hrs, Volume= 708,258 cf
Primary = 222.45 cfs @ 12.06 hrs, Volume= 708,258 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

100 Year Storm Outflow Imported from Southern Expansion Segment 2~Reach CH2a.hce

Summary for Link 2L: Segment 3

Inflow Area = 391,460 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 46.83 cfs @ 11.95 hrs, Volume= 103,535 cf
Primary = 46.83 cfs @ 11.95 hrs, Volume= 103,535 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

100 Year Storm Primary Outflow Imported from Southern Expansion Segment 3~Pond DCCUL5.hce

Summary for Link 3L: Segment 4

Inflow Area = 628,153 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 67.92 cfs @ 11.96 hrs, Volume= 166,137 cf
Primary = 67.92 cfs @ 11.96 hrs, Volume= 166,137 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

100 Year Storm Primary Outflow Imported from Southern Expansion Segment 4~Pond Cul24.hce

Summary for Link 4L: Segment 5

Inflow Area = 337,097 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 29.14 cfs @ 11.99 hrs, Volume= 89,157 cf
Primary = 29.14 cfs @ 11.99 hrs, Volume= 89,157 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

100 Year Storm Primary Outflow Imported from Southern Expansion Segment 5~Pond Cul19.hce

Summary for Link 5L: Segment 6

Inflow Area = 745,851 sf, 0.00% Impervious, Inflow Depth = 3.20" for 100 Year Storm event
Inflow = 71.52 cfs @ 11.97 hrs, Volume= 198,698 cf
Primary = 71.52 cfs @ 11.97 hrs, Volume= 198,698 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

100 Year Storm Outflow Imported from Southern Expansion Segment 6~Reach BCHb.hce

Summary for Link 6L: Segment 7

Inflow Area = 380,399 sf, 0.00% Impervious, Inflow Depth = 3.17" for 100 Year Storm event
Inflow = 50.49 cfs @ 11.96 hrs, Volume= 100,610 cf
Primary = 50.49 cfs @ 11.96 hrs, Volume= 100,610 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-120.00 hrs, dt= 0.01 hrs

100 Year Storm Primary Outflow Imported from Southern Expansion Segment 7~Pond Cul22.hce

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	15-May-20	208-190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	Channel Sizing	
PREPARED BY	**CHECKED BY**	
KLS 5/4/2020	LR 5/15/2020	

Description and Purpose:

Determine size required for each channel to convey the 10-Year storm event runoff with 0.5 feet of freeboard and the peak discharge of the 100-Year storm event without overtopping.

Design Basis/References/Assumptions:

New York State Stormwater Management Design Manual, January 2015 (attached).
HydroCAD Stormwater Modeling, Version 10.00-24.

Remarks/Conclusions/Results:

Channels are sized to convey the 10-year storm event runoff with a minimum of 0.5' of freeboard and the peak discharge without overtopping.

Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Drainage Channel Calculations
Channel Sizing

By: KLS Date: 5/4/2020
Check: LR Date: 5/15/2020

The majority of perimeter channels were installed during final capping of the closed landfill or during construction of the Western Expansion cells 5 and 6.
Some perimeter channels and final cap channels are yet to be installed.
The Southern Expansion will extend capping channels and utilize existing channels to convey stormwater to the stormwater basins.

Appendix E.2 of the December 2012 Engineering Report, Part III of the Part 360 Permit Application for the Valley Fill Landfill Expansion contains a summary of the channel design. The channel nomenclature used for the Valley Fill Expansion was utilized for the Southern Expansion. The following channels were not utilized due to the configuration of the Southern Expansion:

Channel 5
Channel 3a
Channel 3b
Chanel 3c
Channel 4
Existing Channel 4
Existing Channel 5

Channel design criteria is based on the following:

Provide 0.5' freeboard during a 10-year storm event
Does not overtop its banks during a 100-year storm event

Many of the channels were defined as reaches in HydroCAD, therefore hydroCAD estimates flow depth in the channel during each storm event that was evaluated.

Using the HydroCAD reports, the following table can be created to compare channels to the design criteria for the new channels as part of the Southern Expansion. The existing channels to be utilized will not have additional flow routed to them and were not designed.

Channel	Design Depth	10-Year Storm Depth (ft)	10-Year Storm Flow (cfs)	100-Year Storm Depth (ft)	100-Year Storm Flow (cfs)	Comments
CH6	1	0.47	13.8	0.71	31.73	ok
CH7	2	1.29	13.8	1.77	31.72	ok
DC1	1	0.19	19.29	0.32	43.22	ok
DC5	1	0.1	6.61	0.31	43	ok
DC6	1	0.24	28.28	0.4	64.83	ok
DC7	1	0.21	21.56	0.34	48.28	ok
DC8	1	0.16	13.88	0.27	31.83	ok
RCH	1.5	0.71	12.44	0.97	29.17	ok
PCH	2	1.36	29.69	1.95	68.02	ok
BCH	4	1.9	51.68	2.76	123.17	ok

Note:

1. The PCH and BCH for the perimeter channel and berm channel, respectively, show the maximum depth and maximum flow of all channel sections for the storm events.

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	15-May-20	208-190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	Channel Erosion Protection Calculations	
PREPARED BY	**CHECKED BY**	
KLS 5/6/2020	LR 5/15/2020	

Description and Purpose:

Determine erosion protection required for downchutes, perimeter channels, berm channels and basin spillways to convey the peak discharge from a 100-Year storm event without exceeding the maximum allowable shear stress.

Design Basis/References/Assumptions:

New York State Stormwater Management Design Manual, January 2015 (attached)
Design of Roadside Channels with Flexible Linings, HEC-15, Federal Highway Administration, 1988 (attached)
HydroCAD Stormwater Modeling, Version 10.00-24.

Remarks/Conclusions/Results:

Downchutes, perimeter channels, berm channels and basin spillways are lined with the appropriate material to convey the peak discharge without exceeding the maximum allowable shear stress of the material.

Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Drainage Channel Calculations
Channel Erosion Protection Calculations

By: KLS Date: 5/4/2020
Check: LR Date: 5/15/2020

Channel Erosion Protection was sized for many of the channels for the Western Landfill Expansion and Valley Fill Expansion or during capping events.
Downchutes 1, 5, 6 and 7 are new and will require an appropriately designed Channel Erosion Protection.
Channel Erosion Protection will be sized using HEC-15 methods with channel slopes and depths.
The 100-year storm depths will be utilize for the calculations.

$$Shear\ Stress = (\gamma_w)(d)(s)$$

Where:
ɣw: 62.4 pcf
d depth of flow in channel for 100 year storm (ft)
s slope of channel

The permissible shear stress is based on tabular values for grass linings, see attached Tables from the New York State Standards and Specifications for Erosion and Sediment Control.
The permissible shear stress for riprap revetment is based on the following equation.

$$Permissible\ Shear\ Stress = 4.0 D_{50}$$

Where:
D_{50}: mean riprap size in feet

Channel Revetment Design

Channel Number	Description	Channel Slope (ft/ft)	Peak Depth for 100-Year Storm (ft)	Estimated Shear Stress (pcf)	Designed Revetment Type	D_{50} for Riprap (ft)	D_{50} for Riprap (in)	Riprap Thickness (in)	Permissible Shear Stress for Riprap (psf)	Permissible Shear Stress for Grass (psf)
CH6	Channel	0.1835	0.71	8.13	Riprap	2.03	25	45	8.33	
CH7	Channel	0.0081	1.77	0.89	Riprap Bottom, Grass Sides (Class B)	0.22	3	7	1.00	2.1
DC1	Stone Lined Downchute	0.3300	0.32	6.59	Riprap	1.65	20	36	6.67	
DC5	Stone Lined Downchute	0.3300	0.31	6.38	Riprap	1.60	20	36	6.67	
DC6	Stone Lined Downchute	0.3300	0.4	8.24	Riprap	2.06	25	45	8.33	
DC7	Stone Lined Downchute	0.3300	0.34	7.00	Riprap	1.75	22	40	7.33	
DC8	Stone Lined Downchute	0.3000	0.27	5.05	Riprap	1.26	16	29	5.33	
RCH	Road Channel	0.1624	0.97	9.83	Riprap	2.46	30	54	10.00	
PCH	Perimeter Channel	0.0100	1.95	1.22	Riprap Bottom, Grass Sides (Class B)	0.30	4	9	1.33	2.1
BCH	Berm Channel	0.0278	2.76	4.79	Riprap	1.20	15	34	5.00	
Basin #5 ES	Stone Lined Spillway	0.0100	0.95	0.59	Riprap	0.15	2	5	0.67	
Basin #5 ES	Stone Lined Spillway	0.3300	0.31	6.46	Riprap	1.62	20	36	6.67	
Basin #3 ES	Stone Lined Spillway	0.0100	0.57	0.36	Riprap	0.09	2	5	0.67	
Basin #3 ES	Stone Lined Spillway	0.3300	0.19	3.96	Riprap	0.99	12	27	4.00	

Note:
All other channels have previously been designed.

Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Drainage Channel Calculations
Emergency Spillway Flow Depth Calculations

By: KLS Date: 5/6/2020
Check: LR Date: 5/15/2020

Open Channel Flow:

$$Q = \frac{\sqrt{S}(BH)^{5/3}}{n(B+2H)^{2/3}}$$

Where:

Q:	Channel Flow (cfs)
S:	Channel Slope (ft/ft)
B:	Bottom Width (ft)
H:	Flow Depth (ft)
n:	Manning's Roughness Coefficient

Channel	Description	Bottom Width (ft)	Manning's Roughness Coefficient (n)	Chanel Slope (ft/ft)	Channel Sideslope (z:1)	Channel Flow (cfs)	Flow Depth (ft)	Q Check
Basin #5 ES	Stone Lined Spillway	15	0.035	0.3300	3	34.72	0.31	34.72
Basin #3 ES	Stone Lined Spillway	15	0.035	0.3300	3	15.49	0.19	15.49

CHAPTER 3: GENERAL DESIGN PROCEDURE

This chapter outlines the general design procedure for flexible channel linings based on design concepts presented in Chapter 2. The simplest case of the straight channel is described first. Subsequent sections consider variations to the straight channel including side slope stability, composite linings, and bends. The final two sections address additional considerations for channels with a steep longitudinal slope and determination of a maximum discharge for a given channel. This chapter is intended to apply to all flexible linings. Subsequent chapters provide more detailed guidance on specific flexible lining types.

3.1 STRAIGHT CHANNELS

The basic design procedure for flexible channel linings is quite simple. The computations include a determination of the uniform flow depth in the channel, known as the normal depth, and determination of the shear stress on the channel bottom at this depth. Both concepts were discussed in Chapter 2. Recalling Equation 2.8, the maximum shear stress is given by:

$$\tau_d = \gamma d S_o \tag{3.1}$$

where,

τ_d = shear stress in channel at maximum depth, N/m^2 (lb/ft^2)
γ = unit weight of water, N/m^3 (lb/ft^3)
d = depth of flow in channel, m (ft)
S_o = channel bottom slope, m/m (ft/ft)

The basic comparison required in the design procedure is that of permissible to computed shear stress for a lining. If the permissible shear stress is greater than or equal to the computed shear stress, including consideration of a safety factor, the lining is considered acceptable. If a lining is unacceptable, a lining with a higher permissible shear stress is selected, the discharge is reduced (by diversion or retention/detention), or the channel geometry is modified. This concept is expressed as:

$$\tau_p \geq SF\ \tau_d \tag{3.2}$$

where,

τ_p = permissible shear stress for the channel lining, N/m^2 (lb/ft^2)
SF = safety factor (greater than or equal to one)
τ_d = shear stress in channel at maximum depth, N/m^2 (lb/ft^2)

The safety factor provides for a measure of uncertainty, as well as a means for the designer to reflect a lower tolerance for failure by choosing a higher safety factor. A safety factor of 1.0 is appropriate in many cases and may be considered the default. The expression for shear stress at maximum depth (Equation 3.1) is conservative and appropriate for design as discussed in Chapter 2. However, safety factors from 1.0 to 1.5 may be appropriate, subject to the designer's discretion, where one or more of the following conditions may exist:

- critical or supercritical flows are expected
- climatic regions where vegetation may be uneven or slow to establish

Outlets
Each diversion must have an adequate outlet. The outlet may be a grassed waterway, vegetated or paved area, grade stabilization structure, stable watercourse, or subsurface drain outlet. In all cases, the outlet must convey runoff to a point where outflow will not cause damage. Vegetated outlets shall be installed before diversion construction, if needed, to ensure establishment of vegetative cover in the outlet channel.

The design elevation of the water surface in the diversion shall not be lower than the design elevation of the water surface in the outlet at their junction when both are operating at design flow.

Stabilization

Diversions shall be stabilized in accordance with the following tables.

Construction Specifications

See Figure 5B.1 on page 5B.3 for details.

Table 5B.1
Diversion Maximum Permissible Design Velocities

Soil Texture	Retardance and Cover	Permissible Velocity (ft / second) for Selected Channel Vegetation
Sand, Silt, Sandy loam, silty loam, loamy sand (ML, SM, SP, SW)	C-Kentucky 31 tall fescue and Kentucky bluegrass	3.0
	D-Annuals[1] Small grain (rye, oats, barley, millet) Ryegrass	2.5
Silty clay loam, Sandy clay loam (ML-CL, SC)	C-Kentucky 31 tall fescue and Kentucky bluegrass	4.0
	D-Annuals[1] Small grain (rye, oats, barley, millet) Ryegrass	3.5
Clay (CL)	C-Kentucky 31 tall fescue and Kentucky bluegrass	5.0
	D-Annuals[1] Small grain (rye, oats, barley, millet) Ryegrass	4.0

[1] Annuals—Use only as temporary protection until permanent vegetation is established.

Table 5B.2—Retardance Factors for Various Grasses and Legumes

Retardance	Cover	Condition
A	Reed canarygrass……..	Excellent stand, tall (average 36 inches)
B	Smooth bromegrass……	Good stand, mowed (average 12 to 15 inches)
	Tall fescue……..	Good stand, unmowed (average 18 inches)
	Grass-legume mixture—Timothy, smooth bromegrass, or Orchard grass with birdsfoot trefoil……	Good stand, uncut (average 20 inches)
	Reed canarygrass…….	Good stand, mowed (average 12 to 15 inches)
	Tall fescue, with birdsfoot trefoil or ladino clover……..	Good stand, uncut (average 18 inches)
C	Redtop……	Good stand, headed (15 to 20 inches)
	Grass-legume mixture—summer (Orchard grass, redtop, Annual ryegrass, and ladino or white clover)……	Good stand, uncut (6 to 8 inches)
	Kentucky bluegrass…….	Good stand, headed (6 to 12 inches)
D	Red fescue……	Good stand, headed (12 to 18 inches)
	Grass-legume mixture—fall, spring (Orchard grass, redtop, Annual ryegrass, and white or ladino clover)…….	Good stand, uncut (4 to 5 inches)

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	15-May-20	208-190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	Culvert Sizing	
PREPARED BY	**CHECKED BY**	
KLS 5/4/2020	LR 5/15/2020	

Description and Purpose:

Determine size of each culvert required to convey peak discharge from the 100-year storm event without overtopping adjacent roads.

Design Basis/References/Assumptions:

HydroCAD Stormwater Modeling, Version 10.00-24.

Remarks/Conclusions/Results:

Culverts are sized to convey the peak discharge without overtopping adjacent roads.

Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Culvert Calculations
Culvert Sizing

By: KLS Date: 5/4/2020
Check: LR Date: 5/15/2020

Culvert Design criteria is based on the following:

Does not overtop adjacent roadway during 100-year storm event.

The culverts were defined in HydroCAD, therefore HydroCAD peak elevation results are available for each culvert.
Using the HydroCAD reports, the following table can be created to compare culverts to the design criteria for the new culverts as part of the Southern Expansion. The existing culverts to be utilized will not have additional flow routed to them and were not designed. Existing culverts that have additional flow routed to them are included below.

Culvert	Overtopping Elevation	100-Year Storm Elevation	Freeboard (ft)
DCCUL5	1486.5	1486.5	0.0
Cul24	1486	1485.6	0.4
Cul19	1485	1484.45	0.55
Cul17	1484	1483.32	0.68
Cul18	1480	1479.47	0.53
Cul22	1485	1482.62	2.38
CUL15	1464	1462.78	1.22
CUL2	1461.52	1461.25	0.27
CUL20	1482	1481.21	0.79
CUL21	1482	1481.39	0.61
CUL23	1459	1458.49	0.51
CUL5i	1487	1483.65	3.35
CUL7	1454	1452.34	1.66
CUL22	1485	1482.62	2.38
CUL25	1503	1502.61	0.39
CUL26	1480	1479.76	0.24

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	15-May-20	208-190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	Rock Outlet Protection	
PREPARED BY	**CHECKED BY**	
KLS 5/4/2020	LR 5/15/2020	

Description and Purpose:

Determine outlet protection required for culvert outlets to protect downstream conveyance features from erosion from the peak discharge from a 100-Year storm event.

Design Basis/References/Assumptions:

New York State Stormwater Management Design Manual, January 2015 (attached)
HydroCAD Stormwater Modeling, Version 10.00-24.

Remarks/Conclusions/Results:

Rock outlet protection for culverts sized to protect downstream conveyance feature (i.e. channel, pond) from erosion.

Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Culvert Calculations
Rock Outlet Protection Calculations

By: KLS Date: 5/4/2020
Check: LR Date: 5/15/2020

NYS Standards and Specifications for Erosion and Sediment Control, November 2016 (Blue Book)

Rock Outlet Protection
Required for culvert outlets, pipe conduits from sediment basins and channels constructed as outlets for culverts

Culvert	Discharges To	Tailwater Condition[2]	Tailwater/ Discharge Depth (ft)	Pipe Diameter/ Channel Flow Depth (in)	Pipe Diameter/ Channel Flow Depth (ft)	Velocity (fps)[2]	Pipe Discharge (cfs)[2]	D_{50} (ft)[1]	D_{50} (in)	Thickness (in)	Apron Length (ft)[1]	Apron Width at Pipe (ft)	Apron End Width (ft)
Culvert 2	Basin 5	min		72	6	7.75	361.31	1.5	18	32	46	18	52.0
Culvert 7	Basin 5	min	3.95	18	1.5	2.92	4.89	0.2	2	5	1	4.5	2.5
Culvert 15	Culvert 2	min	5.73	60	5	5.00	56.00	0.4	5	11	To Toe of Slope	15	15.0
Culvert 17	Berm Channel a	min	2.03	48	4	5.47	60.99	0.35	4	9	8	12	12.0
Culvert 18	Berm Channel b	min	2.34	24	2	3.64	9.01	0.3	4	9	1	6	3.0
Culvert 19	Berm Channel c	min	2.64	36	3	4.71	29.13	0.4	5	11	2	9	5.0
Culvert 20	Berm Channel d	min	2.61	24	2	3.30	6.55	0.25	3	7	To Toe of Slope	6	6.0
Culvert 21	Berm Channel e	min	2.5	24	2	3.53	8.19	0.25	3	7	To Toe of Slope	6	6.0
Culvert 22	Berm Channel f	min	1.71	60	5	4.86	50.38	0.2	2	5	To Toe of Slope	15	15.0
Culvert 23	Basin 5	min		60	5	6.36	118.11	0.6	7	16	12	15	17.0
Culvert 24	Culvert 2	min	0.25	48	4	5.70	67.83	0.5	6	14	13	12	17.0
Culvert 25	Channel 6	min	0.98	36	3	4.85	31.70	0.4	5	11	3	9	6.0
Culvert 26	Channel 7	min	1.77	36	3	6.09	31.69	0.4	5	11	3	9	6.0
Basin 5 Outlet[3]	Basin 1	min		36	3		105.72	1.15	14	32	33	9	36.0
Basin 1,2,3 Outlet[3]	Hosmer Brook	min		10	0.83		5.68	0.4	5	11	11	2.5	11.8

Notes:
1. Determined based on Figure 5B.12 and Figure 5B.13 for Minimum and Maximum tailwater conditions, respectively, from the NYS Blue Book.
2. Determined based on HydroCAD model.
3. Max discharge through the pipe at peak basin elevation.
4. Rock Outlet Protection based on minimum tailwater condition for culverts with Tailwater/ Discharge depth approximately half of the Pipe Diameter to be conservative.

STANDARD AND SPECIFICATIONS FOR ROCK OUTLET PROTECTION

Definition & Scope

A **permanent** section of rock protection placed at the outlet end of the culverts, conduits, or channels to reduce the depth, velocity, and energy of water, such that the flow will not erode the receiving downstream reach.

Conditions Where Practice Applies

This practice applies where discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach. This applies to:

1. Culvert outlets of all types.
2. Pipe conduits from all sediment basins, dry storm water ponds, and permanent type ponds.
3. New channels constructed as outlets for culverts and conduits.

Design Criteria

The design of rock outlet protection depends entirely on the location. Pipe outlet at the top of cuts or on slopes steeper than 10 percent, cannot be protected by rock aprons or riprap sections due to re-concentration of flows and high velocities encountered after the flow leaves the apron.

Many counties and state agencies have regulations and design procedures already established for dimensions, type and size of materials, and locations where outlet protection is required. Where these requirements exist, they shall be followed.

Tailwater Depth

The depth of tailwater immediately below the pipe outlet must be determined for the design capacity of the pipe. If the tailwater depth is less than half the diameter of the outlet pipe, and the receiving stream is wide enough to accept divergence of the flow, it shall be classified as a Minimum Tailwater Condition; see Figure 3.16 on page 3.42 as an example. If the tailwater depth is greater than half the pipe diameter and the receiving stream will continue to confine the flow, it shall be classified as a Maximum Tailwater Condition; see Figure 3.17 on page 3.43 as an example. Pipes which outlet onto flat areas with no defined channel may be assumed to have a Minimum Tailwater Condition; see Figure 3.16 on page 3.42 as an example.

Apron Size

The apron length and width shall be determined from the curves according to the tailwater conditions:

Minimum Tailwater – Use Figure 3.16 on page 3.42
Maximum Tailwater – Use Figure 3.17 on page 3.43

If the pipe discharges directly into a well defined channel, the apron shall extend across the channel bottom and up the channel banks to an elevation one foot above the maximum tailwater depth or to the top of the bank, whichever is less.

The upstream end of the apron, adjacent to the pipe, shall have a width two (2) times the diameter of the outlet pipe, or conform to pipe end section if used.

Bottom Grade

The outlet protection apron shall be constructed with no slope along its length. There shall be no overfall at the end of the apron. The elevation of the downstream end of the apron shall be equal to the elevation of the receiving channel or adjacent ground.

Alignment

The outlet protection apron shall be located so that there are no bends in the horizontal alignment.

Materials

The outlet protection may be done using rock riprap, grouted riprap, or gabions. Outlets constructed on the bank of a stream or wetland shall not use grouted rip-rap, gabions or concrete.

Riprap shall be composed of a well-graded mixture of rock size so that 50 percent of the pieces, by weight, shall be larger than the d_{50} size determined by using the charts. A

well-graded mixture, as used herein, is defined as a mixture composed primarily of larger rock sizes, but with a sufficient mixture of other sizes to fill the smaller voids between the rocks. The diameter of the largest rock size in such a mixture shall be 1.5 times the d_{50} size.

Thickness

The minimum thickness of the riprap layer shall be 1.5 times the maximum rock diameter for d_{50} of 15 inches or less; and 1.2 times the maximum rock size for d_{50} greater than 15 inches. The following chart lists some examples:

D_{50} (inches)	d_{max} (inches)	Minimum Blanket Thickness (inches)
4	6	9
6	9	14
9	14	20
12	18	27
15	22	32
18	27	32
21	32	38
24	36	43

Rock Quality

Rock for riprap shall consist of field rock or rough unhewn quarry rock. The rock shall be hard and angular and of a quality that will not disintegrate on exposure to water or weathering. The specific gravity of the individual rocks shall be at least 2.5.

Filter

A filter is a layer of material placed between the riprap and the underlying soil surface to prevent soil movement into and through the riprap. Riprap shall have a filter placed under it in all cases.

A filter can be of two general forms: a gravel layer or a plastic filter cloth. The plastic filter cloth can be woven or non-woven monofilament yarns, and shall meet these base requirements: thickness 20-60 mils, grab strength 90-120 lbs; and shall conform to ASTM D-1777 and ASTM D-1682.

Gravel filter blanket, when used, shall be designed by comparing particle sizes of the overlying material and the base material. Design criteria are available in Standard and Specification for Anchored Slope and Channel Stabilization on page 4.7.

Gabions

Gabions shall be made of hexagonal triple twist mesh with heavily galvanized steel wire. The maximum linear dimension of the mesh opening shall not exceed 4 ½ inches and the area of the mesh opening shall not exceed 10 square inches.

Gabions shall be fabricated in such a manner that the sides, ends, and lid can be assembled at the construction site into a rectangular basket of the specified sizes. Gabions shall be of single unit construction and shall be installed according to manufacturer's recommendations.

The area on which the gabion is to be installed shall be graded as shown on the drawings. Foundation conditions shall be the same as for placing rock riprap, and filter cloth shall be placed under all gabions. Where necessary, key, or tie, the structure into the bank to prevent undermining of the main gabion structure.

Maintenance

Once a riprap outlet has been installed, the maintenance needs are very low. It should be inspected after high flows for evidence of scour beneath the riprap or for dislodged rocks. Repairs should be made immediately.

Design Procedure

1. Investigate the downstream channel to assure that nonerosive velocities can be maintained.

2. Determine the tailwater condition at the outlet to establish which curve to use.

3. Use the appropriate chart with the design discharge to determine the riprap size and apron length required. It is noted that references to pipe diameters in the charts are based on full flow. For other than full pipe flow, the parameters of depth of flow and velocity must be used to adjust the design discharges.

4. Calculate apron width at the downstream end if a flare section is to be employed.

Design Examples are demonstrated in Appendix B.

Construction Specifications

1. The subgrade for the filter, riprap, or gabion shall be prepared to the required lines and grades. Any fill required in the subgrade shall be compacted to a density of approximately that of the surrounding undisturbed material.

2. The rock or gravel shall conform to the specified grad-

ing limits when installed respectively in the riprap or filter.

3. Filter cloth shall be protected from punching, cutting, or tearing. Any damage other than an occasional small hole shall be repaired by placing another piece of cloth over the damaged part or by completely replacing the cloth. All overlaps, whether for repairs or for joining two pieces of cloth shall be a minimum of one foot.

4. Rock for the riprap or gabion outlets may be placed by equipment. Both shall each be constructed to the full course thickness in one operation and in such a manner as to avoid displacement of underlying materials. The rock for riprap or gabion outlets shall be delivered and placed in a manner that will ensure that it is reasonably homogenous with the smaller rocks and spalls filling the voids between the larger rocks. Riprap shall be placed in a manner to prevent damage to the filter blanket or filter cloth. Hand placement will be required to the extent necessary to prevent damage to the permanent works.

Figure 3.16
Outlet Protection Design—Minimum Tailwater Condition Chart (Design of Outlet Protection from a Round Pipe Flowing Full, Minimum Tailwater Condition: $T_w < 0.5D_o$) (USDA - NRCS)

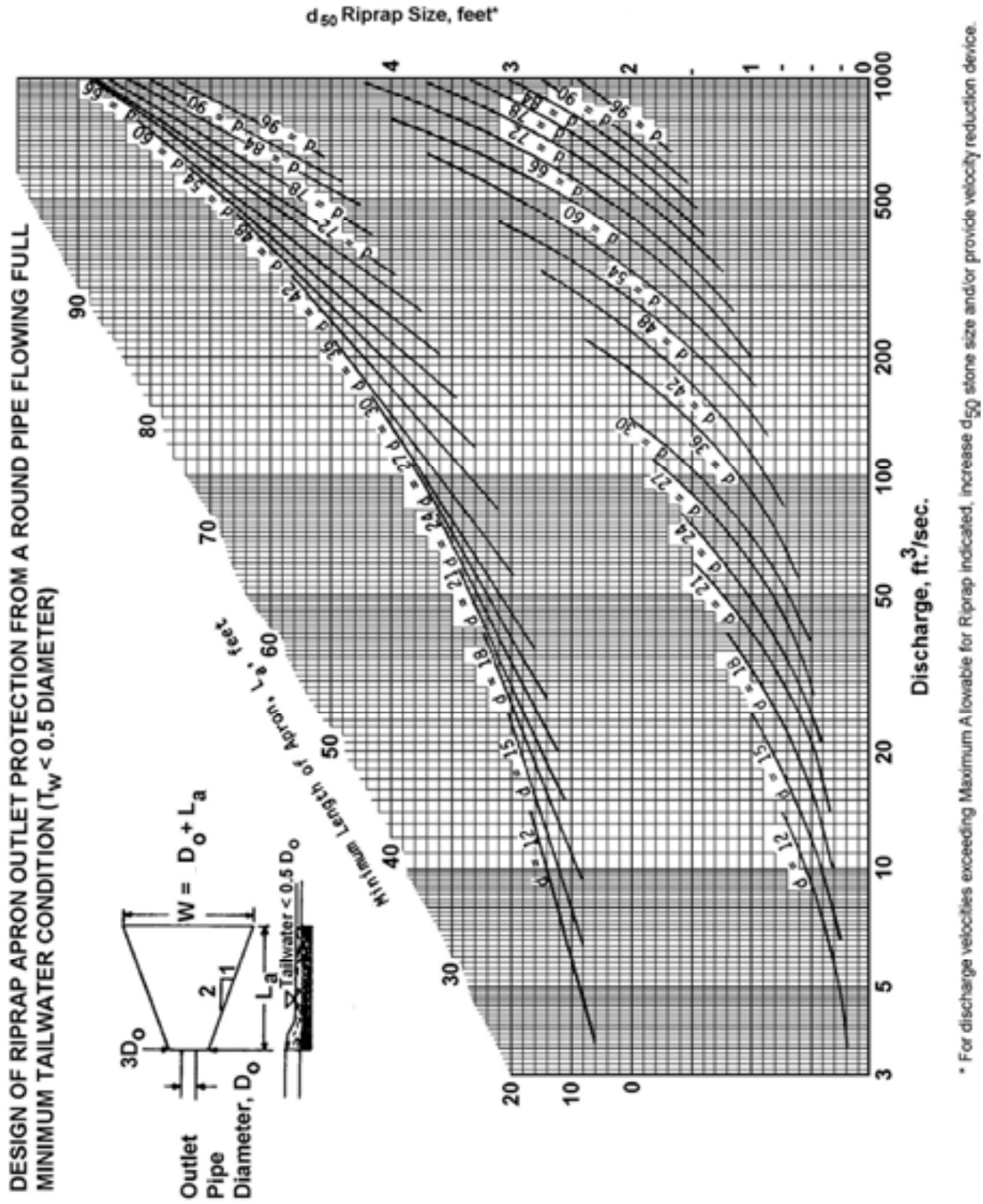
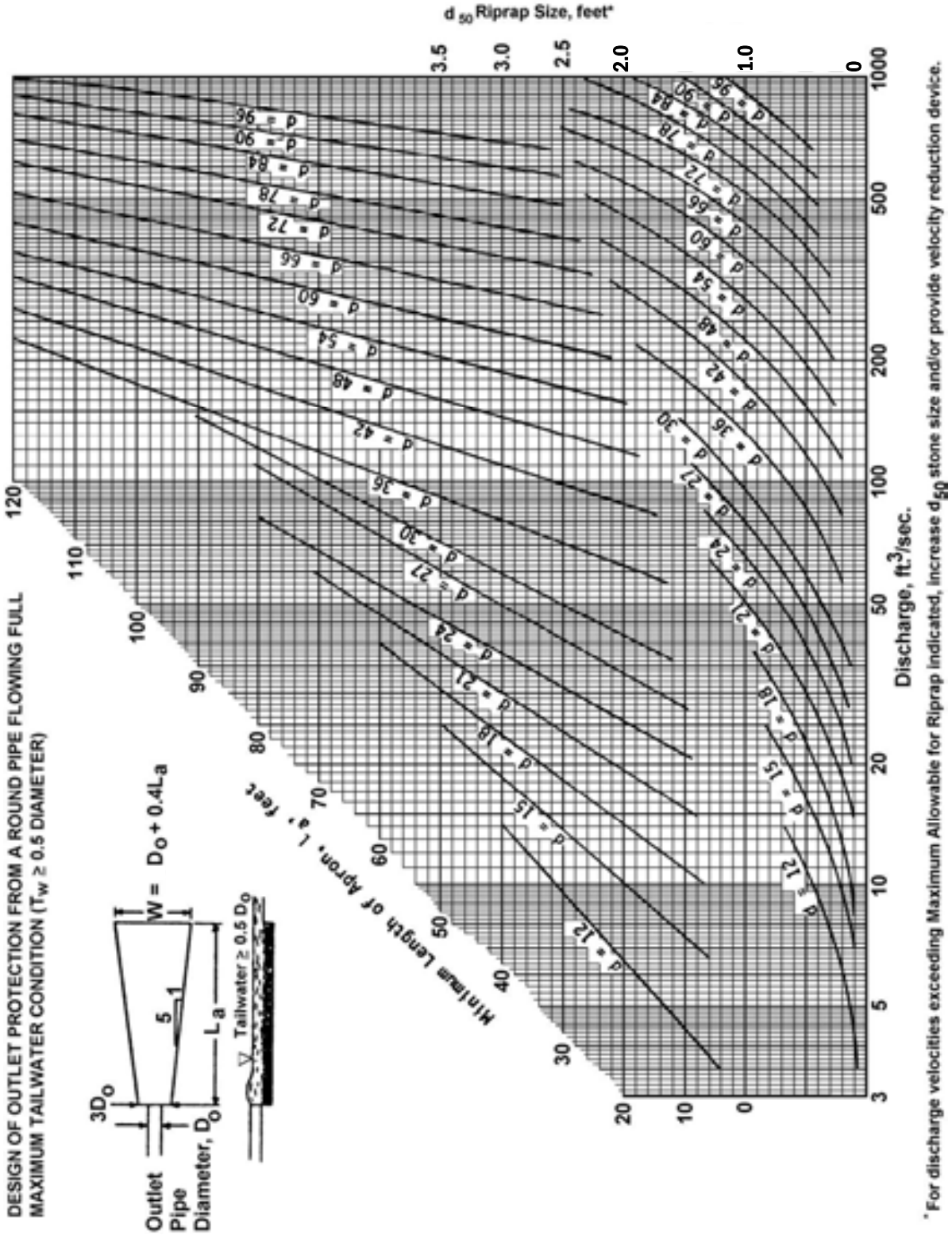


Figure 3.17
Outlet Protection Design—Maximum Tailwater Condition Chart (Design of Outlet Protection from a Round Pipe Flowing Full, Maximum Tailwater Condition: $T_w \geq 0.5D_o$) (USDA - NRCS)



Design Flow Depth (ft.)	Maximum Velocity (ft./sec.)
0.0 - 0.5	25
0.5 - 1.0	15
Greater than 1.0	10

2. Waterways or outlets with velocities exceeding critical shall discharge into an energy dissipater to reduce velocity to less than critical, or to a velocity the downstream soil and vegetative conditions will allow.

Cross Section

The cross section shall be triangular, parabolic, or trapezoidal. Monolithic concrete or gabions may be rectangular.

Freeboard

The minimum freeboard for lined waterways or outlets shall be 0.25 feet above design high water in areas where erosion resistant vegetation cannot be grown adjacent to the paved side slopes. No freeboard is required where good vegetation can be grown and is maintained.

Side Slope

Steepest permissible side slopes, horizontal to vertical will be as follows:

1. Non-Reinforced Concrete
   Hand-placed, formed concrete
   Height of lining, 1.5 ft or less ..... Vertical
   Hand placed screened concrete or mortared
   In-place flagstone
   Height of lining, less than 2 ft ..... 1 to 1
   Height of lining, more than 2 ft ..... 2 to 1
2. Slip form concrete:
   Height of lining, less than 3 ft ..... 1 to 1
3. Rock Riprap ..... 2 to 1
4. Gabions ..... Vertical
5. Pre-cast Concrete Sections ..... Vertical

Lining Thickness

Minimum lining thickness shall be as follows:

1. Concrete ..... 4 in. (In most problem areas, shall be 5 in. with welded wire fabric reinforcing)

2. Rock Riprap ..... 1.5 x maximum stone size plus thickness of filter or bedding.

3. Flagstone ..... 4 in. including mortar bed.

Related Structures

Side inlets, drop structures, and energy dissipaters shall meet the hydraulic and structural requirements of the site.

Filters or Bedding

Filters or bedding to prevent piping, reduce uplift pressure, and collect water will be used as required and will be designed in accordance with sound engineering principles. Weep holes and drains should be provided as needed.

Concrete

Concrete used for lining shall be so proportioned that it is plastic enough for thorough consolidation and stiff enough to stay in place on side slopes. A dense product will be required. A mix that can be certified as suitable to produce a minimum strength of at least 3,000 pounds per square inch will be required. Cement used shall be Portland Cement, Type I, II, IV, or V. Aggregate used shall have a maximum diameter of 1 ½ inches.

Weep holes should be provided in concrete footings and retaining walls to allow free drainage of water. Pipe used for weep holes shall be non-corrosive.

Mortar

Mortar used for mortared in-place flagstone shall consist of a mix of cement, sand, and water. Follow directions on the bag of mortar for proper mixing of mortar and water.

Contraction Joints

Contraction joints in concrete linings, where required, shall be formed transversely to a depth of about one third the thickness of the lining at a uniform spacing in the range of 10 to 15 feet.

Rock Riprap or Flagstone

Stone used for riprap or gabions shall be dense and hard enough to withstand exposure to air, water, freezing, and thawing. Flagstone shall be flat for ease of placement and have the strength to resist exposure and breaking. Rock riprap maximum size shall be as follows:

Velocity (f.p.s.)	d_{max} (in.)
5.0	6
8.5	12
10	18
12	24
15	36

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	29-Apr-20	208-190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	Water Quality Volume	
PREPARED BY	**CHECKED BY**	
KLS 2/21/2020	LR 4/29/2020	

Description and Purpose:

Estimate the water quality volume to the sedimentation basins under final conditions.

Design Basis/References/Assumptions:

New York State Stormwater Management Design Manual, January 2015 (attached).
Capture and treatment of the water quality volume (WQv) which is equal to 90% of the annual average stormwater runoff volume.
Drainage areas and impervious areas were estimated in CAD.

Remarks/Conclusions/Results:

The proposed Area 7/8 Development requires a water quality volume of 1.02 ac-ft. The proposed forebay exceeds this required volume and provides 17.8 ac-ft.

Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Sedimentation Basin Calculations
Water Quality Volume Calculations

By: KLS Date: 11/25/2019
Check: LR Date: 4/29/2020

Water Quality Volume (WQv)

$$WQv = \frac{(P)(R_v)(A)}{12}$$

A (Contributing Area):	242.31	ac
P (90% Rainfall Event Number):	1	inch
I (% impervious Cover):	3.35%	
Rv (0.05+0.009(I)):	0.05	
WQv:	1.02	af
	44,244	cf
Forebay Volume:	586,028	cf

Section 4.1 Introduction

This chapter presents a unified approach for sizing green infrastructure for runoff reduction and SMPs to meet pollutant removal goals, reduce channel erosion, prevent overbank flooding, and help control extreme floods. For a summary, please consult Table 4.1 below. The remaining sections describe the sizing criteria in detail and present guidance on how to properly compute and apply the required reduction and storage volumes.

Section 4.2 Water Quality Volume (WQv)

The Water Quality Volume (denoted as the WQ_v) is intended to improve water quality by capturing and treating runoff from small, frequent storm events that tend to contain higher pollutant levels. New York has defined the WQv as the volume of runoff generated from the entire 90th percentile rain event. Essentially what this means is that a practice sized using the WQv will capture and treat 90% of all 24 hour rain events. The WQ_v is directly related to the amount of impervious cover constructed at a site. Contour lines of the 90% rainfall event are presented in Figure 4.1.

The following equation can be used to determine the water quality storage volume WQ_v (in acre-feet of storage):

$$WQv = \frac{P * R_v * A}{12}$$

where:

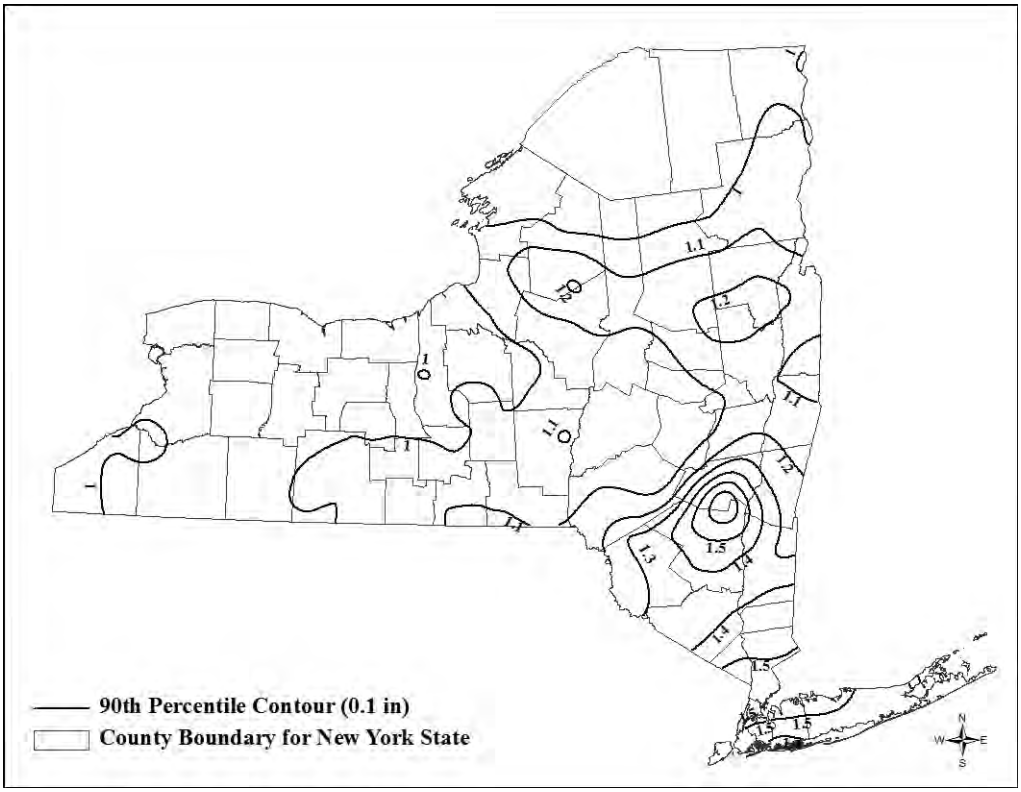
WQ_v = water quality volume (in acre-feet)

P = 90% Rainfall Event Number (see Figure 4.1)

R_v = 0.05 + 0.009(I), where I is percent impervious cover

A = site area in acres (Contributing area)

Figure 4.1: 90th Percentile Rainfall in New York State (NYSDEC, 2013)



Basis of Design for Water Quality

As a basis for design, the following assumptions may be made:

Measuring Impervious Cover: the measured area of a site plan that does not have permanent vegetative or permeable cover shall be considered total impervious cover. Impervious cover is defined as all impermeable surfaces and includes: paved and gravel road surfaces, paved and gravel parking lots, paved driveways, building structures, paved sidewalks, and miscellaneous impermeable structures such as patios, pools, and sheds. Where site size makes direct measurement of impervious cover impractical, the land use/impervious cover relationships presented in Table 4.2 can be used to initially estimate impervious cover. In site specific planning impervious cover must be calculated based the specific proposed impervious cover.

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	29-Apr-20	208-190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	Sedimentation Basin Outlets Calculations	
PREPARED BY	**CHECKED BY**	
KLS 3/18/2020	LR 4/29/2020	

Description and Purpose:

Design and size Sedimentation Basin #5 outlet to pass the discharges for the 1-Year, 10-Year and 100-Year storms. Evaluate the design and size of the existing Sedimentation Basin #1, #2 and #3 outlet to pass the discharges for the 1-Year, 10-Year and 100-Year storms. Pass the 10-Year storm with outflow through only the discharge riser. Pass the 100-Year storm with 1 foot of freeboard to the basin banks.

Design Basis/References/Assumptions:

Appendix E.1 Pre-Development Runoff and Design Criteria of the Engineering Report for the 6 NYCRR Part 360 Solid Waste Management Permit Modification Application prepared by McMahon & Mann Consulting Engineers, P.C., February 2005.
New York State Stormwater Management Design manual, January 2015.
New York State Standards and Specifications for Erosion and Sediment Control, November 2016.
HydroCAD Stormwater Modeling, Version 10.00-24.

Remarks/Conclusions/Results:

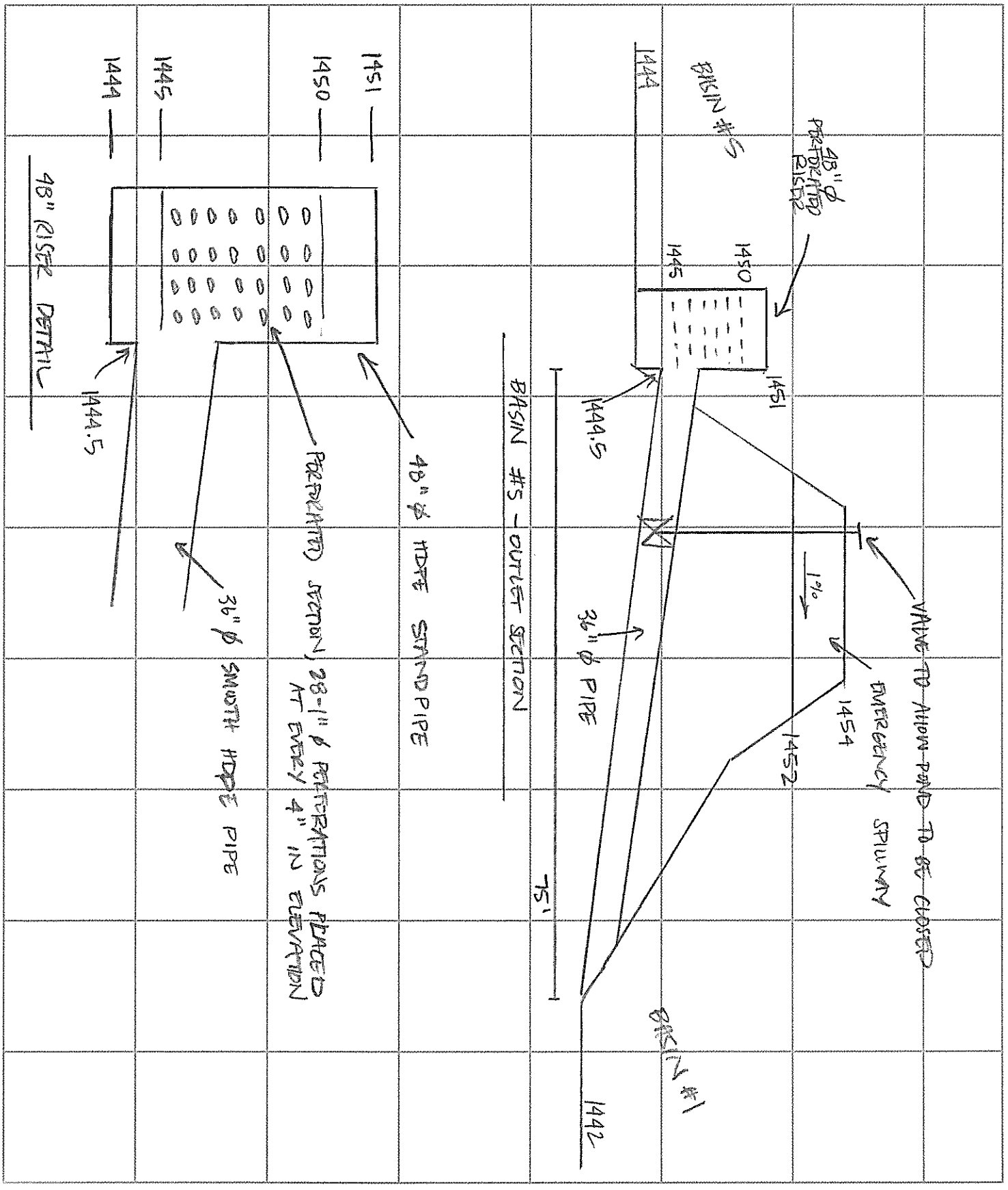
Sedimentation Basin #5 outlet and emergency spillway is designed to pass the 1-Year, 10-Year and 100-Year storm events, passing the 10-Year storm with outflow through only the discharge riser and the 100-Year storm with 1 foot of freeboard to the basin banks. Existing Sedimentation Basin #1, #2 and #3 outlet is adequate to pass the 1-Year, 10-Year and 100-Year storm events, passing the 10-Year storm with outflow through only the discharge riser and the 100-Year storm with 1 foot of freeboard to the basin banks. See attached.

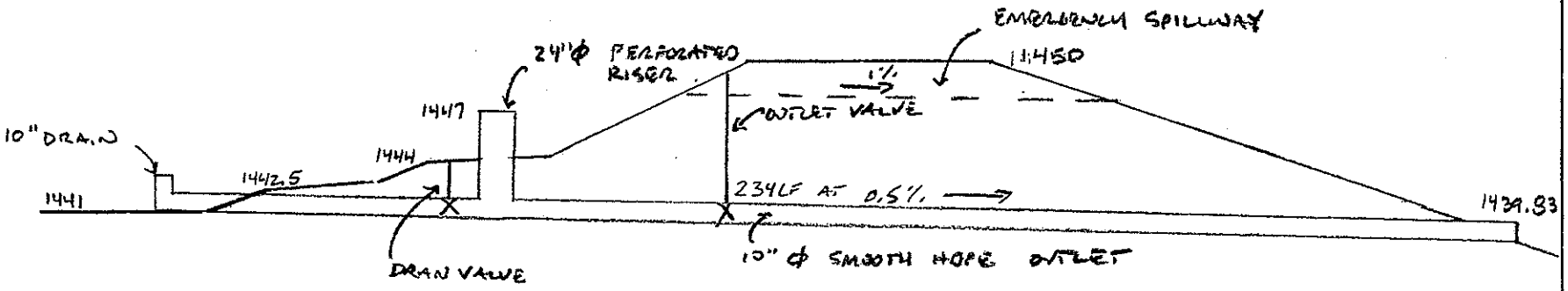
Client Name: CHAFFEE Project Name: SOUTHERN EXPANSION

Subject: BASIN 5 OUTLET Project #: 190260

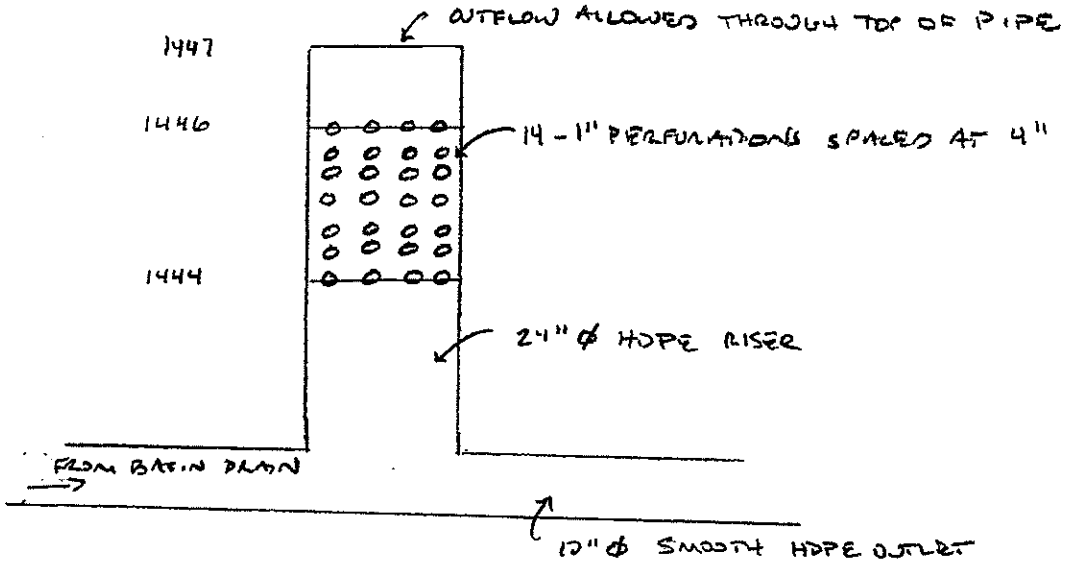
cornerstone
A TETRA TECH COMPANY

Designed By: KLS Date: 11/25/19 Checked By: _____ Date: _____ Sheet No. _____ of _____





BASIN #3 OUTLET SECTION



24" RISER DETAIL

Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Sedimentation Basin Calculations
Basin # 5 Storage

Elevation (ft)	Area (sf)	Incremental Volume (cf)	Cumulative Volume (cf)	Cumulative Volume (gal)	Notes
1444	53,356	0	0	0	Bottom of Basin
1446	65,054	118,410	118,410	885,769	
1448	73,763	138,817	257,227	1,924,195	
1450	82,901	156,665	413,892	3,096,128	Overflow Pipe Elevation @ 1451
1452	89,234	172,136	586,028	4,383,791	Emergency Spillway Elevation
1454	101,595	190,830	776,857	5,811,295	Top of Basin Berm

Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Sedimentation Basin Calculations
Basin #5 Outlet

Basin Bottom Elevation (ft):	1444
Basin Berm Top Elevation (ft):	1454
Perforations Start Elevation (ft):	1446
Perforations End Elevation (ft):	1450
Top of Riser Pipe Elevation (ft):	1451

Discharge through 1 inch perforations

Discharge through an orrifice:

$$Q = C_d A(2gh)^{0.5}$$

C_d:	0.6	discharge coefficient
g (ft/sec^2):	32.174	gravity
$d_{\text{1 inch hole}}$ (ft):	0.167	
$A_{\text{1 inch hole}}$ (ft^2):	0.022	
$A_{\text{B-1 inch holes}}$ (ft^2):	0.305	14 holes per 4 inches of pipe length

Discharge Elevation	1446	1446.3333	1446.66667	1447	1447.333	1447.667	1448	1448.3333	1448.6667	1449	1449.333	1449.667	1450	Total Discharge
1446	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1446.2	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66
1446.4	0.93	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.31
1446.6	1.14	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90
1446.8	1.31	1.00	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86
1447	1.47	1.20	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.52
1447.2	1.61	1.37	1.07	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.71
1447.4	1.74	1.52	1.26	0.93	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.83
1447.6	1.86	1.65	1.42	1.14	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.83
1447.8	1.97	1.78	1.56	1.31	1.00	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.17
1448	2.08	1.90	1.70	1.47	1.20	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.19
1448.2	2.18	2.01	1.82	1.61	1.37	1.07	0.66	0.00	0.00	0.00	0.00	0.00	0.00	10.72
1448.4	2.28	2.11	1.94	1.74	1.52	1.26	0.93	0.38	0.00	0.00	0.00	0.00	0.00	12.15
1448.6	2.37	2.21	2.04	1.86	1.65	1.42	1.14	0.76	0.00	0.00	0.00	0.00	0.00	13.46
1448.8	2.46	2.31	2.15	1.97	1.78	1.56	1.31	1.00	0.54	0.00	0.00	0.00	0.00	15.09
1449	2.55	2.40	2.25	2.08	1.90	1.70	1.47	1.20	0.85	0.00	0.00	0.00	0.00	16.39
1449.2	2.63	2.49	2.34	2.18	2.01	1.82	1.61	1.37	1.07	0.66	0.00	0.00	0.00	18.18

1449.4	2.71	2.57	2.43	2.28	2.11	1.94	1.74	1.52	1.26	0.93	0.38	0.00	0.00	19.87
1449.6	2.79	2.66	2.52	2.37	2.21	2.04	1.86	1.65	1.42	1.14	0.76	0.00	0.00	21.42
1449.8	2.87	2.74	2.60	2.46	2.31	2.15	1.97	1.78	1.56	1.31	1.00	0.54	0.00	23.29
1450	2.94	2.81	2.68	2.55	2.40	2.25	2.08	1.90	1.70	1.47	1.20	0.85	0.00	24.82
1450.2	3.01	2.89	2.76	2.63	2.49	2.34	2.18	2.01	1.82	1.61	1.37	1.07	0.66	26.84
1450.4	3.08	2.96	2.84	2.71	2.57	2.43	2.28	2.11	1.94	1.74	1.52	1.26	0.93	28.38
1450.6	3.15	3.04	2.92	2.79	2.66	2.52	2.37	2.21	2.04	1.86	1.65	1.42	1.14	29.77
1450.8	3.22	3.11	2.99	2.87	2.74	2.60	2.46	2.31	2.15	1.97	1.78	1.56	1.31	31.07
1451	3.29	3.18	3.06	2.94	2.81	2.68	2.55	2.40	2.25	2.08	1.90	1.70	1.47	32.30
1451.2	3.35	3.24	3.13	3.01	2.89	2.76	2.63	2.49	2.34	2.18	2.01	1.82	1.61	33.47
1451.4	3.42	3.31	3.20	3.08	2.96	2.84	2.71	2.57	2.43	2.28	2.11	1.94	1.74	34.59
1451.6	3.48	3.37	3.27	3.15	3.04	2.92	2.79	2.66	2.52	2.37	2.21	2.04	1.86	35.67
1451.8	3.54	3.44	3.33	3.22	3.11	2.99	2.87	2.74	2.60	2.46	2.31	2.15	1.97	36.72
1452	3.60	3.50	3.39	3.29	3.18	3.06	2.94	2.81	2.68	2.55	2.40	2.25	2.08	37.73
1452.2	3.66	3.56	3.46	3.35	3.24	3.13	3.01	2.89	2.76	2.63	2.49	2.34	2.18	38.71
1452.4	3.72	3.62	3.52	3.42	3.31	3.20	3.08	2.96	2.84	2.71	2.57	2.43	2.28	39.66
1452.6	3.78	3.68	3.58	3.48	3.37	3.27	3.15	3.04	2.92	2.79	2.66	2.52	2.37	40.59
1452.8	3.83	3.74	3.64	3.54	3.44	3.33	3.22	3.11	2.99	2.87	2.74	2.60	2.46	41.50
1453	3.89	3.80	3.70	3.60	3.50	3.39	3.29	3.18	3.06	2.94	2.81	2.68	2.55	42.39
1453.2	3.94	3.85	3.76	3.66	3.56	3.46	3.35	3.24	3.13	3.01	2.89	2.76	2.63	43.26
1453.4	4.00	3.91	3.81	3.72	3.62	3.52	3.42	3.31	3.20	3.08	2.96	2.84	2.71	44.10
1453.6	4.05	3.96	3.87	3.78	3.68	3.58	3.48	3.37	3.27	3.15	3.04	2.92	2.79	44.94
1453.8	4.11	4.02	3.93	3.83	3.74	3.64	3.54	3.44	3.33	3.22	3.11	2.99	2.87	45.75
1454	4.16	4.07	3.98	3.89	3.80	3.70	3.60	3.50	3.39	3.29	3.18	3.06	2.94	46.55

Discharge through the 36" Pipe

g (ft/sec^2):	32.174	ν (ft^2/s):	1.41E-05
d $_{pipe}$ (ft):	3	ε:	0.000005
A $_{pipe}$ (ft^2):	7.068583471	ε/d:	0.000006
Pipe Outlet El (ft):	1444		
L $_{pipe}$ (ft):	75		
Ke $_{entrance}$:	1		
Ke $_{gate\ valve}$:	0.2		
f:	0.0157		

Discharge Elevation	ΔH (ft)	Q (cfs)	V (fps)	Re
1446	2	49.80	7.05	1,499,082
1446.2	2.2	52.23	7.39	1,572,250
1446.4	2.4	54.56	7.72	1,642,162
1446.6	2.6	56.78	8.03	1,709,216
1446.8	2.8	58.93	8.34	1,773,737
1447	3	61.00	8.63	1,835,993
1447.2	3.2	63.00	8.91	1,896,205
1447.4	3.4	64.94	9.19	1,954,563
1447.6	3.6	66.82	9.45	2,011,229
1447.8	3.8	68.65	9.71	2,066,341
1448	4	70.43	9.96	2,120,022
1448.2	4.2	72.17	10.21	2,172,376
1448.4	4.4	73.87	10.45	2,223,497
1448.6	4.6	75.53	10.69	2,273,470
1448.8	4.8	77.15	10.92	2,322,367
1449	5	78.75	11.14	2,370,256
1449.2	5.2	80.30	11.36	2,417,197
1449.4	5.4	81.83	11.58	2,463,242
1449.6	5.6	83.34	11.79	2,508,443
1449.8	5.8	84.81	12.00	2,552,844
1450	6	86.26	12.20	2,596,486
1450.2	6.2	87.69	12.41	2,639,406
1450.4	6.4	89.09	12.60	2,681,639
1450.6	6.6	90.47	12.80	2,723,217
1450.8	6.8	91.83	12.99	2,764,170
1451	7	93.17	13.18	2,804,525
1451.2	7.2	94.49	13.37	2,844,307
1451.4	7.4	95.80	13.55	2,883,541
1451.6	7.6	97.08	13.73	2,922,248
1451.8	7.8	98.35	13.91	2,960,449
1452	8	99.61	14.09	2,998,163
1452.2	8.2	100.84	14.27	3,035,409
1452.4	8.4	102.07	14.44	3,072,203
1452.6	8.6	103.27	14.61	3,108,562
1452.8	8.8	104.47	14.78	3,144,500
1453	9	105.65	14.95	3,180,032
1453.2	9.2	106.82	15.11	3,215,172
1453.4	9.4	107.97	15.27	3,249,932
1453.6	9.6	109.11	15.44	3,284,323
1453.8	9.8	110.24	15.60	3,318,359
1454	10	111.36	15.75	3,352,048

Notes

$$\Delta H + \frac{P_o}{\rho g} + \frac{v_o^2}{2g} + \Delta h_p = h_1 + \frac{P_1}{\rho g} + \frac{v_1^2}{2g} + \Delta h_f + \Delta h_m$$

$$\Delta h_f + \Delta h_m = \left(f\frac{L}{d} + \sum Ke\right)\left(\frac{v_1^2}{2g}\right)$$

Basin Conditions:
No pump: $\Delta h_p = 0$
Atmospheric Pressure: Pressures cancel out
$v_o = 0$: $\frac{v_o^2}{2g} = 0$

Simplified equation solving for v_1:

$$v_1 = \mathrm{V} = \sqrt{\frac{\Delta H}{\left(\frac{\left(1 + f\frac{L}{d} + \sum Ke\right)}{2g}\right)}}$$

$$Re = \frac{Vd}{\nu}$$

$$Q = A * V$$

Discharge through the Overflow Pipe

Circular Orrifice Flow

$$Q = C_o A_o (2gH_o)^{0.5}$$

C_o (ft^3/s):	0.6	discharge coefficient
A_o (ft^2):	12.57	area of orifice
H_o (ft):	See Below	effective head on orifice measured from centro
g (ft/sec^2):	32.174	gravity

$$K_{or} = \frac{C_o A_o (2g)^{0.5}}{D^2}$$

K_{or}: 3.78

$$Q = K_{or} D^2 H_o^{0.5}$$

D (ft): 4

Sharp Crested Weir Control

$$Q = C_{scw} L H^{1.5}$$

C_{scw}:	3.27+0.4(H/H_c)	
Wier Crest El (ft):	1451	
D (ft):	4	
L (ft):	12.56637061	
Channel Bot El (ft):	1444.5	
H_c (ft):	6.5	height of weir crest above channel bottom

Discharge Elevation	Orifice Flow		Weir Flow		
	H_o (ft)	Q (cfs)	H (ft)	C_{scw}	Q (cfs)
1451	0.0	0.0	0.0	3.27	0.0
1451.2	0.2	27.0	0.2	3.28	3.7
1451.4	0.4	38.3	0.4	3.29	10.5
1451.6	0.6	46.8	0.6	3.31	19.3
1451.8	0.8	54.1	0.8	3.32	29.8
1452	1.0	60.5	1.0	3.33	41.9
1452.2	1.2	66.3	1.2	3.34	55.2
1452.4	1.4	71.6	1.4	3.36	69.9
1452.6	1.6	76.5	1.6	3.37	85.7
1452.8	1.8	81.1	1.8	3.38	102.6
1453	2.0	85.5	2.0	3.39	120.6
1453.2	2.2	89.7	2.2	3.41	139.6
1453.4	2.4	93.7	2.4	3.42	159.7
1453.6	2.6	97.5	2.6	3.43	180.7
1453.8	2.8	101.2	2.8	3.44	202.7
1454	3.0	104.8	3.0	3.45	225.6

Emergency Spillway

Broad-Crested Emergency Spillway

$$Q = C_{sp} b H^{1.5}$$

C_{sp}: See Below broad-crested discharge coefficient (Figure 8-18)

b (ft): 15 broad-crested spillway bottom width

$H_{initial}$ (ft): 1452

Discharge Elevation	H (ft)	C_{sp}	Q (cfs)
1452	0	2.4	0.00
1452.2	0.2	2.4	3.22
1452.4	0.4	2.4	9.11
1452.6	0.6	2.4	16.73
1452.8	0.8	2.4	25.76
1453	1	2.55	38.25
1453.2	1.2	2.65	52.25
1453.4	1.4	2.8	69.57
1453.6	1.6	2.95	89.56
1453.8	1.8	3.05	110.48
1454	2	3.1	131.52

Discharge Summary

Discharge Elevation	Perforated Pipe Discharge			Overflow Pipe Discharge				Spillway Discharge	Total Basin Discharge
	1" Perforations	36" Pipe	Controlling Discharge	Orifice Flow	Weir Flow	Full Pipe Flow	Controlling Discharge		
1446	0.00	49.80	0.00				0		0.00
1446.2	0.66	52.23	0.66				0		0.66
1446.4	1.31	54.56	1.31				0		1.31
1446.6	1.90	56.78	1.90				0		1.90
1446.8	2.86	58.93	2.86				0		2.86
1447	3.52	61.00	3.52				0		3.52
1447.2	4.71	63.00	4.71				0		4.71
1447.4	5.83	64.94	5.83				0		5.83
1447.6	6.83	66.82	6.83				0		6.83
1447.8	8.17	68.65	8.17				0		8.17
1448	9.19	70.43	9.19				0		9.19
1448.2	10.72	72.17	10.72				0		10.72
1448.4	12.15	73.87	12.15				0		12.15
1448.6	13.46	75.53	13.46				0		13.46
1448.8	15.09	77.15	15.09				0		15.09
1449	16.39	78.75	16.39				0		16.39
1449.2	18.18	80.30	18.18				0		18.18
1449.4	19.87	81.83	19.87				0		19.87
1449.6	21.42	83.34	21.42				0		21.42
1449.8	23.29	84.81	23.29				0		23.29
1450	24.82	86.26	24.82				0		24.82
1450.2	26.84	87.69	26.84				0		26.84
1450.4	28.38	89.09	28.38				0		28.38
1450.6	29.77	90.47	29.77				0.00		29.77
1450.8	31.07	91.83	31.07				0.00		31.07
1451	32.30	93.17	32.30	0.0	0.0	93.17	0.00		32.30
1451.2	33.47	94.49	33.47	27.0	3.7	94.49	3.69		37.16
1451.4	34.59	95.80	34.59	38.3	10.5	95.80	10.47		45.07
1451.6	35.67	97.08	35.67	46.8	19.3	97.08	19.31		54.99
1451.8	36.72	98.35	36.72	54.1	29.8	98.35	29.85		66.56
1452	37.73	99.61	37.73	60.5	41.9	99.61	41.87	0.00	79.59
1452.2	38.71	100.84	38.71	66.3	55.2	100.84	55.24	3.22	97.17
1452.4	39.66	102.07	39.66	71.6	69.9	102.07	69.86	9.11	111.17
1452.6	40.59	103.27	40.59	76.5	85.7	103.27	76.50	16.73	120.00
1452.8	41.50	104.47	41.50	81.1	102.6	104.47	81.15	25.76	130.23
1453	42.39	105.65	42.39	85.5	120.6	105.65	85.53	38.25	143.90
1453.2	43.26	106.82	43.26	89.7	139.6	106.82	89.71	52.25	159.07
1453.4	44.10	107.97	44.10	93.7	159.7	107.97	93.70	69.57	177.54
1453.6	44.94	109.11	44.94	97.5	180.7	109.11	97.52	89.56	198.67
1453.8	45.75	110.24	45.75	101.2	202.7	110.24	101.21	110.48	220.73
1454	46.55	111.36	46.55	104.8	225.6	111.36	104.76	131.52	242.88

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	29-Apr-20	208-190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	Basin Sizing Calculations	
PREPARED BY	**CHECKED BY**	
KLS 2/21/2020	LR 4/29/2020	

Description and Purpose:

Determine if the basins are sized according to New York State requirements for the forebay, sediment storage zone, dewatering zone and surface area.

Design Basis/References/Assumptions:

New York States Standards and Specifications for Erosion and Sediment Control, November 2016.
As built records for South Ponds, West Ponds, Old East Ponds and New East Ponds.

Remarks/Conclusions/Results:

Basin systems are sized with the required volume and area to meet New York State standards.

Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Sedimentation Basin Calculations
Basin Sizing Calculations

Basin Size Design
Basin #1,2,3

Sediment Storage Zone

Minimum Requirement	1,000	cf per disturbed acres
Disturbed Area	1.76	ac
Required Volume	1,760	cf
Volume Provided	225,693	cf
Bottom of Basin El	1441	ft
Top of Sediment Storage Zone El	1444	ft
Depth (Minimum 1 ft Required)	3	ft

Dewatering Zone

Minimum Requirement	3,600	cf per disturbed acres
Drainage Area	1.760303	ac
Required Volume	6,337	cf
Volume Provided	873,983	cf
Top of Sediment Storage Zone El	1444	ft
Emergency Spillway Crest El	1448	ft
Depth (Minimum 3 ft Required)	4	ft

Length to Width Ratio

Length	565	ft
Width	280	ft
Ratio (2:1 Minimum Required)	2.02	:1

Surface Area

$Q_{p(10)}$	22.4	cfs
DA	1.76	ac
$A=0.01Q_{p(10)}$	0.22	ac
A=0.015DA	0.03	ac
A (Greatest)	0.22	ac
Area Provided	6.81	ac

Note:
1. Calculations based on the NYS Standards and Specifications for Erosion and Sediment Control, November 2016 (see attached).

Waste Management of New York
Chaffee Landfill
Area 7/8 Development
Sedimentation Basin Calculations
Basin # 1, 2, 3 Storage

Elevation (ft)	Area (sf)	Incremental Volume (cf)	Cumulative Volume (cf)	Cumulative Volume (gal)	Notes
1441	40,344	0	0	0	Bottom of Basin
1442	65,526	41,794	41,794	312,641	
1444	160,382	142,587	225,693	1,688,302	
1446	258,186	231,822	426,428	3,189,901	Overflow Pipe Elevation @ 1447
1448	272,450	530,636	762,458	5,703,581	Emergency Spillway Elevation
1450	296,591	569,041	1,099,676	8,226,152	Top of Basin Berm

STANDARD AND SPECIFICATIONS FOR SEDIMENT BASIN

Definition & Scope

A **temporary** basin with a barrier or dam constructed across a drainage way or at other suitable locations to intercept sediment-laden runoff and reduce the amount of sediment leaving the disturbed area in order to protect drainageways, properties, and rights-of-way below the sediment basin.

Conditions Where Practice Applies

A sediment basin is appropriate where physical site conditions or land ownership restrictions preclude the installation of other control measures to adequately control runoff, erosion, and sedimentation. However, it is required that other erosion control measures be used with the sediment basin. The basin may be used below construction operations which expose critical areas to soil erosion. The basin shall be maintained until the disturbed area is protected against erosion by permanent stabilization.

This standard applies to the installation of temporary sediment basins on sites where: (a) failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities; (b) the drainage area does not exceed 50 acres; and (c) the basin is to be removed within 36 months after the beginning of construction of the basin.

Permanent (to function more than 36 months) sediment basins, or structures that temporarily function as a sediment basin but are intended for use as a permanent pool shall be classified as **permanent** structures and shall conform to criteria appropriate for permanent structures. These structures shall be designed and constructed to conform to NRCS Standard And Specification No. 378 for Ponds in the National Handbook of Conservation Practices and the New York State Department of Environmental Conservation, "Guidelines for the Design of Dams."

Design Criteria

Compliance with Laws and Regulations

Design and construction shall comply with state and local laws, ordinances, rules and regulations, including permits.

Location - Maximum Drainage Area = 50 acres

The sediment basin should be located to obtain the maximum storage benefit from the terrain and for ease of cleanout of the trapped sediment. It should be located to minimize interference with construction activities and construction of utilities. Whenever possible, sediment basins should be located so that storm drains may outfall or be diverted into the basin. **Do not locate basins in perennial streams.**

Size and Shape of the Basin

The sediment basin will contain two separate zones. The lowest zone is the sediment storage zone. This zone is sized for a volume equal to 1,000 cubic feet per disturbed acre over the course of the life of the project, contributing to the basin as measured from the bottom of the basin to the bottom of the dewatering zone. It shall have a minimum depth of 1 foot. Layered above this zone is the dewatering zone. This zone is sized for a minimum volume equal to 3,600 cubic feet per each acre draining to the basin. This volume is temporarily stored between the sediment storage zone and the crest of the principal spillway. This zone should be a minimum of 3 feet deep. See Figures 5.8 and 5.9 on pages 5.26 and 5.27. This 3,600 cubic feet per acre is equivalent to one inch of sediment per acre of drainage area. The entire drainage area is used for this computation, rather than the disturbed area above, to maximize trapping efficiency. The length to width ratio shall be 2:1 or greater, where length is the distance between the inlet and outlet. A wedge shape shall be used with the inlet located at the narrow end. See Figure 5.22 on page 5.41.

Surface Area

Research studies (Barfield and Clar 1985; Pitt, 2003) indicate that the following relationship between surface area and peak inflow rate gives a trapping efficiency of 75% for silt loam soils, and greater than 90% for loamy sand soils:

$A = 0.01\ Qp$ or, $A = 0.015x$ D.A. (whichever is greater)

where,

A = the basin surface area, acres, measured at the service spillway crest; and

Qp = the peak inflow rate for the design storm. (The minimum design storm will be a 10 year, 24 hour storm under construction conditions).

D.A. = contributing drainage area.

Sediment basins shall be cleaned out when the sediment storage zone volume described above is reduced by 50 percent, except in no case shall the sediment level be permitted to build up higher than one foot below the bottom of the dewatering zone. At this elevation, cleanout shall be performed to restore the original design volume to the sediment storage zone.

The elevation corresponding to the maximum allowable sediment level shall be determined and shall be stated in the design data as a distance below the top of the riser and shall be clearly marked on the riser.

The basin dimensions necessary to obtain the required basin volume as stated above shall be clearly shown on the plans to facilitate plan review, construction, and inspection.

Spillway Design

Runoff shall be computed by standard accepted hydrologic methods noted previously in this book of standards. **Runoff computations shall be based upon the worst soil cover conditions expected to prevail in the contributing drainage area during the anticipated effective life of the structure.** The combined capacities of the principal and emergency spillway shall be sufficient to pass the peak rate of runoff from a ten (10) year frequency, 24 hour duration storm.

1. Principal spillway: A spillway consisting of a vertical pipe or box type riser joined (watertight connection) to a pipe (barrel) which shall extend through the embankment and outlet beyond the downstream toe of the fill. The minimum capacity of the principal spillway shall be 0.2 cfs per acre of drainage area when the water surface is at the emergency spillway crest elevation. For those basins with no emergency spillway, the principal spillway shall have the capacity to handle the peak flow from a ten-year frequency rainfall event. The minimum size of the barrel shall be 8 inches in diameter. See Figures 5.10, 5.11 and 5.12 on pages 5.28, 5.29, and 5.30 for principal spillway sizes and capacities.

   A. Crest elevation: When used in combination with an emergency spillway, the crest elevation of the riser shall be a minimum one foot below the elevation of the control section of the emergency spillway.

   B. Watertight riser and barrel assembly: The riser and all pipe connections shall be completely watertight except for the inlet opening at the top, or a dewatering opening. There shall not be other holes, leaks, rips, or perforations in the structure.

   C. Dewatering the basin:

      1) Preferred Method- The preferred method for dewatering sediment basins is by using surface skimmers to decant the cleaner top surface water from the basin as the sediment settles out. See Dewatering Device Standard, page 5.10.

      2) Alternative Method– A fixed vertical riser pipe configured with perforations and filter fabric with a cone of pea gravel or small crushed stone is an alternative option for use. See Figure 5.5 on page 5.14.

      The sediment basin dewatering system shall be designed to release the dewatering zone volume between 2 to 7 days in watersheds not impaired by sediment, and 4-7 days in sediment impaired watersheds (check the NYSDEC Waterbody Inventory/Priority Waterbody List - **http://www.dec.ny.gov/chemical/36730.html**, to see if your site is in an impaired watershed). The design performance range will depend on the percent of silt and clay in the soils tributary to the basin. If the performance of the basin does not meet water quality objectives after 7 days, chemical treatment may be necessary.

   D. Anti-vortex device and trash rack:

      An anti-vortex device and trash rack shall be securely installed on top of the riser and shall be the concentric type as shown in Figure 5.13 and 5.14 on pages 5.31 and 5.32.

   E. Base:

      The riser shall have a base attached with a watertight connection and shall have sufficient weight to prevent flotation of the riser. Two approved bases for risers ten feet or less in height are: 1) a concrete base 18 in. thick with the riser embedded 9 in. in the base, and 2) a ¼" minimum thickness steel plate attached to the riser by a continuous weld around the circumference of the riser to form a watertight connection. The plate shall have 2.5 feet of stone, gravel, or compacted earth placed on it to prevent flotation. In either case, each side of the square base shall be twice the riser diameter.

      For risers greater than ten feet high, computations

shall be made to design a base which will prevent flotation. The minimum factor of safety shall be 1.20 (Downward forces = 1.20 x upward forces). See Figure 5.15 on page 5.33 for details.

F. Anti-Seep Collars: Anti-seep collars shall be installed around all conduits through earth fills of impoundment structures according to the following criteria:

1) Collars shall be placed to increase the seepage length along the conduit by a minimum of 15 percent of the pipe length located within the saturation zone.

2) Collar spacing shall be between 5 and 14 times the vertical projection of each collar.

3) All collars shall be placed within the saturation zone.

4) The assumed normal saturation zone (phreatic line) shall be determined by projecting a line at a slope of 4 horizontal to 1 vertical from the point where the normal water (riser crest) elevation touches the upstream slope of the fill to a point where this line intersects the invert of the pipe conduit. All fill located within this line may be assumed as saturated.

$$2(N)(P) = 1.15(L_s) \qquad N = (0.075)(L_s)/P$$

When anti-seep collars are used, the equation for revised seepage length becomes:

Where: Ls = Saturated length is length, in feet, of pipe between riser and intersection of phreatic line and pipe invert.

N = number of anti-seep collars.

P = vertical projection of collar from pipe, in feet.

5) All anti-seep collars and their connections shall be watertight. See Figures 5.16 and 5.17 on pages 5.34 and 5.35 for anti-seep collar design and Figure 5.18 on page 5.36 for construction details. Seepage diaphragms may be used in lieu of anti-seep collars. They shall be designed in accordance to USDA NRCS Pond Standard 378.

G. Outlet: An outlet shall be provided, including a means of conveying the discharge in an erosion free manner to an existing stable channel. Where discharge occurs at the property line, drainage easements will be obtained in accordance with local ordinances. Adequate notes and references will be shown on the erosion and sediment control plan.

Protection against scour at the discharge end of the pipe spillway shall be provided. Measures may include basin, riprap, revetment, excavated plunge pools, or other approved methods. See Standard and Specification for Rock Outlet Protection, Section 3, page 3.39.

2. Emergency Spillways: The entire flow area of the emergency spillway shall be constructed in undisturbed ground (not fill). The emergency spillway cross-section shall be trapezoidal with a minimum bottom width of eight feet. This spillway channel shall have a straight control section of at least 20 feet in length; and a straight outlet section for a minimum distance equal to 25 feet.

A. Capacity: The minimum capacity of the emergency spillway shall be that required to pass the peak rate of runoff from the 10 year 24-hour frequency storm, less any reduction due to flow in the pipe spillway. Emergency spillway dimensions may be determined by using the method described in Figure 5.19 on page 5.37 and the Design Tables in Figures 5.20 and 5.21 on pages 5.38 and 5.39.

B. Velocities: The velocity of flow in the exit channel shall not exceed 5 feet per second for vegetated channels. For channels with erosion protection other than vegetation, velocities shall be within the non-erosive range for the type of protection used.

C. Erosion Protection: Erosion protection shall be provided for by vegetation as prescribed in this publication or by other suitable means such as riprap, asphalt or concrete.

D. Freeboard: Freeboard is the difference between the design high water elevation in the emergency spillway and the top of the settled embankment. If there is no emergency spillway, it is the difference between the water surface elevation required to pass the design flow through the pipe and the top of the settled embankment. Freeboard shall be at least one foot.

Embankment Cross-Section

1. The maximum height of dam = 15 feet (measured from the low point of original ground at the downstream toe to the top of the dam).

2. Minimum top width of dam = 10 feet.

3. Side slopes shall be 2.5 to 1 or flatter.

Entrance of Runoff into Basin

Points of entrance of surface runoff into excavated sediment basins shall be protected to prevent erosion. Considerable care should be given to the major points of inflow into basins. In many cases the difference in elevation of the inflow and the bottom of the basin is considerable, thus creating a potential for severe gullying and sediment generation. Often a riprap drop at major points of inflow would eliminate gullying and sediment generation.

Diversions, grade stabilization structures or other water control devices shall be installed as necessary to ensure direction of runoff and protect points of entry into the basin. Points of entry should be located so as to ensure maximum travel distance of entering runoff to point of exit (the riser) from the basin.

Disposal

The sediment basin plans shall indicate the method (s) of disposing of the sediment removed from the basin. The sediment shall be placed in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the basin, adjacent to a stream or floodplain. Disposal sites will be covered by an approved sediment control plan.

The sediment basins plans shall also show the method of disposing of the sediment basin after the drainage area is stabilized, and shall include the stabilization of the sediment basin site. Water contained within the storage areas shall be removed from the basin by pumping, cutting the top of the riser, or other appropriate method prior to removing or breaching the embankment. **Sediment shall not be allowed to flush into a stream or drainageway.**

Chemical Treatment

Precipitation of sediment is enhanced with the use of specific chemical flocculants that can be applied to the sediment basin in liquid, powder, or solid form. Flocculants include anionic polyelectrolytes such as polyacrylimides, aluminum sulfate (alum), polyaluminum chloride and chitosan. Cationic polyelectrolytes have a greater toxicity to fish and other aquatic organisms than anionic polyelectrolytes because they bind to the gills of fish resulting in respiratory failure (Pitt, 2003).

Chemical treatment shall not be substituted for proper erosion and sediment control. To reduce the need for flocculants, proper controls include planning, phasing, sequencing and practice design in accordance to NY Standards. **Chemical applications shall not be applied without written approval from the NYSDEC.**

Safety

Sediment basins are attractive to children and can be very dangerous. Local ordinances and regulations must be adhered to regarding health and safety. The developer or owner shall check with local building officials on applicable safety requirements. If fencing of sediment basins is required, the location of and type of fence shall be shown on the plans.

Construction Specifications

Site Preparation

Areas under the embankment shall be cleared, grubbed, and stripped of topsoil to remove trees, vegetation, roots, or other objectionable material. In order to facilitate cleanout and restoration, the pool area (measured at the top of the pipe spillway) will be cleared of all brush, trees, and other objectionable materials.

Cutoff-Trench

A cutoff trench shall be excavated along the centerline of earth fill embankments. The minimum depth shall be two feet. The cutoff trench shall extend up both abutments to the riser crest elevation. The minimum bottom width shall be four feet, but wide enough to permit operation of excavation and compaction equipment. The side slopes shall be no steeper than 1:1. Compaction requirements shall be the same as those for embankment. The trench shall be dewatered during the back-filling/compaction operations.

Embankment

The fill material shall be taken from approved areas shown on the plans. It shall be clean mineral soil free of roots, woody vegetation, oversized stones, rocks, or other objectionable material. Relatively pervious materials such as sand or gravel (Unified Soil Classes GW, GP, SW & SP) shall not be placed in the embankment. Areas on which fill is to be placed shall be scarified prior to placement of fill. The fill material shall contain sufficient moisture so that it can be formed by hand into a ball without crumbling. If water can be squeezed out of a ball, it is too wet for proper compaction. Fill material shall be placed in six to eight-inch thick continuous layers over the entire length of the fill. Compaction shall be obtained by routing and hauling the construction equipment over the fill so that the entire surface of each layer of the fill is traversed by at least one

wheel or tread track of the equipment or by the use of a compactor. The embankment shall be constructed to an elevation 10 percent higher than the design height to allow for settlement.

Pipe Spillway

The riser shall be securely attached to the barrel or barrel stub by welding the full circumference making a watertight structural connection. The barrel stub must be attached to the riser at the same percent (angle) of grade as the outlet conduit. The connection between the riser and the riser base shall be watertight. All connections between barrel sections must be achieved by approved watertight bank assemblies. The barrel and riser shall be placed on a firm, smooth foundation of impervious soil. Pervious materials such as sand, gravel, or crushed stone shall not be used as backfill around the pipe or anti-seep collars. The fill material around the pipe spillway shall be placed in four-inch layers and compacted under and around the pipe to at least the same density as the adjacent embankment.

A minimum depth of two feet of hand compacted backfill shall be placed over the pipe spillway before crossing it with construction equipment. Steel base plates on risers shall have at least 2 ½ feet of compacted earth, stone, or gravel placed over it to prevent flotation.

Emergency Spillway

The emergency spillway shall be installed in undisturbed ground. The achievement of planned elevations, grades, design width, entrance and exit channel slopes are critical to the successful operation of the emergency spillway and must be constructed within a tolerance of +/- 0.2 feet.

Vegetative Treatment

Stabilize the embankment and emergency spillway in accordance with the appropriate vegetative standard and specification immediately following construction. In no case shall the embankment remain unstabilized for more than three (3) days.

Erosion and Pollution Control

Construction operations shall be carried out in such a manner that erosion and water pollution will be minimized. State and local laws shall be complied with concerning pollution abatement.

Safety

State and local requirements shall be met concerning fencing and signs, warning the public of hazards of soft sediment and floodwater.

Maintenance

1. Repair all damages caused by soil erosion and construction equipment at or before the end of each working day.

2. Sediment shall be removed from the basin when it reaches the specified depth for cleanout noted on the plans which will not exceed 50% of the capacity of the sediment storage zone. This sediment shall be placed in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the embankment, adjacent to a stream or floodplain.

Final Disposal

When temporary structures have served their intended purpose and the contributing drainage area has been properly stabilized, the embankment and resulting sediment deposits are to be leveled or otherwise disposed of in accordance with the approved sediment control plan. The proposed use of a sediment basin site will often dictate final disposition of the basin and any sediment contained therein. If the site is scheduled for future construction, then the basin material and trapped sediments must be removed, safely disposed of, and backfilled with a structural fill. When the basin area is to remain open space, the pond may be pumped dry, graded, and backfilled.

Information to be Submitted

Sediment basin designs and construction plans submitted for review to a local municipality, New York State DEC, New York City DEP, Soil and Water Conservation District, or other agency shall include the following:

1. Specific location of the basin.

2. Plan view of the storage basin and emergency spillway, showing existing and proposed contours.

3. Cross section of dam, principal spillway, emergency spillway, and profile of emergency spillway.

4. Details of pipe connections, riser to pipe connections, riser base, anti-seep control, trash rack cleanout elevation, and anti-vortex device.

5. Runoff calculations for 1 and 10-year frequency storms, if required.

6. Storage Computations

    A. Zones total required

    B. Zones total Available

    C. Elevation of sediment at which cleanout shall be required; also stated as a distance from the riser

B.13 - Leachate Collection Pipe Flow Calculations

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	16-Jul-20	190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Area 7/8 Development	Leachate Collection Pipe Capacity	
PREPARED BY	**CHECKED BY**	
L. Rohr	R. Holmes	

Description and Purpose:

Calculate the size of pipe required to convey the peak leachate generation rate (determined from historical data).
Confirm the proposed 8" secondary pipe can convey the 1000 gpad regulatiory requirements.

Design Basis/References/Assumptions:

Use Manning's Formula to calculate the flow through the pipe.
The drainage area of 10.4 Acres (largest contributing area) was used to calculate the flow for the pipe.
8" HDPE was used as the regulatory minimum for primary leachate collection piping.
6" HDPE was used as the regulatory minimum for secondary leachate collection piping.
See calculations for references and attachments for supporting documents.

Remarks/Conclusions/Results:

The primary collection system meets the flow capacity for the peak leachate generation rate with a factor of safety of 13.4.
The secondary collection system meets the flow capacity for the regulatory 1000 gpad rate with a factor of safety of 27.8.

Client Name:	Waste Management - Chaffee			Project Name:	Area 7/8 Development						
Subject:	Pipe Flow Capacity - Primary			Project #:	190260						
Designed by:	L.Rohr	Date:	7/16/2020	Checked by:	R. Holmes	Date:	7/16/2020	Sheet No.	1	of	1

Purpose: Calculate the size of the pipe required to convey leachate
shaded cell represent values to be input
shaded cells are calculated values

Description: The required flow capacity is determined separately by HELP model or other
The actual flow capacity is calculated based on Manning's Formula
The factor of safety is determined by actual divided by required

Reference: Manning's Formula

$$Q_{full} = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

Q = Flow capacity in full pipe under gravity
n= Manning's coefficient
A= Cross-sectional area of pipe
R= Hydraulic Radius
S= Slope of pipe

Parameters:

	10.4	acres	Maximum contributing area (Area 7/8 overfill)
	1885	gpad	Historical Maximum Leachate Generation Rate (See Leachate Generation Calcs)
	2		Peaking Factor applied to maximum generation rate (conservative)
Q_{req}	39208	gal/day	Peak Historical Daily Drainage over 10.4 Acres (Area 7/8 overfill)
d_{nom}	8		proposed nominal pipe size
d	6.693	inches	proposed inside diameter of pipe
S	0.01	ft/ft	slope of pipe
n	0.012		Mannings coefficient

Calculations:

Area:	0.244	ft2
Hydraulic Radius:	0.139	ft
Allowable Flow:	0.814	ft3/s
	525782	gal/day
Factor of Safety:	13.41	

References: 1. Lindeburg, Michael, CERM

Client Name:	Waste Management - Chaffee			Project Name:	Area 7/8 Development						
Subject:	Pipe Flow Capacity - Secondary			Project #:	190260						
Designed by:	L.Rohr	Date:	7/16/2020	Checked by:	R. Holmes	Date:	7/16/2020	Sheet No.	1	of	1

Purpose: Calculate the size of the pipe required to convey leachate
shaded cell represent values to be input
shaded cells are calculated values

Description: The required flow capacity is determined separately by HELP model or other
The actual flow capacity is calculated based on Manning's Formula
The factor of safety is determined by actual divided by required

Reference: Manning's Formula

$$Q_{full} = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

Q =	Flow capacity in full pipe under gravity
n=	Manning's coefficient
A=	Cross-sectional area of pipe
R=	Hydraulic Radius
S=	Slope of pipe

Parameters:

Q_{req}	10400 gal/day		1000 GPAD over 10.4 Acres (Area 7/8 overfill)
d_{nom}	6		proposed nominal pipe size
d	5.348	inches	proposed inside diameter of pipe
S	0.01	ft/ft	slope of pipe
n	0.012		Mannings coefficient

Calculations:

Area:	0.156	ft2
Hydraulic Radius:	0.111	ft
Allowable Flow:	0.447	ft3/s
	289064	gal/day
Factor of Safety:	27.79	

References: 1. Lindeburg, Michael, CERM

Support Material

Civil Engineering Reference Manual

for the PE Exam

Eleventh Edition

Michael R. Lindeburg, PE

Professional Publications, Inc. • Belmont, CA

Table 17.5 *Approximate Orifice Coefficients for Turbulent Water*

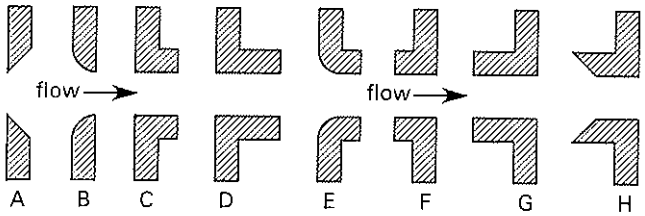


illustration	description	C_d	C_c	C_v
A	sharp-edged	0.62	0.63	0.98
B	round-edged	0.98	1.00	0.98
C	short tube[a] (fluid separates from walls)	0.61	1.00	0.61
D	sharp tube (no separation)	0.82	1.00	0.82
E	sharp tube with rounded entrance	0.97	0.99	0.98
F	reentrant tube, length less than one-half of pipe diameter	0.54	0.55	0.99
G	reentrant tube, length 2 to 3 pipe diameters	0.72	1.00	0.72
H	Borda	0.51	0.52	0.98
(none)	smooth, well-tapered nozzle	0.98	0.99	0.99

[a]A short tube has a length less than 2 to 3 diameters.

and the *coefficient of contraction*, C_c. For water flowing with a high Reynolds number through a small sharp-area is approximately 61 to 63% of the orifice area.

$$A_{\text{vena contracta}} = C_c A_o \qquad 17.73$$

$$C_c = \frac{\text{area of vena contracta}}{\text{orifice area}} \qquad 17.74$$

The theoretical discharge rate from a tank is $\dot{V} = A_o\sqrt{2gh}$. However, this relationship needs to be corrected for friction and contraction by multiplying by C_v and C_c. The *coefficient of discharge*, C_d, is the product of the coefficients of velocity and contraction.

$$\dot{V} = C_c v_o A_o = C_d v_t A_o = C_d A_o \sqrt{2gh} \qquad 17.75$$

$$C_d = C_v C_c = \frac{\text{actual discharge}}{\text{theoretical discharge}} \qquad 17.76$$

22. DISCHARGE FROM PRESSURIZED TANKS

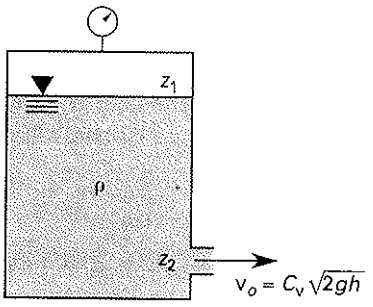
If the gas or vapor above the liquid in a tank is at gage pressure p, and the discharge is to atmospheric pressure, the head causing discharge will be

$$h = z_1 - z_2 + \frac{p}{\rho g} \quad \text{[SI]} \qquad 17.77(a)$$

$$h = z_1 - z_2 + \left(\frac{p}{\rho}\right) \times \left(\frac{g_c}{g}\right) \quad \text{[U.S.]} \qquad 17.77(b)$$

The discharge velocity can be calculated from Eq. 17.69 using the increased discharge head.

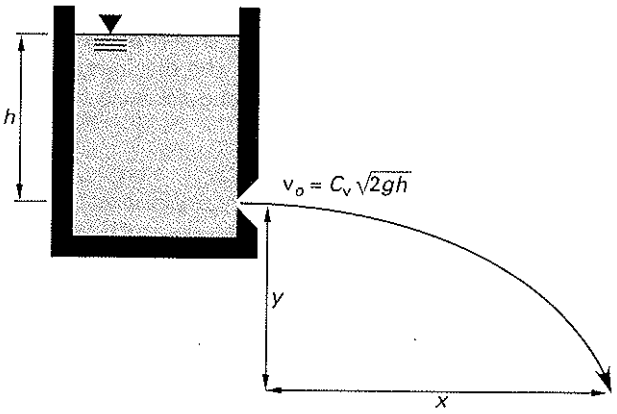
Figure 17.12 *Discharge from a Pressurized Tank*



23. COORDINATES OF A FLUID STREAM

Fluid discharged from an orifice in a tank gets its initial velocity from the conversion of potential energy. After discharge, no additional energy conversion occurs, and all subsequent velocity changes are due to external forces.

Figure 17.13 *Coordinates of a Fluid Stream*



6. GOVERNING EQUATIONS FOR UNIFORM FLOW

Since water is incompressible, the continuity equation is

$$A_1 v_1 = A_2 v_2 \qquad 19.8$$

The most common equation used to calculate the flow velocity in open channels is the 1768 *Chezy equation.*[3]

$$v = C\sqrt{RS} \qquad 19.9$$

Various methods for evaluating the *Chezy coefficient*, C, or "Chezy's C," have been proposed.[4] If the channel is small and very smooth, Chezy's own formula can be used. The friction factor, f, is dependent on the Reynolds number and can be found in the usual manner from the Moody diagram.

$$C = \sqrt{\frac{8g}{f}} \qquad 19.10$$

If the channel is large and the flow is fully turbulent, then the friction loss will not depend so much on the Reynolds number as on the channel roughness. The 1888 Manning formula is frequently used to evaluate the constant C.[5] Notice that the value of C depends only on the channel roughness and geometry. (The conversion constant 1.49 in Eq. 19.11(b) is reported as 1.486 by some authorities. 1.486 is the correct SI-to-English conversion, but it is doubtful whether this equation warrants four significant digits.)

$$C = \left(\frac{1.00}{n}\right) R^{1/6} \qquad \text{[SI]} \qquad 19.11(a)$$

$$C = \left(\frac{1.49}{n}\right) R^{1/6} \qquad \text{[U.S.]} \qquad 19.11(b)$$

n is the *Manning roughness coefficient* (*Manning constant*). Typical values of Manning's n are given in App. 19.A. Judgment is needed in selecting values since tabulated values often differ by as much as 30%. More important to recognize for sewer work is the layer of slime that often coats the sewer walls. Since the slime characteristics can change with location in the sewer, there can be variations in Manning's roughness coefficient along the sewer length.

Independent of these factors, the value of n also depends on the depth of flow, leading to a value (n_{full}) specifically intended for use with full flow. (It is seldom clear from tabulations such as App. 19.A whether the values are for full flow or general use.) The variation in n can be taken into consideration using *Camp's correction*, shown in App. 19.C. However, this degree of sophistication cannot be incorporated into an analysis problem unless a specific value of n is known for a specific depth of flow.

Combining Eqs. 19.9 and 19.11 produces the *Manning equation*, also known as the *Chezy-Manning equation.*

$$v = \left(\frac{1.00}{n}\right) R^{2/3}\sqrt{S} \qquad \text{[SI]} \qquad 19.12(a)$$

$$v = \left(\frac{1.49}{n}\right) R^{2/3}\sqrt{S} \qquad \text{[U.S.]} \qquad 19.12(b)$$

All of the coefficients and constants in the Manning equation may be combined into the *conveyance*, K.

$$Q = vA = \left(\frac{1.00}{n}\right) AR^{2/3}\sqrt{S} = K\sqrt{S} \qquad \text{[SI]} \qquad 19.13(a)$$

$$Q = vA = \left(\frac{1.49}{n}\right) AR^{2/3}\sqrt{S} = K\sqrt{S} \qquad \text{[U.S.]} \qquad 19.13(b)$$

Example 19.1

A rectangular channel on a 0.002 slope is constructed of finished concrete. The channel is 8 ft (2.4 m) wide. Water flows at a depth of 5 ft (1.5 m). What is the flow rate?

SI Solution

The hydraulic radius is

$$R = \frac{A}{P} = \frac{(2.4\text{ m})(1.5\text{ m})}{1.5\text{ m} + 2.4\text{ m} + 1.5\text{ m}} = 0.67\text{ m}$$

From App. 19.A, the roughness coefficient for finished concrete is 0.012. The Manning coefficient is determined by Eq. 19.11(a).

$$C = \left(\frac{1.00}{n}\right) R^{1/6} = \left(\frac{1.00}{0.012}\right)(0.67\text{ m})^{1/6} = 77.9$$

The discharge is

$$Q = vA = C\sqrt{RS}A = \left(77.9\ \frac{\sqrt{\text{m}}}{\text{s}}\right)\left(\sqrt{(0.67\text{ m})(0.002)}\right)(1.5\text{ m})(2.4\text{ m}) = 10.3\text{ m}^3/\text{s}$$

Customary U.S. Solution

The hydranlic radius is

$$R = \frac{A}{P} = \frac{(8\text{ ft})(5\text{ ft})}{5\text{ ft} + 8\text{ ft} + 5\text{ ft}} = 2.22\text{ ft}$$

[3]Pronounced "Shay'-zee." This equation does not appear to be dimensionally consistent. However, the coefficient C is not a pure number. Rather, it has units of (length)$^{1/2}$/time (i.e., (acceleration)$^{1/2}$).

[4]Other methods of evaluating C include the *Kutter equation* (also known as the *G.K. formula*) and the *Bazin formula.* These methods are interesting from a historical viewpoint, but both have been replaced by the Manning equation.

[5]This equation was originally proposed in 1868 by Gaukler and again in 1881 by Hagen, both working independently. For some reason, the Frenchman Flamant attributed the equation to an Irishman, R. Manning. In Europe and many other places, the Manning equation may be known as the *Strickler equation.*

APPENDIX 19.A

Manning's Roughness Coefficient[a,b]
(design use)

channel material	n
plastic (PVC and ABS)	0.009
clean, uncoated cast iron	0.013–0.015
clean, coated cast iron	0.012–0.014
dirty, tuberculated cast iron	0.015–0.035
riveted steel	0.015–0.017
lock-bar and welded steel pipe	0.012–0.013
galvanized iron	0.015–0.017
brass and glass	0.009–0.013
wood stave	
small diameter	0.011–0.012
large diameter	0.012–0.013
concrete	
average value used	0.013
typical commercial, ball and spigot rubber gasketed end connections	
– full (pressurized and wet)	0.010
– partially full	0.0085
with rough joints	0.016–0.017
dry mix, rough forms	0.015–0.016
wet mix, steel forms	0.012–0.014
very smooth, finished	0.011–0.012
vitrified sewer	0.013–0.015
common-clay drainage tile	0.012–0.014
asbestos	0.011
planed timber (flume)	0.012 (0.010–0.014)
canvas	0.012
unplaned timber (flume)	0.013 (0.011–0.015)
brick	0.016
rubble masonry	0.017
smooth earth	0.018
firm gravel	0.023
corrugated metal pipe (CMP)	0.024 (see App. 17.F)
natural channels, good condition	0.025
rip rap	0.035
natural channels with stones and weeds	0.035
very poor natural channels	0.060

[a]Compiled from various sources.
[b]Values outside these ranges have been observed, but these values are typical.

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	5-Mar-20	190260
PROJECT / CALCULATION NUMBER		
Chaffee Area 7/8 Development	Cell 7/8 Calculations	
PREPARED BY	**CHECKED BY**	
A. Alvermann (3/5/20)	R. Holmes (3/5/20)	

Description and Purpose:

Purpose was to verify that the proposed leachate collection pipes within the Chaffee Liner System were sized appropriately to manage a 25-year, 24-hour storm within a 7-day period (remove it from the cell). This flow requirement comes from NYSDEC Regulation 363-6.11(a)(1)

Design Basis/References/Assumptions:

HydroCAD Software was used to model a 25-year Rainfall Event occurring over an approximately 28 acre impervious liner system and draining out via the 8" Leachate Collection Pipe within the liner system.

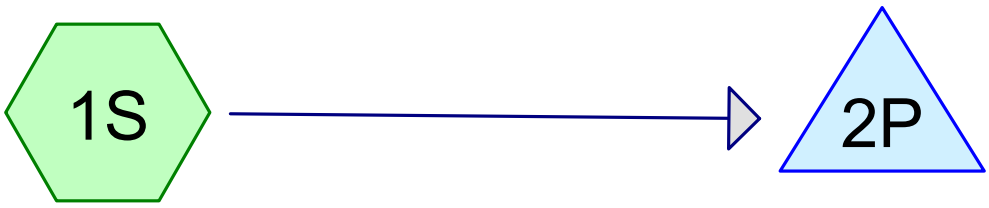
Precipitation data for Chaffee, NY indicate that the extreme 25-year Rainfall Event for a 24-hour period is 3.90"

Design References:

1. Extreme Precipitation Tables, Chaffee NY, Northeast Regional Climate Center. http://precip.eas.cornell.edu

Remarks/Conclusions/Results:

The HydroCAD model shows that a 25-year, 24-hour storm event is drained from the liner system via the proposed 8" leachate pipe in approxiamtely 156 hours or 6.5 days time. This is within the 7 day draining period called out by the regulations, thus the proposed 8" leachate pipe satisfies this regulation. It should be noted that this rainfall can be drained in one pipe; however the 28 acres analyzed include 3 separate sumps and 3 pipes.



Chaffee Cell 7/8 Liner

Subcat Reach Pond Link

Routing Diagram for Chaffee 25Yr Storm Drain
Prepared by Tetra Tech Inc, Printed 7/22/2020
HydroCAD® 10.00-24 s/n 04051 © 2018 HydroCAD Software Solutions LLC

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	2P	0.00	-12.25	1,225.0	0.0100	0.024	8.0	0.0	0.0

Time span=0.00-168.00 hrs, dt=0.10 hrs, 1681 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Chaffee Cell 7/8 Liner Runoff Area=28.320 ac 100.00% Impervious Runoff Depth=3.67"
Flow Length=1,176' Tc=3.9 min CN=98 Runoff=144.03 cfs 8.650 af

Pond 2P: Peak Elev=3.36' Storage=7.385 af Inflow=144.03 cfs 8.650 af
8.0" Round Culvert n=0.024 L=1,225.0' S=0.0100 '/' Outflow=0.72 cfs 8.650 af

Total Runoff Area = 28.320 ac Runoff Volume = 8.650 af Average Runoff Depth = 3.67"
0.00% Pervious = 0.000 ac 100.00% Impervious = 28.320 ac

Summary for Subcatchment 1S: Chaffee Cell 7/8 Liner

[49] Hint: Tc<2dt may require smaller dt

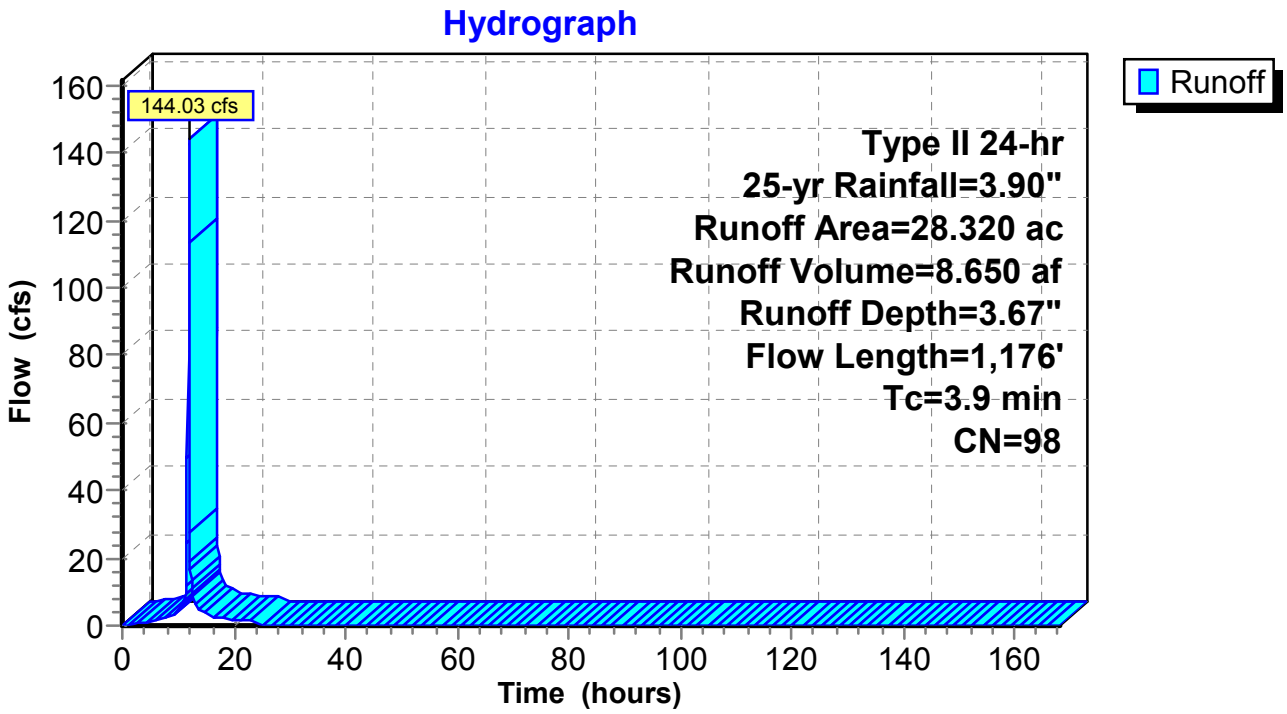
Runoff = 144.03 cfs @ 11.92 hrs, Volume= 8.650 af, Depth= 3.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-168.00 hrs, dt= 0.10 hrs
Type II 24-hr 25-yr Rainfall=3.90"

	Area (ac)	CN	Description
*	28.320	98	Liner system
	28.320		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	601	0.3300	11.66		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
3.0	575	0.0250	3.21		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
3.9	1,176	Total			

Subcatchment 1S: Chaffee Cell 7/8 Liner



Hydrograph for Subcatchment 1S: Chaffee Cell 7/8 Liner

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00
4.00	0.19	0.06	1.02
8.00	0.47	0.29	**2.18**
12.00	2.59	2.36	**113.49**
16.00	3.43	3.20	2.60
20.00	3.71	3.48	1.46
24.00	**3.90**	**3.67**	1.15
28.00	3.90	3.67	0.00
32.00	3.90	3.67	0.00
36.00	3.90	3.67	0.00
40.00	3.90	3.67	0.00
44.00	3.90	3.67	0.00
48.00	3.90	3.67	0.00
52.00	3.90	3.67	0.00
56.00	3.90	3.67	0.00
60.00	3.90	3.67	0.00
64.00	3.90	3.67	0.00
68.00	3.90	3.67	0.00
72.00	3.90	3.67	0.00
76.00	3.90	3.67	0.00
80.00	3.90	3.67	0.00
84.00	3.90	3.67	0.00
88.00	3.90	3.67	0.00
92.00	3.90	3.67	0.00
96.00	3.90	3.67	0.00
100.00	3.90	3.67	0.00
104.00	3.90	3.67	0.00
108.00	3.90	3.67	0.00
112.00	3.90	3.67	0.00
116.00	3.90	3.67	0.00
120.00	3.90	3.67	0.00
124.00	3.90	3.67	0.00
128.00	3.90	3.67	0.00
132.00	3.90	3.67	0.00
136.00	3.90	3.67	0.00
140.00	3.90	3.67	0.00
144.00	3.90	3.67	0.00
148.00	3.90	3.67	0.00
152.00	3.90	3.67	0.00
156.00	3.90	3.67	0.00
160.00	3.90	3.67	0.00
164.00	3.90	3.67	0.00
168.00	3.90	3.67	0.00

Summary for Pond 2P:

Inflow Area = 28.320 ac,100.00% Impervious, Inflow Depth = 3.67" for 25-yr event
Inflow = 144.03 cfs @ 11.92 hrs, Volume= 8.650 af
Outflow = 0.72 cfs @ 24.04 hrs, Volume= 8.650 af, Atten= 100%, Lag= 727.4 min
Primary = 0.72 cfs @ 24.04 hrs, Volume= 8.650 af

Routing by Stor-Ind method, Time Span= 0.00-168.00 hrs, dt= 0.10 hrs
Peak Elev= 3.36' @ 24.04 hrs Surf.Area= 20.182 ac Storage= 7.385 af

Plug-Flow detention time= 3,800.1 min calculated for 8.650 af (100% of inflow)
Center-of-Mass det. time= 3,799.8 min (4,546.3 - 746.5)

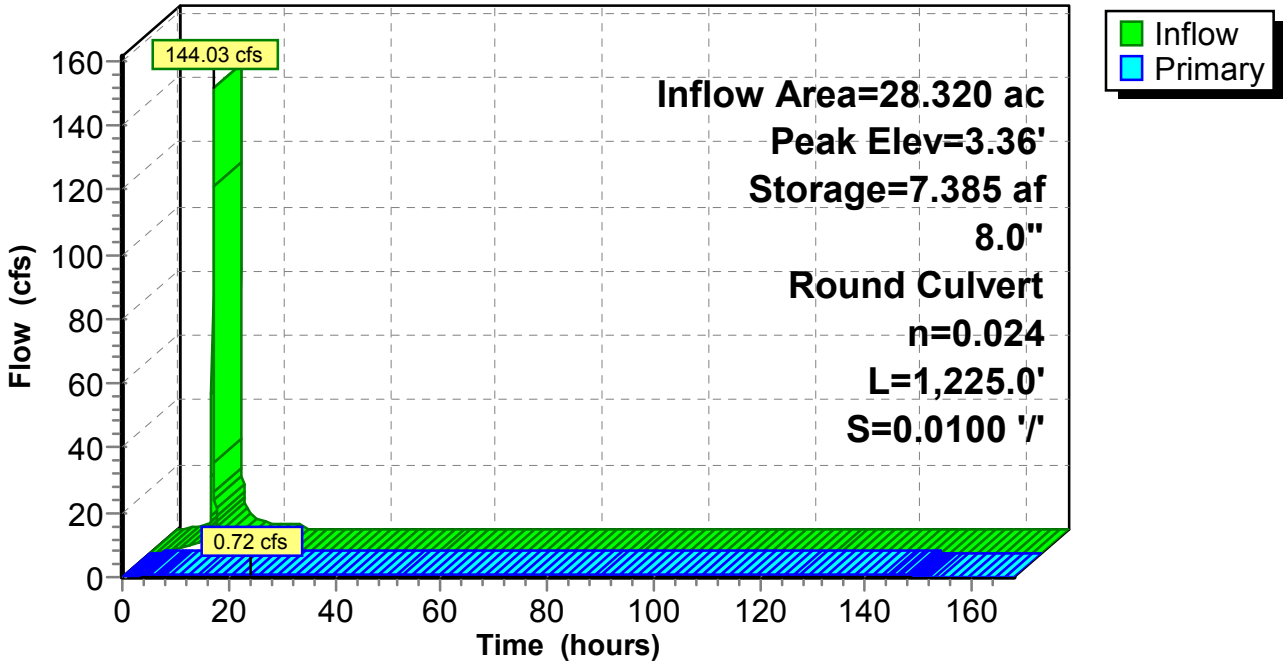
Volume	Invert	Avail.Storage	Storage Description
#1	3.00'	444.814 af	**693.00'W x 1,225.00'L x 20.00'H Prismatoid Z=3.0**
#2	0.00'	0.404 af	**3.00'W x 1,225.00'L x 3.00'H Prismatoid Z=3.0** 1.022 af Overall - 0.012 af Embedded = 1.009 af x 40.0% Voids
#3	1.00'	0.010 af	**8.0" Round Pipe Storage** Inside #2 L= 1,225.0' 0.012 af Overall - 0.5" Wall Thickness = 0.010 af
		445.228 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**8.0" Round Culvert** L= 1,225.0' Ke= 0.010 Inlet / Outlet Invert= 0.00' / -12.25' S= 0.0100 '/' Cc= 1.000 n= 0.024, Flow Area= 0.35 sf

Primary OutFlow Max=0.72 cfs @ 24.04 hrs HW=3.36' (Free Discharge)
1=Culvert (Barrel Controls 0.72 cfs @ 2.06 fps)

Pond 2P:

Hydrograph



Hydrograph for Pond 2P:

Time (hours)	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Primary (cfs)
0.00	0.00	0.000	0.00	0.00
4.00	1.02	0.056	0.87	0.65
8.00	**2.18**	0.363	2.78	0.71
12.00	**113.49**	4.473	3.21	0.72
16.00	2.60	6.755	3.32	0.72
20.00	1.46	7.183	3.35	0.72
24.00	1.15	**7.387**	**3.36**	**0.72**
28.00	0.00	7.155	3.35	0.72
32.00	0.00	6.917	3.33	0.72
36.00	0.00	6.679	3.32	0.72
40.00	0.00	6.442	3.31	0.72
44.00	0.00	6.204	3.30	0.72
48.00	0.00	5.966	3.28	0.72
52.00	0.00	5.729	3.27	0.72
56.00	0.00	5.492	3.26	0.72
60.00	0.00	5.254	3.25	0.72
64.00	0.00	5.017	3.24	0.72
68.00	0.00	4.780	3.22	0.72
72.00	0.00	4.543	3.21	0.72
76.00	0.00	4.306	3.20	0.72
80.00	0.00	4.070	3.19	0.72
84.00	0.00	3.833	3.18	0.72
88.00	0.00	3.596	3.16	0.72
92.00	0.00	3.360	3.15	0.72
96.00	0.00	3.124	3.14	0.71
100.00	0.00	2.887	3.13	0.71
104.00	0.00	2.651	3.11	0.71
108.00	0.00	2.415	3.10	0.71
112.00	0.00	2.179	3.09	0.71
116.00	0.00	1.943	3.08	0.71
120.00	0.00	1.708	3.07	0.71
124.00	0.00	1.472	3.05	0.71
128.00	0.00	1.236	3.04	0.71
132.00	0.00	1.001	3.03	0.71
136.00	0.00	0.765	3.02	0.71
140.00	0.00	0.530	3.01	0.71
144.00	0.00	0.296	2.47	0.70
148.00	0.00	0.071	1.02	0.66
152.00	0.00	0.002	0.04	0.02
156.00	0.00	0.000	0.00	0.00
160.00	0.00	0.000	0.00	0.00
164.00	0.00	0.000	0.00	0.00
168.00	0.00	0.000	0.00	0.00

Extreme Precipitation Tables

Northeast Regional Climate Center

Data represents point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.

Smoothing	Yes
State	New York
Location	
Longitude	78.502 degrees West
Latitude	42.580 degrees North
Elevation	0 feet
Date/Time	Mon, 02 Mar 2020 11:39:58 -0500

Extreme Precipitation Estimates

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.27	0.42	0.52	0.68	0.85	1.04	**1yr**	0.74	0.95	1.18	1.40	1.64	1.90	2.20	**1yr**	1.68	2.11	2.58	3.13	3.60	**1yr**
2yr	0.32	0.50	0.62	0.82	1.03	1.26	**2yr**	0.89	1.15	1.41	1.67	1.93	2.22	2.54	**2yr**	1.97	2.44	2.92	3.48	3.99	**2yr**
5yr	0.38	0.60	0.75	1.01	1.29	1.58	**5yr**	1.11	1.44	1.78	2.08	2.40	2.72	3.11	**5yr**	2.41	2.99	3.53	4.15	4.77	**5yr**
10yr	0.43	0.68	0.86	1.17	1.52	1.88	**10yr**	1.31	1.71	2.11	2.47	2.82	3.18	3.62	**10yr**	2.81	3.48	4.08	4.74	5.45	**10yr**
25yr	0.52	0.82	1.04	1.44	1.91	2.36	**25yr**	1.65	2.14	2.65	3.08	3.50	3.90	4.44	**25yr**	3.45	4.27	4.95	5.66	6.52	**25yr**
50yr	0.58	0.93	1.19	1.67	2.27	2.81	**50yr**	1.96	2.54	3.17	3.66	4.13	4.56	5.18	**50yr**	4.03	4.98	5.72	6.48	7.47	**50yr**
100yr	0.67	1.08	1.40	1.98	2.69	3.35	**100yr**	2.32	3.01	3.76	4.33	4.85	5.32	6.04	**100yr**	4.71	5.81	6.62	7.42	8.56	**100yr**
200yr	0.76	1.25	1.62	2.32	3.20	3.99	**200yr**	2.77	3.58	4.48	5.13	5.71	6.22	7.05	**200yr**	5.51	6.78	7.66	8.49	9.81	**200yr**
500yr	0.92	1.52	1.98	2.88	4.04	5.03	**500yr**	3.48	4.50	5.64	6.42	7.08	7.65	8.66	**500yr**	6.77	8.33	9.30	10.16	11.76	**500yr**

Lower Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.24	0.38	0.46	0.62	0.76	0.81	**1yr**	0.66	0.79	0.88	1.12	1.44	1.71	1.92	**1yr**	1.52	1.85	2.30	2.96	3.29	**1yr**
2yr	0.31	0.48	0.60	0.81	0.99	1.13	**2yr**	0.86	1.11	1.25	1.52	1.81	2.16	2.47	**2yr**	1.92	2.37	2.85	3.38	3.88	**2yr**
5yr	0.35	0.54	0.67	0.92	1.17	1.35	**5yr**	1.01	1.32	1.48	1.79	2.13	2.55	2.90	**5yr**	2.26	2.79	3.32	3.87	4.41	**5yr**
10yr	0.38	0.59	0.73	1.02	1.32	1.52	**10yr**	1.14	1.49	1.65	2.01	2.40	2.88	3.27	**10yr**	2.55	3.14	3.73	4.29	5.00	**10yr**
25yr	0.43	0.65	0.81	1.16	1.53	1.78	**25yr**	1.32	1.74	1.91	2.32	2.76	3.39	3.83	**25yr**	3.00	3.68	4.35	4.93	5.76	**25yr**
50yr	0.47	0.71	0.89	1.28	1.72	2.00	**50yr**	1.48	1.96	2.11	2.60	3.07	3.84	4.32	**50yr**	3.40	4.15	4.89	5.46	6.42	**50yr**
100yr	0.51	0.77	0.96	1.39	1.91	2.26	**100yr**	1.65	2.21	2.34	2.90	3.38	4.35	4.89	**100yr**	3.85	4.70	5.50	6.08	7.16	**100yr**
200yr	0.55	0.83	1.05	1.52	2.11	2.54	**200yr**	1.82	2.48	2.57	3.22	3.72	4.92	5.52	**200yr**	4.35	5.31	6.21	6.78	8.00	**200yr**
500yr	0.61	0.90	1.16	1.69	2.40	2.95	**500yr**	2.07	2.89	2.90	3.66	4.15	5.81	6.51	**500yr**	5.15	6.26	7.30	7.84	9.30	**500yr**

Upper Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.30	0.46	0.56	0.75	0.92	1.08	**1yr**	0.80	1.06	1.19	1.43	1.72	2.14	2.36	**1yr**	1.89	2.27	2.74	3.30	3.79	**1yr**
2yr	0.34	0.53	0.65	0.88	1.08	1.23	**2yr**	0.93	1.21	1.37	1.64	1.97	2.29	2.64	**2yr**	2.03	2.54	3.00	3.60	4.13	**2yr**
5yr	0.42	0.65	0.81	1.11	1.42	1.61	**5yr**	1.22	1.58	1.78	2.16	2.56	2.91	3.33	**5yr**	2.57	3.20	3.73	4.46	5.17	**5yr**
10yr	0.51	0.79	0.98	1.37	1.77	1.99	**10yr**	1.53	1.95	2.18	2.66	3.17	3.49	4.01	**10yr**	3.09	3.86	4.41	5.25	6.01	**10yr**
25yr	0.66	1.01	1.26	1.79	2.36	2.64	**25yr**	2.04	2.58	2.88	3.50	4.19	4.44	5.11	**25yr**	3.93	4.91	5.50	6.51	7.49	**25yr**
50yr	0.81	1.23	1.53	2.19	2.95	3.27	**50yr**	2.55	3.20	3.56	4.34	5.21	5.33	6.15	**50yr**	4.72	5.91	6.50	7.65	8.82	**50yr**
100yr	0.99	1.49	1.87	2.70	3.70	4.06	**100yr**	3.20	3.97	4.42	5.39	6.50	6.41	7.38	**100yr**	5.67	7.10	7.67	9.00	10.40	**100yr**
200yr	1.21	1.82	2.31	3.34	4.66	5.03	**200yr**	4.02	4.91	5.49	6.71	8.14	7.70	8.86	**200yr**	6.82	8.52	9.07	10.59	12.25	**200yr**
500yr	1.60	2.38	3.07	4.45	6.34	6.68	**500yr**	5.47	6.53	7.35	8.99	10.98	9.83	11.28	**500yr**	8.70	10.85	11.29	13.12	15.20	**500yr**

B.14 - Leachate Pipe Loading Calculations

CALCULATION COVER SHEET

CLIENT	DATE	PROJECT NUMBER
Waste Management - Chaffee	20-May-20	190260
PROJECT / CALCULATION NUMBER	**TITLE**	
Chaffee Area 7/8 Development	Pipe Loading	
PREPARED BY	**CHECKED BY**	
L. Rohr	R. Holmes	

Description and Purpose:

- The purpose of this calculation is to analyze the impacts of the Area 7/8 Development on the proposed and existing LCRS pipes.
- Predicted pipe performance criteria (ring deflection, wall buckling, and wall crushing) will be compared to industry recommendations. (Minimum FOS of 1.25)

Design Basis/References/Assumptions:

- Burial depths are computed based on design subgrade and location of pipes relative to subgrade within the liner system.
- The maximum proposed waste thickness (with unit weight of 65 pcf) over the proposed Area 7/8 sump is 70 feet. (Figure 1)
- The maximum proposed waste thickness (with unit weight of 65 pcf) over the proposed Area 7/8 piping is 185 feet. (Figure 1)
- The maximum proposed waste thickness (with unit weight of 65 pcf) over the existing Valley Fill piping is 195 feet. (Figure 1)
- The maximum proposed waste thickness (with unit weight of 65 pcf) over the existing Western Landfill piping is 210 feet. (Figure 2)
- The maximum proposed waste thickness (with unit weight of 65 pcf) over the existing Closed Landfill piping is 230 feet. (Figure 2)
- An additional 4.5 feet of final cover fill (with unit weight of 125 pcf) and an additional 2 feet of baseliner fill (with unit weight of 125 pcf) was added over each pipe to account for the non-waste materials above the pipes.
- An additional 1 foot of baseliner fill was added to the secondary pipe loads to account for its location within the baseliner system.

References:

- "Professional Plastics, Inc. PVC Pipe Specifications, Sizes & Pressure Ratings." August, 2009. https://www.professionalplastics.com/professionalplastics/PVCPipeSpecifications.pdf
- '"The Practical Differences in Material Properties of Flexible Pipe Products." Darrel Sanders, P.E., and Andrew Jenkins, E.I. CONTECH Construction Products Inc. December, 2010
- "High Density Polyethylene Pipe. Typical Physical Properties." ISCO Industries. 2013. http://www.isco-pipe.com/workspace/uploads/typical-properties.pdf
- Uni-Bell Technical Report - Deflection: The Pipe/Soil Mechanism https://www.uni-bell.org/application/files/6614/5930/5531/Deflection_.pdf
- "Design of PE Plastic Pipe - Chapter 6." Plastic Pipe Institute (PPI) Handbook of Polyethylene Pipe. March, 2009 https://plasticpipe.org/pdf/chapter06.pdf
- "Iron Pipe Size (IPS) and Dimension Data. Bulletin: PP 152-4710." Performance Pipe. February 2015. http://www.performancepipe.com/en-us/Documents/PP%20152%204710%20IPS%20Size%20and%20Dimension%20Sheet.pdf
- "Geotechnical Aspects of Landfill Design and Construction." X. Qian, R. Koerner, and D. Gray. September 20, 2001.
- "ISCO HDPE Product Catalog." ISCO Industries. 2013. http://www.isco-pipe.com/workspace/uploads/isco%20product%20catalog%204.1%202013_sm.pdf

Remarks/Conclusions/Results:

- The factors of safety calculated for the selected pipe performance criteria exceeded 1.25 for the proposed and existing pipes.
- The proposed Area 7/8 sump shall consist of 18" and 12" HDPE SDR 11 Piping
- The proposed Area 7/8 LCRS piping shall consist of 8" and 6" HDPE SDR 11 Piping
- The existing 8" and 6" HDPE SDR 11 piping in the Valley Fill and Western Landfill meets industry standards for pipe performance under the proposed Area 7/8 loading.
- The existing 6" and 4" PVC Schedule 40 piping in the Closed Landfill meets industry standards for pipe performance under the proposed Area 7/8 loading.

- The proposed and existing LCRS piping systems meet industry standards for pipe performance under the proposed loading.

N

EXISTING VALLEY FILL HDPE PIPE
PROPOSED WASTE EL: 1670'
APPROX. PIPE EL: 1485'
MAXIMUM WASTE HEIGHT: 195'

12"/8" HDPE DUAL CONTAINED LEACHATE TRANSMISSION LINE

LEACHATE COLLECTION SUMP #2

DUAL
LEACHATE
SION LINES

ONDENSATE DRAIN CONNECTION

CONTAINED
MISSION LINE

RELOCATED LEACHATE COLLECTION SUMP #3/#4 MANHOLE

CONTROL VAULT

ABOVE GROUND LEACHATE STORAGE TANKS

PROPOSED HDPE PIPE
PROPOSED WASTE EL: 1650'
PROPOSED PIPE EL: 1465'
MAXIMUM WASTE HEIGHT: 185'

PROPOSED SUMP: LOCATION #2
PROPOSED WASTE EL: 1518'
PROPOSED SUMP EL: 1448'
MAXIMUM WASTE HEIGHT: 70'

Obscured

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CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

PIPE LOADING FIGURE

SHEET NO. 1

PROJECT NO. 190260

1" 1/2" 0" 1"

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N

4" HDPE SECONDARY COLLECTION PIPES (TYP.)

8" HDPE PRIMARY COLLECTION PIPES (TYP.)

EXISTING HDPE PIPE
PROPOSED WASTE EL: 1690'
APPROX. PIPE EL: 1480'
MAXIMUM WASTE HEIGHT: 210'

EXISTING CLOSED LF PIPE
PROPOSED WASTE EL: 1690'
EXISTING PIPE EL: 1460'
MAXIMUM WASTE HEIGHT: 230'

ALL PIPE BENDS SHALL NOT INCLUDE HARD 90° ELBOWS, BUT SHALL BE MADE BY COLD BENDING THE PIPE TO ITS ALLOWABLE RADIUS BASED ON DIAMETER AND SDR

12"/8" HDPE DUAL

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DATE OF ISSUE MARCH 2020
DRAWN BY DSS
DESIGNED BY
CHECKED BY
APPROVED BY

cornerstone PLLC

PREPARED BY:
CORNERSTONE ENGINEERING, GEOLOGY AND LAND SURVEYING, PLLC

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CHAFFEE FACILITY
AREA 7/8 DEVELOPMENT
SARDINIA, ERIE COUNTY, NEW YORK

PIPE LOADING FIGURE

SHEET NO. 2
PROJECT NO. 190260

1" 1/2" 0" 1"

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Pipe Loading Calculation

Chaffee Area 7/8 Development - Proposed Pipes

Project No: 190260
Prepared by: L. Rohr
Checked by: R. Holmes

A. PIPE PROPERTIES		Primary LCRS	Primary LCRS	Primary Sump	Secondary LCRS	Secondary LCRS	Secondary Sump	Primary Sump	Primary Sump	Primary Sump	Secondary Sump	Secondary Sump	Secondary Sump
diameter (in.)	D =	8	8	8	6	6	6	18	18	18	12	12	12
material		HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE
perforation		PERF.	SOLID	SOLID	PERF.	SOLID	SOLID	SOLID	PERF.	SOLID	PERF.	SOLID	SOLID
specification		SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11
poisson's ratio of pipe material	μ =	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
thickness (in.)	t =	0.784	0.784	0.784	0.602	0.602	0.602	1.636	1.636	1.636	1.159	1.159	1.159
inside diameter (in.)	D_i =	6.963	6.963	6.963	5.349	5.349	5.349	14.532	14.532	14.532	10.293	10.293	10.293
outside diameter (in.)	D_o =	8.625	8.625	8.625	6.620	6.620	6.620	18.000	18.000	18.000	12.750	12.750	12.750
diameter Ratio	SDR =	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
mean diameter	D_m =	7.8	7.8	7.8	6.0	6.0	6.0	16.3	16.3	16.3	11.5	11.5	11.5
mean radius	R =	3.9	3.9	3.9	3.0	3.0	3.0	8.1	8.1	8.1	5.8	5.8	5.8
initial modulus of elasticity (psi)	E_i =	110000	110000	110000	110000	110000	110000	110000	110000	110000	110000	110000	110000
50-yr modulus of elasticity (psi)	E_{50} =	22000	22000	22000	22000	22000	22000	22000	22000	22000	22000	22000	22000
initial compressive yield strength (psi)	$P_{A,I}$	1600	1600	1200	1600	1600	1200	1600	1600	1200	1600	1600	1200
50-yr compressive yield strength (psi)	$P_{A,50}$	800	800	600	800	800	600	800	800	600	800	800	600

*(25% Derating of yield strength for HDPE TEE's)

B. BEDDING MATERIAL PROPERTIES

** gravel bedding*

deflection lag factor	L_f =	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
bedding constant	K =	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
modulus of soil reaction (psi)	E_s =	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000

C. LOADING ON PIPE

$$P_{1,2} = \frac{wh}{\left(1-\frac{nd}{12}\right)} \text{ ------- for slotted pipes}$$

number of holes per row per foot of pipe	n =	2.7	0	0	2.7	0	0	0	2.7	0	2.7	0	2.7
diameter of holes (in.)	d =	0.375	0	0	0.375	0	0	0	0.375	0	0.375	0	0.375
waste unit weight (psf)	w.a =	65	65	65	65	65	65	65	65	65	65	65	65
additional fill (final cover and baseliner soil) unit weight (psf)	w.b =	125	125	125	125	125	125	125	125	125	125	125	125
height of waste over sump, location #1 (ft.)	h1 =	70	70	70	70	70	70	70	70	70	70	70	70
height of waste, maximum, location #2 (ft.)	h2 =	185	185		185	185							
height of additional fill (2.5 ft final cover plus X ft of baseliner soil)	h.add =	6.5	6.5	6.5	7.5	7.5	7.5	6.5	6.5	6.5	7.5	7.5	7.5
location #1 load of fill (psi)	P_1 =	40.7	37.2	37.2	41.6	38.1	38.1	37.2	40.7	37.2	41.6	38.1	41.6
location #2 load of fill (psi)	P_2 =	97.4	89.1		98.3	90.0							
location #1 load of fill (psf)	P_1 =	5857	5363	5363	5993	5488	5488	5363	5857	5363	5993	5488	5993
location #2 load of fill (psf)	P_2 =	14020	12838		14157	12963							

Notes:

Pipe Loading Calculation

Chaffee Area 7/8 Development - Proposed Pipes

Project No: 190260
Prepared by: L. Rohr
Checked by: R. Holmes

A. PIPE PROPERTIES		Primary LCRS	Primary LCRS	Primary Sump	Secondary LCRS	Secondary LCRS	Secondary Sump	Primary Sump	Primary Sump	Primary Sump	Secondary Sump	Secondary Sump	Secondary Sump
diameter (in.)	D =	8	8	8	6	6	6	18	18	18	12	12	12
material		HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE
perforation		PERF.	SOLID	SOLID	PERF.	SOLID	SOLID	SOLID	PERF.	SOLID	PERF.	SOLID	SOLID
specification		SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11

D. RING DEFLECTION

$$\frac{\Delta Y}{D_M} = \frac{L_f K P_{1,2} R^3}{E_{i,50} I + 0.061 E_S R^3}$$ <---- Modified Iowa Formula

$$I = \frac{t^3}{12}$$

moment of inertia (in^3)	I =	0.04016	0.04016	0.04016	0.01818	0.01818	0.01818	0.36490	0.36490	0.36490	0.12974	0.12974	0.12974
critical deflection limit (%)	$\Delta Y/D_M$ =	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	22.50%	22.50%	22.50%	22.50%	22.50%	22.50%
initial deflection at location #1 (%)	$\Delta Y/D_M$ =	1.58%	1.45%	1.45%	1.62%	1.48%	1.48%	1.45%	1.58%	1.45%	1.62%	1.48%	1.62%
intitial FS at location #1	FS =	19.00	20.76	20.76	18.57	20.28	20.28	15.56	14.25	15.56	13.93	15.21	13.93
initial deflection at location #2 (%)	$\Delta Y/D_M$ =	3.78%	3.46%		3.82%	3.49%							
intitial FS at location #2	FS =	7.94	8.67		7.86	8.59							
50-yr deflection at location #1 (%)	$\Delta Y/D_M$ =	2.05%	1.88%	1.88%	2.10%	1.93%	1.93%	1.88%	2.05%	1.88%	2.10%	1.93%	2.10%
50-yr FS at location #1	FS =	14.60	15.94	15.94	14.27	15.58	15.58	11.96	10.95	11.96	10.70	11.69	10.70
50-yr deflection at location #2 (%)	$\Delta Y/D_M$ =	4.92%	4.50%		4.97%	4.55%							
50-yr FS at location #2	FS =	6.10	6.66		6.04	6.60							

Notes:
(1) Critical deflection limit provided by Uni-Bell for PVC material and "Design of PE Piping" for HDPE material

D. WALL BUCKLING

** 25% derating of P applied on HDPE pipe tees*

$$P_{cr} = 2\left[\frac{(E')(E_{i,50})(I/R^3)}{(1-\mu^2)}\right]^{1/2}$$

initial critical buckling pressure (psi)	P_{cr} =	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	795
initial FS at location #1	FS =	26.06	28.46	28.46	25.46	27.81	27.81	28.45	26.05	28.45	25.46	27.81	19.10
initial FS at location #2	FS =	10.88	11.89		10.78	11.77							
50-yr critical buckling pressure (psi)	P_{cr} =	474	474	474	474	474	474	474	474	474	474	474	355
50-yr FS at location #1	FS =	11.65	12.73	12.73	11.39	12.44	12.44	12.72	11.65	12.72	11.39	12.44	8.54
50-yr FS at location #2	FS =	4.87	5.32		4.82	5.27							

Notes:

Pipe Loading Calculation

Chaffee Area 7/8 Development - Proposed Pipes

Project No: 190260
Prepared by: L. Rohr
Checked by: R. Holmes

A. PIPE PROPERTIES		Primary LCRS	Primary LCRS	Primary Sump	Secondary LCRS	Secondary LCRS	Secondary Sump	Primary Sump	Primary Sump	Primary Sump	Secondary Sump	Secondary Sump	Secondary Sump
diameter (in.)	D =	8	8	8	6	6	6	18	18	18	12	12	12
material		HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE
perforation		PERF.	SOLID	SOLID	PERF.	SOLID	SOLID	SOLID	PERF.	SOLID	PERF.	SOLID	SOLID
specification		SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11

E. WALL CRUSHING

** 25% derating of P applied on HDPE pipe tees*

$$P_{SA} = \frac{P_{1,2} D_m}{2 A_W}$$

area of pipe wall per unit circumference (in^2/in) = t	A_W	0.784	0.784	0.784	0.602	0.602	0.602	1.636	1.636	1.636	1.159	1.159	1.159
axial stress at location #1 (psi)	P_{SA}	202	185	185	207	189	189	185	202	185	207	189	207
initial FS at location #1	FS =	7.91	8.64	6.48	7.73	8.45	6.34	8.64	7.91	6.48	7.73	8.45	5.80
50-yr FS at location #1	FS =	3.96	4.32	3.24	3.87	4.22	3.17	4.32	3.96	3.24	3.87	4.22	2.90
axial stress at location #2 (psi)	P_{SA}	484	443		489	447							
initial FS at location #2	FS =	3.31	3.61		3.27	3.58							
50-yr FS at location #2	FS =	1.65	1.81		1.64	1.79							

Notes:

Pipe Loading Calculation

Chaffee Landfill - Valley Fill Pipes

Project No: 190260
Prepared by: L. Rohr
Checked by: R.Holmes

A. PIPE PROPERTIES		Primary LCRS	Primary LCRS	Secondary LCRS	Secondary LCRS
diameter (in.)	D =	8	8	6	6
material		HDPE	HDPE	HDPE	HDPE
perforation		PERF.	SOLID	PERF.	SOLID
specification		SDR 11	SDR 11	SDR 11	SDR 11
poisson's ratio of pipe material	μ =	0.45	0.45	0.45	0.45
thickness (in.)	t =	0.784	0.784	0.602	0.602
inside diameter (in.)	D_i =	6.963	6.963	5.349	5.349
outside diameter (in.)	D_o =	8.625	8.625	6.620	6.620
diameter Ratio	SDR =	11.0	11.0	11.0	11.0
mean diameter	D_m =	7.8	7.8	6.0	6.0
mean radius	R =	3.9	3.9	3.0	3.0
initial modulus of elasticity (psi)	E_i =	110000	110000	110000	110000
50-yr modulus of elasticity (psi)	E_{50} =	22000	22000	22000	22000
initial compressive yield strength (psi)	$P_{A,i}$	1600	1600	1600	1600
50-yr compressive yield strength (psi)	$P_{A,50}$	800	800	800	800

B. BEDDING MATERIAL PROPERTIES

** gravel bedding*

deflection lag factor	L_f =	1.0	1.0	1.0	1.0
bedding constant	K =	0.1	0.1	0.1	0.1
modulus of soil reaction (psi)	E_s =	3000	3000	3000	3000

C. LOADING ON PIPE

$$P_{1,2} = \frac{wh}{\left(1-\frac{nd}{12}\right)} \text{ ------- for slotted pipes}$$

number of holes per row per foot of pipe	n =	2.7	0	2.7	0
diameter of holes (in.)	d =	0.375	0	0.375	0
waste unit weight (psf)	w.a =	65	65	65	65
additional fill (final cover and baseliner soil) unit weight (psf)	w.b =	125	125	125	125
height of waste, maximum, (ft.)	h2 =	195	195	195	195
height of additional fill (2.5 ft final cover plus X ft of baseliner soil)	h.add =	6.5	6.5	7.5	7.5
load of fill (psi)	P_2 =	102.3	93.7	103.2	94.5
load of fill (psf)	P_2 =	14730	13488	14867	13613

Notes:

Pipe Loading Calculation

Chaffee Landfill - Valley Fill Pipes

Project No: 190260
Prepared by: L. Rohr
Checked by: R.Holmes

A. PIPE PROPERTIES		Primary LCRS	Primary LCRS	Secondary LCRS	Secondary LCRS
diameter (in.)	D =	8	8	6	6
material		HDPE	HDPE	HDPE	HDPE
perforation		PERF.	SOLID	PERF.	SOLID
specification		SDR 11	SDR 11	SDR 11	SDR 11

D. RING DEFLECTION

$$\frac{\Delta Y}{D_M} = \frac{L_f K P_{1,2} R^3}{E_{i,50} I + 0.061 E_s R^3}$$ <---- Modified Iowa Formula

$$I = \frac{t^3}{12}$$

moment of inertia (in^3)	I =	0.04016	0.04016	0.01818	0.01818
critical deflection limit (%)	$\Delta Y/D_M$ =	30.00%	30.00%	30.00%	30.00%
initial deflection (%)	$\Delta Y/D_M$ =	3.97%	3.64%	4.01%	3.67%
intitial FS	FS =	7.56	8.25	7.49	8.18
50-yr deflection (%)	$\Delta Y/D_M$ =	5.17%	4.73%	5.22%	4.78%
50-yr FS	FS =	5.80	6.34	5.75	6.28

Notes:
(1) Critical deflection limit provided by Uni-Bell for PVC material and "Design of PE Piping" for HDPE material

D. WALL BUCKLING

** 25% derating of P applied on HDPE pipe tees*

$$P_{cr} = 2\left[\frac{(E')(E_{i,50})(I/R^3)}{(1-\mu^2)}\right]^{1/2}$$

initial critical buckling pressure (psi)	P_{cr} =	1060	1060	1060	1060
initial FS	FS =	10.36	11.31	10.27	11.21
50-yr critical buckling pressure (psi)	P_{cr} =	474	474	474	474
50-yr FS	FS =	4.63	5.06	4.59	5.01

Notes:

E. WALL CRUSHING

** 25% derating of P applied on HDPE pipe tees*

$$P_{SA} = \frac{P_{1,2} D_m}{2 A_W}$$

area of pipe wall per unit circumference (in^2/in) = t	A_W	0.784	0.784	0.602	0.602
axial stress (psi)	P_{SA}	508	466	513	470
initial FS	FS =	3.15	3.44	3.12	3.41
50-yr FS	FS =	1.57	1.72	1.56	1.70

Notes:

Pipe Loading Calculation

Chaffee Western Landfill - Existing Pipes

Project No: 190260
Prepared by: L. Rohr
Checked by: R. Holmes

A. PIPE PROPERTIES		Primary LCRS	Primary LCRS	Primary Sump	Secondary LCRS	Secondary LCRS	Secondary Sump	Primary Sump	Primary Sump	Primary Sump	Secondary Sump	Secondary Sump	Secondary Sump
diameter (in.)	D =	8	8	8	4	4	4	18	18	18	12	12	12
material		HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE
perforation		PERF.	SOLID	SOLID	PERF.	SOLID	SOLID	SOLID	PERF.	SOLID	PERF.	SOLID	SOLID
specification		SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11
poisson's ratio of pipe material	μ =	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
thickness (in.)	t =	0.784	0.784	0.784	0.409	0.409	0.409	1.636	1.636	1.636	1.159	1.159	1.159
inside diameter (in.)	D_i =	6.963	6.963	6.963	3.633	3.633	3.633	14.532	14.532	14.532	10.293	10.293	10.293
outside diameter (in.)	D_o =	8.625	8.625	8.625	4.500	4.500	4.500	18.000	18.000	18.000	12.750	12.750	12.750
diameter Ratio	SDR =	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
mean diameter	D_m =	7.8	7.8	7.8	4.1	4.1	4.1	16.3	16.3	16.3	11.5	11.5	11.5
mean radius	R =	3.9	3.9	3.9	2.0	2.0	2.0	8.1	8.1	8.1	5.8	5.8	5.8
initial modulus of elasticity (psi)	E_i =	110000	110000	110000	110000	110000	110000	110000	110000	110000	110000	110000	110000
50-yr modulus of elasticity (psi)	E_{50} =	22000	22000	22000	22000	22000	22000	22000	22000	22000	22000	22000	22000
initial compressive yield strength (psi)	$P_{A,I}$	1600	1600	1200	1600	1600	1200	1600	1600	1200	1600	1600	1200
50-yr compressive yield strength (psi)	$P_{A,50}$	800	800	600	800	800	600	800	800	600	800	800	600

*(25% Derating of yield strength for HDPE TEE's)

B. BEDDING MATERIAL PROPERTIES

** gravel bedding*

deflection lag factor	L_f =	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
bedding constant	K =	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
modulus of soil reaction (psi)	E_s =	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000

C. LOADING ON PIPE

$$P_{1,2} = \frac{wh}{\left(1-\frac{nd}{12}\right)} \text{ ------- for slotted pipes}$$

number of holes per row per foot of pipe	n =	2.7	0	0	2.7	0	0	0	2.7	0	2.7	0	2.7
diameter of holes (in.)	d =	0.375	0	0	0.375	0	0	0	0.375	0	0.375	0	0.375
waste unit weight (psf)	w.a =	65	65	65	65	65	65	65	65	65	65	65	65
additional fill (final cover and baseliner soil) unit weight (psf)	w.b =	125	125	125	125	125	125	125	125	125	125	125	125
height of waste over sump, location #1 (ft.)	h1 =	50	50	50	50	50	50	50	50	50	50	50	50
height of waste, maximum, location #2 (ft.)	h2 =	210	210		210	210							
height of additional fill (4.5 ft final cover plus X ft of baseliner soil)	h.add =	6.5	6.5	6.5	7.5	7.5	7.5	6.5	6.5	6.5	7.5	7.5	7.5
location #1 load of fill (psi)	P_1 =	30.8	28.2	28.2	31.8	29.1	29.1	28.2	30.8	28.2	31.8	29.1	31.8
location #2 load of fill (psi)	P_2 =	109.7	100.4		110.6	101.3							
location #1 load of fill (psf)	P_1 =	4437	4063	4063	4573	4188	4188	4063	4437	4063	4573	4188	4573
location #2 load of fill (psf)	P_2 =	15795	14463		15932	14588							

Notes:

Pipe Loading Calculation

Chaffee Western Landfill - Existing Pipes

Project No: 190260
Prepared by: L. Rohr
Checked by: R. Holmes

A. PIPE PROPERTIES		Primary LCRS	Primary LCRS	Primary Sump	Secondary LCRS	Secondary LCRS	Secondary Sump	Primary Sump	Primary Sump	Primary Sump	Secondary Sump	Secondary Sump	Secondary Sump
diameter (in.)	D =	8	8	8	4	4	4	18	18	18	12	12	12
material		HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE
perforation		PERF.	SOLID	SOLID	PERF.	SOLID	SOLID	SOLID	PERF.	SOLID	PERF.	SOLID	SOLID
specification		SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11

D. RING DEFLECTION

$$\frac{\Delta Y}{D_M} = \frac{L_f K P_{1,2} R^3}{E_{i,50} I + 0.061 E_S R^3}$$ <---- Modified Iowa Formula

$$I = \frac{t^3}{12}$$

moment of inertia (in^3)	I =	0.04016	0.04016	0.04016	0.00570	0.00570	0.00570	0.36490	0.36490	0.36490	0.12974	0.12974	0.12974
critical deflection limit (%)	$\Delta Y/D_M$ =	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	22.50%	22.50%	22.50%	22.50%	22.50%	22.50%
initial deflection at location #1 (%)	$\Delta Y/D_M$ =	1.20%	1.10%	1.10%	1.23%	1.13%	1.13%	1.10%	1.20%	1.10%	1.23%	1.13%	1.23%
intitial FS at location #1	FS =	25.09	27.40	27.40	24.33	26.58	26.58	20.55	18.81	20.55	18.25	19.94	18.25
initial deflection at location #2 (%)	$\Delta Y/D_M$ =	4.26%	3.90%		4.29%	3.93%							
intitial FS at location #2	FS =	7.05	7.70		6.99	7.63							
50-yr deflection at location #1 (%)	$\Delta Y/D_M$ =	1.56%	1.43%	1.43%	1.60%	1.47%	1.47%	1.43%	1.56%	1.43%	1.60%	1.47%	1.60%
50-yr FS at location #1	FS =	19.27	21.05	21.05	18.70	20.42	20.42	15.79	14.45	15.79	14.02	15.31	14.02
50-yr deflection at location #2 (%)	$\Delta Y/D_M$ =	5.54%	5.07%		5.59%	5.12%							
50-yr FS at location #2	FS =	5.41	5.91		5.37	5.86							

Notes:
(1) Critical deflection limit provided by Uni-Bell for PVC material and "Design of PE Piping" for HDPE material

D. WALL BUCKLING

** 25% derating of P applied on HDPE pipe tees*

$$P_{cr} = 2\left[\frac{(E')(E_{i,50})(I/R^3)}{(1-\mu^2)}\right]^{1/2}$$

initial critical buckling pressure (psi)	P_{cr} =	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	795
initial FS at location #1	FS =	34.40	37.56	37.56	33.36	36.44	36.44	37.56	34.39	37.56	33.37	36.45	25.03
initial FS at location #2	FS =	9.66	10.55		9.58	10.46							
50-yr critical buckling pressure (psi)	P_{cr} =	474	474	474	474	474	474	474	474	474	474	474	355
50-yr FS at location #1	FS =	15.38	16.80	16.80	14.92	16.29	16.29	16.80	15.38	16.80	14.92	16.30	11.19
50-yr FS at location #2	FS =	4.32	4.72		4.28	4.68							

Notes:

Pipe Loading Calculation

Chaffee Western Landfill - Existing Pipes

Project No: 190260
Prepared by: L. Rohr
Checked by: R. Holmes

A. PIPE PROPERTIES		Primary LCRS	Primary LCRS	Primary Sump	Secondary LCRS	Secondary LCRS	Secondary Sump	Primary Sump	Primary Sump	Primary Sump	Secondary Sump	Secondary Sump	Secondary Sump
diameter (in.)	D =	8	8	8	4	4	4	18	18	18	12	12	12
material		HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE	HDPE	HDPE	HDPE - TEE
perforation		PERF.	SOLID	SOLID	PERF.	SOLID	SOLID	SOLID	PERF.	SOLID	PERF.	SOLID	SOLID
specification		SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11	SDR 11

E. WALL CRUSHING

** 25% derating of P applied on HDPE pipe tees*

$$P_{SA} = \frac{P_{1,2} D_m}{2 A_W}$$

area of pipe wall per unit circumference (in^2/in) = t	A_W	0.784	0.784	0.784	0.409	0.409	0.409	1.636	1.636	1.636	1.159	1.159	1.159
axial stress at location #1 (psi)	P_{SA}	153	140	140	158	145	145	140	153	140	158	145	158
initial FS at location #1	FS =	10.45	11.41	8.56	10.13	11.07	8.30	11.41	10.45	8.56	10.14	11.07	7.60
50-yr FS at location #1	FS =	5.22	5.70	4.28	5.07	5.53	4.15	5.70	5.22	4.28	5.07	5.53	3.80
axial stress at location #2 (psi)	P_{SA}	545	499		550	504							
initial FS at location #2	FS =	2.93	3.20		2.91	3.18							
50-yr FS at location #2	FS =	1.47	1.60		1.45	1.59							

Notes:

Pipe Loading Calculation

Chaffee Landfill - Closed LF Pipes

Project No: 190260
Prepared by: L. Rohr
Checked by: R.Holmes

A. PIPE PROPERTIES		Primary LCRS	Primary LCRS	Secondary LCRS	Secondary LCRS
diameter (in.)	D =	6	6	4	4
material		PVC	PVC	PVC	PVC
perforation		PERF.	SOLID	PERF.	SOLID
specification		SCHED 40	SCHED 40	SCHED 40	SCHED 40
poisson's ratio of pipe material	μ =	0.38	0.38	0.38	0.38
thickness (in.)	t =	0.280	0.280	0.237	0.237
inside diameter (in.)	D_i =	6.031	6.031	3.998	3.998
outside diameter (in.)	D_o =	6.625	6.625	4.500	4.500
diameter Ratio	SDR =	23.7	23.7	19.0	19.0
mean diameter	D_m =	6.3	6.3	4.2	4.2
mean radius	R =	3.2	3.2	2.1	2.1
initial modulus of elasticity (psi)	E_i =	440000	440000	440000	440000
50-yr modulus of elasticity (psi)	E_{50} =	140000	140000	140000	140000
initial compressive yield strength (psi)	$P_{A,i}$	9600	9600	9600	9600
50-yr compressive yield strength (psi)	$P_{A,50}$	3700	3700	3700	3700

B. BEDDING MATERIAL PROPERTIES

** gravel bedding*

deflection lag factor	L_f =	1.0	1.0	1.0	1.0
bedding constant	K =	0.1	0.1	0.1	0.1
modulus of soil reaction (psi)	E_s =	3000	3000	3000	3000

C. LOADING ON PIPE

$$P_{1,2} = \frac{wh}{\left(1-\frac{nd}{12}\right)} \text{ ------- for slotted pipes}$$

number of holes per row per foot of pipe	n =	2.7	0	2.7	0
diameter of holes (in.)	d =	0.375	0	0.375	0
waste unit weight (psf)	w.a =	65	65	65	65
additional fill (final cover and baseliner soil) unit weight (psf)	w.b =	125	125	125	125
height of waste, maximum, (ft.)	h2 =	230	230	230	230
height of additional fill (2.5 ft final cover plus X ft of baseliner soil)	h.add =	6.5	6.5	7.5	7.5
load of fill (psi)	P_2 =	119.5	109.5	120.5	110.3
load of fill (psf)	P_2 =	17215	15763	17352	15888

Notes:

Pipe Loading Calculation

Chaffee Landfill - Closed LF Pipes

Project No: 190260
Prepared by: L. Rohr
Checked by: R.Holmes

A. PIPE PROPERTIES		Primary LCRS	Primary LCRS	Secondary LCRS	Secondary LCRS
diameter (in.)	D =	6	6	4	4
material		PVC	PVC	PVC	PVC
perforation		PERF.	SOLID	PERF.	SOLID
specification		SCHED 40	SCHED 40	SCHED 40	SCHED 40

D. RING DEFLECTION

$$\frac{\Delta Y}{D_M} = \frac{L_f K P_{1,2} R^3}{E_{i,50} I + 0.061 E_s R^3}$$ <---- Modified Iowa Formula

$$I = \frac{t^3}{12}$$

moment of inertia (in^3)	I =	0.00183	0.00183	0.00111	0.00111
critical deflection limit (%)	$\Delta Y/D_M$ =	30.00%	30.00%	30.00%	30.00%
initial deflection (%)	$\Delta Y/D_M$ =	5.74%	5.25%	5.15%	4.72%
intitial FS	FS =	5.23	5.71	5.82	6.36
50-yr deflection (%)	$\Delta Y/D_M$ =	6.26%	5.73%	6.05%	5.54%
50-yr FS	FS =	4.80	5.24	4.96	5.42

Notes:
(1) Critical deflection limit provided by Uni-Bell for PVC material and "Design of PE Piping" for HDPE material

D. WALL BUCKLING

** 25% derating of P applied on HDPE pipe tees*

$$P_{cr} = 2\left[\frac{(E')(E_{i,50})(I/R^3)}{(1-\mu^2)}\right]^{1/2}$$

initial critical buckling pressure (psi)	P_{cr} =	597	597	845	845
initial FS	FS =	4.99	5.45	7.01	7.66
50-yr critical buckling pressure (psi)	P_{cr} =	337	337	477	477
50-yr FS	FS =	2.82	3.08	3.96	4.32

Notes:

E. WALL CRUSHING

** 25% derating of P applied on HDPE pipe tees*

$$P_{SA} = \frac{P_{1,2} D_m}{2 A_W}$$

area of pipe wall per unit circumference (in^2/in) = t	A_W	0.280	0.280	0.237	0.237
axial stress (psi)	P_{SA}	1351	1237	1080	989
initial FS	FS =	7.11	7.76	8.89	9.71
50-yr FS	FS =	2.74	2.99	3.43	3.74

Notes:

PVC Pipe Specifications, Sizes & Pressure Ratings

PVC Pipe Physical Properties		
GENERAL	**Value**	**Test Method**
Cell Classification	12454	ASTM D1784
Maximum Service Temp.	140°F	
Color	White, Dark Gray	
Specific Gravity, (g/cu.cm @ 73°F)	1.40 +/-.02	ASTM D792
Water Absorption % increase 24 hrs @ 25°C	0.05	ASTM D570
Hardness, Rockwell	110 - 120	ASTM D785
Poisson's Ratio @ 73°F	0.410	
Hazen-Williams Factor	C =150	
MECHANICAL		
Tensile Strength, psi @ 73°F	7,450	ASTM D638
Tensile Modulus of Elasticity, psi @ 73°F	420,000	ASTM D638
Flexural Strength, psi @ 73°F	14,450	ASTM D790
Flexural Modulus, psi @ 73°F	360,000	ASTM D790
Compressive Strength, psi @ 73°F	9,600	ASTM D695
Izod Impact, notched, ft-lb/in @ 73°F	0.75	ASTM D256
THERMAL		
Coefficient of Linear Expansion (in/in/°F)	2.9×10^{-5}	ASTM D696
Coefficient of Thermal Conductivity (Cal.)(cm)/(cm2)(Sec.)(°C) BTU/in/hr/ft.2/°F Watt/m/°K	 3.5×10^{-4} 1.02 0.147	ASTM C177
Heat Deflection Temperature Under Load (264 psi, annealed)	170	ASTM D648
Specific Heat, Cal./°C/gm	0.25	ASTM D2766
ELECTRICAL		
Dielectric Strength, volts/mil	1,413	ASTM D149
Dielectric Constant, 60Hz, 30°F	3.70	ASTM D150
Volume Resistivity, ohm/cm @ 95°C	1.2×10^{12}	ASTM D257
Harvel PVC Pipe is non-electrolytic		
FIRE PERFORMANCE		
Flammability Rating	V-0	UL-94
Flame Spread Index	<10	
Flame Spread	0-25	ULC
Smoke Generation	80-225	ULC
Flash Ignition Temp.	730°F	
Average Time of Burning (sec.)	<5	ASTM D635
Average Extent of Burning (mm)	<10	
Burning Rate (in/min)	Self Extinguishing	

Softening Starts (approx.)	250°F	
Material Becomes Viscous	350°F	
Material Carbonizes	425°F	
Limiting Oxygen Index (LOI)	43	ASTM D2863
Clean Room Materials Flammability Test	N/A	FM 4910

SCHEDULE 40 & 80 - DIMENSIONS

Schedule 40 Dimensions

Nom. Pipe Size (in)	O.D.	Average I.D.	Min. Wall	Nom. Wt./Ft.	Max. W.P. PSI**
1/8"	0.405	0.249	0.068	0.051	810
1/4"	0.540	0.344	0.088	0.086	780
3/8"	0.675	0.473	0.091	0.115	620
1/2"	0.840	0.602	0.109	0.170	600
3/4"	1.050	0.804	0.113	0.226	480
1"	1.315	1.029	0.133	0.333	450
1-1/4"	1.660	1.360	0.140	0.450	370
1-1/2"	1.900	1.590	0.145	0.537	330
2"	2.375	2.047	0.154	0.720	280
2-1/2"	2.875	2.445	0.203	1.136	300
3"	3.500	3.042	0.216	1.488	260
3-1/2"	4.000	3.521	0.226	1.789	240
4"	4.500	3.998	0.237	2.118	220
5"	5.563	5.016	0.258	2.874	190
6"	6.625	6.031	0.280	3.733	180
8"	8.625	7.942	0.322	5.619	160
10"	10.750	9.976	0.365	7.966	140
12"	12.750	11.889	0.406	10.534	130
14"	14.000	13.073	0.437	12.462	130
16"	16.000	14.940	0.500	16.286	130
18"	18.000	16.809	0.562	20.587	130
20"	20.000	18.743	0.593	24.183	120
24"	24.000	22.544	0.687	33.652	120

Schedule 80 Dimensions

Nom. Pipe Size (in)	O.D.	Average I.D.	Min. Wall	Nom. Wt./Ft.	Max. W.P. PSI**
1/8"	.405	.195	0.095	0.063	1230
1/4"	.540	.282	0.119	0.105	1130
3/8"	.675	.403	0.126	0.146	920
1/2"	.840	.526	0.147	0.213	850
3/4"	1.050	.722	0.154	0.289	690

1"	1.315	.936	0.179	0.424	630
1-1/4"	1.660	1.255	0.191	0.586	520
1-1/2"	1.900	1.476	0.200	0.711	470
2"	2.375	1.913	0.218	0.984	400
2-1/2"	2.875	2.290	0.276	1.500	420
3"	3.500	2.864	0.300	2.010	370
3-1/2"	4.000	3.326	0.318	2.452	350
4"	4.500	3.786	0.337	2.938	320
5"	5.563	4.768	0.375	4.078	290
6"	6.625	5.709	0.432	5.610	280
8"	8.625	7.565	0.500	8.522	250
10"	10.750	9.493	0.593	12.635	230
12"	12.750	11.294	0.687	17.384	230
14"	14.000	12.410	0.750	20.852	220
16"	16.000	14.213	0.843	26.810	220
18"	18.000	16.014	0.937	33.544	220
20"	20.000	17.814	1.031	41.047	220
24"	24.000	21.418	1.218	58.233	210

SCHEDULE 120 - DIMENSIONS

Nom. Pipe Size (in)	O.D.	Average I.D.	Min. Wall	Nom. Wt./Ft.	Max. W.P. PSI**
1/2"	.840	.480	0.170	0.236	1010
3/4"	1.050	.690	0.170	0.311	770
1"	1.315	.891	0.200	0.464	720
1-1/4"	1.660	1.204	0.215	0.649	600
1-1/2"	1.900	1.423	0.225	0.787	540
2"	2.375	1.845	0.250	1.111	470
2-1/2"	2.875	2.239	0.300	1.615	470
3"	3.500	2.758	0.350	2.306	440
4"	4.500	3.574	0.437	3.713	430
6"	6.625	5.434	0.562	7.132	370
8"	8.625	7.189	0.718	11.277	380

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HIGH DENSITY POLYETHYLENE PIPE
Typical Physical Properties***

Property	Specification	Unit	Nominal Value
Material Designation	PPI / ASTM		PE 3408
Material Classificatio	ASTM D-1248		III C 5 P34
Cell Classification	**ASTM D3350-99**		**345464C**
-Density (3)	ASTM D-1505	gm/cm3	0.955
-Melt Index (4)	ASTM D-1238 (216 kg/190¡C)	gm/10 min.	0.11*
-Flex Modulus (5)	ASTM D-790	psi	135,000
-Tensile Strength (4)	ASTM D-638	psi	3,200
PENT (6)	ASTM F-1473	Hours	>100
-HDB @73¡ F (4)	ASTM D-2837	psi	1,600
-HDB @ 140 Deg F	ASTM D-2837	psi	800
-U-V Stabilizer (C)	ASTM D-1603	% C	2.5
Hardness	ASTM D-2240	Shore “D”	65
Compressive Strength (yield)	ASTM D-695	psi	1,600
Tensile Strength @ Yield (Type IV Spec.)	ASTM D-638 (2”/min.)	psi	3,200
Elongation @ Yield	ASTM D-638	%, minimum	8
Tensile Strength @ Break (Type IV Spec.)	ASTM D-638	psi	5,000
Elongation @ Break	ASTM D-638	%, minimum	750
Modulus of Elasticity	ASTM D-638	psi	130,000
PENT (6)	ASTM F-1473	Hours	>100
(Cond. A, B, C: Mold. Slab)	ASTM D-1693	Fo, Hours	>5,000
(Compressed Ring - pipe)	ASTM F-1248	Fo, Hours	>3,500
Slow Crack Growth	Battelle Method	Days to Failure	>64
Impact Strength (IZOD) (.125Ó Thick)	ASTM D-256 (Method A)	In-lb / in notch	42
Linear Thermal Expansion Coef.	ASTM D-696	in / in/¡F	1.2x10-4
Thermal Conductivity	ASTM D-177	BTU-in/ft2/ hrs/ degreesF	2.7
Brittleness Temp.	ASTM D-746	degrees F	< -180
Vicat Soft. Temp.	ASTM D-1525	degrees F	257
Heat Fusion Cond.	ASTM D-1525	@ psi degrees F	75 @ 400

*** This list of typical physical properties is intended for basic characterization of the material and does not represent specific determin - tions of specifications. The physical properties values reported herein were determined on compression molded specimens prepared in accordance with Procedure C of ASTM D 1928 and may differ from specimens taken from pipe.
** Tests were discontinued because no failures and no indication of stress crackinitiation.
* Average Melt Index value with a standard deviation of 0.01

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PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

Iron Pipe Size (IPS) and Dimension Data

PE4710 (PE3408)

DriscoPlex® Pipe for Municipal and Industrial Applications

Pressure Ratings are calculated using 0.63 design factor for HDS at 73°F as listed in PPI TR-4 for PE 4710 materials. HDPE can accomodate up to 1.5 times the pipe pressure rating for a recurring surge and up to 2.0 times the pipe pressure rating for an occasional surge. Temperature, Chemical, and Environmental use considerations may require use of additional design factors.

Pressure Rating		335 psi DR 7.0			250 psi DR 9.0			200 psi DR 11.0			160 psi DR 13.5			
Nominal Pipe Size	IPS OD (in)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Nominal Pipe Size
1 1/4"	1.660	0.237	1.158	0.46	0.184	1.270	0.37	0.151	1.340	0.31	0.123	1.399	0.26	1 1/4"
1 1/2"	1.900	0.271	1.325	0.61	0.211	1.453	0.49	0.173	1.533	0.41	0.141	1.601	0.34	1 1/2"
2"	2.375	0.339	1.656	0.95	0.264	1.815	0.77	0.216	1.917	0.64	0.176	2.002	0.53	2"
3"	3.500	0.500	2.440	2.06	0.389	2.675	1.66	0.318	2.826	1.39	0.259	2.951	1.16	3"
4"	4.500	0.643	3.137	3.40	0.500	3.440	2.75	0.409	3.633	2.31	0.333	3.794	1.92	4"
6"	6.625	0.946	4.619	7.37	0.736	5.065	5.96	0.602	5.349	5.00	0.491	5.584	4.15	6"
8"	8.625	1.232	6.013	12.50	0.958	6.594	10.11	0.784	6.963	8.47	0.639	7.270	7.04	8"
10"	10.750	1.536	7.494	19.42	1.194	8.219	15.70	0.977	8.679	13.16	0.796	9.062	10.93	10"
12"	12.750	1.821	8.889	27.31	1.417	9.746	22.08	1.159	10.293	18.51	0.944	10.749	15.38	12"
14"	14.000	2.000	9.760	32.93	1.556	10.701	26.63	1.273	11.301	22.32	1.037	11.802	18.54	14"
16"	16.000	2.286	11.154	43.01	1.778	12.231	34.78	1.455	12.915	29.15	1.185	13.488	24.22	16"
18"	18.000	2.571	12.549	54.43	2.000	13.760	44.02	1.636	14.532	36.89	1.333	15.174	30.65	18"
20"	20.000	2.857	13.943	67.20	2.222	15.289	54.34	1.818	16.146	45.54	1.481	16.860	37.84	20"
22"	22.000	3.143	15.337	81.32	2.444	16.819	65.75	2.000	17.760	55.10	1.630	18.544	45.79	22"
24"	24.000	3.429	16.731	96.77	2.667	18.346	78.25	2.182	19.374	65.58	1.778	20.231	54.49	24"
26"	26.000				2.889	19.875	91.84	2.364	20.988	76.96	1.926	21.917	63.95	26"
28"	28.000				3.111	21.405	106.51	2.545	22.605	89.26	2.074	23.603	74.17	28"
30"	30.000				3.333	22.934	122.27	2.727	24.219	102.47	2.222	25.289	85.14	30"
32"	32.000				3.556	24.462	139.12	2.909	25.833	116.58	2.370	26.976	96.87	32"
34"	34.000				3.778	25.991	157.05	3.091	27.447	131.61	2.519	28.660	109.36	34"
36"	36.000				4.000	27.520	176.07	3.273	29.061	147.55	2.667	30.346	122.60	36"
42"	42.000							3.818	33.906	200.84	3.111	35.405	166.88	42"
48"	48.000													48"
54"	54.000													54"

This size and dimension chart is intended for reference purposes. It should not be used in place of the advice from a licensed Professional Engineer. Pipe weights are calculated in accordance with PPI TR-7. Average inside diameter is calculated using IPS OD and Minimum wall plus 6% for use in estimating fluid flows. Actual ID will vary. When designing components to fit the pipe ID, refer to pipe dimension and tolerances in the applicable pipe manufacturing specification.

Visit www.performancepipe.com for the most current literature.

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The Practical Differences in Material Properties of Flexible Pipe Products

By Darrell Sanders, P.E., and Andrew Jenkins, E.I.

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CONTECH CONSTRUCTION PRODUCTS INC.

Strain gage placement per steel-reinforced polyethylene pipe full-scale load testing

As a linear elastic material, metals behave predictably within typical service temperatures and maintain their mechanical properties under constant load (Figures 1 and 2). Thermoplastic materials exhibit non-linear elastic behavior and are sensitive to rate of strain, temperature, and creep. Creep is a visco-elastic phenomenon where the strain in a material continues to increase with time when subjected to a constant load (Figure 3). Although glass fibers show linear elastic behavior in a small displacement field (small strain), they do, along with most polymers used to fabricate plastic pipe, behave with visco-elastic characteristics and exhibit creep under long-term loads.

The industry recognizes the difference between short-term and long-term plastic pipe properties and sets elastic modulus properties accordingly. Depending on the chemistry of the thermoplastic material, the ratio of short-term to long-term elastic modulus ranges between 3 and 5.

Design for strength

All flexible pipes are designed for strength using the same general approach. For a given material, wall section, and pipe diameter: the applied loads are determined, soil-interaction with the flexible pipe is modeled, stress in the wall area is computed, then local effects such as buckling or seam strength are checked. Linear elastic materials are addressed in AASHTO LRFD Section 12.7 and non-linear plastic materials are

Table 1 – Comparison of round flexible pipe systems

Primary Structural Material	Elastic Behavior	Creep Behavior	Temperature-Dependent Behavior	Short-Term Elastic Modulus (ksi)	Long-Term Elastic Modulus (ksi)
Corrugated Steel-¼ inch & ½ inch deep	Linear	No	No	29,000	29,000
Corrugated Steel-1 inch deep	Linear	No	No	29,000	29,000
Spiral Ribbed Steel	Linear	No	No	29,000	29,000
Steel Structural Plate	Linear	No	No	29,000	29,000
Steel-Reinforced Polyethylene	Linear	No	No	29,000	29,000
Corrugated Aluminum-¼ inch & ½ inch deep	Linear	No	No	10,000	10,000
Corrugated Aluminum-1 inch deep	Linear	No	No	10,000	10,000
Spiral Ribbed Aluminum	Linear	No	No	10,000	10,000
Aluminum Structural Plate	Linear	No	No	10,000	10,000
Glass-Reinforced Polymer Mortar*	Non-Linear	Yes	Yes	2,600	1,500
Profile Wall PVC	Non-Linear	Yes	Yes	440	140-158.4
Solid Wall PVC	Non-Linear	Yes	Yes	440	140-158.4
Solid Wall HDPE	Non-Linear	Yes	Yes	110	22
Corrugated HDPE	Non-Linear	Yes	Yes	110	22

* GRPM pipe elastic modulus are apparent values based on hoop testing.

crown may completely reverse its curvature inward and collapse. See Figure 3-1A. A deflection limit of 7.5% provides at least a 3 to 1 safety factor against reverse curvature.

Bending strain occurs in the pipe wall as a result of ring deflection—outer-fiber tensile strain at the pipe springline and outer-fiber compressive strain at the crown and invert. While strain limits of 5% have been proposed, Jansen [12] reported that, on tests of PE pipe manufactured from pressure-rated resins and subjected to soil pressure only, "no upper limit from a practical design point of view seems to exist for the bending strain." In other words, as deflection increases, the pipe's performance limit will not be overstraining but reverse curvature collapse.

Thus, for non-pressure applications, a 7.5 percent deflection limit provides a large safety factor against instability and strain and is considered a safe design deflection. Some engineers will design profile wall pipe and other non-pressure pipe applications to a 5% deflection limit, but allow spot deflections up to 7.5% during field inspection.

The deflection limits for pressurized pipe are generally lower than for non-pressurized pipe. This is primarily due to strain considerations. Hoop strain from pressurization adds to the outer-fiber tensile strain. But the internal pressure acts to reround the pipe and, therefore, Eq. 3-10 overpredicts the actual long-term deflection for pressurized pipe. Safe allowable deflections for pressurized pipe are given in Table 3-11. Spangler and Handy [13] give equations for correcting deflection to account for rerounding.

TABLE 3-11
Safe Deflection Limits for Pressurized Pipe

DR or SDR	Safe Deflection as % of Diameter
32.5	7.5
26	7.5
21	7.5
17	6.0
13.5	6.0
11	5.0
9	4.0
7.3	3.0

* Based on Long-Term Design Deflection of Buried Pressurized Pipe given in ASTM F1962.

(3-40)
$$P_{WU} = \frac{f_O}{N_S} \frac{24EI}{(1 - \mu^2) D_M^3}$$

WHERE

P_{WU} = allowable unconstrained pipe wall buckling pressure, psi

DR = Dimension Ratio

E = apparent modulus of elasticity of pipe material, psi

f_O = Ovality Correction Factor, Figure 3-9

N_S = safety factor

I = Pipe wall moment of inertia, in4/in

μ = Poisson's ratio

D_M = Mean diameter, (DI + 2z or DO -t), in

D_I = pipe inside diameter, in

Z = wall-section centroidal distance from inner fiber of pipe, in (obtain from pipe producer)

Although buckling occurs rapidly, long-term external pressure can gradually deform the pipe to the point of instability. This behavior is considered viscoelastic and can be accounted for in Equations 3-39 and 3-40 by using the apparent modulus of elasticity value for the appropriate time and temperature of the specific application as given in the Appendix, Chapter 3. For Poisson's ratio, use a value of 0.45 for all PE pipe materials.

Ovality or deflection of the pipe diameter increases the local radius of curvature of the pipe wall and thus reduces buckling resistance. Ovality is typically reported as the percentage reduction in pipe diameter or:

(3-41)
$$\%DEFLECTION = 100\left(\frac{D_I - D_{MIN}}{D_I}\right)$$

WHERE

D_I = pipe inside diameter, in

D_{MIN} = pipe minimum inside diameter, in

UNI-BELL TECHNICAL REPORT

SUSTAINABLE PIPE INFRASTRUCTURE –
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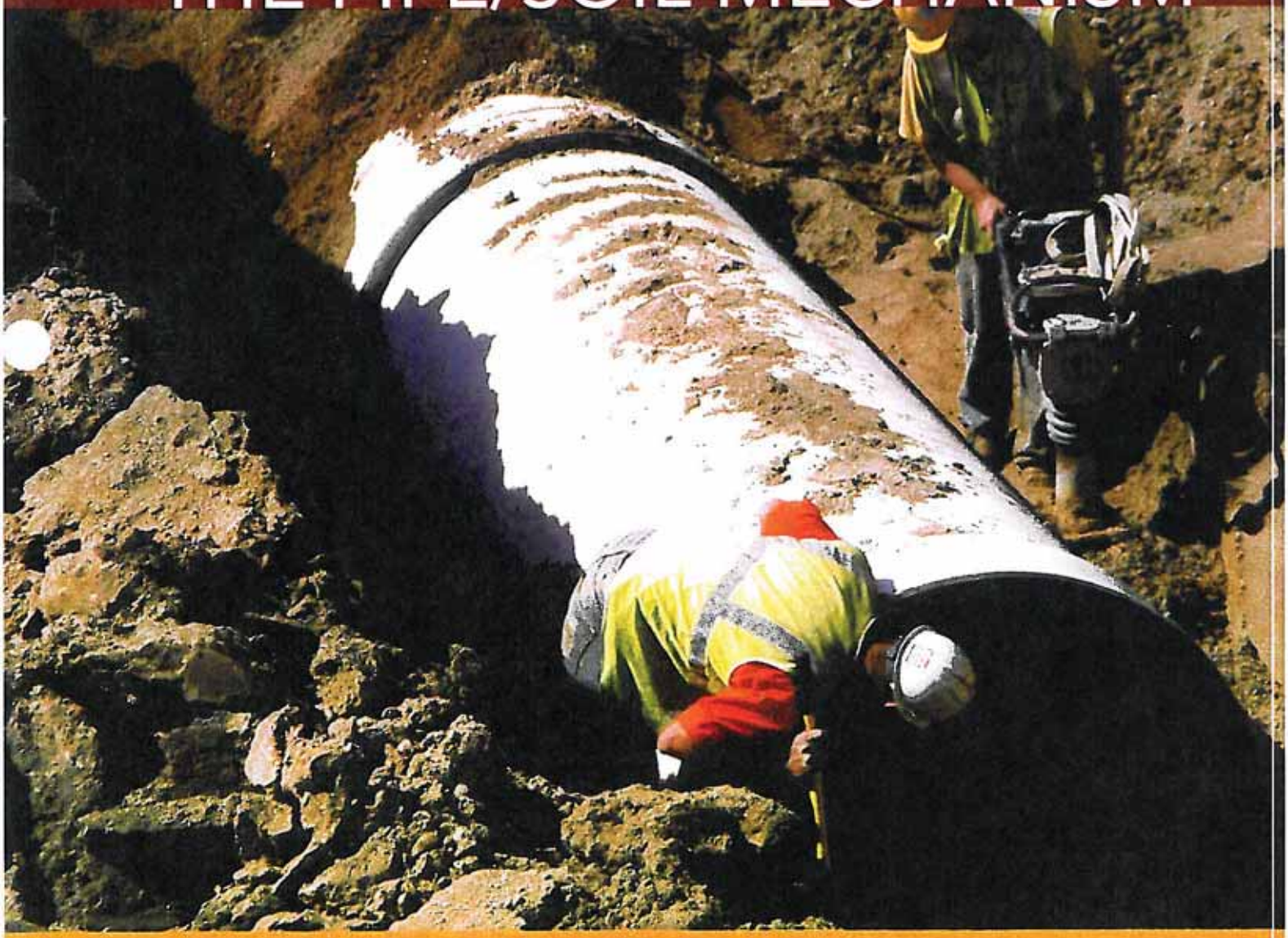
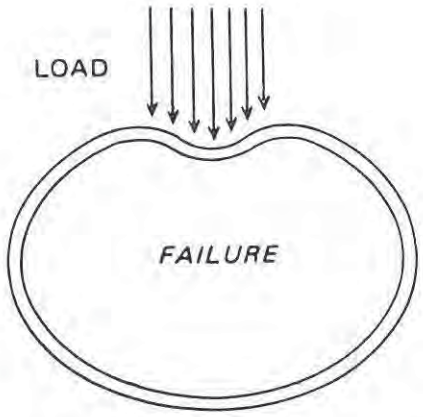
DEFLECTION:
THE PIPE/SOIL MECHANISM



This research revealed that the critical limit is established as the result of a phenomenon called inverse curvature (See Figure 11). If this limit is surpassed in a buried flexible conduit, inverse curvature in the upper portion of the pipe circumference can occur.

FIGURE 11
INVERSE CURVATURE CAUSED BY EXCESSIVE DEFLECTION



Loss of elliptical profile; the pipe can no longer effectively transfer load to side support soil.

This phenomenon in a buried flexible pipe can be considered failure in that the interrelation between the pipe stiffness and the soil stiffness is compromised. Equilibrium derived through a proper function of a flexible pipe is lost. The data indicates that while there is no catastrophic structural failure, and the pipe continues to support the load, the ability to transfer load to the side support soil is decreased once inverse curvature begins.

Figure 10a clearly reveals that inverse curvature has not yet begun at 28.3 percent. However, inverse curvature is evident in 10b at 39.6 percent. Even though the embedment material was slightly compacted, it took extremely high loads to produce these deflections. Using a unit weight of soil of 120 lbs/cu.ft., the equivalent depth of cover required to produce the deflections in Figures 10a and 10b were 88 and 131 feet, respectively.

What is perhaps more significant than this is the increased load it took to get the increase in deflection from 28.3 percent to 39.6 percent. An increase of approximately 5,000 lbs/sq.ft. was required to increase deflection by 11 percent.

Additional load was required to continue deflecting the pipe once inverse curvature began, which was observed at approximately 30 percent. This research clearly revealed that the structural

integrity of PVC pipe, with a minimum pipe stiffness of 46 psi, is maintained at deflections of 30 percent or less. It also revealed that at deflections in excess of 30 percent, additional load is required to increase deflection, but the ability to shift the load to the side columns of soil is decreased. Therefore, the critical deflection limit is 30 percent.

Selection of safety factors is essentially an arbitrary decision. A *4:1* factor of safety is selected in an effort to provide an extremely conservative recommendation for test deflection limits. The recommended allowable test deflection of 7.5 percent is arrived at by dividing 30 by 4.

Wall Structural Failure. PVC sewer pipe meeting ASTM product and performance standards must satisfy a series of quality control tests and inspection requirements. A significant test requirement in many of these standards states that "there shall be no evidence of splitting, cracking or breaking" when the pipe is subjected to the Flattening Test.[10] In this test, as a routine quality control requirement during manufacturing, samples of PVC sewer pipe are placed between parallel plates in a suitable press and flattened "until the distance between the plates is 40 percent of the outside diameter of the pipe."[10] The samples are then removed from the test apparatus and inspected for evidence of failure. Of course, in this test the PVC sewer pipe is subjected to a 60 percent deflection and must not display any signs of structural failure.

It is obvious that wall structural failure is not the critical failure mode which will establish the deflection failure limit for PVC sewer pipe. It must be emphasized that the term, "flexible pipe," is applicable to a broad range of products. Although structural failure does not dictate deflection limits for PVC sewer pipe, it should be considered the critical failure mode for some other flexible pipe products. Each flexible pipe product must be evaluated on its own merits, and design recommendations must consider the specific benefits and limitations, such as the critical structural failure mode, afforded by that product.

Strain. Strain is generally not a performance limiting factor for buried PVC pipe. Total strain in a pipe wall can be caused by two actions: (1) flexure of the pipe as it deforms and (2) hoop stress in the pipe wall. Determination of strains due to hoop stress is straight forward. If a homogeneous wall is assumed and pressure concentrations are neglected, the formula follows:

For a circular ring subjected to uniform external pressure or internal vacuum, the critical buckling pressure (P_{cr}) is defined theoretically by Timoshenko as:[13]

EQUATION 18

$$P_{cr} = \frac{3EI}{r^3}$$

Where:
P_{cr} = Critical buckling pressure, psi
E = Modulus of tensile elasticity of the PVC material, psi
I = Moment of inertia per unit length, $in^4/in = in^3$
r = Mean radius of pipe, in.

With the Moment of Inertia (I) per unit length defined as $t^3/12$, Equation 18 can be rewritten:

EQUATION 19

$$P_{cr} = \frac{2E}{\left(\frac{OD - t}{t}\right)^3} = \frac{2E}{(DR - 1)^3}$$

Where:
P_{cr} = Critical buckling pressure, psi
E = Modulus of tensile elasticity of the PVC material, psi
OD = Outside diameter, in.
t = Wall thickness, in.
DR = Dimension ratio, OD/t

For long tubes (pipelines) under stress, E must be replaced by $E/(1 - v^2)$ where v is the Poisson's Ratio ($v = 0.38$ for PVC pipe). Therefore, in PVC pipelines the critical wall buckling pressure can be properly calculated as follows:

EQUATION 20

$$P_{cr} = \frac{2E}{(1 - v^2)(DR - 1)^3}$$

Note: This equation does not apply to profile wall pipes.

Where:
P_{cr} = Critical buckling pressure, psi
E = Modulus of tensile elasticity of the PVC material, psi
DR = Dimension Ratio, OD/t
v = Poisson's Ratio (0.38 for PVC pipe)

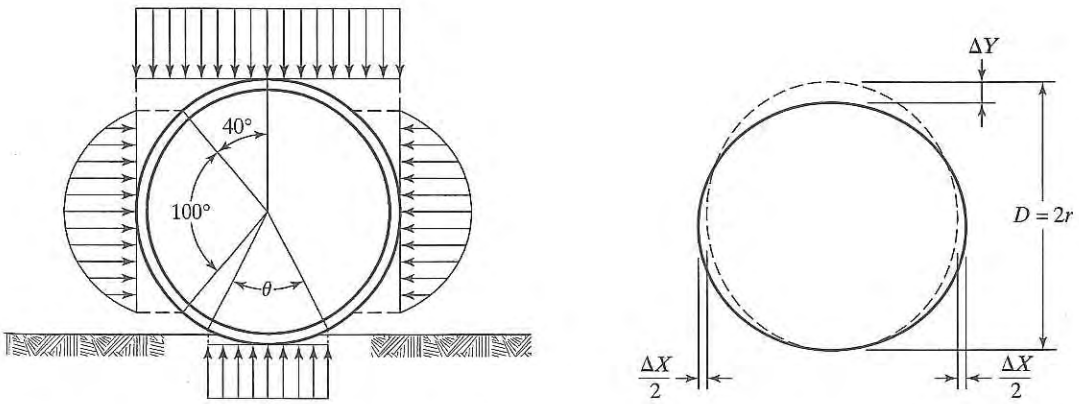
cepts is that a negative projection allows for soil arching which limits the load on the pipe. Conversely, positive projection can actually add load to the pipe. Spangler (1960), among others, explains these concepts for deeply buried pipelines. The design of a pipe must be checked to ascertain whether it will be able to withstand the load during both preconstruction and postconstruction periods. Usually one of two types of pipes are used, HDPE or PVC. These are considered as flexible type pipes. This infers that they do not rupture or break under excessive load, they deform, and if excessively, buckle and/or collapse. The basic design approach consists of calculating the deflection of the pipe, which should not exceed the allowable value. The following formula, commonly known as the Modified Iowa formula, can be used to estimate pipe deflection (Spangler and Handy, 1973; Moser, 1990).

Modified Iowa Formula:

$$\Delta X = \frac{D_L \cdot K \cdot W_c \cdot r^3}{E \cdot I + 0.061 E' \cdot r^3} \tag{9.16}$$

where ΔX = horizontal deflection, in or m (Figure 9.6);
K = bedding constant, its value depending on the bedding angle (see Table 9.1 and Figure 9.7); also, as a general rule, a value of $K = 0.1$ is assumed;
D_L = deflection lag factor (see Table 9.2);
W_c = vertical load per unit length of the pipe, lb/in or kN/m;
r = mean radius of the pipe, $r = (D_o - t)/2$, in or m;
E = elastic modulus of the pipe material, lb/in^2 or kN/m^2;
I = moment of inertia of the pipe wall per unit length, $I = t^3/12$, in^4/in = in^3 or m^4/m = m^3;
t = thickness of pipe, in or m; and
E' = soil reaction modulus, lb/in^2 or kN/m^2, see Table 9.3.

Bedding Constant, K



(a) Assumed pressure distribution on flexible pipe (b) Pipe deflection under pressure

FIGURE 9.6 Buried Flexible Pipe

TABLE 9.2 Approximate Range of Values of D_L

Deflection Lag Factor, L_f

Variable	Range	Remarks
D_L	1.5 to 2.5 1.0	If the soil in the trench is not compacted, then the higher value of D_L should be used. When deflection calculations are based on prism loads.

TABLE 9.3 Average Values of Soil Reaction Modulus, E' (for Short Term Flexible Pipe Deflection) (Howard, 1977)

Soil type-pipe bedding material (United Classification System)[a]	E' for degree of compaction of bedding			
	Dumped	Slight, < 85% Proctor, < 40% relative density	Moderate, 85%–95% Proctor, 40%–70% relative density	High, > 95% Proctor, > 70% relative density
Fine-grained soils (LL > 50)[b] Soils with medium to high plasticity CH, MH, CH-MH	No data available; consult a competent soils engineer; Otherwise use $E' = 0$			
Fine-grained soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with less than 25% coarse-grained particles	50 lb/in^2 (345 kN/m^2)	200 lb/in^2 (1,380 kN/m^2)	400 lb/in^2 (2,760 kN/m^2)	1,000 lb/in^2 (6,900 kN/m^2)
Fine-grained soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with more than 25% coarse-grained particles	100 lb/in^2 (690 kN/m^2)	400 lb/in^2 (2,760 kN/m^2)	1,000 lb/in^2 (6,900 kN/m^2)	2,000 lb/in^2 (13,800 kN/m^2)
Coarse-grained soils with fines GM, GC, SM, SC contains more than 12% fines				
Coarse-grained soils with little or no fines GW, GP, SW, SP[c] contains less than 12% fines	200 lb/in^2 (1,380 kN/m^2)	1,000 lb/in^2 (6,900 kN/m^2)	2,000 lb/in^2 (13,800 kN/m^2)	3,000 lb/in^2 (20,700 kN/m^2)
Crushed rock	1,000 lb/in^2 (6,900 kN/m^2)	3,000 lb/in^2 (20,700 kN/m^2)	3,000 lb/in^2 (20,700 kN/m^2)	3,000 lb/in^2 (20,700 kN/m^2)
Accuracy in term of percentage deflection[d]	±2	±2	±1	±0.5

E_s

[a] ASTM Designation D2487, USBR Designation E-3
[b] LL = Liquid Limit
[c] or any borderline soil beginning with one of these symbols (i.e., GM-GC, GC-SC)
[d] for ±1% accuracy and predicted deflection of 3%, actual deflection would be between 2% and 4%

Note: Values applicable only for soil fills less than 50 ft (15 m). Table does not include any safety factor. For use in predicting initial deflections only—appropriate deflection lag factor must be applied for long-term deflections. If bedding falls on the borderline between two compaction categories, select lower E' value or average the two values. Percentage Proctor based on laboratory maximum dry density from test standards using about 12,500 ft-lb/ft^3 (600 m-kN/m^3) (ASTM D698, AASHO T-99, USBR Designation E-11).

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HDPE Fittings

Pressure Ratings for Molded and Fabricated Fittings

There are two basic methods of creating most HDPE fittings, either by injection molding or by fabricating from pipe or cylinders. Molded fittings are typically fully pressure rated, since the body of the molded fitting is thicker (extra material around the OD, except at the ends) than the pipe to provide additional strength and maintain the intended pressure rating. Fittings that are typically made by injection molding are 90 degree elbows, 45 degree elbows, tees, reducers, end caps and flange adapters. Molded fittings are typically available in 12" and smaller sizes due to cost and processing reasons.

Fabricated elbows or ells have a reduced pressure rating because the miter cut and weld create an effective diameter change at that point. Stress is increased because of changes in flow direction. The larger the angle of the miter cut, the greater the stress and the greater the need to decrease the pressure rating to maintain an adequate safety factor, typically accepted as 2 to 1.

In the past, a standard 25% derating for HDPE elbows has commonly been used throughout the industry. With the advent of elbows made with larger miter angles (i.e. 3 segment 90/2 segment 45) and new resins, a more systematic approach was needed. The American Society of Mechanical Engineers offers an equation within the process piping code B31.3. In section 304.2, equations 4a and 4b are used to determine pressure ratings of mitered elbows. For HDPE piping, the pressure rating is based on three criteria: the miter angle, the resin's material properties (Pipe Design Stress), and the wall thickness.

The outputs of these equations result in the pressure rating charts that are shown in Table 3 and the margins of the pages of this catalog for each style elbow. In a couple of instances, the listed pressure ratings are 2-3% higher than the calculated values so that, for simplicity in ordering, they will match an existing pressure rating of a pipe with a higher DR (thinner wall). This is justifiable when you consider the majority of pipe comes with an average wall thickness that 3 to 6 % greater than the required minimum wall. Also, rarely is a pipe system designed so that it operates consistently at 98% or greater of full pipe pressure rating. The standard ISCO warranty applies to all fittings at the listed ratings we are publish in this catalog version.

Other fittings such as tees and wyes do not have formulas to account for the pressure ratings. Recently, modeling of fittings has served to confirm or contradict historical/legacy rating of fittings. Fabricated tees have typically held a 25% derating in the past, but as with elbows, the strength of the fitting is affected by the wall thickness. Tees made from DR 13.5 or thinner are now derated by 35%. Crosses are of similar form and function, so for DR 11 and thicker crosses, the rerating factor will be 50%, while thinner walls will be 60% derated. Wyes have had a historical/legacy derating in the industry of 40% but modeling has confirmed they should be considered much weaker, so a derating factor of 67% has been applied.

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Table 3: Re-rating Factors for Fabricating Fittings

For HDPE fittings made from pipe with no additional reinforcement

Elbows fabricated with 11.25 mitered cuts - including 5 segment 90° mitered bend, 3 segment 45° mitered bend, and 22.5° mitered bend	DR	Rerating %:
	7	82%
	9	80%
	11	78%
	13.5	76%
	15.5	75%
	17	74%
	21	72%
	26	69%
	32.5	67%
Elbows fabricated with 22.5 mitered cuts - including 3 segment 90° mitered bend and 2 segment 45° mitered bend	DR	Rerating %:
	7	69%
	9	66%
	11	63%
	13.5	60%
	15.5	59%
	17	57%
	21	55%
	26	52%
	32.5	49%
Tees-Fabricated	DR	Rerating %:
	7, 9, 11	75%
	13.5 - 32.5	65%
Branch Saddle Reducing Tee	DR	Rerating %:
	7 - 32.5	100%
Crosses-Fabricated	DR	Rerating %:
	7, 9, 11	60%
	13.5 - 32.5	50%
Lateral Wyes-Fabricated	DR	Rerating %:
	7, 9, 11	33%
	13.5 - 32.5	33%
Caps- Fabricated Flat, Non-Molded * Fully pressure rated caps are typically available to match pipe in all DR's up to 24". Larger caps may have reduced capacity-verify pressure requirements at time of order.	DR	Rerating %:
	7 - 32.5	* conditional
Plastic Blind Flanges- HDPE/PVC * Blind Flanges are available in 1" thick as standard with limited ranges of full pressure capacity. Some additional thickness options are available. Larger blinds likely have reduced capacity-verify pressure requirements at time of order.	DR	Rerating %:
	7 - 32.5	* conditional
Cleanout Fittings-HDPE Cleanout Fittings are used in gravity flow applications and are only designed for preventing the intrusion of ambeint environment into the pipe.	DR	Rerating %:
	7 - 32.5	0%

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