STORMWATER REPORT

FOR

FACTORY SQUARE

3, 5 & 7 FISHER STREET

FRANKLIN, MASSACHUSETTS

NOVEMBER 5, 2021

Prepared By:

Level Design Group, L.L.C.

249 South Street, Unit 1

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Prepared For:

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Franklin, MA 02052

LDG Project No.:
1899.00

LEVEL
DESIGN GROUP

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HYDROLOGIC SUMMARY

METHODOLOGY

The HydroCAD computer program (HydroCAD) was used to model the existing and proposed hydrology of the site and design a stormwater management system. HydroCAD generates flood hydrographs dependent upon the type of land use, vegetation, soil types, land slope, watershed areas and rainfall data. HydroCAD also takes into account the antecedent moisture condition of the soil. The peak rate of runoff and volume of runoff are projected for the input storm frequency events (design storms).

Rainfall data was obtained from the Northeast Regional Climate Center and are based on Extreme Precipitation Events for the 2" Storm Event and the 2-, 10-, 25- and 100-year return periods Plainville, Massachusetts. A 24-hour type III rainfall distribution was used in the HydroCAD analysis as prescribed for New England by the Northeast Regional Climate Center. A copy of the precipitation table is included herein.

PRE-DEVELOPMENT CONDITIONS

The existing site is located at 3, 5 & 7Fisher Street in Franklin, MA. The majority of the site is developed with old factory and mixed use buildings. A small area of the site to the south east is undeveloped but is landscaped with grass and existing mature trees. The Site is bounded by West Central Street to the north. Fisher Street to the east, Hayward Street to the south and an existing BVW to the west. The adjacent properties to the roadways are residential with exception toward the southwest are more commercial facilities. The development site is approximately 14.7 ± Acres with approximately 85% of the existing property being developed with various sized and use buildings, pavement and utilities. Existing ground cover of the site includes the asphalt pavement and building footprint. The existing site does contain a formal stormwater management system which ultimately drains to the Bordering Vegetated Wetlands to the West.

The majority of the site is defined as redevelopment. The existing stormwater system serves the existing building and pavement and will be utilized to the maximum extent feasible for the redevelopment project. Approximately 10,000 s.f. of pavement and roof area will be removed and replaced with green space. This reduction in impervious area will cause runoff to be reduced for the redevelopment portion of the site. Due to the complexity of the existing utility systems the applicant is proposing to re-use the current configuration where feasible. Modified piping and drainage where necessary in the redevelopment area is shown on the site plans. The redevelopment area has not been modeled for pre- and post- runoff due to the reduction of impervious area and the implied reduction of runoff to the same drainage point (the westerly BVW system).

The on-site soils as classified by the Soil Survey for Norfolk County Massachusetts, the redevelopment portion of the site area is classified as Urban Land. The new construction area of new parking is located in an area of Udorthents sandy, Hydrologic Soil Group A which are soils having a high infiltration rate (low runoff potential) when thoroughly wet. These soils consist mainly of deep, well drained to excessively drained sands or gravelly sands. Based on test pits done by Level Design Group, LLC parent material of the area for new construction is a Medium Gravelly Sand with a classification of HSG A. Please see the SCS soils documentation attached herein.

POST-DEVELOPMENT CONDITIONS

The Applicant is proposing to redevelop the site and renovate and rehab the existing buildings for a mixed-use development. A portion of the existing buildings will be demolished and replaced with parking, patios and green space. The existing catch basins and drainage in those area will be re-used to capture the runoff from the reconfigured impervious areas. Impervious areas will be reduced for the redevelopment areas and due to the complexity of the site the existing drainage will stay in place to the maximum extent feasible and no additional calculations will be provided for the existing system. During construction, if it is determined that a portion of the existing system is failing or inadequate, the engineer shall be consulted and a replacement or redesign of those components will be considered.

A new fully compliant stormwater management system has been designed to support the area of new construction in the southeast corner of the property. The newly designed parking lot will collect the runoff, treat it, and infiltrated the runoff into a subsurface infiltration system. Deep sump catch basins will capture the runoff, then it will be routed through proprietary treatment structures, then infiltrated after pretreatment has been achieved. Runoff from the impervious areas and building rooftops will be directed to two infiltrating BMPs.

A fully compliant stormwater management system for the new construction portion of the site addressing compliance with the 10 MADEP Stormwater Standards will be part of the site redevelopment. Site improvement have been made to the maximum extent practicable in accordance with MADEP Stormwater Regulations.

STANDARD 1: Untreated Discharges

Stormwater Management Standard 1 requires that, “No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth”.

This standard is met by the proposed redevelopment not creating any new non-treated stormwater discharges. All surface runoff from the proposed impervious areas is collected and treated for suspended solids removal and directed to the existing on-site drainage line. The treatment of the site drainage prior to discharge mimic existing drainage flow patterns while maintaining a cleaner site flow.

STANDARD 2: Peak Rate Control and Flood Prevention

Stormwater Management Standard 2 requires that, “Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for land subject to coastal storm flowage.”

This standard is met by the proposed development mitigating the post-development peak discharge rates at the designated control point for all design storm events. This is accomplished by directing stormwater flow from the proposed building roof area to multiple infiltration systems located on the site. Below is a description of the control point used in the hydrologic analysis and a summary of pre- and post- development discharge rates. The proposed development will reduce the peak rate of runoff at all the design control points and provide ample groundwater recharge.

SUMMARY OF PEAK STORMWATER RUNOFF (CFS)

One singular control point was used in the analysis. This point was chosen as it is the outfall at the terminus of the on-site channel. There is an accumulation along the short path of the channel as depicted in the HydroCAD.

Control Point – R1				
Storm	Pre-Dev. Flow (CFS)	Post-Dev. Flow (CFS	Pre-Dev .,Volume (af)	Post-Dev. Volume (af)
2-yr	30.12	26.74	0.041	0.038
10-yr	55.51	51.32	0.064	0.060
100-yr	126.84	119.71	0.117	0.112

The roadway included in the calculations is a constant, but the roadway area (estimated) contributes approximately ¼ of the flow to each the pre and post development scenarios. The net peak discharge is controlled and does not increase at the control points for any of the evaluated design storms.

STANDARD 3: Recharge to Groundwater

Stormwater Management Standard 3 requires that, "Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures, including environmentally sensitive site design, low impact development techniques, best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from the pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook."

This standard is fulfilled through the infiltration of the proposed building roof area. This 12,230 s.f. is controlled through proposed Stormtech infiltration field, which overflow to each other until the final basin which has a catch basin grate, which will flow to the low point double catch basin, flow through the on-site CDS prior to discharge. There is very little infiltration which occurs through the on-site 4,000 s.f. of pervious area. All stormwater discharged to the proposed infiltration practices is roof drainage and is considered "clean" by stormwater standards and the remainder of the site discharge is treated in excess of 44% TSS removal prior to discharge to the municipal system. Below is a detailed calculation demonstrating full compliance with the recharge to groundwater requirements.

GROUND WATER RECHARGE

The on-site soils as classified by the Soil Survey for Bristol County Massachusetts, Northern Part are Hinckley loamy sand, 8 to 15 percent slopes, Hydrologic Soil Group (HSG) B. Based on test pits by Level Design Group, LLC, on-site parent soils are identified as sand and/or gravelly sand within the area of the proposed infiltration basins and an infiltration rate of 2.41 inches per hour was used based on the Rawls Rates and the material observed. The required infiltration for a HSG B soil is 0.35 inches of runoff times the total impervious area.

The post-development increase in impervious area must be utilized for the recharge calculations as a redevelopment project. However, there is an overall decrease in impervious area on-site through the development. As such the evaluation which took place incorporates the final site impervious area for the analysis. The required recharge volume is calculated as follows:

Required Recharge Volume for the New Development area = (70,278± sf of impervious area) x (0.35 in of runoff for HSG B) x (1 ft./12 in.) = <u>1,317± cu. ft.</u>

Franklin Stormwater By-Law Required Recharge Volume for the Development = (237,961± sf of impervious area) x (0.80 in of runoff for Franklin Standards) x (1 ft./12 in.) = <u>15,864± cu. ft.</u>

Water used to satisfy the recharge to groundwater standard is from pretreated surface runoff from the parking area and driveway and from the proposed building rooftops. The Simple Dynamic Method of Recharge Volume was utilized to calculate recharged groundwater.

<u>Simple Dynamic Method Calculations for all proposed infiltration practices:</u>

<u>Required Recharge Volume:</u>

Rv = F x impervious area created
Rv = (HSG "B") x (impervious area created)

<u>Recharge Volume Provided:</u>

A=Rv÷(d+Kt), where d=depth below outlet, Kt=Rawls Rate=2.41 inches per hour
t=time (2 hours – Stormwater Handbook Recommendation)

Minimum Required Volume of Infiltration Practice = V (cf) =A x d (or n x d where n is the void space % of the system) where n =Overall Storage Efficiency of the Infiltration pits, d = depth below lowest outlet

The calculations for each of the infiltration systems are detailed in the table below.

System	*Impervious Area (sf.)*	*Rv (cf)*	**n x d (ft)*	*Kt in/hr*	*t (hr)*	*Min Req. Area (sf).*	*Minimum Volume Required (cf)*	*Volume Provided Below Outlet (cf.)*
Stormtech Infiltratio n	45,146	0	*n=0.72 d=6 nd=4.32	*2.41*	*2*	0	15,864	*16,300*

**overall storage system efficiency values (n) for the Infiltration Pits is taken from HydroCAD Chamber Wizard for each basin.*

The total minimum recharge volume requirement 15,864± cu. ft. for the entire site is exceeded with a total provided recharge volume of 16,300± cu.ft. of storage provided below the lowest outlet of each subsurface infiltration system. All proposed systems far exceed the required design volumes as detailed in the above table.

STANDARD 4: 80% TSS Removal

Stormwater Management Standard 4 requires that, "Stormwater management systems must be designed to remove 80% of the average annual post-construction of Total Suspended Solids (TSS). This standard is met when:

a. Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan and thereafter are implemented and maintained;
b. Stormwater BMPs are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook and;
c. Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook"

This standard is met by collecting all surface runoff form all paved areas with deep sump and hooded catch basins. This flow is then treated by a CDS or VortSentry Stormwater Treatment Unit prior to discharge to an infiltration basin providing greater than the required 80% TSS removal as detailed in the attached MADEP TSS Removal Calculation Sheets.

<u>Water Quality Calculations:</u>

The volume of stormwater runoff to be treated for water quality is calculated as one-half inches times the total post-development impervious area of the site based on current MADEP Stormwater Management Standards. With the understanding that the proposed development sensitive resources downstream from the development water quality calculations detail compliance with a water quality volume equal to one inch times the total post-development impervious The water quality volume calculation is detailed below.

Total Site Imperious Area= 70,278± ± s.f.
1.0 inch x 1 foot/12 inches= 0.0833 feet
0.0833 feet x 70,278± s.f.= 5,854± cu.ft.

Total Volume to be treated for Water Quality= 5,854± cu.ft.

As detailed above, the proposed infiltration system provides 16,300± cu.ft. of volume below their lowest outlets. This volume satisfies the required 5,854± cu.ft of water quality volume to be treated for the proposed development. To achieve the required 44% TSS removal prior to flow being infiltrated a variety of structural practices are utilized. All impervious areas, not including roof top runoff directly piped to an infiltration practice, will be collected in deep sump and hooded catch basins and treated by a CDS Stormwater Treatment Unit to achieve the minimum 44% TSS removal required for each system prior to flows being infiltrated. Sizing calculation for the two Stormwater Treatment Units is detailed below.

The overall water quality onsite is improved through the installation of treatment units at two main locations, other than the new development area. The two areas of installation are the reconfigured parking area to the south of 5 Fisher Street. This parking area previously travelled under the existing structure and connected into the existing line which traverses the site from Fisher Street. This it being reconfigured with a new main drain line outside of the building footprint and a CDS treatment units prior to discharge into the main drain. The second area is in the location of building removal and replacement with parking area. The replacement will decrease the on-site impervious however will still pick up the overall from the CB's on West Central Street as it does today. This flow will be treated through a new CDS unit as well prior to discharge, onsite. The treatment exceeds the requirements for discharge on property.

CDS Stormwater Treatment Unit Sizing

The CDS Units are sized using the *Massachusetts Department of Environmental Protection Wetlands Program – Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Practices*.

Flow to DBLE CB

$Q_{1.0}$=(qu)(A)(WQV)
qu=774 csm/in for a Tc of 0.1 hours (taken from Figure 2 of the Massachusetts Department of Environmental Protection Wetlands program - Standard Method to Convert Required Water Quality Volume to a Discharge Rate
A=0.587 Acres
WQV=1.0 inches

$Q_{1.0}$ =(774 csm/in) (0.587 acres - impervious coverage) (0.0015625 sq. mi / acre) (1.0 inch)

Q1.0 = 0.059 cfs < CDS Model 2015 with a Treatment Capacity =1.4 cfs

Flow to CB

$Q_{1.0}$=(qu)(A)(WQV)

qu=774 csm/in for a Tc of 0.1 hours (taken from Figure 2 of the Massachusetts Department of Environmental Protection Wetlands program - Standard Method to Convert Required Water Quality Volume to a Discharge Rate
A=0.179 acres
WQV=1.0 inches
$Q_{1.0}$ =(774 csm/in) (0.179 acres) (0.0015625 sq. mi / acre) (1.0 inch)

$Q_{1.0}$ = 0.018 cfs < VortSentry with a Treatment Capacity = 1.2 cfs

STANDARD 5: Higher Potential Pollutant Loads

Stormwater Management Standard 5 requires that, "For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention, all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt and stormwater runoff, the proponent shall use the specific stormwater BMPs determined by the Department to be suitable for such use as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 2,§26-53, and the regulations promulgated thereunder at 314 CMF 3.00, 314 CMR 4.00 and 314 CMR 5.00."

The proposed use in not considered a use that would generate Higher Potential Pollutant Loads.

STANDARD 6: Critical Areas

Stormwater Management Standard 6 requires that Stormwater discharge to a Zone II Interim Wellhead Protection Area of a public water supply and stormwater discharges near any other critical area require the use of specific source control and pollution prevention measures and the specific stormwater best management practices determined by the Department to be suitable for managing discharges to such area, as provided in the Massachusetts Stormwater Handbook. A discharge near a critical area, if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters or Special Resource Waters shall be set back from the receiving water and receive the highest and best practical method of treatment. A "stormwater discharge," as defined in 314 CMR 3.04(2)(a)1. or (b), to an Outstanding Resource Waters or Special Resource Waters shall comply with 314 CMF 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A area prohibited unless essential to the operation of the public water supply."

The development site is not located within a Critical Area as defined by the Massachusetts Stormwater Handbook.

STANDARD 7: Redevelopment and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The definition of a Redevelopment Project under the definition provided in the MADEP Stormwater Handbook for Standard 7 is listed below:

> "Development rehabilitation, expansion and phased projected on previously developed sites, provided that redevelopment results in no next increase in impervious area."

The proposed development is considered a Redevelopment Project however, it fully complies with the requirements of the MADEP Stormwater Management Standards.

STANDARD 8: Erosion and Sediment Control

Stormwater Management Standard 8 requires that, "A plan to control construction-related impacts, including erosion sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan), must be developed and implemented."

This standard is met by including erosion and sediment controls within the design plans. A gravel construction entrance is proposed at the access point to the site once the pavement is removed from that area of the site. A 9" diameter Filtrexx Silt Sox is proposed at the limits of all site related construction activities. Silt sacks are also proposed to be installed in all of the existing catch basins within the area of the proposed site disturbance and within proposed structures until the site has been stabilized and the stormwater management system is brought on-line. A draft Stormwater Pollution Prevention Plan (SWPPP) has been prepared and is included as part of the Stormwater Report. The SWPPP will be finalized prior to construction as required when a NPDES General Construction Permit is applied for.

STANDARD 9: Operation and Maintenance

Stormwater Management Standard 9 requires that, "A long-term operation and maintenance plan must be developed and implemented to ensure that stormwater management systems function as designed".

This standard is fully met with development and implementation of an Operation and Maintenance Plan, which is included in Stormwater Management Report.

STANDARD 10: Illicit Discharges

Stormwater Management Standard 10 requires that, "All illicit discharges to the stormwater management system are prohibited".

This standard is fully met with development and implementation of a Long Term Pollution Prevention which is included in the Stormwater Management Report. An Illicit Discharge statement has been prepared and is included herein.

22CONCLUSION

The proposed development of this parcel will be a significant improvement to the area and to the on-site resource areas. The proposed development meets or exceeds the current MADEP Stormwater Management Standards and Guidelines and provides a stormwater management system that will maintain water quality while attenuating peak rates of runoff at the control points which providing maximum on-site groundwater recharge. This was achieved by using pretreatment BMPs and directing the stormwater runoff to multiple infiltration basins which attenuate peak flows while maximizing groundwater recharge and providing high a level of TSS removal. An Operation and Maintenance Plan for post-construction maintenance of the Stormwater Management System has been developed and is included with this report.

MADEP Stormwater Report Checklist

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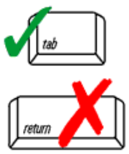
TEL 508 695 2221 FAX 508 695 2219 CONTACT@LEVELDG.COM LEVELDG.COM

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

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[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

COMMONWEALTH OF MASSACHUSETTS
DANIEL R. CAMPBELL
CIVIL
No. 46245
REGISTERED
PROFESSIONAL ENGINEER

7/6/21
Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☒ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☒ Reduced Impervious Area (Redevelopment Only)
- ☐ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of “country drainage” versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☐ Other (describe): ____________________

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☐ Static ☒ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☐ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist (continued)

Standard 3: Recharge (continued)

☒ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:
- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☐ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☒ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☒ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☒ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

To be completed at the end of permitting for review by the Town selected review Engineer

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☒ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☐ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

USGS Topographic Map (MAGIS)

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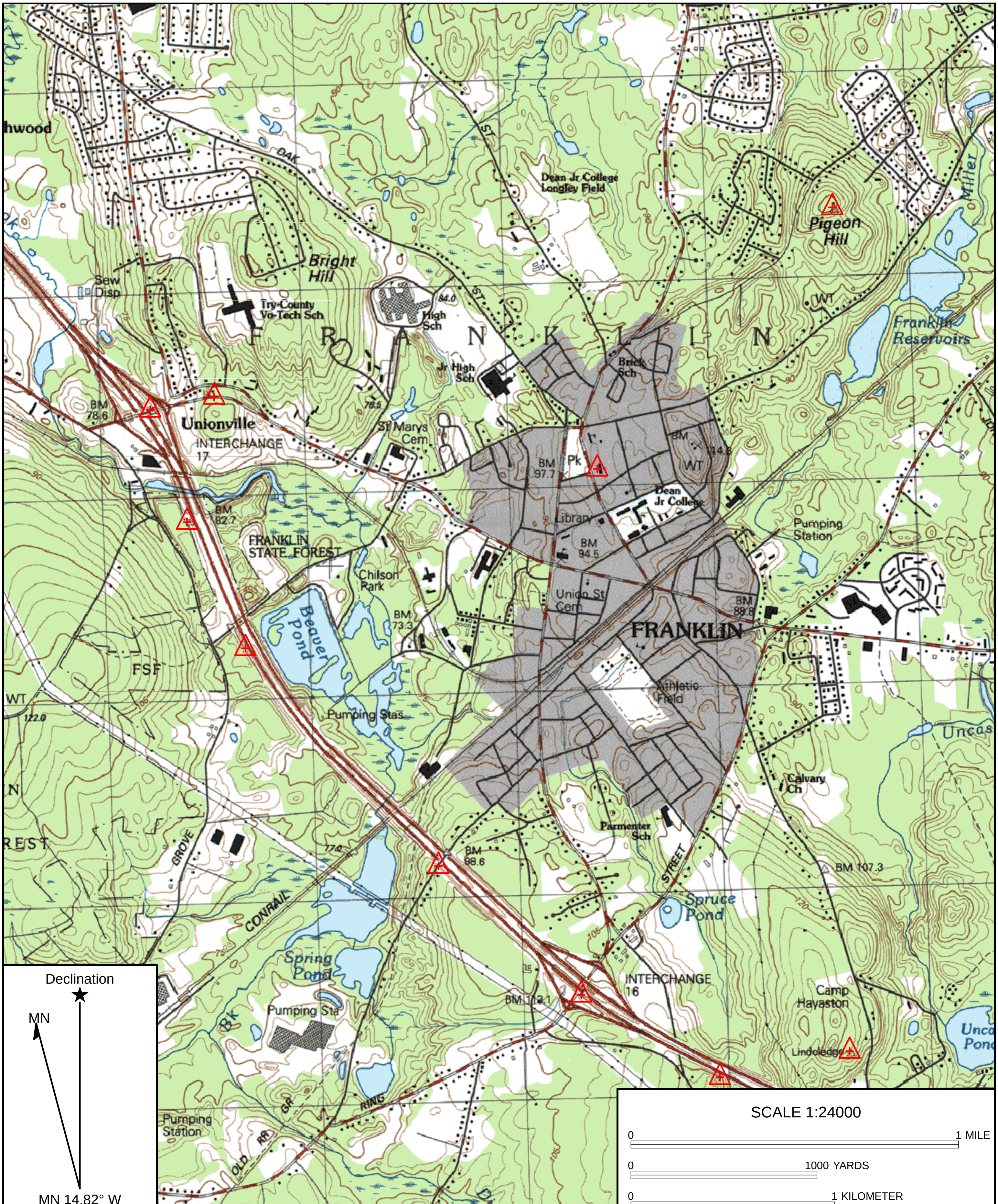

Name: FRANKLIN
Date: 06/29/21
Scale: 1 inch = 2,000 ft.

Location: 042° 04' 53.36" N 071° 24' 23.57" W

DESIGN GROUP

FEMA FIRM Map

249 SOUTH STREET UNIT 1 PLAINVILLE MA 02762
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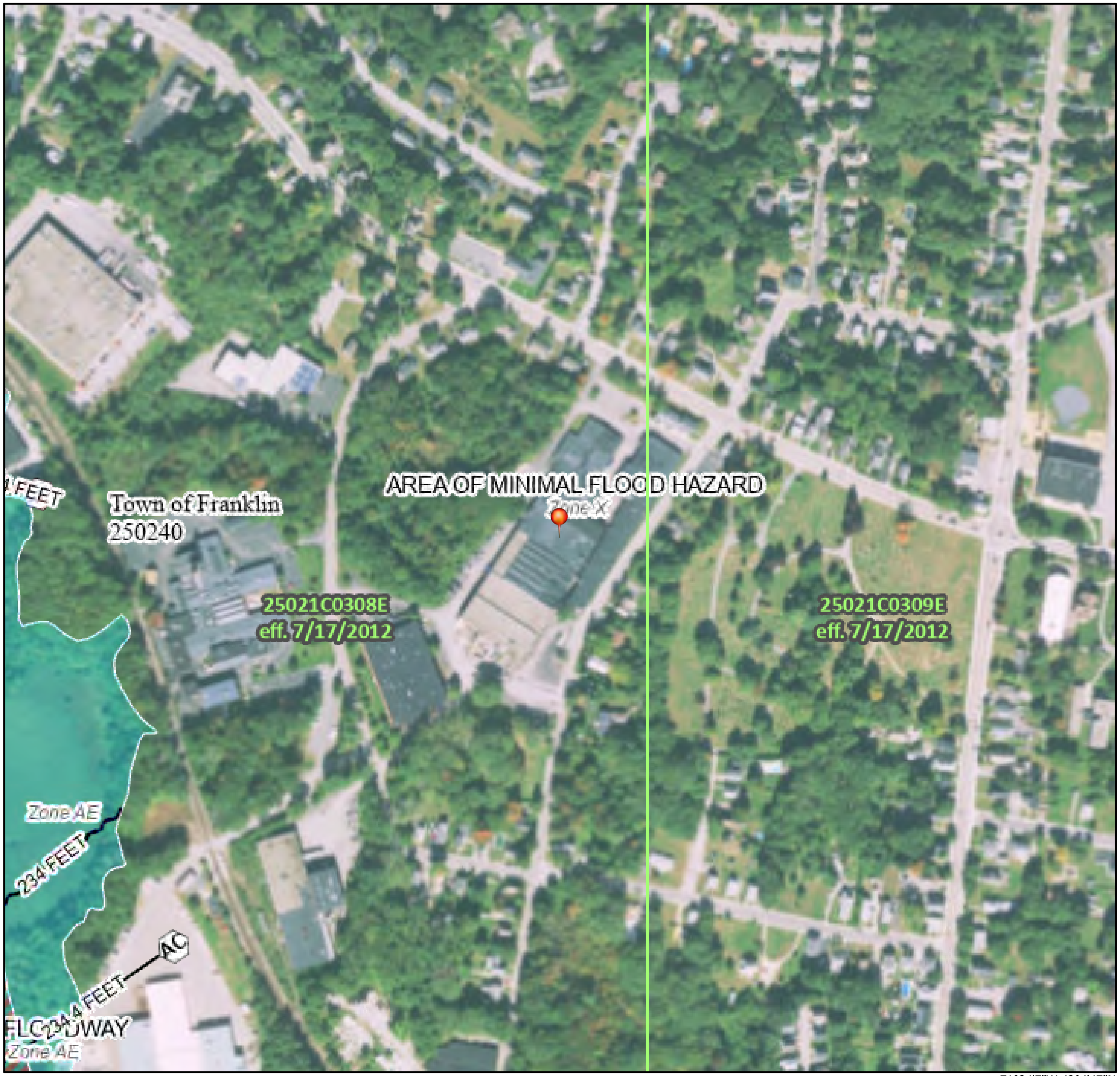
National Flood Hazard Layer FIRMette

FEMA

71°24'44"W 42°5'14"N



71°24'7"W 42°4'47"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
	Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X*
	Effective LOMRs
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	B 20.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
	8 Coastal Transect
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
MAP PANELS	Digital Data Available
	No Digital Data Available
	Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/21/2021 at 8:31 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

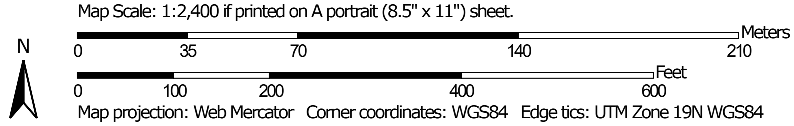
LEVEL
DESIGN GROUP

On-Site Soils Documentation

249 SOUTH STREET UNIT 1 PLAINVILLE MA 02762
TEL 508 695 2221 FAX 508 695 2219 CONTACT@LEVELDG.COM LEVELDG.COM

Soil Map—Norfolk and Suffolk Counties, Massachusetts
(5 FISHER REDEVELOPMENT)

Map Scale: 1:2,400 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 16, Jun 11, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 5, 2019—Jul 8, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
51	Swansea muck, 0 to 1 percent slopes	1.3	7.4%
245B	Hinckley loamy sand, 3 to 8 percent slopes	3.4	19.7%
602	Urban land, 0 to 15 percent slopes	8.9	51.6%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	1.0	5.7%
653	Udorthents, sandy	2.7	15.6%
Totals for Area of Interest		**17.3**	**100.0%**

Hydrologic Soil Group—Norfolk and Suffolk Counties, Massachusetts
(5 FISHER REDEVELOPMENT)

Map Scale: 1:2,400 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 35, 70, 140, 210

Feet: 0, 100, 200, 400, 600

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 16, Jun 11, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 5, 2019—Jul 8, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
51	Swansea muck, 0 to 1 percent slopes	B/D	1.3	7.4%
245B	Hinckley loamy sand, 3 to 8 percent slopes	A	3.4	19.7%
602	Urban land, 0 to 15 percent slopes		8.9	51.6%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	A	1.0	5.7%
653	Udorthents, sandy	A	2.7	15.6%
Totals for Area of Interest			**17.3**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Soil Testing

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GROUNDWATER MOUND UNDER A RECTANGULAR RECHARGE AREA Using the Hantush (1967) Derivation

Inputs

w (Percolation Rate): 16.54 **[L/T]*K (Hydraulic Conductivity)*:** 16.54 **[L/T]*S***

(Specific Yield): 22 **[-]*t*(Time):** 3 **[T]h_i**

(Initial Saturated Thickness): 248.2 **[L]*a (Length of Recharge Area)*:** 110.42 **[L]*b***
(Width of Recharge Area): 68 **[L]**

****KEEP UNITS CONSISTENT****

Calculate

Results

****Note that because of estimations of an integral function, this is an estimate****

Maximum hydraulic head: 250.27937332 **[L]Increase in hydraulic head:** 2.07937332 **[L]**

Hantush, M.S.(1967). *Growth and Decay of Groundwater-Mounds in Response to Uniform Percolation*, Water Resources Research vol. 3, no.1, pp 227-234.

Example:

Whatis the maximum mounding at the water table if 1000 liters/day of wateris discharged on an area 3 x 4 m after 2 days (all water infiltrates). Given a hydraulic conductivity of 1 x10^{-6} m/s, and specific yield of 0.01 and an initial saturated thickness of 2 m.

Your results should yield a maximum hydraulic head of approximately 3.3 m and an increase in hydraulic head of 1.3 m.

What might have gone wrong?

- converting from 1000 liters/day to m/day. Convert to m3/day using 1000 liters/m3, then divide by area to get the m/day of water infiltrating. This value should be approximately 0.08 m/day

-converting the hydraulic conductivity to units of m/day. This value should be approximately 0.086

Summary
Inputs
w = 0.08 m/day, K = 0.086m/day, S=0.01, t = 2 days, hi = 2 m, a = 3m, b= 4 m

Results

Maximum hydraulic head = 3.3 m
Increase in hydraulic head = 1.3 m

HYDROLOGIC PROPERTIES OF EARTH MATERIALS

SPECIFIC YIELD—COMPILATION OF SPECIFIC YIELDS FOR VARIOUS MATERIALS

By A. I. Johnson

ABSTRACT

Specific yield is defined as the ratio of (1) the volume of water that a saturated rock or soil will yield by gravity to (2) the total volume of the rock or soil. Specific yield is usually expressed as a percentage. The value is not definitive, because the quantity of water that will drain by gravity depends on variables such as duration of drainage, temperature, mineral composition of the water, and various physical characteristics of the rock or soil under consideration. Values of specific yield, nevertheless, offer a convenient means by which hydrologists can estimate the water-yielding capacities of earth materials and, as such, are very useful in hydrologic studies.

The present report consists mostly of direct or modified quotations from many selected reports that present and evaluate methods for determining specific yield, limitations of those methods, and results of the determinations made on a wide variety of rock and soil materials. Although no particular values are recommended in this report, a table summarizes values of specific yield, and their averages, determined for 10 rock textures. The following is an abstract of the table:

Specific yields, in percent, of various materials

[Rounded to nearest whole percent]

Material	Number of determinations	Specific yield		
		Maximum	Minimum	Average
Clay	15	5	0	2
Silt	16	19	3	8
Sandy clay	12	12	3	7
Fine sand	17	28	10	21
Medium sand	17	32	15	26
Coarse sand	17	35	20	27
Gravelly sand	15	35	20	25
Fine gravel	17	35	21	25
Medium gravel	14	26	13	23
Coarse gravel	14	26	12	22

INTRODUCTION

PURPOSE AND SCOPE

The purpose of this report is to assist hydrologists in estimating the quantity of water in storage in ground-water reservoirs by providing

Stormwater Treatment Unit Documentation

249 SOUTH STREET UNIT 1 PLAINVILLE MA 02762
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Project:	**Factory Square**
Location:	**Franklin, MA**
Prepared For:	**Level Design / Dan Campbell**

Purpose: To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1" of runoff from the contributing impervious surface.

Reference: Massachusetts Dept. of Environmental Protection Wetlands Program / United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual

Procedure: Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi^2/watershed inches (csm/in).

Compute Q Rate using the following equation:

Q = (qu) (A) (WQV)

where:

Q = flow rate associated with first 1" of runoff
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1" in this case)

Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
CB 1	0.40	0.0006250	5.0	0.083	1.00	795.00	0.50
CB 2	0.40	0.0006250	5.0	0.083	1.00	795.00	0.50
WQU 1	0.81	0.0012656	5.0	0.083	1.00	795.00	1.01
WQU 2	0.59	0.0009219	5.0	0.083	1.00	795.00	0.73
WQU 3	1.50	0.0023438	5.0	0.083	1.00	795.00	1.86

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD

FACTORY SQUARE
FRANKLIN, MA

Area	**0.40 ac**	Unit Site Designation	**CB 1**
Weighted C	**0.9**	Rainfall Station #	**68**
t_c	**5 min**		
CDS Model	**1515-3**	CDS Treatment Capacity	**1.0 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.3%	9.3%	0.01	0.01	9.3
0.04	9.5%	18.8%	0.01	0.01	9.5
0.06	8.7%	27.5%	0.02	0.02	8.7
0.08	10.1%	37.6%	0.03	0.03	10.1
0.10	7.2%	44.8%	0.04	0.04	7.1
0.12	6.0%	50.8%	0.04	0.04	6.0
0.14	6.3%	57.1%	0.05	0.05	6.2
0.16	5.6%	62.7%	0.06	0.06	5.5
0.18	4.7%	67.4%	0.06	0.06	4.6
0.20	3.6%	71.0%	0.07	0.07	3.5
0.25	8.2%	79.1%	0.09	0.09	7.9
0.50	14.9%	94.0%	0.18	0.18	13.8
0.75	3.2%	97.3%	0.27	0.27	2.9
1.00	1.2%	98.5%	0.36	0.36	1.0
1.50	0.7%	99.2%	0.54	0.54	0.5
2.00	0.8%	100.0%	0.72	0.72	0.5
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					97.3
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.5%
				Predicted Net Annual Load Removal Efficiency =	**90.9%**

1 - Based on 10 years of rainfall data from NCDC station 736, Blue Hill, Norfolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

FACTORY SQUARE
FRANKLIN, MA

Area	**0.40 ac**	Unit Site Designation	**CB 2**
Weighted C	**0.9**	Rainfall Station #	**68**
t_c	**5 min**		
CDS Model	**1515-3**	CDS Treatment Capacity	**1.0 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.3%	9.3%	0.01	0.01	9.3
0.04	9.5%	18.8%	0.01	0.01	9.5
0.06	8.7%	27.5%	0.02	0.02	8.7
0.08	10.1%	37.6%	0.03	0.03	10.1
0.10	7.2%	44.8%	0.04	0.04	7.1
0.12	6.0%	50.8%	0.04	0.04	6.0
0.14	6.3%	57.1%	0.05	0.05	6.2
0.16	5.6%	62.7%	0.06	0.06	5.5
0.18	4.7%	67.4%	0.06	0.06	4.6
0.20	3.6%	71.0%	0.07	0.07	3.5
0.25	8.2%	79.1%	0.09	0.09	7.9
0.50	14.9%	94.0%	0.18	0.18	13.8
0.75	3.2%	97.3%	0.27	0.27	2.9
1.00	1.2%	98.5%	0.36	0.36	1.0
1.50	0.7%	99.2%	0.54	0.54	0.5
2.00	0.8%	100.0%	0.72	0.72	0.5
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					97.3

Removal Efficiency Adjustment[2] = 6.5%

Predicted % Annual Rainfall Treated = 93.5%

Predicted Net Annual Load Removal Efficiency = 90.9%

1 - Based on 10 years of rainfall data from NCDC station 736, Blue Hill, Norfolk County, MA

2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

FACTORY SQUARE
FRANKLIN, MA

Area	**0.81 ac**	Unit Site Designation	**WQU 1**
Weighted C	**0.9**	Rainfall Station #	**68**
t_c	**5 min**		
CDS Model	**2015-4**	CDS Treatment Capacity	**1.4 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.3%	9.3%	0.01	0.01	9.3
0.04	9.5%	18.8%	0.03	0.03	9.5
0.06	8.7%	27.5%	0.04	0.04	8.7
0.08	10.1%	37.6%	0.06	0.06	10.0
0.10	7.2%	44.8%	0.07	0.07	7.1
0.12	6.0%	50.8%	0.09	0.09	5.9
0.14	6.3%	57.1%	0.10	0.10	6.2
0.16	5.6%	62.7%	0.12	0.12	5.5
0.18	4.7%	67.4%	0.13	0.13	4.5
0.20	3.6%	71.0%	0.15	0.15	3.5
0.25	8.2%	79.1%	0.18	0.18	7.8
0.50	14.9%	94.0%	0.36	0.36	13.3
0.75	3.2%	97.3%	0.55	0.55	2.7
1.00	1.2%	98.5%	0.73	0.73	1.0
1.50	0.7%	99.2%	1.09	1.09	0.5
2.00	0.8%	100.0%	1.46	1.40	0.4
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					95.7

Removal Efficiency Adjustment[2] =	6.5%
Predicted % Annual Rainfall Treated =	93.5%
Predicted Net Annual Load Removal Efficiency =	**89.2%**

1 - Based on 10 years of rainfall data from NCDC station 736, Blue Hill, Norfolk County, MA

2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

FACTORY SQUARE
FRANKLIN, MA

Area	**0.59 ac**	Unit Site Designation	**WQU 2**
Weighted C	**0.9**	Rainfall Station #	**68**
t_c	**5 min**		
CDS Model	**1515-3**	CDS Treatment Capacity	**1.0 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.3%	9.3%	0.01	0.01	9.3
0.04	9.5%	18.8%	0.02	0.02	9.5
0.06	8.7%	27.5%	0.03	0.03	8.7
0.08	10.1%	37.6%	0.04	0.04	10.0
0.10	7.2%	44.8%	0.05	0.05	7.1
0.12	6.0%	50.8%	0.06	0.06	5.9
0.14	6.3%	57.1%	0.07	0.07	6.2
0.16	5.6%	62.7%	0.08	0.08	5.4
0.18	4.7%	67.4%	0.10	0.10	4.5
0.20	3.6%	71.0%	0.11	0.11	3.5
0.25	8.2%	79.1%	0.13	0.13	7.8
0.50	14.9%	94.0%	0.27	0.27	13.2
0.75	3.2%	97.3%	0.40	0.40	2.7
1.00	1.2%	98.5%	0.53	0.53	0.9
1.50	0.7%	99.2%	0.80	0.80	0.5
2.00	0.8%	100.0%	1.06	1.00	0.4
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					95.6
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.5%
				Predicted Net Annual Load Removal Efficiency =	**89.1%**

1 - Based on 10 years of rainfall data from NCDC station 736, Blue Hill, Norfolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD

FACTORY SQUARE
FRANKLIN, MA

Area	1.50 ac	Unit Site Designation	WQU 3
Weighted C	0.9	Rainfall Station #	68
t_c	5 min		
CDS Model	2020-5	CDS Treatment Capacity	**2.2 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	9.3%	9.3%	0.03	0.03	9.3
0.04	9.5%	18.8%	0.05	0.05	9.5
0.06	8.7%	27.5%	0.08	0.08	8.7
0.08	10.1%	37.6%	0.11	0.11	10.0
0.10	7.2%	44.8%	0.14	0.14	7.1
0.12	6.0%	50.8%	0.16	0.16	5.9
0.14	6.3%	57.1%	0.19	0.19	6.1
0.16	5.6%	62.7%	0.22	0.22	5.4
0.18	4.7%	67.4%	0.24	0.24	4.5
0.20	3.6%	71.0%	0.27	0.27	3.5
0.25	8.2%	79.1%	0.34	0.34	7.7
0.50	14.9%	94.0%	0.68	0.68	12.9
0.75	3.2%	97.3%	1.01	1.01	2.6
1.00	1.2%	98.5%	1.35	1.35	0.9
1.50	0.7%	99.2%	2.03	2.03	0.4
2.00	0.8%	100.0%	2.70	2.20	0.3
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
0.00	0.0%	100.0%	0.00	0.00	0.0
					94.7
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.4%
				Predicted Net Annual Load Removal Efficiency =	**88.3%**

1 - Based on 10 years of rainfall data from NCDC station 736, Blue Hill, Norfolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

NJCAT TECHNOLOGY VERIFICATION

HIGH EFFICIENCY CONTINUOUS DEFLECTIVE SEPARATOR (CDS®)

CONTECH CONSTRUCTION PRODUCTS Inc.

January 2010

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1. Introduction

1.1 New Jersey Corporation for Advance Technology (NJCAT) Program

NJCAT is a not-for-profit corporation to promote in New Jersey the retention and growth of technology-based businesses in emerging fields such as environmental and energy technologies. NJCAT provides innovators with the regulatory, commercial, technological and financial assistance required to bring their ideas to market successfully. Specifically, NJCAT functions to:

- Advance policy strategies and regulatory mechanisms to promote technology commercialization;
- Identify, evaluate, and recommend specific technologies for which the regulatory and commercialization process should be facilitated;
- Facilitate funding and commercial relationships/alliances to bring new technologies to market and new business to the state; and
- Assist in the identification of markets and applications for commercialized technologies.

The technology verification program specifically encourages collaboration between vendors and users of technology. Through this program, teams of academic and business professionals are formed to implement a comprehensive evaluation of vendor specific performance claims. Thus, suppliers have the competitive edge of an independent third party confirmation of claims.

Pursuant to N.J.S.A. 13:1D-134 et seq. (Energy and Environmental Technology Verification Program) the New Jersey Department of Environmental Protection (NJDEP) and NJCAT have established a Performance Partnership Agreement (PPA) whereby NJCAT performs the technology verification review and NJDEP certifies that the technology meets the regulatory intent and that there is a net beneficial environmental effect of the technology. In addition, NJDEP/NJCAT work in conjunction to develop expedited or more efficient timeframes for review and decision-making of permits or approvals associated with the verified/certified technology.

The PPA also requires that:

- The NJDEP shall enter into reciprocal environmental technology agreements concerning the evaluation and verification protocols with the United States Environmental Protection Agency, other local required or national environmental agencies, entities or groups in other states and New Jersey for the purpose of encouraging and permitting the reciprocal acceptance of technology data and information concerning the evaluation and verification of energy and environmental technologies; and

- The NJDEP shall work closely with the State Treasurer to include in State bid specifications, as deemed appropriate by the State Treasurer, any technology verified under the Energy and Environment Technology Verification Program.

1.2 Interim Certification

CONTECH Construction Products Inc. (CONTECH) is a leading provider of innovative, long-term, stormwater treatment solutions, offering a variety of products, maintenance, laboratory, and engineering support to meet stormwater treatment needs. CONTECH's patented product, the High Efficiency Continuous Deflective Separator (CDS®) unit is a Best Management Practice (BMP) designed to meet federal, state, and local requirements for treating stormwater runoff in compliance with the Clean Water Act. The High Efficiency CDS unit improves the quality of stormwater runoff before it enters receiving waterways through continuous deflective separation and settling to provide enhanced solids removal. (See Section 2 for an additional description of the technology.)

CDS Technologies, Inc., now CONTECH, received New Jersey Corporation for Advanced Technology (NJCAT) verification of claims for the CDS in June 2003. This verification was revised in December of 2004 and a Conditional Interim Certification was issued by NJDEP in January of 2005 for the High Efficiency CDS when used as a pre-treatment device. A major condition of this Conditional Interim Certification was the execution of a field evaluation in accordance with the TARP Tier II Protocol (TARP, 2003) and New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2006). Conditional Interim Certification was extended in August of 2007. A Project Plan for the Field Evaluation was completed in November of 2007, resulting in the commencement of monitoring activities.

1.3 Applicant Profile

CONTECH offers a range of stormwater treatment products including filtration, hydrodynamic separation, volumetric separation, detention/retention, screening, oil/water separation, and flow control technologies. A knowledgeable team of 200 professionals across the U.S. provide the engineering and customer service support to determine a project's most appropriate stormwater treatment system that meets the requirements of the relevant permitting jurisdiction.

At CONTECH's state-of-the-art laboratories, engineers and scientists conduct ongoing research to further the understanding of non-point source pollution and develop practical product solutions. CONTECH helps its customers achieve their water quality goals by providing treatment technologies that remove a variety of pollutants from stormwater runoff. These stormwater treatment products are specifically designed to meet federal, state, and local regulations.

Former CONTECH subsidiaries Vortechnics (2004) and Stormwater Management, Inc. (2005) combined to form Stormwater360 (2006), and later became CONTECH Stormwater Solutions, Inc. a division of CONTECH Construction Products Inc. In December 2006, CDS Technologies, Inc. was added into CONTECH's product offerings.

CONTECH has four primary regional offices that service their customers.

Ohio (Headquarters)
9025 Centre Pointe Drive, Suite 400
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800-395-0608

Maryland
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866-740-3318

Maine
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Scarborough, ME 04074
207-885-9830

Oregon
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Portland, OR 97220
866-400-3180

California
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Long Beach, CA 90807
562-264-0701

Key managers of CONTECH are Rick Stepien – President CONTECH Marketing, James Lenhart – Chief Technical Officer, and Frank Birney – Vice President of Stormwater.

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2. The High Efficiency CDS

The High Efficiency CDS unit is typically comprised of a manhole that houses flow and screening controls designed around patented, continuous deflective separation technology. Stormwater runoff enters the High Efficiency CDS unit's diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed. The separation and containment chamber consist of a containment sump in the lower section and an upper separation section. Gross pollutants are separated within the chamber using a perforated plate allowing the filtered water to pass through to a volute return system and thence to the outlet pipe. The water and associated pollutants contained within the separation chamber are kept in continuous motion by the energy generated by the incoming flow. This has the effect of preventing the separation plate from being blocked by the gross solids separated from the inflow. The heavier solids ultimately settle into the containment sump. Figure 1 is a schematic representation of the solid separation mechanism of the CDS technology.

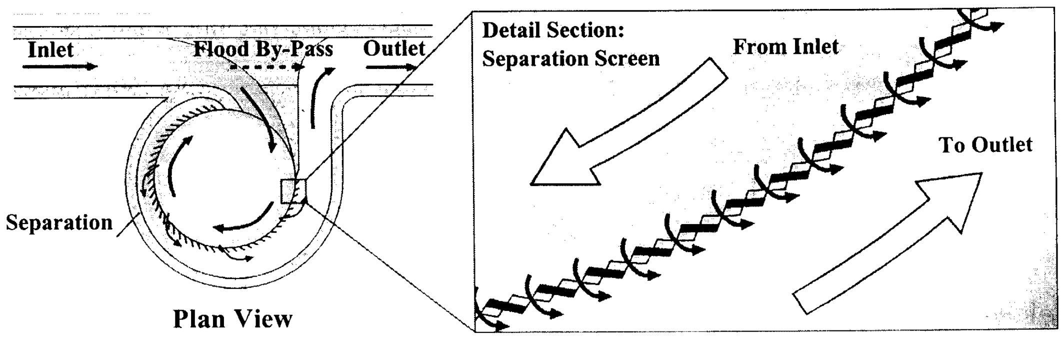

Figure 1 Schematic Representation of the CDS System

The diversion of the stormwater and associated pollutants into a separation chamber overcomes problems associated with the direct filtration systems of conventional gross pollutant traps. The present design of the CDS system utilizes a simple solid diversion unit to divert flows into the separation chamber. The diversion unit is designed to divert all flows into the separation chamber as long as water levels are below the crest level of the diversion unit. As water levels exceed the crest of the diversion unit, some flows would by-pass the CDS system. The crest level of the diversion unit may be adjusted to suit individual installations.

The solid separation system consists of a large expanded stainless steel plate which acts as a filter screen with an outer volute outlet passage. The perforations in the separation screen are typically elongated in shape and are aligned with the longer axis in the vertical direction. The size of the elliptical holes can be specified according to performance requirements and typical width of the short axis ranges from 2.4 mm to 4.7 mm. The separation screen is installed in the unit such that the leading edge of each perforation extends into the flow within the containment chamber.

Operating Mechanism

The essential operational function of the CDS unit is to ensure that the separation screen remains free from blocking by trapped material as the volume of pollutants trapped increases. All flows up to the unit's treatment design capacity enter the separation chamber. Swirl concentration and screen deflection forces direct floatables and solids to the center of the separation chamber, where floatables and neutrally buoyant debris larger than the screen apertures are trapped. Stormwater then moves through the separation screen, over the sediment weir, and exits the unit. The separation screen remains clog free due to continuous deflection. During flow events exceeding the design treatment capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants will not wash out. Once treated, stormwater is directed to a collection pipe or discharged to an open channel drainage way. For more detailed information about the High Efficiency CDS unit visit www.contechstormwater.com.

The screen surface area is of the order of 40-45 times the pipe inlet area. Measurement of screen perforations indicates that the orifice area in the direction perpendicular to the plate is approximately 20% of the total plate area. The radial flow velocity through the screen is thus an order of magnitude less than the pipe inlet velocity. Gross solids are prevented from blocking the separation screen using the significantly higher tangential flow velocity compared to the radial velocity throughout the surface of the separation screen. The flow direction in the outer volute outlet system is opposite to that of the circular motion in the separation chamber.

Tangential velocity decreases along the separation screen as well as with depth and decreases from the screen to the center of the separation chamber. The radial velocity distribution is a direct reflection of the distribution of flow through the separation screen. Different inlet conditions can influence distribution of flow through the separation screen and optimization of the CDS unit configuration has been conducted to promote a radial velocity distribution which is consistent with the distribution of tangential velocities along the separation screen. Thus the ratio of tangential to radial velocities is maintained at a high level throughout the surface of the separation screen with both velocities decreasing with increasing distance from the inlet.

Gross Solids Separation

Solids entering the separation chamber can either be floating or settleable materials with those solids which are larger than the aperture size of the separation screen being prevented from passing through the screen. The trapped material is kept in motion within the separation chamber by the design of the unit which maintains the ratio of tangential to radial velocities necessary to promote the non-blocking mechanism throughout the surface of the separation screen. The settleable material ultimately settles into the containment sump. The floating material that enters the CDS unit (including organic matter which over time absorbs water and eventually sinks, e.g. leaf litter) remains within the separation chamber and circulates at the water surface until the water level drops and inflow ceases. The action of the inflow jet, the shaping of the screen and centrifugal effects tend to concentrate this floating material towards the center of the chamber away from the screen.

Fine Solids Separation

For solids which are smaller than the aperture size of the separation screen, trapping efficiency will be affected by the ability of the unit in keeping these solids away from the separation screen as they progressively settle into the containment chamber. The trajectory of these fine particles within the separation chamber is defined by the combined effect of fluid velocity within the chamber and the settling velocity of the particles. The likelihood for very fine particles to flow through the separation screen is higher than coarser particles owing to the trajectory of the former being more exposed to the separation screen. Both particle size and its settling velocity have a direct influence on the trapping efficiency of these particles by the CDS unit.

Oil and Grease Removal

Oil and grease and other total petroleum hydrocarbons (TPHs) are primary water quality constituents of concern from many catchment areas, such as parking areas and highways. CDS units are equipped with a conventional oil baffle to capture and retain oil and grease and TPH pollutants as they are transported through the storm drain system during dry weather (gross spills) and wet weather flows.

There are three (3) types of configurations that CDS units are available in to meet the hydraulic and water quality needs of large and small projects. These treatment configurations can have either an internal or external bypass. Figure 2 provides an illustration of a typical off-line CDS unit.

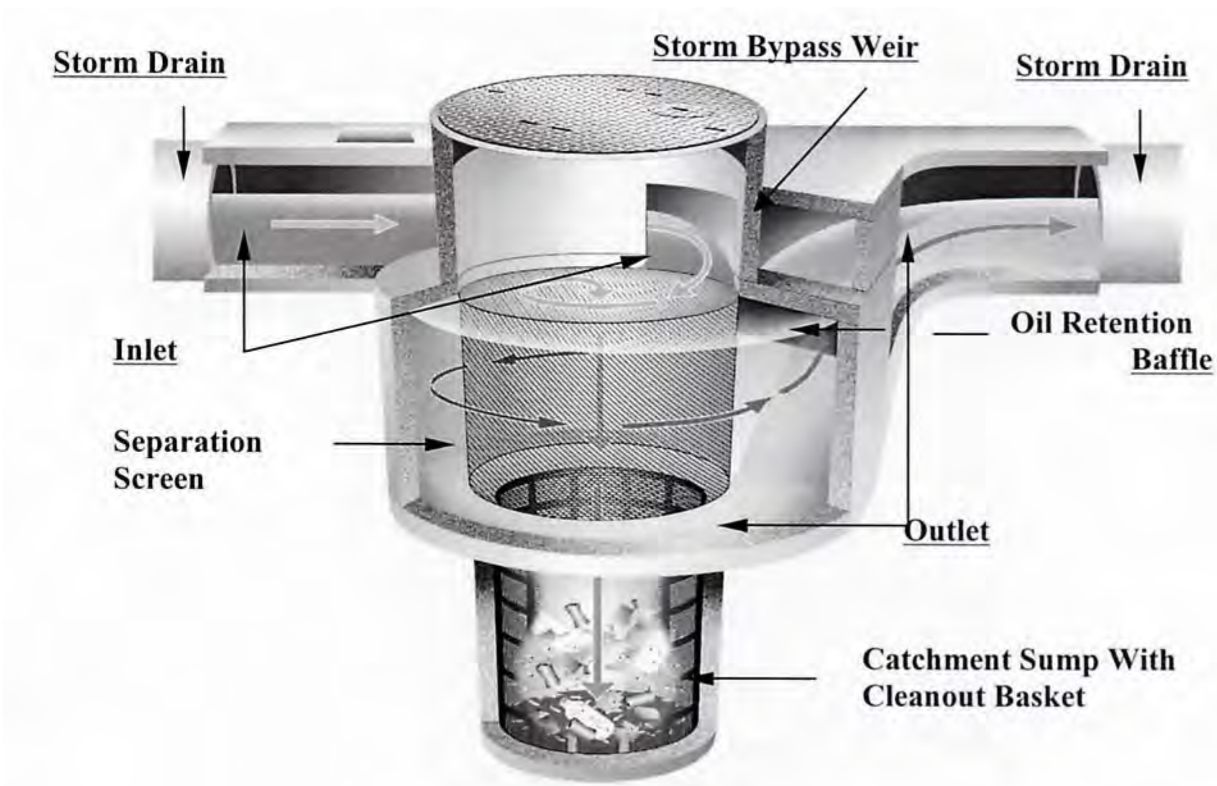

Figure 2 Schematic of an Off-Line CDS Unit

3. Technology System Evaluation: Project Plan

3.1 Introduction

CDS Technologies, Inc., now CONTECH, received New Jersey Corporation for Advanced Technology (NJCAT) verification of claims for the CDS in June 2003. This verification was revised in December of 2004 and a Conditional Interim Certification (CIC) was issued by NJDEP on January of 2005 for the High Efficiency CDS for 50% TSS removal. A major condition of this Conditional Interim Certification was the execution of a field evaluation in accordance with the TARP Tier II Protocol (TARP, 2003) and New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2006). Conditional Interim Certification was extended in August of 2007. A Project Plan for the Field Evaluation was completed in November of 2007, resulting in the commencement of monitoring activities.

3.2 Site and System Description

The Manasquan Savings Bank study site is located in the Borough of Point Pleasant, New Jersey (Lat: N 40.0834, Lon: W 74.07208) approximately 18 feet above sea level and is situated at the northeastern end of Ocean County, New Jersey. The site is located at the intersection of Route 88 and Herbertsville Road. A convenience store and bank currently occupy the site. Based on information provided by the specifying engineer the total drainage area of the site is 1.972 acres, 79% impervious. The contributing drainage area to the High Efficiency CDS installed on site is 0.90 acres. An aerial photo of the Manasquan Savings Bank study site is shown in Figure 3 and photographs of the study site are provided in Figures 4 and 5.

Stormwater runoff from the site is directed to a High Efficiency CDS unit model PMSU20_25 (CDS2025) seen in Figure 6, before eventually discharging into the Manasquan River. The unit was installed during redevelopment of the site. The installation was allowed by NJDEP under the Conditional Interim Certification of the High Efficiency CDS. The High Efficiency CDS unit is designed in an on-line configuration with respect to the stormwater conveyance pipe system.

The water quality flow rate provided by the specifying engineer for the Manasquan Savings Bank study site is 1.4 cfs, based on the New Jersey Water Quality Design Storm of 1.25 inches over 2 hours. The Model 20_25 High Efficiency CDS unit is rated to treat a maximum water quality flow rate of 1.6 cfs and a peak flow rate of 5.43 cfs. The next smallest CDS Model is only rated for a water quality flow of 1.1 cfs so the Model 20_25 is appropriately sized for this site. Sizing is based on laboratory testing that serves as the basis of the CIC; the testing demonstrated a suspended solids removal rate of 73.7% or greater based on silica sand particles <100µm with a d_{50} of 63µm.

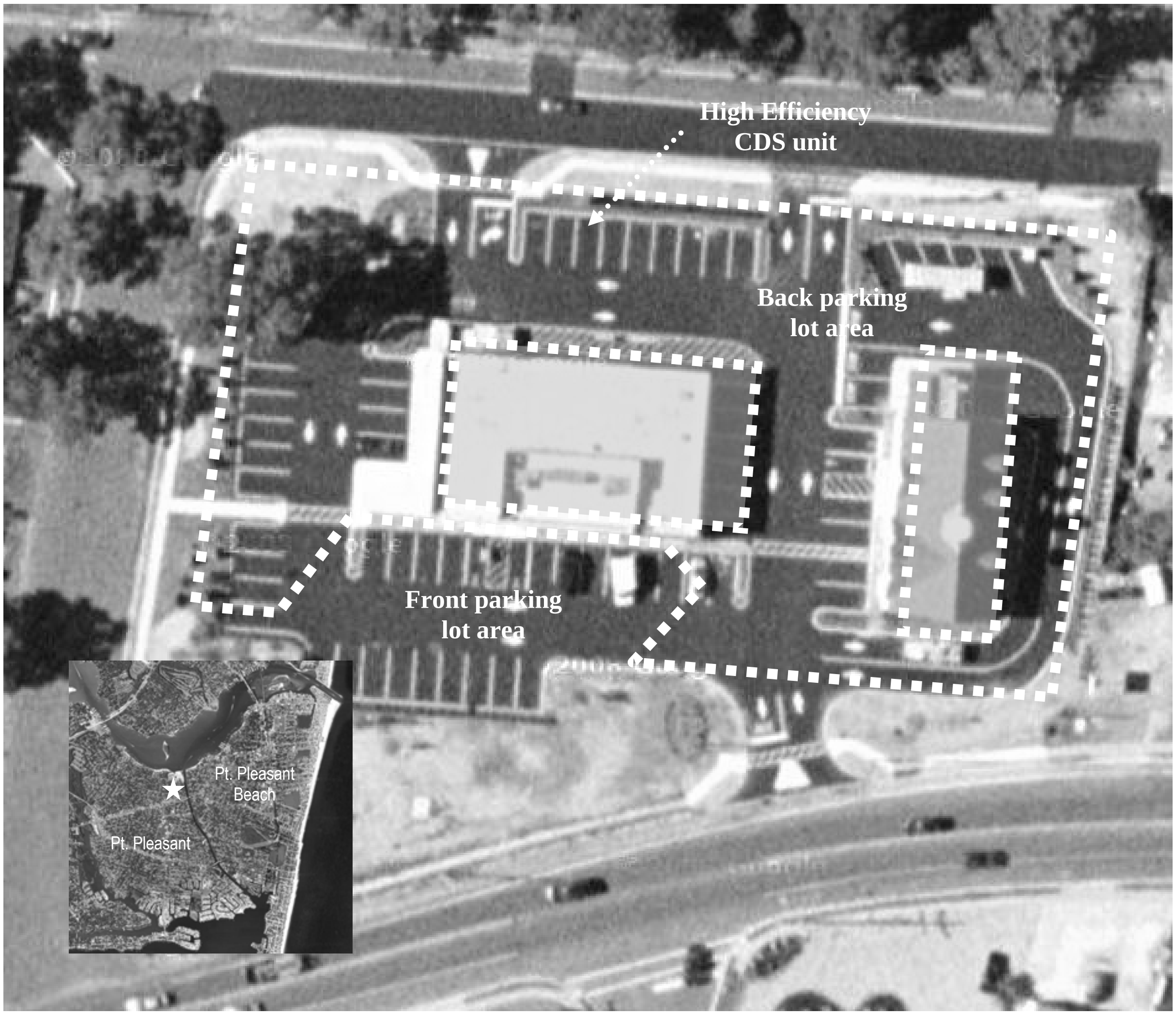

Figure 3 Aerial view of Manasquan Savings Bank study site with drainage area outlined.

Figure 4 View of front parking lot area of Manasquan Savings Bank study site

Figure 5 View of back parking lot area of Manasquan Savings Bank study site

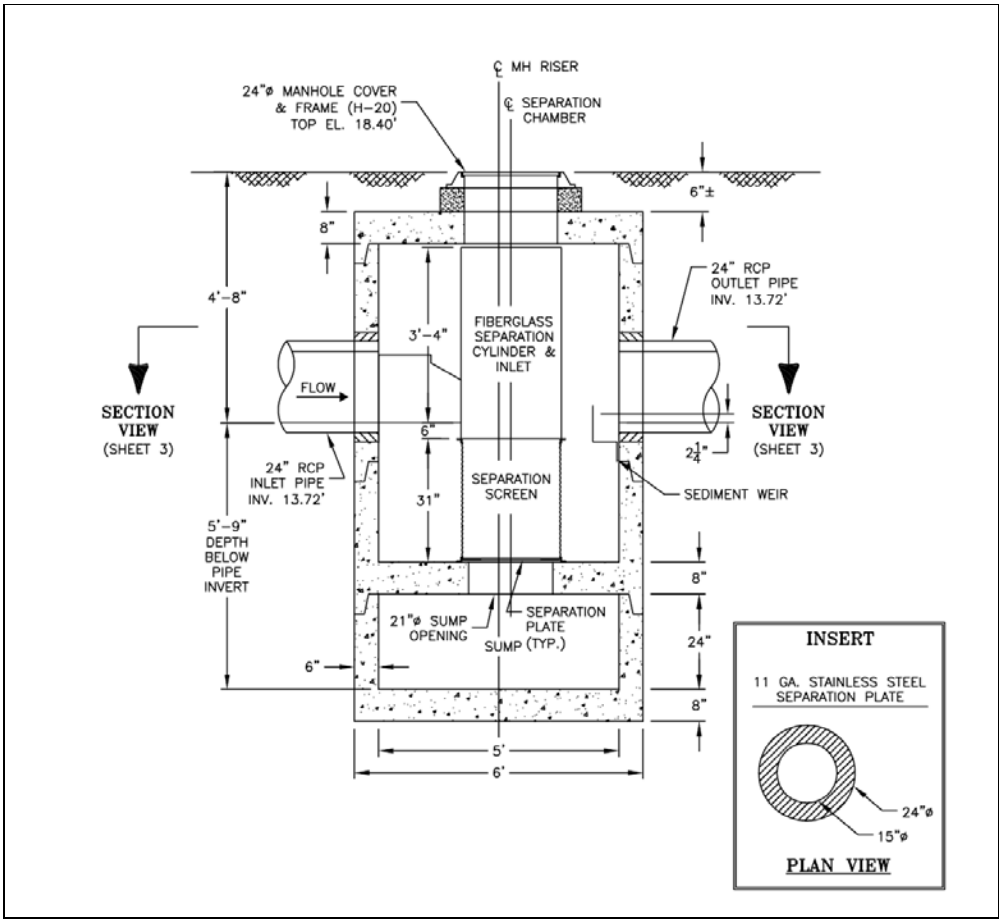

Figure 6 Elevation view of High Efficiency CDS unit installed at Manasquan Savings Bank study site

3.3 Sampling Design

The equipment and sampling techniques used for this study are in accordance with the Project Plan (CONTECH, 2007) developed by CONTECH in consultation with NJDEP and NJCAT under the TARP Tier II Stormwater Protocol (TARP, 2003) and New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2006). CONTECH personnel were responsible for the installation, operation, and maintenance of the sampling equipment. Sovereign Consulting was utilized for sample retrieval, system reset, and sample submittal activities. Water sample processing and analysis was performed by NJAL and Test America. A general overview of the methodology is provided.

A mobile monitoring unit (MMU) was provided, installed, maintained, and operated by CONTECH for sampling purposes. The MMU is a towable, fully enclosed, self-contained stormwater monitoring system specially designed and built by CONTECH for remote, extended-deployment stormwater monitoring. The design allows for remote control of sampling equipment, eliminates confined space entry requirements, and streamlines the sample pickup and data collection process. The MMU is shown in Figure 7.

Figure 7 View of Mobile Monitoring Unit (MMU) installed at the Manasquan Savings Bank study site

Influent and effluent samples were collected using individual ISCO 6712 Portable Automated Samplers configured for standard, individual, round, wide-mouth sample bottles with HDPE bottles in the 1 through 12 positions for discrete sample collection. The samplers were connected to individual 12VDC deep cycle power supplies recharged by a solar panel. The effluent sampler was equipped with an ISCO 750 Area Velocity Flow Module with a Low Profile Area Velocity Flow Sensor for flow analysis and effluent sample pacing. Sample pacing was based upon effluent flow readings by using a paired sampler configuration though the use of an ISCO SPA 1026 cable. Each sampler was also connected to an ISCO SPA 1489 Digital Cell Phone Modem to allow for remote communication and data access. Rainfall was analyzed with 0.01-in resolution with a Texas Electronics TR-4 tipping bucket-type rain gauge. The sample intake from each automated sampler pump was connected to a stainless steel sample strainer (9/16" diameter, 6" length, with multiple ¼" openings) via a length of 3/8" ID Acutech Duality FEP/LDPE tubing. Sample strainers and the effluent flow sensor were mounted to the invert of the influent/effluent pipes using stainless steel spring rings.

The sample collection program input into each automated sampler was a two-part program developed to maximize the number of water quality samples collected as well as the coverage of the storm event. Influent and effluent sample collection programs were configured to collect two 500-mL aliquots per bottle spread between up to 12 1-L HDPE bottles. Samplers were programmed to enable and start the sample collection program when flow conditions exceeded 5 gpm. Once enabled, the sampling equipment collected samples on a volume-paced basis allowing the specified pacing volume to pass before taking a sample. Pacing volumes were calculated for each storm event based on the predicted depth of precipitation in order to satisfy storm event coverage requirements.

Upon the collection of samples following a precipitation event, CONTECH personnel remotely communicated with the automated sampling equipment to confirm sample collection and dispatch personnel from Sovereign to retrieve the samples and reset the automated sampling equipment. Samples were delivered to NJAL by Sovereign using cold transport and accompanied by chain-of-custody documentation. At the direction of CONTECH personnel, sample bottles were combined by NJAL to create composite samples through identification of those bottles best representing the storm event based upon the storm event hydrograph. Selected sample bottles were thoroughly shaken and emptied into a cone splitter with a 2000 micron sieve on top to remove particles greater than 2000µm to ensure proper operation of the cone splitter (USGS, 1980).

Table 1 Analytical methods used for analytical parameters of interest

Parameter	Analytical Method
Suspended Sediment Conc. (SSC)	ASTM D3977
Total Suspended Solids (TSS-SM)	SM2540 D
Total Suspended Solids (TSS-EPA)	EPA 160.2
Total Volatile Suspended Solids (TVSS)	SM 2540G
Particle Size Distribution	ASTM D4464

As per the Project Plan, the following quality control samples were used to assess the quality of both field sampling and analytical activities: equipment rinsate blanks, equipment field blanks, method blank, and duplicate analysis. Sample processing blank samples were not taken. Except for solids analyses that employ the use of the whole sample volume (SSC), all method blanks and duplicate analyses were handled by NJAL. Since solids analyses that employ the use of whole sample volume (SSC) consume the entire sample volume, replicate samples were prepared in place of duplicate samples and analyzed to allow the assessment of analytical accuracy. The results of equipment rinsate blanks, equipment blanks, and sample processing blanks are shown in Table 2 accompanied by associated decisions and action items for instances of detection.

Table 2 Instances of contaminant detection in equipment rinsate blank and equipment field blank samples

Date	Blank Type	Detections	Level (mg/L)	Action	% of Sample Pairs Affected
04/15/08	**Rinsate**			**None**	**0**
09/18/08	**Field**			**None**	**0**
01/29/08	**Field**	**TVSS**	**0.9**	**Disqualify TVSS results ≤4.5 mg/L for events since last QC Blank.**	**TVSS(<50μm) 21%** **TVSS(<500μm) 16%** **TVSS(<2000μm) 5%** **TVSS(>2000μm) 21%**

3.4 Particle Size Distribution and Residual Solids Assessment Methods

Two methods of evaluating influent particle size were used for this project. The first method, laser diffraction, was used in accordance with the TARP Tier II Protocol. The second method was a serial filtration process that was utilized for every storm event sampled. The serial filtration method is a direct measurement of particle size by mass whereas indirect methods such as Laser Diffraction and the electrical sensing zone method (Coulter Principle) convert counted data points into mass by way of assumptions regarding particle shape and density (CONTECH, 2004). For each storm event sampled, samples were poured through a 2000μm sieve prior to being split with a cone splitter as seen in Figure 6. Subsamples intended for SSC (<50μm) and SSC (<500um) analysis were passed through 50μm and 500μmsieves respectively prior to analysis, as seen in Figure 8 and 9.

Results were obtained for SSC, SSC (>2000μm), SSC (<2000μm), SSC (<500μm), and SSC (<50μm). Results for SSC (>2000μm) and SSC were calculated. SSC (>2000μm) was calculated using the estimated volume of the sample used for the composite and the mass of material retained by the 2000μm sieve. SSC was equal to the sum of SSC (>2000μm) and SSC (<2000μm). The use of 2000μm and 50μm sieves to bracket the sand fraction is based upon the USDA particle size distribution system.

Residual solids captured by the system were assessed at the end of the monitoring phase of the project. The assessment involved the estimation of captured material found inside the system and the collection of a 20 liter composite sample of the residual solids. The composite sample of residual solids was homogenized by hand and representatively sampled for analysis. Subsamples were analyzed to determine moisture content, bulk density, and particle size distribution using hydrometer and sieve techniques. Results were used to characterize and determine the dry mass of captured residual solids.

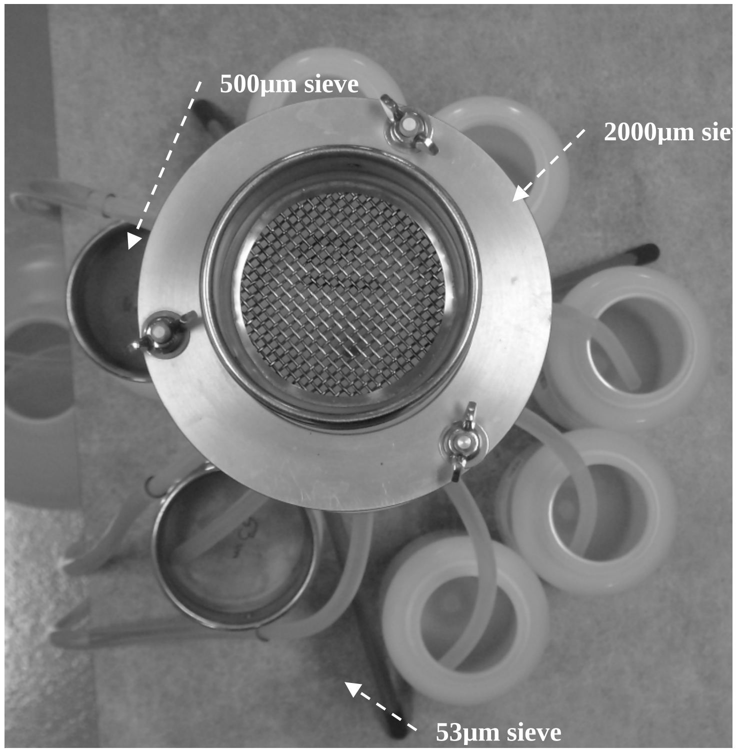

Figure 8 Top view of cone splitter apparatus prior sample splitting using sieves

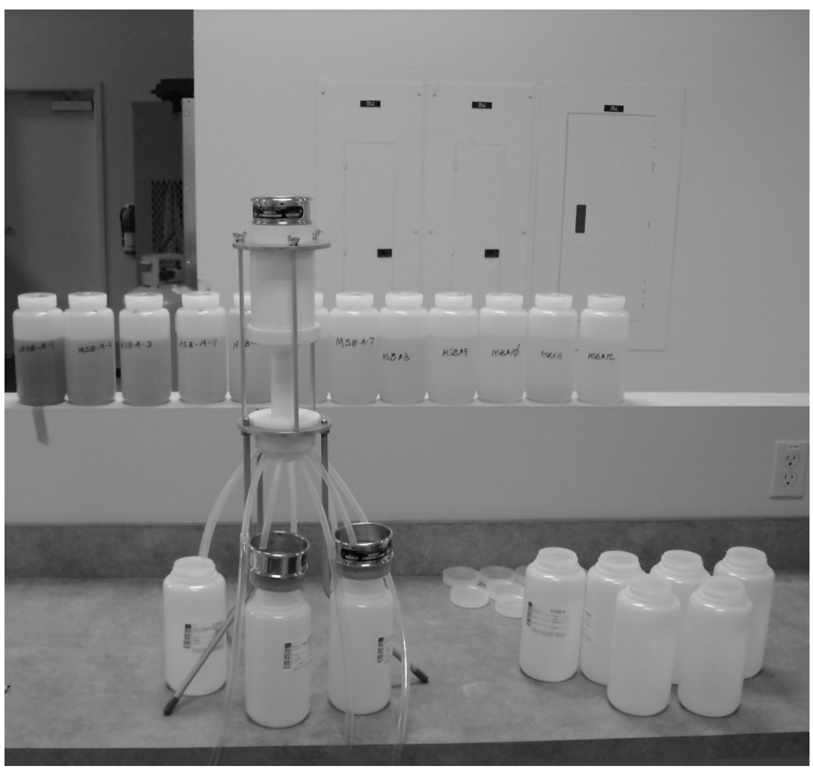

Figure 9 Side view of cone splitter apparatus prior to sample splitting using sieves

3.5 Precipitation Measurement

Rainfall was measured with a Texas Electronics TR-4 tipping bucket-type rain gauge. The rain gage was connected to the ISCO 6712 programmed to record the total number of tips (0.01 inch per tip) every 5 minutes. A comparison of data collected during the monitoring period to data from a National Weather Service (NWS) cooperative station in Toms River, NJ (about 12 miles south of Point Pleasant) on a monthly basis indicated that the rain gauge was working properly during the monitoring period (Table 3). A comparison of the Toms River rain gauge monthly totals to monthly normal totals shows that rainfall in the area was below normal in October (2007), November (2007), January (2008), April (2008), June (2008), July (2008), August (2008), and October (2008). Rainfall was noticeably above normal in December (2007), February (2008) and September (2008).

Table 3 Comparison of monthly rainfall data between National Weather Service (NWS) cooperative station in Toms River, NJ and Manasquan Savings Bank study site rain gage

Month	MSB rain gage (in.)	NCDC Toms River rain gage (in.)	Percent of normal (%)	Monthly normal totals (1977-2000)
October (2007)	--	2.6	73	3.6
November (2007)	2.0	1.9	46	4.1
December (2007)	6.1	6.8	167	4.1
January (2008)	2.2	2.6	61	4.2
February (2008)	5.3	5.6	168	3.4
March (2008)	4.5	4.8	110	4.3
April (2008)	2.2	1.5	37	4.0
May (2008)	4.6	4.9	118	4.2
June (2008)	3.8	2.6	73	3.5
July (2008)	3.0	3.2	70	4.6
August (2008)	1.3	2.9	58	5.0
September (2008)	3.9	8.5	214	4.0
October (2008)	2.1	1.6	46	3.6
November (2008)	5.0	4.6	114	4.1

A total of 19 qualifying storm events were successfully sampled during the monitoring period between January of 2008 and November of 2008. Collection of storm events commenced after the review and conditional approval of the Project Plan by project stake holders. Storm event durations ranged from 2.58 hours to 27.08 hours, rainfall depth for sampled events ranged from 0.31 to 3.20 inches, and 15 and 30 minute maximum intensities were 2.44 and 1.74 inches/hour respectively. Based on the drainage area provided by the specifying engineer of 0.90 acres the calculated total rainfall volume ranged from 7575 to 78,199 gallons (Table 4).

Table 4 Rainfall and runoff statistics for sampled events at the Manasquan Savings Bank study site.

Event ID	Duration of storm event (hours)	Total rainfall (in.)	P15 (in/hr)	P30 (in/hr)	Total rainfall volume (gal)
MSB011008	11.25	0.50	0.16	0.52	12219
MSB011308	10.08	0.63	0.32	0.46	15395
MSB011708	15.08	0.70	0.24	0.30	17106
MSB020108	9.08	1.22	0.40	0.62	29813
MSB040408	27.00	0.57	0.24	0.24	13929
MSB050908	23.58	1.21	0.36	0.40	29569
MSB051208	18.08	0.97	0.28	0.38	23704
MSB052708	2.58	0.39	0.52	0.66	9530
MSB053108	21.58	0.31	0.52	0.26	7576
MSB060408	10.83	0.85	0.64	0.90	20772
MSB061408	10.58	0.57	1.12	0.56	13929
MSB061508	21.08	0.92	2.44	1.74	22482
MSB070508	21.08	0.88	0.80	0.88	21505
MSB072408	8.08	1.14	1.44	0.80	27858
MSB081408	27.08	0.85	0.76	0.46	20772
MSB092508	15.08	3.20	1.40	1.38	78199
MSB111508	25.33	0.97	0.28	0.26	23704
MSB112508	14.83	0.97	0.16	0.30	23704
MSB113008	32.08	1.46	0.36	0.50	35678

3.6 Flow Measurement

An ISCO 750 Area Velocity Flow Module with a Low Profile Area Velocity Flow Sensor was used to measure flow and pace sample collection. Level measurements were adjusted by applying corrections that reflected differences between recorded and measured water surface elevations in the effluent pipe where the ISCO flow sensor was installed. On average 78 percent of the calculated total rainfall volume was measured as runoff for the events monitored (Table 5).

Table 5 Percentage of calculated rainfall runoff volumes measured at Manasquan Savings Bank study site

Event ID	Event depth (in)	Influent volume (gal)	Total rainfall volume (gal)	Percent runoff (%)
MSB011008	0.50	8275	12219	68
MSB011308	0.63	10530	15395	68
MSB011708	0.70	9487	17106	55
MSB020108	1.22	30508	29813	102
MSB040408	0.57	4740	13929	34
MSB050908	1.21	13134	29569	44
MSB051208	0.97	10050	23704	42
MSB052708	0.39	7915	9530	83
MSB053108	0.31	10153	7576	134
MSB060408	0.85	24003	20772	116
MSB061408	0.57	13560	13929	97
MSB061508	0.92	15465	22482	69
MSB070508	0.92	24748	22482	110
MSB072408	1.14	28963	27858	104
MSB081408	0.85	19781	20772	95
MSB092508	3.20	65868	78199	84
MSB111508	0.97	15806	23704	67
MSB112508	0.97	11707	23704	49
MSB113008	1.46	24187	35678	68

3.7 Stormwater Data Collection Requirements

Of the 19 qualifying storm events sampled between January of 2008 and November of 2008: 1) the total rainfall was greater than 0.1 inch for all storm events sampled, 2) the minimum inter-event period was greater than 12 hours for all storm events sampled, 3) flow-weighted composite samples covered a minimum of 70% of total storm flow for all storm events sampled, 4) the average number of samples collected per storm event was 11, 5) the total sampled rainfall was 18.35 inches, 6) three events exceeded 75% of the design treatment capacity, and 6) TSS-SM, TSS-EPA, and SSC data were collected for all storm events sampled. All but two of the events qualified to strict interpretation of the stormwater data collection requirements as per New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2006) and the NJDEP interpretation of TARP (2003), Table 6. For the storm events in question, MSB040408 and MSB072408, less than 6 samples were collected but storm event coverage was greater than 90%. Considering the very small margin separating these events from qualification, they were deemed qualified based upon best professional judgment.

Table 6 Stormwater data collection requirements results

Event ID	Coverage (nearest 10%)	Number of samples	Event depth (in.)	Antecedent dry period (hr)	Influent volume (gal)	Peak flow (gpm)	Percent of hyd. design (%)
MSB011008	70	6	0.50	734	8275	241	34
MSB011308	70	8	0.63	53	10530	162	23
MSB011708	90	9	0.70	64	9487	113	16
MSB020108	80	24	1.22	49	30508	209	29
MSB040408	>90	5	0.57	45	4740	66	9
MSB050908	70	9	1.21	235	13134	132	18
MSB051208	80	8	0.97	51	10050	103	14
MSB052708	90	9	0.39	12	7915	353	49
MSB053108	90	9	0.31	81	10153	238	33
MSB060408	>90	22	0.85	69	24003	339	47
MSB061408	>90	14	0.57	228	13560	436	61
MSB061508	>90	9	0.92	12	15465	743	103
MSB070508	>90	8	0.92	89.6	24748	363	51
MSB072408	>90	5	1.14	84.8	28963	620	86
MSB081408	90	6	0.85	14.8	19781	349	49
MSB092508	>90	21	3.20	304	65868	619	86
MSB111508	>90	10	0.97	33	15806	145	20
MSB112508	>90	8	0.97	212	11707	57	8
MSB113008	>90	14	1.46	114	24187	158	22

4. Technology System Performance

4.1 Data Analysis

Of the 19 storm events captured between January of 2008 and November of 2008, data verification and validation did not lead to the outright disqualification of any events due to obvious monitoring, handling, or analytical errors, or the substantial exceedance of the design operating parameters. However, some instances were encountered that suggested the disqualification or separation of select analytical results from the data set. Some monitoring error was encountered in the form of equipment contamination as discussed in the Sampling Design section. This suggests the disqualification of a portion of the Total Volatile Suspended Solids (TVSS) data as well as calculated parameters that utilize TVSS data according to Table 2. Disqualification of either an influent or effluent result resulted in the elimination of the paired data from the final data set. Event mean concentrations (EMCs) from influent and effluent samples are summarized in Table 7, 8, and 9.

Table 7 Suspended Solids Event Mean Concentrations (EMCs) for the 19 events sampled at the Manasquan Savings Bank study site

Event ID	TSS-SM (<2000µm) (mg/l)		TSS-EPA (<2000µm) (mg/l)		SSC (mg/l)		SSC (>2000µm) (mg/l)		SSC (<2000µm) (mg/l)		SSC (<500µm) (mg/l)		SSC (<50µm) (mg/l)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
MSB011008	180.0	40.0	130.0	30.0	1360.0	40.3	367.0	2.5	993.0	40.3	397.0	40.3	55.7	26.9
MSB011308	60.0	10.0	50.0	10.0	760.0	13.2	381.0	4.1	379.0	13.2	101.0	13.0	26.2	12.8
MSB011708	60.0	30.0	60.0	40.0	178.0	36.5	25.5	4.4	152.0	36.5	81.1	35.7	44.2	35.5
MSB020108	60.0	50.0	60.0	50.0	152.0	65.3	42.7	11.1	109.0	54.2	70.0	43.4	56.6	51.6
MSB040408	310.0	2.9	40.0	10.0	341.0	2.4	NT	NT	341.0	2.4	99.7	2.9	26.5	2.9
MSB050908	56	21	48	21	78.7	23.3	24.7	0.2	54	23.3	27.7	23.8	4.8	7.6
MSB051208	41	6	32	8.7	50.6	9.3	15.7	0.2	34.9	9.3	10.2	6.3	4.6	3.7
MSB052708	68	32	60	34.7	74.5	40.7	7	2.4	67.5	38.3	40.5	29.6	14.3	7.5
MSB053108	154	43.2	141	41	188.5	41.1	27.7	0.27	160.8	40.8	60	30.3	20.8	12.8
MSB060408	24.3	9	23.3	7.7	27.7	10.5	0.8	0.6	26.9	9.9	17.4	5.3	6	7.3
MSB061408	718	84	658	51	710.7	74.7	25.2	4.4	685.5	70.3	508.6	41.6	125.1	32.8
MSB061508	304	40	298	37	299.5	55.9	11	0.1	288.5	55.9	241	29.5	72.6	11.8
MSB070508	271	26	232	25.5	241.9	30.3	3.9	0.38	238	29.9	158	13.6	52.4	6.8
MSB072408	458.7	46	427	43.3	500	49.7	8.6	6.71	491.1	43	256.2	24.2	74.4	9.4
MSB081408	657	48	468.5	41	598	42.5	55.2	0.2	542.8	42.3	271.2	31.9	50	14.2
MSB092508	2259	13.8	2075	12.7	6995	22.5	845	0.1	6150	22.5	2558	9.1	16.2	4.7
MSB111508	75.5	25.1	46.6	17	113	21.8	41.1	0.1	71.9	21.7	21.4	9.3	11.6	7.2
MSB112508	29.4	2.5	20.5	2.5	38.9	3.8	14.2	0.1	24.7	3.7	9.2	1.4	ND	ND
MSB113008	519	16.8	348	16.7	381.8	15.7	25.5	0.1	356.3	15.6	178.6	7.6	56.1	5.1
Min	24.3	2.5	20.5	2.5	27.7	2.4	0.8	0.1	24.7	2.4	9.2	1.4	4.6	2.9
Max	2259.0	84.0	2075.0	51.0	6995.0	74.7	845.0	11.1	6150.0	70.3	2558.0	43.4	125.1	51.6
Median	154.0	26.0	60.0	25.5	241.9	30.3	25.4	0.3	238.0	29.9	99.7	23.8	35.4	8.5
Mean	331.8	28.8	274.6	26.3	688.9	31.6	106.8	2.1	587.7	30.2	268.8	21.0	39.9	14.5

ND = Non-detect
NT = Not Tested

Table 8 Total Volatile Suspended Solids Event Mean Concentrations (EMCs) for the 19 events sampled at the Manasquan Savings Bank study site

Event ID	TVSS (>2000µm) (mg/l)		TVSS (<2000µm) (mg/l)		TVSS (<500µm) (mg/l)		TVSS (<50µm) (mg/l)		TVSS (mg/l)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
MSB011008	NT	NT	90.7	17.3	46.5	19.2	20.9	11.5	NT	NT
MSB011308	NT	NT	41.1	7.3	21.2	7.2	12.2	7.1	NT	NT
MSB011708	NT	NT	29.0	15.1	23.8	14.8	17.4	14.7	NT	NT
MSB020108	NT	NT	25.9	20.7	24.3	16.8	21.1	19.8	NT	NT
MSB040408	NT	NT	24.9	2.4	19.9	2.9	11.8	2.9	NT	NT
MSB050908	23.4	0.2	35.4	14.8	16.4	12.7	5.1	3.6	58.8	14.8
MSB051208	14.4	0.2	28	9.3	8.8	8.5	6.4	5.2	42.4	9.3
MSB052708	6.6	2.3	40.3	19.9	23	15.6	6.6	2.6	46.9	22.2
MSB053108	9.6	0.3	100.8	22	30.1	14.5	6.6	6	110.4	22.3
MSB060408	0.8	0.6	13.9	6.8	8.9	3.4	3.2	1.4	14.7	7.4
MSB061408	22.9	4	284.5	32.8	207.6	18	38.6	12.4	307.4	36.8
MSB061508	8.7	0.1	119	23.9	91.8	10.7	20.2	4.1	127.7	23.9
MSB070508	3.5	0.3	106	11.9	58.3	6.3	15.4	2.7	109	12.2
MSB072408	8.6	5.7	220.2	43	106.4	24.2	23.6	9.4	229	49
MSB081408	39.6	0.2	235.2	13.2	94.4	11.6	3.2	6.1	274.8	13.4
MSB092508	QC DQ	QC DQ	67.2	9.1	QC DQ	QC DQ	QC DQ	QC DQ	97.4	9.2
MSB111508	QC DQ	QC DQ	44.8	10.9	10.3	4.8	QC DQ	QC DQ	69	11
MSB112508	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	21	2.9
MSB113008	QC DQ	QC DQ	145.6	6.2	QC DQ	QC DQ	QC DQ	QC DQ	171.1	6.3
Min	0.8	0.1	13.9	2.4	8.8	2.9	3.2	1.4	14.7	2.9
Max	39.6	5.7	284.5	43.0	207.6	24.2	38.6	19.8	307.4	49.0
Median	9.2	0.3	56.0	14.0	24.1	12.2	12.2	6.0	103.2	12.8
Mean	13.8	1.4	91.8	15.9	49.5	11.9	14.2	7.3	120.0	17.2

NT = Not Tested
QC DQ = Quality Control Disqualification

Table 9 Calculated Parameters (mineral) Event Mean Concentrations (EMCs) for the 19 events sampled at the Manasquan Savings Bank study site

Event ID	Coarse Solids (mineral) (material >2000um) (mg/l)		Sand (mineral) (material 2000um to 50um) (mg/l)		Silt (mineral) (material <50um) (mg/l)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent
MSB011008	NT	NT	868.0	2.4	35.0	15.0
MSB011308	NT	NT	324.0	1.8	14.0	6.0
MSB011708	NT	NT	96.0	1.6	27.0	21.0
MSB020108	NT	NT	48.0	1.4	36.0	32.0
MSB040408	NT	NT	301.0	2.9	14.7	2.9
MSB050908	1.3	0.2	19	4.5	1.7	4
MSB051208	1.3	0.2	8.7	2.3	ND	ND
MSB052708	0.4	0.1	19.5	13.5	7.7	4.9
MSB053108	18.1	0.1	45.8	12	14.2	6.8
MSB060408	ND	ND	10.2	0.6	2.8	5.9
MSB061408	2.3	0.4	314.5	17.1	86.5	20.4
MSB061508	2.3	0.1	117.1	24.3	52.4	7.7
MSB070508	ND	ND	95	13.9	37	4.1
MSB072408	0	1.01	220.1	0	50.8	0
MSB081408	15.6	0.2	260.8	21	46.8	8.1
MSB092508	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ
MSB111508	QC DQ	QC DQ	20.9	5.1	QC DQ	QC DQ
MSB112508	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ
MSB113008	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ
Min	0.0	0.1	8.7	0.0	1.7	0.0
Max	18.1	1.0	868.0	24.3	86.5	32.0
Median	1.8	0.2	95.5	3.7	31.0	6.4
Mean	5.2	0.3	173.0	7.8	30.5	9.9

ND = Non-detect
NT = Not Tested
QC DQ = Quality Control Disqualification

Using SSC (<500 µm) and SSC (<50 µm) EMC results the percent of corresponding SSC (<2000 µm) EMC results was calculated. The calculated percentages of corresponding SSC (<2000µm) EMC results indicates the portion of material that are less than 500 µm and 50 µm in size and are summarized in Table 13.

Using TVSS EMC results the percent of corresponding SSC results was calculated. The calculated percentages of corresponding SSC (<2000µm) results indicate the portion of material that is less than 500 µm and 50 µm in size and are summarized in Table 14.

Appendix A details system performance on an individual storm basis (discrete removal efficiency) using the Washington State Department of Ecology "individual storm reduction in pollutant concentration" method (WADOE, 2002 method #1)—the performance of the system over the course of a single storm event based upon EMC. Hydrograph and rainfall data from the events are also shown in Appendix A.

In order to determine if data was normally or log-normally distributed the Kolmogorov-Smirnov test was used. EMCs for all parameters analyzed were tested. Influent EMCs for SSC (<50µm), TVSS, TVSS (>2000µm), TVSS (<50µm), and Silt (mineral) were normally distributed. Effluent EMCs for SSC, TVSS, SSC (<2000µm), SSC (<500µm), TVSS (<2000µm), TVSS (<500µm), TVSS (<50µm), TSS-SM (<2000µm), and TSS-EPA (<2000µm) were normally distributed. Influent EMCs for Sand (mineral), SSC, SSC (>2000µm), SSC (<2000µm), SSC (<500µm), TVSS (<2000µm), TVSS (<500µm), and TSS-SM (<2000µm) were log normally distributed. Effluent EMCs for Coarse Solids (mineral) and SSC (>2000µm) were log-normally distributed.

Non-parametric statistical methods were used to evaluate correlations and differences between influent and effluent EMCs since influent and effluent EMCs were generally not from the same statistical distribution. To test for positive correlations between influent and effluent EMCs, the Spearman Rank Order Correlation test was used (USGS, 1991). To evaluate the significance of differences between influent and effluent EMCs, the Mann-Whitney Rank Sum Test was used (USGS, 1991). For the Mann-Whitney Rank Sum Test the null hypothesis was that the two samples were not drawn from populations with different medians. A significant difference between influent and effluent EMCs was concluded when $P<0.05$.

Performance was calculated using the summation of loads (SOL) method. The SOL method defines the efficiency as a percentage based on the ratio of the summation of all incoming loads to the summation of all outlet loads. The SOL method assumes: 1) monitoring data accurately represents the actual entire total loads in and out of the BMP for a period long enough to overshadow any temporary storage or export of pollutants and 2) any significant storm events that were not monitored had a ratio of inlet to outlet loads similar to the storm events that were monitored (URS/ EPA 1999). Sum of Loads (SOL) Efficiency Calculations for the 19 events sampled at the Manasquan Savings Bank study are summarized in Tables 10, 11, and 12.

Detectible concentrations were observed for all parameters analyzed except for SSC (<50µm) for the MSB092508 event, Coarse Solids (mineral) for the MSB060408 and MSB070508 events, and Silt (mineral) for the MSB051208 event. For values that were reported as non-detect no substitutions were made for statistical testing or calculation of event loads.

Table 10 Suspended Solids Event Sum of Loads (SOL) Efficiency Calculations for the 19 events sampled at the Manasquan Savings Bank study site

Event ID	TSS-SM (<2000µm) (kg)		TSS-EPA (<2000µm) (kg)		SSC (kg)		SSC (>2000µm) (kg)		SSC (<2000µm) (kg)		SSC (<500µm) (kg)		SSC (<50µm) (kg)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
MSB011008	5.6	1.3	4.1	0.9	42.6	1.3	11.5	0.1	31.1	1.3	12.4	1.3	1.7	0.8
MSB011308	2.4	0.4	2.0	0.4	30.3	0.5	15.2	0.2	15.1	0.5	4.0	0.5	1.0	0.5
MSB011708	2.2	1.1	2.2	1.4	6.4	1.3	0.9	0.2	5.5	1.3	2.9	1.3	1.6	1.3
MSB020108	6.9	5.8	6.9	5.8	17.6	7.5	4.9	1.3	12.6	6.3	8.1	5.0	6.5	6.0
MSB040408	5.6	0.1	0.7	0.2	6.1	0.0	NT	NT	6.1	0.0	1.8	0.1	0.5	0.1
MSB050908	2.8	1.0	2.4	1.0	3.9	1.2	1.2	0.0	2.7	1.2	1.4	1.2	0.2	0.4
MSB051208	1.6	0.2	1.2	0.3	1.9	0.4	0.6	0.0	1.3	0.4	0.4	0.2	0.2	0.1
MSB052708	2.0	1.0	1.8	1.0	2.2	1.2	0.2	0.1	2.0	1.1	1.2	0.9	0.4	0.2
MSB053108	5.9	1.7	5.4	1.6	7.2	1.6	1.1	0.0	6.2	1.6	2.3	1.2	0.8	0.5
MSB060408	2.2	0.8	2.1	0.7	2.5	1.0	0.1	0.1	2.4	0.9	1.6	0.5	0.5	0.7
MSB061408	36.9	4.3	33.8	2.6	36.5	3.8	1.3	0.2	35.2	3.6	26.1	2.1	6.4	1.7
MSB061508	17.8	2.3	17.4	2.2	17.5	3.3	0.6	0.0	16.9	3.3	14.1	1.7	4.2	0.7
MSB070508	25.4	2.4	21.7	2.4	22.7	2.8	0.4	0.0	22.3	2.8	14.8	1.3	4.9	0.6
MSB072408	50.3	5.0	46.8	4.7	54.8	5.4	0.9	0.7	53.8	4.7	28.1	2.7	8.2	1.0
MSB081408	49.2	3.6	35.1	3.1	44.8	3.2	4.1	0.0	40.6	3.2	20.3	2.4	3.7	1.1
MSB092508	563.2	3.4	517.3	3.2	1743.9	5.6	210.7	0.0	1533.3	5.6	637.7	2.3	4.0	1.2
MSB111508	4.5	1.5	2.8	1.0	6.8	1.3	2.5	0.0	4.3	1.3	1.3	0.6	0.7	0.4
MSB112508	1.3	0.1	0.9	0.1	1.7	0.2	0.6	0.0	1.1	0.2	0.4	0.1	ND	ND
MSB113008	47.5	1.5	31.9	1.5	35.0	1.4	2.3	0.0	32.6	1.4	16.4	0.7	5.1	0.5
Total	833.2	37.6	736.5	34.2	2084.4	43.0	259.2	2.9	1825.1	40.6	795.3	25.8	50.9	17.7
SOL Efficiency	95		95		98		99		98		97		65	

ND = Non-detect
NT = Not Tested

Table 11 Total Volatile Suspended Solids Event Sum of Loads (SOL) Efficiency Calculations for the 19 events sampled at the Manasquan Savings Bank study site

Event ID	TVSS (>2000µm) (kg)		TVSS (<2000µm) (kg)		TVSS (<500µm) (kg)		TVSS (<50µm) (kg)		TVSS (kg)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
MSB011008	NT	NT	2.8	0.5	1.5	0.6	0.7	0.4	NT	NT
MSB011308	NT	NT	1.6	0.3	0.8	0.3	0.5	0.3	NT	NT
MSB011708	NT	NT	1.0	0.5	0.9	0.5	0.6	0.5	NT	NT
MSB020108	NT	NT	3.0	2.4	2.8	1.9	2.4	2.3	NT	NT
MSB040408	NT	NT	0.4	0.0	0.4	0.1	0.2	0.1	NT	NT
MSB050908	1.2	0.0	1.8	0.7	0.8	0.6	0.3	0.2	2.9	0.7
MSB051208	0.5	0.0	1.1	0.4	0.3	0.3	0.2	0.2	1.6	0.4
MSB052708	0.2	0.1	1.2	0.6	0.7	0.5	0.2	0.1	1.4	0.7
MSB053108	0.4	0.0	3.9	0.8	1.2	0.6	0.3	0.2	4.2	0.9
MSB060408	0.1	0.1	1.3	0.6	0.8	0.3	0.3	0.1	1.3	0.7
MSB061408	1.2	0.2	14.6	1.7	10.7	0.9	2.0	0.6	15.8	1.9
MSB061508	0.5	0.0	7.0	1.4	5.4	0.6	1.2	0.2	7.5	1.4
MSB070508	0.3	0.0	9.9	1.1	5.5	0.6	1.4	0.3	10.2	1.1
MSB072408	0.9	0.6	24.1	4.7	11.7	2.7	2.6	1.0	25.1	5.4
MSB081408	3.0	0.0	17.6	1.0	7.1	0.9	0.2	0.5	20.6	1.0
MSB092508	QC DQ	QC DQ	16.8	2.3	QC DQ	QC DQ	QC DQ	QC DQ	24.3	2.3
MSB111508	QC DQ	QC DQ	2.7	0.7	0.6	0.3	QC DQ	QC DQ	4.1	0.7
MSB112508	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	0.9	0.1
MSB113008	QC DQ	QC DQ	13.3	0.6	QC DQ	QC DQ	QC DQ	QC DQ	15.7	0.6
Total	8.3	1.0	124.1	20.3	51.0	11.6	13.1	6.9	135.7	17.7
SOL Efficiency	88		84		77		47		87	

NT = Not Tested
QC DQ = Quality Control Disqualification

Table 12 Calculated Parameters (mineral) Event Sum of Loads (SOL) Efficiency Calculations for the 19 events sampled at the Manasquan Savings Bank study site

Event ID	Coarse Solids (mineral) (kg)		Sand (mineral) (kg)		Silt (mineral) (kg)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent
MSB011008	NT	NT	27.2	0.1	1.1	0.5
MSB011308	NT	NT	12.9	0.1	0.6	0.2
MSB011708	NT	NT	3.4	0.1	1.0	0.8
MSB020108	NT	NT	5.5	0.2	4.2	3.7
MSB040408	NT	NT	5.4	0.1	0.3	0.1
MSB050908	0.1	0.0	0.9	0.2	0.1	0.2
MSB051208	0.0	0.0	0.3	0.1	ND	ND
MSB052708	0.0	0.0	0.6	0.4	0.2	0.1
MSB053108	0.7	0.0	1.8	0.5	0.5	0.3
MSB060408	ND	ND	0.9	0.1	0.3	0.5
MSB061408	0.1	0.0	16.1	0.9	4.4	1.0
MSB061508	0.1	0.0	6.9	1.4	3.1	0.5
MSB070508	ND	ND	8.9	1.3	3.5	0.4
MSB072408	0.0	0.1	24.1	0.0	5.6	0.0
MSB081408	1.2	0.0	19.5	1.6	3.5	0.6
MSB092508	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ
MSB111508	QC DQ	QC DQ	1.3	0.3	QC DQ	QC DQ
MSB112508	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ
MSB113008	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ
Total	2.2	0.2	135.8	7.1	28.2	8.8
SOL Efficiency	92		95		69	

ND = Non-detect
NT = Not Tested
QC DQ = Quality Control Disqualification

Table 13 Calculated percentages of material less than 500 µm and 50 µm for the 19 events sampled at the Manasquan Savings Bank study site

Event ID	SSC (<500-um) (mg/l)/ SSC (<2000-um) (mg/l)		SSC (<50-um) (mg/l)/ SSC (<2000-um) (mg/l)	
	Influent	Effluent	Influent	Effluent
MSB011008	40%	100%	6%	67%
MSB011308	27%	98%	7%	97%
MSB011708	53%	98%	29%	97%
MSB020108	64%	80%	52%	95%
MSB040408	29%	121%	8%	125%
MSB050908	51%	102%	9%	33%
MSB051208	29%	68%	13%	40%
MSB052708	60%	77%	21%	20%
MSB053108	37%	74%	13%	31%
MSB060408	65%	54%	22%	74%
MSB061408	74%	59%	18%	47%
MSB061508	84%	53%	25%	21%
MSB070508	66%	45%	22%	23%
MSB072408	52%	56%	15%	22%
MSB081408	50%	75%	9%	34%
MSB092508	42%	40%	0%	21%
MSB111508	30%	43%	16%	33%
MSB112508	37%	38%	ND	ND
MSB113008	50%	49%	16%	33%
Min	27%	38%	0%	20%
Max	84%	121%	52%	125%
Median	50%	68%	15%	33%
Mean	50%	70%	17%	51%

ND = Non-detect

Table 14 Calculated percentages of combustible materials that are assumed to be organic in nature for the 19 events sampled at the Manasquan Savings Bank study site

Event ID	TVSS (<2000-um) (mg/l) / SSC (<2000-um) (mg/l)		TVSS (<500-um) (mg/l) / SSC (<500-um) (mg/l)		TVSS (<50-um) (mg/l) / SSC (<50-um) (mg/l)		TVSS (>2000-um) (mg/l) / SSC (>2000-um) (mg/l)		TVSS (mg/l) / SSC(mg/l)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
MSB011008	9%	43%	12%	48%	38%	43%	NT	NT	NT	NT
MSB011308	11%	56%	21%	56%	47%	56%	NT	NT	NT	NT
MSB011708	19%	41%	29%	41%	39%	41%	NT	NT	NT	NT
MSB020108	24%	38%	35%	39%	37%	38%	NT	NT	NT	NT
MSB040408	7%	100%	20%	100%	45%	100%	NT	NT	NT	NT
MSB050908	66%	64%	59%	53%	106%	47%	95%	100%	75%	64%
MSB051208	80%	100%	86%	135%	139%	141%	92%	100%	84%	100%
MSB052708	60%	52%	57%	53%	46%	35%	94%	96%	63%	55%
MSB053108	63%	54%	50%	48%	32%	47%	35%	111%	59%	54%
MSB060408	52%	69%	51%	64%	53%	19%	100%	100%	53%	70%
MSB061408	42%	47%	41%	43%	31%	38%	91%	91%	43%	49%
MSB061508	41%	43%	38%	36%	28%	35%	79%	100%	43%	43%
MSB070508	45%	40%	37%	46%	29%	40%	90%	79%	45%	40%
MSB072408	45%	100%	42%	100%	32%	100%	100%	85%	46%	99%
MSB081408	43%	31%	35%	36%	6%	43%	72%	100%	46%	32%
MSB092508	1%	40%	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	1%	41%
MSB111508	62%	50%	48%	52%	QC DQ	QC DQ	QC DQ	QC DQ	61%	50%
MSB112508	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	54%	76%
MSB113008	41%	40%	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	QC DQ	45%	40%
Min	1%	31%	12%	36%	6%	19%	35%	79%	1%	32%
Max	80%	100%	86%	135%	139%	141%	100%	111%	84%	100%
Median	42%	48%	39%	50%	38%	43%	91%	100%	50%	52%
Mean	39%	56%	41%	59%	47%	55%	85%	96%	51%	58%

NT = Not Tested
QC DQ = Quality Control Disqualification

4.2 Test Results

Based on the use of the Spearman Rank Order correlation, test positive correlations ($P<0.05$) were determined between influent and effluent EMCs for TVSS, SSC (<50µm), TVSS (<500µm), TVSS (<50µm), and TSS-EPA (<2000µm). The concentration of influent and effluent sample pairs tended to increase together.

Based on the use of the Mann-Whitney Rank Sum test the difference in the median values between the influent and effluent EMCs is greater than would be expected by chance; there is a statistically significant difference ($P< 0.05$) for all parameters analyzed.

Suspended Solids Parameters

Influent EMCs for TSS-SM (<2000µm) ranged from 24.3 mg/l to 2259.0 mg/l with a median of 154.0 mg/l and a mean of 331.8 mg/l. Corresponding effluent EMCs ranged from 2.5 mg/l to 84.0 mg/l with a median of 26.0 mg/l and a mean of 28.8 mg/l. Total event loadings for the study were 833.2 kg at the influent and 37.6 kg at the effluent sampling location, resulting in an overall removal efficiency of 95%.

Influent EMCs for SSC (<2000µm) ranged from 24.7 mg/l to 6150.0 mg/l with a median of 238.0 mg/l and a mean of 587.7 mg/l. Corresponding effluent EMCs ranged from 2.4 mg/l to 70.3 mg/l with a median of 29.9 mg/l and a mean of 30.2 mg/l. Total event loadings for the study were 1825.1 kg at the influent and 40.6 kg at the effluent sampling location, resulting in an overall removal efficiency of 98 %.

In general, the relationship between TSS-SM (<2000µm) and SSC (<2000µm) was determined to be positive based on the linear regression results for both influent (R^2 =0.9) and effluent (R^2 =0.91) EMCs. The ratio of TSS-SM (<2000µm) to SSC (<2000µm) EMCs ranged from 0.2 to 1.5 with a median of 1.0 for the influent compared to a range from 0.6 to 1.2 with a median of 0.9 for the effluent.

Influent EMCs for TSS-EPA (<2000µm) ranged from 20.5 mg/l to 2075.0 mg/l with a median of 60.0 mg/l and a mean of 274.6 mg/l. Corresponding effluent EMCs ranged from 2.5 mg/l to 51.0 mg/l with a median of 25.5 mg/l and a mean of 26.3 mg/l. Total event loadings for the study were 736.5 kg at the influent and 34.2 kg at the effluent sampling location, resulting in an overall removal efficiency of 95%.

Influent EMCs for SSC ranged from 27.7 mg/l to 6995.0 mg/l with a median of 241.9 mg/l and a mean of 688.9 mg/l. Corresponding effluent EMCs ranged from 2.4 mg/l to 74.7 mg/l with a median of 30.3 mg/l and a mean of 31.6 mg/l. Total event loadings for the study were 2084.4 kg at the influent and 43.0 kg at the effluent sampling location, resulting in an overall removal efficiency of 98%.

Influent EMCs for SSC (>2000µm) ranged from 0.8 mg/l to 845.0 mg/l with a median of 25.4 mg/l and a mean of 106.8 mg/l. Corresponding effluent EMCs ranged from 0.1 mg/l to 11.1 mg/l with a median of 0.3 mg/l and a mean of 2.1 mg/l. Total event loadings for the study were 259.2

kg at the influent and 2.9 kg at the effluent sampling location, resulting in an overall removal efficiency of 99%.

Influent EMCs for SSC (<500µm) ranged from 9.2 mg/l to 2558.0 mg/l with a median of 99.7 mg/l and a mean of 268.8 mg/l. Corresponding effluent EMCs ranged from 1.4 mg/l to 43.4 mg/l with a median of 23.8 mg/l and a mean of 21.0 mg/l. Total event loadings for the study were 795.3 kg at the influent and 25.8 kg at the effluent sampling location, resulting in an overall removal efficiency of 97%. For each storm event the percent of SSC (<2000 µm) represented by SSC (<500 µm) was calculated. Influent and effluent median percentages of SSC (<2000µm) were 50% and 68% respectively. The percentage of corresponding SSC (<2000µm) results indicates the portion of material that are less than 500µm in size.

Influent EMCs for SSC (<50µm) ranged from 4.6 mg/l to 125.1 mg/l with a median of 35.4 mg/l and a mean of 39.9 mg/l. Corresponding effluent EMCs ranged from 2.9 mg/l to 51.6 mg/l with a median of 8.5 mg/l and a mean of 14.5 mg/l. Total event loadings for the study were 50.9 kg at the influent and 17.7 kg at the effluent sampling location, resulting in an overall removal efficiency of 65 %. For each storm event the percent of SSC (<2000 µm) represented by SSC (<50 µm) was calculated. Influent and effluent median percentages of SSC (<2000µm) were 15% and 33% respectively. The percentage of corresponding SSC (<2000µm) results indicates the portion of materials that are less than 50µm in size.

Volatile Suspended Solids Parameters

Influent EMCs for TVSS (>2000µm) ranged from 0.8 mg/l and 39.6 mg/l with a median of 9.2 mg/l and a mean of 13.8 mg/l. Corresponding effluent EMCs ranged from 0.1 mg/l to 5.7 mg/l with a median of 0.3 mg/l and a mean of 1.4 mg/l. Total event loadings for the study were 8.3 kg at the influent and 1.0 kg at the effluent sampling location, resulting in an overall removal efficiency of 88%. For each storm event the percent of SSC (>2000 µm) represented by TVSS (>2000µm) was calculated. Influent and effluent median percentages of SSC (>2000µm) were 91% and 100% respectively. Percentage of corresponding SSC (>2000µm) results indicates the percent of combustible materials that are assumed to be organic in nature.

Influent EMCs for TVSS ranged from 14.7 mg/l and 307.4 mg/l with a median of 103.2 mg/l and a mean of 120.0 mg/l. Corresponding effluent EMCs ranged from 2.9 mg/l to 49.0 mg/l with a median of 12.8 mg/l and a mean of 17.2 mg/l. Total event loadings for the study were 135.7 kg at the influent and 17.7 kg at the effluent sampling location, resulting in an overall removal efficiency of 87%. For each storm event the percent of SSC represented by TVSS was calculated. Influent and effluent median percentages of SSC were 50% and 52% respectively. Percentage of corresponding SSC results indicates the percent of combustible materials that are assumed to be organic in nature.

Influent EMCs for TVSS (<2000µm) ranged from 284.5 mg/l and 13.9 mg/l with a median of 56.0 mg/l and a mean of 91.8 mg/l. Corresponding effluent EMCs ranged from 2.4 mg/l to 43.0 mg/l with a median of 14.0 mg/l and a mean of 15.9 mg/l. Total event loadings for the study were 124.1 kg at the influent and 20.3 kg at the effluent sampling location, resulting in an overall removal efficiency of 84%. For each storm event the percent of SSC (<2000 µm) represented by

TVSS (<2000µm) was calculated. Influent and effluent median percentages of SSC (<2000µm) were 42% and 48% respectively. Percentage of corresponding SSC (<2000µm) results indicates the percent of combustible materials that are assumed to be organic in nature.

Influent EMCs for TVSS (<500µm) ranged from 207.6 mg/l and 8.8 mg/l with a median of 24.1 mg/l and a mean of 49.5 mg/l. Corresponding effluent EMCs ranged from 24.2 mg/l to 2.9 mg/l with a median of 12.2 mg/l and a mean of 11.9 mg/l. Total event loadings for the study were 51.0 kg at the influent and 11.6 kg at the effluent sampling location, resulting in an overall removal efficiency of 77%. For each storm event the percent of SSC (<500 µm) represented by TVSS (<500 µm) was calculated. Influent and effluent median percentages of SSC (<500µm) were 39% and 50% respectively. Percentage of corresponding SSC (<500µm) results indicates the percent of combustible materials that are assumed to be organic in nature.

Influent EMCs for TVSS (<50µm) ranged from 3.2 mg/l and 38.6 mg/l with a median of 12.2 mg/l and a mean of 14.2 mg/l. Corresponding effluent EMCs ranged from 1.4 mg/l to 19.8 mg/l with a median of 6.0 mg/l and a mean of 7.3 mg/l. Total event loadings for the study were 13.1 kg at the influent and 6.9 kg at the effluent sampling location, resulting in an overall removal efficiency of 47%. For each storm event the percent of SSC (<50 µm) represented by TVSS (<50 µm) was calculated. Influent and effluent median percentages of SSC (<50µm) were 38% and 43% respectively. Percentage of corresponding SSC (<50µm) results indicates the percent of combustible materials that are assumed to be organic in nature.

Additional Parameters

Influent EMCs for Coarse Solids (mineral) ranged from 0.00 mg/l and 18.1 mg/l with a median of 1.8 mg/l and a mean of 5.2 mg/l. Corresponding effluent EMCs ranged from 0.1 mg/l to 1.0 mg/l with a median 0.2 mg/l and a mean of 0.3 mg/l. Total event loadings for the study were 2.2 kg at the influent and 0.2 kg at the effluent sampling location, resulting in an overall removal efficiency of 92%.

Influent EMCs for Sand (mineral) ranged from 8.7 mg/l and 868.0 mg/l with a median of 95.5 mg/l and a mean of 173.0 mg/l. Corresponding effluent EMCs ranged from 0.0 mg/l to 24.3 mg/l with a median of 3.7 mg/l and a mean of 7.8 mg/l. Total event loadings for the study were 135.8 kg at the influent and 7.1 kg at the effluent sampling location, resulting in an overall removal efficiency of 95%.

Influent EMCs for Silt (mineral) ranged from 1.7 mg/l and 86.5 mg/l with a median of 31.0 mg/l and a mean of 30.5 mg/l. Corresponding effluent EMCs ranged from 0.0 mg/l to 32.0 mg/l with a median of 6.4 mg/l and a mean of 9.9 mg/l. Total event loadings for the study were 28.2 kg at the influent and 8.8 kg at the effluent sampling location, resulting in an overall removal efficiency of 69%.

4.3 System Maintenance and Residual Solids Assessment Results

Inspection of the CDS system in April 2008 revealed that a substantial volume of leaf litter had accumulated in the separation chamber. A vactor truck was contracted to remove this material from the separation chamber on April, 15, 2008. Upon removal of the leaf litter it was determined that the remainder of the system did not require maintenance. At the conclusion of the monitoring period in January 2009 a vactor truck was contracted to remove all contents from the CDS system. Prior to this maintenance event on January 13, 2009 samples were collected from the separation chamber, sediment sump and annulus area for evaluation. In order to safely enter the system a vactor truck was used to dewater the system. Following the dewatering of the system, multiple sediment samples were collected of materials contained in the system and depth measurements taken. Sediment samples were combined into a composite sample. Subsamples were then collected from this composite and analyzed for bulk density and particle size distribution. Prior to particle size distribution analysis the subsample was passed through a 2000µm sieve in an effort to isolate soil separates. Particle size analysis of materials <2000µm revealed that the total solids portion of materials contained in the system had a sand texture (USDA classification).

The mass of materials contained in the system was estimated using depth measurements and bulk density results. The mass of materials contained in the system included material removed during both the maintenance inspection performed on April 15, 2008 and final maintenance performed on January 13, 2009. The estimated total dry mass of materials contained in the system, after dewatering, was approximately 1300 kg (2860 lbs). Approximately 8% of the of the mass was located in the annulus area outside of the separation chamber, approximately 51% of the mass was located in the treatment chamber, and approximately 41% of the mass was located in the sump of the unit. The accuracy of the estimated mass of materials contained in the system should be considered limited, due to the non uniform distribution of materials contained in the system as well as the unaccounted for material removed by the vactor truck during the dewatering process.

Particle Size Distribution Analysis Results

The particle size distribution (PSD) results obtained using the Laser Diffraction method are summarized in Table 15. Results suggest the average d_{50} is greater than 100µm for both influent and effluent sampling locations for all three events submitted for analysis. These results are supported by the observed (TSS-EPA, TSS-SM, and SSC<2000µm) removal efficiency of greater than 90%, which suggests the presence of a substantial mass of coarse solids and a d_{50} greater than 100µm.

Table 15 Particle size distribution analysis results using ASTM D4464 for events sampled at the Manasquan Savings Bank study site

Event ID	SAND		SILT		CLAY		d_{50}	
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
MSB051208A	99.17	97.82	0.83	2.18	0.00	0.00	1315.63	1163.59
MSB061408A	50.49	66.54	47.11	31.67	2.40	1.80	76.38	392.77
MSB111508A	76.93	67.47	22.11	31.15	0.96	1.38	582.00	412.15
Median	76.93	67.47	22.11	31.15	0.96	1.38	582.00	412.15
Mean	75.53	77.28	23.35	21.67	1.12	1.06	658.00	656.17

Influent particle size distribution (PSD) obtained using the serial filtration method covering the 6350µm to 1.5µm particle size range suggests that the average d_{50} is greater than 100µm for all of the events captured to date, as shown in Figure 10. The upper size limit of 6350µm is approximately equal to the sample strainer opening. It is assumed that particles larger then the opening will not be sampled. The lower size limit of 1.5µm is equal to the pore size of filters used by the analytical laboratory for solids analysis. Serial filtration particle size distribution results are also supported by observed solids (TSS-EPA, TSS-SM, and SSC <2000um removal efficiency rates of greater than 90%, which suggests the presence of a substantial mass of coarse solids and a d_{50} greater than 100µm.

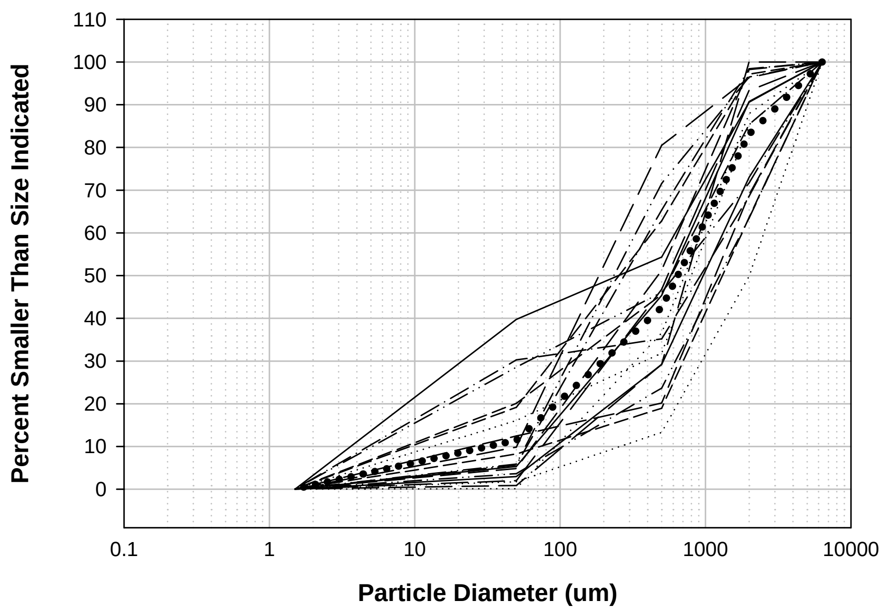

Figure 10 Influent particle size distribution generated using serial filtration covering 6350µm to 1.5µm particle size range; dashed line represents mean particle size distribution

Influent particle size distribution (PSD) obtained using the serial filtration method covering the 500µm to 1.5µm particle size range reflect an average d_{50} that is less than 100µm for all the events captured to date, as seen in Figure 11.

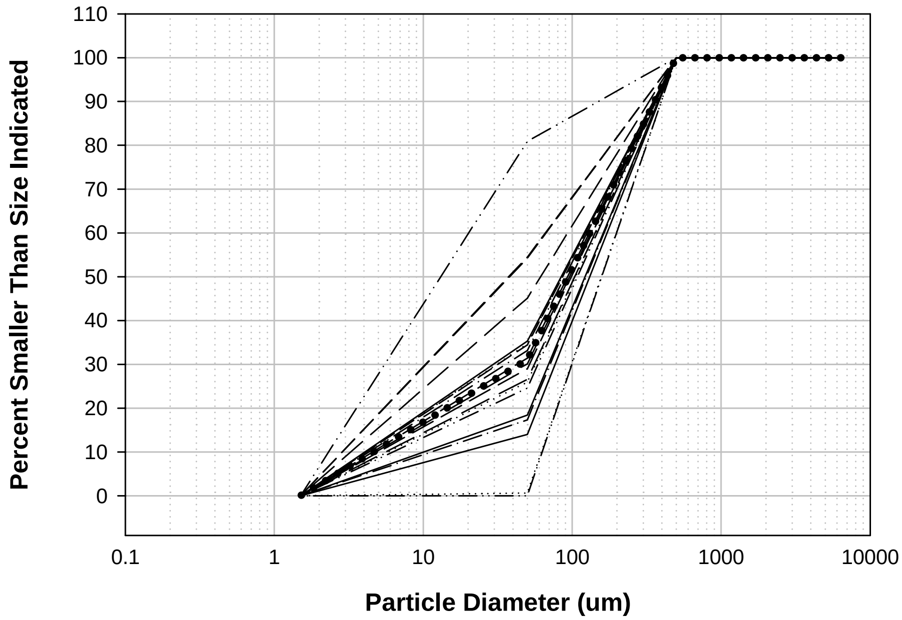

Figure 11 Influent PSD generated using serial filtration covering 500µm to 1.5µm particle size range; dashed line represents mean particle size distribution

Influent and effluent mean particle size distributions were compared using data obtained using serial filtration covering the 6350µm to 1.5µm particle size range, as seen in Figure 12. Plotted results indicate that the d_{50} values were greater than 100µm for the influent sampling location and less than 100µm at the effluent sampling location.

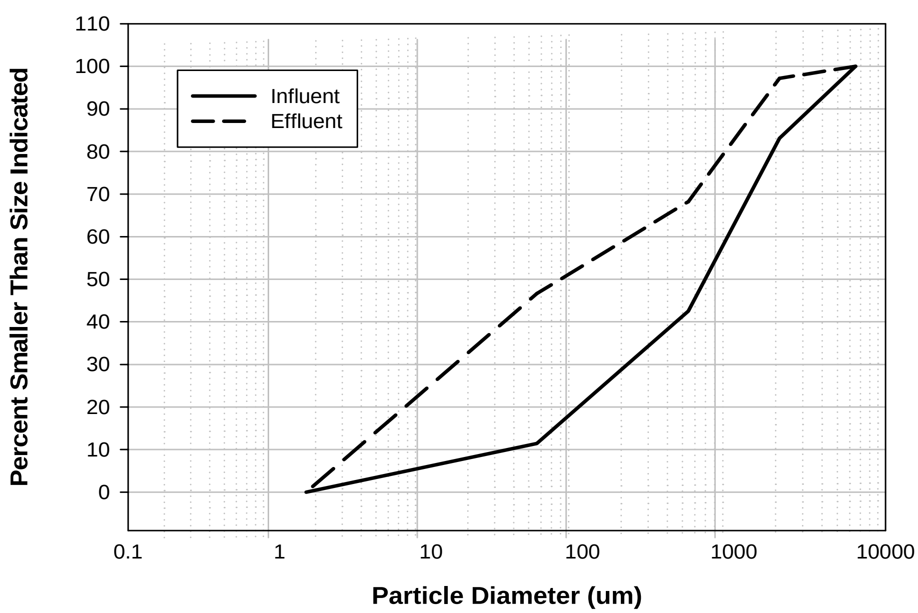

Figure 12 Comparison of mean influent and effluent particle size distributions generated using serial filtration covering 6350µm to 1.5µm particle size range

Influent and effluent mean particle size distributions were compared using data obtained using serial filtration covering the 500µm to 1.5µm particle size range, as seen in Figure 13. Plotted results indicate that the d_{50} values were less than 100µm for both the influent sampling location and the effluent sampling location.

4.4 Summary

Between January of 2008 and November of 2008, 19 storm events were monitored and were determined to meet the storm data collection requirements as per New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2006) and the NJDEP interpretation of TARP (2003). Total rainfall depth for qualified events was 18.35 inches and three events exceeded 75% of the design treatment capacity, thus satisfying TARP Tier II and NJDEP completeness criteria.

Significant reductions for suspended solids loads were observed between influent and effluent sampling locations: SSC (<2000µm) 98%, TSS-SM (<2000µm) 95%, TSS-EPA (<2000µm) 95%, SSC (<500µm) 97%, and SSC (<50µm) 65%. The positive capture of solids by the system was verified as part of the residual solids assessment during both the maintenance inspection as well as the final maintenance. Comparison of the estimated mass of material contained in the system to calculated loads using water quality results was determined to be within the realm of expectations for the study.

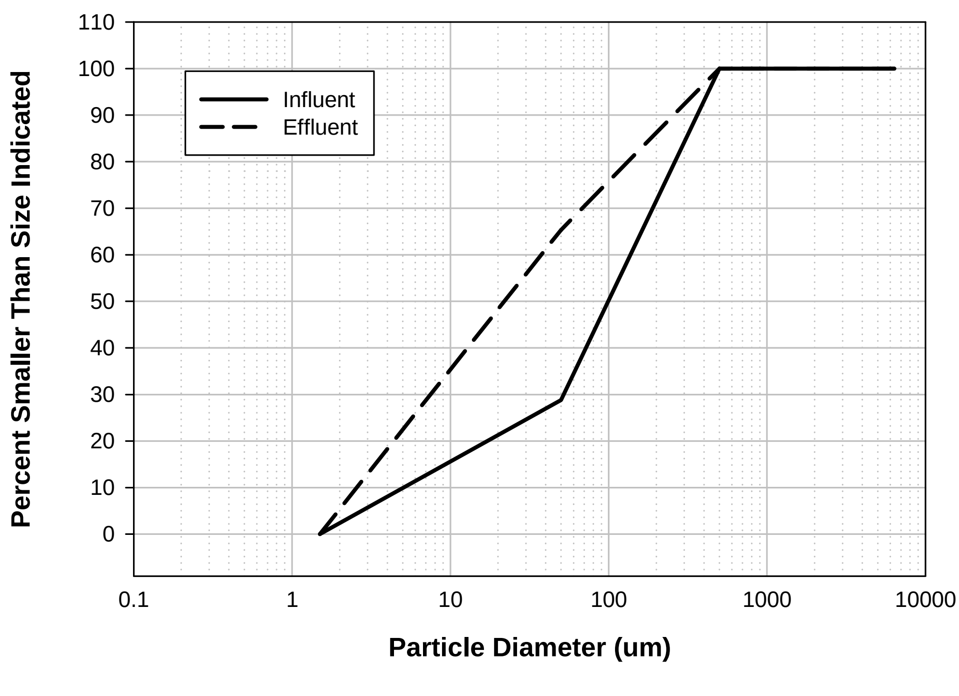

Figure 13 Comparison of mean influent and effluent particle size distributions generated using serial filtration covering 500µm to 1.5µm particle size range

5. Performance Claim Verification

Given that the performance standard is based on TSS-SM, and TSS-SM removal efficiency results for this study are associated with suspended solids with a d_{50} greater than 100µm, the review of additional data was required to further understand removal efficiency results. In general, removal efficiency results in excess of 90% are not typical for a flow through gravity separation technology but are within the realm of expected performance associated with observed influent TSS-SM EMCs with a d_{50} greater than 100µm. In an effort to isolate suspended sediment removal efficiency based on specific particle size ranges, SSC samples were sieved prior to analysis. The particle size ranges that were isolated for this study include 6350µm to 1.5µm, 2000µm to 1.5µm, 500µm to 1.5µm, and 50µm to 1.5µm.

The isolation of suspended solids removal efficiency based on particles 500µm to 1.5µm with d_{50} less than 100µm and particles between 50µm and 1.5 µm with a d_{50} less than 50µm resulted in an overall removal efficiency of 97% and 65% respectively. The use of these results is proposed to confirm favorable removal of solids and in order to satisfy the site qualification requirements (d_{50}< 100um) as per New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2006) and the NJDEP interpretation of TARP (2003). Additionally, these results demonstrate performance greater than 60% removal (65% SSC<50µm) of suspended solids with a d_{50} less than 50µm. Past research has concluded that when coarse particles are not present results obtained with the SSC method differ very little from results obtained using the TSS method (Gray et al 2000, Guo 2006), so results of the SSC<50um analysis are expected to be representative of TSS results.

Focusing on finer solids fractions also reduces the potential for bias towards the sampling of coarse mineral solids using accepted sampling techniques. Finer mineral particles smaller than 50µm (Silt (mineral)) are generally expected to be more or less uniformly distributed throughout the water column. In addition to SSC, removal efficiency based on mineral particles smaller than 50µm was isolated. Silt (mineral) results were calculated by subtracting the volatile suspended solids results (TVSS (<50µm)) composed of combustible materials assumed to be organic in nature from the suspended solids results (SSC (<50µm)). Removal efficiency based on Silt (Mineral) results resulted in an overall removal efficiency of 69%.

Recognizing the potential of a limited number of storm events to dominate sum of loads performance efficiency calculations, storm events with TSS-SM (<2000µm) EMCs less than 500 mg/l were segregated from the data set and evaluated. Significant reductions for suspended solids loads were observed between influent and effluent sampling locations: SSC (<2000µm) 85%, TSS-SM (<2000µm) 82%, TSS-EPA (<2000µm) 80%, SSC (<500µm) 81%, SSC (<50µm) 58%, and Silt (mineral) 65%.

The primary purpose of this project was to document High Efficiency CDS system performance with respect to suspended solids removal and quantify performance in accordance with the TARP Protocol for Stormwater Best Management Practice Demonstrations and NJDEP Tier II monitoring requirements.

The High Efficiency CDS unit model PMSU20_25 (CDS2025) installed online at the Manasquan Savings Bank study site sized based on the New Jersey Water Quality Design Storm to treat a maximum water quality flow rate of 1.6 cfs and a peak flow of 5.43 cfs demonstrated significant suspended solids removal including greater than 60% removal of suspended solids with a d_{50} less than 50µm. The CDS2025 also demonstrated the ability to remove greater than 80% of stormwater solids when the influent particle size distribution is predominantly sand sized particles (50-2000 microns).

6. Net Environmental Benefit

The High Efficiency CDS unit requires no input of raw material, has no moving parts and therefore uses no water or energy other than that provided by stormwater runoff. During the 11-month monitoring period the mass of materials captured and retained by the High Efficiency CDS unit was approximately 1300 kg (2860 lbs). This material would otherwise have been released to the environment during runoff producing rain events.

7. References

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APPENDIX A

INDIVIDUAL STORM REPORTS

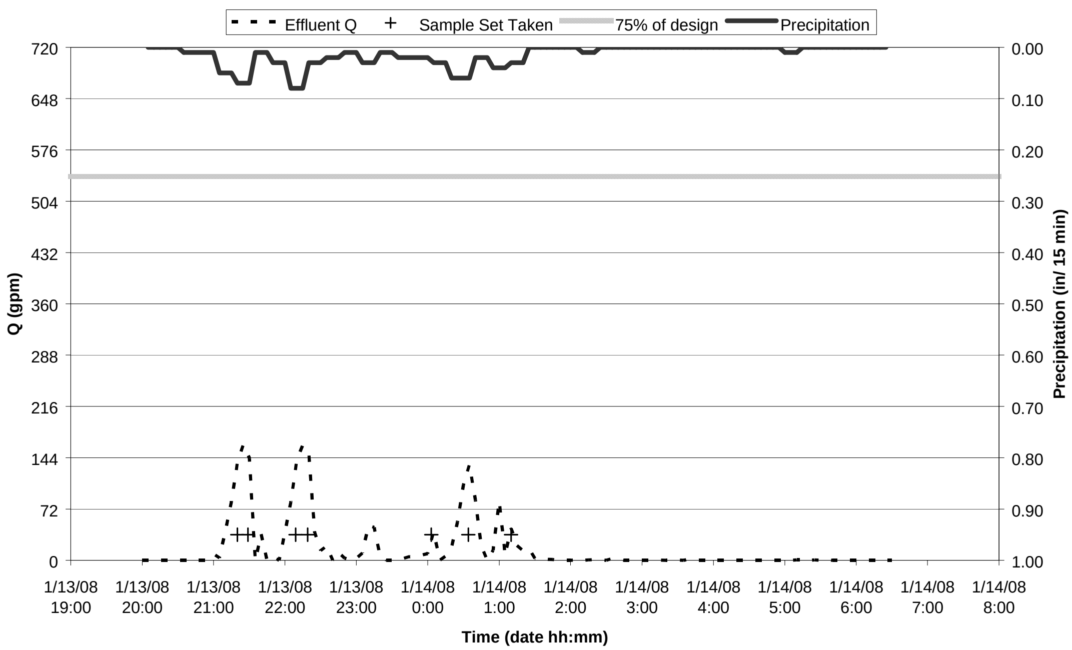
General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	01/13/08
Date of Last Maintenance:	10/29/07
Antecedent Conditions:	53 hours since last rain event, 0.11"

Hydrology

Total Precipitation (in):	0.63
Peak Flow (gpm):	162 (23% of design)
Total Runoff Volume (gal):	10530
Vol. Coverage (nearest 10%):	70

Event Hydrograph



Analytical

Number of Aliquots:	Parameter	Concentrations (mg/L) Influent EMC	Effluent EMC	MRL	Dup. RPD	Discrete Removal Efficiency
IN: 8 (3.2-L)	~~Sand (mineral)~~	324	ND	1.79	20%	99%
EFF: 8	~~Silt (mineral)~~	14	6	1.75	20%	60%
	~~SSC (>2000-um)~~	381	ND	4.08	20%	99%
	~~SSC~~	760	13.2	4.08	20%	98%
	SSC (<2000-um)	379	13.2	1.79	24.3%	97%
	SSC (<500-um)	101	13.0	1.77	24.3%	87%
	SSC (<50-um)	26.2	12.8	1.75	24.3%	51%
	TVSS (<2000-um)	41.1	7.33	1.79	20%	82%
	TVSS (<500-um)	21.2	7.22	1.77	20%	66%
	TVSS (<50-um)	12.2	7.13	1.75	20%	42%
	TSS (SM)	60.0	10.0	10.0	20%	83%
	TSS (EPA)	50.0	10.0	10.0	20%	80%

Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results. A single influent and effluent aliquot from 01/10/2008 (not displayed) was included in the composite due to overlap between events and their corresponding sample bottles on account of the "stacked" sampling approach.

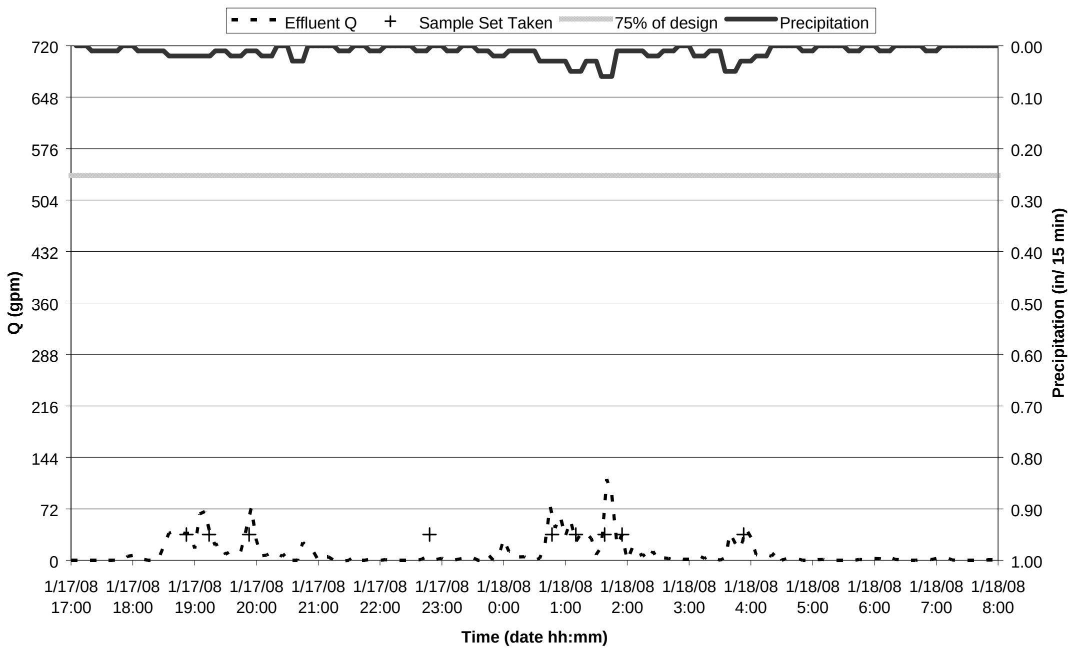
General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	01/17/08
Date of Last Maintenance:	10/29/07
Antecedent Conditions:	64 hours since last rain event, 0.09”

Hydrology

Total Precipitation (in):	0.70
Peak Flow (gpm):	113 (16% of design)
Total Runoff Volume (gal):	9487
Vol. Coverage (nearest 10%):	90

Event Hydrograph



Analytical

Number of Aliquots:	Parameter	Concentrations (mg/L) Influent EMC	Effluent EMC	MRL	Dup. RPD	Discrete Removal Efficiency
IN: 9 (3.6-L)	Sand (mineral)	96	ND	1.61	20%	98%
EFF: 9	Silt (mineral)	27	21	1.58	20%	22%
	SSC (>2000-um)	25.5	ND	4.37	20%	83%
	SSC	178	36.5	4.37	20%	79%
	SSC (<2000-um)	152	36.5	1.61	15.8%	76%
	SSC (<500-um)	81.1	35.7	1.59	15.8%	56%
	SSC (<50-um)	44.2	35.5	1.58	15.8%	20%
	TVSS (<2000-um)	29.0	15.1	1.61	20%	48%
	TVSS (<500-um)	23.8	14.8	1.59	20%	38%
	TVSS (<50-um)	17.4	14.7	1.58	20%	undeterminable
	TSS (SM)	60.0	30.0	10.0	20%	50%
	TSS (EPA)	60.0	40.0	10.0	20%	33%

Notes

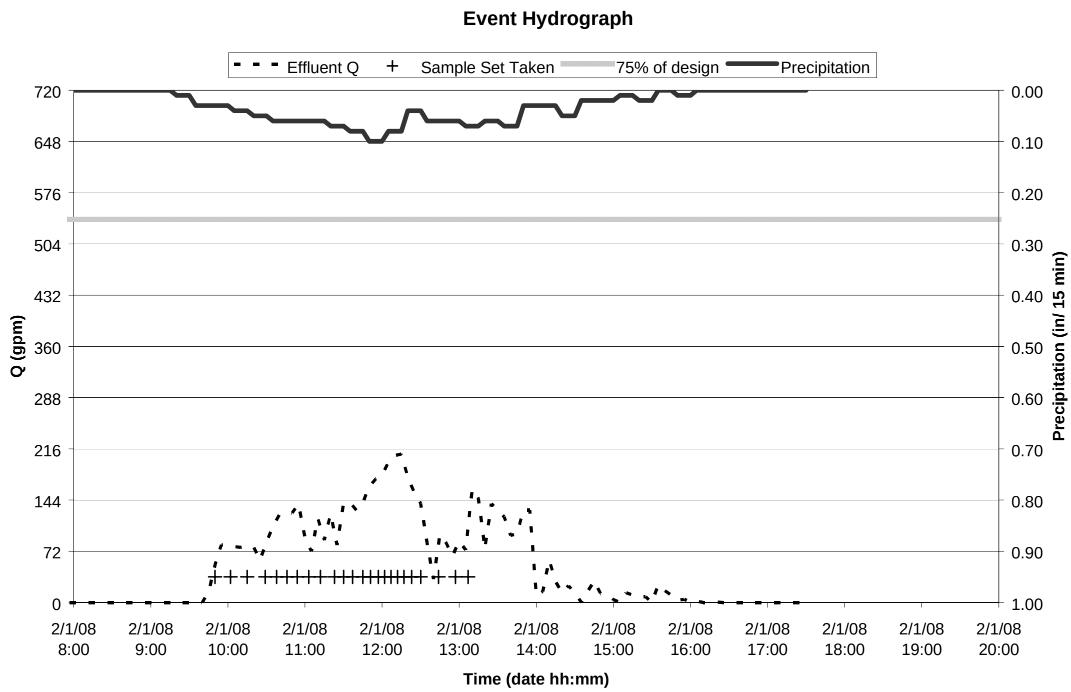
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	02/01/2008
Date of Last Maintenance:	10/29/07
Antecedent Conditions:	49 hours since last rain event, 0.05"

Hydrology

Total Precipitation (in):	1.22
Peak Flow (gpm):	209 (29% of design)
Total Runoff Volume (gal):	30508
Vol. Coverage (nearest 10%):	80



Analytical

Number of Aliquots:	Parameter	Concentrations (mg/L) Influent EMC	Effluent EMC	MRL	Dup. RPD	Discrete Removal Efficiency
IN: 24 (9.1-L)	Sand (mineral)	48	ND	1.43	20%	97%
EFF: 24	Silt (mineral)	36	32	1.32	20%	undeterminable
	SSC (>2000-um)	42.7	ND	11.1	20%	74%
	SSC	152	65.3	11.1	20%	57%
	SSC (<2000-um)	109	54.2	1.18	5.7%	50%
	SSC (<500-um)	70.0	43.4	1.43	5.7%	38%
	SSC (<50-um)	56.6	51.6	1.32	5.7%	9%
	TVSS (<2000-um)	25.9	20.7	1.18	20%	20%
	TVSS (<500-um)	24.3	16.8	1.43	20%	31%
	TVSS (<50-um)	21.1	19.8	1.32	20%	undeterminable
	TSS (SM)	60.0	50.0	10.0	20%	undeterminable
	TSS (EPA)	60.0	50.0	10.0	20%	undeterminable

Notes

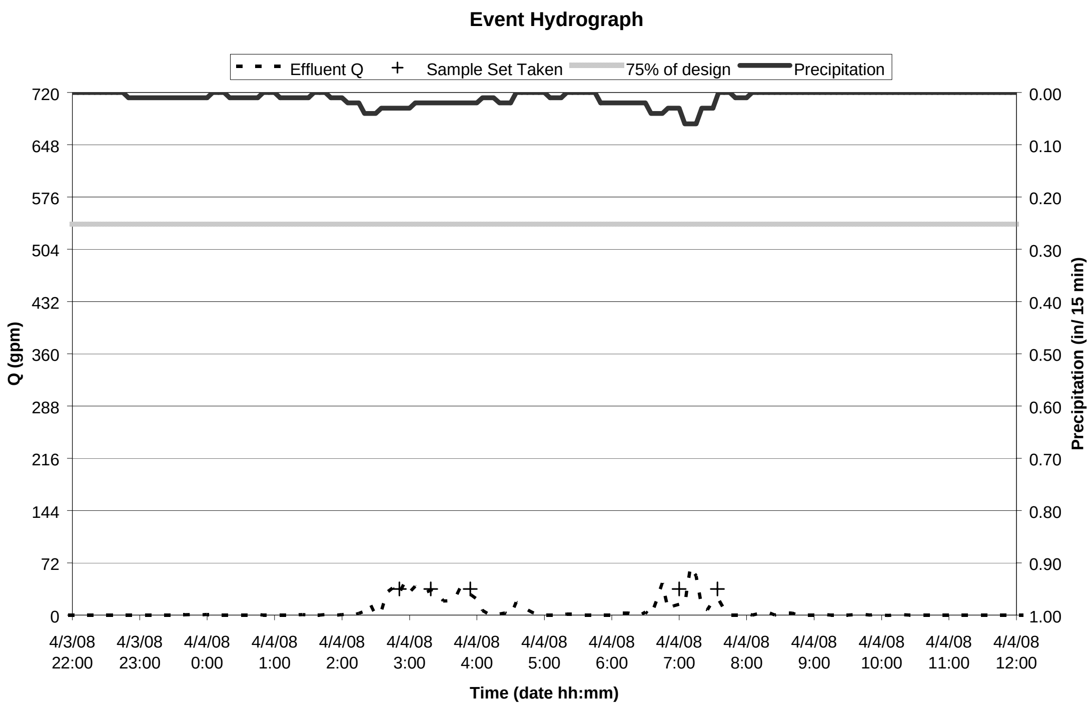
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	04/04/08
Date of Last Maintenance:	10/29/07
Antecedent Conditions:	45 hours since last rain event, 0.06"

Hydrology

Total Precipitation (in):	0.57
Peak Flow (gpm):	66(9% of design)
Total Runoff Volume (gal):	4740
Vol. Coverage (nearest 10%):	>90%



Analytical

Number of Aliquots:	Parameter	Concentrations (mg/L) Influent EMC	Effluent EMC	MRL	Dup. RPD	Discrete Removal Efficiency
IN: 5 (2.5-L)	Sand (mineral)	301	ND	2.85	20%	99%
EFF: 5	Silt (mineral)	14.7	ND	2.94	20%	80%
	SSC (>2000-um)	NT	NT	---	---	---
	SSC	341	2.36	2.8	20%	99%
	SSC (<2000-um)	341	2.36	2.77	20%	99%
	SSC (<500-um)	99.7	ND	2.85	20%	97%
	SSC (<50-um)	26.5	ND	2.94	20%	89%
	TVSS (<2000-um)	24.9	2.36	2.77	20%	91%
	TVSS (<500-um)	19.9	ND	2.85	20%	86%
	TVSS (<50-um)	11.8	ND	2.94	20%	75%
	TSS (SM)	310	ND	2.87	0.00%	99%
	TSS (EPA)	40.0	10.0	10.0	0.00%	75%

Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot

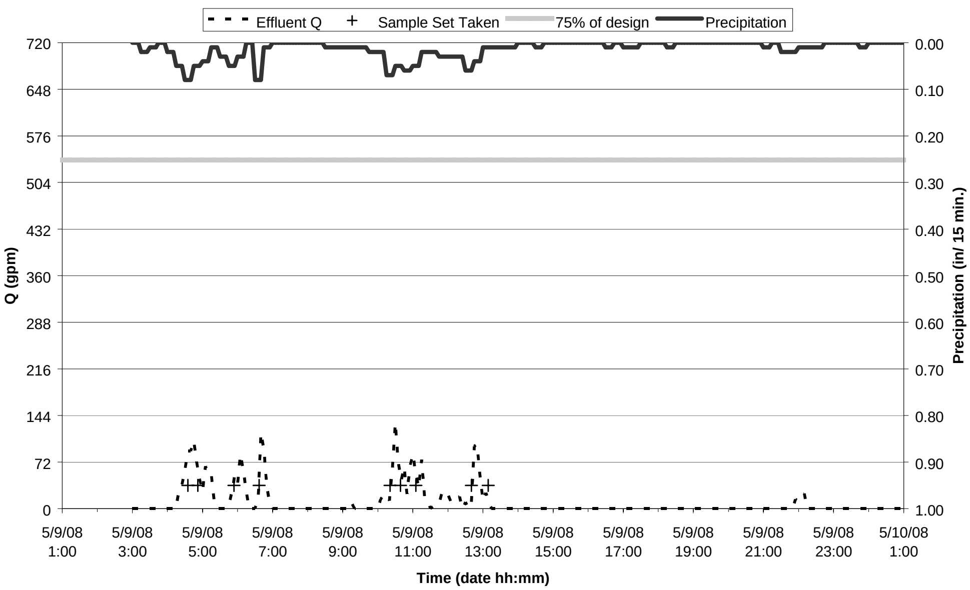
General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	05/09/08
Date of Last Maintenance:	4/15/08
Antecedent Conditions:	235 hours since last rain event, 0.62”

Hydrology

Total Precipitation (in):	1.21
Peak Flow (gpm):	132 (18% of design)
Total Runoff Volume (gal):	13134
Vol. Coverage (nearest 10%):	70

Event Hydrograph



Analytical

	Parameter	Concentrations (mg/L)				Discrete Removal
Number of Aliquots:		Influent EMC	Effluent EMC	MRL	Dup. RPD	Efficiency
IN: 9 (4.5-L)	Coarse Solids (mineral)	1.3	ND	0.2	20%	85%
EFF: 9	Sand (mineral)	19	4.5	1.7	20%	76%
	Silt (mineral)	ND	4.0	1.7	20%	release
	SSC	78.7	23.3	1.7	10%	70%
	TVSS	58.8	14.8	1.7	20%	75%
	SSC (>2000-um)	24.7	ND	0.2	10%	99%
	SSC (<2000-um)	54.0	23.3	1.7	10%	57%
	SSC (<500-um)	27.7	23.8	1.7	10%	14%
	SSC (<50-um)	4.8	7.6	1.7	10%	release
	TVSS(>2000-um)	23.4	ND	0.2	20%	99%
	TVSS (<2000-um)	35.4	14.8	1.7	20%	58%
	TVSS (<500-um)	16.4	12.7	1.7	20%	23%
	TVSS (<50-um)	5.1	3.6	1.7	20%	29%
	TSS (SM)	56.0	21.0	5.0	20%	63%
	TSS (EPA)	48.0	21.0	5.0	20%	56%

Notes

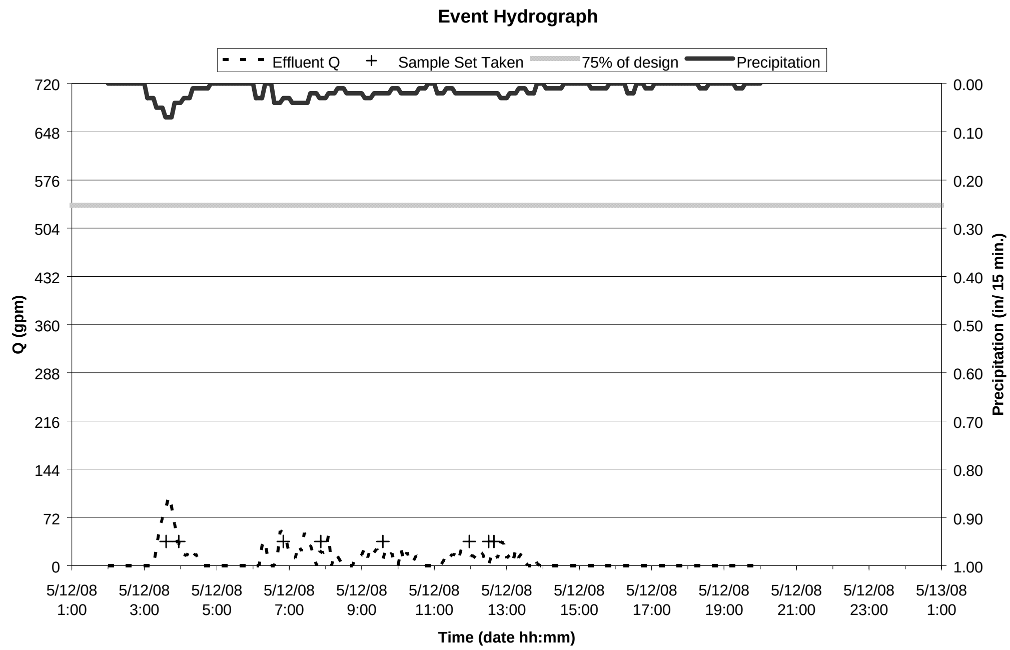
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	05/12/08
Date of Last Maintenance:	4/15/08
Antecedent Conditions:	51 hours since last rain event, 1.21”

Hydrology

Total Precipitation (in):	0.97
Peak Flow (gpm):	103 (14% of design)
Total Runoff Volume (gal):	10050
SF Vol. Coverage (nearest 10%):	80



Analytical

Number of Aliquots:	Parameter	Concentrations (mg/L) Influent EMC	Effluent EMC	MRL	Dup. RPD	Discrete Removal Efficiency
IN: 8 (8-L)	Coarse Material (mineral)	1.3	ND	0.2	20%	85%
EFF: 8	Sand (mineral)	8.7	ND	2.3	20%	74%
	Silt (mineral)	ND	ND	2.3	20%	undeterminable
	SSC	50.6	9.3	2.3	8%	82%
	TVSS	42.4	9.3	2.3	20%	78%
	SSC (>2000-um)	15.7	ND	0.2	8%	99%
	SSC (<2000-um)	34.9	9.3	2.3	8%	73%
.	SSC (<500-um)	10.2	6.3	2.3	8%	38%
	SSC (<50-um)	4.6	3.7	2.3	8%	20%
	TVSS(>2000-um)	14.4	ND	0.2	20%	99%
	TVSS (<2000-um)	28	9.3	2.3	20%	67%
	TVSS (<500-um)	8.8	8.5	2.3	20%	undeterminable
	TVSS (<50-um)	6.4	5.2	2.3	20%	19%
	TSS (SM)	41.0	6.0	5.0	20%	85%
	TSS (EPA)	32.0	8.7	5.0	20%	73%

Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

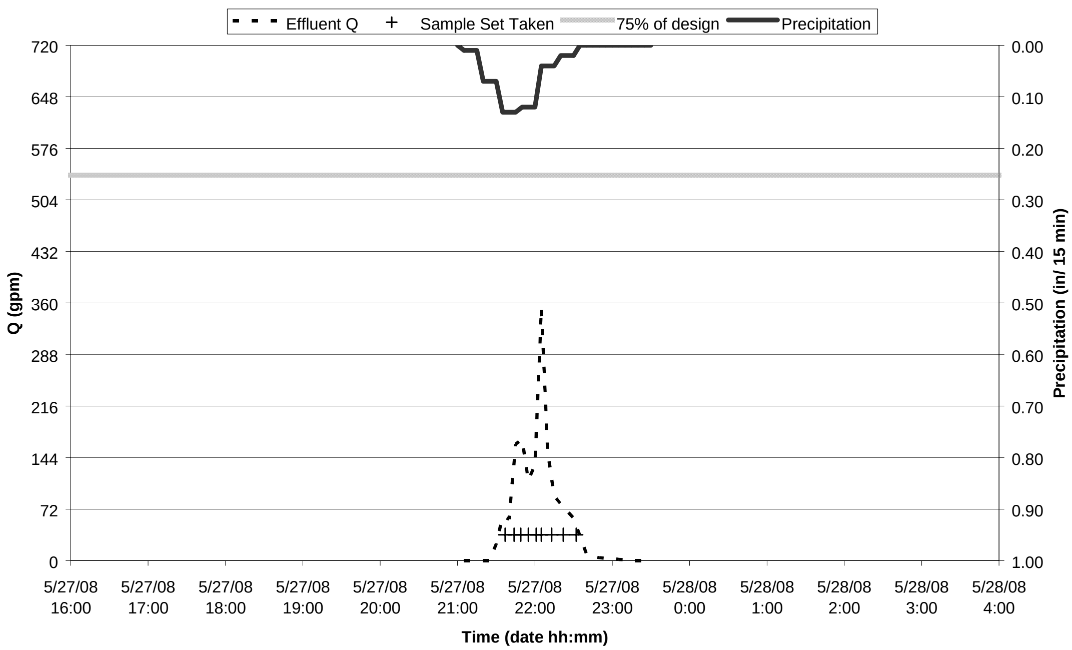
General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	05/27/08
Date of Last Maintenance:	4/15/08
Antecedent Conditions:	12 hours since last rain event, 0.04"

Hydrology

Total Precipitation (in):	0.39
Peak Flow (gpm):	353 (49% of design)
Total Runoff Volume (gal):	7915
Vol. Coverage (nearest 10%):	>90

Event Hydrograph



Analytical

	Parameter	Concentrations (mg/L)				Discrete Removal
Number of Aliquots:		Influent EMC	Effluent EMC	MRL	Dup. RPD	Efficiency
IN: 9 (8.5-L)	Coarse Material (mineral)	0.4	0.1	0.1	20%	75%
EFF: 9	Sand (mineral)	19.5	13.5	1.4	20%	31%
	Silt (mineral)	7.7	4.9	1.4	20%	36%
	SSC	74.5	40.7	1.4	20%	45%
	TVSS	46.9	22.2	1.4	20%	53%
	SSC (>2000-um)	7.0	2.4	0.1	14%	66%
	SSC (<2000-um)	67.5	38.3	1.4	14%	43%
.	SSC (<500-um)	40.5	29.6	1.4	14%	27%
	SSC (<50-um)	14.3	7.5	1.4	14%	48%
	TVSS(>2000-um)	6.6	2.3	0.1	20%	65%
	TVSS (<2000-um)	40.3	19.9	1.4	20%	51%
	TVSS (<500-um)	23.0	15.6	1.4	20%	32%
	TVSS (<50-um)	6.6	2.6	1.4	20%	61%
	TSS (SM)	68.0	32.0	5.0	4.3%	53%
	TSS (EPA)	60.0	34.7	6.3	12.5%	42%

Notes

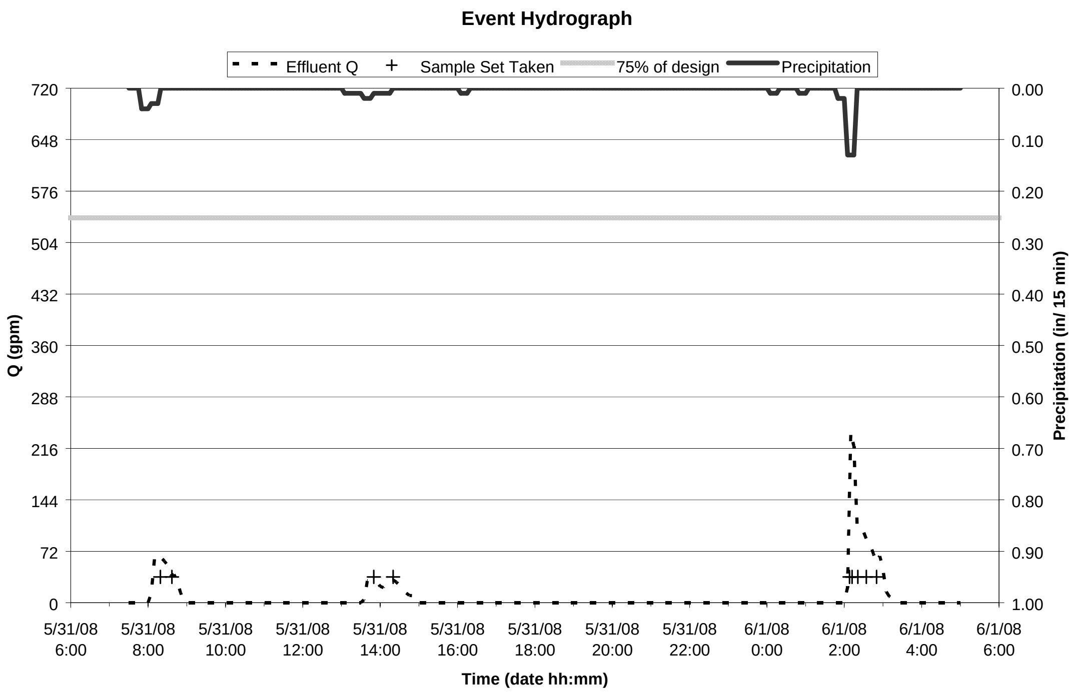
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	05/31/08
Date of Last Maintenance:	4/15/08
Antecedent Conditions:	81.4 hours since last rain event, 0.39”

Hydrology

Total Precipitation (in):	0.31
Peak Flow (gpm):	238 (33% of design)
Total Runoff Volume (gal):	10153
Vol. Coverage (nearest 10%):	90



Analytical

Number of Aliquots:
IN: 9 (8.5-L)
EFF: 9

Parameter	Concentrations (mg/L)			Dup. RPD	Discrete Removal
	Influent EMC	Effluent EMC	MRL		Efficiency
Coarse Material (mineral)	18.1	ND	0.1	20%	99%
Sand (mineral)	45.8	12.0	1.4	20%	74%
Silt (mineral)	14.2	6.8	1.4	20%	52%
SSC	188.5	41.1	1.4	14%	78%
TVSS	110.4	22.3	1.4	20%	80%
SSC (>2000-um)	27.7	0.27	0.1	14%	99%
SSC (<2000-um)	160.8	40.8	1.4	14%	75%
SSC (<500-um)	60.0	30.3	1.4	14%	50%
SSC (<50-um)	20.8	12.8	1.4	14%	38%
TVSS(>2000-um)	9.6	0.3	0.1	20%	97%
TVSS (<2000-um)	100.8	22.0	1.4	20%	78%
TVSS (<500-um)	30.1	14.5	1.4	20%	52%
TVSS (<50-um)	6.6	6.0	1.4	20%	undeterminable
TSS (SM)	154.0	43.2	5.0	0.7%	72%
TSS (EPA)	141.0	41.0	5.0	24.1%	71%

Notes

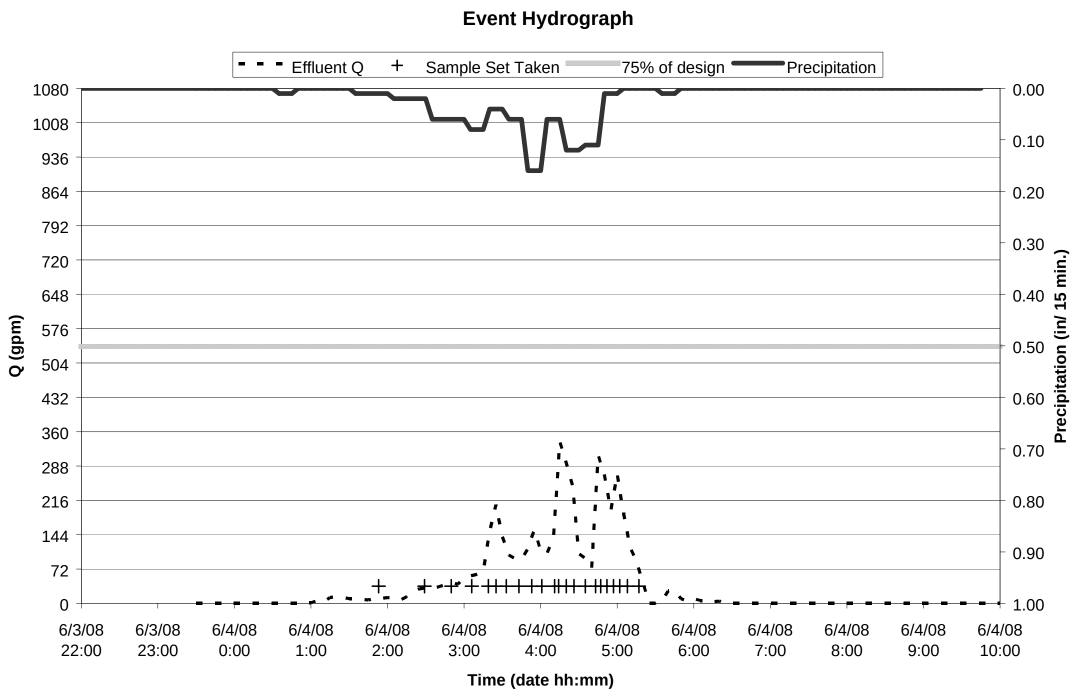
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	06/04/08
Date of Last Maintenance:	04/15/08
Antecedent Conditions:	69 hours since last rain event, 0.17 ”

Hydrology

Total Precipitation (in):	0.85
Peak Flow (gpm):	339 (47% of design)
Total Runoff Volume (gal):	24003
Vol. Coverage (nearest 10%):	>90%



Analytical

Number of Aliquots:	Parameter	Concentrations (mg/L) Influent EMC	Effluent EMC	MRL	Dup. RPD	Discrete Removal Efficiency
IN: 22 (11-L)	Coarse Material (mineral)	ND	ND	0.1	20%	undeterminable
EFF: 22 (11-L)	Sand (mineral)	10.2	ND	0.6	20%	94%
	Silt (mineral)	2.8	5.9	0.6	20%	release
	SSC	27.7	10.5	0.6	5.7%	62%
	TVSS	14.7	7.4	0.6	20%	50%
	SSC (>2000-um)	0.8	0.6	0.1	5.7%	25%
	SSC (<2000-um)	26.9	9.9	0.6	5.7%	63%
.	SSC (<500-um)	17.4	5.3	0.6	5.7%	70%
	SSC (<50-um)	6.0	7.3	0.6	5.7%	release
	TVSS(>2000-um)	0.8	0.6	0.1	20%	25%
	TVSS (<2000-um)	13.9	6.8	0.6	20%	51%
	TVSS (<500-um)	8.9	3.4	0.6	20%	62%
	TVSS (<50-um)	3.2	1.4	0.6	20%	56%
	TSS (SM)	24.3	9.0	2.5	22.6%	63%
	TSS (EPA)	23.3	7.7	2.5	6.4%	67%

Notes

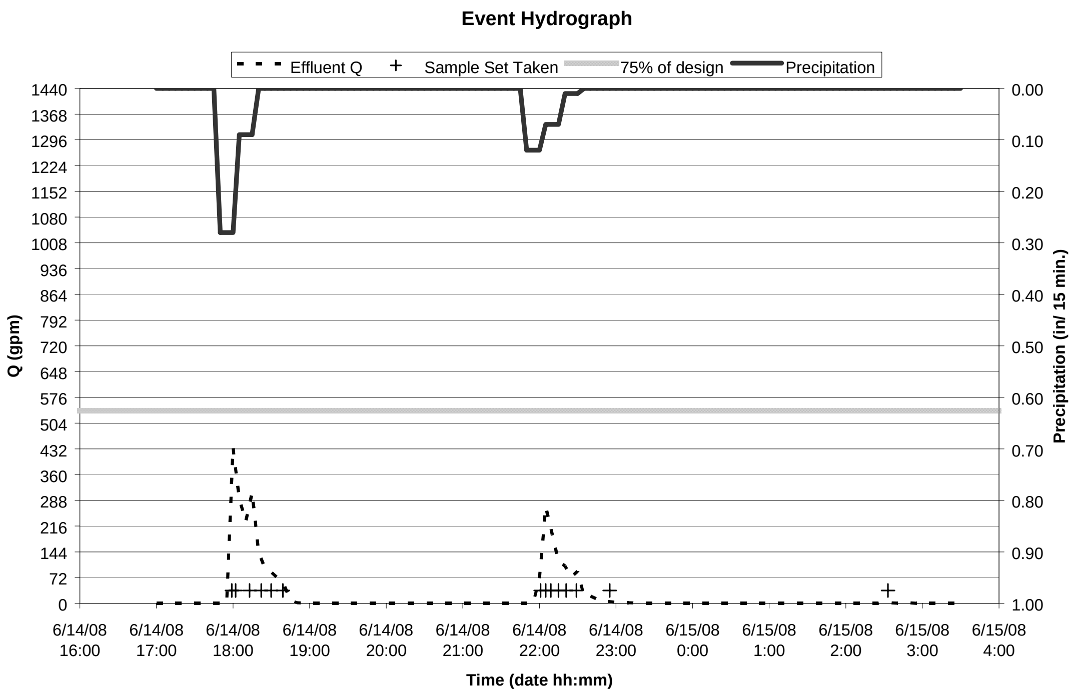
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	06/14/08
Date of Last Maintenance:	04/15/08
Antecedent Conditions:	228 hours since last rain event, 1.55”

Hydrology

Total Precipitation (in):	0.57
Peak Flow (gpm):	436(61% of design)
Total Runoff Volume (gal):	13560
Vol. Coverage (nearest 10%):	>90%



Analytical

Number of Aliquots:	Parameter	Concentrations (mg/L) Influent EMC	Effluent EMC	MRL	Dup. RPD	Discrete Removal Efficiency
IN: 14 (7000-mL)	Coarse Solids (mineral)	2.30	0.40	0.1	20%	83%
EFF: 14 (7000-mL)	Sand (mineral)	314.5	17.1	1.1	20%	95%
	Silt (mineral)	86.5	20.4	1.1	20%	76%
	SSC	710.7	74.7	1.1	6.9%	89%
	TVSS	307.4	36.8	1.1	20%	88%
	SSC (>2000-um)	25.2	4.4	0.1	6.9%	83%
	SSC (<2000-um)	685.5	70.3	1.1	6.9%	90%
.	SSC (<500-um)	508.6	41.6	1.1	6.9%	92%
	SSC (<50-um)	125.1	32.8	1.1	6.9%	74%
	TVSS(>2000-um)	22.9	4.0	0.1	20%	83%
	TVSS (<2000-um)	284.5	32.8	1.1	20%	88%
	TVSS (<500-um)	207.6	18.0	1.1	20%	91%
	TVSS (<50-um)	38.6	12.4	1.1	20%	68%
	TSS (SM)	718.0	84.0	20.0	1.1%	88%
	TSS (EPA)	658.0	51.0	20.0	3.0%	92%

Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

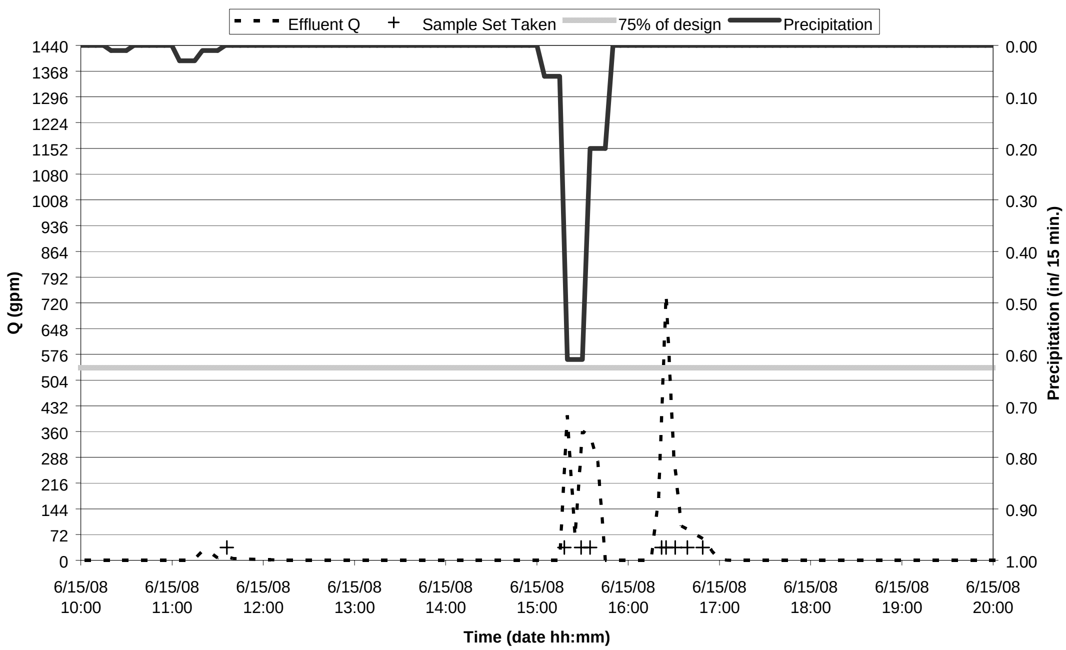
General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	06/15/08
Date of Last Maintenance:	04/15/08
Antecedent Conditions:	12 hours since last rain event, 0.57”

Hydrology

Total Precipitation (in):	0.92
Peak Flow (gpm):	743 (103% of design)
Total Runoff Volume (gal):	15465
Vol. Coverage (nearest 10%):	>90%

Event Hydrograph



Analytical

	Parameter	Concentrations (mg/L)			Dup. RPD	Discrete Removal Efficiency
Number of Aliquots:		Influent EMC	Effluent EMC	MRL		
IN: 9 (4500-mL)	Coarse Solids (mineral)	2.3	ND	0.1	20%	96%
EFF: 9 (4500-mL)	Sand (mineral)	117.1	24.3	1.1	20%	79%
	Silt (mineral)	52.4	7.7	1.1	20%	85%
	SSC	299.5	55.9	1.1	10.0%	81%
	TVSS	127.7	23.9	1.1	20%	81%
	SSC (>2000-um)	11.0	ND	0.1	10.0%	99%
	SSC (<2000-um)	288.5	55.9	1.1	10.0%	81%
.	SSC (<500-um)	241.0	29.5	1.1	10.0%	88%
	SSC (<50-um)	72.6	11.8	1.1	10.0%	84%
	TVSS(>2000-um)	8.7	ND	0.1	20%	99%
	TVSS (<2000-um)	119	23.9	1.1	20%	80%
	TVSS (<500-um)	91.8	10.7	1.1	20%	88%
	TVSS (<50-um)	20.2	4.1	1.1	20%	80%
	TSS (SM)	304.0	40.0	10.0	1.1%	87%
	TSS (EPA)	298.0	37.0	10.0	3.0%	88%

Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

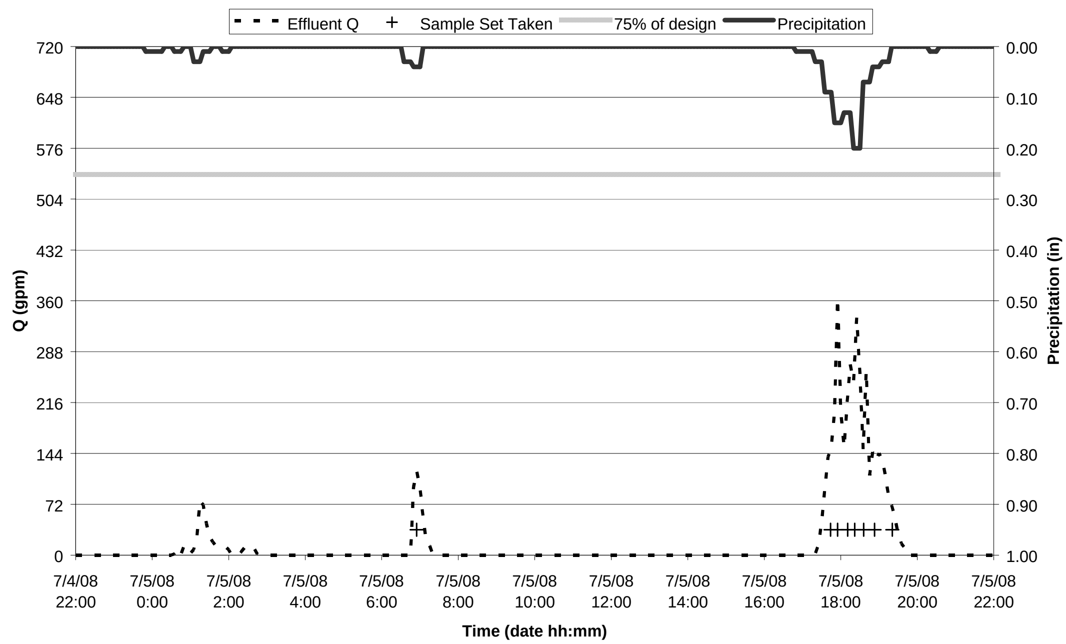
General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	07/05/08
Date of Last Maintenance:	04/15/08
Antecedent Conditions:	89.6 hours since last rain event, 0.06"

Hydrology

Total Precipitation (in):	0.92
Peak Flow (gpm):	363 (51% of design)
Total Runoff Volume (gal):	24748
Vol. Coverage (nearest 10%):	>90%

Event Hydrograph



Analytical

Number of Aliquots:
IN: 8 (4000-mL)
EFF: 8 (4000-mL)

Parameter	Concentrations (mg/L) Influent EMC	Effluent EMC	MRL	Dup. RPD	Discrete Removal Efficiency
Coarse Solids (mineral)	ND	ND	0.1	20%	undeterminable
Sand (mineral)	95	13.9	1.4	20%	85%
Silt (mineral)	37.0	4.1	1.4	20%	89%
SSC	241.9	30.3	1.4	4.1%	87%
TVSS	109	12.2	1.4	20%	89%
SSC (>2000-um)	3.9	0.38	0.1	4.1%	90%
SSC (<2000-um)	238	29.9	1.4	4.1%	87%
SSC (<500-um)	158	13.6	1.4	4.1%	91%
SSC (<50-um)	52.4	6.8	1.4	4.1%	87%
TVSS(>2000-um)	3.5	0.3	0.1	20%	91%
TVSS (<2000-um)	106	11.9	1.4	20%	89%
TVSS (<500-um)	58.3	6.3	1.4	20%	89%
TVSS (<50-um)	15.4	2.7	1.4	20%	82%
TSS (SM)	271	26.0	5.0	4.9%	90%
TSS (EPA)	232	25.5	5.0	3.0%	89%

Notes

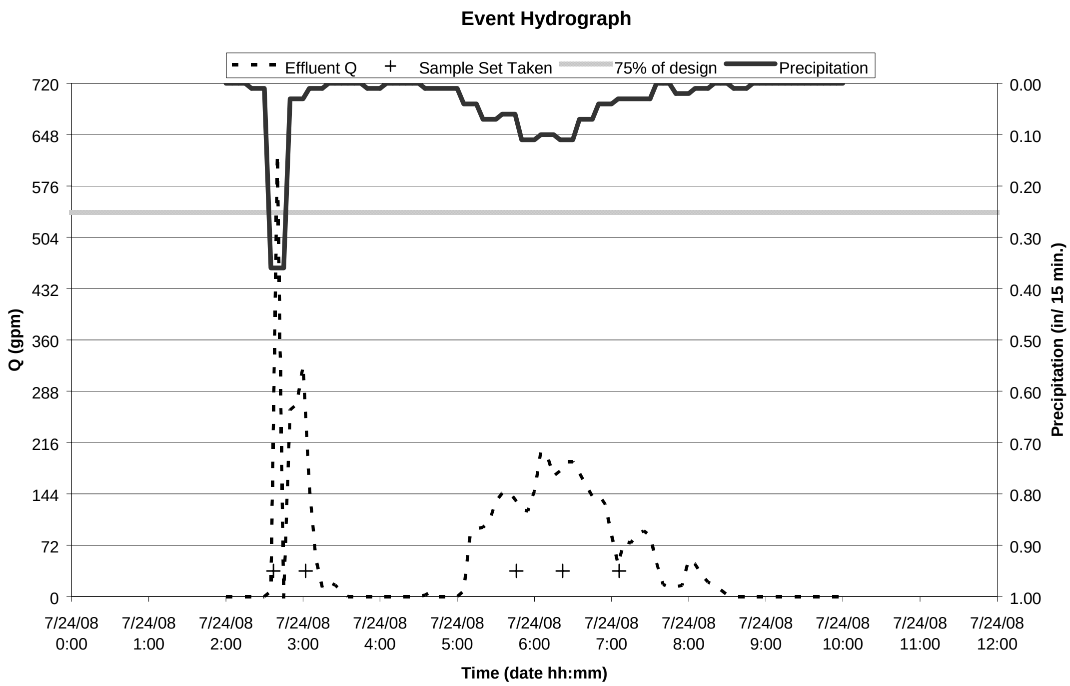
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	07/24/08
Date of Last Maintenance:	04/15/08
Antecedent Conditions:	84.8 hours since last rain event, 0.24"

Hydrology

Total Precipitation (in):	1.14
Peak Flow (gpm):	620 (86% of design)
Total Runoff Volume (gal):	28963
Vol. Coverage (nearest 10%):	>90%



Analytical

Number of Aliquots:	Parameter	Concentrations (mg/L) Influent EMC	Effluent EMC	MRL	Dup. RPD	Discrete Removal Efficiency
IN: 5(2500-mL)	Coarse Solids (mineral)	0.0	1.01	0.2	20%	release
EFF: 5 (2500-mL)	Sand (mineral)	220.1	0.0	2.5	20%	100%
	Silt (mineral)	50.8	0.0	2.5	20%	100%
	SSC	500	49.7	2.5	1.3%	90%
	TVSS	229	49	1.4	20%	79%
	SSC (>2000-um)	8.6	6.71	0.2	1.3%	22%
	SSC (<2000-um)	491.1	43.0	2.5	1.3%	91%
.	SSC (<500-um)	256.2	24.2	2.5	1.3%	91%
	SSC (<50-um)	74.4	9.4	2.5	1.3%	87%
	TVSS(>2000-um)	8.6	5.7	0.2	20%	34%
	TVSS (<2000-um)	220.2	43.0	2.5	20%	80%
	TVSS (<500-um)	106.4	24.2	2.5	20%	77%
	TVSS (<50-um)	23.6	9.4	2.5	20%	60%
	TSS (SM)	458.7	46.0	5.0	2.3%	90%
	TSS (EPA)	427.0	43.3	6.7	6.6%	90%

Notes

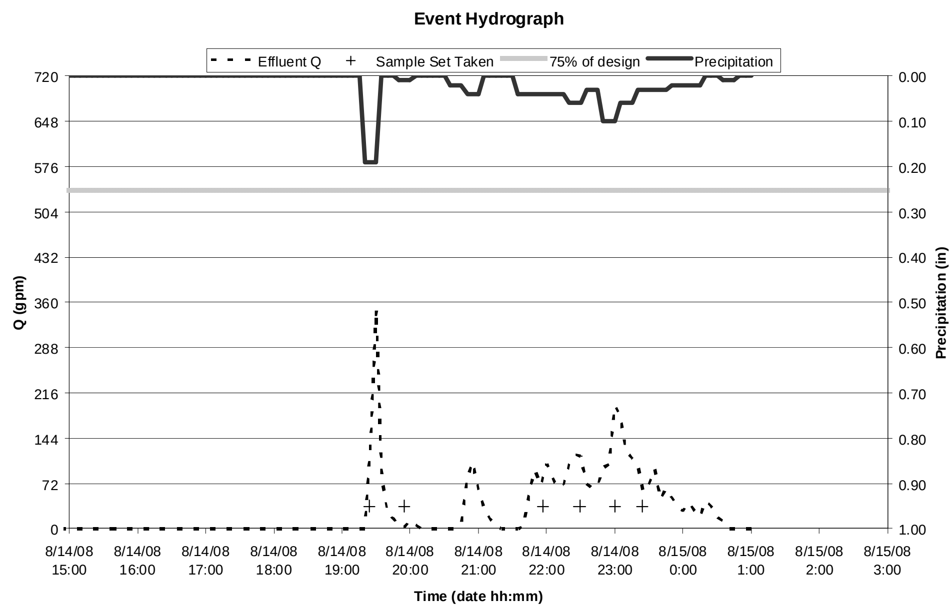
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	08/14/08
Date of Last Maintenance:	04/15/08
Antecedent Conditions:	14.8 hours since last rain event, 0.08”

Hydrology

Total Precipitation (in):	0.85
Peak Flow (gpm):	349 (49% of design)
Total Runoff Volume (gal):	19781
Vol. Coverage (nearest 10%):	90



Analytical

Number of Aliquots:	Parameter	Concentrations (mg/L) Influent EMC	Effluent EMC	MRL	Dup. RPD	Discrete Removal Efficiency
IN: 6 (3000-mL)	Coarse Solids (mineral)	15.6	ND	0.2	20%	99%
EFF: 6 (3000-mL)	Sand (mineral)	260.8	21.0	1.6	20%	92%
	Silt (mineral)	46.8	8.1	1.6	20%	83%
	SSC	598.0	42.5	1.6	10.0%	93%
	TVSS	274.8	13.4	1.6	20%	95%
	SSC (>2000-um)	55.2	ND	0.2	10.0%	100%
	SSC (<2000-um)	542.8	42.3	1.6	10.0%	92%
.	SSC (<500-um)	271.2	31.9	1.6	10.0%	88%
	SSC (<50-um)	50.0	14.2	1.6	10.0%	72%
	TVSS(>2000-um)	39.6	ND	0.2	20%	99%
	TVSS (<2000-um)	235.2	13.2	1.6	20%	94%
	TVSS (<500-um)	94.4	11.6	1.6	20%	88%
	TVSS (<50-um)	3.2	6.1	1.6	20%	release
	TSS (SM)	657.0	48.0	4.0	4.1%	93%
	TSS (EPA)	468.5	41.0	4.0	16.9%	91%

Notes

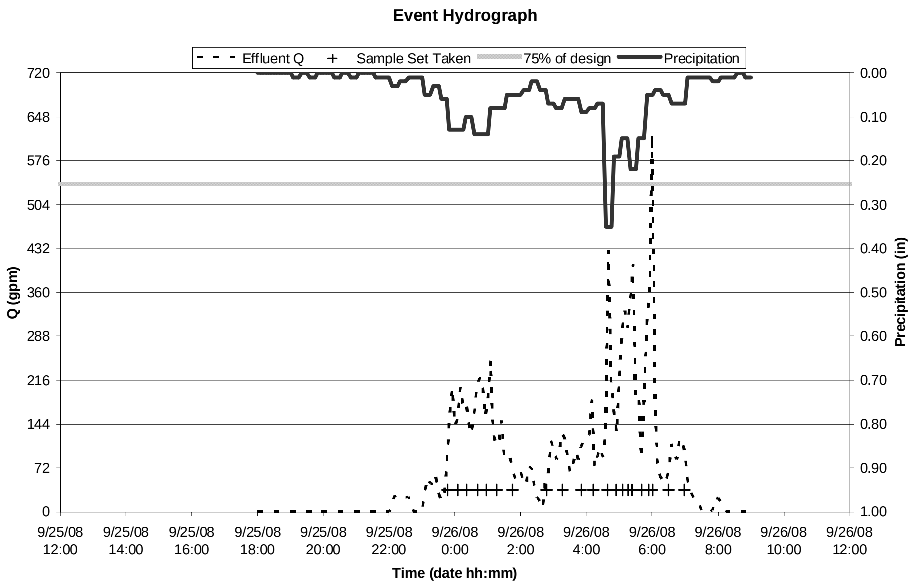
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	09/25/08
Date of Last Maintenance:	04/15/08
Antecedent Conditions:	304 hours since last rain event, 0.68"

Hydrology

Total Precipitation (in):	3.20
Peak Flow (gpm):	619 (86% of design)
Total Runoff Volume (gal):	65868
Vol. Coverage (nearest 10%):	>90



Analytical

Number of Aliquots:	Parameter	Influent EMC (Concentrations (mg/L))	Effluent EMC (Concentrations (mg/L))	MRL (Concentrations (mg/L))	Dup. RPD	Discrete Removal Efficiency
IN: 21 (10500-mL)	Coarse Solids (mineral)	815	ND	0.1	20%	100%
EFF: 21 (10500-mL)	Sand (mineral)	6071	10.5	1.0	20%	100%
	Silt (mineral)	11.8	2.9	1.0	20%	75%
	SSC	6995	22.5	1.0	20%	100%
	TVSS	97.4	9.2	1.0	20%	91%
	SSC (>2000-um)	845	ND	0.1	20%	100%
	SSC (<2000-um)	6150	22.5	1.0	20%	100%
.	SSC (<500-um)	2558	9.1	1.0	20%	100%
	SSC (<50-um)	16.2	4.7	1.0	20%	71%
	TVSS(>2000-um)	30.2	ND	0.1	20%	100%
	TVSS (<2000-um)	67.2	9.1	1.0	20%	86%
	TVSS (<500-um)	25.0	3.6	1.0	20%	86%
	TVSS (<50-um)	4.4	1.8	1.0	20%	59%
	TSS (SM)	2259	13.8	5.0	14.5%	99%
	TSS (EPA)	2075	12.7	5.0	2.4%	99%

Notes

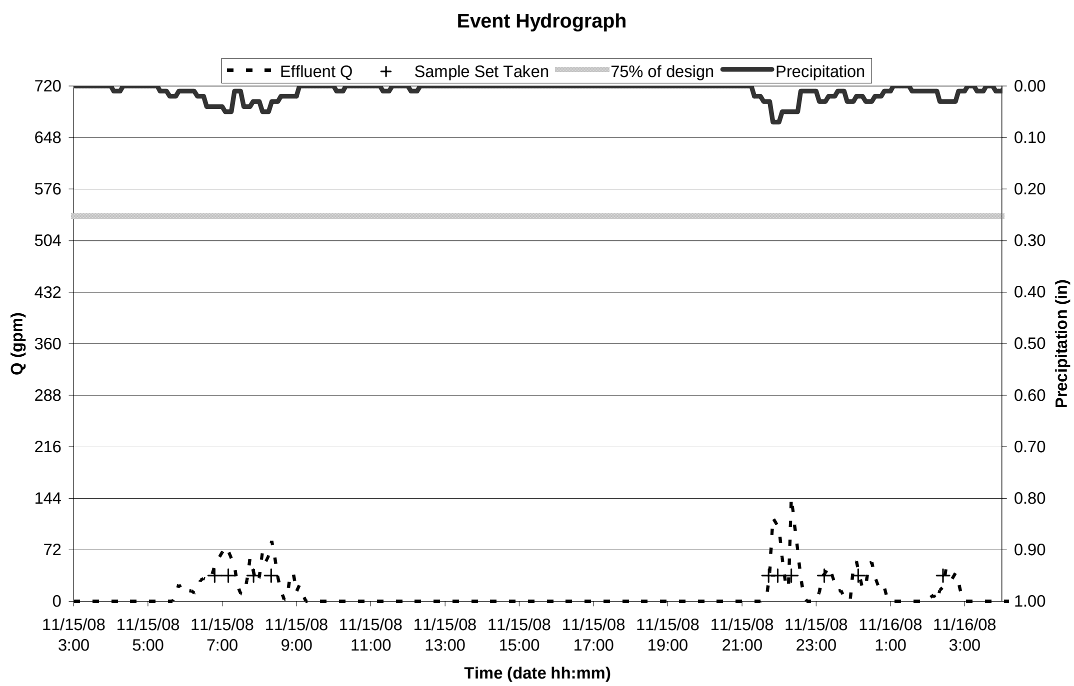
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	11/15/08
Date of Last Maintenance:	04/15/08
Antecedent Conditions:	33 hours since last rain event, 0.57"

Hydrology

Total Precipitation (in):	0.97
Peak Flow (gpm):	145 (20% of design)
Total Runoff Volume (gal):	15806
Vol. Coverage (nearest 10%):	>90%



Analytical

Number of Aliquots:	Parameter	Concentrations (mg/L) Influent EMC	Effluent EMC	MRL	Dup. RPD	Discrete Removal Efficiency
IN: 10 (5000-mL)	Coarse Solids (mineral)	16.9	ND	0.1	20%	99%
EFF: 10 (5000-mL)	Sand (mineral)	20.9	5.1	1.0	20%	76%
	Silt (mineral)	6.2	5.7	1.0	20%	undeterminable
	SSC	113	21.8	1.0	27.7%	81%
	TVSS	69.0	11.0	1.0	20%	84%
	SSC (>2000-um)	41.1	ND	0.1	27.7%	100%
	SSC (<2000-um)	71.9	21.7	1.0	27.7%	70%
.	SSC (<500-um)	21.4	9.3	1.0	27.7%	57%
	SSC (<50-um)	11.6	7.2	1.0	27.7%	38%
	TVSS(>2000-um)	24.2	0.1	0.1	20%	100%
	TVSS (<2000-um)	44.8	10.9	2.2	20%	76%
	TVSS (<500-um)	10.3	4.8	2.1	20%	53%
	TVSS (<50-um)	5.4	1.5	1.0	20%	72%
	TSS (SM)	75.5	25.1	5.0	5.7%	67%
	TSS (EPA)	46.6	17.0	5.0	9.0%	64%

Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

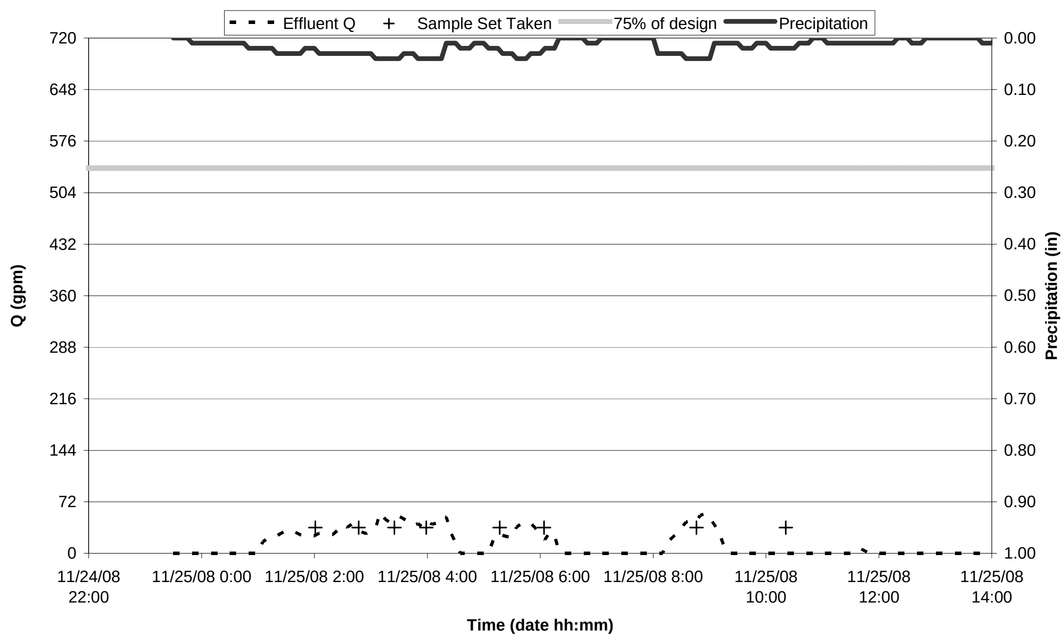
General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	11/25/08
Date of Last Maintenance:	04/15/08
Antecedent Conditions:	212 hours since last rain event, 0.53”

Hydrology

Total Precipitation (in):	0.97
Peak Flow (gpm):	57 (8% of design)
Total Runoff Volume (gal):	11707
Vol. Coverage (nearest 10%):	>90%

Event Hydrograph



Analytical

	Parameter	Concentrations (mg/L)				Discrete Removal
Number of Aliquots:		Influent EMC	Effluent EMC	MRL	Dup. RPD	Efficiency
IN: 8 (4000-mL)	Coarse Solids (mineral)	2.6	ND	0.1	20%	96%
EFF: 8 (4000-mL)	Sand (mineral)	15.3	ND	1.4	20%	91%
	Silt (mineral)	ND	ND	1.4	20%	undeterminable
	SSC	38.9	3.8	1.4	8.5%	90%
	TVSS	21.0	2.9	1.4	20%	86%
	SSC (>2000-um)	14.2	ND	0.1	8.5%	99%
	SSC (<2000-um)	24.7	3.7	1.4	8.5%	85%
.	SSC (<500-um)	9.2	ND	1.4	8.5%	85%
	SSC (<50-um)	ND	ND	1.4	8.5%	undeterminable
	TVSS(>2000-um)	11.6	ND	0.1	20%	99%
	TVSS (<2000-um)	9.4	2.8	1.4	20%	70%
	TVSS (<500-um)	5.0	ND	1.4	20%	72%
	TVSS (<50-um)	1.4	ND	1.4	20%	undeterminable
	TSS (SM)	29.4	2.5	2.5	20%	91%
	TSS (EPA)	20.5	ND	2.5	20%	88%

Notes

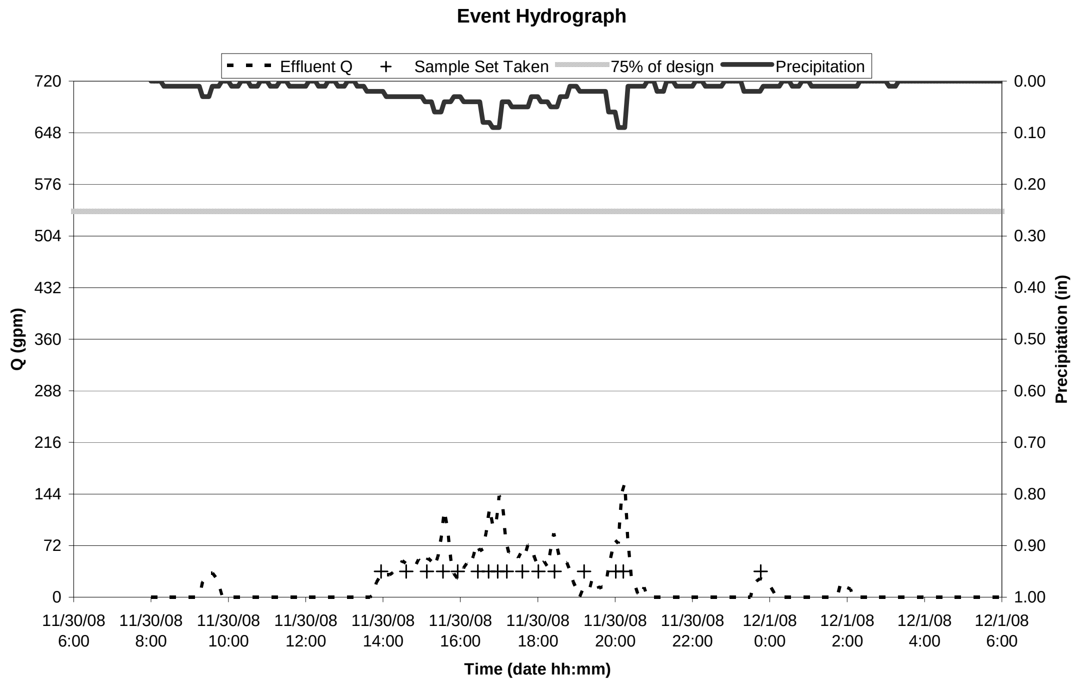
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

General Information

Site:	Manasquan Savings Bank, (31378), Point Pleasant, NJ
System Description:	CDS PMSU20_25HE (40.5 ft^2 sediment storage capacity, design 1.6 cfs)
Event Date:	11/30/08
Date of Last Maintenance:	04/15/08
Antecedent Conditions:	14 days since last rain event, 0.97"

Hydrology

Total Precipitation (in):	1.46
Peak Flow (gpm):	158(22% of design)
Total Runoff Volume (gal):	24187
Vol. Coverage (nearest 10%):	>90%



Analytical

	Parameter	Concentrations (mg/L)				Discrete Removal
Number of Aliquots:		Influent EMC	Effluent EMC	MRL	Dup. RPD	Efficiency
IN: 14(7000-mL)	Coarse Solids (mineral)	ND	ND	0.1	20%	undeterminable
EFF: 14(7000-mL)	Sand (mineral)	170.1	7.0	1.4	20%	96%
	Silt (mineral)	40.6	2.4	1.4	20%	94%
	SSC	381.8	15.7	1.4	11.1%	96%
	TVSS	171.1	6.3	1.4	20%	96%
	SSC (>2000-um)	25.5	ND	0.1	11.1%	100%
	SSC (<2000-um)	356.3	15.6	1.4	11.1%	96%
.	SSC (<500-um)	178.6	7.6	1.4	11.1%	96%
	SSC (<50-um)	56.1	5.1	1.4	11.1%	91%
	TVSS(>2000-um)	25.5	ND	0.1	20%	100%
	TVSS (<2000-um)	145.6	6.2	1.4	20%	96%
	TVSS (<500-um)	66.5	4.4	1.4	20%	93%
	TVSS (<50-um)	15.5	2.7	1.4	20%	83%
	TSS (SM)	519.0	16.8	10.0	20%	97%
	TSS (EPA)	348.0	16.7	10.0	0%	95%

Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

State of New Jersey

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KIM GUADAGNO
Lt. Governor

BOB MARTIN
Commissioner

January 9, 2015

Derek M. Berg
CONTECH Engineered Solutions, LLC
71 US Route 1, Suite F
Scarborough, ME 04074

Re: MTD Lab Certification for the
Continuous Deflective Separator (CDS®) Stormwater Treatment Device
By Contech Engineered Solutions LLC

TSS Removal Rate 50%

Dear Mr. Berg:

The Stormwater Management rules under N.J.A.C. 7:8-5.5(b) and 5.7 (c) allow the use of manufactured treatment devices (MTDs) for compliance with the design and performance standards at N.J.A.C. 7:8-5 if the pollutant removal rates have been verified by the New Jersey Corporation for Advanced Technology (NJCAT) and have been certified by the New Jersey Department of Environmental Protection (NJDEP). Contech Engineered Solutions, LLC has requested a Laboratory Certification for the CDS® Stormwater Treatment Device.

The projects falls under the "Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advance Technology" dated January 25, 2013. The applicable protocol is the "New Jersey Laboratory Testing Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device" dated January 25, 2013.

NJCAT verification documents submitted to the NJDEP indicate that the requirements of the aforementioned protocol have been met or exceeded. The NJCAT letter also included a recommended certification TSS removal rate and the required maintenance plan. The NJCAT Verification Report with the Verification Appendix for this device is published online at http://www.njcat.org/verification-process/technology-verification-database.html.

The NJDEP certifies the use of the Continuous Deflective Separator (CDS®) Stormwater Treatment Device by Contech Engineered Solutions LLC at a TSS removal rate of 50% when designed, operated and maintained in accordance with the information provided in the Verification Appendix.

Be advised a detailed maintenance plan is mandatory for any project with a Stormwater BMP subject to the Stormwater Management Rules, N.J.A.C. 7:8. The plan must include all of the items identified in the Stormwater Management Rules, N.J.A.C. 7:8-5.8. Such items include, but are not limited to, the list of inspection and maintenance equipment and tools, specific corrective and preventative maintenance tasks, indication of problems in the system, and training of maintenance personnel. Additional information can be found in Chapter 8: Maintenance of the New Jersey Stormwater Best Management Practices Manual.

If you have any questions regarding the above information, please contact Mr. Titus Magnanao of my office at (609) 633-7021.

Sincerely,

James J. Murphy, Chief
Bureau of Nonpoint Pollution Control

C: Chron File
Richard Magee, NJCAT
Madhu Guru, DLUR
Ravi Patraju, NJDEP
Elizabeth Dragon, BNPC
Titus Magnanao, BNPC

CONTECH®
ENGINEERED SOLUTIONS

CDS® Inspection and Maintenance Guide – New Jersey

CDS TECHNOLOGIES

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump. Refer to Table 1 for depth from water surface to top of sediment pile for each model size indicating that maintenance is required.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be power washed to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile[1]		Sediment Storage Capacity	
	ft	m	ft	m	yd^3	m^3
CDS-4	4	1.2	3.0	0.9	0.9	0.7
CDS-5	5	1.5	3.7	1.1	1.5	1.1
CDS-6	6	1.8	4.7	1.4	2.1	1.6
CDS-8	8	2.4	5.8	1.8	3.7	2.8
CDS-10	10	3.0	7.4	2.3	5.8	4.4
CDS-12	12	3.4	8.0	2.4	8.4	6.4

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

[1] Distances from water surface to top of sediment pile are based on 75% of sump capacity being occupied.

Support

- Drawings and specifications are available at www.contechstormwater.com.
- Site-specific design support is available from our engineers.

Contech Engineered Solutions LLC provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, stormwater, earth stabilization and wastewater treament products. For information, visit www.ContechES.com or call 800.338.1122

CONTECH ENGINEERED SOLUTIONS
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CDS Inspection & Maintenance Log

CDS Model: ______________________________ Location: ______________________________

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

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Parameter Brief

Removal of Suspended Solids using the CDS® System – Laboratory Evaluations

The CDS® system is a hydrodynamic separator which uses patented continuous deflective separation (CDS) technology to separate and capture trash, debris, sediment and oil and grease from stormwater runoff. Indirect screening allows for 100% removal of floatables and neutrally buoyant material without blinding the screen. Flow and screening controls separate captured solids and minimize resuspension of previously captured pollutants.

The CDS system can effectively capture 100% of particulate material, including trash and debris, greater than screen aperture size (2400 or 4700 microns). In addition, the CDS can remove medium and coarse sediments. A full-scale laboratory evaluation of the CDS system using test materials with various particle size distributions is summarized here.

Laboratory Study – Full-Scale Evaluation at University of Florida

A full-scale CDS unit (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This full-scale CDS unit was evaluated under controlled laboratory conditions of pumped influent and the controlled addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSD) of the test materials were analyzed using standard method “Gradation ASTM D-422 with Hydrometer” by a certified laboratory. UF Sediment is a mixture of three different U.S. Silica Sand products referred as: “Sil-Co-Sil 106”, “#1 DRY” and “20/40 Oil Frac”. Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d_{50} = 20 to 30 µm) covering a wide size range (uniform coefficient C_u averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d_{50} (d_{50} for NJDEP is approximately 50 µm) (NJDEP, 2003). The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d_{50}) of 106 microns. The PSDs for the test material are shown in Figure 1.

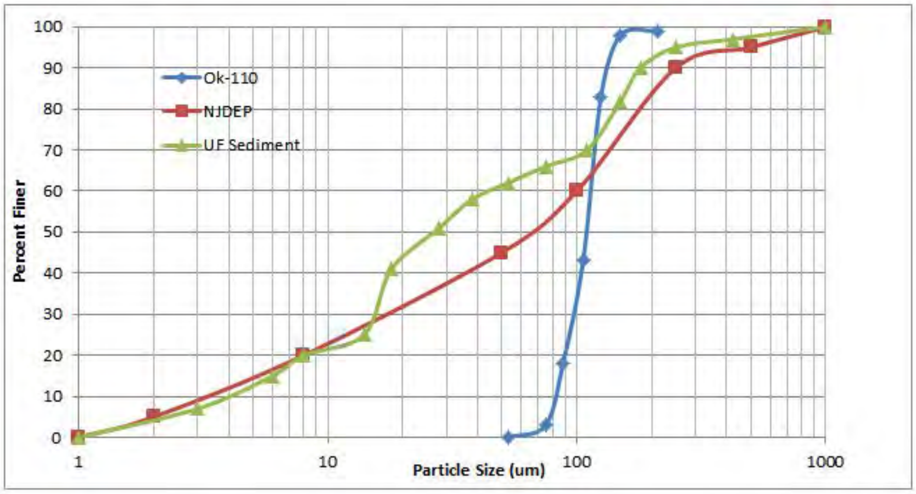

Figure 1. Particle size distributions for the test materials, as compared to the NJCAT/NJDEP theoretical distribution.

Tests were conducted to quantify the CDS unit (1.1 cfs design capacity) performance at various flow rates, ranging from 1% up to 125% of the design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC – ASTM Standard Method D3977-97) and particle size distribution analysis.

Results and Modeling

Based on the testing data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve for the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect to SSC removal for any particle size gradation assuming sandy-silt type of inorganic components of SSC. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand).

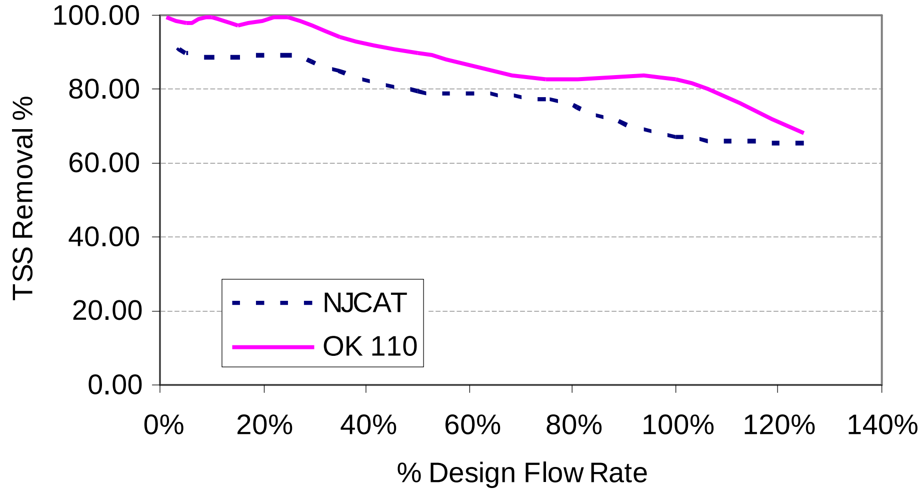

Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d_{50}) of 125 microns (WADOE, 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). Supported by the laboratory data, the model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at 100% of design flow rate, for this particle size distribution (d_{50} = 125 µm).

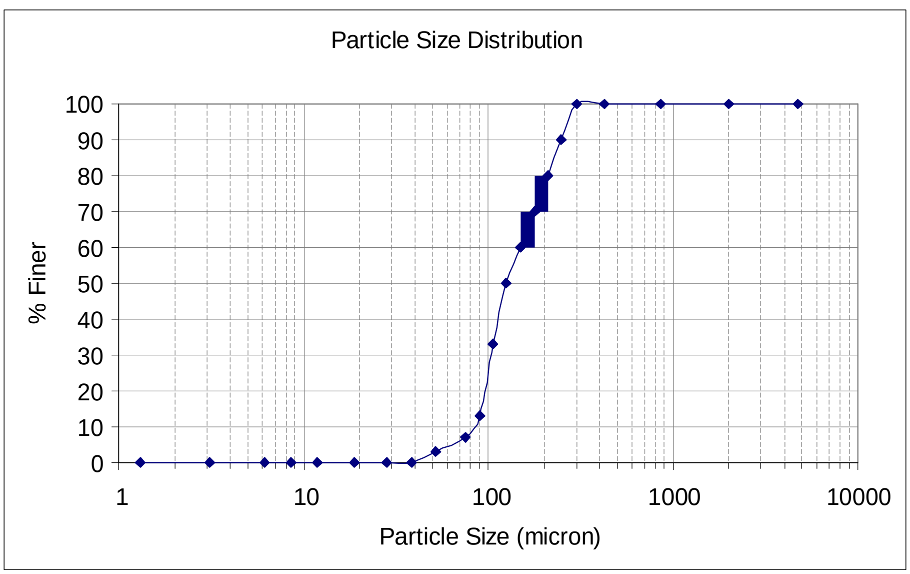

Figure 3. PSD with d_{50} = 125 microns, used to model performance for Ecology submittal.

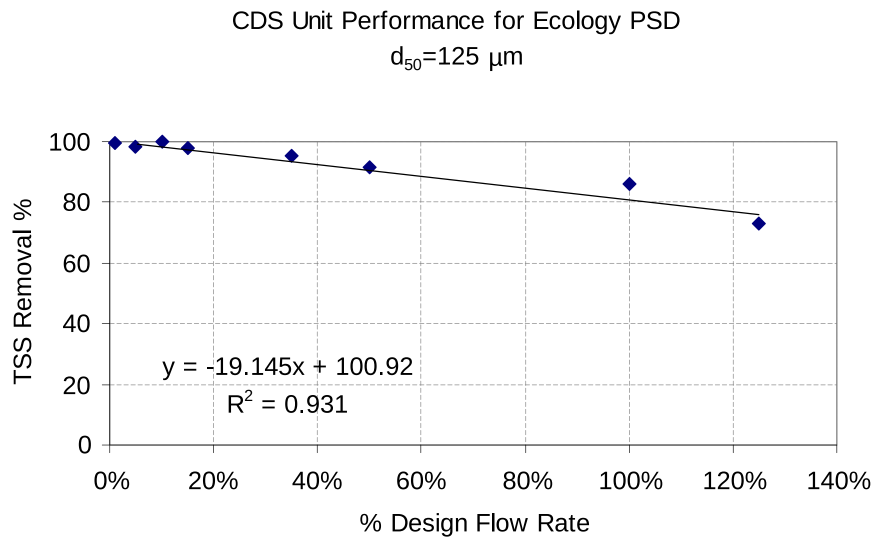

Figure 4. Modeled performance for CDS unit with 2400 microns screen, using Ecology PSD.

References:

New Jersey Department of Environmental Protection (NJDEP). (2003). Total Suspended Solids Laboratory Testing Procedures (December 23, 2003).

Washington State Department of Ecology (WADOE). (2008). Guidance for Evaluating Emerging Stormwater Treatment Technologies: Technology Assessment Protocol—Ecology (TAPE) (Publication Number 02-10-037). Olympia, Washington: Author. Available Online: www.ecy.wa.gov/biblio/0210037.html

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March 21, 2017

Derek M. Berg
Contech Engineered Solutions, LLC
71 US Route 1, Suite F
Scarborough, ME 04074

Re: Revised MTD Lab Certification
Continuous Deflective Separator (CDS®) Stormwater Treatment Device by Contech Engineered Solutions, LLC
On-line Installation

TSS Removal Rate 50%

Dear Mr. Berg:

This revised certification letter supersedes the Department's prior certification dated January 9, 2015. This revision was completed to reflect the updated Manufactured Treatment Device (MTD) scaling methodology as agreed upon by the manufacturers' working group on September 19, 2016. In part, the updated scaling for hydrodynamic MTDs is based on the depth of the reference (tested) MTD from the top of the false floor utilized during removal efficiency testing, not from the physical bottom of the unit. Based on the above decision, Table A-2 of the NJCAT Technology Verification report located at http://www.njcat.org/uploads/newDocs/CDSVerificationReportFinal1.pdf has been revised, and Table 1 noted below has been added.

The Stormwater Management rules under N.J.A.C. 7:8-5.5(b) and 5.7 (c) allow the use of manufactured treatment devices (MTDs) for compliance with the design and performance standards at N.J.A.C. 7:8-5 if the pollutant removal rates have been verified by the New Jersey Corporation for Advanced Technology (NJCAT) and have been certified by the New Jersey Department of Environmental Protection (NJDEP). Contech Engineered Solutions, LLC has requested an MTD Laboratory Certification for the CDS® Stormwater Treatment Device.

The verification is subject to the "Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advance Technology" dated January 25, 2013. The applicable protocol is the "New Jersey Laboratory Testing Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device" dated January 25, 2013.

NJCAT verification documents submitted to the NJDEP indicate that the requirements of the aforementioned protocol have been met or exceeded. The NJCAT letter also included a recommended certification TSS removal rate and the required maintenance plan. The NJCAT Verification Report with the Verification

Appendix dated September 2014 (Revised January 2017) for this device is published online at http://www.njcat.org/verification-process/technology-verification-database.html.

The NJDEP certifies the use of the CDS® Stormwater Treatment Device by Contech Engineered Solutions, LLC at a TSS removal rate of 50% when designed, operated, and maintained in accordance with the information provided in the Verification Appendix and the following conditions:

1. The maximum treatment flow rate (MTFR) for the manufactured treatment device (MTD) is calculated using the New Jersey Water Quality Design Storm (1.25 inches in 2 hrs) in N.J.A.C. 7:8-5.5.

2. The CDS® Stormwater Treatment Device shall be installed using the same configuration reviewed by NJCAT and shall be sized in accordance with the criteria specified in item 6 below.

3. This CDS® Stormwater Treatment Device cannot be used in series with another MTD or a media filter (such as a sand filter) to achieve an enhanced removal rate for total suspended solids (TSS) removal under N.J.A.C. 7:8-5.5.

4. Additional design criteria for MTDs can be found in Chapter 9.6 of the New Jersey Stormwater Best Management Practices (NJ Stormwater BMP) Manual which can be found on-line at www.njstormwater.org.

5. The maintenance plan for a site using this device shall incorporate, at a minimum, the maintenance requirements for the CDS® Stormwater Treatment Device. A copy of the maintenance plan is attached to this certification. However, it is recommended to review the maintenance website at http://www.conteches.com/products/stormwater-management/treatment/cds.aspx#1822141-technical-info for any changes to the maintenance requirements.

6. Sizing Requirements:

   The example below demonstrates the sizing procedure for the CDS®:

   Example: A 0.25-acre impervious site is to be treated to 50% TSS removal using a CDS®. The impervious site runoff (Q) based on the New Jersey Water Quality Design Storm was determined to be 0.79 cfs.

   Maximum Treatment Flow Rate (MTFR) Evaluation:

   The site runoff (Q) was based on the following:
   time of concentration = 10 minutes
   i=3.2 in/hr (page 5-8, Fig. 5-3 of the NJ Stormwater BMP Manual)
   c=0.99 (runoff coefficient for impervious)
   Q=ciA=0.99x3.2x0.25=0.79 cfs

   Given the site runoff is 0.79 cfs and based on Table 1 below, the CDS® Model CDS-4 with an MTFR of 0.93 cfs would be the smallest model approved that could be used for this site that could remove 50% of the TSS from the impervious area without exceeding the MTFR.

The sizing table corresponding to the available system models is noted below. Additional specifications regarding each model can be found in the Verification Appendix under Table A-1 and A-2.

Table 1 CDS Models

CDS Model	Manhole Diameter (ft.)	Treatment Chamber Depth (ft.)	MTFR (cfs)
CDS-3	3	3.50	0.52
CDS-4	4	3.50	0.93
CDS-5	5	3.75	1.5
CDS-6	6	4.50	2.1
CDS-7	7	5.25	2.8
CDS-8	8	6.00	3.7
CDS-10	10	7.50	5.8
CDS-12	12	9.00	8.4

- Treatment Chamber Depth is defined as the depth below the invert to the top of the false floor installed at 50% sediment depth.

A detailed maintenance plan is mandatory for any project with a Stormwater BMP subject to the Stormwater Management Rules, N.J.A.C. 7:8. The plan must include all of the items identified in the Stormwater Management Rules, N.J.A.C. 7:8-5.8. Such items include, but are not limited to, the list of inspection and maintenance equipment and tools, specific corrective and preventative maintenance tasks, indication of problems in the system, and training of maintenance personnel. Additional information can be found in Chapter 8: Maintenance and Retrofit of Stormwater Management Measures.

If you have any questions regarding the above information, please contact Mr. Shashi Nayak of my office at (609) 633-7021.

Sincerely,

James J. Murphy, Chief
Bureau of Nonpoint Pollution Control

Attachment: Maintenance Plan

c: Chron File
Richard Magee, NJCAT
Vince Mazzei, NJDEP - DLUR
Ravi Patraju, NJDEP - BES
Gabriel Mahon, NJDEP - BNPC
Shashi Nayak, NJDEP – BNPC

CDS® Inspection and Maintenance Guide – New Jersey

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump. Refer to Table 1 for depth from water surface to top of sediment pile for each model size indicating that maintenance is required.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be power washed to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile[1]		Sediment Storage Capacity	
	ft	m	ft	m	yd^3	m^3
CDS-3	3	0.9	3.0	0.9	0.5	0.4
CDS-4	4	1.2	3.0	0.9	0.9	0.7
CDS-5	5	1.5	3.25	1.0	1.5	1.1
CDS-6	6	1.8	4.0	1.2	2.1	1.6
CDS-7	7	2.1	4.75	1.4	2.9	2.2
CDS-8	8	2.4	5.5	1.7	3.7	2.8
CDS-10	10	3.0	7.0	2.1	5.8	4.4
CDS-12	12	3.4	8.5	2.6	8.4	6.4

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

[1] Distances from water surface to top of sediment pile are based on 75% of sump capacity being occupied.

Support

- Drawings and specifications are available at www.contechstormwater.com.
- Site-specific design support is available from our engineers.

Contech Engineered Solutions LLC provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, earth stabilization and stormwater treament products. For information, visit www.ContechES.com or call 800.338.1122

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CDS Inspection & Maintenance Log

CDS Model: ______________________ Location: ______________________

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

NJCAT TECHNOLOGY VERIFICATION

Continuous Deflective Separator (CDS®) Stormwater Treatment Device

(For Models that meet New Jersey's Unique Sizing Requirements)

Contech Engineered Solutions LLC

September, 2014

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1. Description of Technology

The CDS is a stormwater treatment device intended to remove pollutants, including suspended solids, trash and debris and floating oils from stormwater runoff. The CDS unit is typically comprised of a manhole that houses flow and screening controls designed around patented, continuous deflective separation technology. Figure 1 is a schematic representation of the solid separation mechanism of the CDS technology.

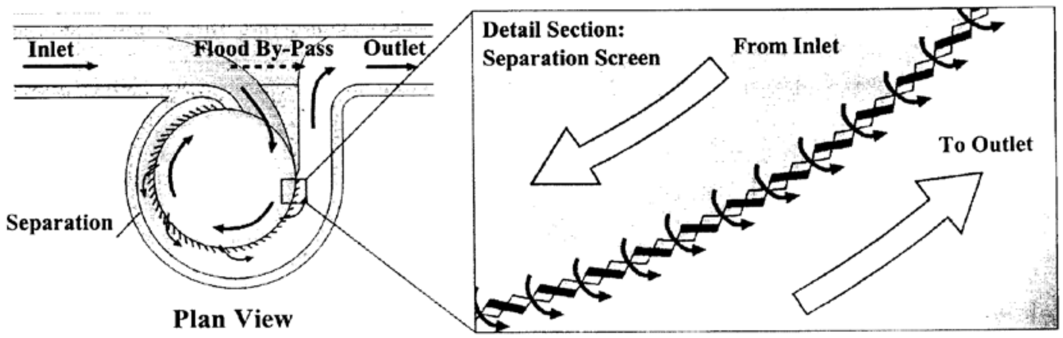

Figure 1 Schematic Representation of the CDS Solid Separation Mechanism

Stormwater runoff enters the CDS unit's diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed. The separation and containment chamber consist of a containment sump in the lower section and an upper separation section. Gross pollutants are separated within the chamber using a perforated screen plate allowing the filtered water to pass through to a volute return system and thence to the outlet pipe. The water and associated gross pollutants contained within the separation chamber are kept in continuous motion by the energy generated by the incoming flow. This has the effect of preventing the separation plate (screen) from being blocked by the gross solids separated from the inflow. The heavier solids ultimately settle into the containment sump. Figure 2 is a schematic representation of a typical CDS unit including critical components. For more details on the functionality of the CDS including drawings, videos and maintenance procedures please visit http://www.conteches.com/Products/Stormwater-Management/Treatment/CDS.aspx

The primary purpose of this verification testing was to establish the ability of the CDS to remove suspended solids from runoff as specified in the testing requirements detailed in the "*New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device*" (NJDEP HDS Protocol) dated January 25, 2013 (NJDEP 2013a). In particular, the CDS was tested to determine the maximum operating rate that would enable retention of more than 50% of the "NJDEP Particle Size Distribution" as calculated using the weighted annualized formula that is described in Appendix A of the NJDEP HDS Protocol. Since the CDS is most effective at removing the coarser fraction of the suspended solids load it is recommended that the CDS be used as the first component of a treatment train.

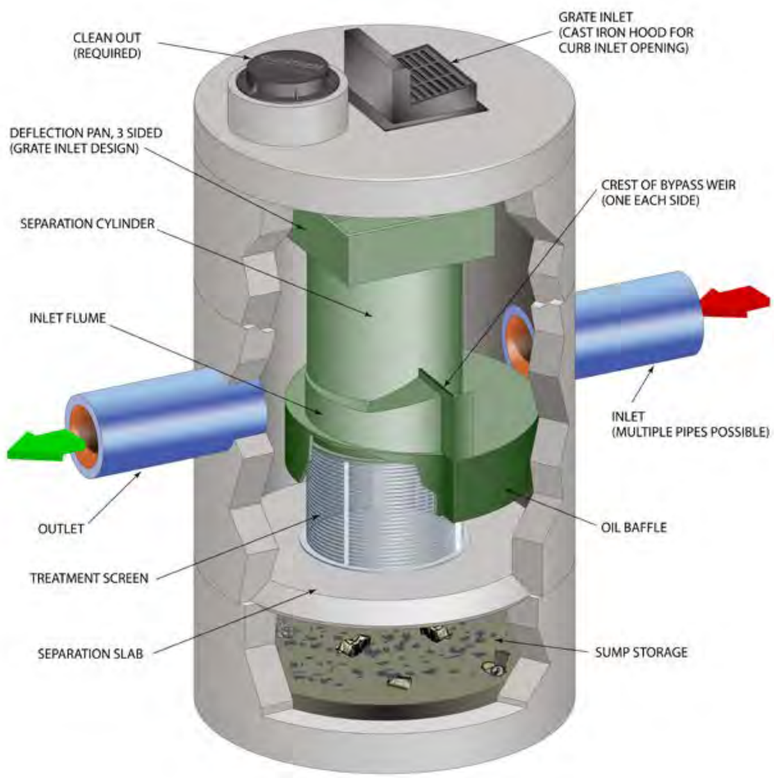

Figure 2 Graphic of Typical Inline CDS Unit and Core Components

2. Laboratory Testing

All TSS removal efficiency testing for this project was carried out at Contech's Scarborough, Maine laboratory under the direct supervision of FB Environmental Associates Inc. (FB). FB is a Portland, Maine based environmental consulting firm with past experience in a diverse suite of stormwater quality projects including past oversight of manufactured BMP testing initiatives. All water quality samples collected during this testing process were analyzed by Maine Environmental Laboratory, which is an independent analytical testing facility. Since Maine Environmental Laboratory does not conduct particle size analysis, and an alternate qualified facility was not identified locally, all particle size distribution (PSD) analysis was completed in-house at Contech's laboratory under the direct supervision of FB for the duration of all PSD analysis.

2.1 Test Setup

A CDS-4 Model (4 ft. diameter) unit was tested in accordance with the NJDEP HDS Protocol. A schematic of the CDS-4 unit is shown in Figure 3. The CDS-4 test unit did not have a sediment weir, as traditionally units sold in NJ have had in the past. (Note: Contech plans to move away from units with a sediment weir.) The CDS-4 is a commercially available unit with a 2 ft diameter x 1.5 ft high 2400 micron perforated screen plate and is offered in New Jersey and other

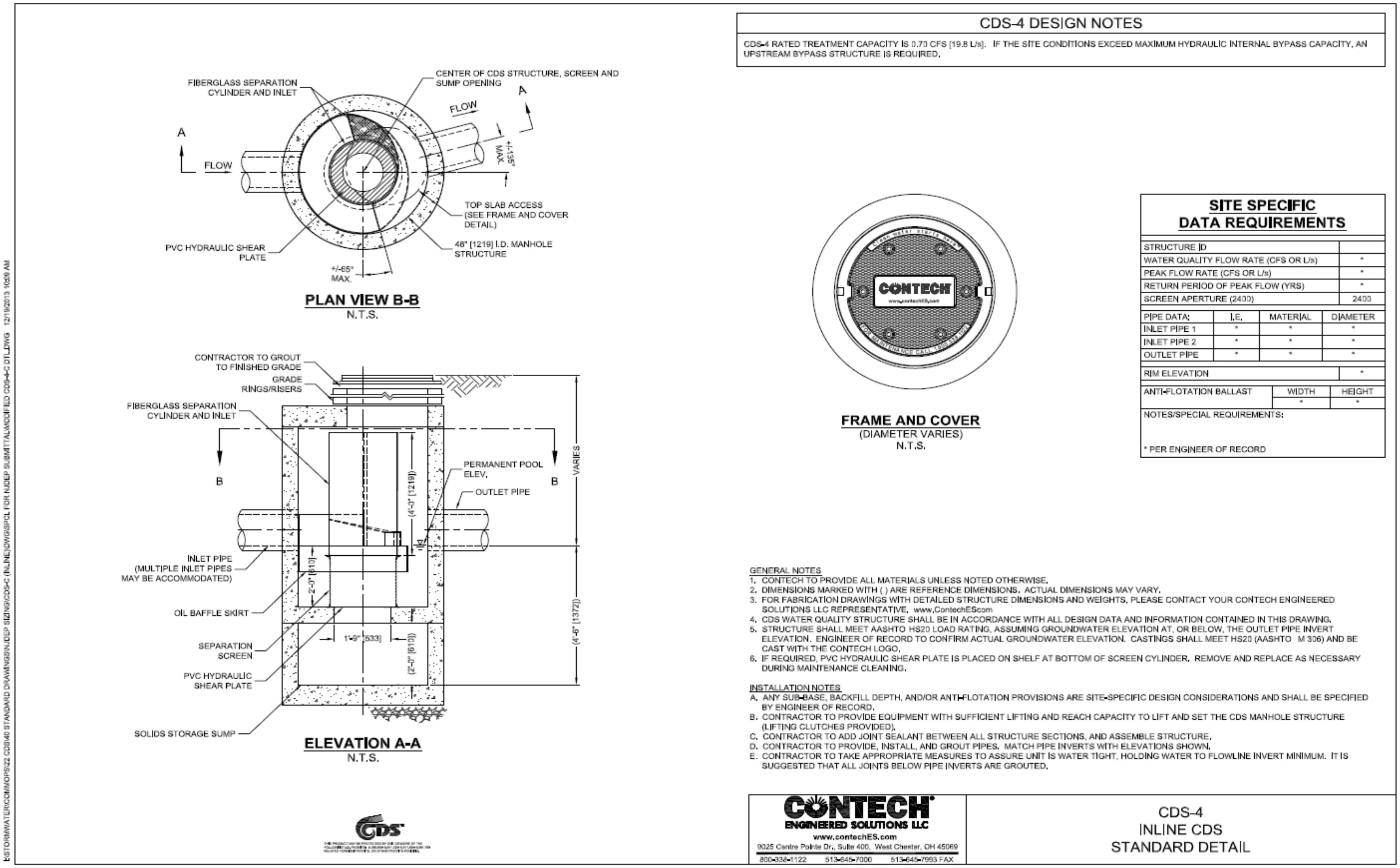

Figure 3 Schematic of Test Unit

areas that formally adopt New Jersey's unique sizing requirements. Since New Jersey has very specific criteria in place that govern scaling and determination of treatment flow, as well as a unique weighted 50% removal efficiency calculation tied to historical New Jersey rainfall measurements, CDS models have been specifically tailored to comply with these requirements. Like many technologies, different CDS model configurations are available in different regions depending on local sizing and performance criteria.

Total Suspended Solids Removal Efficiency Laboratory Setup

The laboratory CDS-4 prototype is housed in a 4 ft. diameter cylindrical aluminum tank with a depth of 4.7 ft. below the inlet and outlet inverts to the sump floor. These dimensions are consistent with the commercially available CDS-4. The CDS-4 was TSS removal efficiency tested in a closed loop, re-circulatory laboratory system that is detailed in Figure 4. Inlet and outlet piping consists of 12 in. diameter schedule 40 PVC. Water enters the inlet pipe 12 ft. upstream from the test unit and the test sediment is dry fed through a 6 in. port located 6 ft. upstream from the test unit. Treated effluent is able to freely discharge through a downturned 90 degree elbow into an aluminum catch tank. The catch tank is configured with two filter partitions that filter remaining fines from the effluent prior to recirculation in order to maintain background concentrations at levels less than 20 mg/L. The first partition consists of 24-1 um nominal rated pre-filter bags while the second partition consists of 24-0.5 um rated primary filter bags. Filtered water is re-circulated into the 12 in. inlet pipe through a 6 in. schedule 40 PVC line via a 10 hp pump. Flows are controlled by a 6 in. gate valve and monitored by a SeaMetrics Online Magmeter (model WMX104) coupled with SeaMetrics model EX201 flow computer.

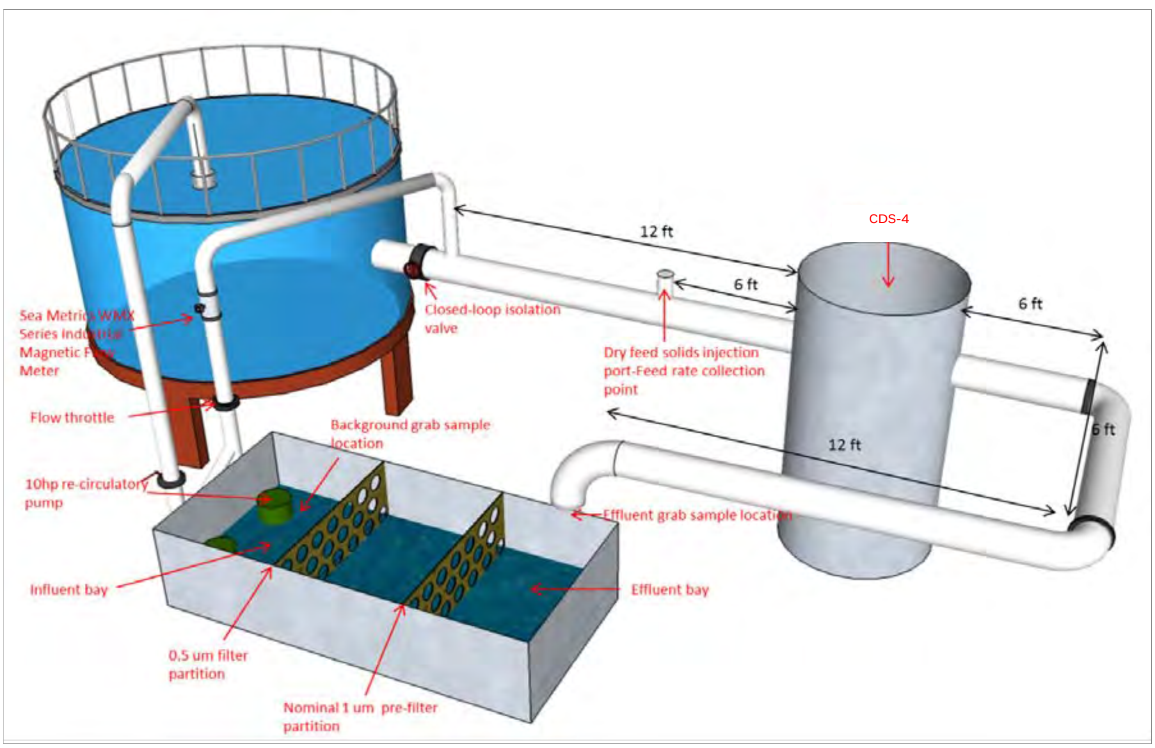

Figure 4 Schematic of TSS Removal Efficiency Laboratory Setup

Scour Test Laboratory Setup

Concerns were raised during the public comment review process on the CDS December 2013 posted verification report relative to the online scour testing procedure followed for the CDS-4 during testing originally completed and submitted to NJCAT in 2013. As a result, Contech agreed to alter the scour testing procedure and repeat the scour testing requirements described in the NJDEP laboratory protocol for hydrodynamic separators. Specifically, commenters questioned whether in addition to the dedicated sedimentation sump, sediment may also accumulate in the annular area outside of the screening chamber. Contech's experience with the CDS has demonstrated that sediment accumulation in this area is generally minimal. Since the possibility of some sediment accumulating in this area during low flows could not be ruled out, Contech agreed to repeat the scour testing procedure after preloading scour testing sediment in the sedimentation sump as well as on top of the annular area outside of the screening chamber.

The scour testing and associated procedures described herein were completed at Contech's full scale laboratory in Portland, Oregon since the Scarborough Maine laboratory was no longer available. All testing and procedures conducted at Contech's facility in Portland were overseen by Dr. Chris Berger, PhD., a colleague of Dr. Scott Wells, from Portland State University who has an extensive background in water quality research. Samples prepared for particle size analysis were sent to Apex Labs in Tigard, Oregon. Apex Labs is an independent certified analytical laboratory. All background and effluent samples collected during the scour testing procedure were also sent to Apex Labs for SSC analysis.

Testing was conducted on a full scale 4 ft. diameter (CDS-4) laboratory unit consistent in all dimensions with the commercially available CDS-4. The CDS-4 unit was housed in a 4 ft. diameter cylindrical aluminum tank. The 50% sediment storage capacity is defined as a sediment depth of 1 ft. and a vertical distance of 1 ft. from the bottom of the 6-inch separation slab. To simulate this condition a false floor was constructed eight inches from the sump floor and covered with four inches of the scour test sediment.

The scour testing on the CDS-4 was completed on a closed loop, re-circulatory laboratory system that is detailed in Figure 5. Water is provided to the unit via a 10 HP pump that pulls water from the HDPE open source tank and directs the water into a 12 in. diameter pipe 11.25 ft. upstream from the test unit. Flow is controlled through three 4 in. actuated valves, and one 4 in. manual bypass valve. Flow is monitored by a SeaMetrics Online Magmeter (model WMX104) coupled with a SeaMetrics FT420 rate indicator and a SeaMetrics DL76 data logger. Treated effluent is able to freely discharge through a downturned 90 degree elbow into an HDPE catch tank (discharge tank). A second 10 HP pump moves water from the discharge tank through two in-line filters of 5um and 1um respectively to remove particulate from the effluent prior to recirculation.

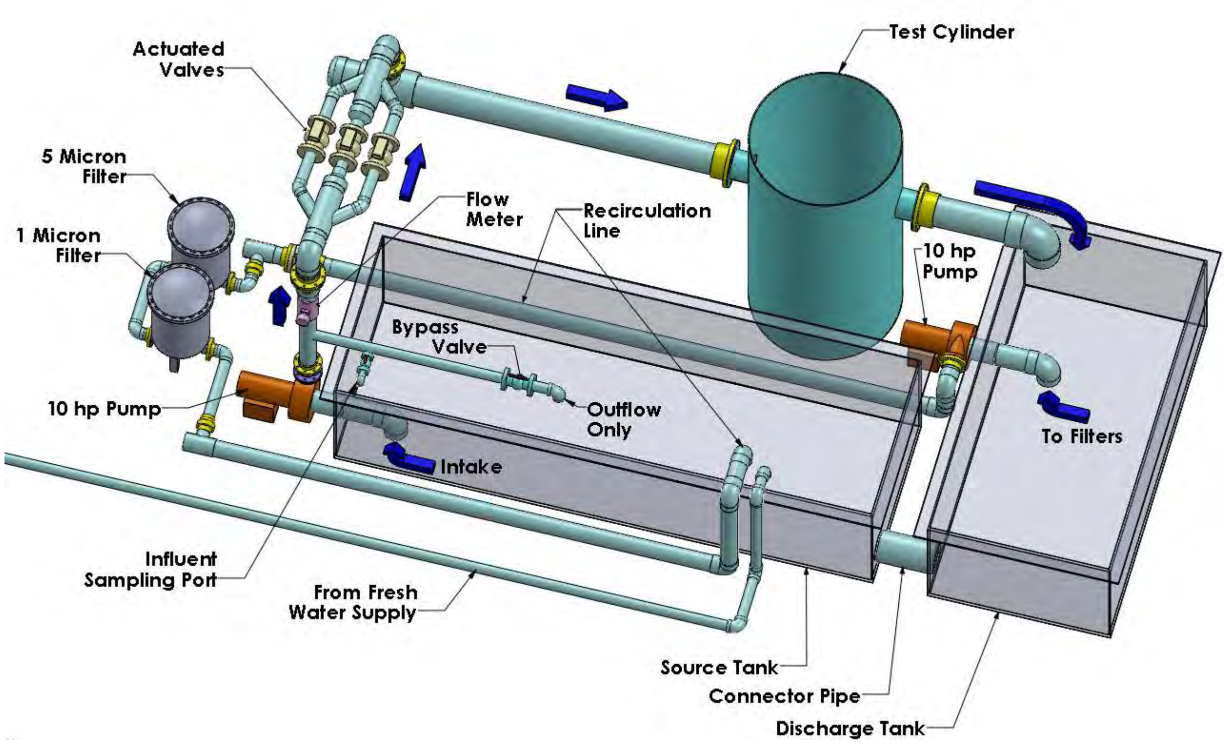

Figure 5 Schematic of Scour Testing Laboratory Setup

2.2 Test Sediment

Test Sediment Feed for Suspended Solids Removal Efficiency Testing

Sediment used for all solids removal testing was high purity silica (SiO_2 99.8%) material (Sp. gr. -2.65) with a particle size distribution (PSD) approximating 55% sand, 40% silt, and 5% clay. Sediment for the entire project was supplied by an outside vendor, blended together in a single batch and then packaged and shipped in fifty 50- lb. bags to Contech. Batch PSD was confirmed by Contech prior to testing by collecting subsamples from 20% of the bags (10 bags/subsamples) and compositing the subsamples into a single sample for PSD analysis. Each of the 50 bags was numbered 1-50 prior to subsample collection. The numbers 1-50 were then written on individual slips of paper and placed into a container. Numbers were pulled from the container at random to determine which of the 10 bags subsamples would be collected from. This process was repeated three times for a total of three separate PSD analyses, each of which was comprised of 10 subsamples.

The mean of the three PSD samples was calculated and plotted as a single PSD curve representing the batch of material. Sediment sampling for PSD analysis was conducted in-house with oversight from FB Environmental Associates, Inc. The three PSD analyses were also carried out in-house under the direct supervision of FB in accordance with ASTM D422-63 (reapproved 2007).

Scour Test Sediment

Prior to the start of testing, Contech procured a batch of scour sediment manufactured to be compliant with the scour sediment PSD specification defined in the NJDEP laboratory protocol. The scour sediment was packaged by the manufacturer into 50 lb. bags for delivery and storage. To ensure that the scour sediment was compliant with the PSD specifications, three composite samples comprised of 12 randomly pulled subsamples were collected and analyzed for PSD. The compositing procedure was as follows: 59 bags of washout sediment were numbered 1-59 prior to subsample collection. Microsoft Excel randomizer function was used to determine 3 sets of 12 randomly determined values using the RANDBETWEEN (x, y) function, where x = 1, and y= 59. Bags with numbers matching each set of randomly determined values were well mixed and then subsamples were collected and mixed together into a sample jar. Each subsample consisted of two level tablespoons of material with a combined weight of approximately 50 grams. The 3 composite samples were sent to Apex Labs in Tigard, Oregon for PSD testing following ASTM D422-63 (Reapproved 2007).

2.3 Removal Efficiency Testing Procedure

Removal efficiency testing utilized the “Effluent Grab Sampling Method,” as described in section 5D of the NJDEP HDS Protocol. FB Environmental provided third party oversight for the duration of all testing. Prior to each test, the flow rate was stabilized at the desired test rate. Once the flow rate was stabilized dry feed of the surrogate test contaminant commenced subsequently initiating the testing procedure. A vibratory hopper and auger (manufactured by Vibra-Screw Inc.) was used to meter solids into the flow stream at a rate calculated to yield 200 mg/L (±10%). Target feed rate (mg/min) was determined by the following formula:

$$Feed\ Rate = Target\ Concentration \times\ Target\ Influent\ Flow\ Rate$$

The grab sampling method was used to directly obtain each effluent, background and feed rate calibration sample. Effluent samples were collected by sweeping bottles in a circular motion through the freely discharging effluent stream. The duration required to obtain each feed rate sample was measured and recorded to the nearest second. The first effluent and background sample were collected simultaneously three detention times after the target flow rate was achieved. Detention time of the test unit was determined through the following formulas:

Volume of CDS-4 = $\pi \times (2ft)^2 \times 3.7ft = 46.5ft^3$

Detention time: $\frac{46.5\ ft^3}{Target\ flow\ rate\ (cfs)}$

Collection of the first feed rate calibration sample occurred immediately following the collection of the first effluent and background samples. Since the feed rate sampling procedure temporarily disrupts the introduction of solids, a period of three detention times was allowed to elapse before obtaining the second effluent sample. Since feed rate and background samples were collected immediately following and during collection of each odd numbered effluent sample, the collection interval for treated effluent consisted of three detention times after odd numbered effluent samples and one minute after even numbered effluent samples. After the sixth and final feed rate sample was collected, sampling continued in one minute increments for the remainder of the test until a total of 15 effluent samples were collected.

Following each test all feed rate calibration samples were weighed to the nearest milligram in-house on a calibrated balance. The resultant mass of each sample was divided by the duration required to obtain the sample. FB Environmental oversaw all in-house measurements and calculations. After each test, effluent and background samples were packed for delivery and sent to Maine Environmental Laboratory for analysis in accordance with ASTM D3977-97 (SSC) (re-approved 2007).

The test procedure was repeated for each flow rate corresponding to 25%, 50%, 75%, 100% and 125% of the target MTFR.

2.4 Scour Testing Procedure

Prior to the start of testing, sediment was loaded into the sedimentation sump and leveled at a depth of 4 inches bringing the top of the sediment pile to an elevation consistent with 50% of the maximum sediment storage capacity (12 inches below separation slab). In order to be conservative, 4 inches of sediment was also loaded onto the top surface of the separation slab and leveled accordingly. To gain access to the top of the separation slab the screen and upper internals were temporarily removed from the test unit. After loading and leveling the sediment on the separation slab, the screen and internals were carefully installed to insure minimal disturbance of the pre-loaded sediment.

After sediment had been loaded into the sedimentation sump and onto the separation slab and the unit was fully assembled, the CDS-4 was filled with water using a spray nozzle adjusted to a gentle spray and attached to a garden hose. Water was directed into the center of the sump and an effort was made to minimize disturbance of the sediment. The unit was filled with water to the invert of the inlet and outlet pipe which is consistent with the dry weather condition of the CDS. Filling was terminated just before water reached the height of the inverts. The scour test was carried out 68 hours after filling the unit with water. During testing, the flow was monitored and recorded using a SeaMetrics Online Magmeter (model WMX104) coupled with a SeaMetrics FT420 rate indicator and a SeaMetrics DL76 data logger.

Testing commenced by gradually introducing and increasing flow into the system until a minimum 200% MTFR was achieved. The target tested flow rate was achieved (+/- 10%) within four minutes of introducing flow to the system. The first background and effluent samples were collected five minutes after the introduction of water to the system. Effluent samples were collected by sweeping the sample container through the free discharge of the outlet pipe. Effluent grab sampling continued in two minute increments until a total of 15 samples were obtained. Background samples were collected in new 500ml HDPE bottles through a sample port in the influent pipe upstream of the test unit in evenly spaced intervals throughout the duration of the test. A total of 8 background samples were collected. At the conclusion of testing the effluent and background samples were sent to Apex Laboratories in Tigard, Oregon for suspended solids concentration (SSC) analysis in accordance with ASTM D3977-97.

3. Performance Claims

Per the NJDEP verification procedure document (NJDEP, 2013a), the following are the performance claims made by Contech and/or established via the laboratory testing conducted.

Total Suspended Solids Removal Rate

Based on the laboratory testing conducted, the Contech Continuous Deflective Separation (CDS) Stormwater Treatment Device achieved greater than 50% removal efficiency of suspended solids. In accordance with the NJDEP procedure for obtaining verification of a stormwater manufactured treatment device from NJCAT (NJDEP 2013a) the TSS removal efficiency is rounded down to 50%.

Maximum Treatment Flow Rate (MTFR)

For all of the commercially available model sizes, the hydraulic loading rate used to calculate the MTFR is 33.2 gpm/ft^2.

Maximum sediment storage depth and volume

The maximum sediment storage depth for each CDS model is one foot. One-foot represents 50% of the 2 ft. sediment sump that is part of each CDS standard model. The available volume is dependent on the size of the manhole. The CDS-4 tested (4' diameter manhole) has 25.1 cubic feet of available storage volume.

Effective treatment area

The effective treatment area is dependent on the size of the CDS model used and is the surface area of the CDS model selected.

Detention time and volume

The CDS-4 detention time at the MTFR is 50 seconds and the total wet volume including sediment sump is 50.3 ft^3.

Effective sedimentation area

The effective sedimentation area and effective treatment area for the CDS Stormwater Treatment System are identical.

Online installation

Based on the testing results shown in Section 4.4 the CDS Stormwater Treatment System qualifies for online installation.

4. Supporting Documentation

The NJDEP Procedure (NJDEP, 2013a) for obtaining verification of a stormwater manufactured treatment device (MTD) from the New Jersey Corporation for Advanced Technology (NJCAT) requires that "copies of the laboratory test reports, including all collected and measured data; all data from performance evaluation test runs; spreadsheets containing original data from all performance test runs; all pertinent calculations; etc." be included in this section. This was discussed with NJDEP and it was agreed that as long as such documentation could be made available by NJCAT upon request that it would not be prudent or necessary to include all this information in this verification report.

4.1 Test Sediment PSD Analysis – Removal Efficiency Testing

Prior to the start of removal efficiency testing Contech procured 2500 pounds of test sediment deemed compliant with the PSD specification detailed in the NJDEP HDS Protocol and had it packaged into fifty 50 lb bags for delivery and storage. To ensure that sediment was uniformly mixed across the entire batch, three composite samples were created and analyzed for PSD. Test sediment batch PSD for the project was verified by collecting subsamples from 20% of the bags (10 bags/subsamples per composite) and compositing the subsamples into a single sample for PSD analysis. Each of the 50 bags was numbered 1-50 prior to subsample collection. The numbers 1-50 were then written on individual slips of paper and placed into a container. Numbers were pulled from the container at random to determine which of the 10 bags subsamples would be collected from. This process was repeated three times to create a total of three separate composite samples for PSD analyses, each of which was comprised of 10 subsamples from 10 different bags. Sediment sampling for PSD analysis was conducted in-house with oversight from FB Environmental Associates, Inc. The three PSD analyses were also carried out in-house under the direct supervision of FB in accordance with ASTM D422-63 (reapproved 2007).

Results of the three PSD analyses completed on the batch of test sediment are provided in Table 1. The median particle size (d_{50}) of the test material is less than 75 microns for all three samples.

Table 1 Removal Efficiency Sediment Particle Size Distribution Analysis

Contech Test Sediment Particle Distribution Results							
Contech PSD Sample 1		Contech PSD Sample 2		Contech PSD Sample 3		Contech Mean PSD	
Particle Size (µm)	Percent Finer	Particle Size (µm)	Percent Finer	Particle Size (µm)	Percent Finer	Particle Size (µm)	Percent Finer
2000	100.0	2000	100.0	2000	100.0	**2000**	**100.0**
1000	99.6	1000	99.7	1000	99.6	**1000**	**99.7**
500	96.2	500	96.1	500	96.1	**500**	**96.1**
250	87.9	250	87.6	250	93.4	**250**	**89.6**
212	83.7	212	83.4	212	89.9	**212**	**85.7**
150	74.2	150	73.6	150	80.1	**150**	**76.0**
125	67.9	125	67.6	125	73.9	**125**	**69.8**
106	62.0	106	61.8	106	68.0	**106**	**63.9**
75	51.9	75	51.4	75	57.7	**75**	**53.7**
53	45.8	53	45.4	53	51.6	**53**	**47.6**
32.9	44.0	32.9	44.0	32.7	45.0	**32.8**	**44.4**
21.2	38.0	21.2	38.0	21.2	38.4	**21.2**	**38.2**
12.5	32.0	12.5	32.0	12.5	32.0	**12.5**	**32.0**
9.1	27.0	9.0	27.0	9.1	26.0	**9.0**	**26.7**
6.4	22.0	6.4	23.0	6.4	22.0	**6.4**	**22.3**
3.3	15.0	3.3	14.0	3.2	14.0	**3.2**	**14.3**
1.4	7.0	1.4	8.0	1.4	8.0	**1.4**	**7.7**

The mean PSD for the 3 samples was also calculated and presented in Table 1. As described in the NJDEP HDS Protocol the mean PSD serves as the PSD of the batch of test sediment.

The mean PSD of Contech's test sediment complies with the PSD criteria established by the NJDEP HDS protocol. Figure 6 plots the Contech PSD against the NJDEP PSD specification. The Contech sediment gradation is equivalent to or finer than the NJDEP gradation at all points along the curve. Overall, the Contech sediment blend contains more fines than the NJDEP gradation, particularly below 50 microns. The median particle size of the Contech gradation is approximately 60 microns.

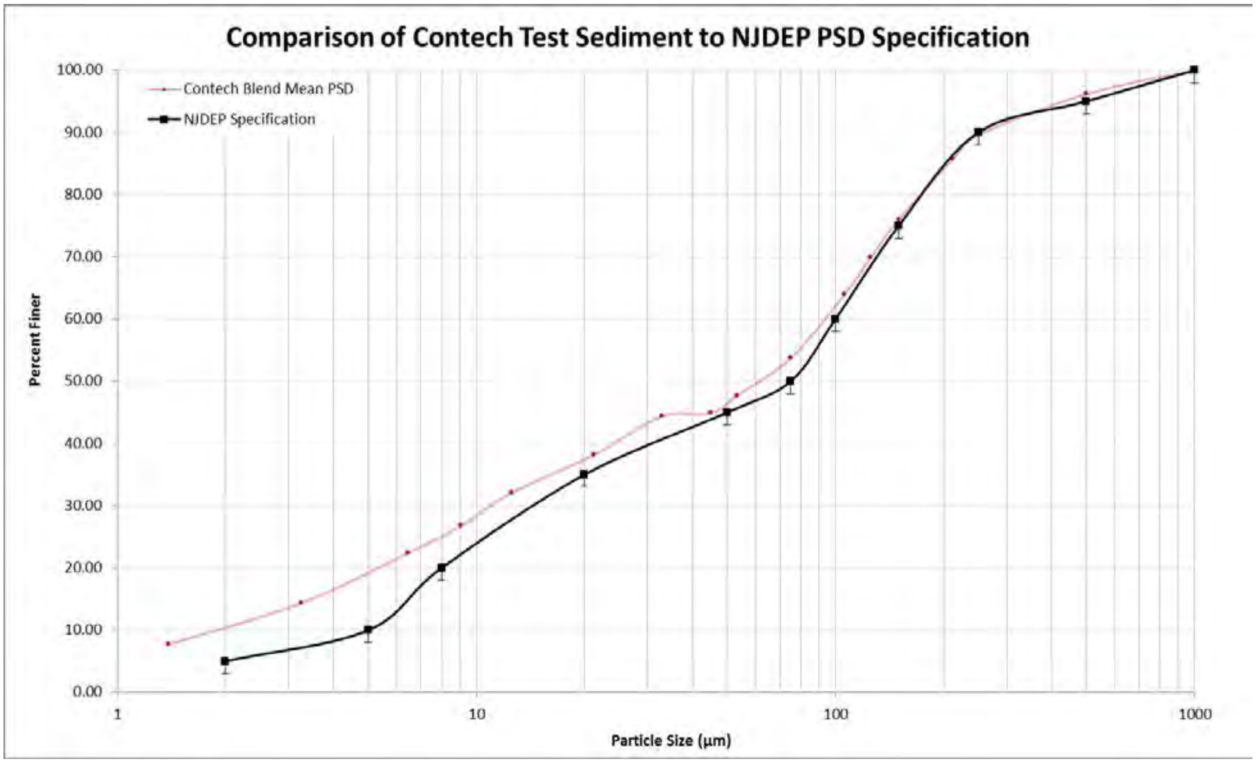

Figure 6 Comparison of the Mean Contech Test Sediment PSD to the NJDEP Removal Efficiency Test Sediment PSD Specification

4.2 Removal Efficiency Testing

In accordance with the NJDEP HDS Protocol, removal efficiency testing was executed on the CDS-4 laboratory unit in order to establish the ability of the CDS to remove the specified test sediment at 25%, 50%, 75%, 100% and 125% of the target MTFR. Prior to the start of testing Contech reviewed existing data and decided to utilize a target MTFR of 0.93 cfs. This target was chosen based on the ultimate goal of demonstrating greater than 50% annualized weighted solids removal as defined in the NJDEP HDS Protocol. The Mean Influent Concentration was calculated from the mean feed rate and the mean flow rate; while the mean effluent concentration was adjusted by subtraction of the background concentration.

25% MTFR Results

To establish the performance of the CDS-4 at 25% MTFR a test was conducted in accordance with the criteria in the NJDEP HDS Protocol at a target flow rate of 0.23 cfs. Table 2 provides an overview of the test conditions and a summary of the results for the 25% MTFR test. The feed rate calibration sample results are provided in Table 3. Background and effluent sampling results for the trial are presented in Table 4. The CDS-4 removed 67.0% of the test sediment at an operating rate of 0.24 cfs. Each of the QA/QC parameters that pertain to sampling and flow measurement are presented in Table 5 and are in compliance with the thresholds defined in the NJDEP HDS Protocol.

Table 2 Summary of CDS-4 25% MTFR Laboratory Test

CDS-4 25% MTFR Trial Summary					
Trial Date	**Target Flow (cfs)**	**Detention Time (sec)**	**Target Sediment Concentration (mg/l)**	**Target Feed Rate (mg/min)**	**Test Duration (Min)**
4-Apr-13	0.23	199	200mg/l	78,547	83.73
Measured Values					
Mean Flow Rate (cfs)	**Mean Influent Concentration (mg/l)**	**Mean Water Temperature F**	**Mean Adjusted Effluent Concentration (mg/l)**	**Average Removal Efficiency**	**QA/QC Compliance**
0.24cfs	194	52	64	**67.0%**	Yes

Table 3 CDS-4 25% MTFR Feed Rate Calibration Sample Results

CDS-4 25% MTFR Feed Rate Calibration Sample Results					
Target Concentration	**200 mg/l**	**Target Feed Rate**		**78,547 mg/min**	
Sample ID	**Sample Time (min)**	**Sample Weight (mg)**	**Sample Duration (sec)**	**Feed Rate (mg/min)**	**Calculated Influent Concentration (mg/L)**
Feed Rate 1	9.96	84605	60.31	84170	205
Feed Rate 2	21.92	79959	60.28	79588	193
Feed Rate 3	33.88	78509	60.25	78183	190
Feed Rate 4	45.85	77831	60.25	77508	188
Feed Rate 5	57.81	77270	60.31	76873	187
Feed Rate 6	69.77	82288	60.47	81648	198
			Mean	**79662**	**194**

Table 4 CDS-4 25% MTFR Background and Effluent Sample Results

CDS-4 25% of MTFR Test Background and Effluent Sample Results					
Sample ID	**Time (min)**	**Concentration (mg/L)**			
Background 1	9.96	2			
Background 2	21.92	2			
Background 3	33.88	2			
Background 4	45.85	2			
Background 5	57.81	2			
Background 6	69.77	2			
Background 7	81.73	2			
Background 8	83.73	2			
Note that the analytical laboratory established a limit of quantification (LOQ) for SSC of 4mg/l. Values below this threshold are reported as non detect (ND) by the laboratory. In following standard reporting practices ND values have been reported at 1/2 the LOQ which is 2mg/l for this study.					
Sample ID	**Time (min)**	**Concentration (mg/L)**	**Associated Background Concentration (mg/l)**	**Adjusted Concentration (mg/l)**	**Temperature F**
Effluent 1	9.96	67	2	65	61
Effluent 2	20.92	68	2	66	57
Effluent 3	21.92	68	2	66	56
Effluent 4	32.88	62	2	60	55
Effluent 5	33.88	65	2	63	55
Effluent 6	44.85	63	2	61	54
Effluent 7	45.85	71	2	69	53
Effluent 8	56.81	66	2	64	50
Effluent 9	57.81	66	2	64	51
Effluent 10	68.77	67	2	65	48
Effluent 11	69.77	68	2	66	48
Effluent 12	80.73	71	2	69	47
Effluent 13	81.73	63	2	61	47
Effluent 14	82.73	63	2	61	47
Effluent 15	83.73	66	2	64	47
	Mean	**66**	**2**	**64**	**52**

Table 5 CDS-4 25% MTFR QA/QC Parameters

CDS-4 25% of MTFR QA/QC Parameters				
Flow Rate				
Target (gpm)	Mean (gpm)	Coef. of Variance	Acceptable Parameters Target	Acceptable Parameters Coef. Of Variance
103.75	108.7	0.01		<0.03
Feed Rate				
Target (mg/min)	Mean (mg/min)	Coef. of Variance	Acceptable Parameter Target	Acceptable Parameters Coef. Of Variance
78547	79662	0.04		<0.1
Influent Concentration				
Target (mg/L)	Mean (mg/L)	Coef. of Variance	Acceptable Parameter Target	Acceptable Parameters Coef. Of Variance
200	194	0.04		<0.1
Background Concentration				
Low (mg/L)	High (mg/L)	Mean (mg/L)	Acceptable Threshold (mg/L)	
2	2	2	<20	

50% MTFR Results

To establish the performance of the CDS-4 at 50% MTFR a test was conducted in accordance with the criteria in the NJDEP HDS Protocol at a target flow rate of 0.46 cfs. Table 6 provides an overview of the test conditions and a summary of the results for the 50% MTFR test. The feed rate calibration sample results are provided in Table 7. Background and effluent sampling results for the trial are presented in Table 8. The CDS-4 removed 54.3% of the test sediment at an operating rate of 0.46 cfs. Each of the QA/QC parameters that pertain to sampling and flow measurement are presented in Table 9 and are in compliance with the thresholds defined in the NJDEP HDS Protocol.

Table 6 Summary of CDS-4 50% MTFR Laboratory Test

CDS-4 50% MTFR Trial Summary					
Trial Date	**Target Flow (cfs)**	**Detention Time (sec)**	**Target Sediment Concentration (mg/l)**	**Target Feed Rate (mg/min)**	**Test Duration (Min)**
4-Apr-13	0.46	100	200mg/l	157,095	48.87
Measured Values					
Mean Flow Rate (cfs)	**Mean Influent Concentration (mg/l)**	**Mean Water Temperature F**	**Mean Adjusted Effluent Concentration (mg/l)**	**Average Removal Efficiency**	**QA/QC Compliance**
0.46cfs	195	48	89	**54.3%**	Yes

Table 7 CDS-4 50% MTFR Feed Rate Calibration Sample Results

CDS-4 50% MTFR Feed Rate Calibration Sample Results					
Target Concentration	**200 mg/l**	**Target Feed Rate**		**157,095 mg/min**	
Sample ID	**Sample Time (min)**	**Sample Weight (mg)**	**Sample Duration (sec)**	**Feed Rate (mg/min)**	**Calculated Influent Concentration (mg/L)**
Feed Rate 1	4.98	103404	40.32	153875	196
Feed Rate 2	11.96	104049	40.28	154989	198
Feed Rate 3	18.94	105251	40.59	155582	199
Feed Rate 4	25.92	107070	40.32	159330	203
Feed Rate 5	32.90	97634	40.35	145181	185
Feed Rate 6	39.88	99647	40.32	148284	189
			Mean	**152873**	**195**

Table 8 CDS-4 50% MTFR Background and Effluent Sample Results

CDS-4 50% of MTFR Background and Effluent Sample Results					
Sample ID	**Time (min)**	**Concentration (mg/L)**			
Background 1	4.98	2			
Background 2	11.96	2			
Background 3	18.94	2			
Background 4	25.92	2			
Background 5	32.90	2			
Background 6	39.88	2			
Background 7	46.87	2			
Background 8	48.87	2			
Note that the analytical laboratory established a limit of quantification (LOQ) for SSC of 4mg/l. Values below this threshold are reported as non detect (ND) by the laboratory. In following standard reporting practices ND values have been reported at 1/2 the LOQ which is 2mg/l for this study.					
Sample ID	**Time (min)**	**Concentration (mg/L)**	**Associated Background Concentration (mg/l)**	**Adjusted Concentration (mg/l)**	**Temperature F**
Effluent 1	4.98	83	2	81	52
Effluent 2	10.96	87	2	85	49
Effluent 3	11.96	91	2	89	49
Effluent 4	17.94	91	2	89	48
Effluent 5	18.94	88	2	86	48
Effluent 6	24.92	88	2	86	49
Effluent 7	25.92	92	2	90	49
Effluent 8	31.90	87	2	85	48
Effluent 9	32.90	94	2	92	47
Effluent 10	38.88	95	2	93	47
Effluent 11	39.88	99	2	97	47
Effluent 12	45.87	86	2	84	47
Effluent 13	46.87	92	2	90	47
Effluent 14	47.87	102	2	100	46
Effluent 15	48.87	93	2	91	46
	Mean	**91**	**2**	**89**	**48**

Table 9 CDS-4 50% MTFR QA/QC Parameters

CDS-4 50 % of MTFR QA/QC Parameters				
Flow Rate				
Target (gpm)	Mean (gpm)	Coef. of Variance	Acceptable Parameters Target	Acceptable Parameters Coef. Of Variance
207.5	205.3	0.01		<0.03
Feed Rate				
Target (mg/min)	Mean (mg/min)	Coef. of Variance	Acceptable Parameter Target	Acceptable Parameters Coef. Of Variance
157095	152873	0.03		<0.1
Influent Concentration				
Target (mg/L)	Mean (mg/L)	Coef. of Variance	Acceptable Parameter Target	Acceptable Parameters Coef. Of Variance
200	195	0.03		<0.1
Background Concentration				
Low (mg/L)	High (mg/L)	Mean (mg/L)	Acceptable Threshold (mg/L)	
2	2	2	<20	

75% MTFR Results

To establish the performance of the CDS-4 at 75% MTFR a test was conducted in accordance with the criteria in the NJDEP HDS Protocol at a target flow rate of 0.69 cfs. Table 10 provides an overview of the test conditions and a summary of the results for the 75% MTFR test. The feed rate calibration sample results are provided in Table 11. Background and effluent sampling results for the trial are presented in Table 12. The CDS-4 removed 45.7% of the test sediment at an operating rate of 0.71 cfs. Each of the QA/QC parameters that pertain to sampling and flow measurement are presented in Table 13 and are in compliance with the thresholds defined in the NJDEP HDS Protocol.

Table 10 Summary of CDS-4 75% MTFR Laboratory Test

CDS-4 75% MTFR Trial Summary					
Trial Date	**Target Flow (cfs)**	**Detention Time (sec)**	**Target Sediment Concentration (mg/l)**	**Target Feed Rate (mg/min)**	**Test Duration (Min)**
5-Apr-13	0.69	66	200mg/l	235,453	37.26
Measured Values					
Mean Flow Rate (cfs)	**Mean Influent Concentration (mg/l)**	**Mean Water Temperature F**	**Mean Adjusted Effluent Concentration (mg/l)**	**Average Removal Efficiency**	**QA/QC Compliance**
0.71	198	59	108	**45.7%**	Yes

Table 11 CDS-4 75% MTFR Feed Rate Calibration Sample Results

CDS-4 75% MTFR Feed Rate Calibration Sample Results					
Target Concentration	**200 mg/l**	**Target Feed Rate**		**238,394 mg/min**	
Sample ID	**Sample Time (min)**	**Sample Weight (mg)**	**Sample Duration (sec)**	**Feed Rate (mg/min)**	**Calculated Influent Concentration (mg/L)**
Feed Rate 1	3.32	118724	30.28	235252	195
Feed Rate 2	8.65	120157	30.29	238013	197
Feed Rate 3	13.97	120241	30.34	237787	197
Feed Rate 4	19.29	117986	30.31	233559	194
Feed Rate 5	24.62	124367	30.47	244897	203
Feed Rate 6	29.94	121793	30.34	240856	200
			Mean	**238394**	**198**

Table 12 CDS-4 75% MTFR Background and Effluent Sample Results

CDS-4 75% of MTFR Background and Effluent Sample Results					
Sample ID	**Time (min)**	**Concentration (mg/L)**			
Background 1	3.32	2			
Background 2	8.65	4			
Background 3	13.97	2			
Background 4	19.29	5			
Background 5	24.62	8			
Background 6	29.94	9			
Background 7	35.26	14			
Background 8	37.26	14			
Note that the analytical laboratory established a limit of quantification (LOQ) for SSC of 4mg/l. Values below this threshold are reported as non detect (ND) by the laboratory. In following standard reporting practices ND values have been reported at 1/2 the LOQ which is 2mg/l for this study.					
Sample ID	**Time (min)**	**Concentration (mg/L)**	**Associated Background Concentration (mg/l)**	**Adjusted Concentration (mg/l)**	**Temperature F**
Effluent 1	3.32	98	2	96	66
Effluent 2	7.65	99	3	96	63
Effluent 3	8.65	104	3	101	63
Effluent 4	12.97	101	3	98	61
Effluent 5	13.97	106	3	103	61
Effluent 6	18.29	107	5	102	60
Effluent 7	19.29	117	5	112	60
Effluent 8	23.62	118	7	111	59
Effluent 9	24.62	115	7	108	58
Effluent 10	28.94	122	9	113	57
Effluent 11	29.94	122	10	112	56
Effluent 12	34.26	118	12	106	55
Effluent 13	35.26	134	13	121	54
Effluent 14	36.26	137	14	123	54
Effluent 15	37.26	125	15	110	54
	Mean	**115**	**7**	**108**	**59**

Table 13 CDS-4 75% MTFR QA/QC Parameters

75% of MTFR QA/QC Parameters				
Flow Rate				
Target (gpm)	Mean (gpm)	Coef. of Variance	Acceptable Parameters Target	Acceptable Parameters Coef. Of Variance
311	318.4	0.01		<0.03
Feed Rate				
Target (mg/min)	Mean (mg/min)	Coef. of Variance	Acceptable Parameter Target	Acceptable Parameters Coef. Of Variance
235453	238394	0.02		<0.1
Influent Concentration				
Target (mg/L)	Mean (mg/L)	Coef. of Variance	Acceptable Parameter Target	Acceptable Parameters Coef. Of Variance
200	198	0.02		<0.1
Background Concentration				
Low (mg/L)	High (mg/L)	Mean (mg/L)	Acceptable Threshold (mg/L)	
2	14	7	<20	

100% MTFR Results

To establish the performance of the CDS-4 at 100% MTFR a test was conducted in accordance with the criteria in the NJDEP HDS Protocol at a target flow rate of 0.93 cfs. Table 14 provides an overview of the test conditions and a summary of the results for the 100% MTFR test. The feed rate calibration sample results are provided in Table 15. Background and effluent sampling results for the trial are presented in Table 16. The CDS-4 removed 39.2% of the test sediment at an operating rate of 0.93 cfs. Each of the QA/QC parameters that pertain to sampling and flow measurement are presented in Table 17 and are in compliance with the thresholds defined in the NJDEP HDS Protocol.

Table 14 Summary of CDS-4 100% MTFR Laboratory Test

CDS-4 100% MTFR Trial Summary					
Trial Date	**Target Flow (cfs)**	**Detention Time (sec)**	**Target Sediment Concentration (mg/l)**	**Target Feed Rate (mg/min)**	**Test Duration (Min)**
3-Apr-13	0.925	49.8	200mg/l	314,189	31.43
Measured Values					
Mean Flow Rate (cfs)	**Mean Influent Concentration (mg/l)**	**Mean Water Temperature F**	**Mean Adjusted Effluent Concentration (mg/l)**	**Average Removal Efficiency**	**QA/QC Compliance**
0.93	198	67	120	**39.2%**	Yes

Table 15 CDS-4 100% MTFR Feed Rate Calibration Sample Results

CDS-4 100% MTFR Feed Rate Calibration Sample Results					
Target Concentration	**200 mg/l**	**Target Feed Rate**		**314,189 mg/min**	
Sample ID	**Sample Time (min)**	**Sample Weight (mg)**	**Sample Duration (sec)**	**Feed Rate (mg/min)**	**Calculated Influent Concentration (mg/L)**
Feed Rate 1	2.49	107412	20.25	318258	202
Feed Rate 2	6.98	102117	20.28	302121	192
Feed Rate 3	11.47	104403	20.35	307822	195
Feed Rate 4	15.96	105087	20.43	308626	196
Feed Rate 5	20.45	109563	20.72	317267	201
Feed Rate 6	24.94	105835	20.19	314517	200
			Mean	**311435**	**198**

Table 16 CDS-4 100% MTFR Background and Effluent Sample Results

CDS-4 100% of MTFR Background and Effluent Sample Results					
Sample ID	**Time (min)**	**Concentration (mg/L)**			
Background 1	2.49	2			
Background 2	6.98	6			
Background 3	11.47	10			
Background 4	15.96	9			
Background 5	20.45	13			
Background 6	24.94	11			
Background 7	29.43	13			
Background 8	31.43	14			
Note that the analytical laboratory established a limit of quantification (LOQ) for SSC of 4mg/l. Values below this threshold are reported as non detect (ND) by the laboratory. In following standard reporting practices ND values have been reported at 1/2 the LOQ which is 2mg/l for this study.					
Sample ID	**Time (min)**	**Concentration (mg/L)**	**Associated Background Concentration (mg/l)**	**Adjusted Concentration (mg/l)**	**Temperature F**
Effluent 1	2.49	101	2	99	78
Effluent 2	5.98	119	6	113	75
Effluent 3	6.98	120	7	113	74
Effluent 4	10.47	127	8	119	72
Effluent 5	11.47	127	9	118	71
Effluent 6	14.96	128	10	118	69
Effluent 7	15.96	135	10	125	69
Effluent 8	19.45	138	11	127	66
Effluent 9	20.45	132	11	121	65
Effluent 10	23.94	136	12	124	64
Effluent 11	24.94	129	12	117	63
Effluent 12	28.43	134	13	121	61
Effluent 13	29.43	143	13	130	60
Effluent 14	30.43	142	13	129	59
Effluent 15	31.43	144	13	131	59
	Mean	**130**	**10**	**120**	**67**

Table 17 CDS-4 100% MTFR QA/QC Parameters

100% of MTFR QA/QC Parameters				
Flow Rate				
Target (gpm)	Mean (gpm)	Coef. of Variance	Acceptable Parameters Target	Acceptable Parameters Coef. Of Variance
415	416.1	0.01		<0.03
Feed Rate				
Target (mg/min)	Mean (mg/min)	Coef. of Variance	Acceptable Parameter Target	Acceptable Parameters Coef. Of Variance
314189	311435	0.02		<0.1
Influent Concentration				
Target (mg/L)	Mean (mg/L)	Coef. of Variance	Acceptable Parameter Target	Acceptable Parameters Coef. Of Variance
200	198	0.02		<0.1
Background Concentration				
Low (mg/L)	High (mg/L)	Mean (mg/L)	Acceptable Threshold (mg/L)	
2	14	10	<20	

125% MTFR Results

To establish the performance of the CDS-4 at 125% MTFR a test was conducted in accordance with the criteria in the NJDEP HDS Protocol at a target flow rate of 1.16 cfs. Table 18 provides an overview of the test conditions and a summary of the results for the 125% MTFR test. The feed rate calibration sample results are provided in Table 19. Background and effluent sampling results for the trial are presented in Table 20. The CDS-4 removed 25.1% of the test sediment at an operating rate of 1.18 cfs. Each of the QA/QC parameters that pertain to sampling and flow measurement are presented in Table 21 and are in compliance with the thresholds defined in the NJDEP HDS Protocol.

Table 18 Summary of CDS-4 125% MTFR Laboratory Test

CDS-4 125% MTFR Trial Summary					
Trial Date	**Target Flow (cfs)**	**Detention Time (sec)**	**Target Sediment Concentration (mg/l)**	**Target Feed Rate (mg/min)**	**Test Duration (Min)**
18-Apr-13	1.16	40	200mg/l	392,926	27.94
Measured Values					
Mean Flow Rate (cfs)	**Mean Influent Concentration (mg/l)**	**Mean Water Temperature F**	**Mean Adjusted Effluent Concentration (mg/l)**	**Average Removal Efficiency**	**QA/QC Compliance**
1.18	207	55	155	**25.1%**	Yes

Table 19 CDS-4 125% MTFR Feed Rate Calibration Sample Results

CDS-4 125% MTFR Feed Rate Calibration Sample Results					
Target Concentration	**200 mg/l**	**Target Feed Rate**		**392926 mg/min**	
Sample ID	**Sample Time (min)**	**Sample Weight (mg)**	**Sample Duration (sec)**	**Feed Rate (mg/min)**	**Calculated Influent Concentration (mg/L)**
Feed Rate 1	1.99	140782	20.28	416515	208
Feed Rate 2	5.98	140724	20.25	416960	208
Feed Rate 3	9.97	139761	20.29	413290	207
Feed Rate 4	13.97	136840	20.25	405452	203
Feed Rate 5	17.96	136211	20.28	402991	201
Feed Rate 6	21.95	143011	19.9	431189	216
			Mean	**414400**	**207**

Table 20 CDS-4 125% MTFR Background and Effluent Sample Results

CDS-4 125% of MTFR Background and Effluent Sample Results					
Sample ID	**Time (min)**	**Concentration (mg/L)**			
Background 1	1.99	2			
Background 2	5.98	7			
Background 3	9.97	10			
Background 4	13.97	11			
Background 5	17.96	11			
Background 6	21.95	15			
Background 7	25.94	16			
Background 8	27.94	18			
Note that the analytical laboratory established a limit of quantification (LOQ) for SSC of 4mg/l. Values below this threshold are reported as non detect (ND) by the laboratory. In following standard reporting practices ND values have been reported at 1/2 the LOQ which is 2mg/l for this study.					
Sample ID	**Time (min)**	**Concentration (mg/L)**	**Associated Background Concentration (mg/l)**	**Adjusted Concentration (mg/l)**	**Temperature F**
Effluent 1	1.99	130	3	127	63
Effluent 2	4.98	137	5	132	
Effluent 3	5.98	171	6	165	
Effluent 4	8.97	145	8	137	
Effluent 5	9.97	161	9	152	
Effluent 6	12.97	174	10	164	
Effluent 7	13.97	176	11	165	
Effluent 8	16.96	171	12	159	
Effluent 9	17.96	170	13	157	
Effluent 10	20.95	174	14	160	
Effluent 11	21.95	162	15	147	52
Effluent 12	24.94	170	16	154	
Effluent 13	25.94	172	16	156	
Effluent 14	26.94	191	17	174	
Effluent 15	27.94	196	17	179	50
	Mean	**167**	**12**	**155**	**55**

Table 21 CDS-4 125% MTFR QA/QC Parameters

125% of MTFR QA/QC Parameters				
Flow Rate				
Target (gpm)	Mean (gpm)	Coef. of Variance	Acceptable Parameters Target	Acceptable Parameters Coef. Of Variance
519	528.5	0.02		<0.03
Feed Rate				
Target (mg/min)	Mean (mg/min)	Coef. of Variance	Acceptable Parameter Target	Acceptable Parameters Coef. Of Variance
392926	414400	0.02		<0.1
Influent Concentration				
Target (mg/L)	Mean (mg/L)	Coef. of Variance	Acceptable Parameter Target	Acceptable Parameters Coef. Of Variance
200	207	0.02		<0.1
Background Concentration				
Low (mg/L)	High (mg/L)	Mean (mg/L)	Acceptable Threshold (mg/L)	
2	18	11	<20	

Excluded Data/Results

The NJDEP HDS Protocol requires that any data collected as part of the testing process that is ultimately excluded from the reported results be discussed during the reporting process. No data was excluded from the datasets that make up each of the 5 qualifying test trials reported herein and ultimately used to determine the annualized weighted TSS Removal Efficiency.

During the testing process four trials were conducted at the target 125% MTFR flow condition that were not included in the qualifying data set. On 4/5/2013, a trial was executed at the target 125% MTFR, but was suspended before the completion of sampling due to a pump failure in the laboratory. On 4/9/2013, a second attempt was made to complete a 125% of MTFR test. This data was disqualified because one of the background samples exceeded the maximum allowable threshold of 20 mg/l. A third 125% MTFR trial was conducted on 4/9/2013 but deemed out of compliance because an issue with the dry feed auger resulted in average influent concentrations below 180 mg/l, which falls below the allowable range of influent concentrations. A fourth attempt to complete the 125% MTFR testing on 4/9/2013 was quickly suspended after a circuit breaker tripped, effectively disabling the laboratory in the middle of the test.

This disclosure represents the only data not otherwise reported and included in the calculations herein.

Annualized Weighted TSS Removal Efficiency

The results of TSS removal efficiency testing at 25%, 50%, 75%, 100% and 125% of a target MTFR of 0.93 cfs and reported herein were entered into the NJDEP specified annualized weighted TSS removal efficiency calculation. The results are presented in Table 22.

Testing in accordance with all of the provisions detailed in the NJDEP HDS Protocol demonstrate that the CDS-4 achieved 50.57% annualized weighted TSS removal at an MTFR of 0.93 cfs (33.2 gpm/ft^2). This testing also demonstrates that the CDS-4 exceeds the NJDEP requirement for HDS devices of demonstrating greater than 50% weighted annualized TSS Removal Efficiency at the chosen MTFR.

Table 22 Annualized Weighted TSS Removal of the CDS-4 Tested in Accordance with the NJDEP HDS Protocol at a MTFR of 0.93 cfs.

CDS-4 Annualized Weighted TSS Removal at 0.93cfs MTFR					
Tested Flow Rate as Percentage of MTFR	**Actual Tested Flow Rate (cfs)**	**Actual Percent MTFR**	**Measured Removal Efficiency**	**Annual Weighting Factor**	**Weighted Removal Efficiency**
25%	0.24	26%	67.0	0.25	16.75%
50%	0.46	49%	54.3	0.3	16.29%
75%	0.71	76%	45.7	0.2	9.14%
100%	0.93	100%	39.2	0.15	5.88%
125%	1.18	127%	25.1	0.1	2.51%
Weighted Annualized TSS Removal Efficiency					**50.57%**

4.3 Test Sediment PSD Analysis - Scour Testing

As described in Section 2.2 *Scour Test Sediment*, prior to the start of testing Contech procured a batch of scour sediment deemed compliant with the scour sediment PSD specification defined in the NJDEP HDS Protocol and had it packaged into fifty-nine 50 lb bags for delivery and storage. To ensure that the scour sediment was uniformly mixed across the entire batch, three composite samples were created and analyzed for PSD as previously described.

The results of the PSD analysis performed on the three samples are presented in Table 23 along with the mean PSD for the batch of sediment used for the scour testing. This analysis confirmed that the batch of scour test sediment procured by Contech is in compliance with the NJDEP scour test PSD specification. A visual comparison of the Contech scour sediment PSD and the NJDEP scour test PSD is provided in Figure 7.

Table 23 Results of Scour Testing Sediment Particle Size Distribution Analysis

Contech Scour Test Sediment Particle Distribution Results						
NJDEP Specifications		Contech Scour Sediment				
Particle size (um)	Percent Finer	Particle size (um)	Percent Finer Sample 1	Percent Finer Sample 2	Percent Finer Sample 3	Percent Finer Mean Contech Samples
1000	100	1000	100	100	100	100.0
500	90	500	92.1	91.77	91.22	91.7
250	55	250	56.37	55.28	54.44	55.4
150	40	150	42.15	41.13	40.38	41.2
100	25	106	31.44	30.58	29.97	30.7
75	10	75	11.41	11.08	10.97	11.2
50	0	63	1.64	1.59	1.54	1.6
		53	0	0	0	0

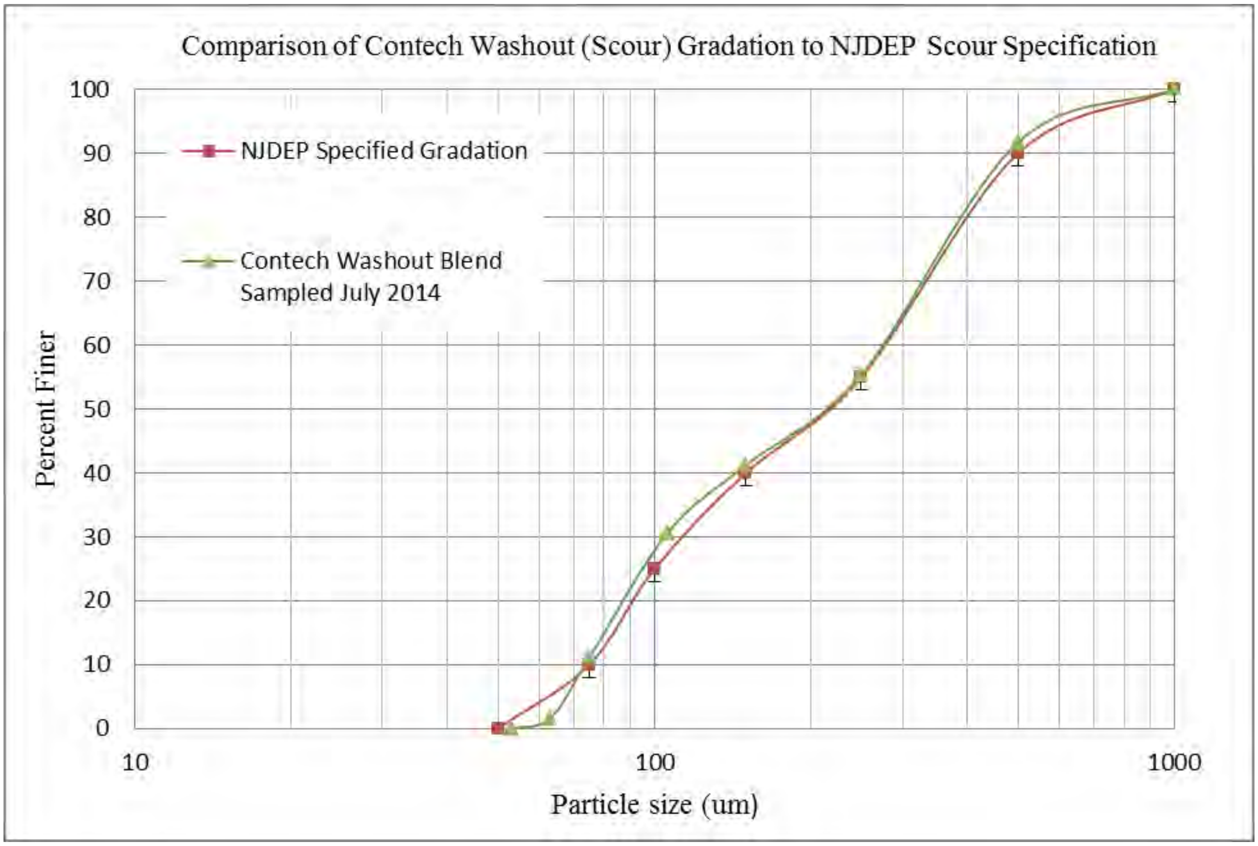

Figure 7 Comparison of Contech Scour Test Sediment PSD to NJDEP Scour Sediment PSD Specification

4.4 Scour Testing for Online Installation

In order to demonstrate the ability of the CDS to be used as an online treatment device scour testing was conducted at greater than 200% of the MTFR in accordance with the NJDEP HDS Protocol. The average flow rate during the online scour test was 838.9 gpm (1.87 cfs), which is 201% of the MTFR (MTFR = 0.93 cfs). The COV for the flow rate during the test period was 0.009, which is less than the allowable maximum COV of 0.03. The water temperature during the testing was 73 degrees. All 8 of the background samples collected during the test were reported as non-detect for suspended solids by the analytical laboratory. All non-detect values of concentration have been reported as ½ of the limit of quantification herein. The limit of quantification was calculated by the laboratory and provided in the laboratory report for each sample. Background results and sample times are provided in Table 24. All background concentrations are well below the 20 mg/l maximum for suspended solids.

Table 24 Concentrations of Background Samples during CDS Scour Testing

Sample	Sample Time (minute)	Reported Result (mg/L)	Reporting Limit (Limit of Quantification) (mg/L)	Background Concentration (mg/l)
Background 1	5	ND	2.00	1.00
Background 2	9	ND	1.98	0.99
Background 3	13	ND	2.04	1.02
Background 4	17	ND	2.00	1.00
Background 5	21	ND	1.98	0.99
Background 6	25	ND	1.98	0.99
Background 7	29	ND	2.00	1.00
Background 8	33	ND	1.98	0.99

A total of 15 effluent grab samples were collected during the testing process. The majority of effluent samples (10 of 15) were reported as non-detect by the analytical lab. The 5 remaining samples all had effluent concentrations less than 5mg/l. Non-detect values were reported at ½ the limit of quantification as calculated by the analytical laboratory. The resulting effluent concentrations were then adjusted to account for the applicable background concentration at the time the sample was collected. The applicable background sample is defined as the background sample/concentration associated with a given effluent sample based on sample time. Note that there are 15 effluent samples vs. 8 background samples as a result of effluent samples being collected more frequently. As a result, multiple effluent samples correspond to most background samples. Since background sample concentration is essentially constant throughout the test period the applicable adjustment to the effluent concentration is also consistent at ~1mg/l for all samples. The resulting effluent concentrations are all 3mg/l or less and well below the 20mg/l threshold established by the NJDEP scour protocol. All effluent sample results are presented in Table 25.

Testing at greater than 200% of the proposed MTFR for the CDS-4 with sediment preloaded in both the sedimentation sump and on top of the unit's separation slab has confirmed that previously captured sediment does not wash out and that the CDS meets the criteria for online use.

Table 25 Results of CDS-4 Online Scour Testing at 201% MTFR

Sample	Sample Time (minute)	Reported Result (mg/L)	Reporting Limit (Limit of Quantification) (mg/L)	Effluent Concentration (mg/l)	Adjusted Effluent Concentration (mg/l)
Effluent 1	5	3.33	2.38	3.33	2.33
Effluent 2	7	ND	3.08	1.54	0.54
Effluent 3	9	ND	2.86	1.43	0.43
Effluent 4	11	ND	2.67	1.34	0.34
Effluent 5	13	ND	2.63	1.32	0.32
Effluent 6	15	4.00	2.35	4.00	3.00
Effluent 7	17	ND	2.78	1.39	0.39
Effluent 8	19	2.41	2.41	2.41	1.41
Effluent 9	21	2.33	2.33	2.33	1.33
Effluent 10	23	3.15	2.25	3.15	2.15
Effluent 11	25	ND	2.44	1.22	0.22
Effluent 12	27	ND	2.38	1.19	0.19
Effluent 13	29	ND	2.90	1.45	0.45
Effluent 14	31	ND	3.17	1.59	0.59
Effluent 15	33	ND	2.33	1.17	0.17

5. Design Limitations

Contech's engineering staff typically works with the site design engineer to ensure all potential constraints are addressed during the specification process and that the CDS Stormwater Treatment System will function as intended.

Required Soil Characteristics

The CDS is an enclosed system that is typically housed within a concrete manhole. The functionality of the CDS system is not influenced by the existing soil conditions at the install location and as such the CDS system can be installed in all soil types.

Slope

It is generally not advisable to install the CDS unit on steep slopes. When the CDS is being considered on slopes exceeding 10% Contech recommends contacting their engineering staff to evaluate the design prior to specification.

Maximum Flow Rate

The MTFR is 33.2 gpm/ft^2.

Maintenance Requirements

The CDS system must be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants depends heavily on site activities. See Section 6 for a more detailed discussion of maintenance and inspection requirements.

Driving Head

The driving head required for a given CDS model at MTFR or greater flows (for online units) is typically a function of the model size and storm sewer characteristics. Contech's engineering staff consults with the design engineer on each project to ensure there will not be any adverse impacts to the hydraulic grade-line as a result of installing the CDS unit.

Installation limitations

Prior to installation Contech provides contractors detailed installation and assembly instructions and is also available to consult onsite during installation. Pick weights for CDS components are provided prior to delivery so that the contractor can secure proper equipment for lifting CDS units into place.

Configurations

CDS units can be installed online or offline. Online units are equipped with an internal bypass to convey extreme flows around the treatment chamber of the unit.

Structural Load Limitations

CDS units are typically designed for HS-20 loading (32,000 pounds per truck axle). If additional loading is expected it is advisable to contact Contech to assess loading options

Pretreatment Requirements

There are no pre-treatment requirements for the CDS Stormwater Treatment System.

Limitations in Tailwater

If tail-water is present it is important to increase the available driving head within the unit to ensure that the full MTFR is still treated prior to any internal bypass.

Depth to Seasonal High Water Table

CDS unit performance is not typically impacted by high groundwater. Occasionally, when groundwater is expected to be within several feet of finished grade it may be necessary to add a base extension to the unit to counter buoyant forces. If high groundwater is expected Contech's engineering staff can evaluate whether anti-buoyancy measures are required during the design process, but buoyancy issues are relatively uncommon for concrete manhole structures like the CDS.

6. Maintenance Plans

The CDS system must be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit, e.g., unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping will slow accumulation. Additional information on maintenance, including a simple CDS Inspection & Maintenance Log form, can be found in the CDS Inspection and Maintenance Guide – New Jersey at:
http://www.conteches.com/products/stormwater-management/treatment/cds.aspx#1822141-technical-info

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant deposition and transport may vary from year to year and regular inspections will help insure that the system is cleaned out at the appropriate time. At a minimum, inspections must be performed twice per year (i.e. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid pollutant accumulations, or in equipment wash-down areas. Additionally, installations where excessive amounts of trash are expected should be inspected more frequently.

The visual inspection must ascertain that the system components are in working order and that there are no blockages or obstructions to the inlet and/or separation screen. The inspection must also identify accumulations of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick such as a stadia rod, tape measure or other measuring instrument. If sorbent material is used for enhanced removal of hydrocarbons then the level of discoloration of the sorbent material should also be identified during inspection. Sorbent material must be replaced when it is predominantly dark in color (similar to oil). It is useful and often required as part of a permit to keep a record of each inspection.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (screen/cylinder) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained behind the screen. For units possessing a sizable depth below grade (depth to pipe), a single access point allows for both sump cleanout and access behind the screen.

The CDS system must be cleaned when the level of sediment in the sump has reached a depth of 18 inches or more to avoid exceeding the maximum 24 inch sediment depth and/or when an appreciable level of hydrocarbons and trash has accumulated. If sorbent material is used, it must be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Finer, silty particles at the top of the pile typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine if the height of the sediment pile off the bottom of the sump floor exceeds 75% (18 inches) of the total height of isolated sump.

Cleaning

Cleaning of the CDS systems should be done during dry weather conditions when no flow is entering the system. Cleanout of the CDS with a vacuum truck is generally the most effective and convenient method of excavating pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be pumped out if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, an oil or gasoline spill must be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis must be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use adsorbent pads since they are usually less expensive to dispose of than the oil/water emulsion that may be created by vacuuming the oily layer. Trash can be netted out if you wish to separate it from the other pollutants. The screen should be power washed to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure proper safety precautions. Confined Space Entry procedures need to be followed.

Disposal of all material removed from the CDS system must be done is accordance with local regulations. In many locations, disposal of evacuated sediments may be handled in the same manner as disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

7. Statements

The following signed statements from the manufacturer, third-party observer and NJCAT are required to complete the NJCAT verification process.

In addition, it should be noted that this report has been subjected to public review (e.g. stormwater industry) and all comments and concerns have been satisfactorily addressed.

STATEMENT OF THIRD PARTY OBSERVER

To: Derek Berg, Contech Engineered Solutions, Scarborough, Maine

From: Forrest Bell, FB Environmental Associates

Subject: Third Party Review Under *Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology* (NJDEP, January 25 2013)[1]

Date: September 16, 2013

cc: Cayce Dalton, FB Environmental Associates

Statement of Third Party Observer

FB Environmental has served as the third-party observer for tests performed by Contech Engineered Solutions (Contech) in March through June of 2013. The tests measured the performance of the CDS-4 hydrodynamic separator, including particle size distribution tests for the sediment used in testing. Tests were performed by Contech at their laboratory at 200 Enterprise Drive, Scarborough, Maine, to meet the standards described in *Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology* (NJDEP, January 25 2013)[1]. On March 12, 2013, we submitted a statement of our qualifications and disclosure record stating we have no conflict of interests, as required by NJCAT MTD process.

A member of our staff verified compliance with the laboratory test protocol above, and our staff member was physically present to observe the full duration of all laboratory testing. We have also reviewed the data, calculations, and conclusions associated with CDS and particle size distribution testing in the *Verification Testing Report for the CONTINUOUS DEFLECTIVE SEPARATOR (CDS®) Stormwater Treatment Device*, by Contech Engineered Solutions, dated July 1, 2013, and state that they conform to what we saw during our supervision as third-party observer.

Forrest Bell — September 16, 2013

Signed: Date

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[1] Available at http://www.nj.gov/dep/stormwater/treatment.html

CONTECH
ENGINEERED SOLUTIONS

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July 2, 2013

Dr. Richard Magee
Technical Director
New Jersey Corporation for Advanced Technology
c/o Center for Environmental Systems
Stevens Institute of Technology
One Castle Point on Hudson
Hoboken, NJ 07030

RE: 2013 Verification of the CDS Stormwater Treatment Device

Dr. Magee,
This correspondence is being sent to you in accordance with the "*Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology*" (Process Document) dated January 25, 2013. Specifically, the process document requires that manufacturers submit a signed statement confirming that all of the procedures and requirements identified in the aforementioned process document and the accompanying NJDEP HDS Laboratory Testing Protocol have been met. We believe that the testing executed at Contech's laboratory in Scarborough, ME on the CDS stormwater treatment system during the spring of 2013 under the direct supervision of FB Environmental Associates was conducted in full compliance with all applicable protocol and process criteria. Additionally, we believe that all of the required documentation of the testing and resulting performance calculations has been provided within the submittal accompanying this correspondence.

Please do not hesitate to contact me with any additional questions related to this matter.

Respectfully,

Derek M. Berg
Regulatory Manager- Stormwater

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September 15, 2013

Elizabeth Dragon
Environmental Engineer
New Jersey Department of Environmental Protection
Bureau of Nonpoint Pollution Control
401-02B, PO Box 420
Trenton, NJ 08625-0420

Derek M. Berg
CONTECH Engineered Solutions LLC
71 US Route 1, Suite F
Scarborough, ME 04074

Forrest Bell
FB Environmental Associates Inc.
97A Exchange Street, Suite 305
Portland, ME 04101

To all,

Based on my review, evaluation and assessment of the testing conducted on the Continuous Deflective Separator (CDS®) by Contech and observed by FB Environmental Associates, the test protocol requirements contained in the "New Jersey Laboratory Testing Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device" (NJDEP HDS Protocol) were met or exceeded. Specifically:

Test Sediment Feed

The mean PSD of Contech's test sediment complies with the PSD criteria established by the NJDEP HDS protocol. The Contech PSD was plotted against the NJDEP PSD specification.

The Contech sediment gradation is equivalent to or finer than the NJDEP gradation at all points along the curve. Overall, the Contech sediment blend contains more fines than the NJDEP gradation, particularly below 50 microns. The median particle size of the Contech gradation is approximately 60 microns.

Prior to the start of testing Contech procured a 2500 lbs. batch of scour sediment deemed compliant with the scour sediment PSD specification defined in the NJDEP HDS Protocol. The results of the three scour sediment PSD analysis confirmed that the batch of scour test sediment procured by Contech is in compliance with the NJDEP scour test PSD specification.

Removal Efficiency Testing

In accordance with the NJDEP HDS Protocol, removal efficiency testing was executed on the CDS-4 laboratory unit in order to establish the ability of the CDS to remove the specified test sediment at 25%, 50%, 75%, 100% and 125% of the target MTFR. Prior to the start of testing Contech reviewed existing data and decided to utilize a target MTFR of 0.93 cfs. This target was chosen based on the ultimate goal of demonstrating greater than 50% annualized weighted solids removal as defined in the NJDEP HDS Protocol. The flow rates, feed rates and influent concentration all met the Test protocol's coefficient of variance requirements and the background concentration for all five test runs never exceeded 20 mg/L.

Scour Testing

In order to demonstrate the ability of the CDS to be used as an online treatment device scour testing was conducted at greater than 200% of MTFR in accordance with the NJDEP HDS Protocol. The average flow rate during the online scour test was 1.99 cfs, which is equivalent to 214% of the MTFR (MTFR = 0.93 cfs). With the exception of one background sample and one effluent sample that both had concentrations of 4 mg/l all background and effluent samples were measured as Non Detect during the online scour testing. These results confirm that the CDS-4 did not scour at 214% MTFR and meets the criteria for online use.

Maintenance Frequency

The predicted maintenance frequency for all models is 96 months.

Sincerely,

Richard S Magee

Richard S. Magee, Sc.D., P.E., BCEE

Memorandum

August 11, 2014

To: Deborah Beck, Contech Engineered Solutions LLC

From: Dr. Chris Berger and Dr. Scott Wells

Re: NJDEP Scour Testing Results for the CDS-4

Scour testing of the Contech CDS-4 were overseen by Dr. Chris Berger during July, 2014 at the Contech Portland, Oregon laboratory. Except for the particle size analysis which was conducted by an outside laboratory, all phases of the test were observed. This included the randomized mixing of the test sediment, preloading and filling of the CDS-4, and the scour test itself. During preloading the initial sediment depths measured in the sedimentation sump and within annular area outside of the screening chamber were confirmed by the observer. The flow rates and frequency of sampling reported for the scour test were also observed and are reported accurately. The test used applicable NJCAT protocol and that their report accurately reflects the testing observed by Dr. Berger.

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August 13, 2014

Dr. Richard Magee
Technical Director
New Jersey Corporation for Advanced Technology (NJCAT)
c/o Center for Environmental Systems
Stevens Institute of Technology
One Castle Point on Hudson
Hoboken, NJ 07030

RE: Updated CDS-4 Scour Test Results

Dr. Magee,
This correspondence is to confirm that Contech has successfully completed online scour testing on a full-scale CDS-4 in full compliance with the applicable policies and procedures detailed in the "*2013 NJDEP Laboratory Protocol for Hydrodynamic Separators*". Specifically testing was limited to completion of the applicable scour testing criteria for use as an online BMP. Also, said scour testing was completed according to the additional conditions described to and agreed upon by NJCAT and the commenters that had raised concern with scour testing previously completed and reported to NJCAT for public review and comment. Please do not hesitate to contact me at any time if you need any additional information about this testing.

Respectfully,

Derek M. Berg
Regulatory Manager- Stormwater

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Hoboken, NJ 07030-0000

August 27, 2014

Lisa Schafer
Environmental Engineer
New Jersey Department of Environmental Protection
Bureau of Nonpoint Pollution Control
401-02B, PO Box 420
Trenton, NJ 08625-0420

To all,

Based on my review, evaluation and assessment of the scour retesting conducted on the Continuous Deflective Separator (CDS®) by Contech and observed by Dr. Chris Berger, a colleague of Dr. Scott Wells, from Portland State University, the scour test protocol requirements contained in the "New Jersey Laboratory Testing Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device" (NJDEP HDS Protocol) were met or exceeded. The scour retesting was conducted to address concerns raised during the public comment process that sediment that may have been deposited in the annular area outside of the screening chamber during removal efficiency testing could subsequently washout at higher flows.

During the retesting sediment meeting the NJDEP PSD scour test requirement was loaded to a depth of four inches in this annular region and the scour testing repeated. The results confirmed the earlier testing that the resulting effluent concentrations are all 3mg/l or less and well below the 20mg/l threshold established by the NJDEP scour protocol. Therefore the CDS meets the criteria for online use.

Sincerely,

Richard S. Magee

Richard S. Magee, Sc.D., P.E., BCEE

8. References

Contech 2013. *Verification Testing Report for the CONTINUOUS DEFLECTIVE SEPARATOR (CDS®) Stormwater Treatment Device.* Prepared by Contech Engineered Solutions LLC. July 1.

Contech 2014. *NJDEP Scour Testing Results for the CDS-4.* Prepared by Contech Engineered Solutions, LLC. August 1.

NJDEP 2013a. *New Jersey Department of Environmental Protection Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology.* Trenton, NJ. January 25.

NJDEP 2013b. *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device.* Trenton, NJ. January 25.

VERIFICATION APPENDIX

Introduction

- Manufacturer – Contech Engineered Solutions LLC, 9025 Centre Pointe Drive, West Chester, OH 45069. *General Phone*: 800-338-1122. *Website*: http://www.conteches.com/

- MTD – Continuous Deflective Separator (CDS®) Stormwater Treatment Device. Model numbers verified are shown in Table A-1 and Table A-2. Other CDS models (e.g. CDS3020) may be available, however only the models listed in Tables A-1 and A-2 are NJCAT verified/NJDEP certified. CDS units not listed in the Tables within the CDS-4 classification family are acceptable under the verification/certification as long as they maintain the approved hydraulic loading rate, 2400 micron screen aperture and proportional scaling to the test unit.

- TSS Removal Rate – 50%

- On-line installation

- 2400 micron perforated screen plate

- No sediment weir

Detailed Specification

- NJDEP sizing tables attached (Table A-1 and Table A-2).

- New Jersey requires that the peak flow rate of the NJWQ Design Storm event of 1.25 inch in 2 hours shall be used to determine the appropriate size for the MTD.

- Prior to installation Contech provides contractors detailed installation and assembly instructions and is also available to consult onsite during installation.

- Maximum sediment depth prior to cleaning is 12 inches

- See Contech CDS® Inspection and Maintenance Guide – New Jersey for New Jersey verified models maintenance guidance at: http://www.conteches.com/products/stormwater-management/treatment/cds.aspx#1822141-technical-info

- A hydrodynamic separator, such as CDS, cannot be used in series with another hydrodynamic separator to achieve an enhanced removal rate for total suspended solids (TSS) removal under N.J.A.C. 7:8-5.5.

Table A-1 MTFRs and Required Sediment Removal Intervals for Common CDS Models

CDS Model	Manhole Diameter (ft)	Maximum Treatment Flow Rate (cfs)	Effective Treatment Area (ft^2)	Hydraulic Loading Rate (gpm/ft^2)	50% Max Sediment Storage Volume (ft^3)	Required Sediment Removal Interval (Months)
CDS-4	4	0.93	12.6	33.2	12.6	96
CDS-5	5	1.5	19.6	33.2	19.6	96
CDS-6	6	2.1	28.3	33.2	28.3	96
CDS-8	8	3.7	50.3	33.2	50.3	96
CDS-10	10	5.8	78.5	33.2	78.5	96
CDS-12	12	8.4	113.1	33.2	113.1	96

***Sediment Removal Interval Calculated Using The "Monthly" Calculation In Section B, Appendix A of the NJDEP HDS Protocol**

****Note that in some areas CDS units are available in additional diameters. Units not listed here are sized not to exceed 33.2 gpm/ft2 of effective treatment during the peak water quality flow and maintain proper geometric proportioning to the tested CDS-4**

***** 50% Sediment Storage Capacity is equal to effective treatment area x 1ft of sediment depth. Each CDS has a 2ft deep sediment sump**

Table A-2 Dimensional Overview for Common CDS Models

CDS Model	Manhole Diameter (ft)	Treatment Chamber Depth* (ft)	Treatment Chamber Wet Volume (ft^3)	Aspect Ratio Depth/Dia**	Detention Time at MTFR (sec)	Sediment Sump Depth*** (ft)	Screen Plate Dia./Depth (ft)	50% Max Sediment Storage Volume (ft^3)	Total Wet Volume Including Sediment Sump (ft^3)
CDS-4	4	2.00	25.13	0.50	50	2	2/1.5	12.6	50.26
CDS-5	5	2.58	50.66	0.52	58	2	2.5/2	19.6	89.93
CDS-6	6	3.54	100.09	0.59	71	2	3/3	28.3	156.64
CDS-8	8	4.58	230.21	0.57	85	2	4/4	50.3	330.74
CDS-10	10	5.91	464.16	0.59	103	2	5/5	78.5	621.23
CDS-12	12	6.5	735.11	0.54	111	2	6/6	113.1	961.30

*Treatment Chamber Depth is defined as the depth below the invert to the top of the separation slab that isolates the sediment sump

**The aspect ratio of treatment chamber depth/unit diameter for the tested unit is 0.5. An aspect ratio of 0.5 or greater indicates that the treatment depth of the unit is proportional to or deeper than is required based on the diameter to depth relationship in the tested model. An aspect ratio less than 0.5 would indicate insufficient treatment chamber depth

***Each CDS model has an additional 2ft of sump depth below the separation slab to accommodate sediment accumulation that is not considered part of the treatment chamber since the area is partially isolated by a separation slab.

Rational Method Pipe-to-Pipe Calculations

249 SOUTH STREET UNIT 1 PLAINVILLE MA 02762
TEL 508 695 2221 FAX 508 695 2219 CONTACT@LEVELDG.COM LEVELDG.COM

STORM SEWER SYSTEM DESIGN (25 yr. Design Storm)
Factory Square
FRANKLIN, MA
LDG PROJ. # 1899.00

EGMEN TYPE	TIME TO INLET	TIME IN PIPE	ACCUMUL TIME	RUNOFF COEFF "C"	AREA (acres)	SUM OF AxC	ACCUMUL AxC	RAINFALL I	SYSTEM Q (cfs)	PIPE SIZE (in)	PIPE (ft) LENGTH	SLOPE (ft/ft)	Vfull (fps)	Qfull (cfs)	ROUGH. COEFF. "n"	CAPACITY CHECK
I	5.00	0.53	5.00	0.90	0.13											
				0.30	0.00											
				0.20	0.05											
						0.13	0.13	6.00	0.76	12	121	0.0050	3.79	2.98	0.0110	WITHIN CAPACITY
I	5.00	0.01	5.00	0.90	0.16											
				0.30	0.00											
				0.20	0.03											
						0.15	0.15	6.00	0.90	12	6	0.0150	6.57	5.16	0.0110	WITHIN CAPACITY
C	5.00	0.50	5.01	0.90	0.29											
				0.30	0.00											
				0.20	0.08											
						0.28	0.55	6.00	3.31	15	131	0.0050	4.40	5.40	0.0110	WITHIN CAPACITY
I	5.00	0.02	5.00	0.90	0.16											
				0.30	0.00											
				0.20	0.05											
						0.15	0.15	6.00	0.93	12	6	0.0150	6.57	5.16	0.0110	WITHIN CAPACITY
C	5.00	0.38	5.02	0.90	0.45											
				0.30	0.00											
				0.20	0.13											
						0.43	0.58	6.00	3.51	15	100	0.0050	4.40	5.40	0.0110	WITHIN CAPACITY
C	5.00	0.57	5.39	0.90	2.50											
				0.30	0.00											
				0.20	0.60											
						2.37	3.11	6.00	4.44	15	151	0.0050	4.40	5.40	0.0110	WITHIN CAPACITY

LEVEL DESIGN GROUP, LLC
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Plainville, MA 02762
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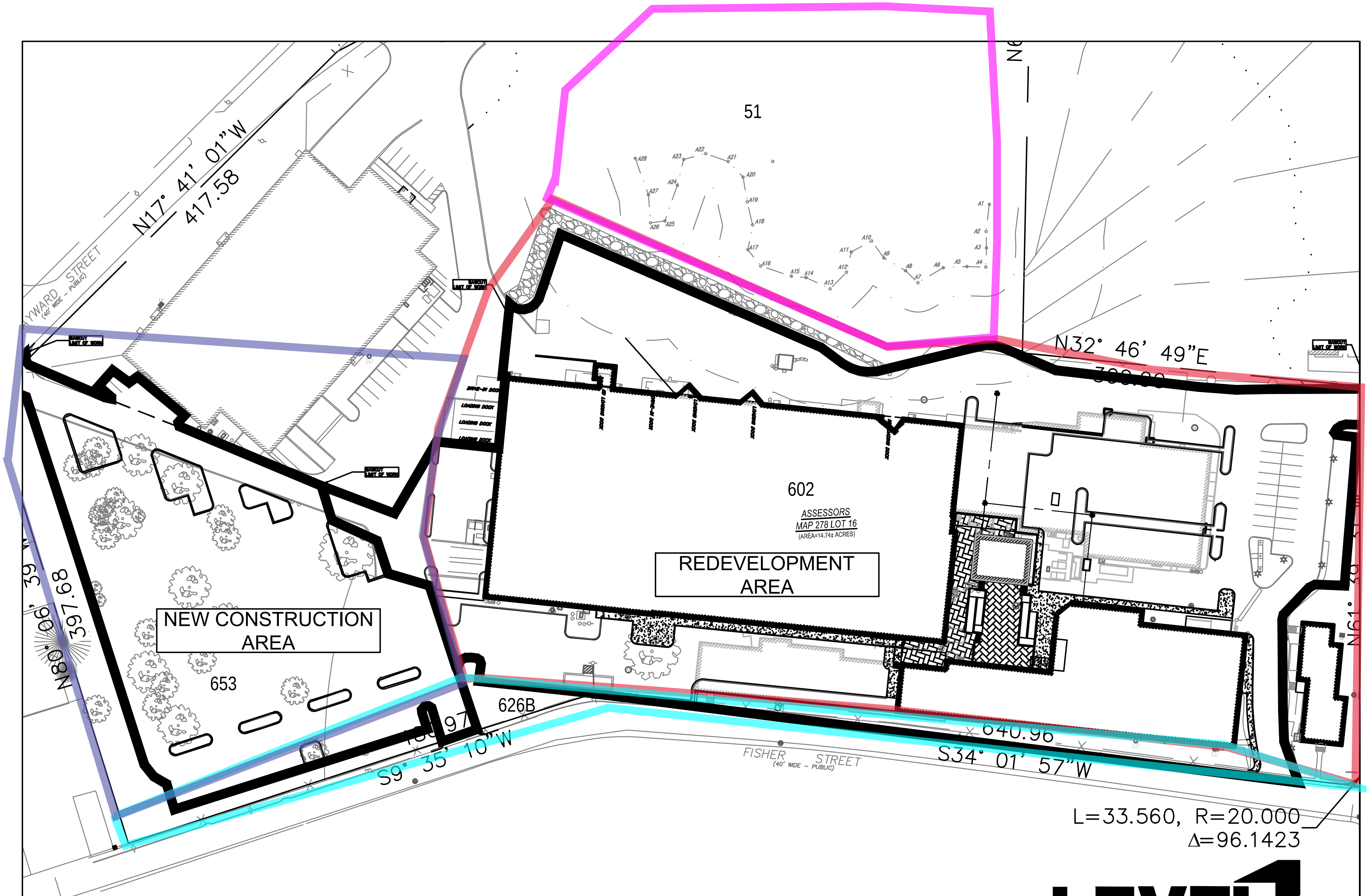
Existing Conditions – Subcatchments

249 SOUTH STREET UNIT 1 PLAINVILLE MA 02762
TEL508 695 2221 FAX508 695 2219 CONTACT@LEVELDG.COM LEVELDG.COM



LEVEL 1 DESIGN GROUP

CIVIL ENGINEERING / LAND SURVEYING

249 SOUTH STREET
UNIT 1
PLAINVILLE, MA 02762
TEL. (508) 695-2221 FAX. (508) 695-2219

DRAINAGE EXHIBIT - REDEVELOPMENT AREA AND NEW CONSTRUCTION AREA
SCALE: 1" = 120'

Proposed Conditions – Subcatchments

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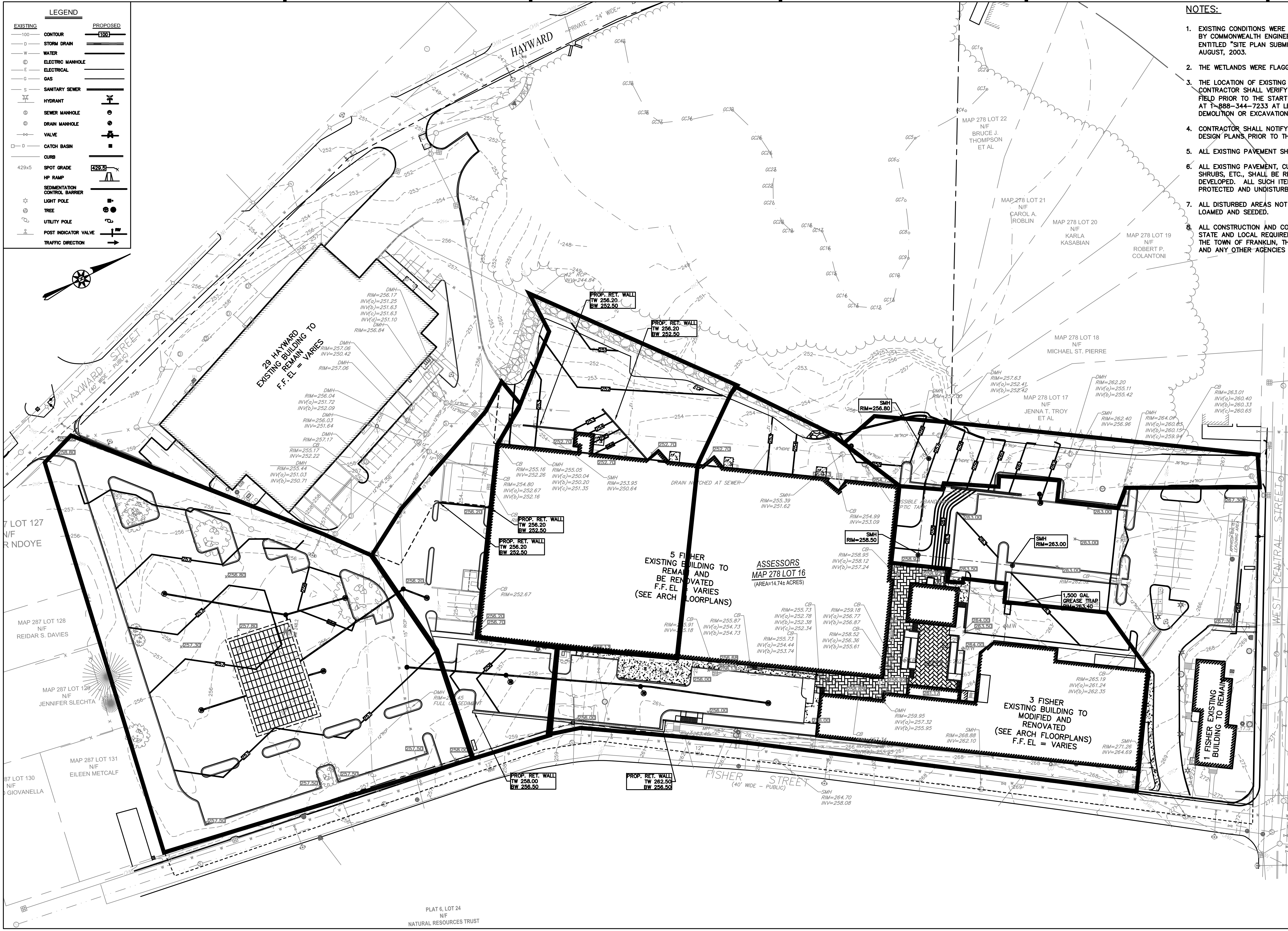

NOTES:

1. EXISTING CONDITIONS WERE OBTAINED FROM FIELD SURVEY PREPARED BY COMMONWEALTH ENGINEERS & CONSULTANTS, INC. PROVIDENCE, RI ENTITLED "SITE PLAN SUBMISSION" DATED JUNE 2, 2003 AS AMENDED AUGUST, 2003.
2. THE WETLANDS WERE FLAGGED BY GODDARD CONSULTING, JUNE 2021.
3. THE LOCATION OF EXISTING UTILITIES IS APPROXIMATE, THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL UTILITIES IN THE FIELD PRIOR TO THE START OF CONSTRUCTION. NOTIFY "DIG-SAFE" AT 1-888-344-7233 AT LEAST 72 HOURS PRIOR TO ANY SITE DEMOLITION OR EXCAVATION.
4. CONTRACTOR SHALL NOTIFY ENGINEER OF ANY DISCREPANCIES IN THE DESIGN PLANS PRIOR TO THE START OF CONSTRUCTION.
5. ALL EXISTING PAVEMENT SHALL BE SAWCUT PRIOR TO REMOVAL.
6. ALL EXISTING PAVEMENT, CURB, WALKS, UTILITIES, LIGHT POLES, TREES, SHRUBS, ETC., SHALL BE REMOVED FROM THE AREAS TO BE DEVELOPED. ALL SUCH ITEMS NOT WITHIN THE WORK AREA SHALL BE PROTECTED AND UNDISTURBED.
7. ALL DISTURBED AREAS NOT RECEIVING IMPROVEMENTS SHALL BE LOAMED AND SEEDED.
8. ALL CONSTRUCTION AND CONSTRUCTION ACTIVITIES SHALL CONFORM TO STATE AND LOCAL REQUIREMENTS. INCLUDING BUT NOT LIMITED TO THE TOWN OF FRANKLIN, THE COMMONWEALTH OF MASSACHUSETTS AND ANY OTHER AGENCIES HAVING JURISDICTION.

Not For Construction

consultant / contractor information:

LEVEL DESIGN GROUP
CIVIL ENGINEERING / LAND SURVEYING
249 SOUTH STREET
UNIT 1
PLAINVILLE, MA 02762
TEL. (508) 695-2221 FAX. (508) 695-2219

stamp:

revision	revision description	date
1	COMMENT RESPONSE	9-15-2021

project title:
FACTORY SQUARE FRANKLIN

5 FISHER STREET, FRANKLIN, MA 02038

client information:
K FISHER STREET LLC

1 FISHER STREET, FRANKLIN, MA 02038

J t A
JOE THE ARCHITECT
343 Medford Street, Suite 4C Somerville, MA 02145
t: +1(617) 764-3593 e: askjoe@joethearchitect.com
www.joethearchitect.com

drawing title
PROPOSED dRAINAGE

project number	drawing scale	approver
1899.00	1" = 40'	

drawing number	revision
D-2.0	

6/28/2021 8:25:56 AM

LEVEL
DESIGN GROUP

HydroCAD Analysis

Existing & Proposed Conditions –

2 Year Storm

10 Year Storm

25 Year Storm

100 Year Storm

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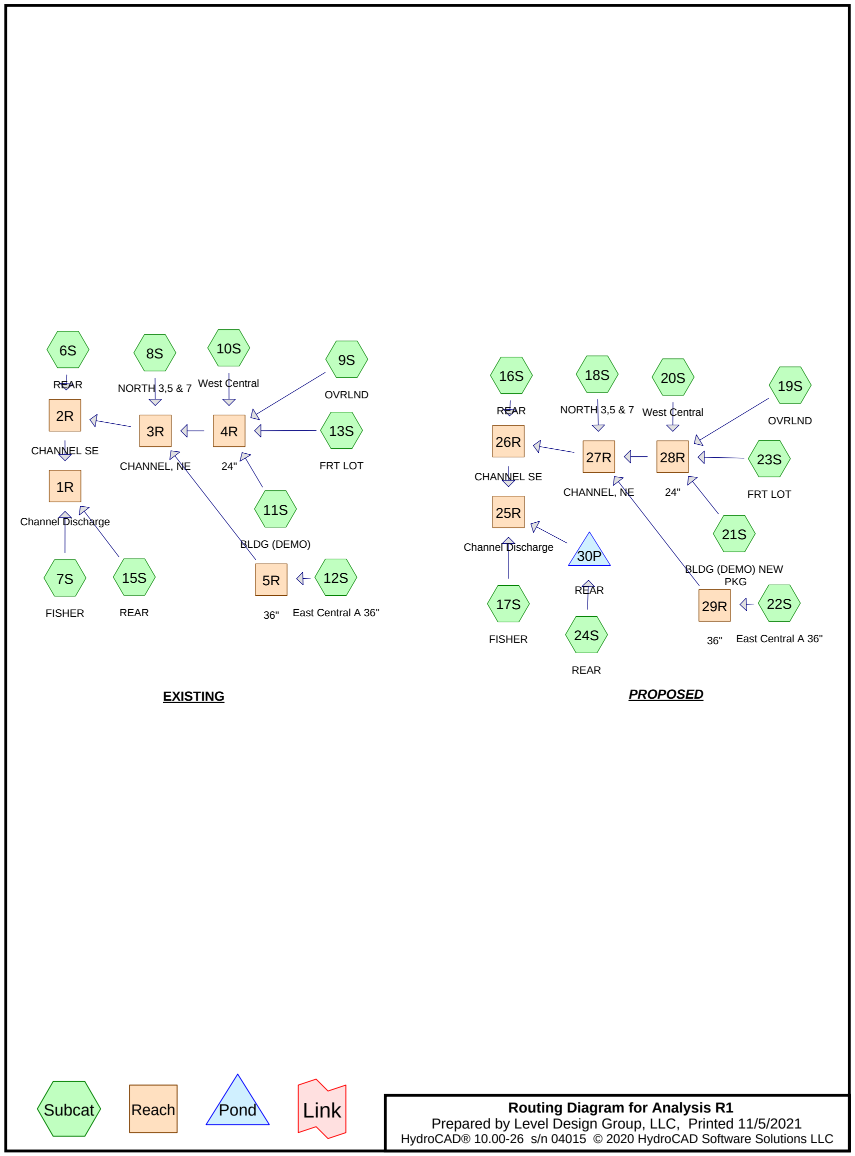


Project Notes

Rainfall events imported from "Analysis R1.hcp"

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
20.000	57	(Approximated) 1/3 acre lots, 30% imp, HSG A (12S, 22S)
0.051	49	50-75% Grass cover, Fair, HSG A (9S)
1.838	39	>75% Grass cover, Good, HSG A (13S, 16S, 18S, 19S, 21S, 23S, 24S)
22.852	98	Paved parking, HSG A (6S, 7S, 8S, 9S, 13S, 15S, 16S, 17S, 18S, 19S, 21S, 23S, 24S)
0.459	98	Paved roads w/curbs & sewers, HSG A (10S, 20S)
0.476	98	Unconnected roofs, HSG A (11S)
2.331	57	Woods/grass comb., Poor, HSG A (15S)
48.006	**77**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
48.006	HSG A	6S, 7S, 8S, 9S, 10S, 11S, 12S, 13S, 15S, 16S, 17S, 18S, 19S, 20S, 21S, 22S, 23S, 24S
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
48.006		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchr Numbers
20.000	0.000	0.000	0.000	0.000	20.000	(Approximated) 1/3 acre lots, 30% imp	
0.051	0.000	0.000	0.000	0.000	0.051	50-75% Grass cover, Fair	
1.838	0.000	0.000	0.000	0.000	1.838	>75% Grass cover, Good	
22.852	0.000	0.000	0.000	0.000	22.852	Paved parking	
0.459	0.000	0.000	0.000	0.000	0.459	Paved roads w/curbs & sewers	
0.476	0.000	0.000	0.000	0.000	0.476	Unconnected roofs	
2.331	0.000	0.000	0.000	0.000	2.331	Woods/grass comb., Poor	
48.006	**0.000**	**0.000**	**0.000**	**0.000**	**48.006**	**TOTAL AREA**	

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	1R	250.00	225.00	800.0	0.0313	0.013	48.0	0.0	0.0
2	4R	263.00	255.00	380.0	0.0211	0.015	24.0	0.0	0.0
3	5R	263.00	255.00	500.0	0.0160	0.013	36.0	0.0	0.0
4	25R	250.00	225.00	800.0	0.0313	0.013	48.0	0.0	0.0
5	28R	263.00	255.00	380.0	0.0211	0.015	24.0	0.0	0.0
6	29R	263.00	255.00	500.0	0.0160	0.013	36.0	0.0	0.0
7	30P	254.00	252.00	122.0	0.0164	0.012	12.0	0.0	0.0

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 6S: REAR Runoff Area=58,428 sf 100.00% Impervious Runoff Depth>2.79"
Tc=6.0 min CN=98 Runoff=4.09 cfs 0.312 af

Subcatchment 7S: FISHER Runoff Area=280,000 sf 100.00% Impervious Runoff Depth>2.79"
Tc=10.0 min CN=98 Runoff=17.39 cfs 1.495 af

Subcatchment 8S: NORTH 3,5 & 7 Runoff Area=81,346 sf 100.00% Impervious Runoff Depth>2.79"
Tc=6.0 min CN=98 Runoff=5.70 cfs 0.434 af

Subcatchment 9S: OVRLND Runoff Area=20,061 sf 89.03% Impervious Runoff Depth>2.33"
Tc=6.0 min CN=93 Runoff=1.26 cfs 0.089 af

Subcatchment 10S: West Central Runoff Area=10,000 sf 100.00% Impervious Runoff Depth>2.79"
Tc=6.0 min CN=98 Runoff=0.70 cfs 0.053 af

Subcatchment 11S: BLDG (DEMO) Runoff Area=20,719 sf 100.00% Impervious Runoff Depth>2.79"
Tc=6.0 min CN=98 Runoff=1.45 cfs 0.111 af

Subcatchment 12S: East Central A 36" Runoff Area=435,600 sf 30.00% Impervious Runoff Depth>0.27"
Tc=6.0 min CN=57 Runoff=1.51 cfs 0.225 af

Subcatchment 13S: FRT LOT Runoff Area=37,280 sf 50.00% Impervious Runoff Depth>0.71"
Tc=0.0 min CN=69 Runoff=0.80 cfs 0.051 af

Subcatchment 15S: REAR Runoff Area=122,723 sf 17.28% Impervious Runoff Depth>0.50"
Tc=22.0 min CN=64 Runoff=0.92 cfs 0.117 af

Subcatchment 16S: REAR Runoff Area=58,900 sf 82.55% Impervious Runoff Depth>1.89"
Tc=6.0 min CN=88 Runoff=3.12 cfs 0.213 af

Subcatchment 17S: FISHER Runoff Area=280,000 sf 100.00% Impervious Runoff Depth>2.79"
Tc=10.0 min CN=98 Runoff=17.39 cfs 1.495 af

Subcatchment 18S: NORTH 3,5 & 7 Runoff Area=86,000 sf 74.42% Impervious Runoff Depth>1.51"
Tc=6.0 min CN=83 Runoff=3.69 cfs 0.248 af

Subcatchment 19S: OVRLND Runoff Area=20,061 sf 74.08% Impervious Runoff Depth>1.51"
Tc=6.0 min CN=83 Runoff=0.86 cfs 0.058 af

Subcatchment 20S: West Central Runoff Area=10,000 sf 100.00% Impervious Runoff Depth>2.79"
Tc=6.0 min CN=98 Runoff=0.70 cfs 0.053 af

Subcatchment 21S: BLDG (DEMO) NEW Runoff Area=20,709 sf 73.41% Impervious Runoff Depth>1.44"
Tc=6.0 min CN=82 Runoff=0.85 cfs 0.057 af

Subcatchment 22S: East Central A 36" Runoff Area=435,600 sf 30.00% Impervious Runoff Depth>0.27"
Tc=6.0 min CN=57 Runoff=1.51 cfs 0.225 af

Subcatchment 23S: FRT LOT Runoff Area=37,240 sf 67.13% Impervious Runoff Depth>1.25"
Tc=0.0 min CN=79 Runoff=1.54 cfs 0.089 af

Subcatchment 24S: REAR Runoff Area=76,475 sf 91.90% Impervious Runoff Depth>2.32"
Tc=22.0 min CN=93 Runoff=3.19 cfs 0.339 af

Reach 1R: Channel Discharge Avg. Flow Depth=0.94' Max Vel=13.61 fps Inflow=30.99 cfs 2.887 af
48.0" Round Pipe n=0.013 L=800.0' S=0.0313 '/' Capacity=253.93 cfs Outflow=30.12 cfs 2.883 af

Reach 2R: CHANNEL SE Inflow=13.84 cfs 1.275 af
Outflow=13.84 cfs 1.275 af

Reach 3R: CHANNEL, NE Inflow=9.78 cfs 0.963 af
Outflow=9.78 cfs 0.963 af

Reach 4R: 24" Avg. Flow Depth=0.50' Max Vel=6.35 fps Inflow=3.95 cfs 0.304 af
24.0" Round Pipe n=0.015 L=380.0' S=0.0211 '/' Capacity=28.45 cfs Outflow=3.83 cfs 0.304 af

Reach 5R: 36" Avg. Flow Depth=0.28' Max Vel=4.57 fps Inflow=1.51 cfs 0.225 af
36.0" Round Pipe n=0.013 L=500.0' S=0.0160 '/' Capacity=84.37 cfs Outflow=1.50 cfs 0.224 af

Reach 25R: Channel Discharge Avg. Flow Depth=0.88' Max Vel=13.17 fps Inflow=27.46 cfs 2.438 af
48.0" Round Pipe n=0.013 L=800.0' S=0.0313 '/' Capacity=253.93 cfs Outflow=26.74 cfs 2.434 af

Reach 26R: CHANNEL SE Inflow=10.39 cfs 0.943 af
Outflow=10.39 cfs 0.943 af

Reach 27R: CHANNEL, NE Inflow=7.31 cfs 0.730 af
Outflow=7.31 cfs 0.730 af

Reach 28R: 24" Avg. Flow Depth=0.47' Max Vel=6.07 fps Inflow=3.41 cfs 0.257 af
24.0" Round Pipe n=0.015 L=380.0' S=0.0211 '/' Capacity=28.45 cfs Outflow=3.31 cfs 0.257 af

Reach 29R: 36" Avg. Flow Depth=0.28' Max Vel=4.57 fps Inflow=1.51 cfs 0.225 af
36.0" Round Pipe n=0.013 L=500.0' S=0.0160 '/' Capacity=84.37 cfs Outflow=1.50 cfs 0.224 af

Pond 30P: REAR Peak Elev=250.90' Storage=2,154 cf Inflow=3.19 cfs 0.339 af
Discarded=1.60 cfs 0.339 af Primary=0.00 cfs 0.000 af Outflow=1.60 cfs 0.339 af

Total Runoff Area = 48.006 ac Runoff Volume = 5.667 af Average Runoff Depth = 1.42"
37.95% Pervious = 18.219 ac 62.05% Impervious = 29.787 ac

Summary for Subcatchment 6S: REAR

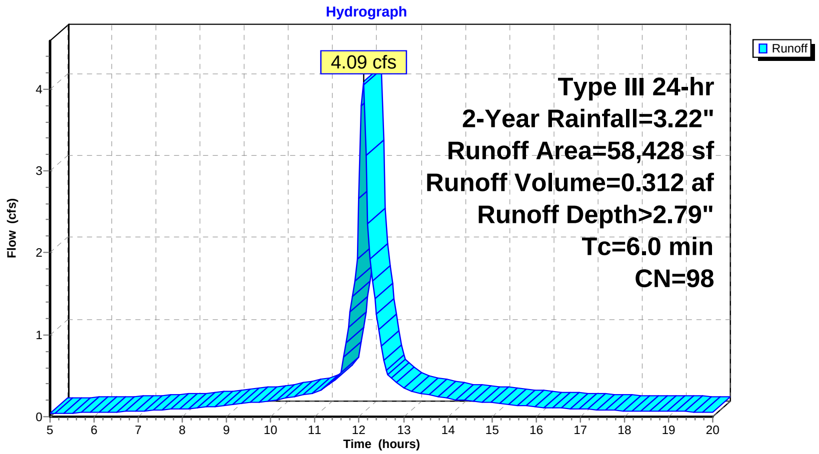
Runoff = 4.09 cfs @ 12.09 hrs, Volume= 0.312 af, Depth> 2.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
58,428	98	Paved parking, HSG A
58,428		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 6S: REAR



Summary for Subcatchment 7S: FISHER

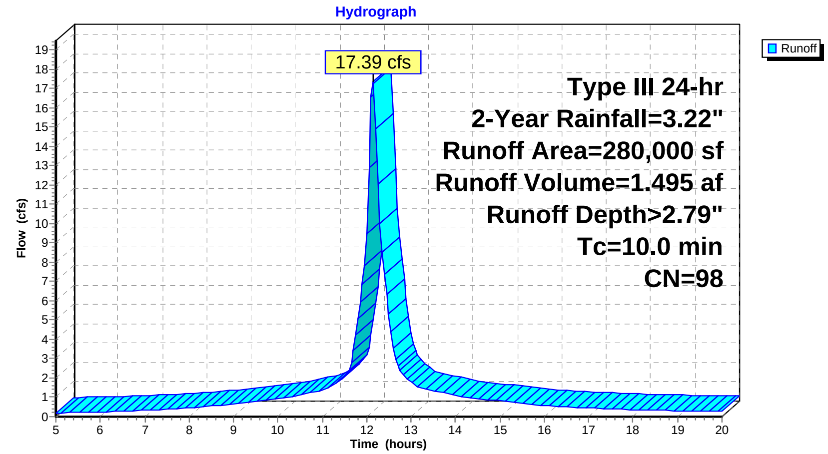
Runoff = 17.39 cfs @ 12.14 hrs, Volume= 1.495 af, Depth> 2.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
280,000	98	Paved parking, HSG A
280,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 7S: FISHER



Summary for Subcatchment 8S: NORTH 3,5 & 7

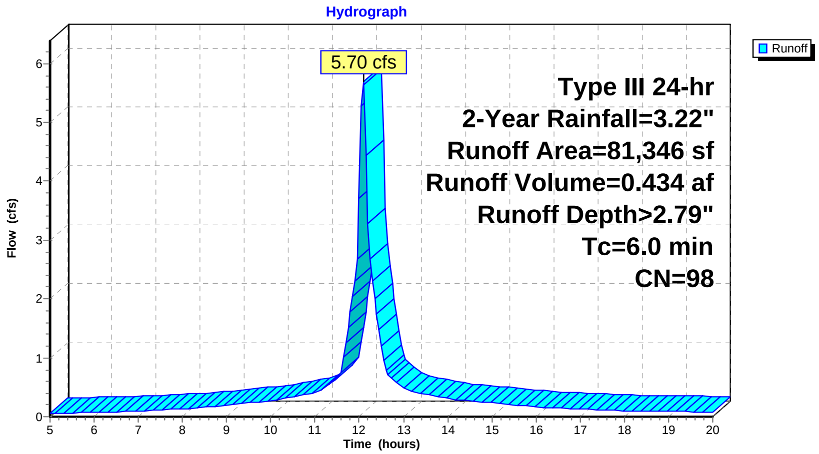
Runoff = 5.70 cfs @ 12.09 hrs, Volume= 0.434 af, Depth> 2.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
81,346	98	Paved parking, HSG A
81,346		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 8S: NORTH 3,5 & 7



Summary for Subcatchment 9S: OVRLND

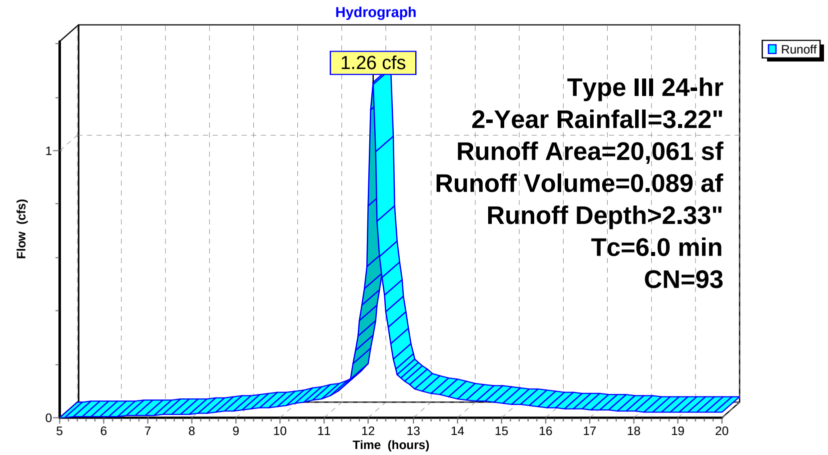
Runoff = 1.26 cfs @ 12.09 hrs, Volume= 0.089 af, Depth> 2.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
17,861	98	Paved parking, HSG A
2,200	49	50-75% Grass cover, Fair, HSG A
20,061	93	Weighted Average
2,200		10.97% Pervious Area
17,861		89.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 9S: OVRLND



Summary for Subcatchment 10S: West Central

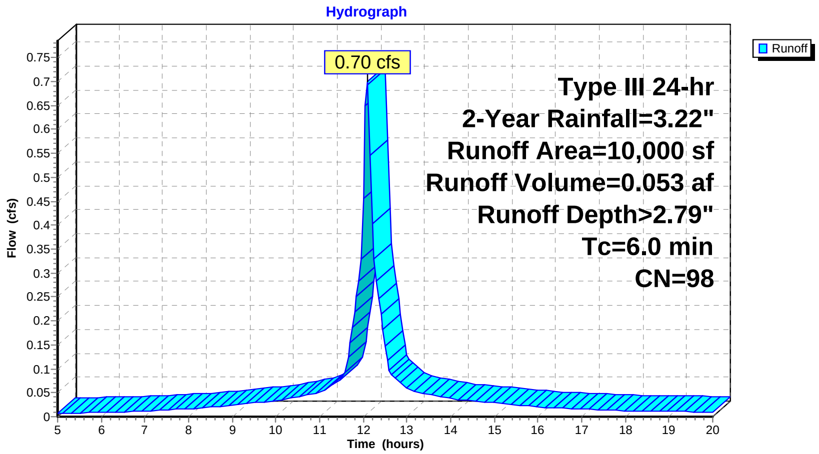
Runoff = 0.70 cfs @ 12.09 hrs, Volume= 0.053 af, Depth> 2.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
10,000	98	Paved roads w/curbs & sewers, HSG A
10,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 10S: West Central



Summary for Subcatchment 11S: BLDG (DEMO)

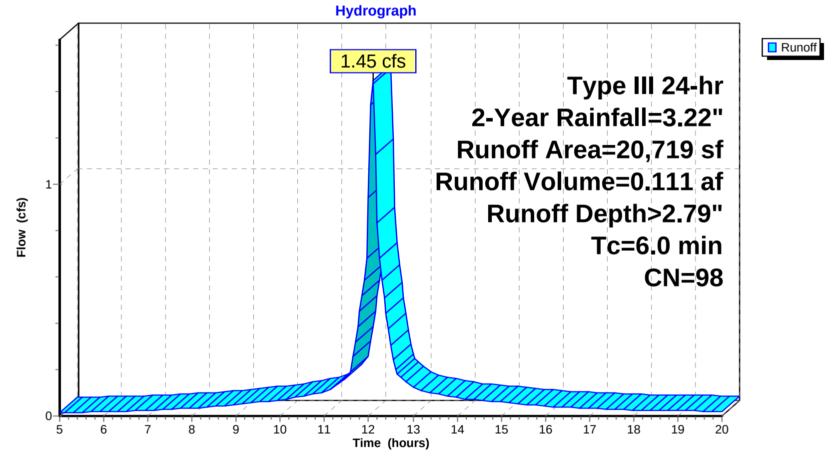
Runoff = 1.45 cfs @ 12.09 hrs, Volume= 0.111 af, Depth> 2.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
20,719	98	Unconnected roofs, HSG A
20,719		100.00% Impervious Area
20,719		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 11S: BLDG (DEMO)



Summary for Subcatchment 12S: East Central A 36"

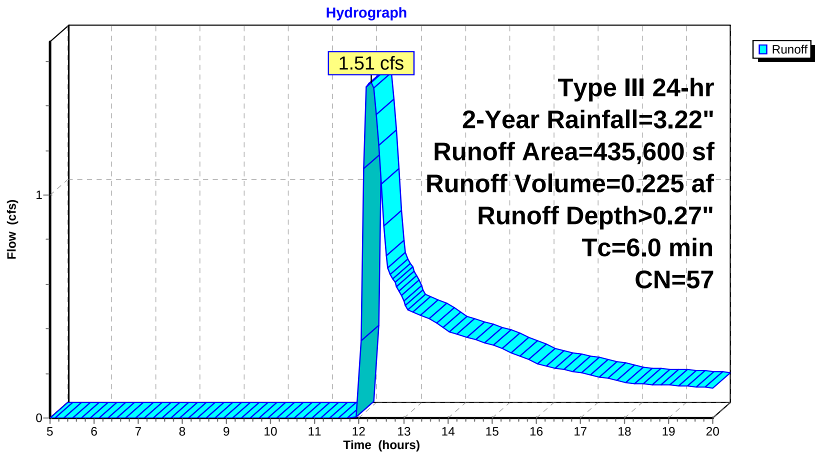
Runoff = 1.51 cfs @ 12.27 hrs, Volume= 0.225 af, Depth> 0.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

	Area (sf)	CN	Description
*	435,600	57	(Approximated) 1/3 acre lots, 30% imp, HSG A
	304,920		70.00% Pervious Area
	130,680		30.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 12S: East Central A 36"



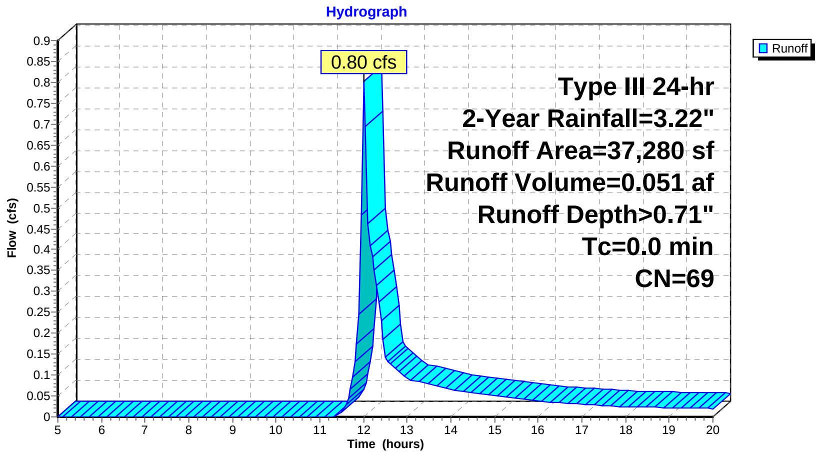
Summary for Subcatchment 13S: FRT LOT

Runoff = 0.80 cfs @ 12.01 hrs, Volume= 0.051 af, Depth> 0.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
18,640	98	Paved parking, HSG A
18,640	39	>75% Grass cover, Good, HSG A
37,280	69	Weighted Average
18,640		50.00% Pervious Area
18,640		50.00% Impervious Area

Subcatchment 13S: FRT LOT



Summary for Subcatchment 15S: REAR

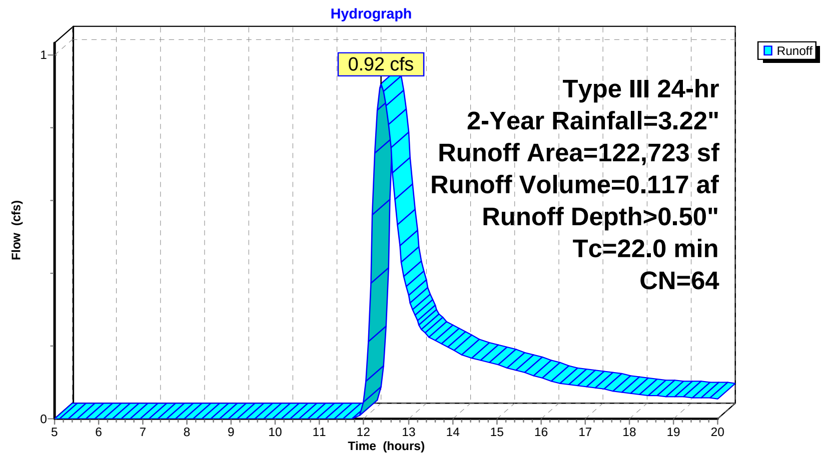
Runoff = 0.92 cfs @ 12.39 hrs, Volume= 0.117 af, Depth> 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
101,521	57	Woods/grass comb., Poor, HSG A
21,202	98	Paved parking, HSG A
122,723	64	Weighted Average
101,521		82.72% Pervious Area
21,202		17.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.0					**Direct Entry,**

Subcatchment 15S: REAR



Summary for Subcatchment 16S: REAR

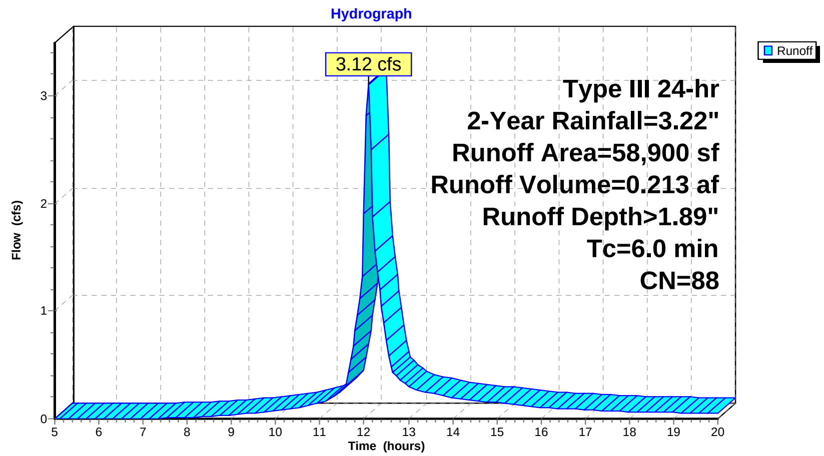
Runoff = 3.12 cfs @ 12.09 hrs, Volume= 0.213 af, Depth> 1.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
48,620	98	Paved parking, HSG A
10,280	39	>75% Grass cover, Good, HSG A
58,900	88	Weighted Average
10,280		17.45% Pervious Area
48,620		82.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 16S: REAR



Summary for Subcatchment 17S: FISHER

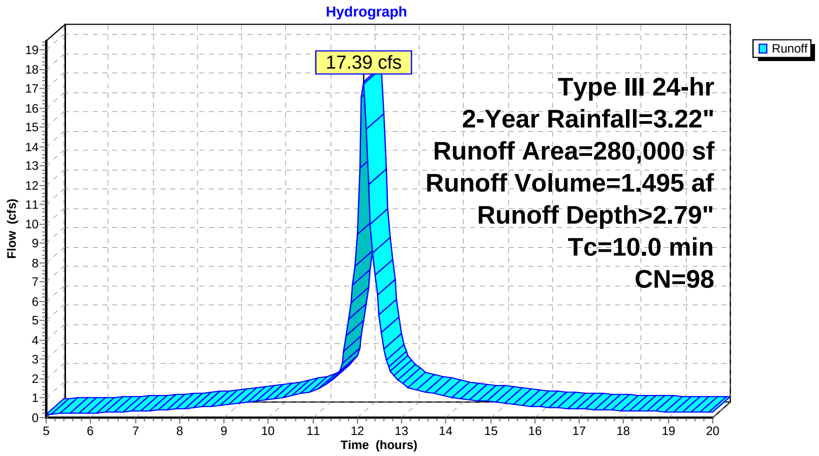
Runoff = 17.39 cfs @ 12.14 hrs, Volume= 1.495 af, Depth> 2.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
280,000	98	Paved parking, HSG A
280,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 17S: FISHER



Summary for Subcatchment 18S: NORTH 3,5 & 7

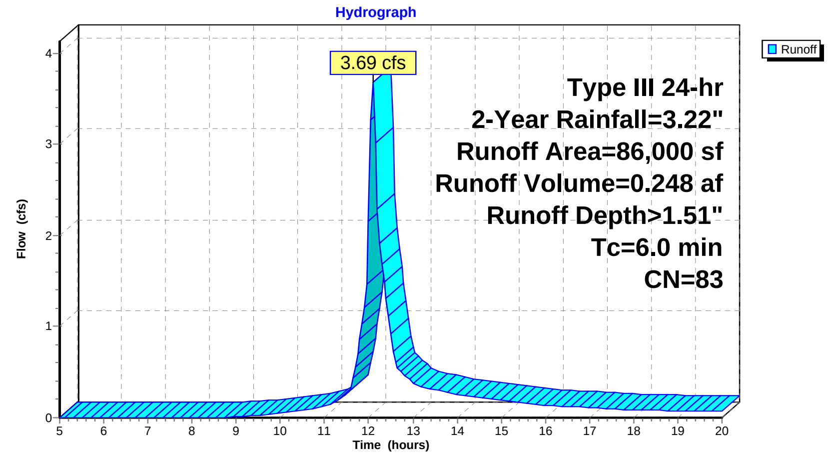
Runoff = 3.69 cfs @ 12.09 hrs, Volume= 0.248 af, Depth> 1.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
64,000	98	Paved parking, HSG A
22,000	39	>75% Grass cover, Good, HSG A
86,000	83	Weighted Average
22,000		25.58% Pervious Area
64,000		74.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 18S: NORTH 3,5 & 7



Summary for Subcatchment 19S: OVRLND

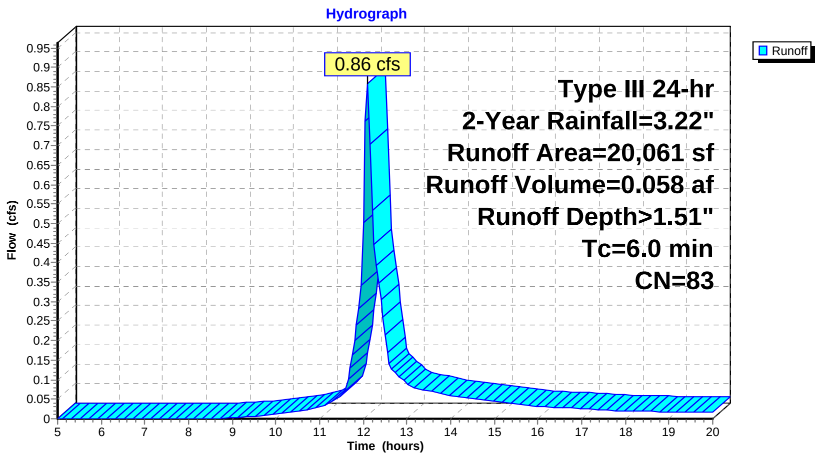
Runoff = 0.86 cfs @ 12.09 hrs, Volume= 0.058 af, Depth> 1.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
14,861	98	Paved parking, HSG A
5,200	39	>75% Grass cover, Good, HSG A
20,061	83	Weighted Average
5,200		25.92% Pervious Area
14,861		74.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 19S: OVRLND



Summary for Subcatchment 20S: West Central

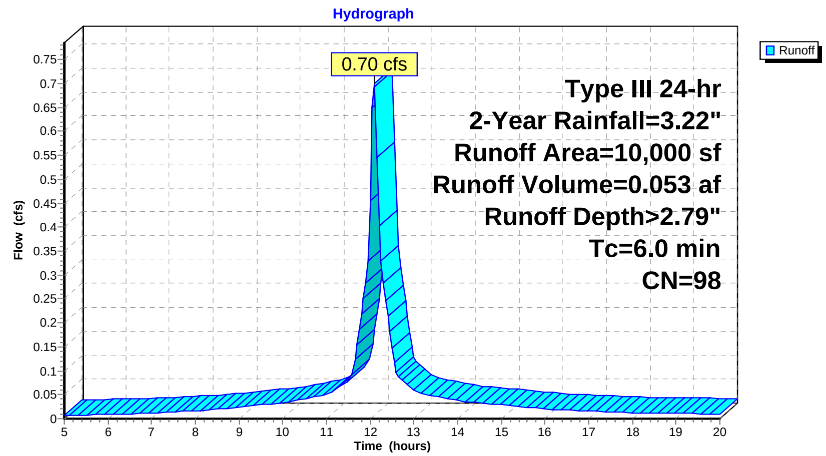
Runoff = 0.70 cfs @ 12.09 hrs, Volume= 0.053 af, Depth> 2.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
10,000	98	Paved roads w/curbs & sewers, HSG A
10,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 20S: West Central



Summary for Subcatchment 21S: BLDG (DEMO) NEW PKG

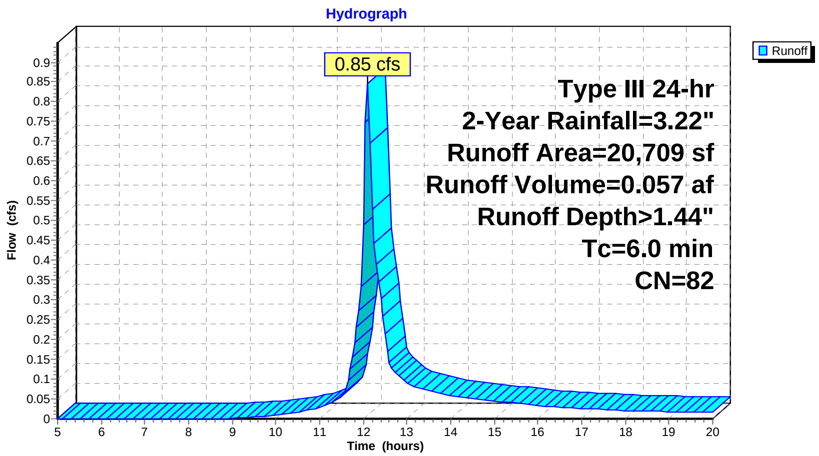
Runoff = 0.85 cfs @ 12.09 hrs, Volume= 0.057 af, Depth> 1.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
15,202	98	Paved parking, HSG A
5,507	39	>75% Grass cover, Good, HSG A
20,709	82	Weighted Average
5,507		26.59% Pervious Area
15,202		73.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 21S: BLDG (DEMO) NEW PKG



Summary for Subcatchment 22S: East Central A 36"

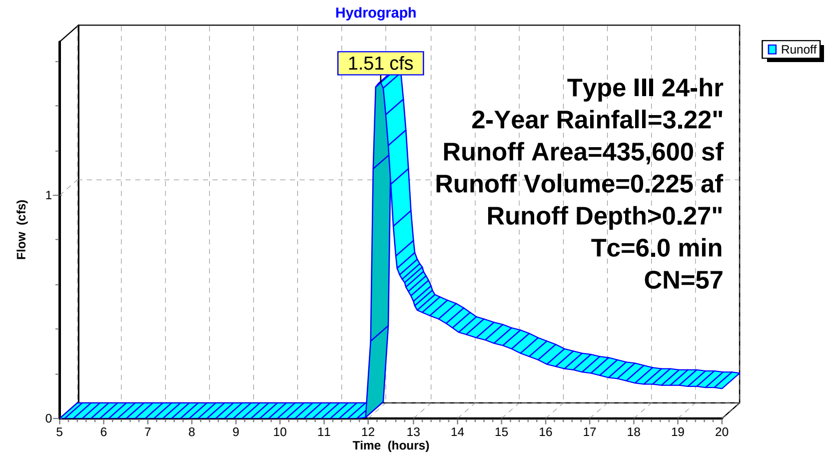
Runoff = 1.51 cfs @ 12.27 hrs, Volume= 0.225 af, Depth> 0.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

	Area (sf)	CN	Description
*	435,600	57	(Approximated) 1/3 acre lots, 30% imp, HSG A
	304,920		70.00% Pervious Area
	130,680		30.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 22S: East Central A 36"



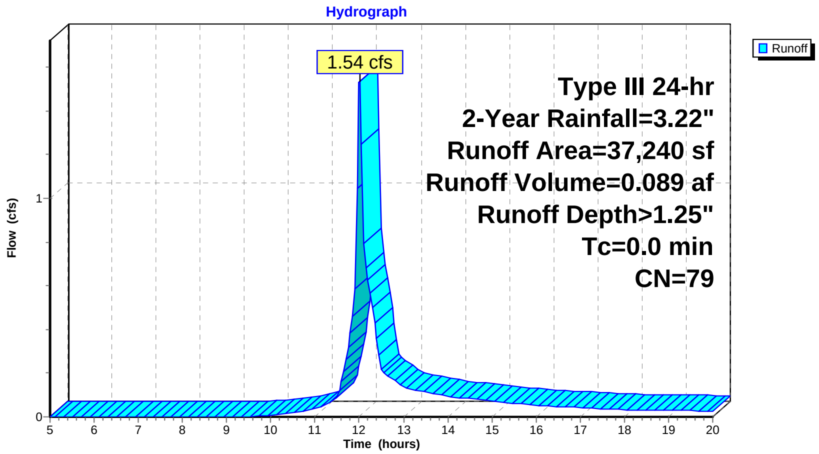
Summary for Subcatchment 23S: FRT LOT

Runoff = 1.54 cfs @ 12.01 hrs, Volume= 0.089 af, Depth> 1.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
25,000	98	Paved parking, HSG A
12,240	39	>75% Grass cover, Good, HSG A
37,240	79	Weighted Average
12,240		32.87% Pervious Area
25,000		67.13% Impervious Area

Subcatchment 23S: FRT LOT



Summary for Subcatchment 24S: REAR

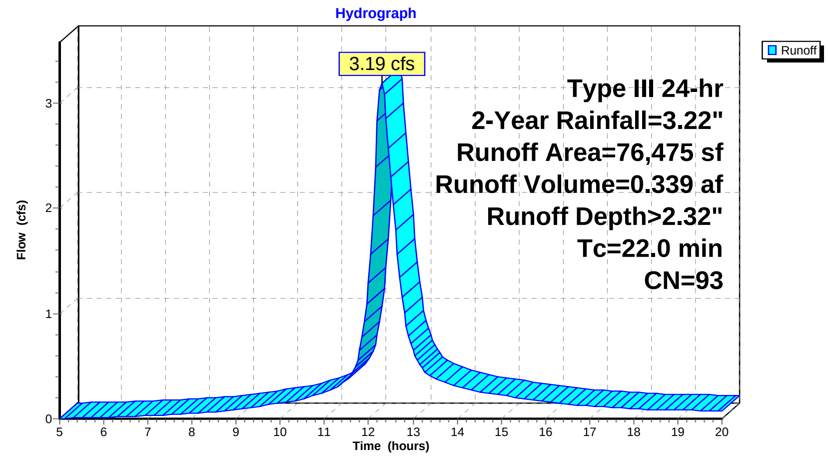
Runoff = 3.19 cfs @ 12.29 hrs, Volume= 0.339 af, Depth> 2.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
70,278	98	Paved parking, HSG A
6,197	39	>75% Grass cover, Good, HSG A
76,475	93	Weighted Average
6,197		8.10% Pervious Area
70,278		91.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.0					**Direct Entry,**

Subcatchment 24S: REAR



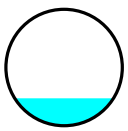
Summary for Reach 1R: Channel Discharge

Inflow Area = 24.476 ac, 59.92% Impervious, Inflow Depth > 1.42" for 2-Year event
Inflow = 30.99 cfs @ 12.12 hrs, Volume= 2.887 af
Outflow = 30.12 cfs @ 12.15 hrs, Volume= 2.883 af, Atten= 3%, Lag= 2.0 min

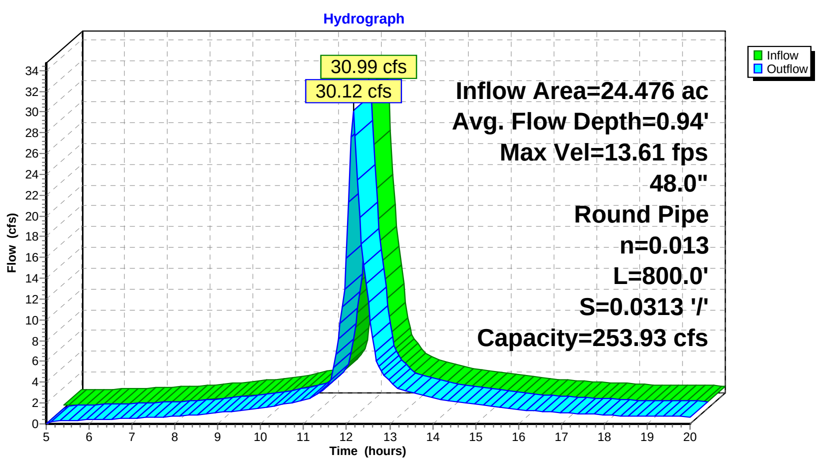
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 13.61 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 5.56 fps, Avg. Travel Time= 2.4 min

Peak Storage= 1,796 cf @ 12.13 hrs
Average Depth at Peak Storage= 0.94'
Bank-Full Depth= 4.00' Flow Area= 12.6 sf, Capacity= 253.93 cfs

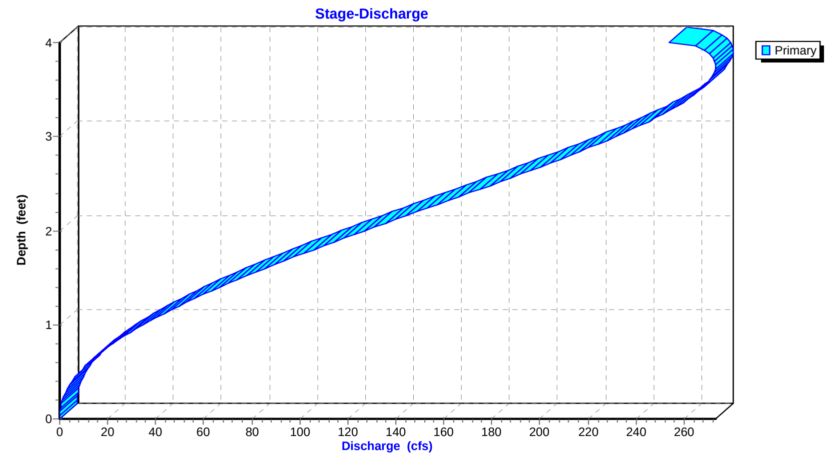
48.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 800.0' Slope= 0.0313 '/'
Inlet Invert= 250.00', Outlet Invert= 225.00'



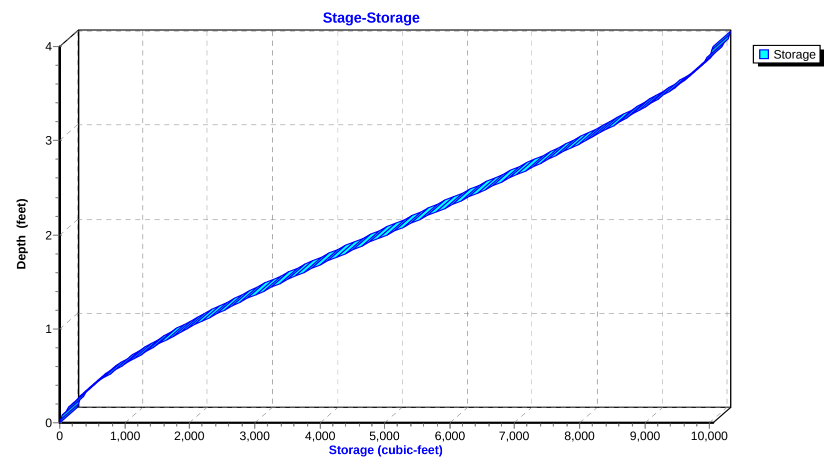
Reach 1R: Channel Discharge



Reach 1R: Channel Discharge



Reach 1R: Channel Discharge

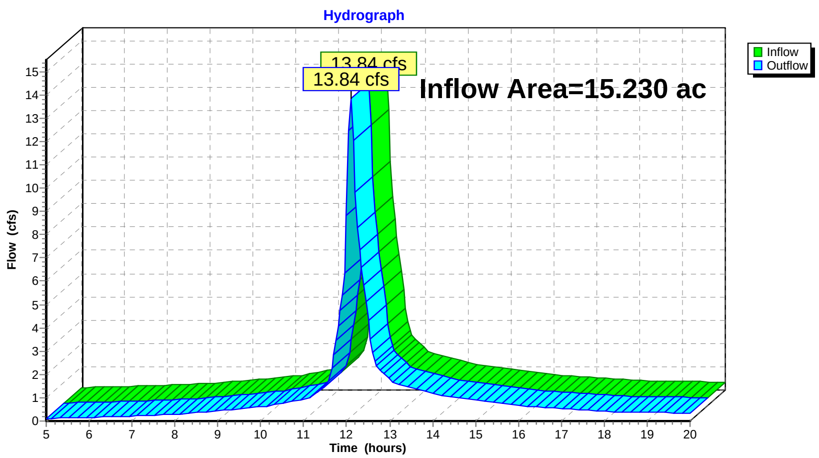


Summary for Reach 2R: CHANNEL SE

Inflow Area = 15.230 ac, 50.90% Impervious, Inflow Depth > 1.00" for 2-Year event
Inflow = 13.84 cfs @ 12.10 hrs, Volume= 1.275 af
Outflow = 13.84 cfs @ 12.10 hrs, Volume= 1.275 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 2R: CHANNEL SE

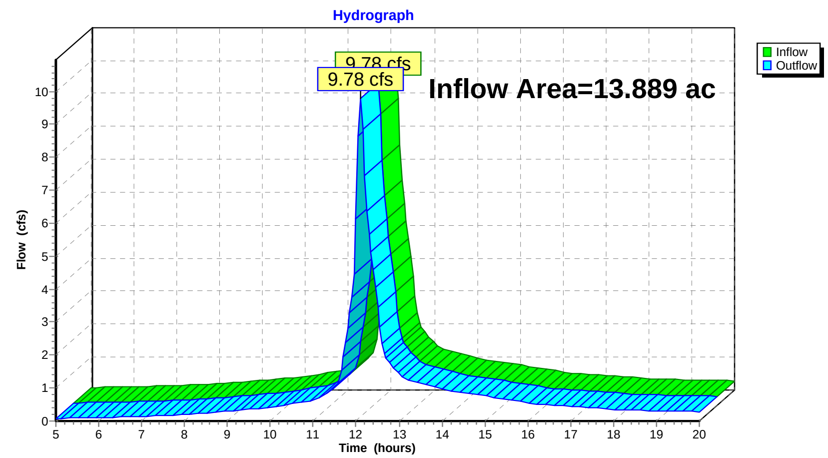


Summary for Reach 3R: CHANNEL, NE

Inflow Area = 13.889 ac, 46.16% Impervious, Inflow Depth > 0.83" for 2-Year event
Inflow = 9.78 cfs @ 12.10 hrs, Volume= 0.963 af
Outflow = 9.78 cfs @ 12.10 hrs, Volume= 0.963 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 3R: CHANNEL, NE



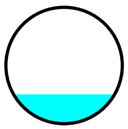
Summary for Reach 4R: 24"

Inflow Area = 2.022 ac, 76.33% Impervious, Inflow Depth > 1.81" for 2-Year event
Inflow = 3.95 cfs @ 12.07 hrs, Volume= 0.304 af
Outflow = 3.83 cfs @ 12.11 hrs, Volume= 0.304 af, Atten= 3%, Lag= 1.8 min

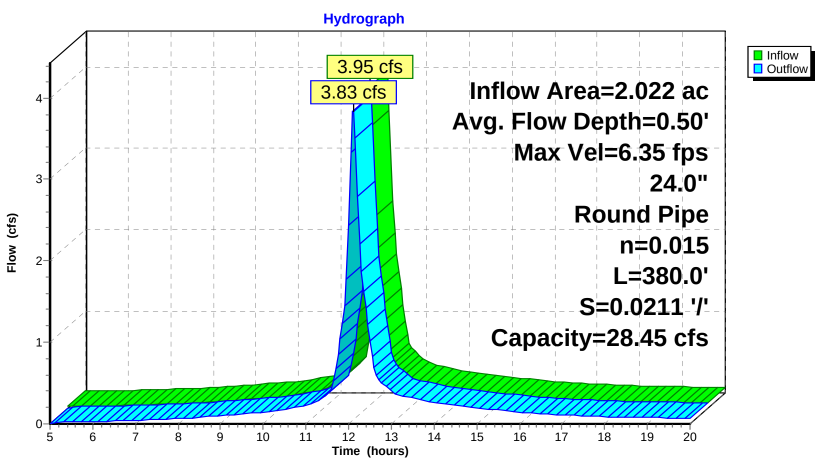
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.35 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 2.40 fps, Avg. Travel Time= 2.6 min

Peak Storage= 235 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.50'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 28.45 cfs

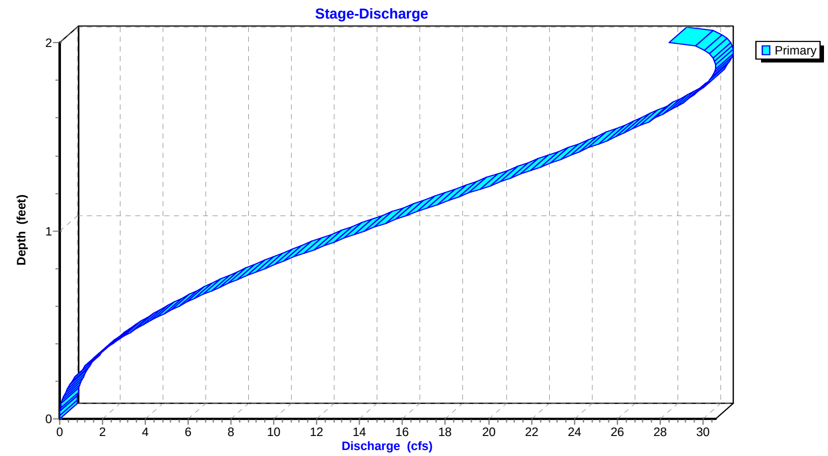
24.0" Round Pipe
n= 0.015 Concrete sewer w/manholes & inlets
Length= 380.0' Slope= 0.0211 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



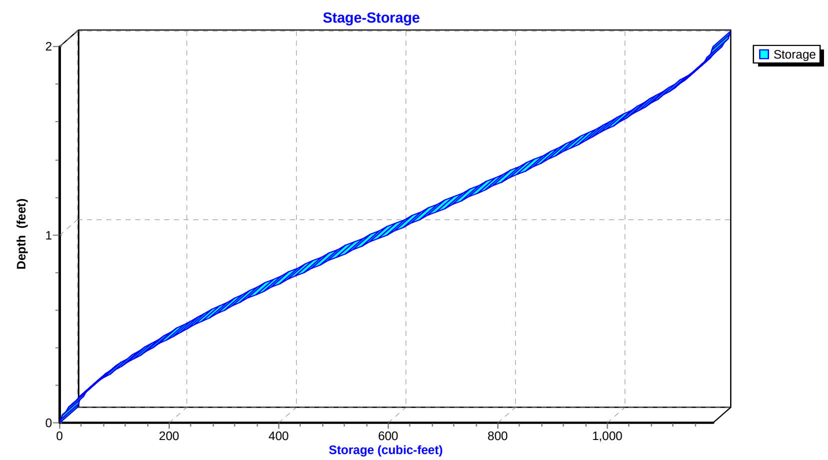
Reach 4R: 24"



Reach 4R: 24"



Reach 4R: 24"



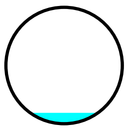
Summary for Reach 5R: 36"

Inflow Area = 10.000 ac, 30.00% Impervious, Inflow Depth > 0.27" for 2-Year event
Inflow = 1.51 cfs @ 12.27 hrs, Volume= 0.225 af
Outflow = 1.50 cfs @ 12.28 hrs, Volume= 0.224 af, Atten= 0%, Lag= 1.0 min

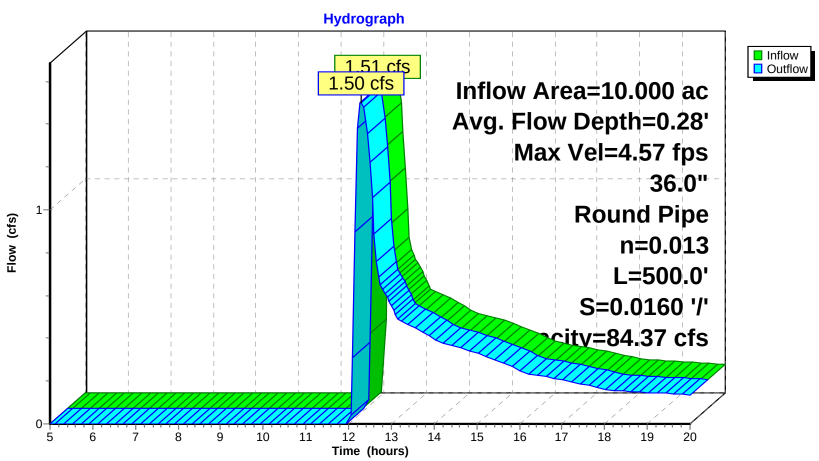
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.57 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 2.77 fps, Avg. Travel Time= 3.0 min

Peak Storage= 165 cf @ 12.30 hrs
Average Depth at Peak Storage= 0.28'
Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 84.37 cfs

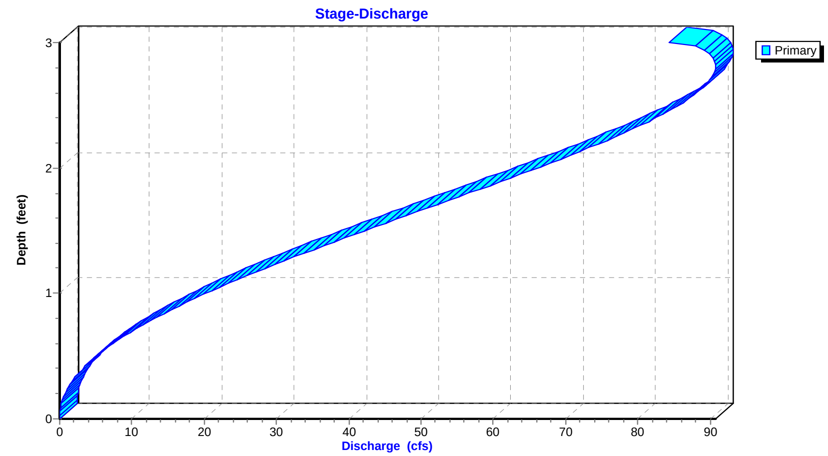
36.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0160 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



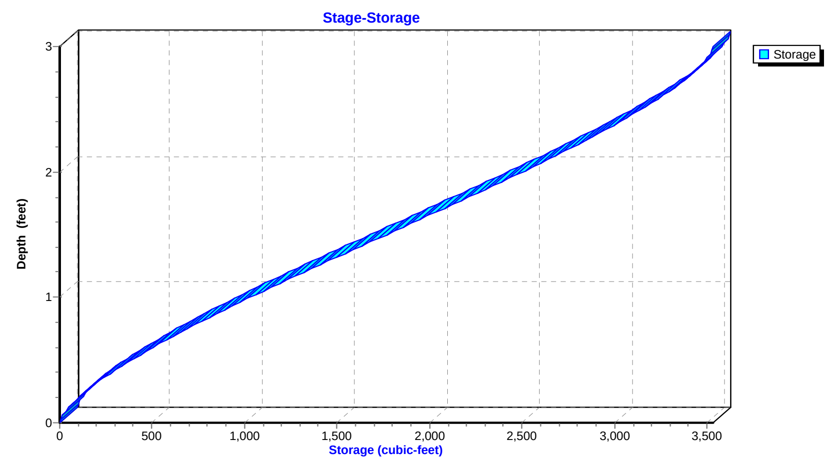
Reach 5R: 36"



Reach 5R: 36"



Reach 5R: 36"



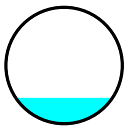
Summary for Reach 25R: Channel Discharge

Inflow Area = 23.530 ac, 64.26% Impervious, Inflow Depth > 1.24" for 2-Year event
Inflow = 27.46 cfs @ 12.12 hrs, Volume= 2.438 af
Outflow = 26.74 cfs @ 12.16 hrs, Volume= 2.434 af, Atten= 3%, Lag= 2.0 min

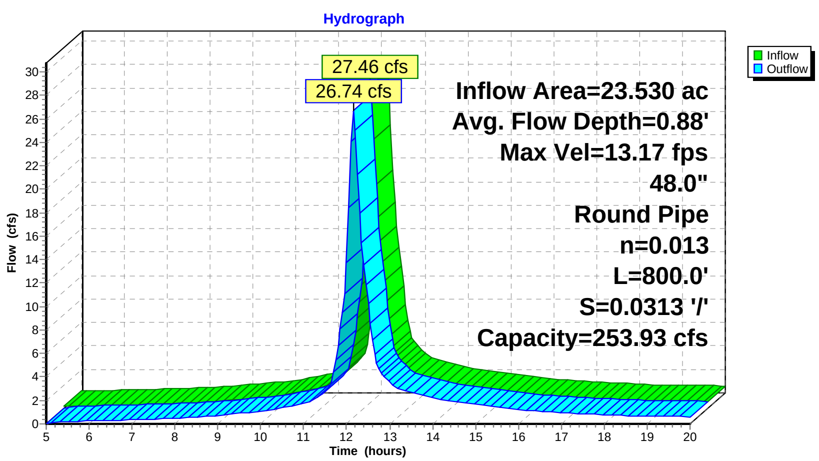
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 13.17 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 5.21 fps, Avg. Travel Time= 2.6 min

Peak Storage= 1,652 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.88'
Bank-Full Depth= 4.00' Flow Area= 12.6 sf, Capacity= 253.93 cfs

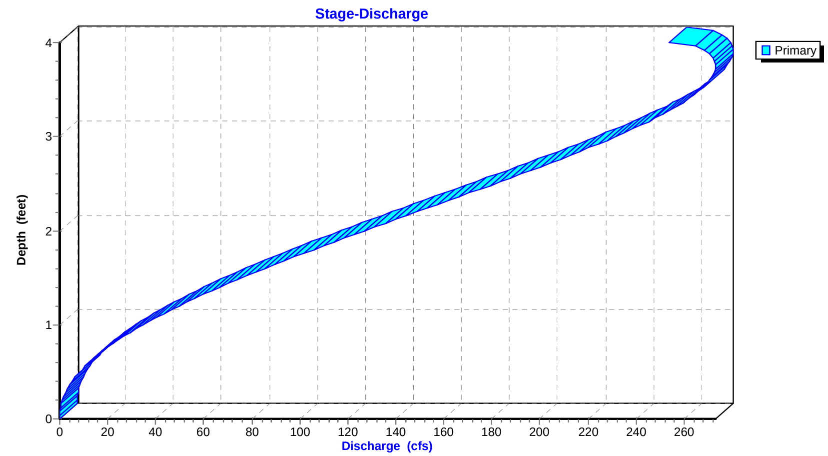
48.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 800.0' Slope= 0.0313 '/'
Inlet Invert= 250.00', Outlet Invert= 225.00'



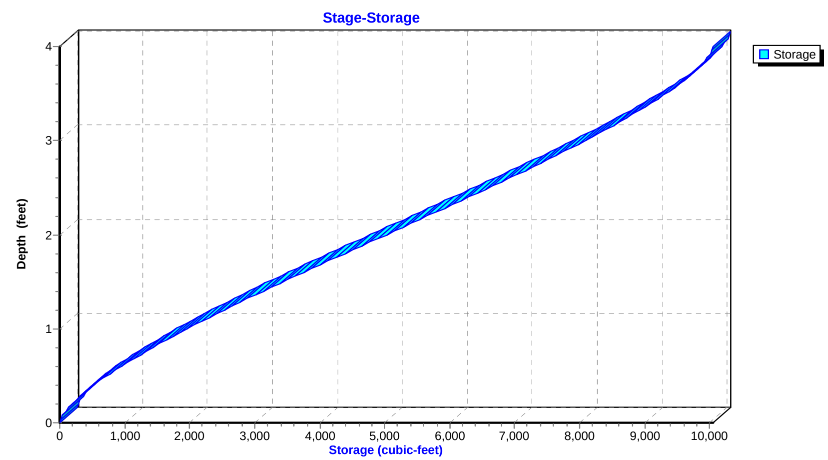
Reach 25R: Channel Discharge



Reach 25R: Channel Discharge



Reach 25R: Channel Discharge

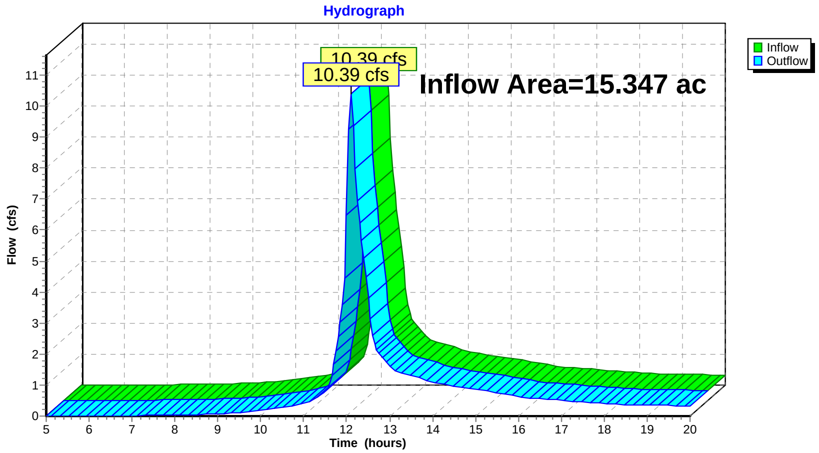


Summary for Reach 26R: CHANNEL SE

Inflow Area = 15.347 ac, 46.13% Impervious, Inflow Depth > 0.74" for 2-Year event
Inflow = 10.39 cfs @ 12.10 hrs, Volume= 0.943 af
Outflow = 10.39 cfs @ 12.10 hrs, Volume= 0.943 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 26R: CHANNEL SE

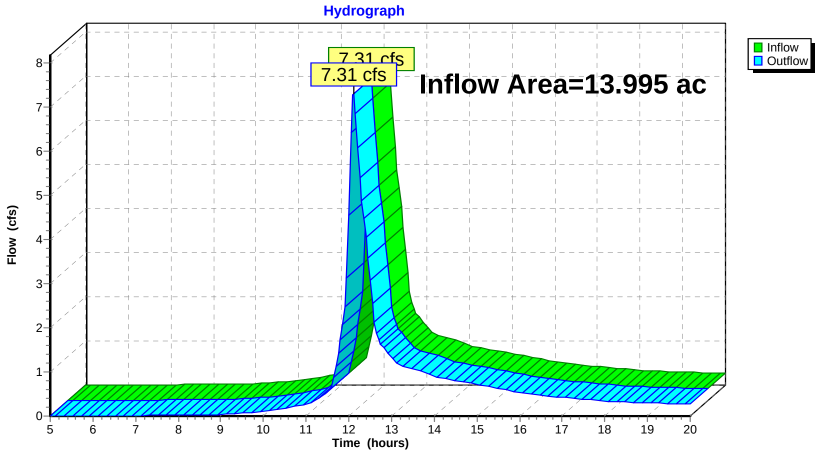


Summary for Reach 27R: CHANNEL, NE

Inflow Area = 13.995 ac, 42.61% Impervious, Inflow Depth > 0.63" for 2-Year event
Inflow = 7.31 cfs @ 12.11 hrs, Volume= 0.730 af
Outflow = 7.31 cfs @ 12.11 hrs, Volume= 0.730 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 27R: CHANNEL, NE



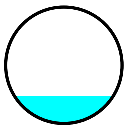
Summary for Reach 28R: 24"

Inflow Area = 2.020 ac, 73.93% Impervious, Inflow Depth > 1.53" for 2-Year event
Inflow = 3.41 cfs @ 12.06 hrs, Volume= 0.257 af
Outflow = 3.31 cfs @ 12.09 hrs, Volume= 0.257 af, Atten= 3%, Lag= 2.0 min

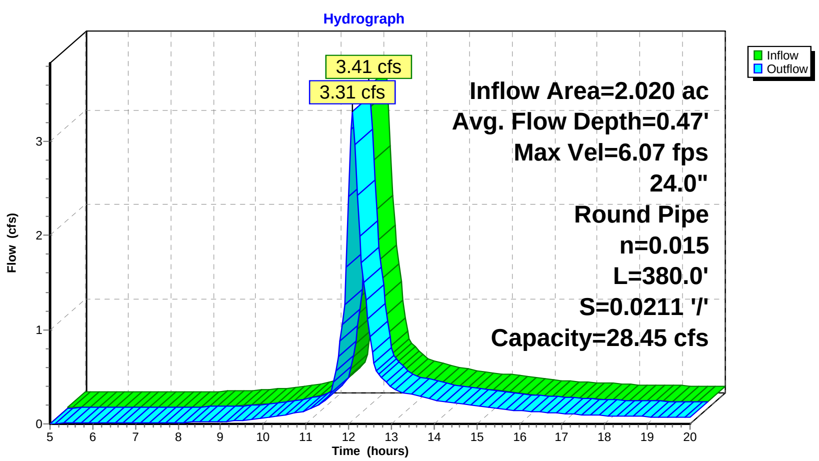
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.07 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 2.16 fps, Avg. Travel Time= 2.9 min

Peak Storage= 212 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.47'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 28.45 cfs

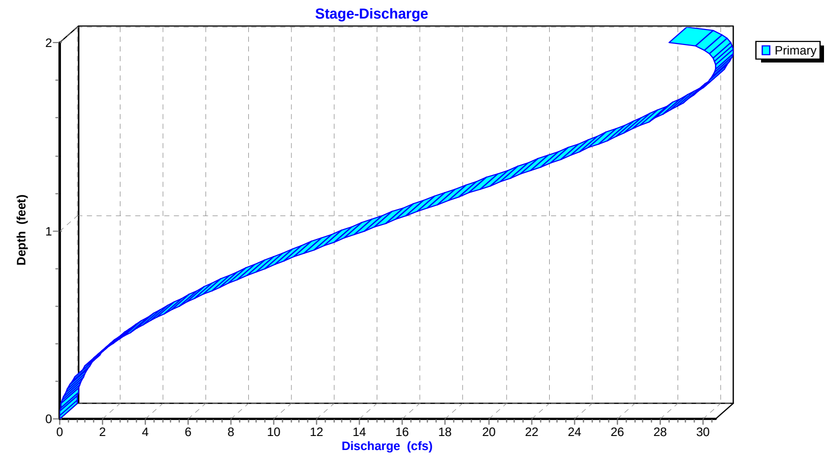
24.0" Round Pipe
n= 0.015 Concrete sewer w/manholes & inlets
Length= 380.0' Slope= 0.0211 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



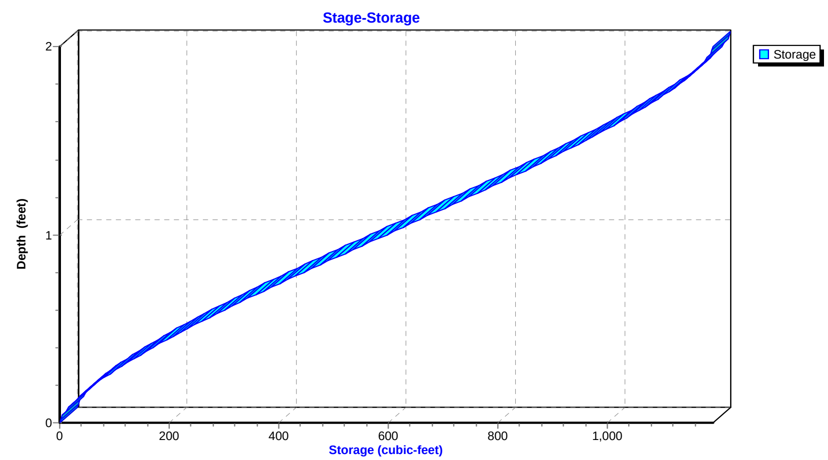
Reach 28R: 24"



Reach 28R: 24"



Reach 28R: 24"



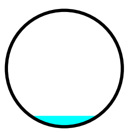
Summary for Reach 29R: 36"

Inflow Area = 10.000 ac, 30.00% Impervious, Inflow Depth > 0.27" for 2-Year event
Inflow = 1.51 cfs @ 12.27 hrs, Volume= 0.225 af
Outflow = 1.50 cfs @ 12.28 hrs, Volume= 0.224 af, Atten= 0%, Lag= 1.0 min

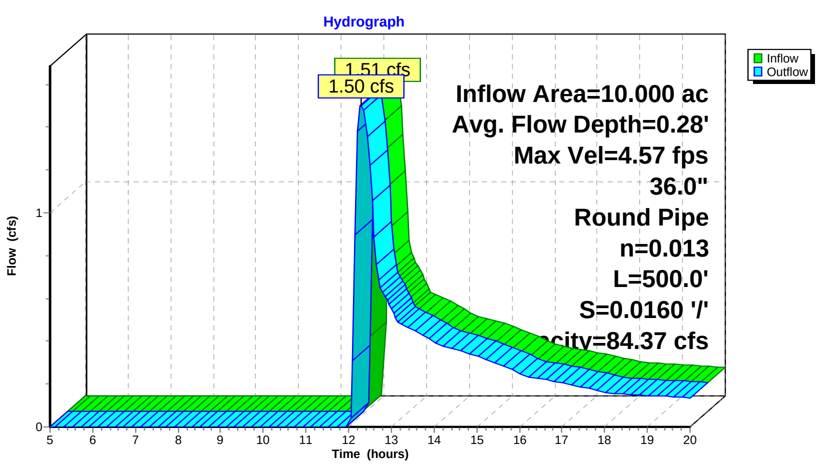
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.57 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 2.77 fps, Avg. Travel Time= 3.0 min

Peak Storage= 165 cf @ 12.30 hrs
Average Depth at Peak Storage= 0.28'
Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 84.37 cfs

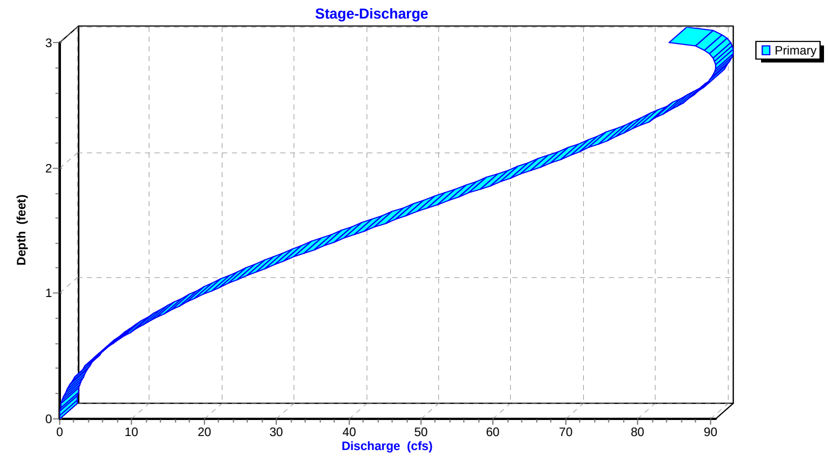
36.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0160 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



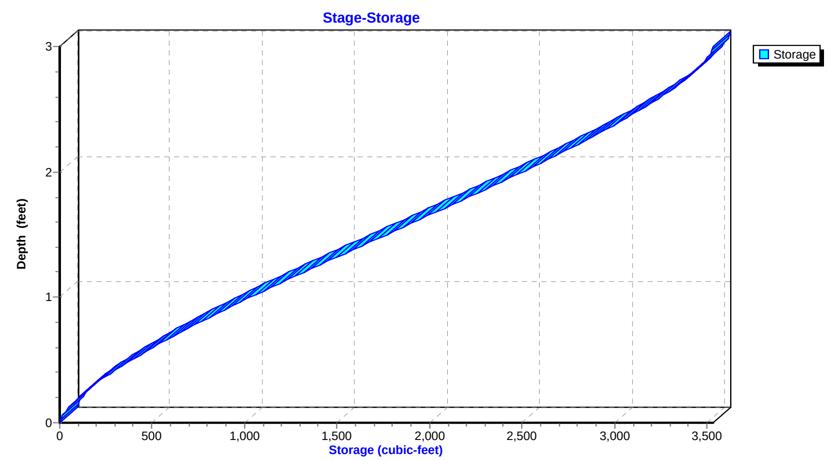
Reach 29R: 36"



Reach 29R: 36"



Reach 29R: 36"



Summary for Pond 30P: REAR

Inflow Area =	1.756 ac,	91.90% Impervious,	Inflow Depth > 2.32"	for 2-Year event	
Inflow =	3.19 cfs @	12.29 hrs,	Volume=	0.339 af	
Outflow =	1.60 cfs @	12.64 hrs,	Volume=	0.339 af,	Atten= 50%, Lag= 20.8 min
Discarded =	1.60 cfs @	12.64 hrs,	Volume=	0.339 af	
Primary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 250.90' @ 12.64 hrs Surf.Area= 7,508 sf Storage= 2,154 cf

Plug-Flow detention time= 7.7 min calculated for 0.338 af (100% of inflow)
Center-of-Mass det. time= 7.5 min (782.5 - 775.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	250.30'	6,653 cf	**68.00'W x 110.42'L x 3.50'H Field A** 26,279 cf Overall - 9,647 cf Embedded = 16,632 cf x 40.0% Voids
#2A	250.80'	9,647 cf	**ADS_StormTech SC-740 +Cap** x 210 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 210 Chambers in 14 Rows
		16,300 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	250.30'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 245.00'
#2	Primary	254.00'	**12.0" Round Culvert** L= 122.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 254.00' / 252.00' S= 0.0164 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf

Discarded OutFlow Max=1.60 cfs @ 12.64 hrs HW=250.90' (Free Discharge)
└─**1=Exfiltration** (Controls 1.60 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=250.30' (Free Discharge)
└─**2=Culvert** (Controls 0.00 cfs)

Pond 30P: REAR - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

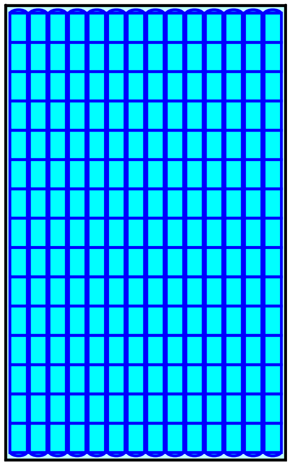
15 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 108.42' Row Length +12.0" End Stone x 2 = 110.42' Base Length
14 Rows x 51.0" Wide + 6.0" Spacing x 13 + 12.0" Side Stone x 2 = 68.00' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

210 Chambers x 45.9 cf = 9,647.4 cf Chamber Storage

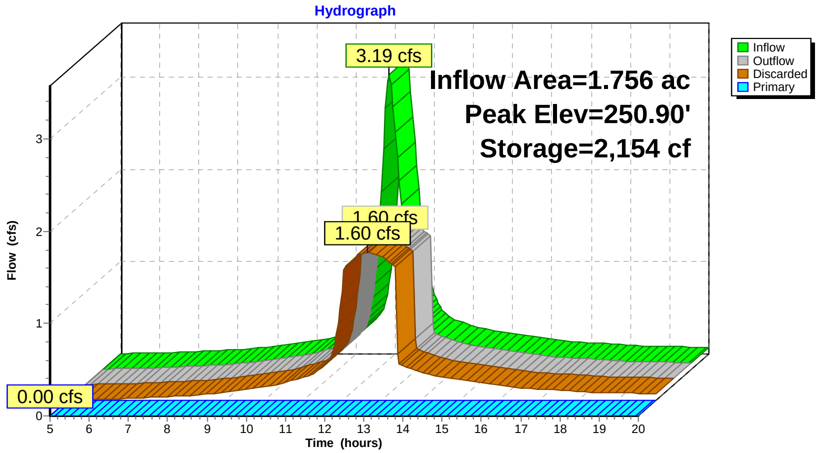
26,279.2 cf Field - 9,647.4 cf Chambers = 16,631.8 cf Stone x 40.0% Voids = 6,652.7 cf Stone Storage

Chamber Storage + Stone Storage = 16,300.1 cf = 0.374 af
Overall Storage Efficiency = 62.0%
Overall System Size = 110.42' x 68.00' x 3.50'

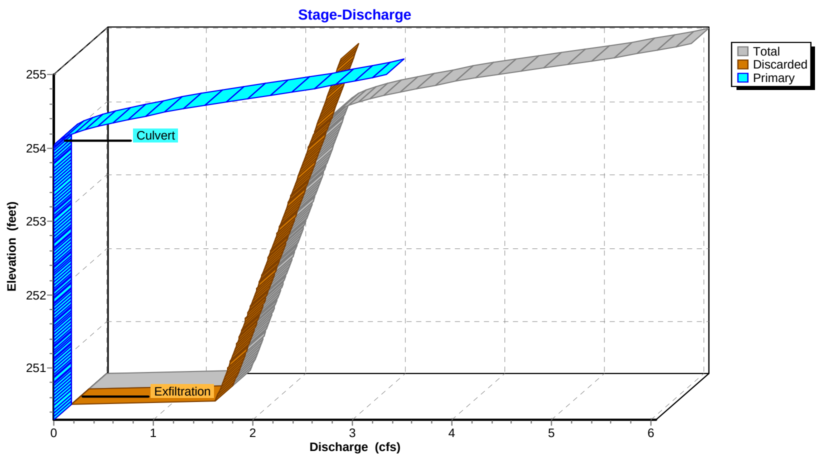
210 Chambers
973.3 cy Field
616.0 cy Stone



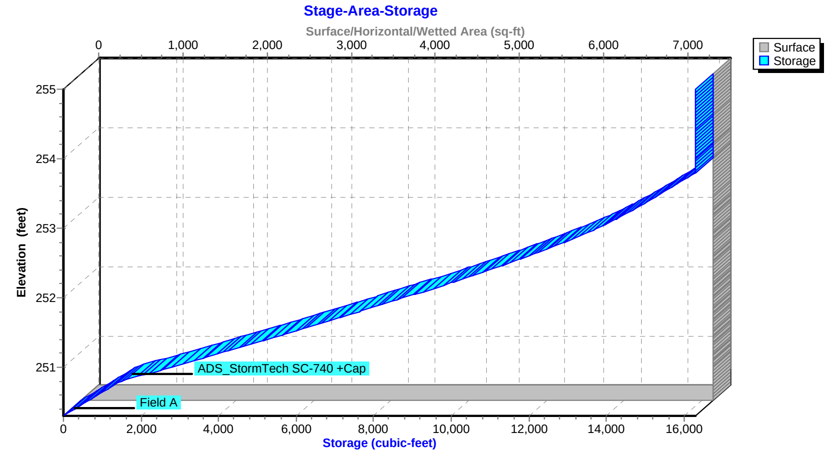
Pond 30P: REAR



Pond 30P: REAR



Pond 30P: REAR



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 6S: REAR Runoff Area=58,428 sf 100.00% Impervious Runoff Depth>4.29"
Tc=6.0 min CN=98 Runoff=6.23 cfs 0.480 af

Subcatchment 7S: FISHER Runoff Area=280,000 sf 100.00% Impervious Runoff Depth>4.29"
Tc=10.0 min CN=98 Runoff=26.44 cfs 2.298 af

Subcatchment 8S: NORTH 3,5 & 7 Runoff Area=81,346 sf 100.00% Impervious Runoff Depth>4.29"
Tc=6.0 min CN=98 Runoff=8.67 cfs 0.668 af

Subcatchment 9S: OVRLND Runoff Area=20,061 sf 89.03% Impervious Runoff Depth>3.84"
Tc=6.0 min CN=93 Runoff=2.02 cfs 0.147 af

Subcatchment 10S: West Central Runoff Area=10,000 sf 100.00% Impervious Runoff Depth>4.29"
Tc=6.0 min CN=98 Runoff=1.07 cfs 0.082 af

Subcatchment 11S: BLDG (DEMO) Runoff Area=20,719 sf 100.00% Impervious Runoff Depth>4.29"
Tc=6.0 min CN=98 Runoff=2.21 cfs 0.170 af

Subcatchment 12S: East Central A 36" Runoff Area=435,600 sf 30.00% Impervious Runoff Depth>0.92"
Tc=6.0 min CN=57 Runoff=9.91 cfs 0.768 af

Subcatchment 13S: FRT LOT Runoff Area=37,280 sf 50.00% Impervious Runoff Depth>1.71"
Tc=0.0 min CN=69 Runoff=2.09 cfs 0.122 af

Subcatchment 15S: REAR Runoff Area=122,723 sf 17.28% Impervious Runoff Depth>1.35"
Tc=22.0 min CN=64 Runoff=2.96 cfs 0.316 af

Subcatchment 16S: REAR Runoff Area=58,900 sf 82.55% Impervious Runoff Depth>3.33"
Tc=6.0 min CN=88 Runoff=5.36 cfs 0.376 af

Subcatchment 17S: FISHER Runoff Area=280,000 sf 100.00% Impervious Runoff Depth>4.29"
Tc=10.0 min CN=98 Runoff=26.44 cfs 2.298 af

Subcatchment 18S: NORTH 3,5 & 7 Runoff Area=86,000 sf 74.42% Impervious Runoff Depth>2.86"
Tc=6.0 min CN=83 Runoff=6.88 cfs 0.470 af

Subcatchment 19S: OVRLND Runoff Area=20,061 sf 74.08% Impervious Runoff Depth>2.86"
Tc=6.0 min CN=83 Runoff=1.61 cfs 0.110 af

Subcatchment 20S: West Central Runoff Area=10,000 sf 100.00% Impervious Runoff Depth>4.29"
Tc=6.0 min CN=98 Runoff=1.07 cfs 0.082 af

Subcatchment 21S: BLDG (DEMO) NEW Runoff Area=20,709 sf 73.41% Impervious Runoff Depth>2.77"
Tc=6.0 min CN=82 Runoff=1.61 cfs 0.110 af

Subcatchment 22S: East Central A 36" Runoff Area=435,600 sf 30.00% Impervious Runoff Depth>0.92"
Tc=6.0 min CN=57 Runoff=9.91 cfs 0.768 af

Subcatchment 23S: FRT LOT Runoff Area=37,240 sf 67.13% Impervious Runoff Depth>2.51"
Tc=0.0 min CN=79 Runoff=3.09 cfs 0.178 af

Subcatchment 24S: REAR Runoff Area=76,475 sf 91.90% Impervious Runoff Depth>3.82"
Tc=22.0 min CN=93 Runoff=5.13 cfs 0.559 af

Reach 1R: Channel Discharge Avg. Flow Depth=1.28' Max Vel=16.21 fps Inflow=57.01 cfs 5.049 af
48.0" Round Pipe n=0.013 L=800.0' S=0.0313 '/' Capacity=253.93 cfs Outflow=55.51 cfs 5.042 af

Reach 2R: CHANNEL SE Inflow=29.69 cfs 2.434 af
Outflow=29.69 cfs 2.434 af

Reach 3R: CHANNEL, NE Inflow=23.61 cfs 1.955 af
Outflow=23.61 cfs 1.955 af

Reach 4R: 24" Avg. Flow Depth=0.66' Max Vel=7.34 fps Inflow=6.67 cfs 0.521 af
24.0" Round Pipe n=0.015 L=380.0' S=0.0211 '/' Capacity=28.45 cfs Outflow=6.48 cfs 0.521 af

Reach 5R: 36" Avg. Flow Depth=0.69' Max Vel=7.89 fps Inflow=9.91 cfs 0.768 af
36.0" Round Pipe n=0.013 L=500.0' S=0.0160 '/' Capacity=84.37 cfs Outflow=9.37 cfs 0.766 af

Reach 25R: Channel Discharge Avg. Flow Depth=1.23' Max Vel=15.86 fps Inflow=52.71 cfs 4.389 af
48.0" Round Pipe n=0.013 L=800.0' S=0.0313 '/' Capacity=253.93 cfs Outflow=51.32 cfs 4.384 af

Reach 26R: CHANNEL SE Inflow=26.74 cfs 2.091 af
Outflow=26.74 cfs 2.091 af

Reach 27R: CHANNEL, NE Inflow=21.50 cfs 1.715 af
Outflow=21.50 cfs 1.715 af

Reach 28R: 24" Avg. Flow Depth=0.64' Max Vel=7.28 fps Inflow=6.33 cfs 0.480 af
24.0" Round Pipe n=0.015 L=380.0' S=0.0211 '/' Capacity=28.45 cfs Outflow=6.14 cfs 0.479 af

Reach 29R: 36" Avg. Flow Depth=0.69' Max Vel=7.89 fps Inflow=9.91 cfs 0.768 af
36.0" Round Pipe n=0.013 L=500.0' S=0.0160 '/' Capacity=84.37 cfs Outflow=9.37 cfs 0.766 af

Pond 30P: REAR Peak Elev=251.46' Storage=5,615 cf Inflow=5.13 cfs 0.559 af
Discarded=1.75 cfs 0.559 af Primary=0.00 cfs 0.000 af Outflow=1.75 cfs 0.559 af

Total Runoff Area = 48.006 ac Runoff Volume = 10.002 af Average Runoff Depth = 2.50"
37.95% Pervious = 18.219 ac 62.05% Impervious = 29.787 ac

Summary for Subcatchment 6S: REAR

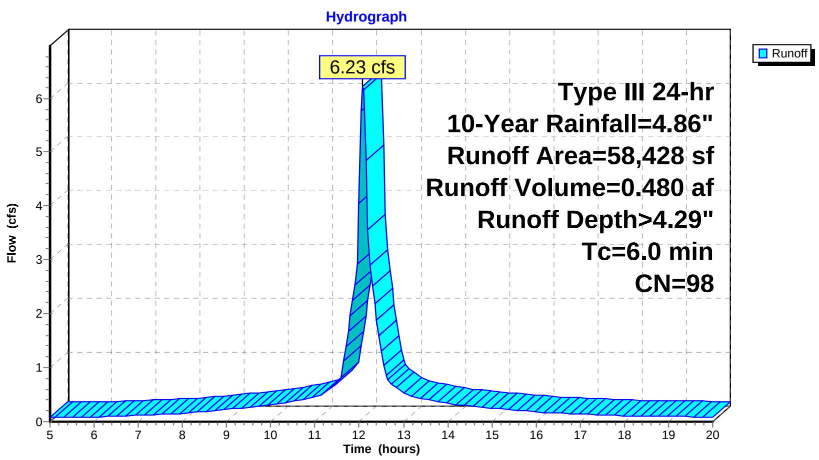
Runoff = 6.23 cfs @ 12.09 hrs, Volume= 0.480 af, Depth> 4.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
58,428	98	Paved parking, HSG A
58,428		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 6S: REAR



Summary for Subcatchment 7S: FISHER

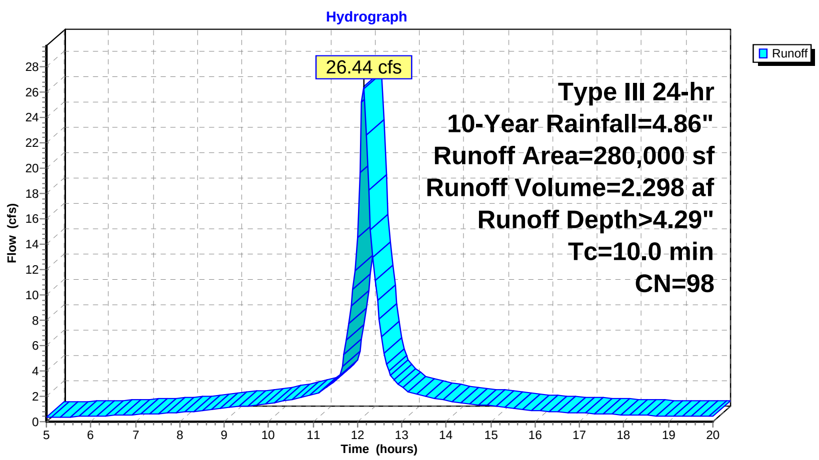
Runoff = 26.44 cfs @ 12.14 hrs, Volume= 2.298 af, Depth> 4.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
280,000	98	Paved parking, HSG A
280,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 7S: FISHER



Summary for Subcatchment 8S: NORTH 3,5 & 7

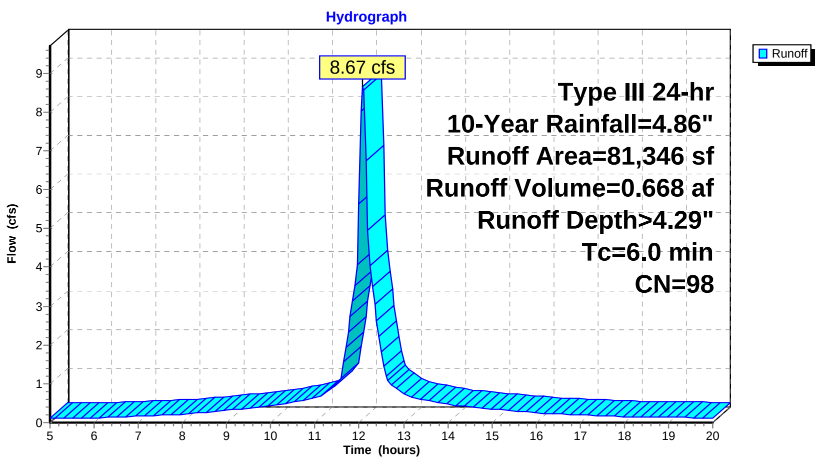
Runoff = 8.67 cfs @ 12.09 hrs, Volume= 0.668 af, Depth> 4.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
81,346	98	Paved parking, HSG A
81,346		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 8S: NORTH 3,5 & 7



Summary for Subcatchment 9S: OVRLND

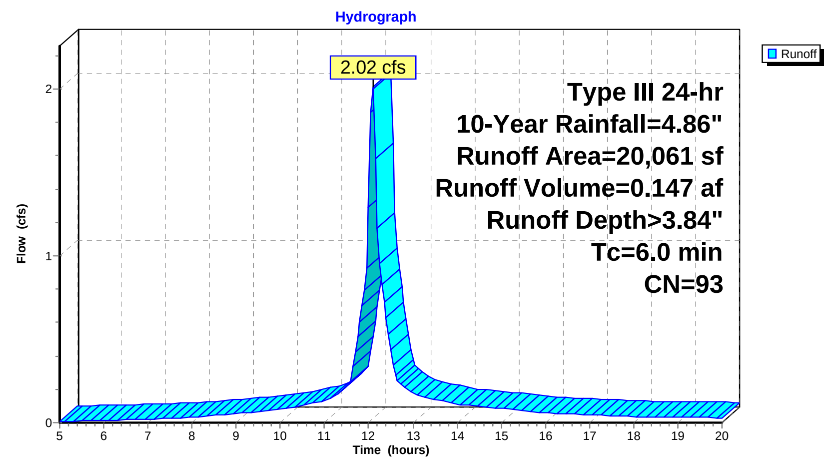
Runoff = 2.02 cfs @ 12.09 hrs, Volume= 0.147 af, Depth> 3.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
17,861	98	Paved parking, HSG A
2,200	49	50-75% Grass cover, Fair, HSG A
20,061	93	Weighted Average
2,200		10.97% Pervious Area
17,861		89.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 9S: OVRLND



Summary for Subcatchment 10S: West Central

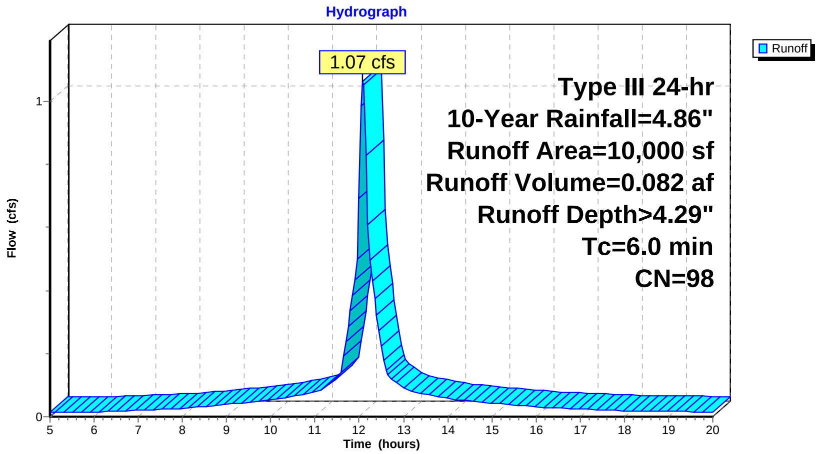
Runoff = 1.07 cfs @ 12.09 hrs, Volume= 0.082 af, Depth> 4.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
10,000	98	Paved roads w/curbs & sewers, HSG A
10,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 10S: West Central



Summary for Subcatchment 11S: BLDG (DEMO)

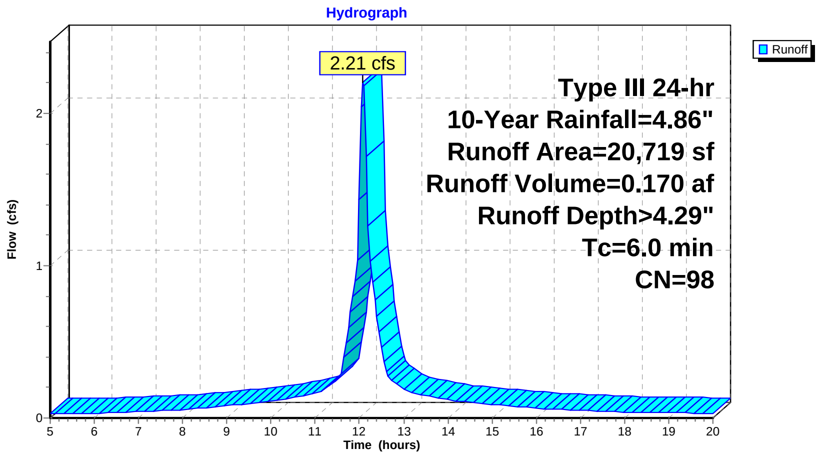
Runoff = 2.21 cfs @ 12.09 hrs, Volume= 0.170 af, Depth> 4.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
20,719	98	Unconnected roofs, HSG A
20,719		100.00% Impervious Area
20,719		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 11S: BLDG (DEMO)



Summary for Subcatchment 12S: East Central A 36"

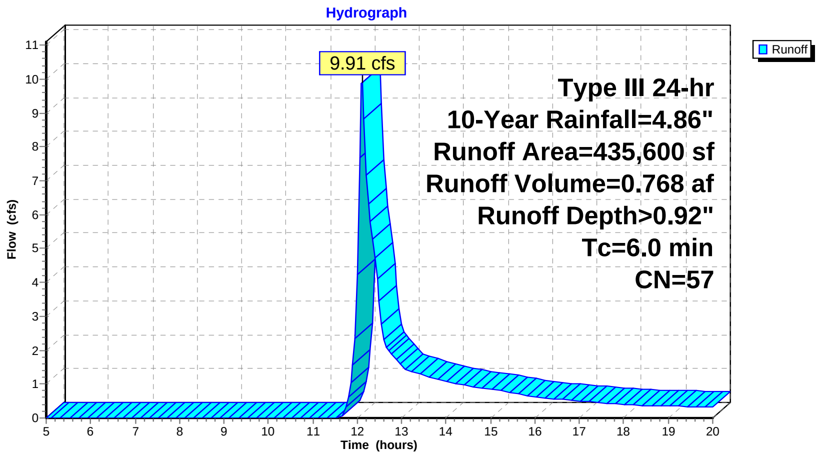
Runoff = 9.91 cfs @ 12.11 hrs, Volume= 0.768 af, Depth> 0.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

	Area (sf)	CN	Description
*	435,600	57	(Approximated) 1/3 acre lots, 30% imp, HSG A
	304,920		70.00% Pervious Area
	130,680		30.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 12S: East Central A 36"



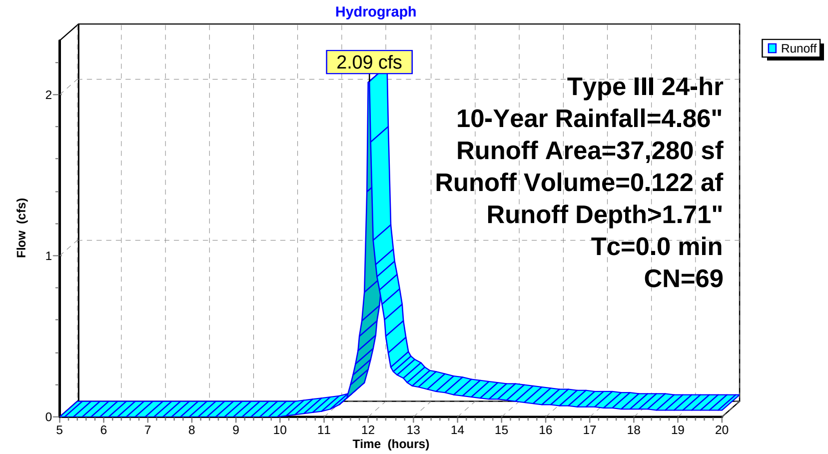
Summary for Subcatchment 13S: FRT LOT

Runoff = 2.09 cfs @ 12.01 hrs, Volume= 0.122 af, Depth> 1.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
18,640	98	Paved parking, HSG A
18,640	39	>75% Grass cover, Good, HSG A
37,280	69	Weighted Average
18,640		50.00% Pervious Area
18,640		50.00% Impervious Area

Subcatchment 13S: FRT LOT



Summary for Subcatchment 15S: REAR

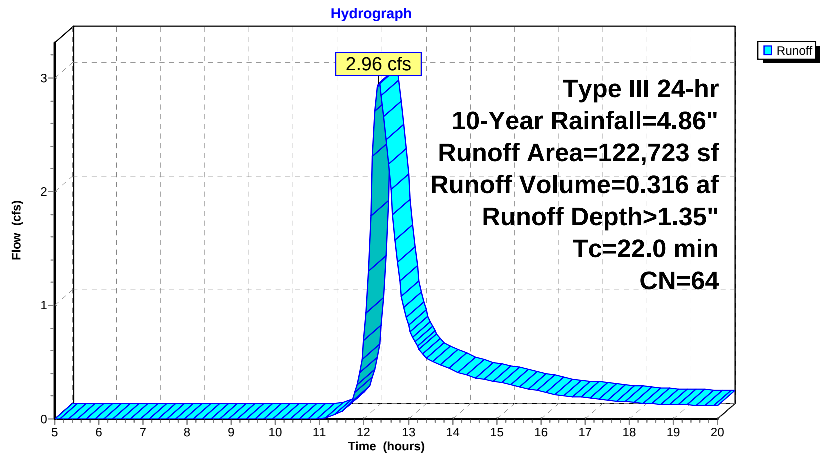
Runoff = 2.96 cfs @ 12.34 hrs, Volume= 0.316 af, Depth> 1.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
101,521	57	Woods/grass comb., Poor, HSG A
21,202	98	Paved parking, HSG A
122,723	64	Weighted Average
101,521		82.72% Pervious Area
21,202		17.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.0					**Direct Entry,**

Subcatchment 15S: REAR



Summary for Subcatchment 16S: REAR

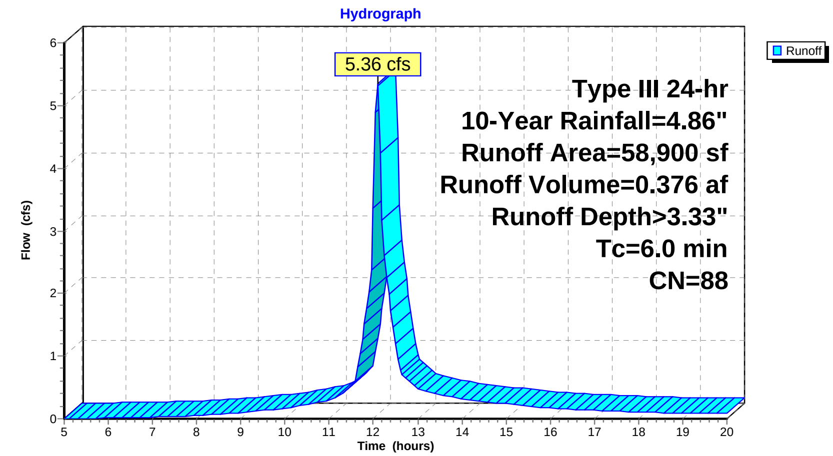
Runoff = 5.36 cfs @ 12.09 hrs, Volume= 0.376 af, Depth> 3.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
48,620	98	Paved parking, HSG A
10,280	39	>75% Grass cover, Good, HSG A
58,900	88	Weighted Average
10,280		17.45% Pervious Area
48,620		82.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 16S: REAR



Summary for Subcatchment 17S: FISHER

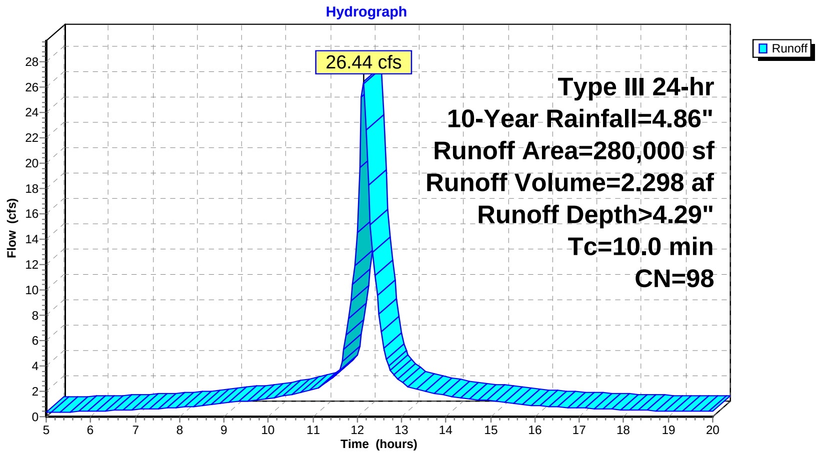
Runoff = 26.44 cfs @ 12.14 hrs, Volume= 2.298 af, Depth> 4.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
280,000	98	Paved parking, HSG A
280,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 17S: FISHER



Summary for Subcatchment 18S: NORTH 3,5 & 7

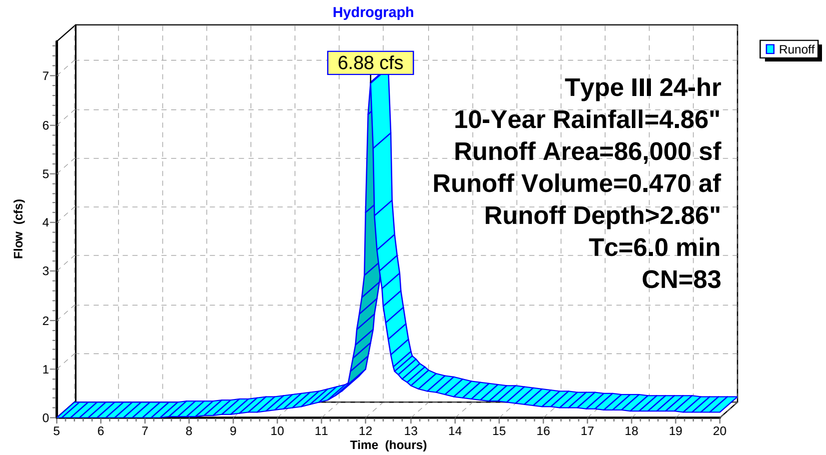
Runoff = 6.88 cfs @ 12.09 hrs, Volume= 0.470 af, Depth> 2.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
64,000	98	Paved parking, HSG A
22,000	39	>75% Grass cover, Good, HSG A
86,000	83	Weighted Average
22,000		25.58% Pervious Area
64,000		74.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 18S: NORTH 3,5 & 7



Summary for Subcatchment 19S: OVRLND

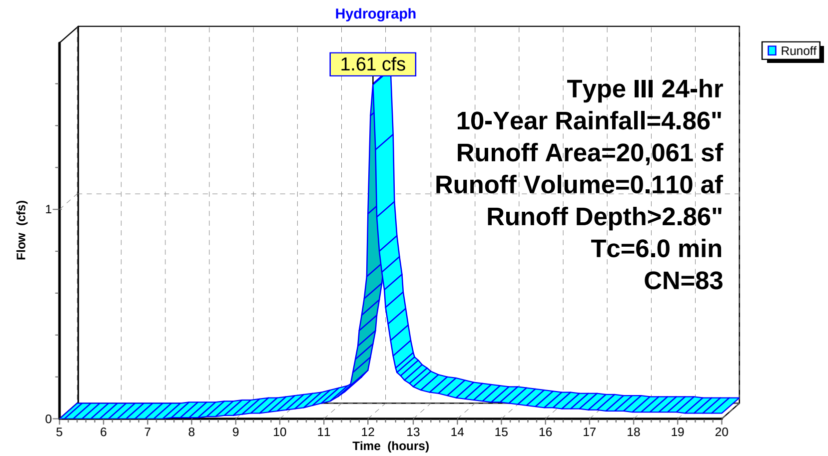
Runoff = 1.61 cfs @ 12.09 hrs, Volume= 0.110 af, Depth> 2.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
14,861	98	Paved parking, HSG A
5,200	39	>75% Grass cover, Good, HSG A
20,061	83	Weighted Average
5,200		25.92% Pervious Area
14,861		74.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 19S: OVRLND



Summary for Subcatchment 20S: West Central

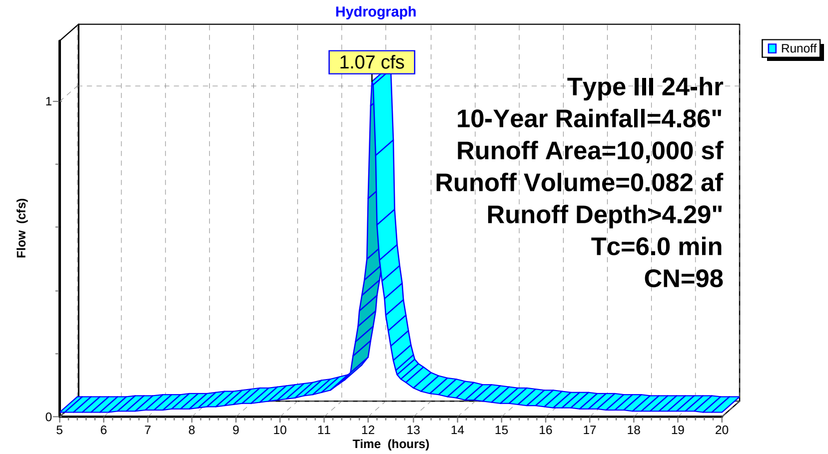
Runoff = 1.07 cfs @ 12.09 hrs, Volume= 0.082 af, Depth> 4.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
10,000	98	Paved roads w/curbs & sewers, HSG A
10,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 20S: West Central



Summary for Subcatchment 21S: BLDG (DEMO) NEW PKG

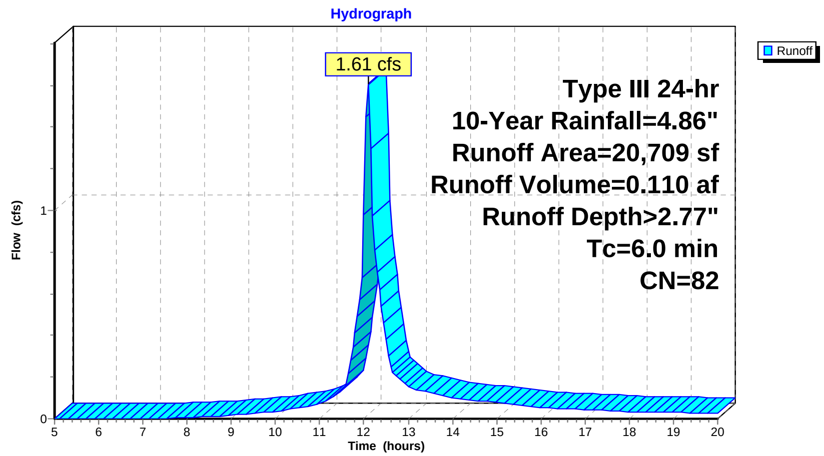
Runoff = 1.61 cfs @ 12.09 hrs, Volume= 0.110 af, Depth> 2.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
15,202	98	Paved parking, HSG A
5,507	39	>75% Grass cover, Good, HSG A
20,709	82	Weighted Average
5,507		26.59% Pervious Area
15,202		73.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 21S: BLDG (DEMO) NEW PKG



Summary for Subcatchment 22S: East Central A 36"

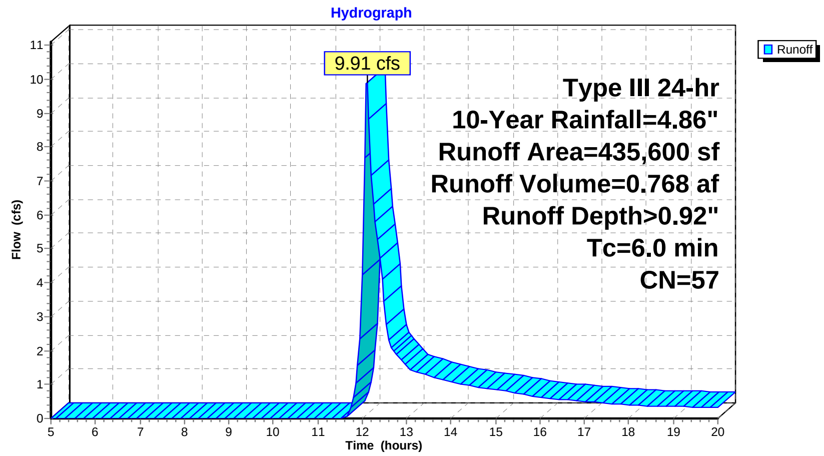
Runoff = 9.91 cfs @ 12.11 hrs, Volume= 0.768 af, Depth> 0.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

	Area (sf)	CN	Description
*	435,600	57	(Approximated) 1/3 acre lots, 30% imp, HSG A
	304,920		70.00% Pervious Area
	130,680		30.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 22S: East Central A 36"



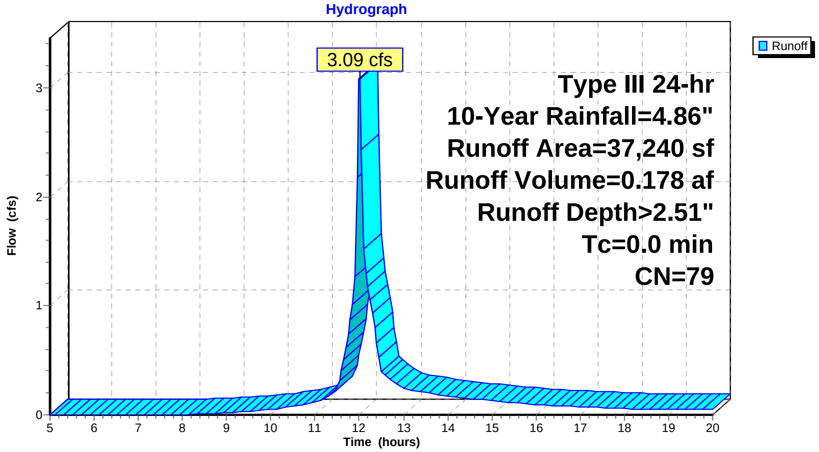
Summary for Subcatchment 23S: FRT LOT

Runoff = 3.09 cfs @ 12.00 hrs, Volume= 0.178 af, Depth> 2.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
25,000	98	Paved parking, HSG A
12,240	39	>75% Grass cover, Good, HSG A
37,240	79	Weighted Average
12,240		32.87% Pervious Area
25,000		67.13% Impervious Area

Subcatchment 23S: FRT LOT



Summary for Subcatchment 24S: REAR

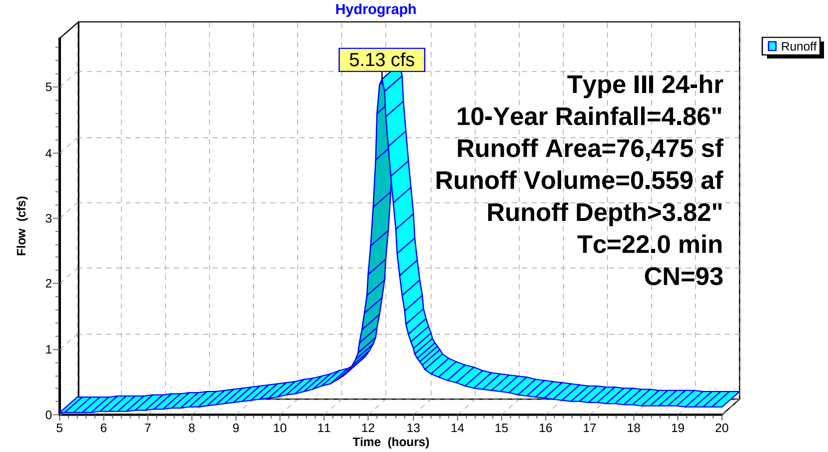
Runoff = 5.13 cfs @ 12.29 hrs, Volume= 0.559 af, Depth> 3.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.86"

Area (sf)	CN	Description
70,278	98	Paved parking, HSG A
6,197	39	>75% Grass cover, Good, HSG A
76,475	93	Weighted Average
6,197		8.10% Pervious Area
70,278		91.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.0					**Direct Entry,**

Subcatchment 24S: REAR



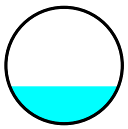
Summary for Reach 1R: Channel Discharge

Inflow Area = 24.476 ac, 59.92% Impervious, Inflow Depth > 2.48" for 10-Year event
Inflow = 57.01 cfs @ 12.12 hrs, Volume= 5.049 af
Outflow = 55.51 cfs @ 12.15 hrs, Volume= 5.042 af, Atten= 3%, Lag= 1.7 min

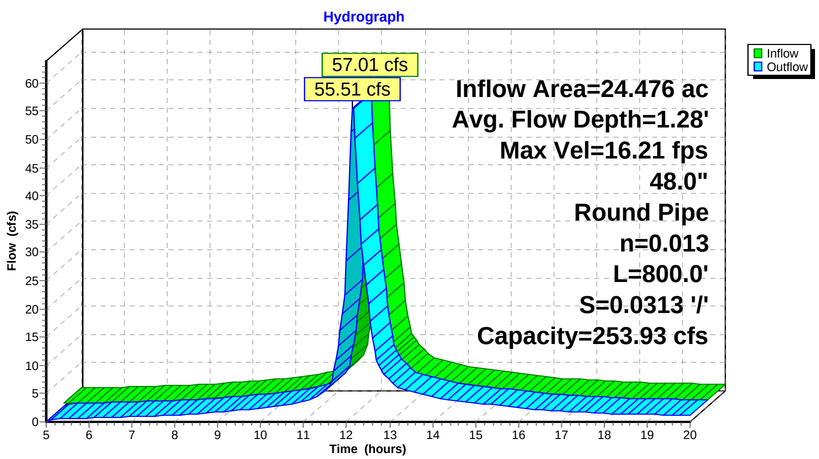
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 16.21 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 6.55 fps, Avg. Travel Time= 2.0 min

Peak Storage= 2,778 cf @ 12.13 hrs
Average Depth at Peak Storage= 1.28'
Bank-Full Depth= 4.00' Flow Area= 12.6 sf, Capacity= 253.93 cfs

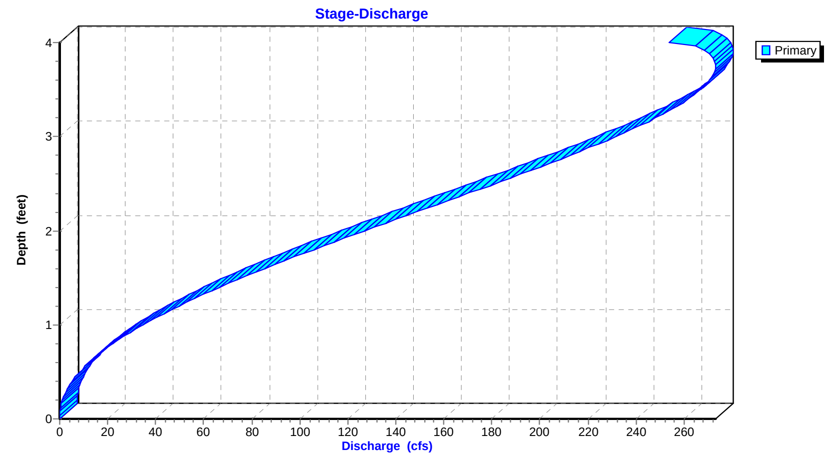
48.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 800.0' Slope= 0.0313 '/'
Inlet Invert= 250.00', Outlet Invert= 225.00'



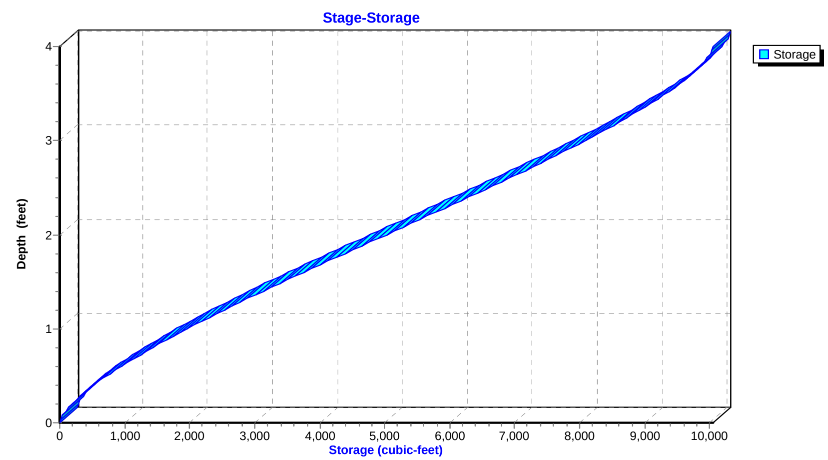
Reach 1R: Channel Discharge



Reach 1R: Channel Discharge



Reach 1R: Channel Discharge

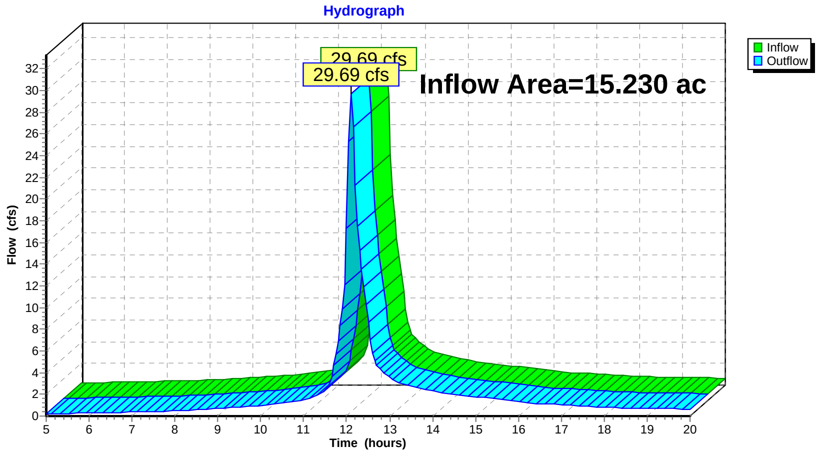


Summary for Reach 2R: CHANNEL SE

Inflow Area = 15.230 ac, 50.90% Impervious, Inflow Depth > 1.92" for 10-Year event
Inflow = 29.69 cfs @ 12.10 hrs, Volume= 2.434 af
Outflow = 29.69 cfs @ 12.10 hrs, Volume= 2.434 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 2R: CHANNEL SE

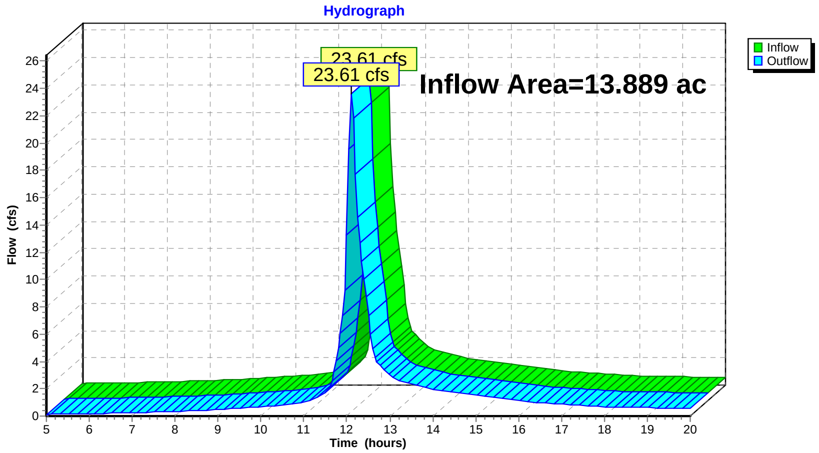


Summary for Reach 3R: CHANNEL, NE

Inflow Area = 13.889 ac, 46.16% Impervious, Inflow Depth > 1.69" for 10-Year event
Inflow = 23.61 cfs @ 12.11 hrs, Volume= 1.955 af
Outflow = 23.61 cfs @ 12.11 hrs, Volume= 1.955 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 3R: CHANNEL, NE



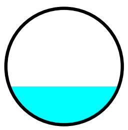
Summary for Reach 4R: 24"

Inflow Area = 2.022 ac, 76.33% Impervious, Inflow Depth > 3.09" for 10-Year event
Inflow = 6.67 cfs @ 12.07 hrs, Volume= 0.521 af
Outflow = 6.48 cfs @ 12.09 hrs, Volume= 0.521 af, Atten= 3%, Lag= 1.7 min

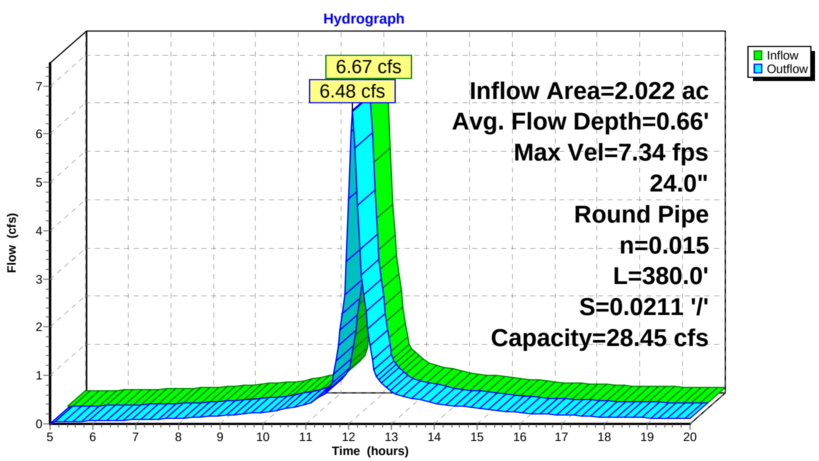
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.34 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 2.82 fps, Avg. Travel Time= 2.2 min

Peak Storage= 340 cf @ 12.08 hrs
Average Depth at Peak Storage= 0.66'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 28.45 cfs

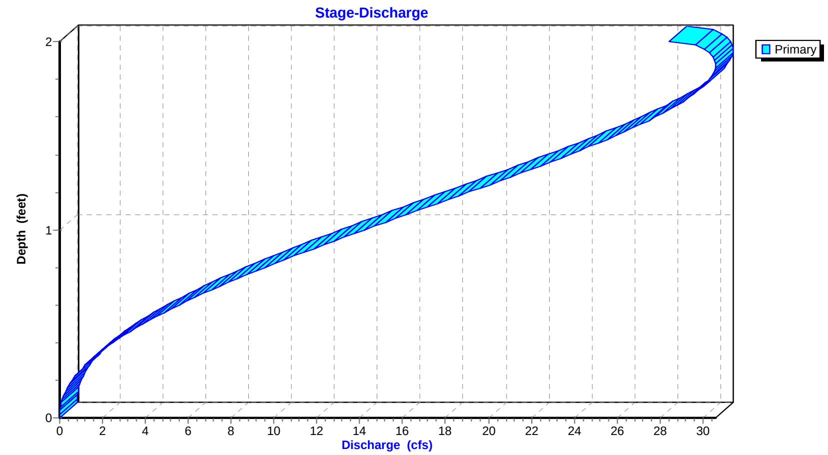
24.0" Round Pipe
n= 0.015 Concrete sewer w/manholes & inlets
Length= 380.0' Slope= 0.0211 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



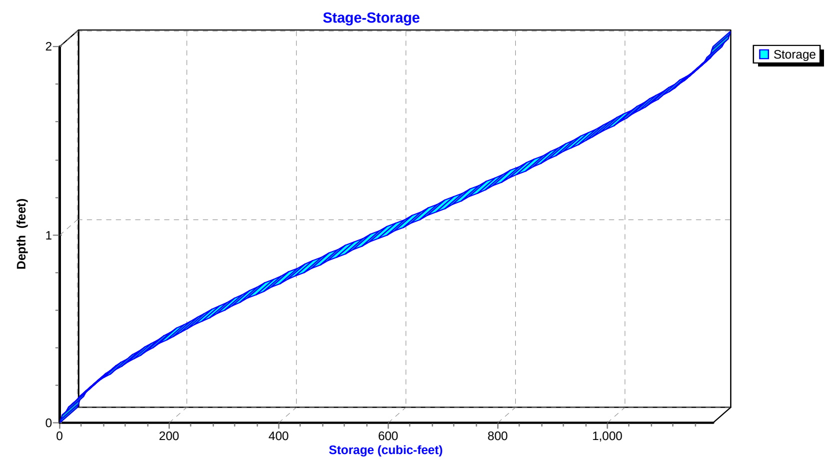
Reach 4R: 24"



Reach 4R: 24"



Reach 4R: 24"



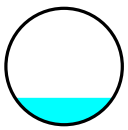
Summary for Reach 5R: 36"

Inflow Area = 10.000 ac, 30.00% Impervious, Inflow Depth > 0.92" for 10-Year event
Inflow = 9.91 cfs @ 12.11 hrs, Volume= 0.768 af
Outflow = 9.37 cfs @ 12.15 hrs, Volume= 0.766 af, Atten= 5%, Lag= 2.3 min

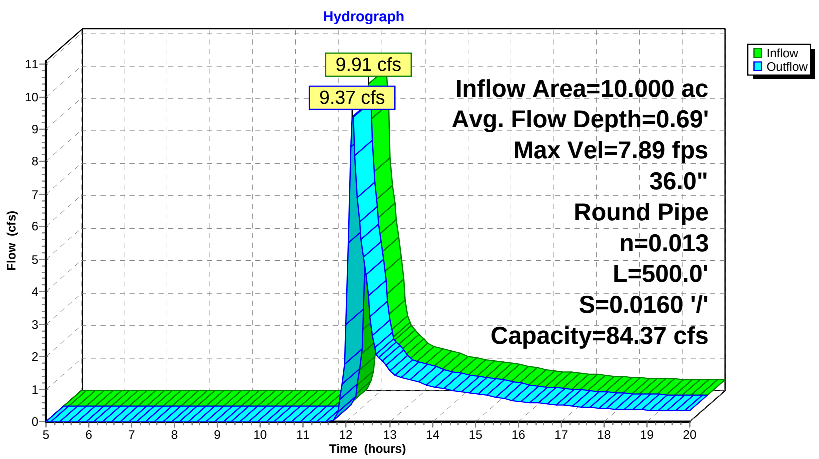
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.89 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 3.78 fps, Avg. Travel Time= 2.2 min

Peak Storage= 614 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.69'
Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 84.37 cfs

36.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0160 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



Reach 5R: 36"



Analysis R1 *Type III 24-hr 10-Year Rainfall=4.86"*
Prepared by Level Design Group, LLC Printed 11/5/2021
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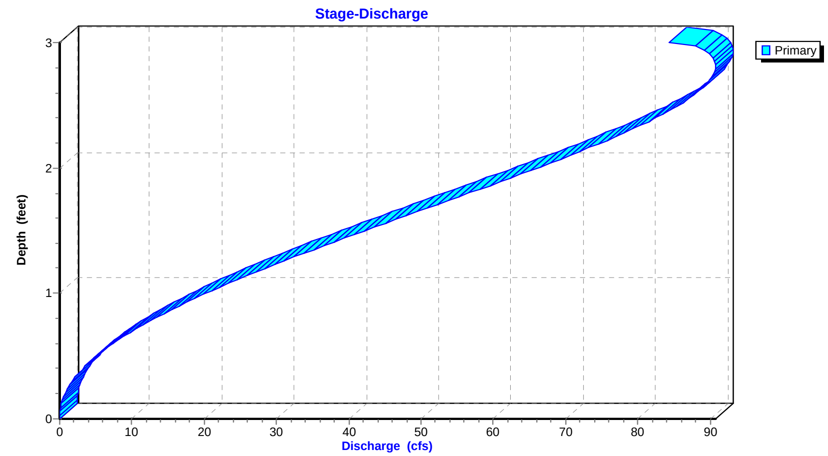
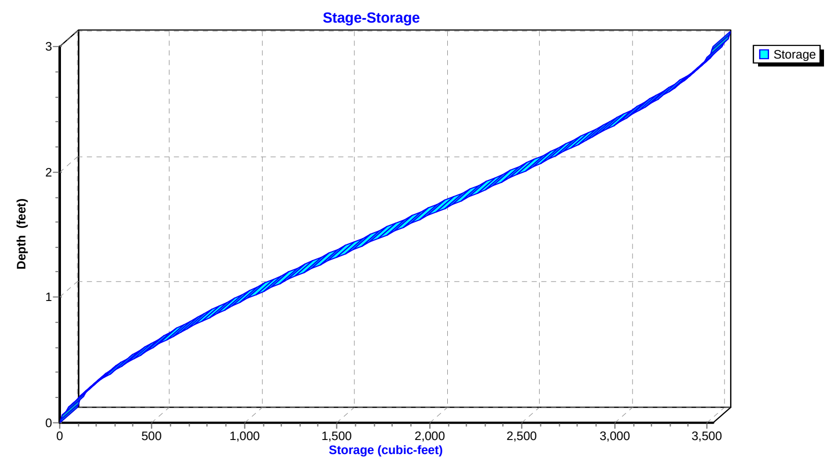
Reach 5R: 36"



Reach 5R: 36"



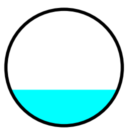
Summary for Reach 25R: Channel Discharge

Inflow Area = 23.530 ac, 64.26% Impervious, Inflow Depth > 2.24" for 10-Year event
Inflow = 52.71 cfs @ 12.12 hrs, Volume= 4.389 af
Outflow = 51.32 cfs @ 12.15 hrs, Volume= 4.384 af, Atten= 3%, Lag= 1.7 min

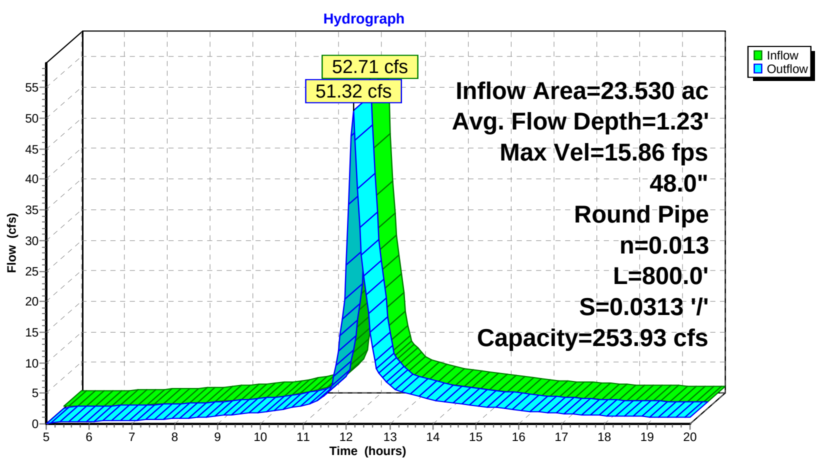
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 15.86 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 6.19 fps, Avg. Travel Time= 2.2 min

Peak Storage= 2,627 cf @ 12.13 hrs
Average Depth at Peak Storage= 1.23'
Bank-Full Depth= 4.00' Flow Area= 12.6 sf, Capacity= 253.93 cfs

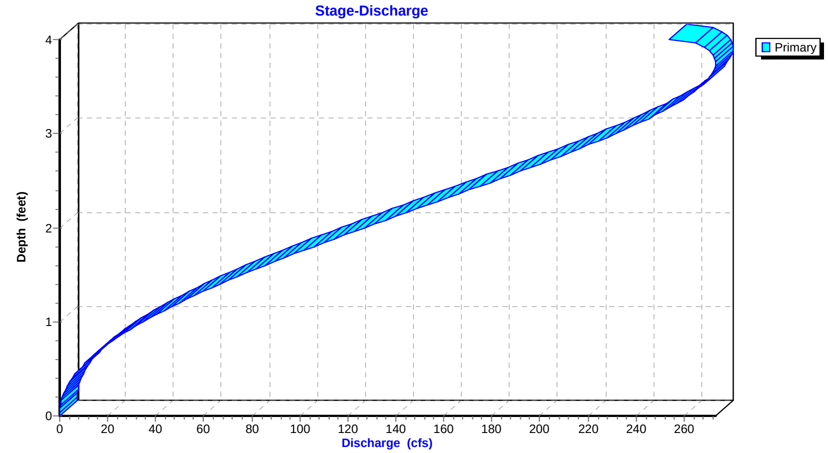
48.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 800.0' Slope= 0.0313 '/'
Inlet Invert= 250.00', Outlet Invert= 225.00'



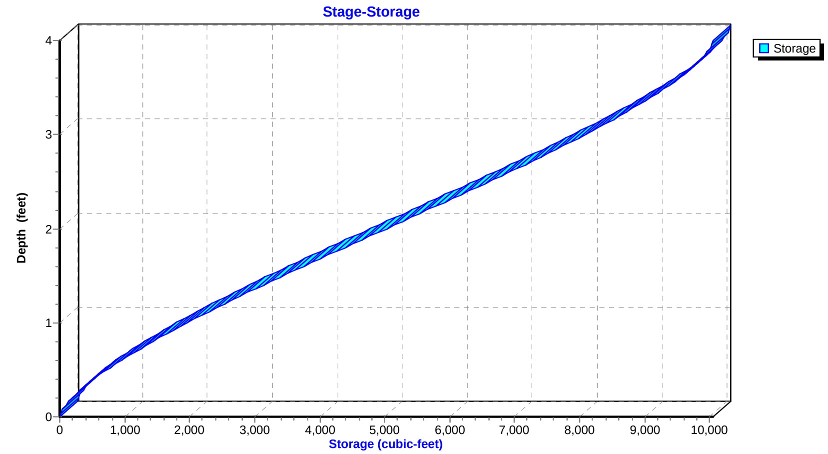
Reach 25R: Channel Discharge



Reach 25R: Channel Discharge



Reach 25R: Channel Discharge

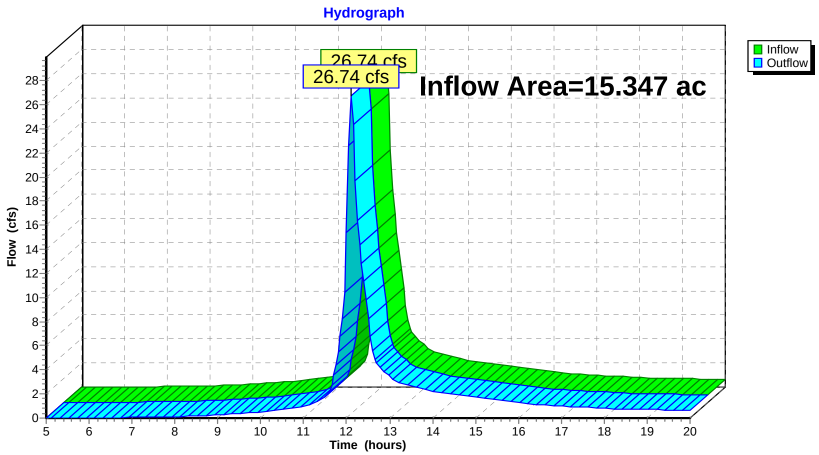


Summary for Reach 26R: CHANNEL SE

Inflow Area = 15.347 ac, 46.13% Impervious, Inflow Depth > 1.64" for 10-Year event
Inflow = 26.74 cfs @ 12.11 hrs, Volume= 2.091 af
Outflow = 26.74 cfs @ 12.11 hrs, Volume= 2.091 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 26R: CHANNEL SE

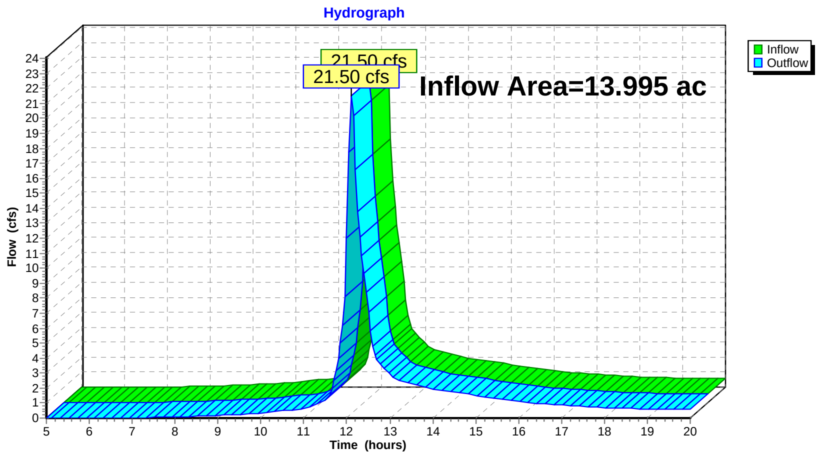


Summary for Reach 27R: CHANNEL, NE

Inflow Area = 13.995 ac, 42.61% Impervious, Inflow Depth > 1.47" for 10-Year event
Inflow = 21.50 cfs @ 12.11 hrs, Volume= 1.715 af
Outflow = 21.50 cfs @ 12.11 hrs, Volume= 1.715 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 27R: CHANNEL, NE



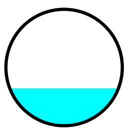
Summary for Reach 28R: 24"

Inflow Area = 2.020 ac, 73.93% Impervious, Inflow Depth > 2.85" for 10-Year event
Inflow = 6.33 cfs @ 12.05 hrs, Volume= 0.480 af
Outflow = 6.14 cfs @ 12.08 hrs, Volume= 0.479 af, Atten= 3%, Lag= 1.5 min

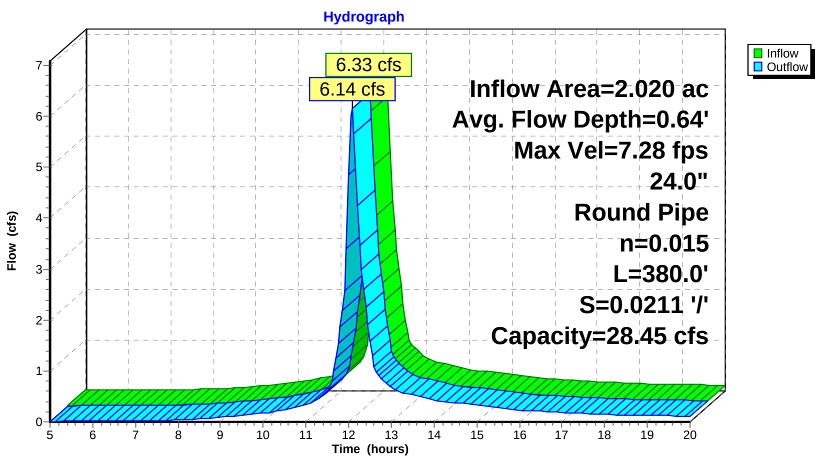
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.28 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 2.62 fps, Avg. Travel Time= 2.4 min

Peak Storage= 331 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.64'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 28.45 cfs

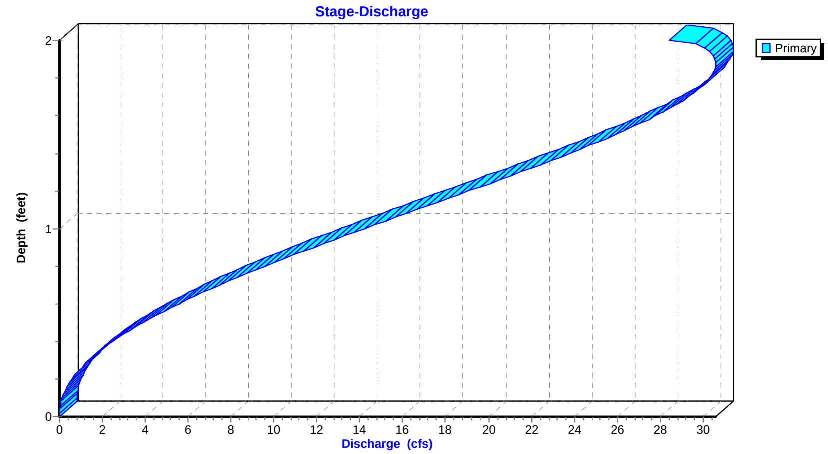
24.0" Round Pipe
n= 0.015 Concrete sewer w/manholes & inlets
Length= 380.0' Slope= 0.0211 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



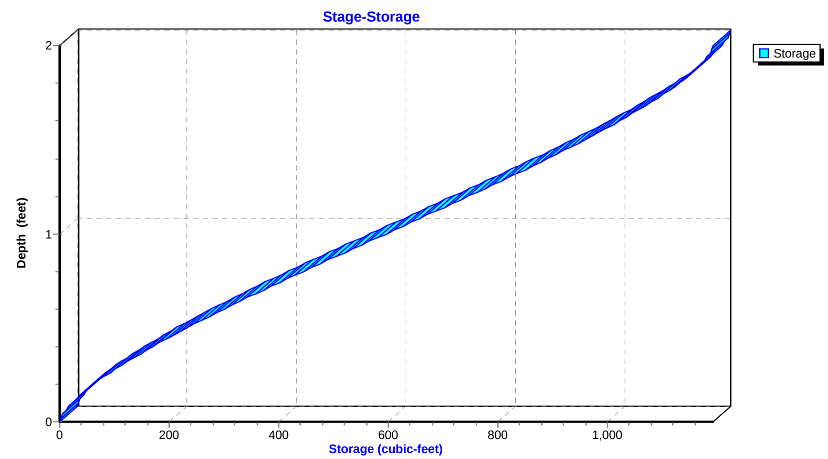
Reach 28R: 24"



Reach 28R: 24"



Reach 28R: 24"



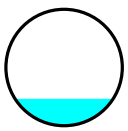
Summary for Reach 29R: 36"

Inflow Area = 10.000 ac, 30.00% Impervious, Inflow Depth > 0.92" for 10-Year event
Inflow = 9.91 cfs @ 12.11 hrs, Volume= 0.768 af
Outflow = 9.37 cfs @ 12.15 hrs, Volume= 0.766 af, Atten= 5%, Lag= 2.3 min

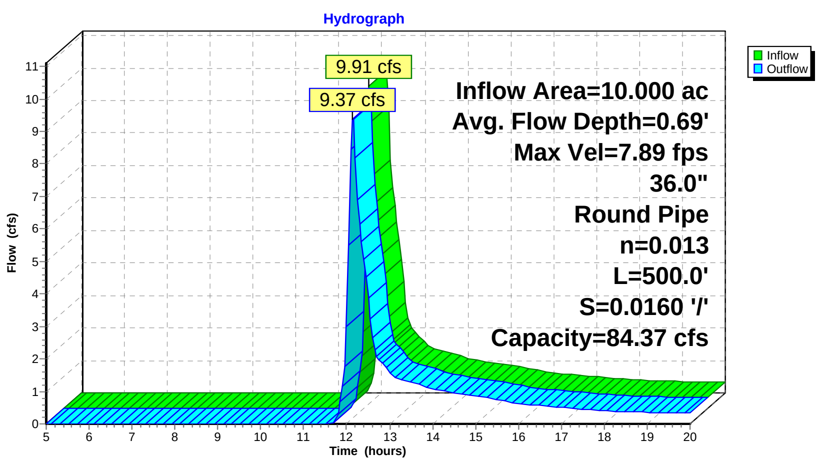
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.89 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 3.78 fps, Avg. Travel Time= 2.2 min

Peak Storage= 614 cf @ 12.12 hrs
Average Depth at Peak Storage= 0.69'
Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 84.37 cfs

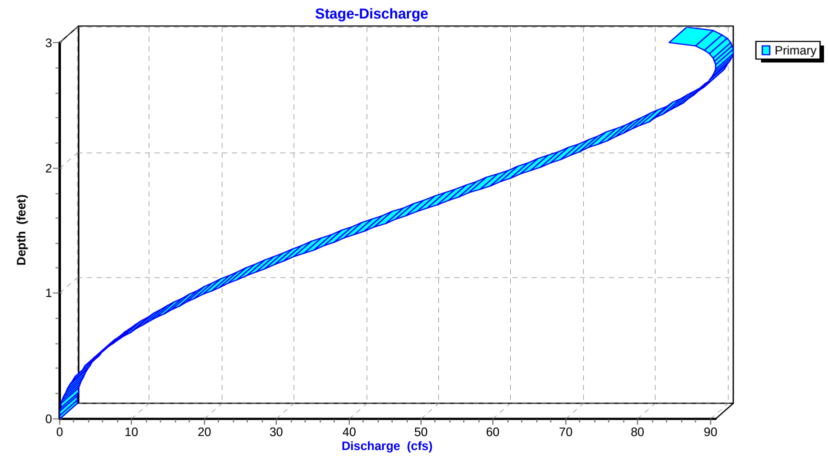
36.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0160 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



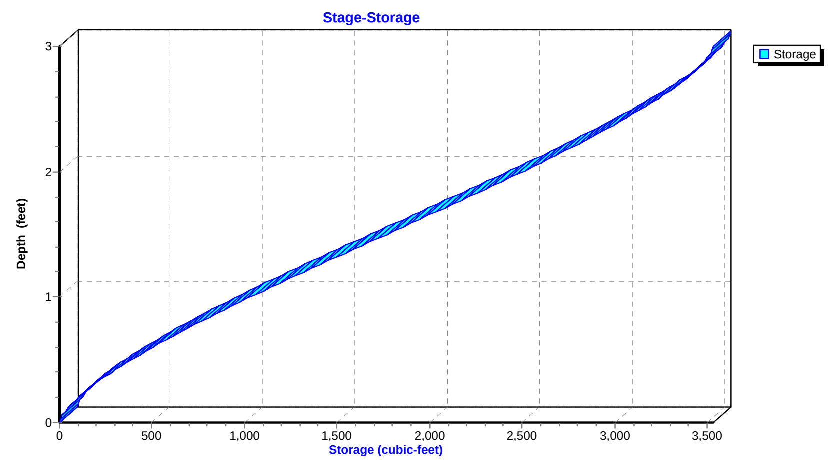
Reach 29R: 36"



Reach 29R: 36"



Reach 29R: 36"



Summary for Pond 30P: REAR

Inflow Area =	1.756 ac, 91.90% Impervious, Inflow Depth > 3.82"	for 10-Year event		
Inflow =	5.13 cfs @	12.29 hrs, Volume=	0.559 af	
Outflow =	1.75 cfs @	12.77 hrs, Volume=	0.559 af,	Atten= 66%, Lag= 28.4 min
Discarded =	1.75 cfs @	12.77 hrs, Volume=	0.559 af	
Primary =	0.00 cfs @	5.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 251.46' @ 12.77 hrs Surf.Area= 7,508 sf Storage= 5,615 cf

Plug-Flow detention time= 19.7 min calculated for 0.557 af (100% of inflow)
Center-of-Mass det. time= 19.4 min (783.9 - 764.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	250.30'	6,653 cf	**68.00'W x 110.42'L x 3.50'H Field A** 26,279 cf Overall - 9,647 cf Embedded = 16,632 cf x 40.0% Voids
#2A	250.80'	9,647 cf	**ADS_StormTech SC-740 +Cap** x 210 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 210 Chambers in 14 Rows
		16,300 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	250.30'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 245.00'
#2	Primary	254.00'	**12.0" Round Culvert** L= 122.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 254.00' / 252.00' S= 0.0164 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf

Discarded OutFlow Max=1.75 cfs @ 12.77 hrs HW=251.46' (Free Discharge)
↑—**1=Exfiltration** (Controls 1.75 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=250.30' (Free Discharge)
↑—**2=Culvert** (Controls 0.00 cfs)

Pond 30P: REAR - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

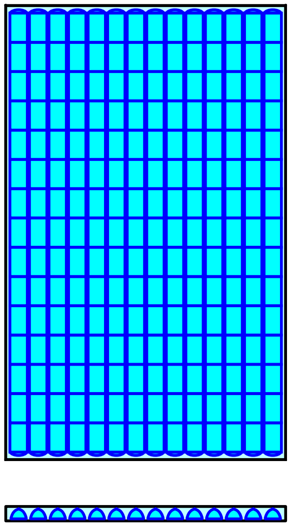
15 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 108.42' Row Length +12.0" End Stone x 2 = 110.42' Base Length
14 Rows x 51.0" Wide + 6.0" Spacing x 13 + 12.0" Side Stone x 2 = 68.00' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

210 Chambers x 45.9 cf = 9,647.4 cf Chamber Storage

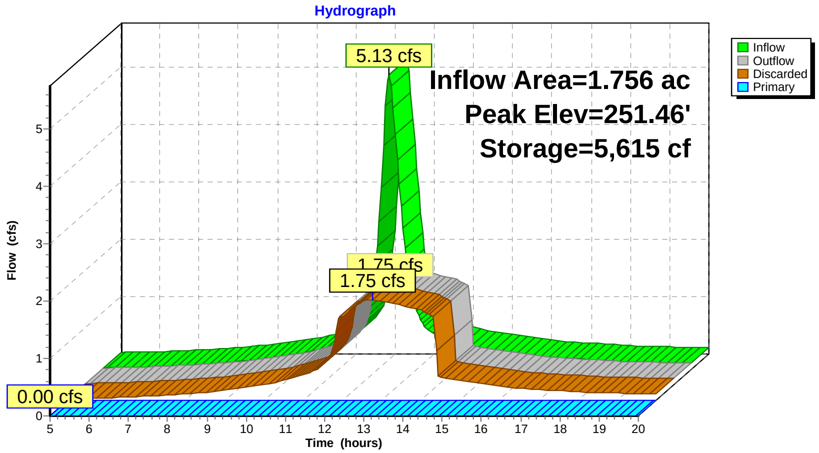
26,279.2 cf Field - 9,647.4 cf Chambers = 16,631.8 cf Stone x 40.0% Voids = 6,652.7 cf Stone Storage

Chamber Storage + Stone Storage = 16,300.1 cf = 0.374 af
Overall Storage Efficiency = 62.0%
Overall System Size = 110.42' x 68.00' x 3.50'

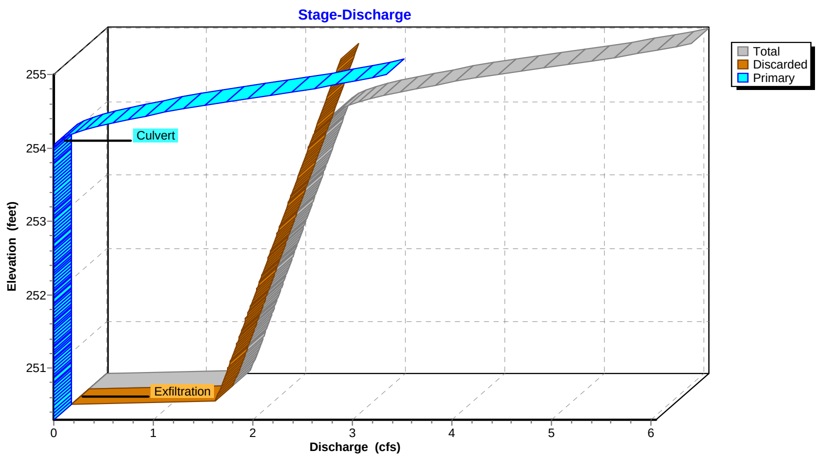
210 Chambers
973.3 cy Field
616.0 cy Stone



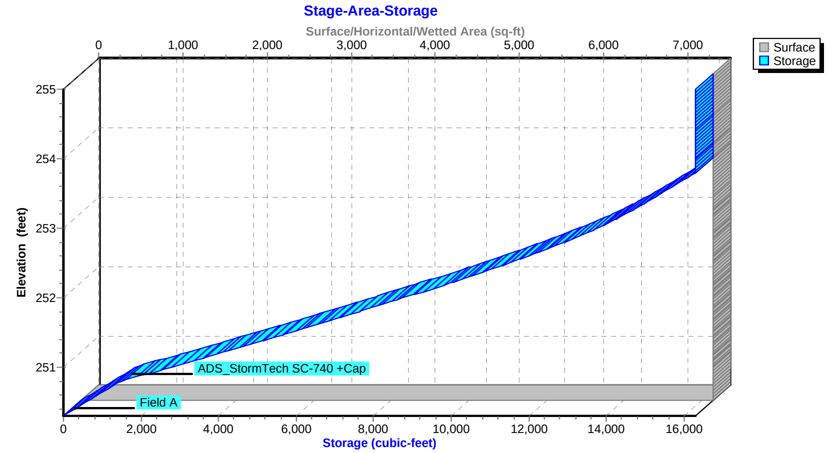
Pond 30P: REAR



Pond 30P: REAR



Pond 30P: REAR



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 6S: REAR Runoff Area=58,428 sf 100.00% Impervious Runoff Depth>5.47"
Tc=6.0 min CN=98 Runoff=7.90 cfs 0.611 af

Subcatchment 7S: FISHER Runoff Area=280,000 sf 100.00% Impervious Runoff Depth>5.46"
Tc=10.0 min CN=98 Runoff=33.54 cfs 2.927 af

Subcatchment 8S: NORTH 3,5 & 7 Runoff Area=81,346 sf 100.00% Impervious Runoff Depth>5.47"
Tc=6.0 min CN=98 Runoff=10.99 cfs 0.851 af

Subcatchment 9S: OVRLND Runoff Area=20,061 sf 89.03% Impervious Runoff Depth>5.03"
Tc=6.0 min CN=93 Runoff=2.61 cfs 0.193 af

Subcatchment 10S: West Central Runoff Area=10,000 sf 100.00% Impervious Runoff Depth>5.47"
Tc=6.0 min CN=98 Runoff=1.35 cfs 0.105 af

Subcatchment 11S: BLDG (DEMO) Runoff Area=20,719 sf 100.00% Impervious Runoff Depth>5.47"
Tc=6.0 min CN=98 Runoff=2.80 cfs 0.217 af

Subcatchment 12S: East Central A 36" Runoff Area=435,600 sf 30.00% Impervious Runoff Depth>1.60"
Tc=6.0 min CN=57 Runoff=18.83 cfs 1.336 af

Subcatchment 13S: FRT LOT Runoff Area=37,280 sf 50.00% Impervious Runoff Depth>2.63"
Tc=0.0 min CN=69 Runoff=3.25 cfs 0.187 af

Subcatchment 15S: REAR Runoff Area=122,723 sf 17.28% Impervious Runoff Depth>2.16"
Tc=22.0 min CN=64 Runoff=4.92 cfs 0.508 af

Subcatchment 16S: REAR Runoff Area=58,900 sf 82.55% Impervious Runoff Depth>4.51"
Tc=6.0 min CN=88 Runoff=7.13 cfs 0.508 af

Subcatchment 17S: FISHER Runoff Area=280,000 sf 100.00% Impervious Runoff Depth>5.46"
Tc=10.0 min CN=98 Runoff=33.54 cfs 2.927 af

Subcatchment 18S: NORTH 3,5 & 7 Runoff Area=86,000 sf 74.42% Impervious Runoff Depth>3.98"
Tc=6.0 min CN=83 Runoff=9.46 cfs 0.655 af

Subcatchment 19S: OVRLND Runoff Area=20,061 sf 74.08% Impervious Runoff Depth>3.98"
Tc=6.0 min CN=83 Runoff=2.21 cfs 0.153 af

Subcatchment 20S: West Central Runoff Area=10,000 sf 100.00% Impervious Runoff Depth>5.47"
Tc=6.0 min CN=98 Runoff=1.35 cfs 0.105 af

Subcatchment 21S: BLDG (DEMO) NEW Runoff Area=20,709 sf 73.41% Impervious Runoff Depth>3.88"
Tc=6.0 min CN=82 Runoff=2.23 cfs 0.154 af

Subcatchment 22S: East Central A 36" Runoff Area=435,600 sf 30.00% Impervious Runoff Depth>1.60"
Tc=6.0 min CN=57 Runoff=18.83 cfs 1.336 af

Subcatchment 23S: FRT LOT Runoff Area=37,240 sf 67.13% Impervious Runoff Depth>3.58"
Tc=0.0 min CN=79 Runoff=4.38 cfs 0.255 af

Subcatchment 24S: REAR Runoff Area=76,475 sf 91.90% Impervious Runoff Depth>5.01"
Tc=22.0 min CN=93 Runoff=6.64 cfs 0.734 af

Reach 1R: Channel Discharge Avg. Flow Depth=1.53' Max Vel=17.77 fps Inflow=79.85 cfs 6.931 af
48.0" Round Pipe n=0.013 L=800.0' S=0.0313 '/' Capacity=253.93 cfs Outflow=77.72 cfs 6.923 af

Reach 2R: CHANNEL SE Inflow=44.52 cfs 3.496 af
Outflow=44.52 cfs 3.496 af

Reach 3R: CHANNEL, NE Inflow=36.78 cfs 2.885 af
Outflow=36.78 cfs 2.885 af

Reach 4R: 24" Avg. Flow Depth=0.77' Max Vel=7.96 fps Inflow=8.90 cfs 0.701 af
24.0" Round Pipe n=0.015 L=380.0' S=0.0211 '/' Capacity=28.45 cfs Outflow=8.66 cfs 0.700 af

Reach 5R: 36" Avg. Flow Depth=0.96' Max Vel=9.56 fps Inflow=18.83 cfs 1.336 af
36.0" Round Pipe n=0.013 L=500.0' S=0.0160 '/' Capacity=84.37 cfs Outflow=17.78 cfs 1.334 af

Reach 25R: Channel Discharge Avg. Flow Depth=1.48' Max Vel=17.44 fps Inflow=74.76 cfs 6.089 af
48.0" Round Pipe n=0.013 L=800.0' S=0.0313 '/' Capacity=253.93 cfs Outflow=72.69 cfs 6.082 af

Reach 26R: CHANNEL SE Inflow=41.98 cfs 3.162 af
Outflow=41.98 cfs 3.162 af

Reach 27R: CHANNEL, NE Inflow=34.98 cfs 2.654 af
Outflow=34.98 cfs 2.654 af

Reach 28R: 24" Avg. Flow Depth=0.76' Max Vel=7.96 fps Inflow=8.70 cfs 0.666 af
24.0" Round Pipe n=0.015 L=380.0' S=0.0211 '/' Capacity=28.45 cfs Outflow=8.53 cfs 0.665 af

Reach 29R: 36" Avg. Flow Depth=0.96' Max Vel=9.56 fps Inflow=18.83 cfs 1.336 af
36.0" Round Pipe n=0.013 L=500.0' S=0.0160 '/' Capacity=84.37 cfs Outflow=17.78 cfs 1.334 af

Pond 30P: REAR Peak Elev=251.97' Storage=8,612 cf Inflow=6.64 cfs 0.734 af
Discarded=1.89 cfs 0.733 af Primary=0.00 cfs 0.000 af Outflow=1.89 cfs 0.733 af

Total Runoff Area = 48.006 ac Runoff Volume = 13.761 af Average Runoff Depth = 3.44"
37.95% Pervious = 18.219 ac 62.05% Impervious = 29.787 ac

Summary for Subcatchment 6S: REAR

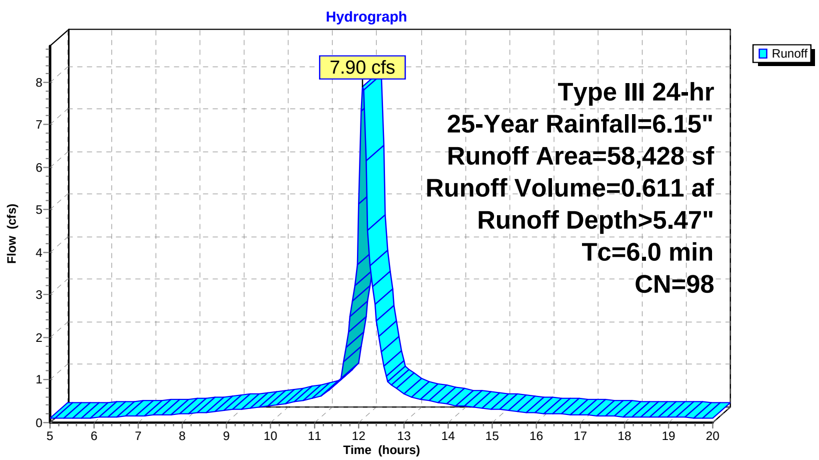
Runoff = 7.90 cfs @ 12.09 hrs, Volume= 0.611 af, Depth> 5.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
58,428	98	Paved parking, HSG A
58,428		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 6S: REAR



Summary for Subcatchment 7S: FISHER

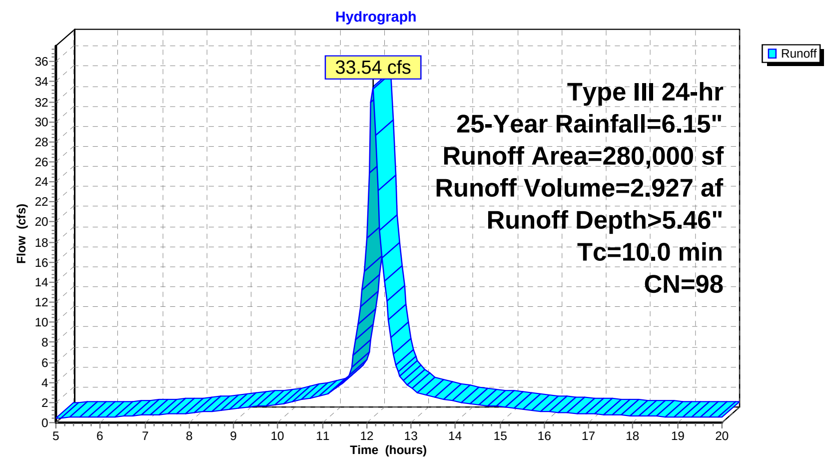
Runoff = 33.54 cfs @ 12.14 hrs, Volume= 2.927 af, Depth> 5.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
280,000	98	Paved parking, HSG A
280,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 7S: FISHER



Summary for Subcatchment 8S: NORTH 3,5 & 7

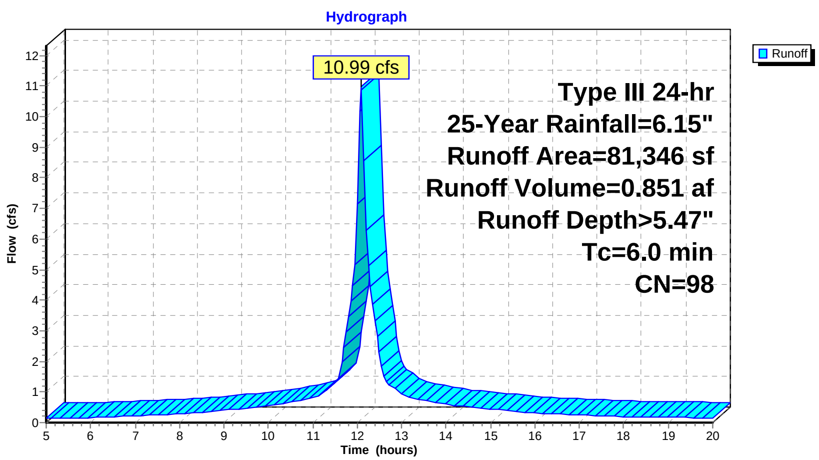
Runoff = 10.99 cfs @ 12.09 hrs, Volume= 0.851 af, Depth> 5.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
81,346	98	Paved parking, HSG A
81,346		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 8S: NORTH 3,5 & 7



Summary for Subcatchment 9S: OVRLND

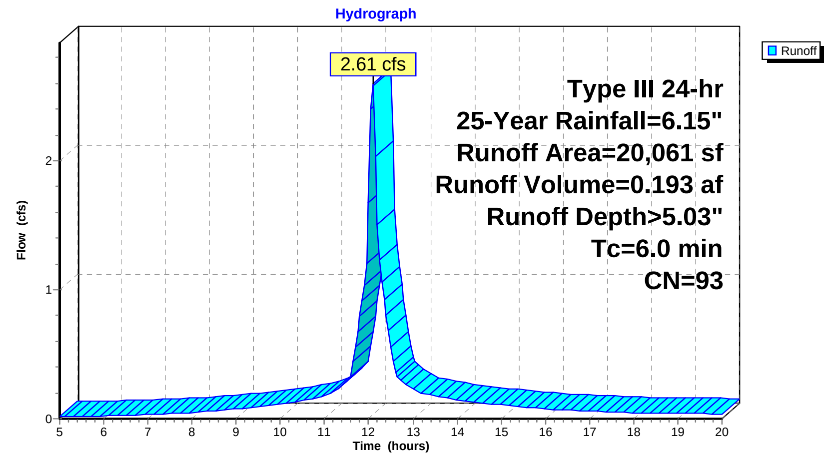
Runoff = 2.61 cfs @ 12.09 hrs, Volume= 0.193 af, Depth> 5.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
17,861	98	Paved parking, HSG A
2,200	49	50-75% Grass cover, Fair, HSG A
20,061	93	Weighted Average
2,200		10.97% Pervious Area
17,861		89.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 9S: OVRLND



Summary for Subcatchment 10S: West Central

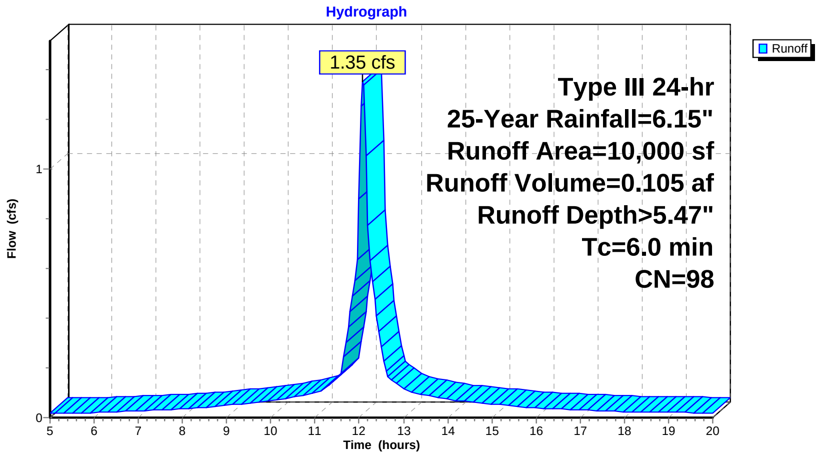
Runoff = 1.35 cfs @ 12.09 hrs, Volume= 0.105 af, Depth> 5.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
10,000	98	Paved roads w/curbs & sewers, HSG A
10,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 10S: West Central



Summary for Subcatchment 11S: BLDG (DEMO)

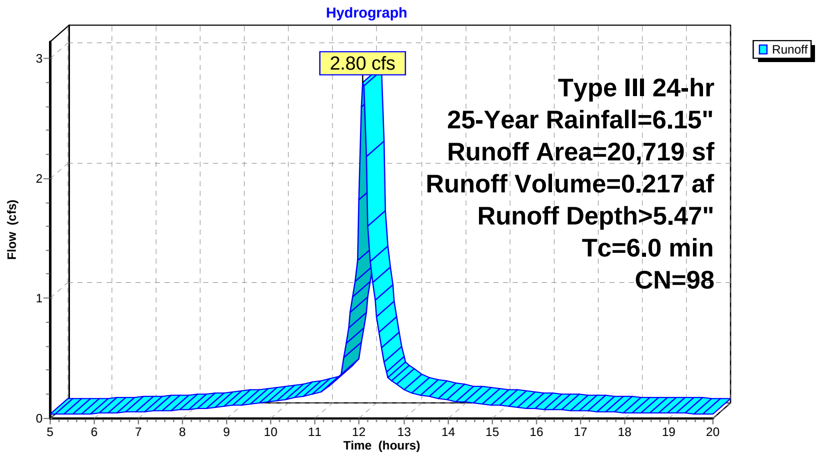
Runoff = 2.80 cfs @ 12.09 hrs, Volume= 0.217 af, Depth> 5.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
20,719	98	Unconnected roofs, HSG A
20,719		100.00% Impervious Area
20,719		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 11S: BLDG (DEMO)



Summary for Subcatchment 12S: East Central A 36"

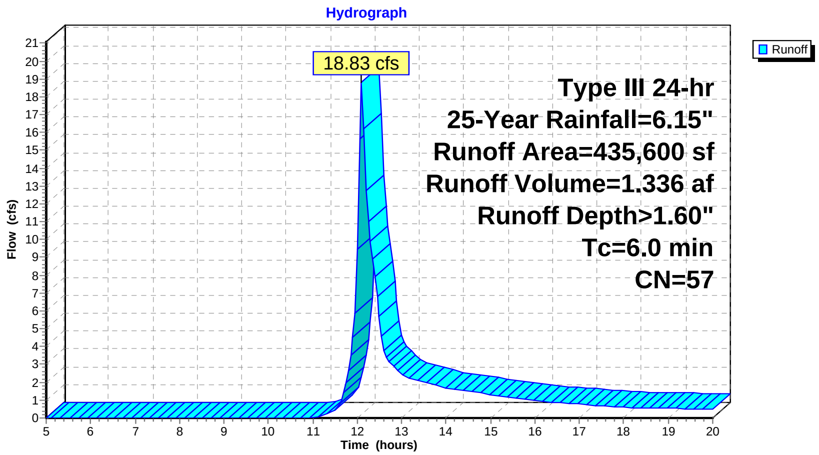
Runoff = 18.83 cfs @ 12.10 hrs, Volume= 1.336 af, Depth> 1.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

	Area (sf)	CN	Description
*	435,600	57	(Approximated) 1/3 acre lots, 30% imp, HSG A
	304,920		70.00% Pervious Area
	130,680		30.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 12S: East Central A 36"



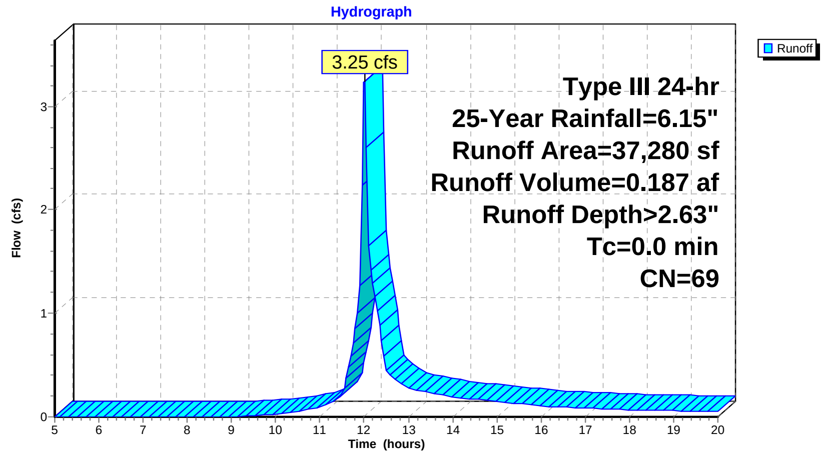
Summary for Subcatchment 13S: FRT LOT

Runoff = 3.25 cfs @ 12.01 hrs, Volume= 0.187 af, Depth> 2.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
18,640	98	Paved parking, HSG A
18,640	39	>75% Grass cover, Good, HSG A
37,280	69	Weighted Average
18,640		50.00% Pervious Area
18,640		50.00% Impervious Area

Subcatchment 13S: FRT LOT



Summary for Subcatchment 15S: REAR

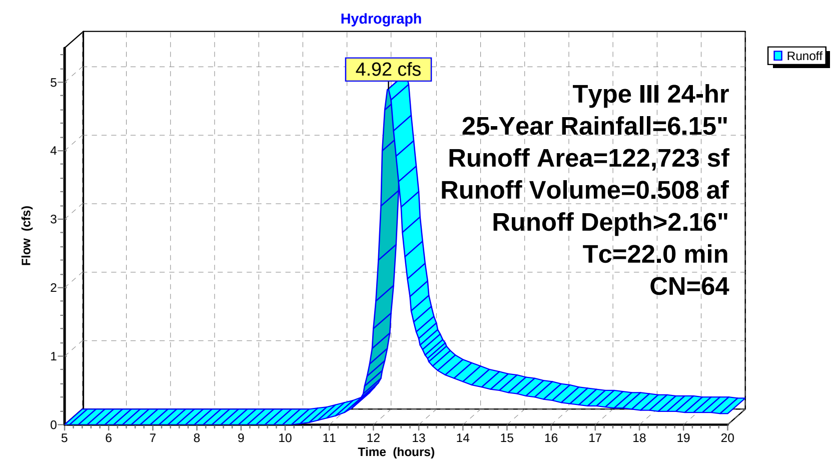
Runoff = 4.92 cfs @ 12.32 hrs, Volume= 0.508 af, Depth> 2.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
101,521	57	Woods/grass comb., Poor, HSG A
21,202	98	Paved parking, HSG A
122,723	64	Weighted Average
101,521		82.72% Pervious Area
21,202		17.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.0					**Direct Entry,**

Subcatchment 15S: REAR



Summary for Subcatchment 16S: REAR

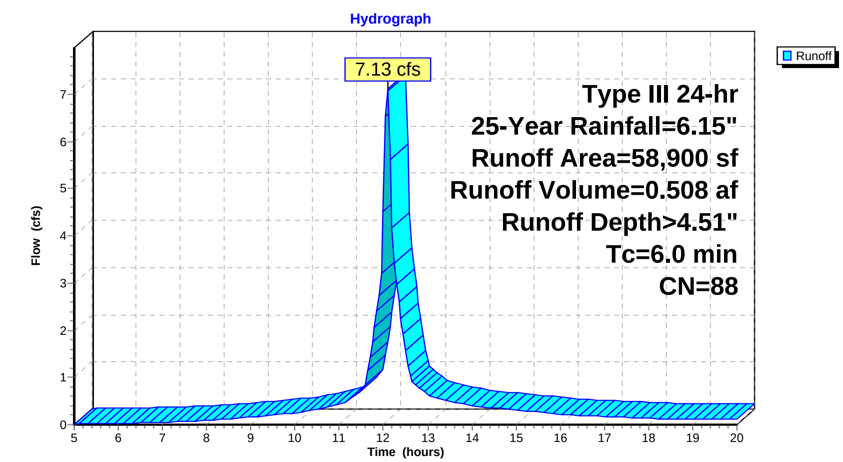
Runoff = 7.13 cfs @ 12.09 hrs, Volume= 0.508 af, Depth> 4.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
48,620	98	Paved parking, HSG A
10,280	39	>75% Grass cover, Good, HSG A
58,900	88	Weighted Average
10,280		17.45% Pervious Area
48,620		82.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 16S: REAR



Summary for Subcatchment 17S: FISHER

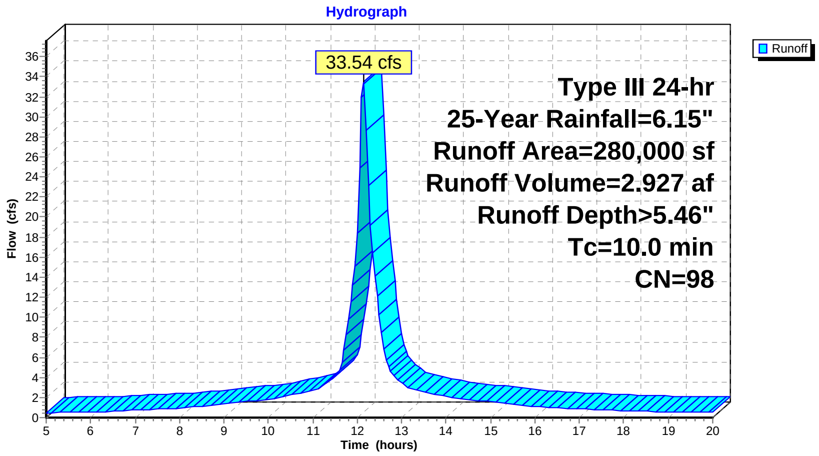
Runoff = 33.54 cfs @ 12.14 hrs, Volume= 2.927 af, Depth> 5.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
280,000	98	Paved parking, HSG A
280,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 17S: FISHER



Summary for Subcatchment 18S: NORTH 3,5 & 7

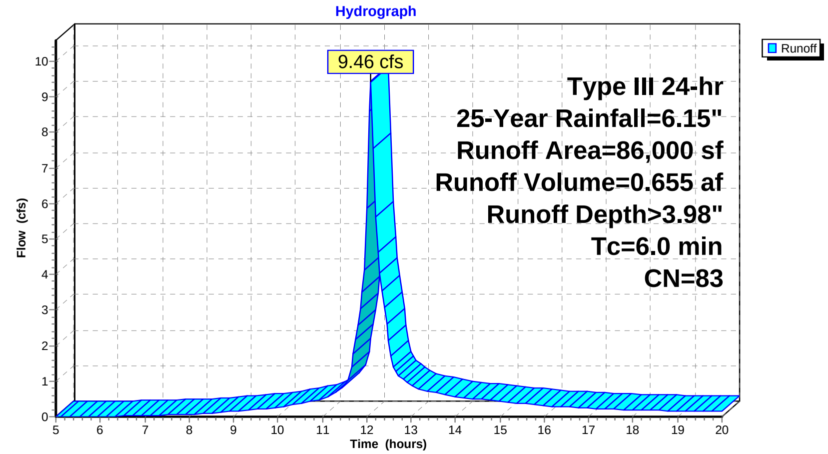
Runoff = 9.46 cfs @ 12.09 hrs, Volume= 0.655 af, Depth> 3.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
64,000	98	Paved parking, HSG A
22,000	39	>75% Grass cover, Good, HSG A
86,000	83	Weighted Average
22,000		25.58% Pervious Area
64,000		74.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 18S: NORTH 3,5 & 7



Summary for Subcatchment 19S: OVRLND

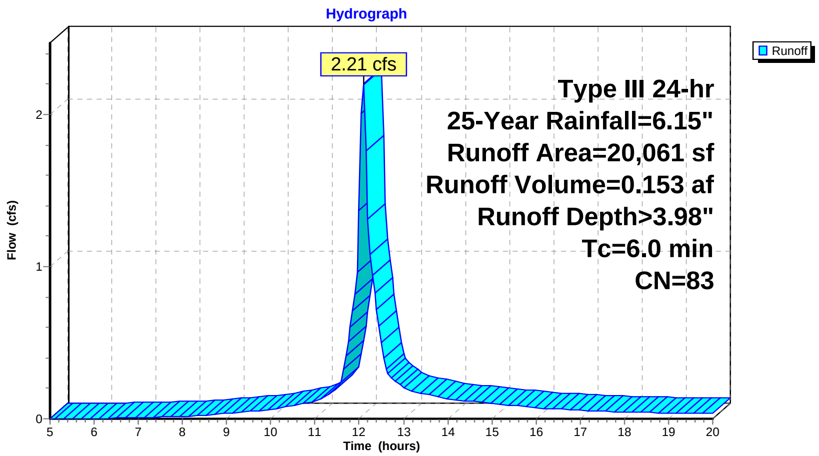
Runoff = 2.21 cfs @ 12.09 hrs, Volume= 0.153 af, Depth> 3.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
14,861	98	Paved parking, HSG A
5,200	39	>75% Grass cover, Good, HSG A
20,061	83	Weighted Average
5,200		25.92% Pervious Area
14,861		74.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 19S: OVRLND



Summary for Subcatchment 20S: West Central

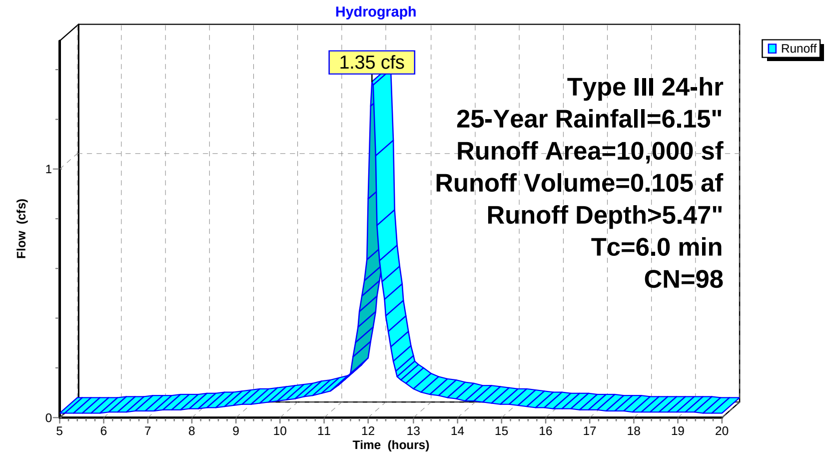
Runoff = 1.35 cfs @ 12.09 hrs, Volume= 0.105 af, Depth> 5.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
10,000	98	Paved roads w/curbs & sewers, HSG A
10,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 20S: West Central



Summary for Subcatchment 21S: BLDG (DEMO) NEW PKG

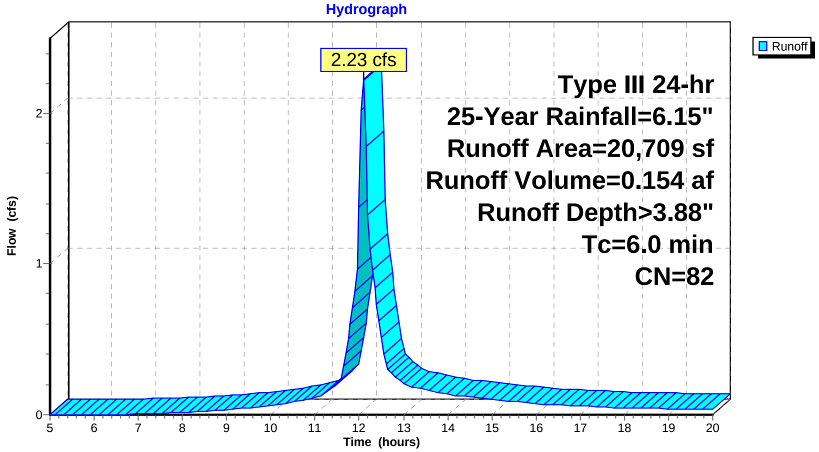
Runoff = 2.23 cfs @ 12.09 hrs, Volume= 0.154 af, Depth> 3.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
15,202	98	Paved parking, HSG A
5,507	39	>75% Grass cover, Good, HSG A
20,709	82	Weighted Average
5,507		26.59% Pervious Area
15,202		73.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 21S: BLDG (DEMO) NEW PKG



Summary for Subcatchment 22S: East Central A 36"

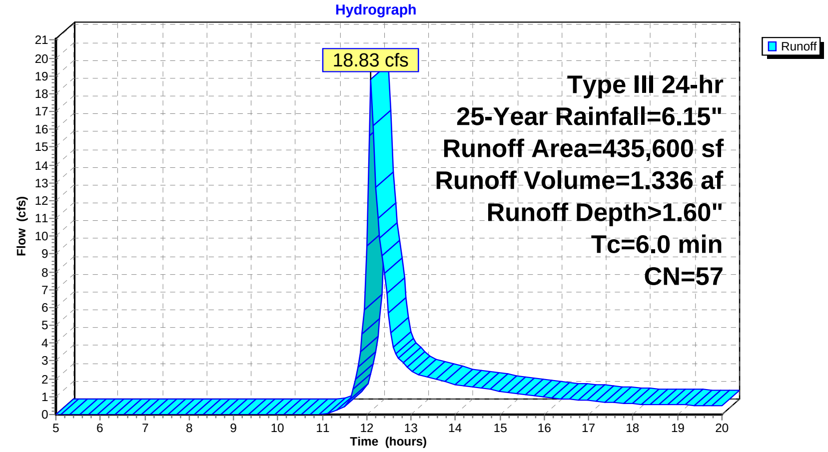
Runoff = 18.83 cfs @ 12.10 hrs, Volume= 1.336 af, Depth> 1.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

	Area (sf)	CN	Description
*	435,600	57	(Approximated) 1/3 acre lots, 30% imp, HSG A
	304,920		70.00% Pervious Area
	130,680		30.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 22S: East Central A 36"



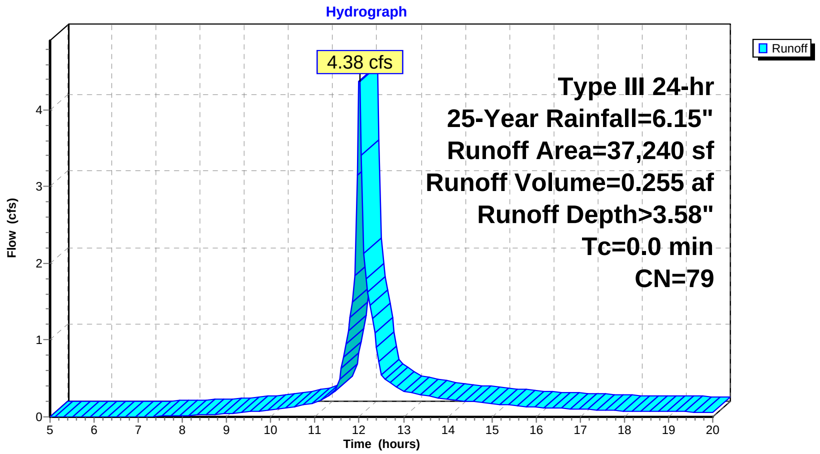
Summary for Subcatchment 23S: FRT LOT

Runoff = 4.38 cfs @ 12.00 hrs, Volume= 0.255 af, Depth> 3.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
25,000	98	Paved parking, HSG A
12,240	39	>75% Grass cover, Good, HSG A
37,240	79	Weighted Average
12,240		32.87% Pervious Area
25,000		67.13% Impervious Area

Subcatchment 23S: FRT LOT



Summary for Subcatchment 24S: REAR

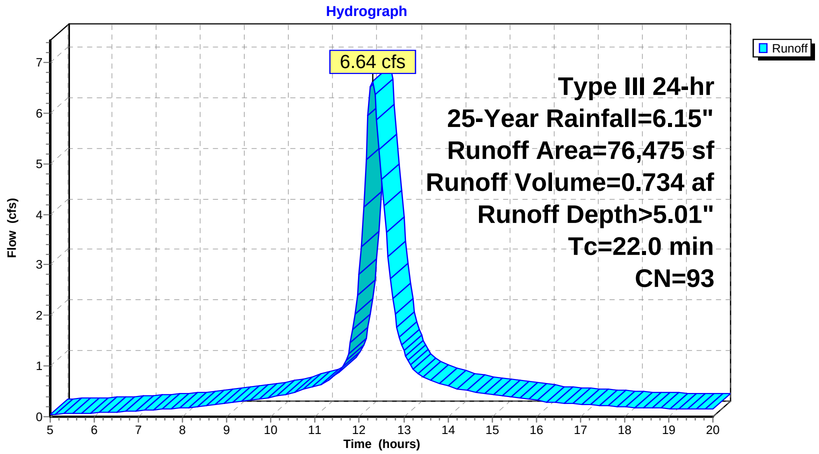
Runoff = 6.64 cfs @ 12.29 hrs, Volume= 0.734 af, Depth> 5.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.15"

Area (sf)	CN	Description
70,278	98	Paved parking, HSG A
6,197	39	>75% Grass cover, Good, HSG A
76,475	93	Weighted Average
6,197		8.10% Pervious Area
70,278		91.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.0					**Direct Entry,**

Subcatchment 24S: REAR



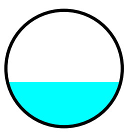
Summary for Reach 1R: Channel Discharge

Inflow Area = 24.476 ac, 59.92% Impervious, Inflow Depth > 3.40" for 25-Year event
Inflow = 79.85 cfs @ 12.12 hrs, Volume= 6.931 af
Outflow = 77.72 cfs @ 12.14 hrs, Volume= 6.923 af, Atten= 3%, Lag= 1.6 min

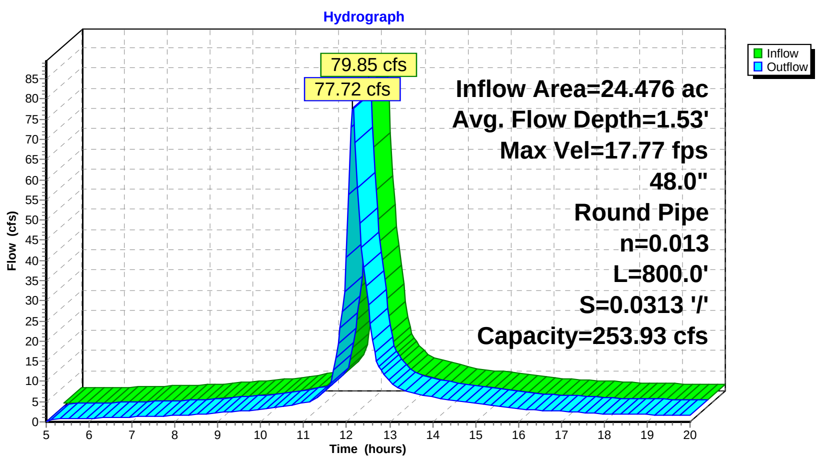
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 17.77 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 7.17 fps, Avg. Travel Time= 1.9 min

Peak Storage= 3,542 cf @ 12.13 hrs
Average Depth at Peak Storage= 1.53'
Bank-Full Depth= 4.00' Flow Area= 12.6 sf, Capacity= 253.93 cfs

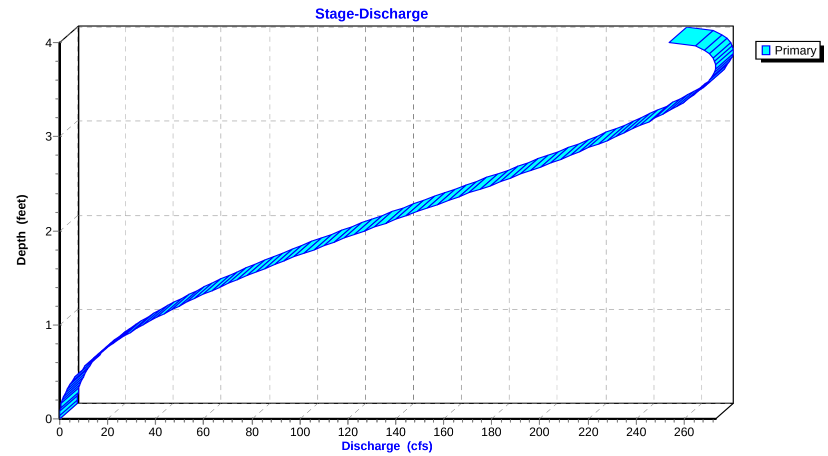
48.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 800.0' Slope= 0.0313 '/'
Inlet Invert= 250.00', Outlet Invert= 225.00'



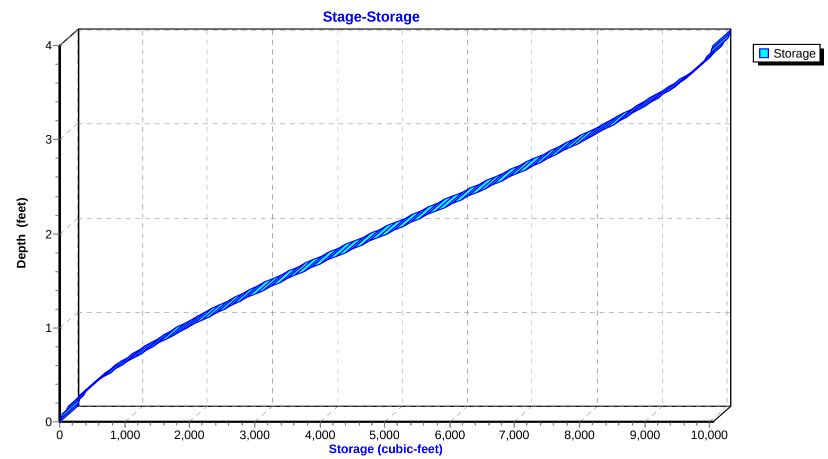
Reach 1R: Channel Discharge



Reach 1R: Channel Discharge



Reach 1R: Channel Discharge

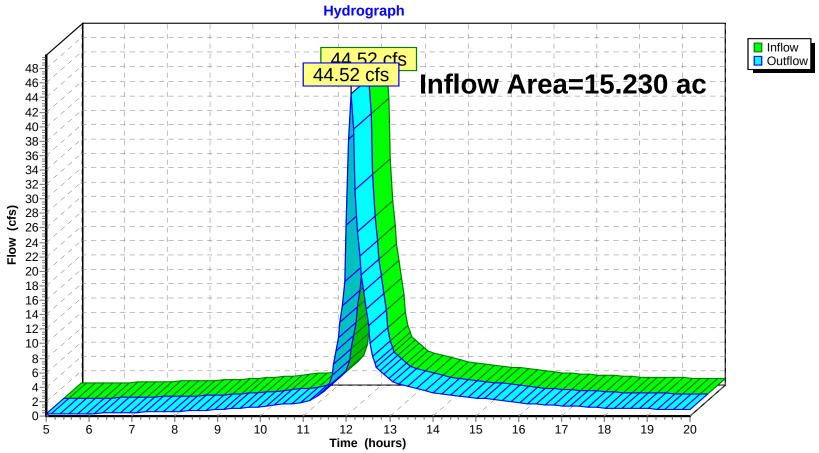


Summary for Reach 2R: CHANNEL SE

Inflow Area = 15.230 ac, 50.90% Impervious, Inflow Depth > 2.75" for 25-Year event
Inflow = 44.52 cfs @ 12.10 hrs, Volume= 3.496 af
Outflow = 44.52 cfs @ 12.10 hrs, Volume= 3.496 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 2R: CHANNEL SE

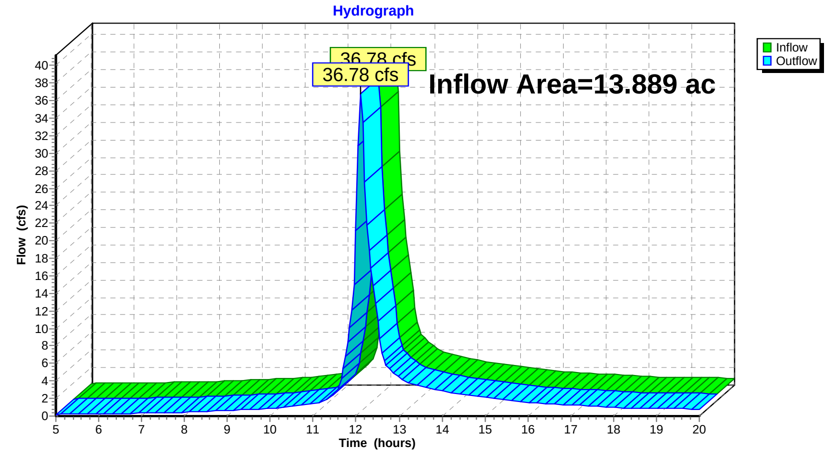


Summary for Reach 3R: CHANNEL, NE

Inflow Area = 13.889 ac, 46.16% Impervious, Inflow Depth > 2.49" for 25-Year event
Inflow = 36.78 cfs @ 12.11 hrs, Volume= 2.885 af
Outflow = 36.78 cfs @ 12.11 hrs, Volume= 2.885 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 3R: CHANNEL, NE



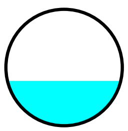
Summary for Reach 4R: 24"

Inflow Area = 2.022 ac, 76.33% Impervious, Inflow Depth > 4.16" for 25-Year event
Inflow = 8.90 cfs @ 12.06 hrs, Volume= 0.701 af
Outflow = 8.66 cfs @ 12.09 hrs, Volume= 0.700 af, Atten= 3%, Lag= 1.5 min

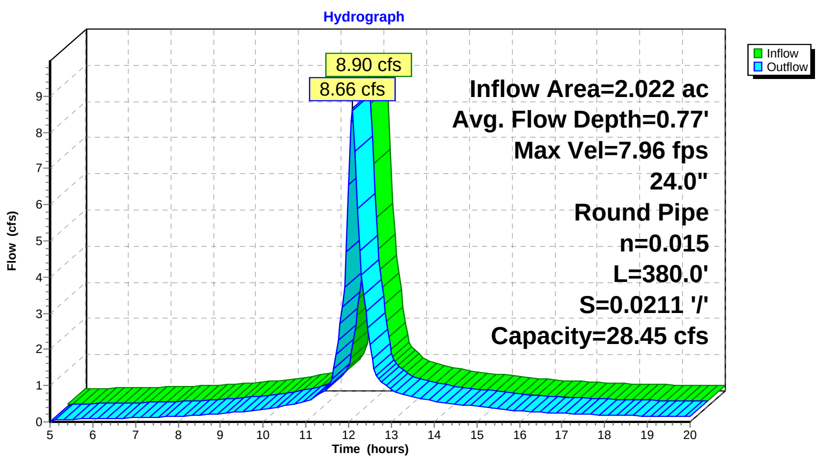
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.96 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 3.08 fps, Avg. Travel Time= 2.1 min

Peak Storage= 422 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.77'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 28.45 cfs

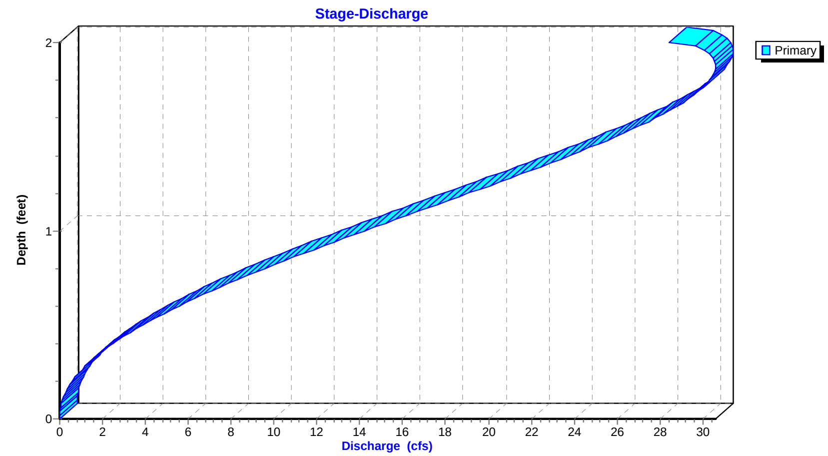
24.0" Round Pipe
n= 0.015 Concrete sewer w/manholes & inlets
Length= 380.0' Slope= 0.0211 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



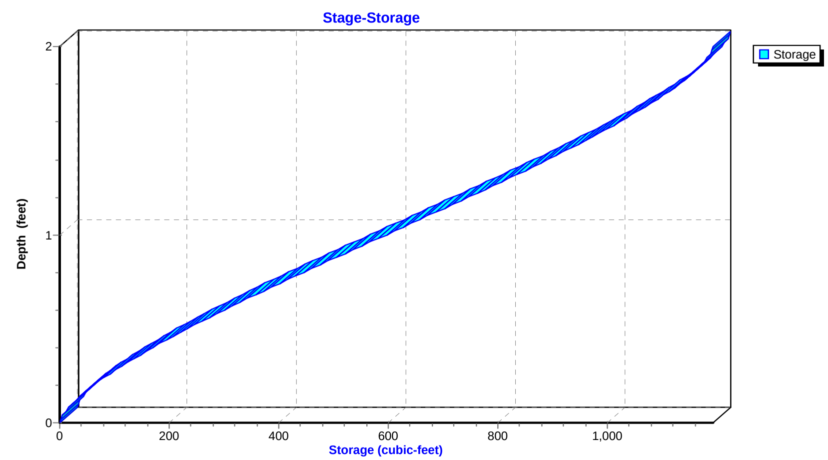
Reach 4R: 24"



Reach 4R: 24"



Reach 4R: 24"



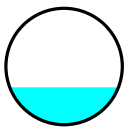
Summary for Reach 5R: 36"

Inflow Area = 10.000 ac, 30.00% Impervious, Inflow Depth > 1.60" for 25-Year event
Inflow = 18.83 cfs @ 12.10 hrs, Volume= 1.336 af
Outflow = 17.78 cfs @ 12.13 hrs, Volume= 1.334 af, Atten= 6%, Lag= 1.6 min

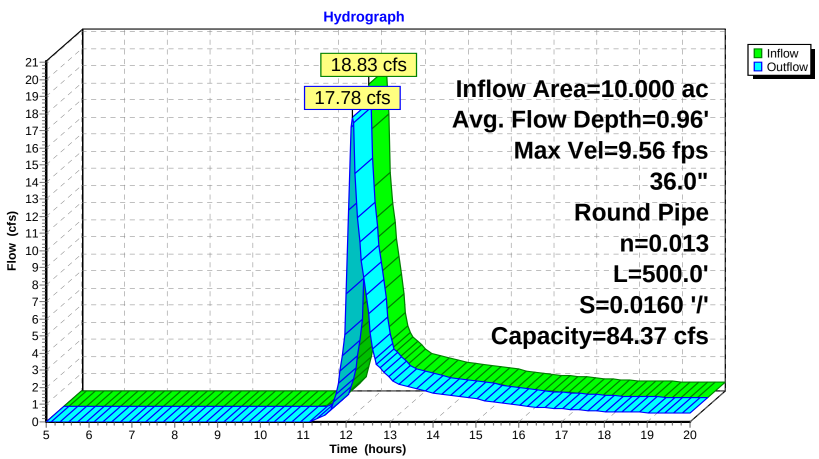
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.56 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 4.26 fps, Avg. Travel Time= 2.0 min

Peak Storage= 975 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.96'
Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 84.37 cfs

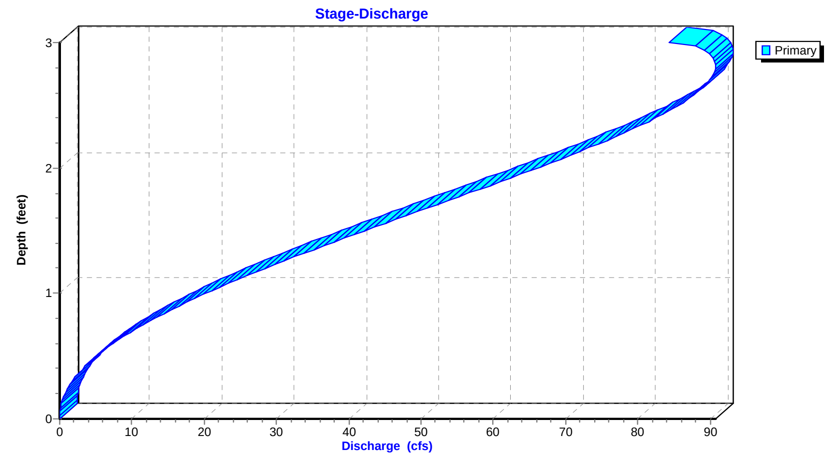
36.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0160 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



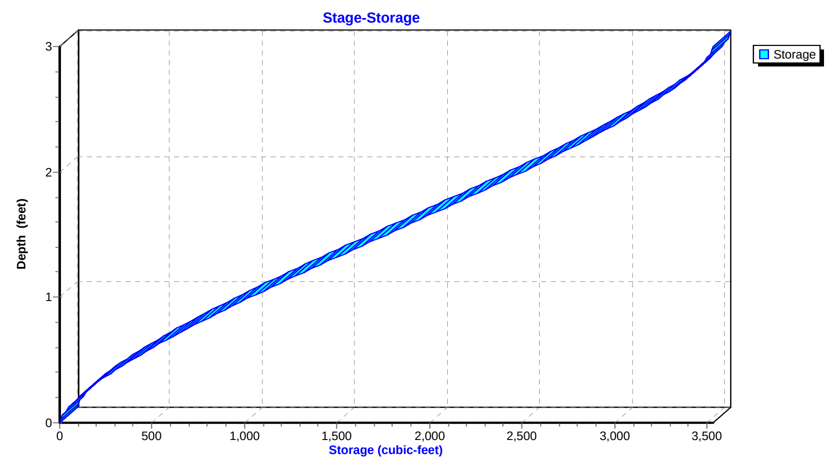
Reach 5R: 36"



Reach 5R: 36"



Reach 5R: 36"



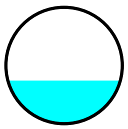
Summary for Reach 25R: Channel Discharge

Inflow Area = 23.530 ac, 64.26% Impervious, Inflow Depth > 3.11" for 25-Year event
Inflow = 74.76 cfs @ 12.12 hrs, Volume= 6.089 af
Outflow = 72.69 cfs @ 12.14 hrs, Volume= 6.082 af, Atten= 3%, Lag= 1.6 min

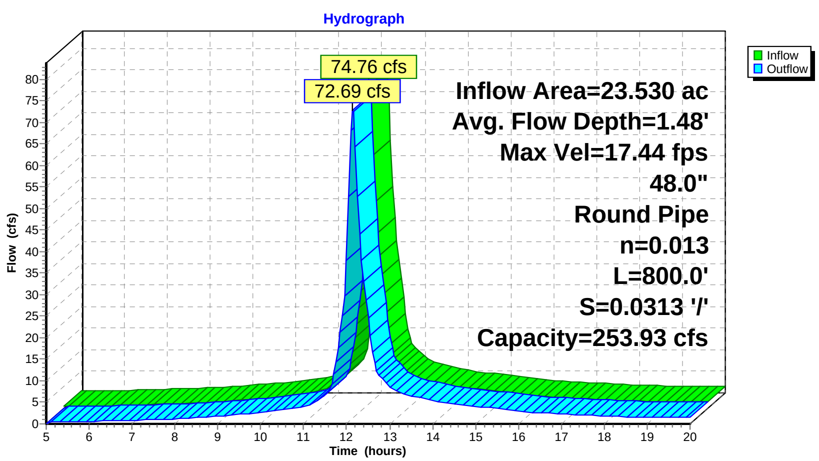
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 17.44 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 6.81 fps, Avg. Travel Time= 2.0 min

Peak Storage= 3,376 cf @ 12.13 hrs
Average Depth at Peak Storage= 1.48'
Bank-Full Depth= 4.00' Flow Area= 12.6 sf, Capacity= 253.93 cfs

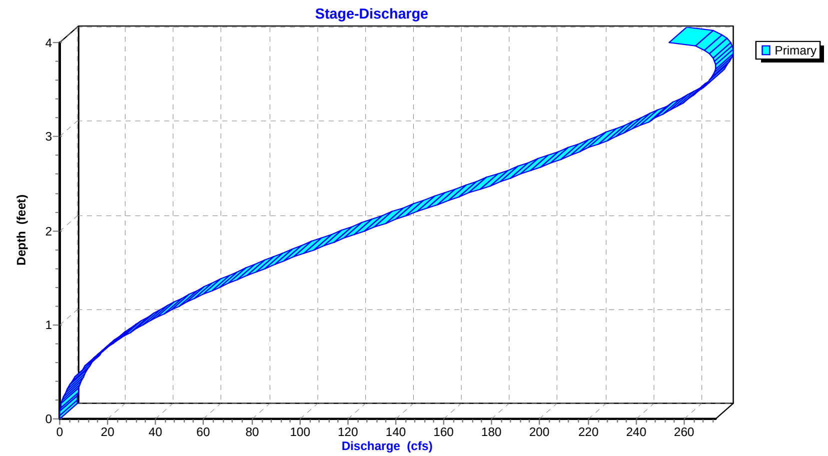
48.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 800.0' Slope= 0.0313 '/'
Inlet Invert= 250.00', Outlet Invert= 225.00'



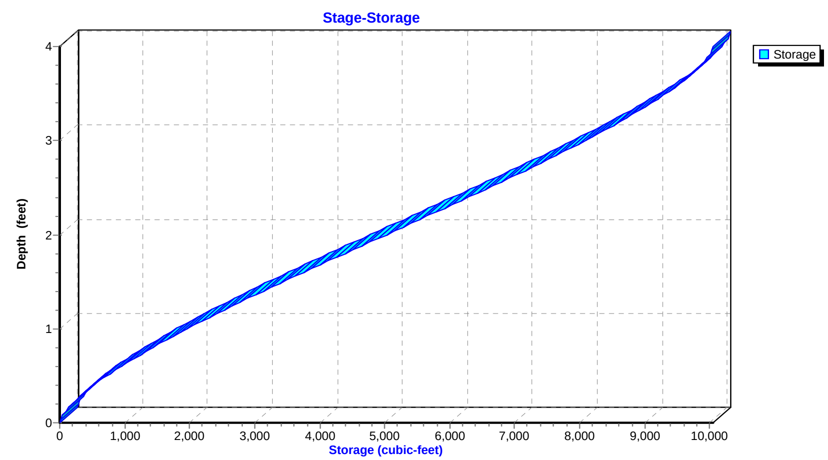
Reach 25R: Channel Discharge



Reach 25R: Channel Discharge



Reach 25R: Channel Discharge

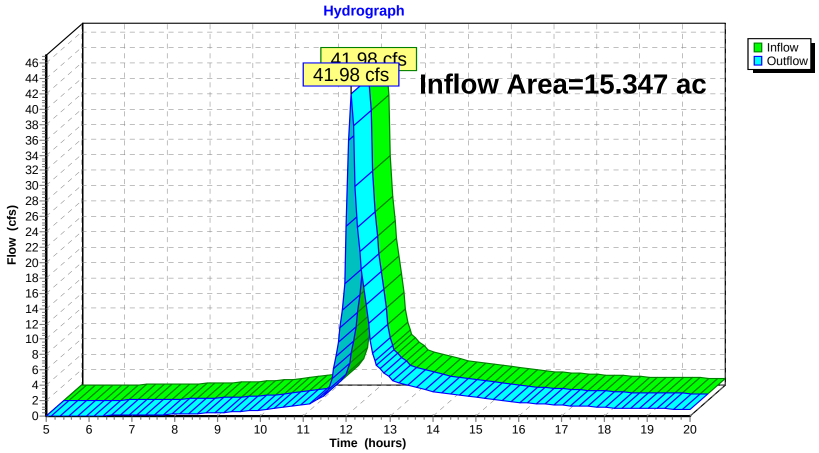


Summary for Reach 26R: CHANNEL SE

Inflow Area =	15.347 ac, 46.13% Impervious, Inflow Depth > 2.47"	for 25-Year event
Inflow =	41.98 cfs @ 12.10 hrs, Volume=	3.162 af
Outflow =	41.98 cfs @ 12.10 hrs, Volume=	3.162 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 26R: CHANNEL SE

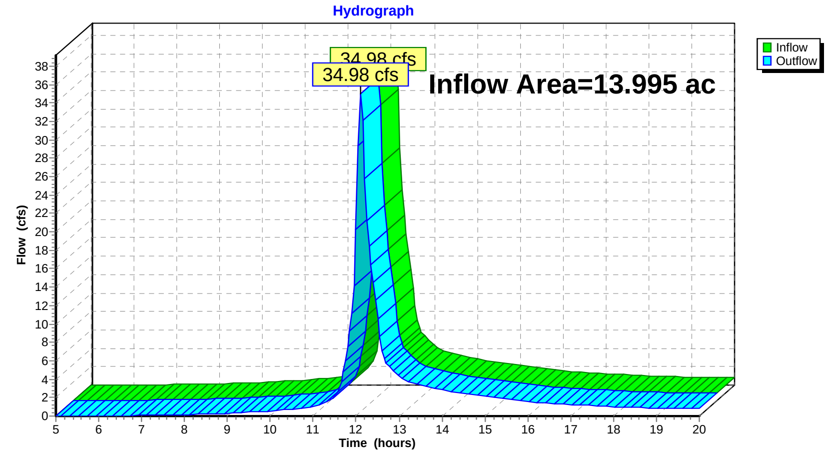


Summary for Reach 27R: CHANNEL, NE

Inflow Area =	13.995 ac, 42.61% Impervious, Inflow Depth > 2.28"	for 25-Year event
Inflow =	34.98 cfs @ 12.11 hrs, Volume=	2.654 af
Outflow =	34.98 cfs @ 12.11 hrs, Volume=	2.654 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 27R: CHANNEL, NE



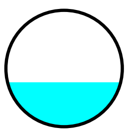
Summary for Reach 28R: 24"

Inflow Area = 2.020 ac, 73.93% Impervious, Inflow Depth > 3.96" for 25-Year event
Inflow = 8.70 cfs @ 12.05 hrs, Volume= 0.666 af
Outflow = 8.53 cfs @ 12.07 hrs, Volume= 0.665 af, Atten= 2%, Lag= 1.4 min

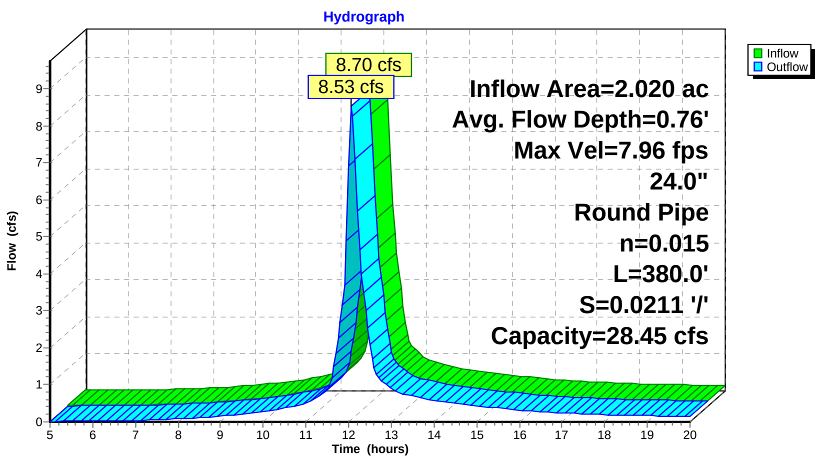
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.96 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 2.92 fps, Avg. Travel Time= 2.2 min

Peak Storage= 417 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.76'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 28.45 cfs

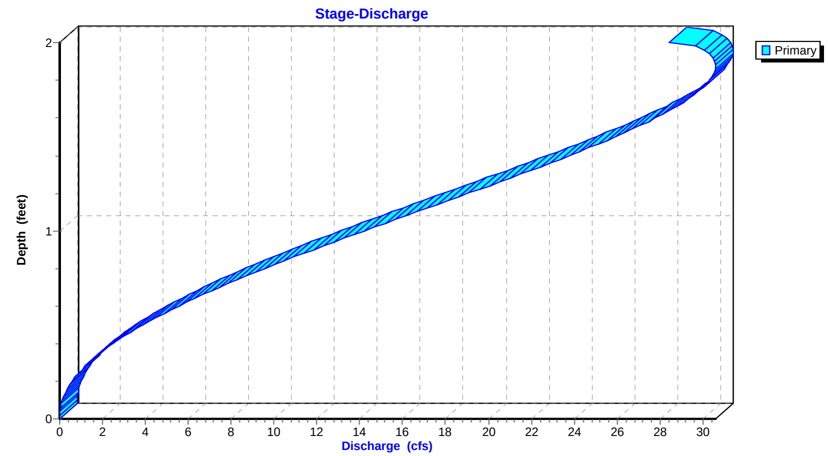
24.0" Round Pipe
n= 0.015 Concrete sewer w/manholes & inlets
Length= 380.0' Slope= 0.0211 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



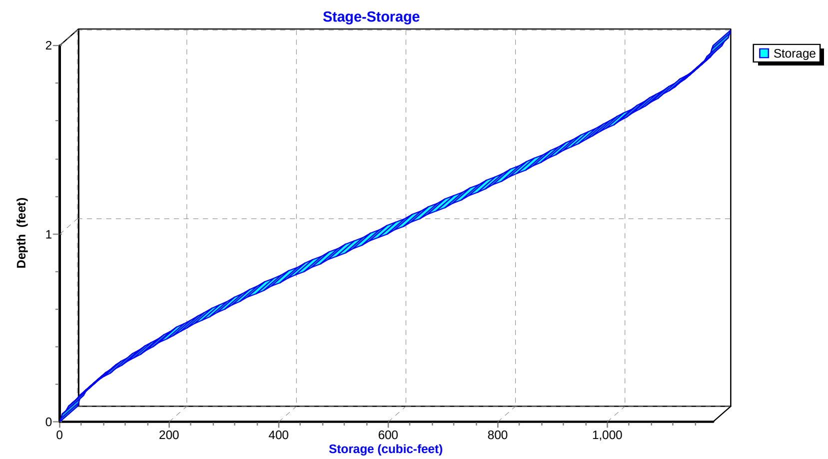
Reach 28R: 24"



Reach 28R: 24"



Reach 28R: 24"



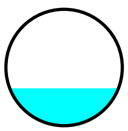
Summary for Reach 29R: 36"

Inflow Area = 10.000 ac, 30.00% Impervious, Inflow Depth > 1.60" for 25-Year event
Inflow = 18.83 cfs @ 12.10 hrs, Volume= 1.336 af
Outflow = 17.78 cfs @ 12.13 hrs, Volume= 1.334 af, Atten= 6%, Lag= 1.6 min

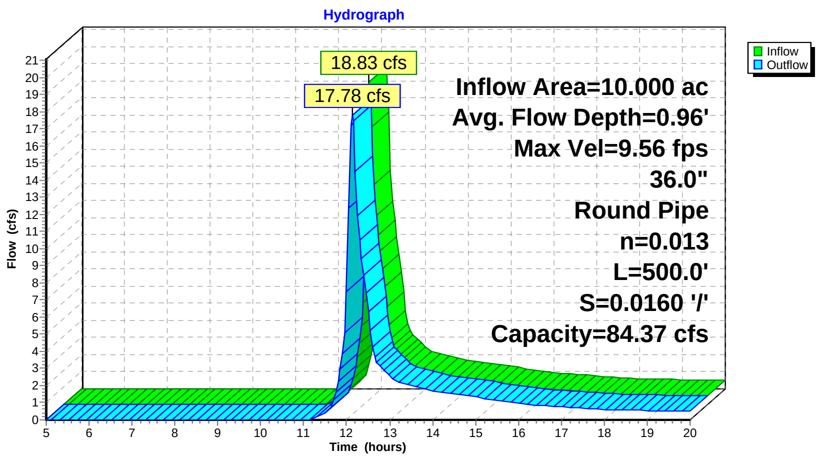
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.56 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 4.26 fps, Avg. Travel Time= 2.0 min

Peak Storage= 975 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.96'
Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 84.37 cfs

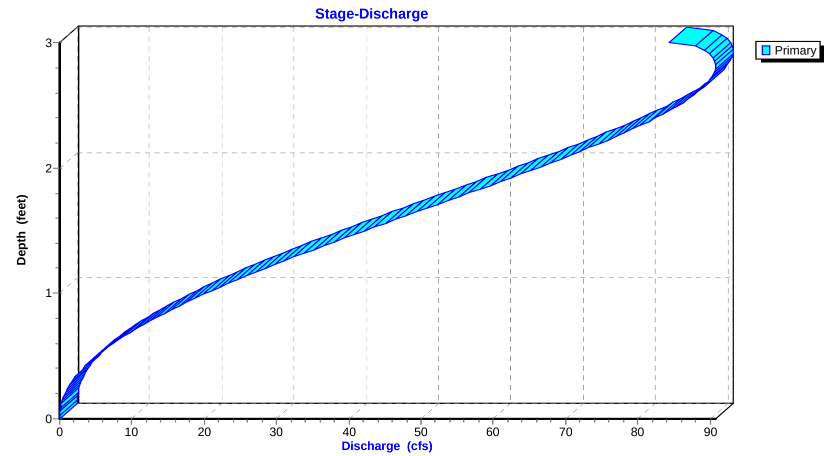
36.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0160 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



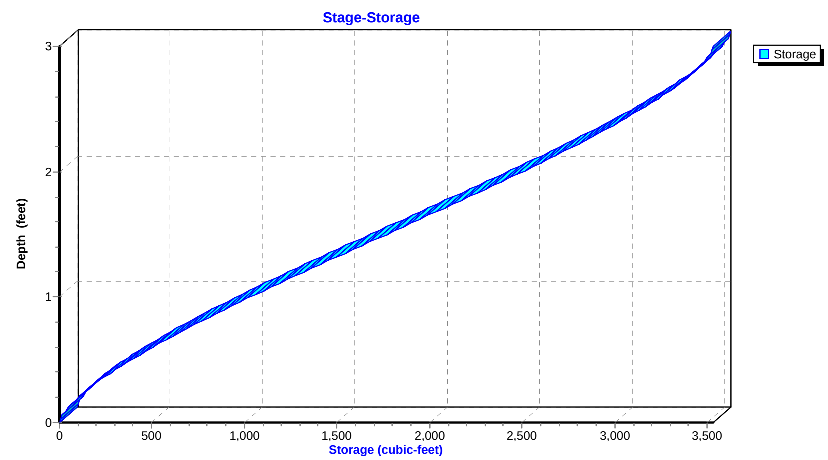
Reach 29R: 36"



Reach 29R: 36"



Reach 29R: 36"



Summary for Pond 30P: REAR

Inflow Area = 1.756 ac, 91.90% Impervious, Inflow Depth > 5.01" for 25-Year event
Inflow = 6.64 cfs @ 12.29 hrs, Volume= 0.734 af
Outflow = 1.89 cfs @ 12.83 hrs, Volume= 0.733 af, Atten= 72%, Lag= 32.2 min
Discarded = 1.89 cfs @ 12.83 hrs, Volume= 0.733 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 251.97' @ 12.83 hrs Surf.Area= 7,508 sf Storage= 8,612 cf

Plug-Flow detention time= 30.1 min calculated for 0.731 af (100% of inflow)
Center-of-Mass det. time= 29.8 min (789.6 - 759.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	250.30'	6,653 cf	**68.00'W x 110.42'L x 3.50'H Field A** 26,279 cf Overall - 9,647 cf Embedded = 16,632 cf x 40.0% Voids
#2A	250.80'	9,647 cf	**ADS_StormTech SC-740 +Cap** x 210 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 210 Chambers in 14 Rows
		16,300 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	250.30'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 245.00'
#2	Primary	254.00'	**12.0" Round Culvert** L= 122.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 254.00' / 252.00' S= 0.0164 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf

Discarded OutFlow Max=1.89 cfs @ 12.83 hrs HW=251.97' (Free Discharge)
↑—**1=Exfiltration** (Controls 1.89 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=250.30' (Free Discharge)
↑—**2=Culvert** (Controls 0.00 cfs)

Pond 30P: REAR - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

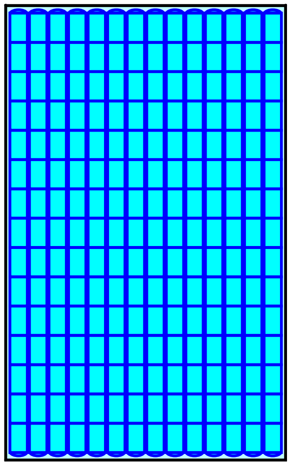
15 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 108.42' Row Length +12.0" End Stone x 2 = 110.42' Base Length
14 Rows x 51.0" Wide + 6.0" Spacing x 13 + 12.0" Side Stone x 2 = 68.00' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

210 Chambers x 45.9 cf = 9,647.4 cf Chamber Storage

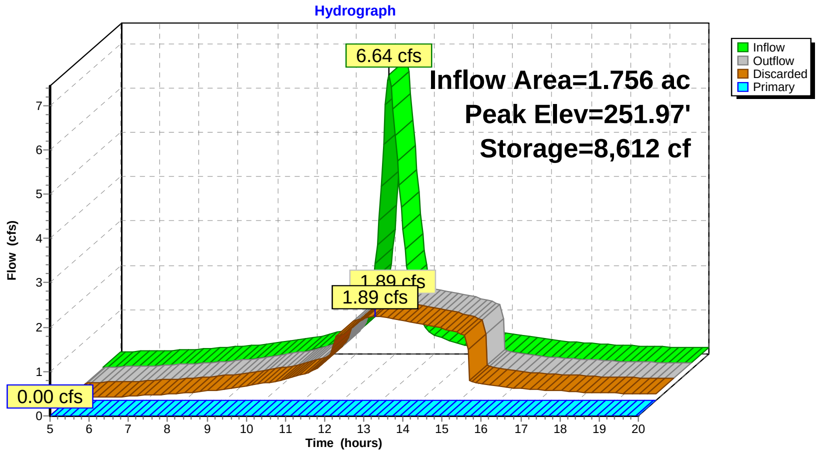
26,279.2 cf Field - 9,647.4 cf Chambers = 16,631.8 cf Stone x 40.0% Voids = 6,652.7 cf Stone Storage

Chamber Storage + Stone Storage = 16,300.1 cf = 0.374 af
Overall Storage Efficiency = 62.0%
Overall System Size = 110.42' x 68.00' x 3.50'

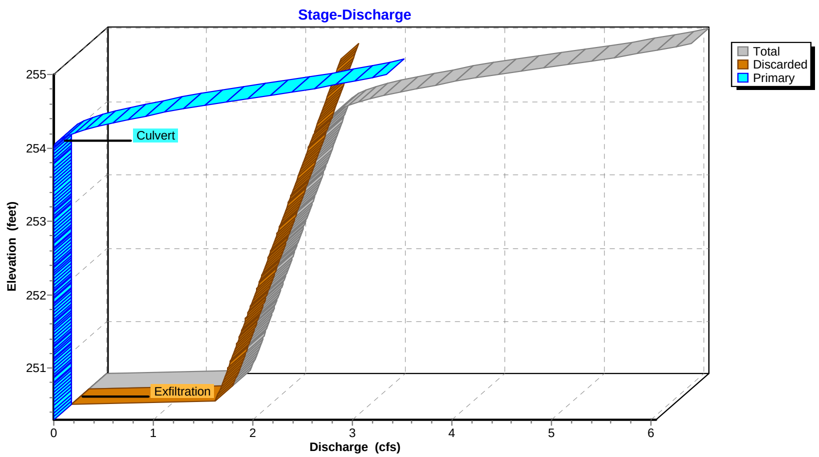
210 Chambers
973.3 cy Field
616.0 cy Stone



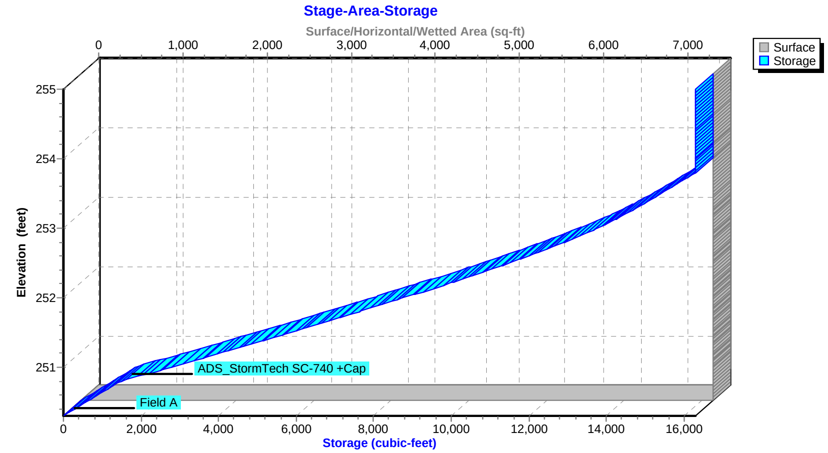
Pond 30P: REAR



Pond 30P: REAR



Pond 30P: REAR



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 6S: REAR Runoff Area=58,428 sf 100.00% Impervious Runoff Depth>7.87"
Tc=6.0 min CN=98 Runoff=11.32 cfs 0.880 af

Subcatchment 7S: FISHER Runoff Area=280,000 sf 100.00% Impervious Runoff Depth>7.87"
Tc=10.0 min CN=98 Runoff=48.09 cfs 4.215 af

Subcatchment 8S: NORTH 3,5 & 7 Runoff Area=81,346 sf 100.00% Impervious Runoff Depth>7.87"
Tc=6.0 min CN=98 Runoff=15.76 cfs 1.225 af

Subcatchment 9S: OVRLND Runoff Area=20,061 sf 89.03% Impervious Runoff Depth>7.47"
Tc=6.0 min CN=93 Runoff=3.81 cfs 0.287 af

Subcatchment 10S: West Central Runoff Area=10,000 sf 100.00% Impervious Runoff Depth>7.87"
Tc=6.0 min CN=98 Runoff=1.94 cfs 0.151 af

Subcatchment 11S: BLDG (DEMO) Runoff Area=20,719 sf 100.00% Impervious Runoff Depth>7.87"
Tc=6.0 min CN=98 Runoff=4.01 cfs 0.312 af

Subcatchment 12S: East Central A 36" Runoff Area=435,600 sf 30.00% Impervious Runoff Depth>3.30"
Tc=6.0 min CN=57 Runoff=40.54 cfs 2.750 af

Subcatchment 13S: FRT LOT Runoff Area=37,280 sf 50.00% Impervious Runoff Depth>4.71"
Tc=0.0 min CN=69 Runoff=5.81 cfs 0.336 af

Subcatchment 15S: REAR Runoff Area=122,723 sf 17.28% Impervious Runoff Depth>4.09"
Tc=22.0 min CN=64 Runoff=9.43 cfs 0.960 af

Subcatchment 16S: REAR Runoff Area=58,900 sf 82.55% Impervious Runoff Depth>6.94"
Tc=6.0 min CN=88 Runoff=10.72 cfs 0.783 af

Subcatchment 17S: FISHER Runoff Area=280,000 sf 100.00% Impervious Runoff Depth>7.87"
Tc=10.0 min CN=98 Runoff=48.09 cfs 4.215 af

Subcatchment 18S: NORTH 3,5 & 7 Runoff Area=86,000 sf 74.42% Impervious Runoff Depth>6.37"
Tc=6.0 min CN=83 Runoff=14.76 cfs 1.048 af

Subcatchment 19S: OVRLND Runoff Area=20,061 sf 74.08% Impervious Runoff Depth>6.37"
Tc=6.0 min CN=83 Runoff=3.44 cfs 0.244 af

Subcatchment 20S: West Central Runoff Area=10,000 sf 100.00% Impervious Runoff Depth>7.87"
Tc=6.0 min CN=98 Runoff=1.94 cfs 0.151 af

Subcatchment 21S: BLDG (DEMO) NEW Runoff Area=20,709 sf 73.41% Impervious Runoff Depth>6.25"
Tc=6.0 min CN=82 Runoff=3.51 cfs 0.248 af

Subcatchment 22S: East Central A 36" Runoff Area=435,600 sf 30.00% Impervious Runoff Depth>3.30"
Tc=6.0 min CN=57 Runoff=40.54 cfs 2.750 af

Subcatchment 23S: FRT LOT Runoff Area=37,240 sf 67.13% Impervious Runoff Depth>5.90"
Tc=0.0 min CN=79 Runoff=7.07 cfs 0.421 af

Subcatchment 24S: REAR Runoff Area=76,475 sf 91.90% Impervious Runoff Depth>7.46"
Tc=22.0 min CN=93 Runoff=9.71 cfs 1.091 af

Reach 1R: Channel Discharge Avg. Flow Depth=2.03' Max Vel=20.20 fps Inflow=130.40 cfs 11.111 af
48.0" Round Pipe n=0.013 L=800.0' S=0.0313 '/' Capacity=253.93 cfs Outflow=126.84 cfs 11.099 af

Reach 2R: CHANNEL SE Inflow=78.36 cfs 5.935 af
Outflow=78.36 cfs 5.935 af

Reach 3R: CHANNEL, NE Inflow=67.20 cfs 5.055 af
Outflow=67.20 cfs 5.055 af

Reach 4R: 24" Avg. Flow Depth=0.98' Max Vel=8.94 fps Inflow=13.62 cfs 1.085 af
24.0" Round Pipe n=0.015 L=380.0' S=0.0211 '/' Capacity=28.45 cfs Outflow=13.33 cfs 1.084 af

Reach 5R: 36" Avg. Flow Depth=1.46' Max Vel=11.80 fps Inflow=40.54 cfs 2.750 af
36.0" Round Pipe n=0.013 L=500.0' S=0.0160 '/' Capacity=84.37 cfs Outflow=39.11 cfs 2.747 af

Reach 25R: Channel Discharge Avg. Flow Depth=1.96' Max Vel=19.93 fps Inflow=123.30 cfs 9.855 af
48.0" Round Pipe n=0.013 L=800.0' S=0.0313 '/' Capacity=253.93 cfs Outflow=119.71 cfs 9.845 af

Reach 26R: CHANNEL SE Inflow=76.64 cfs 5.640 af
Outflow=76.64 cfs 5.640 af

Reach 27R: CHANNEL, NE Inflow=66.05 cfs 4.857 af
Outflow=66.05 cfs 4.857 af

Reach 28R: 24" Avg. Flow Depth=0.98' Max Vel=8.97 fps Inflow=13.62 cfs 1.063 af
24.0" Round Pipe n=0.015 L=380.0' S=0.0211 '/' Capacity=28.45 cfs Outflow=13.42 cfs 1.062 af

Reach 29R: 36" Avg. Flow Depth=1.46' Max Vel=11.80 fps Inflow=40.54 cfs 2.750 af
36.0" Round Pipe n=0.013 L=500.0' S=0.0160 '/' Capacity=84.37 cfs Outflow=39.11 cfs 2.747 af

Pond 30P: REAR Peak Elev=253.37' Storage=15,020 cf Inflow=9.71 cfs 1.091 af
Discarded=2.27 cfs 1.091 af Primary=0.00 cfs 0.000 af Outflow=2.27 cfs 1.091 af

Total Runoff Area = 48.006 ac Runoff Volume = 22.066 af Average Runoff Depth = 5.52"
37.95% Pervious = 18.219 ac 62.05% Impervious = 29.787 ac

Summary for Subcatchment 6S: REAR

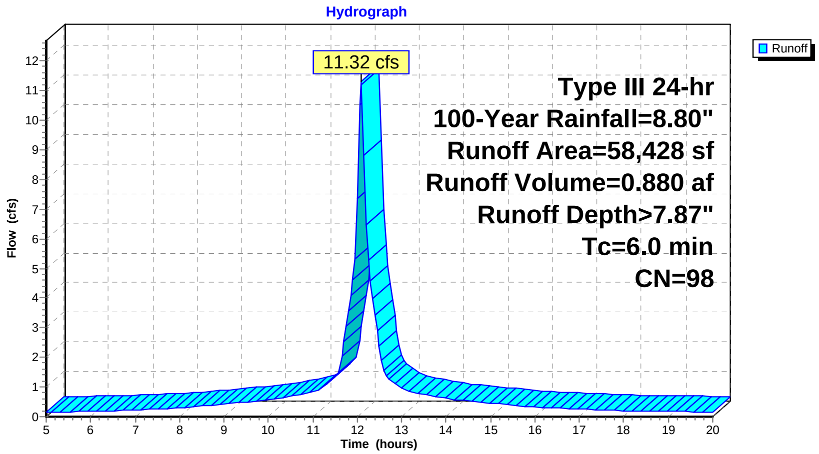
Runoff = 11.32 cfs @ 12.09 hrs, Volume= 0.880 af, Depth> 7.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
58,428	98	Paved parking, HSG A
58,428		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 6S: REAR



Summary for Subcatchment 7S: FISHER

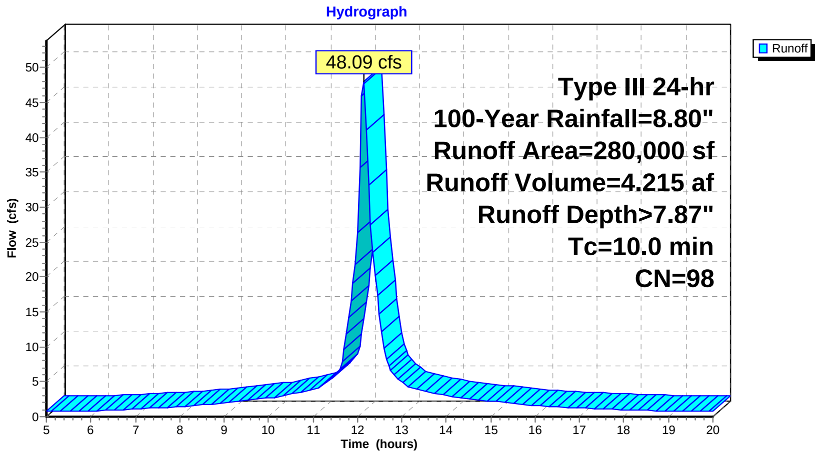
Runoff = 48.09 cfs @ 12.14 hrs, Volume= 4.215 af, Depth> 7.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
280,000	98	Paved parking, HSG A
280,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 7S: FISHER



Summary for Subcatchment 8S: NORTH 3,5 & 7

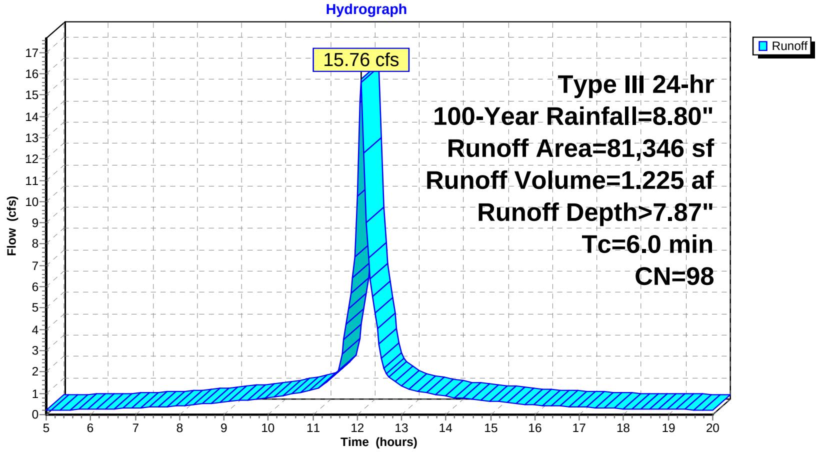
Runoff = 15.76 cfs @ 12.09 hrs, Volume= 1.225 af, Depth> 7.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
81,346	98	Paved parking, HSG A
81,346		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 8S: NORTH 3,5 & 7



Summary for Subcatchment 9S: OVRLND

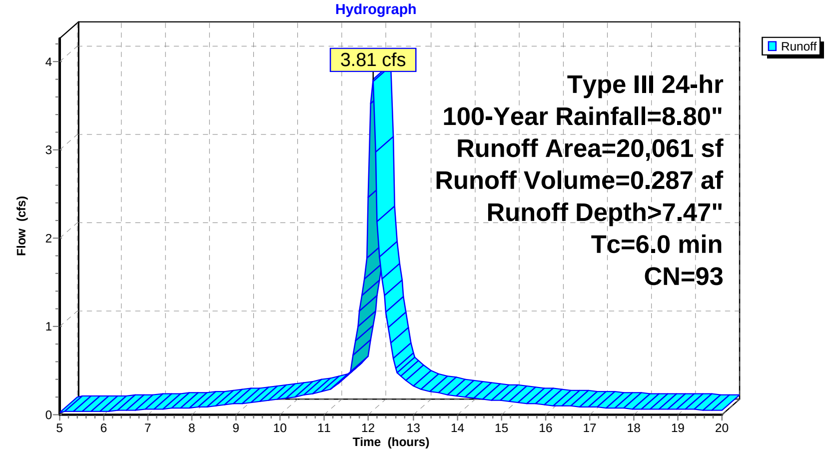
Runoff = 3.81 cfs @ 12.09 hrs, Volume= 0.287 af, Depth> 7.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
17,861	98	Paved parking, HSG A
2,200	49	50-75% Grass cover, Fair, HSG A
20,061	93	Weighted Average
2,200		10.97% Pervious Area
17,861		89.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 9S: OVRLND



Summary for Subcatchment 10S: West Central

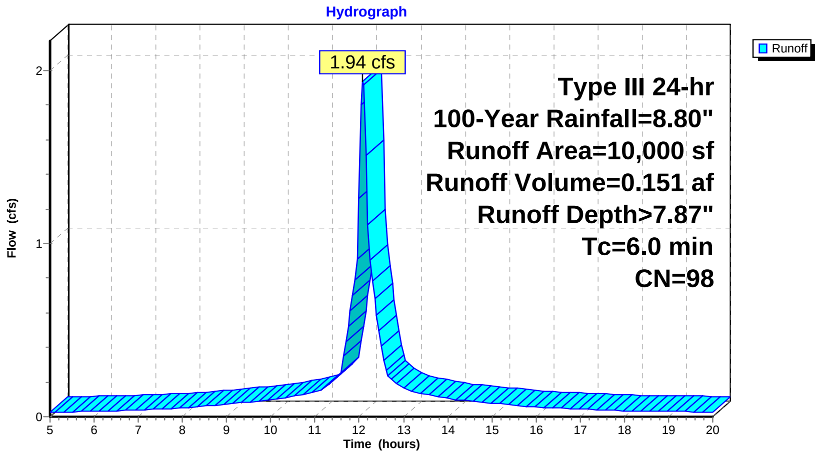
Runoff = 1.94 cfs @ 12.09 hrs, Volume= 0.151 af, Depth> 7.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
10,000	98	Paved roads w/curbs & sewers, HSG A
10,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 10S: West Central



Summary for Subcatchment 11S: BLDG (DEMO)

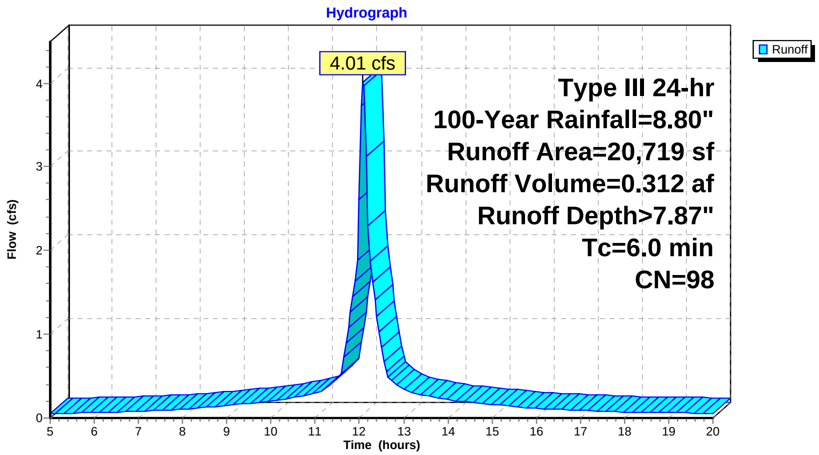
Runoff = 4.01 cfs @ 12.09 hrs, Volume= 0.312 af, Depth> 7.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
20,719	98	Unconnected roofs, HSG A
20,719		100.00% Impervious Area
20,719		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 11S: BLDG (DEMO)



Summary for Subcatchment 12S: East Central A 36"

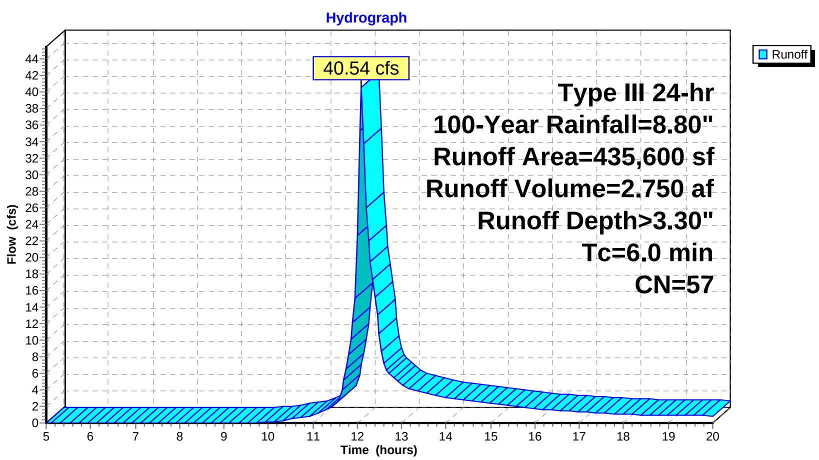
Runoff = 40.54 cfs @ 12.10 hrs, Volume= 2.750 af, Depth> 3.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

	Area (sf)	CN	Description
*	435,600	57	(Approximated) 1/3 acre lots, 30% imp, HSG A
	304,920		70.00% Pervious Area
	130,680		30.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 12S: East Central A 36"



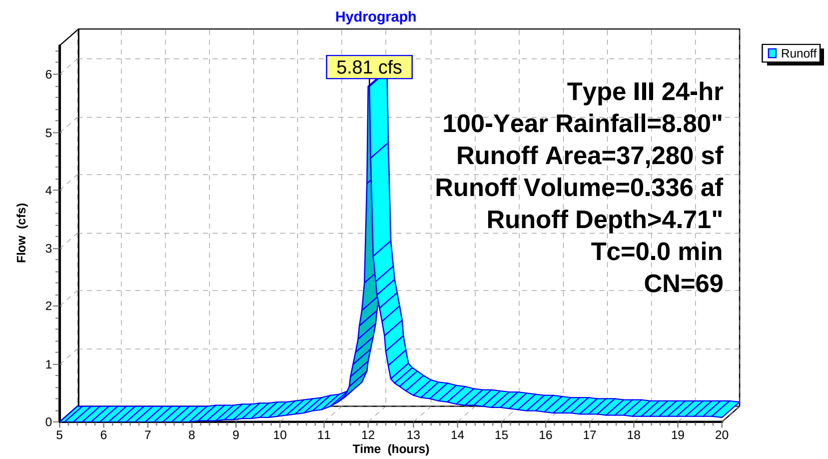
Summary for Subcatchment 13S: FRT LOT

Runoff = 5.81 cfs @ 12.00 hrs, Volume= 0.336 af, Depth> 4.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
18,640	98	Paved parking, HSG A
18,640	39	>75% Grass cover, Good, HSG A
37,280	69	Weighted Average
18,640		50.00% Pervious Area
18,640		50.00% Impervious Area

Subcatchment 13S: FRT LOT



Summary for Subcatchment 15S: REAR

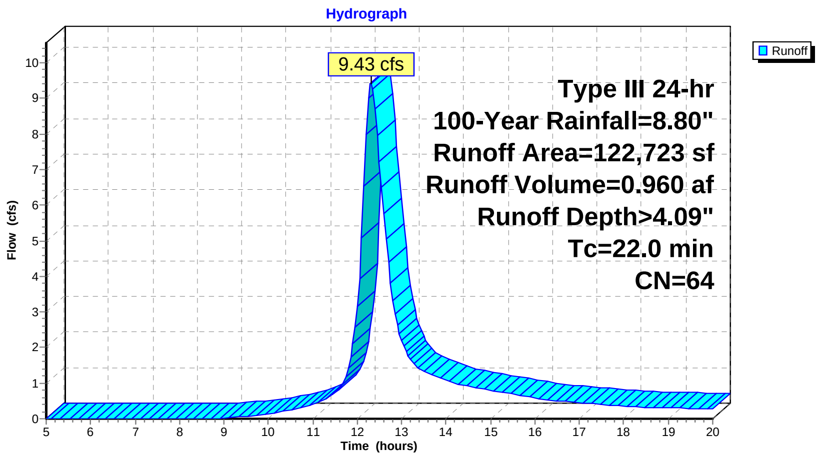
Runoff = 9.43 cfs @ 12.31 hrs, Volume= 0.960 af, Depth> 4.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
101,521	57	Woods/grass comb., Poor, HSG A
21,202	98	Paved parking, HSG A
122,723	64	Weighted Average
101,521		82.72% Pervious Area
21,202		17.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.0					**Direct Entry,**

Subcatchment 15S: REAR



Summary for Subcatchment 16S: REAR

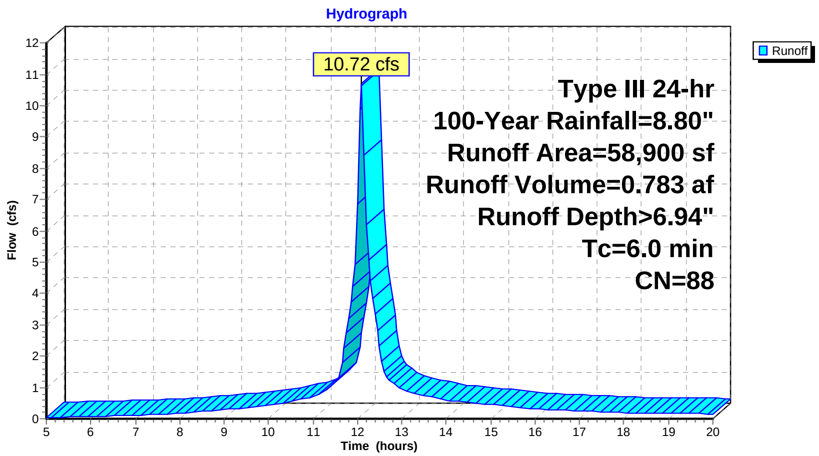
Runoff = 10.72 cfs @ 12.09 hrs, Volume= 0.783 af, Depth> 6.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
48,620	98	Paved parking, HSG A
10,280	39	>75% Grass cover, Good, HSG A
58,900	88	Weighted Average
10,280		17.45% Pervious Area
48,620		82.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 16S: REAR



Summary for Subcatchment 17S: FISHER

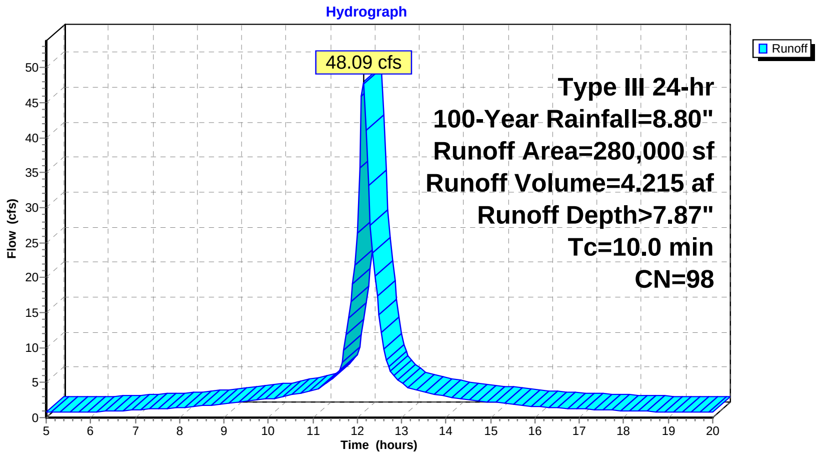
Runoff = 48.09 cfs @ 12.14 hrs, Volume= 4.215 af, Depth> 7.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
280,000	98	Paved parking, HSG A
280,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry,**

Subcatchment 17S: FISHER



Summary for Subcatchment 18S: NORTH 3,5 & 7

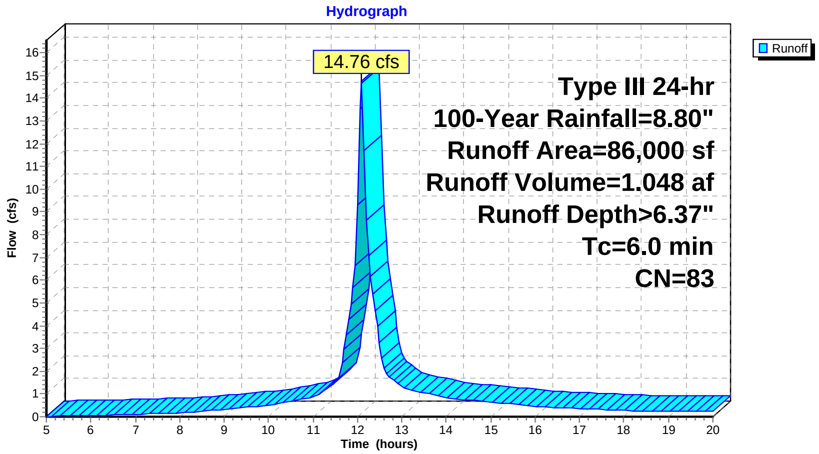
Runoff = 14.76 cfs @ 12.09 hrs, Volume= 1.048 af, Depth> 6.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
64,000	98	Paved parking, HSG A
22,000	39	>75% Grass cover, Good, HSG A
86,000	83	Weighted Average
22,000		25.58% Pervious Area
64,000		74.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 18S: NORTH 3,5 & 7



Summary for Subcatchment 19S: OVRLND

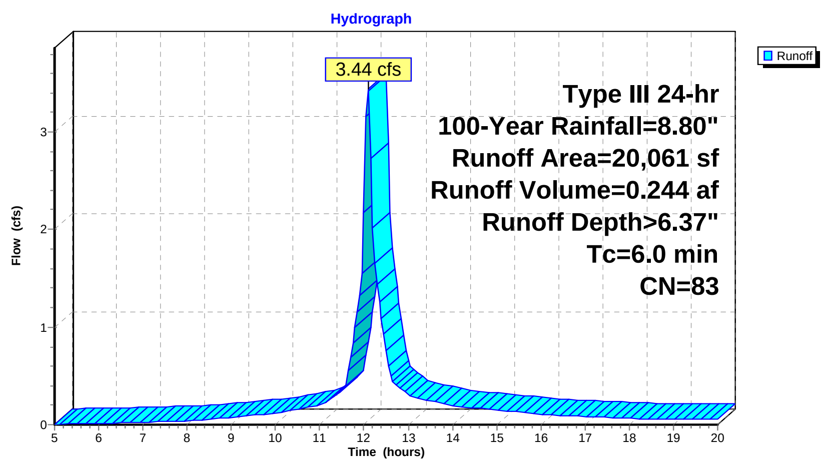
Runoff = 3.44 cfs @ 12.09 hrs, Volume= 0.244 af, Depth> 6.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
14,861	98	Paved parking, HSG A
5,200	39	>75% Grass cover, Good, HSG A
20,061	83	Weighted Average
5,200		25.92% Pervious Area
14,861		74.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 19S: OVRLND



Summary for Subcatchment 20S: West Central

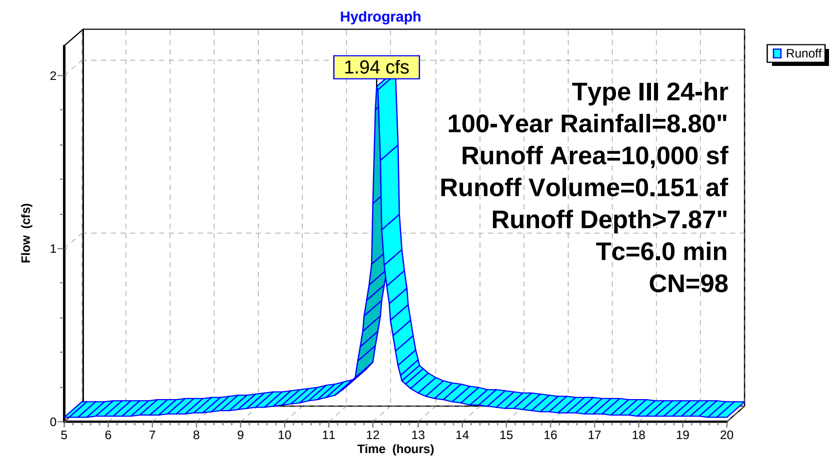
Runoff = 1.94 cfs @ 12.09 hrs, Volume= 0.151 af, Depth> 7.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
10,000	98	Paved roads w/curbs & sewers, HSG A
10,000		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 20S: West Central



Summary for Subcatchment 21S: BLDG (DEMO) NEW PKG

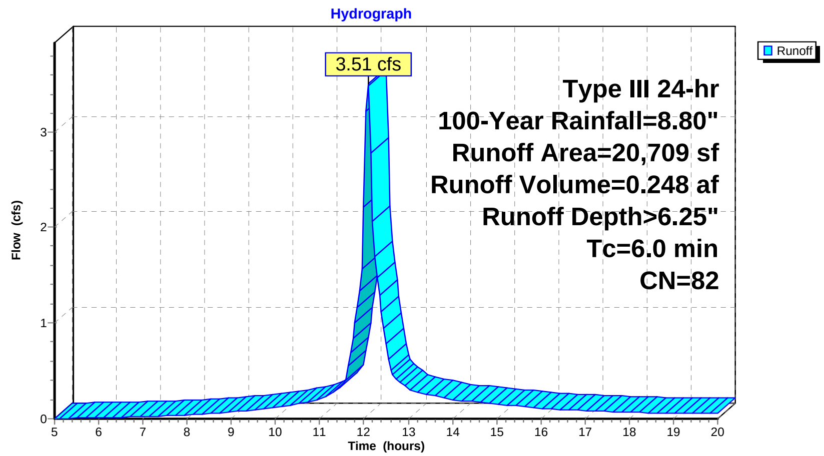
Runoff = 3.51 cfs @ 12.09 hrs, Volume= 0.248 af, Depth> 6.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
15,202	98	Paved parking, HSG A
5,507	39	>75% Grass cover, Good, HSG A
20,709	82	Weighted Average
5,507		26.59% Pervious Area
15,202		73.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 21S: BLDG (DEMO) NEW PKG



Summary for Subcatchment 22S: East Central A 36"

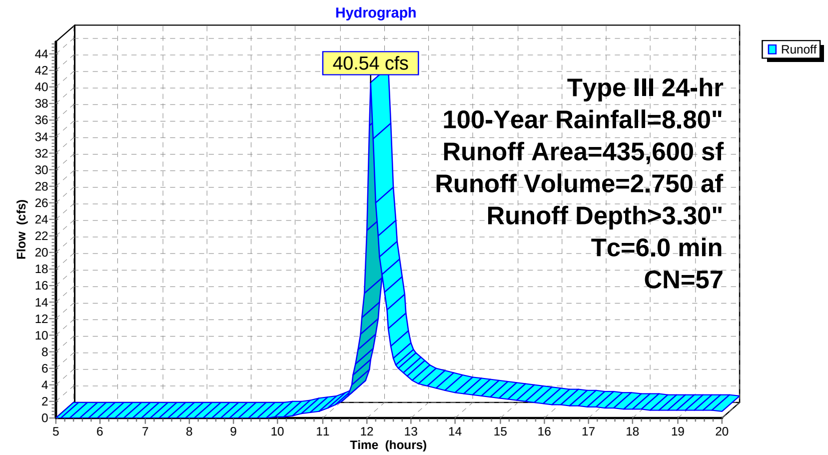
Runoff = 40.54 cfs @ 12.10 hrs, Volume= 2.750 af, Depth> 3.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

	Area (sf)	CN	Description
*	435,600	57	(Approximated) 1/3 acre lots, 30% imp, HSG A
	304,920		70.00% Pervious Area
	130,680		30.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 22S: East Central A 36"



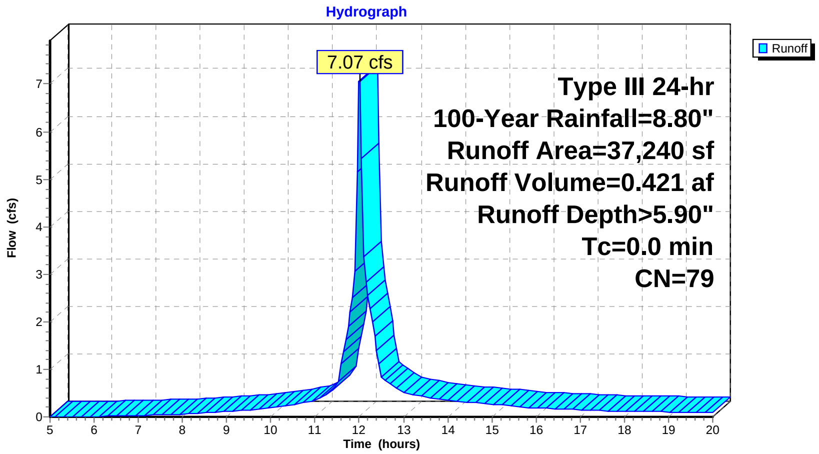
Summary for Subcatchment 23S: FRT LOT

Runoff = 7.07 cfs @ 12.00 hrs, Volume= 0.421 af, Depth> 5.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
25,000	98	Paved parking, HSG A
12,240	39	>75% Grass cover, Good, HSG A
37,240	79	Weighted Average
12,240		32.87% Pervious Area
25,000		67.13% Impervious Area

Subcatchment 23S: FRT LOT



Summary for Subcatchment 24S: REAR

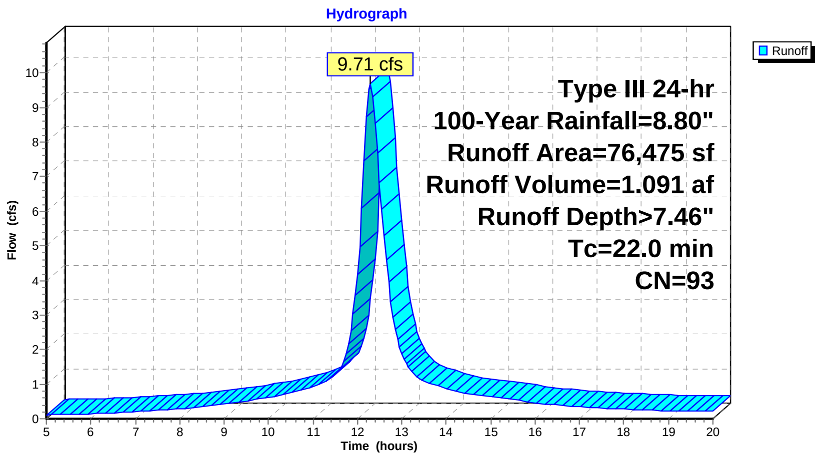
Runoff = 9.71 cfs @ 12.29 hrs, Volume= 1.091 af, Depth> 7.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.80"

Area (sf)	CN	Description
70,278	98	Paved parking, HSG A
6,197	39	>75% Grass cover, Good, HSG A
76,475	93	Weighted Average
6,197		8.10% Pervious Area
70,278		91.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.0					**Direct Entry,**

Subcatchment 24S: REAR



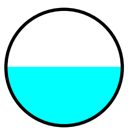
Summary for Reach 1R: Channel Discharge

Inflow Area = 24.476 ac, 59.92% Impervious, Inflow Depth > 5.45" for 100-Year event
Inflow = 130.40 cfs @ 12.11 hrs, Volume= 11.111 af
Outflow = 126.84 cfs @ 12.14 hrs, Volume= 11.099 af, Atten= 3%, Lag= 1.4 min

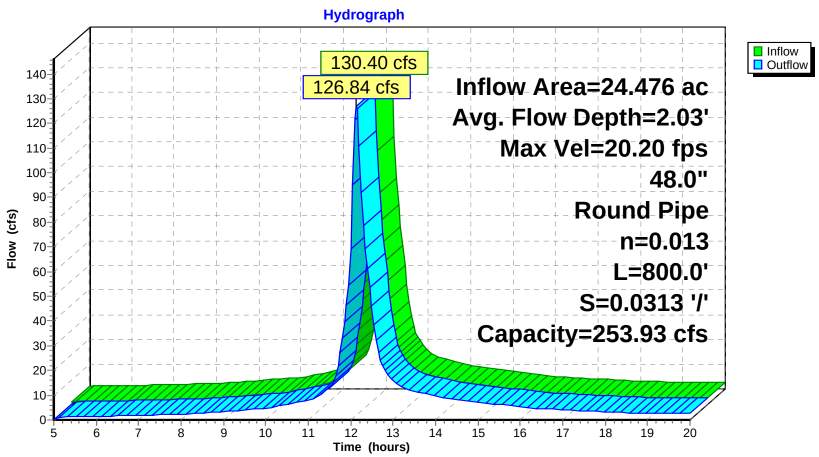
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 20.20 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 8.20 fps, Avg. Travel Time= 1.6 min

Peak Storage= 5,109 cf @ 12.12 hrs
Average Depth at Peak Storage= 2.03'
Bank-Full Depth= 4.00' Flow Area= 12.6 sf, Capacity= 253.93 cfs

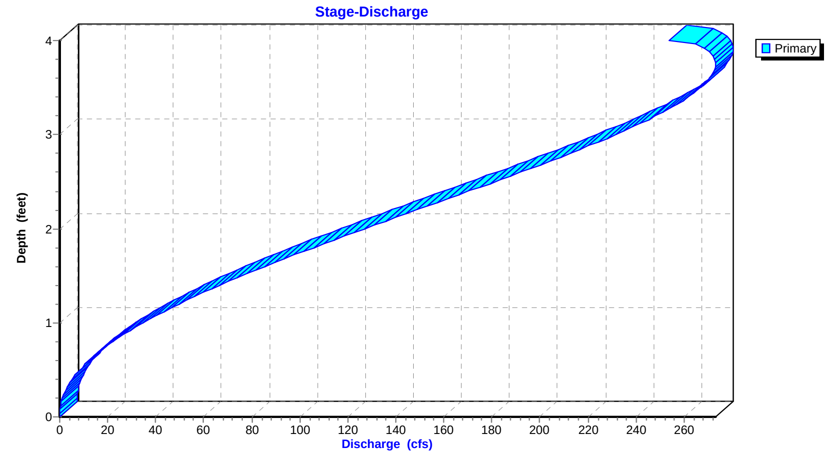
48.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 800.0' Slope= 0.0313 '/'
Inlet Invert= 250.00', Outlet Invert= 225.00'



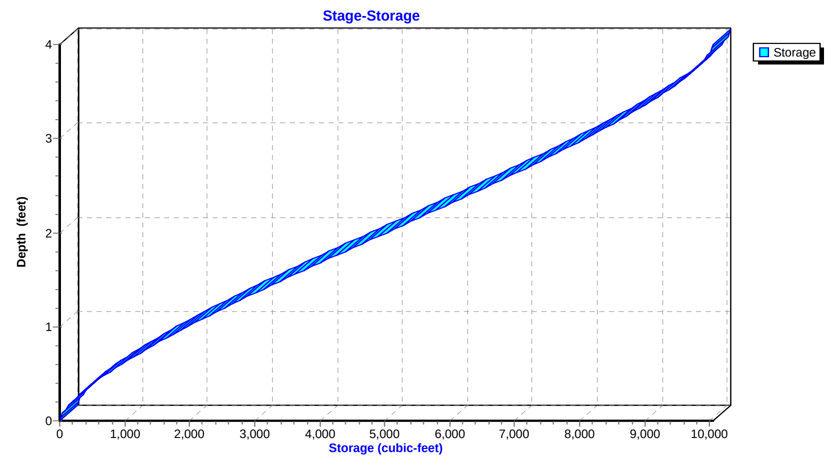
Reach 1R: Channel Discharge



Reach 1R: Channel Discharge



Reach 1R: Channel Discharge

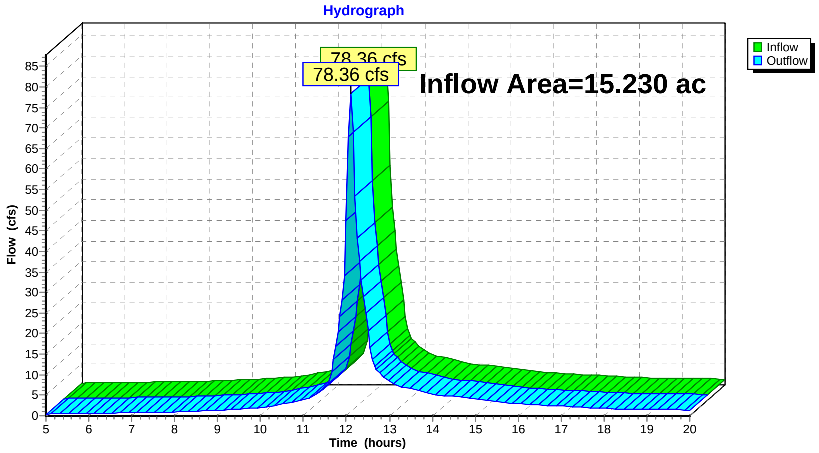


Summary for Reach 2R: CHANNEL SE

Inflow Area = 15.230 ac, 50.90% Impervious, Inflow Depth > 4.68" for 100-Year event
Inflow = 78.36 cfs @ 12.10 hrs, Volume= 5.935 af
Outflow = 78.36 cfs @ 12.10 hrs, Volume= 5.935 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 2R: CHANNEL SE

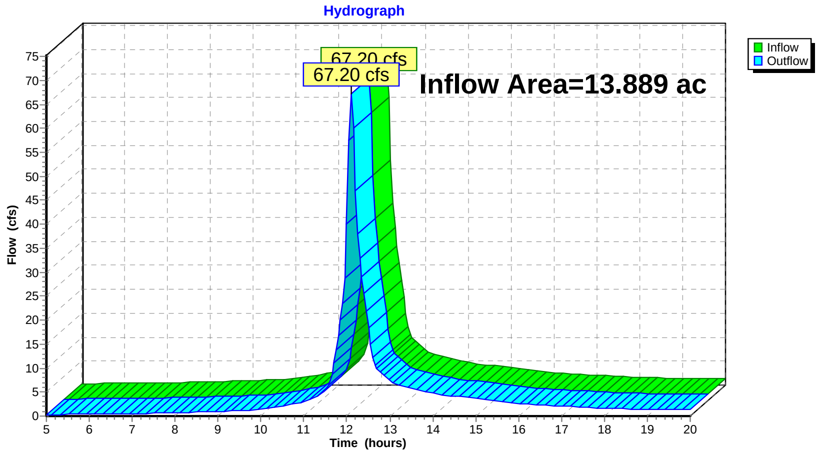


Summary for Reach 3R: CHANNEL, NE

Inflow Area = 13.889 ac, 46.16% Impervious, Inflow Depth > 4.37" for 100-Year event
Inflow = 67.20 cfs @ 12.10 hrs, Volume= 5.055 af
Outflow = 67.20 cfs @ 12.10 hrs, Volume= 5.055 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 3R: CHANNEL, NE



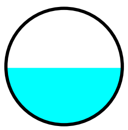
Summary for Reach 4R: 24"

Inflow Area = 2.022 ac, 76.33% Impervious, Inflow Depth > 6.44" for 100-Year event
Inflow = 13.62 cfs @ 12.05 hrs, Volume= 1.085 af
Outflow = 13.33 cfs @ 12.07 hrs, Volume= 1.084 af, Atten= 2%, Lag= 1.2 min

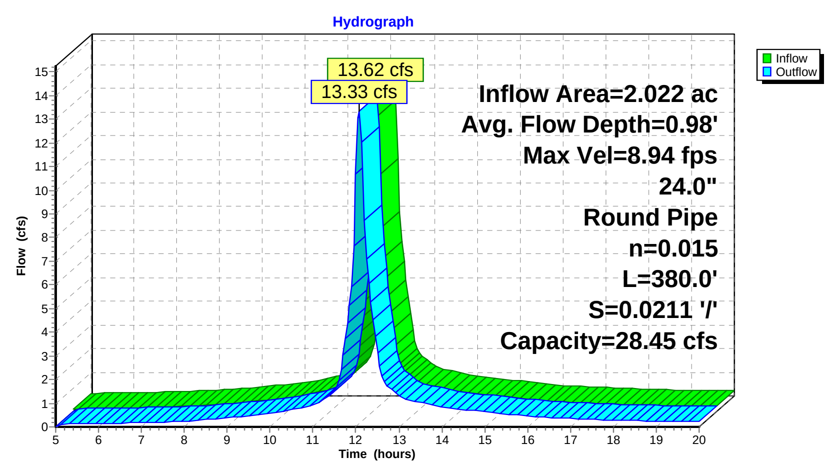
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.94 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 3.52 fps, Avg. Travel Time= 1.8 min

Peak Storage= 578 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.98'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 28.45 cfs

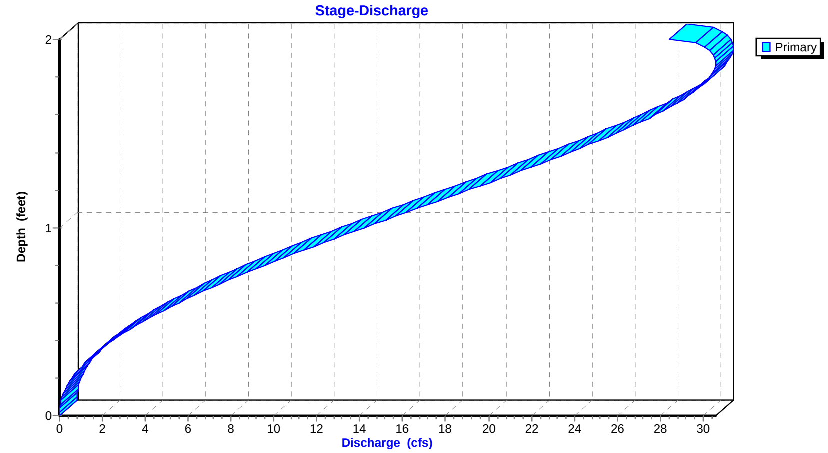
24.0" Round Pipe
n= 0.015 Concrete sewer w/manholes & inlets
Length= 380.0' Slope= 0.0211 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



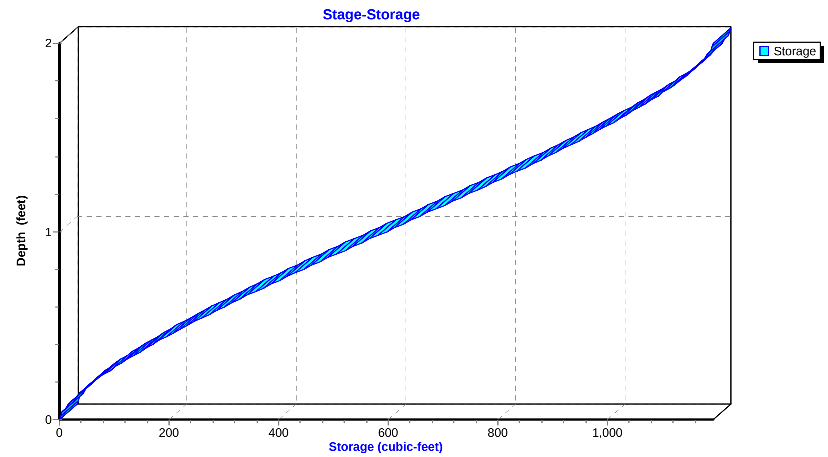
Reach 4R: 24"



Reach 4R: 24"



Reach 4R: 24"



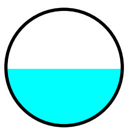
Summary for Reach 5R: 36"

Inflow Area = 10.000 ac, 30.00% Impervious, Inflow Depth > 3.30" for 100-Year event
Inflow = 40.54 cfs @ 12.10 hrs, Volume= 2.750 af
Outflow = 39.11 cfs @ 12.12 hrs, Volume= 2.747 af, Atten= 4%, Lag= 1.2 min

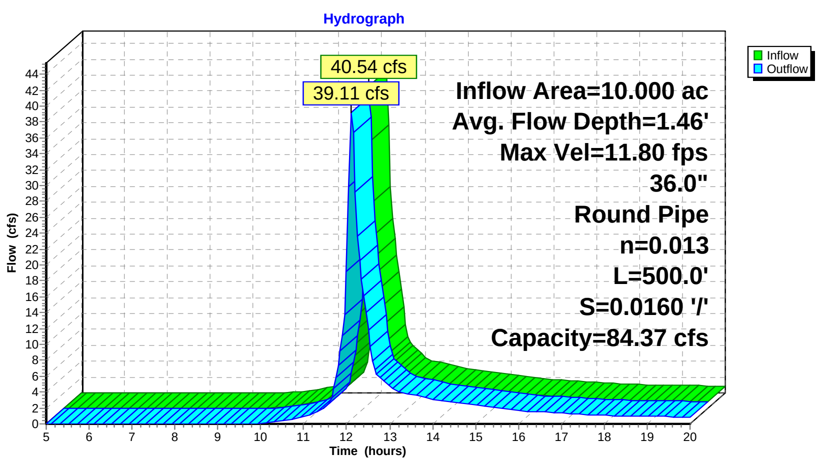
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 11.80 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 4.94 fps, Avg. Travel Time= 1.7 min

Peak Storage= 1,713 cf @ 12.11 hrs
Average Depth at Peak Storage= 1.46'
Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 84.37 cfs

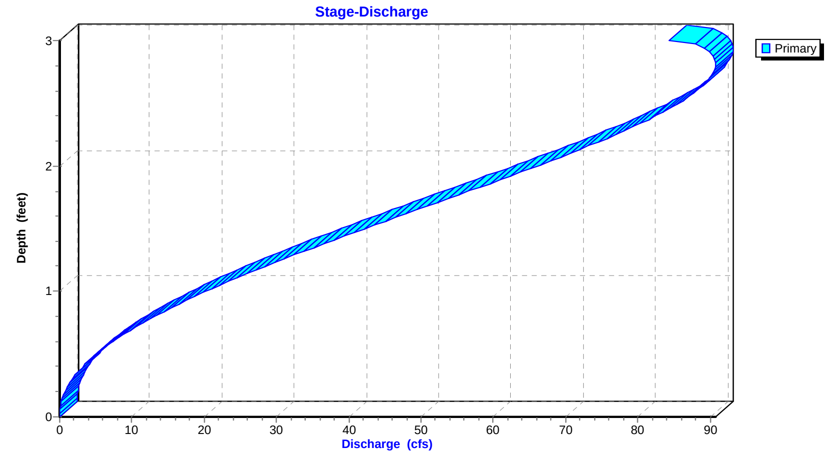
36.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0160 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



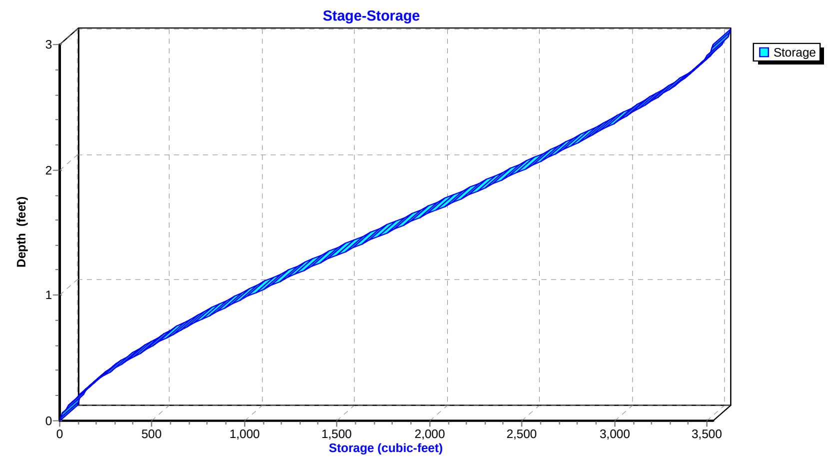
Reach 5R: 36"



Reach 5R: 36"



Reach 5R: 36"



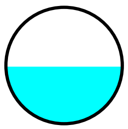
Summary for Reach 25R: Channel Discharge

Inflow Area = 23.530 ac, 64.26% Impervious, Inflow Depth > 5.03" for 100-Year event
Inflow = 123.30 cfs @ 12.11 hrs, Volume= 9.855 af
Outflow = 119.71 cfs @ 12.13 hrs, Volume= 9.845 af, Atten= 3%, Lag= 1.3 min

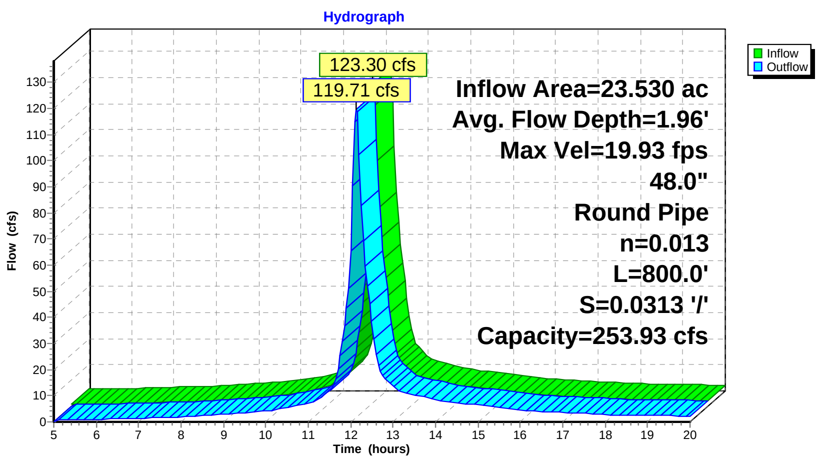
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 19.93 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 7.85 fps, Avg. Travel Time= 1.7 min

Peak Storage= 4,897 cf @ 12.12 hrs
Average Depth at Peak Storage= 1.96'
Bank-Full Depth= 4.00' Flow Area= 12.6 sf, Capacity= 253.93 cfs

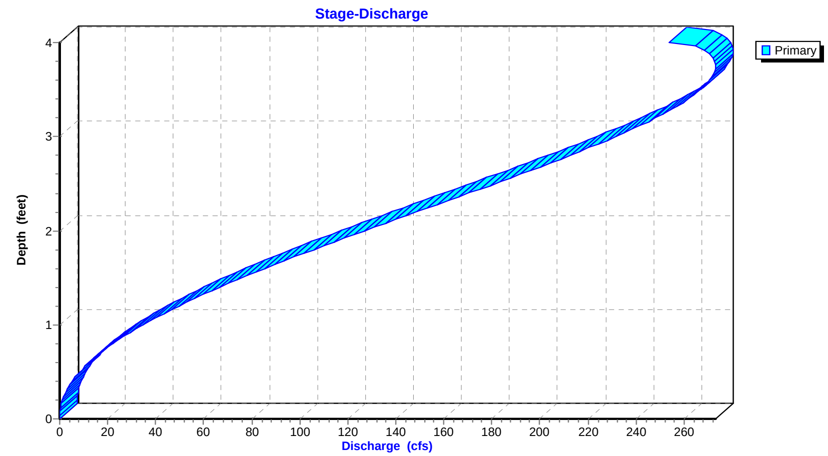
48.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 800.0' Slope= 0.0313 '/'
Inlet Invert= 250.00', Outlet Invert= 225.00'



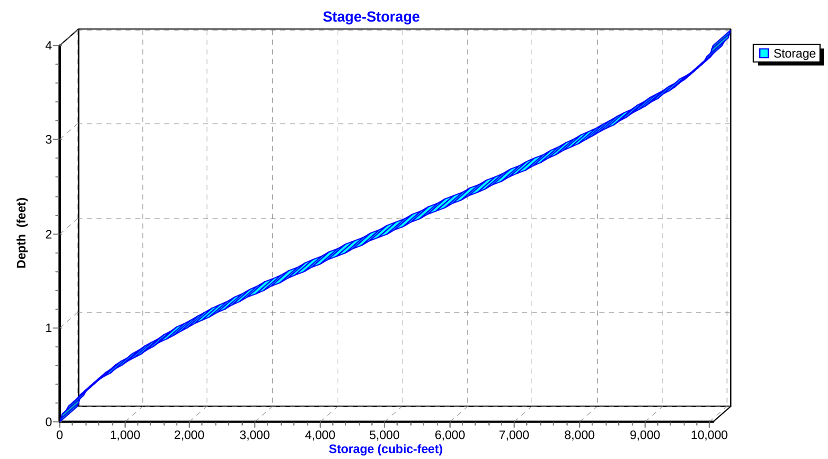
Reach 25R: Channel Discharge



Reach 25R: Channel Discharge



Reach 25R: Channel Discharge

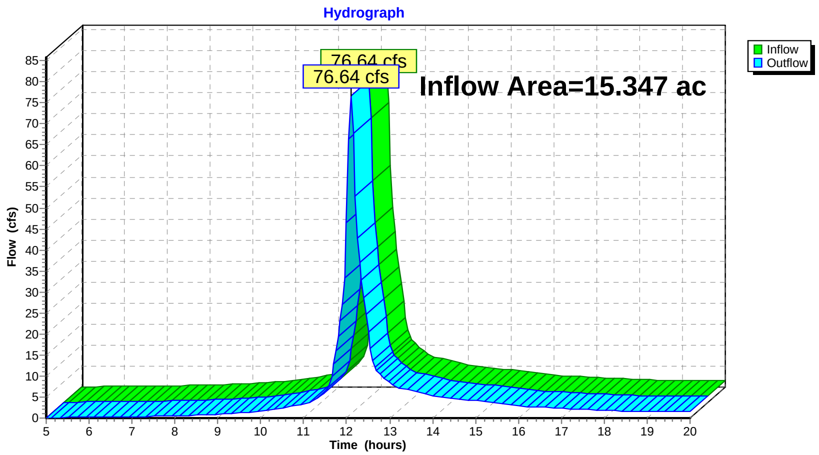


Summary for Reach 26R: CHANNEL SE

Inflow Area =	15.347 ac, 46.13% Impervious, Inflow Depth > 4.41"	for 100-Year event
Inflow =	76.64 cfs @ 12.10 hrs, Volume=	5.640 af
Outflow =	76.64 cfs @ 12.10 hrs, Volume=	5.640 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 26R: CHANNEL SE

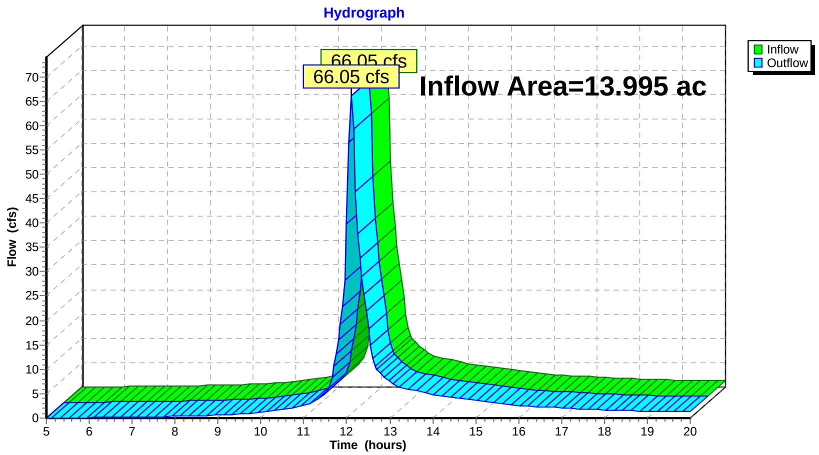


Summary for Reach 27R: CHANNEL, NE

Inflow Area =	13.995 ac, 42.61% Impervious, Inflow Depth > 4.16"	for 100-Year event
Inflow =	66.05 cfs @ 12.10 hrs, Volume=	4.857 af
Outflow =	66.05 cfs @ 12.10 hrs, Volume=	4.857 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 27R: CHANNEL, NE



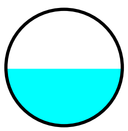
Summary for Reach 28R: 24"

Inflow Area = 2.020 ac, 73.93% Impervious, Inflow Depth > 6.32" for 100-Year event
Inflow = 13.62 cfs @ 12.04 hrs, Volume= 1.063 af
Outflow = 13.42 cfs @ 12.07 hrs, Volume= 1.062 af, Atten= 2%, Lag= 1.3 min

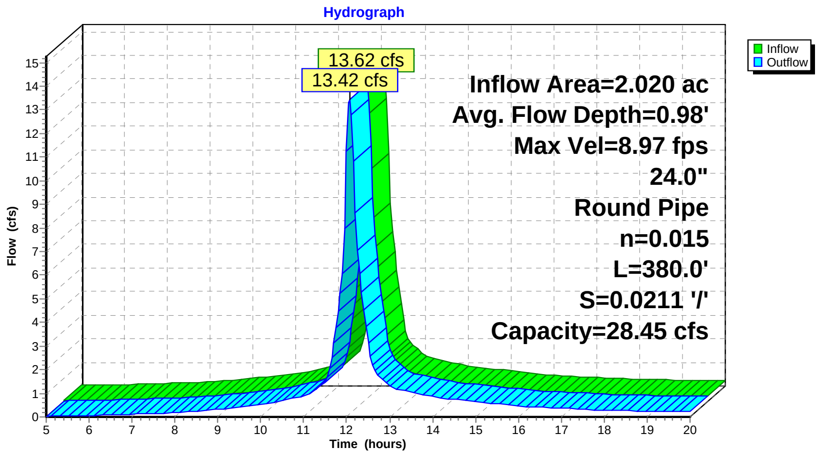
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.97 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 3.41 fps, Avg. Travel Time= 1.9 min

Peak Storage= 580 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.98'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 28.45 cfs

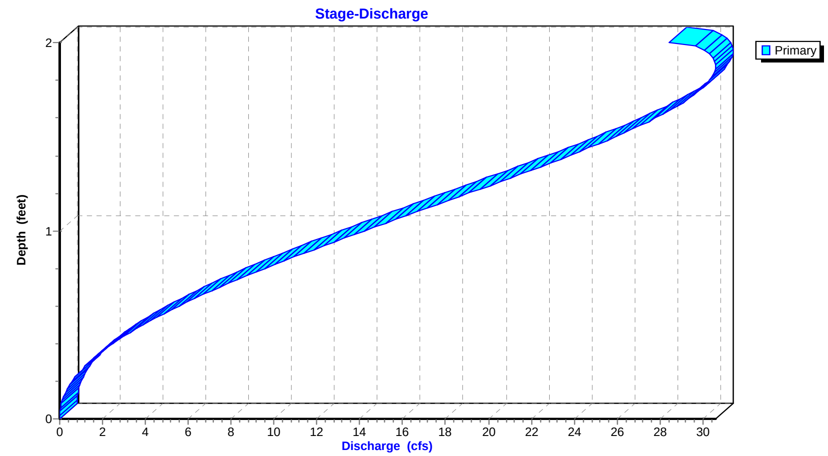
24.0" Round Pipe
n= 0.015 Concrete sewer w/manholes & inlets
Length= 380.0' Slope= 0.0211 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



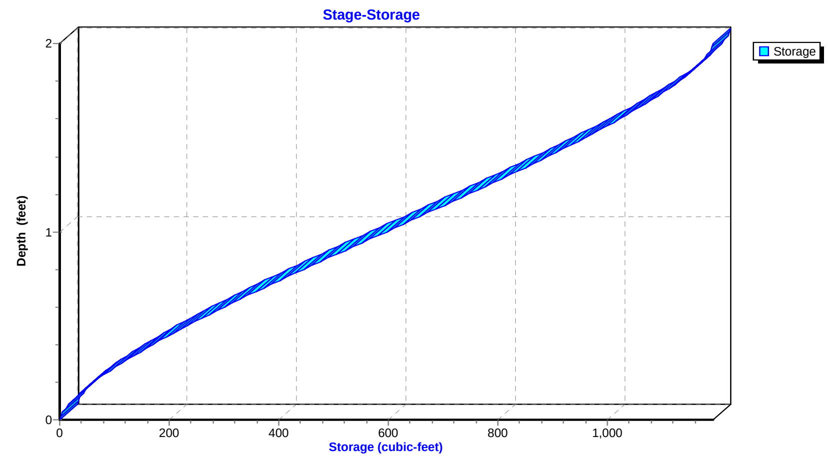
Reach 28R: 24"



Reach 28R: 24"



Reach 28R: 24"



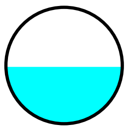
Summary for Reach 29R: 36"

Inflow Area = 10.000 ac, 30.00% Impervious, Inflow Depth > 3.30" for 100-Year event
Inflow = 40.54 cfs @ 12.10 hrs, Volume= 2.750 af
Outflow = 39.11 cfs @ 12.12 hrs, Volume= 2.747 af, Atten= 4%, Lag= 1.2 min

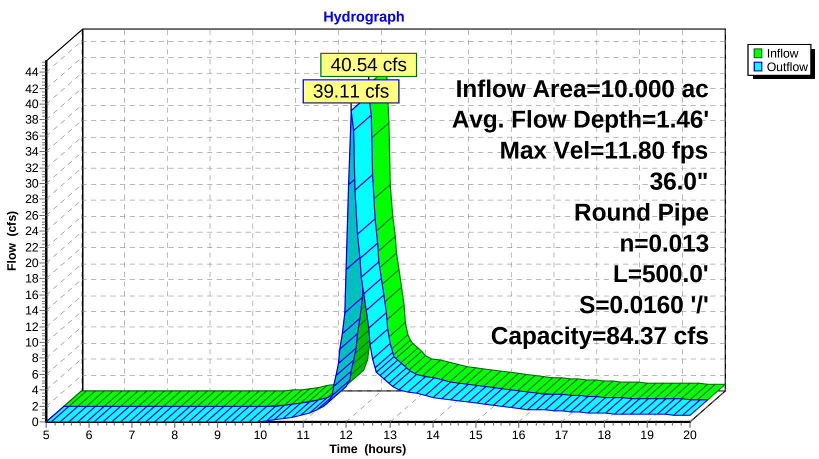
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 11.80 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 4.94 fps, Avg. Travel Time= 1.7 min

Peak Storage= 1,713 cf @ 12.11 hrs
Average Depth at Peak Storage= 1.46'
Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 84.37 cfs

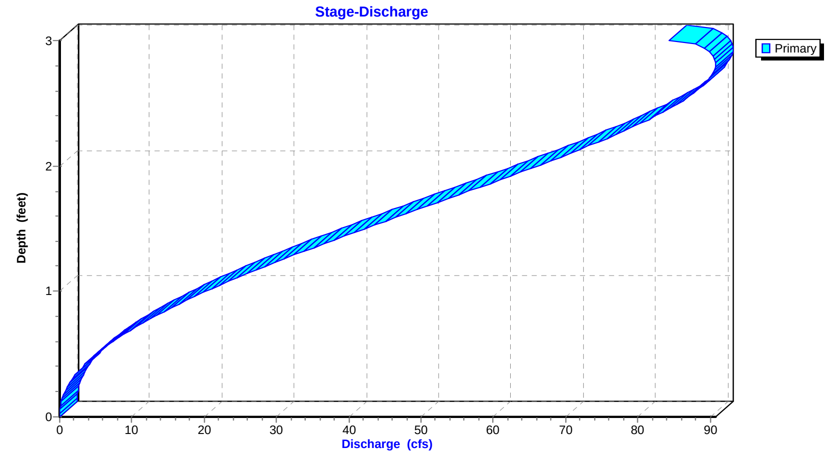
36.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 500.0' Slope= 0.0160 '/'
Inlet Invert= 263.00', Outlet Invert= 255.00'



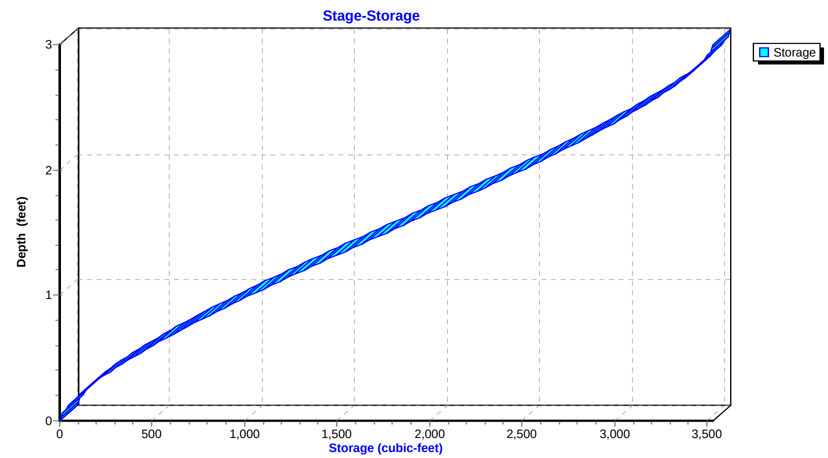
Reach 29R: 36"



Reach 29R: 36"



Reach 29R: 36"



Summary for Pond 30P: REAR

Inflow Area = 1.756 ac, 91.90% Impervious, Inflow Depth > 7.46" for 100-Year event
Inflow = 9.71 cfs @ 12.29 hrs, Volume= 1.091 af
Outflow = 2.27 cfs @ 12.91 hrs, Volume= 1.091 af, Atten= 77%, Lag= 37.0 min
Discarded = 2.27 cfs @ 12.91 hrs, Volume= 1.091 af
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 253.37' @ 12.91 hrs Surf.Area= 7,508 sf Storage= 15,020 cf

Plug-Flow detention time= 50.5 min calculated for 1.087 af (100% of inflow)
Center-of-Mass det. time= 50.0 min (804.1 - 754.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	250.30'	6,653 cf	**68.00'W x 110.42'L x 3.50'H Field A** 26,279 cf Overall - 9,647 cf Embedded = 16,632 cf x 40.0% Voids
#2A	250.80'	9,647 cf	**ADS_StormTech SC-740 +Cap** x 210 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 210 Chambers in 14 Rows
		16,300 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	250.30'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 245.00'
#2	Primary	254.00'	**12.0" Round Culvert** L= 122.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 254.00' / 252.00' S= 0.0164 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf

Discarded OutFlow Max=2.27 cfs @ 12.91 hrs HW=253.37' (Free Discharge)
└─**1=Exfiltration** (Controls 2.27 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=250.30' (Free Discharge)
└─**2=Culvert** (Controls 0.00 cfs)

Pond 30P: REAR - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

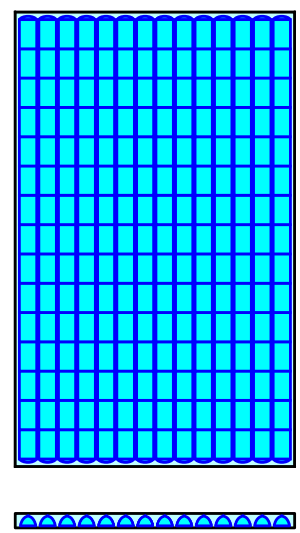
15 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 108.42' Row Length +12.0" End Stone x 2 = 110.42' Base Length
14 Rows x 51.0" Wide + 6.0" Spacing x 13 + 12.0" Side Stone x 2 = 68.00' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

210 Chambers x 45.9 cf = 9,647.4 cf Chamber Storage

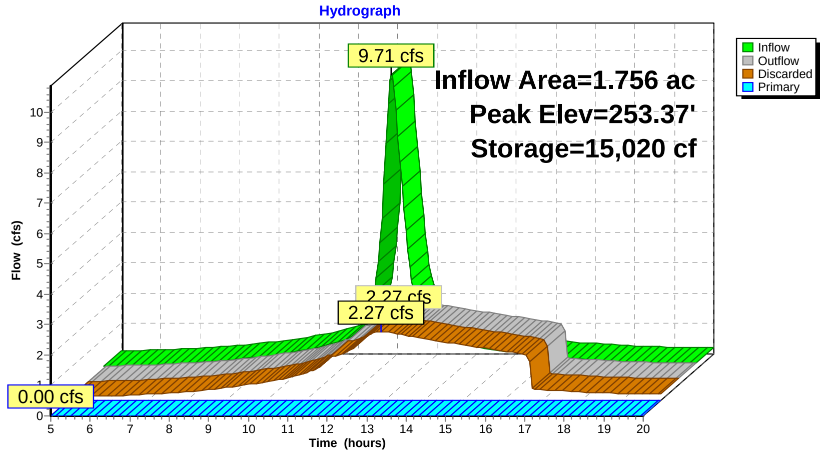
26,279.2 cf Field - 9,647.4 cf Chambers = 16,631.8 cf Stone x 40.0% Voids = 6,652.7 cf Stone Storage

Chamber Storage + Stone Storage = 16,300.1 cf = 0.374 af
Overall Storage Efficiency = 62.0%
Overall System Size = 110.42' x 68.00' x 3.50'

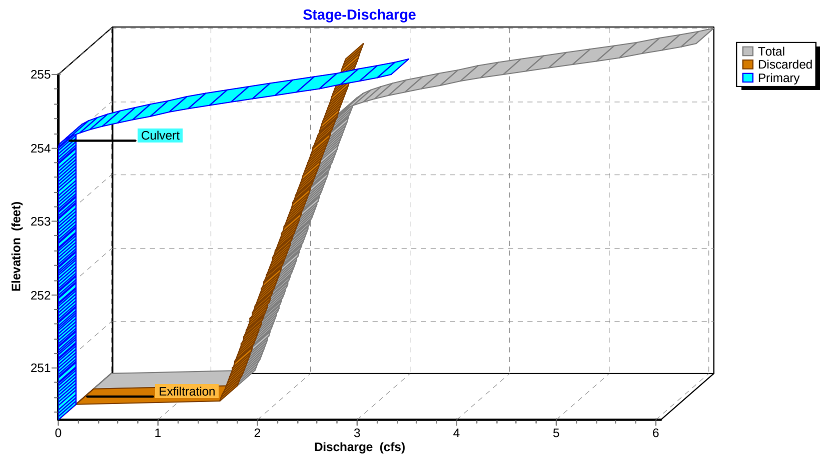
210 Chambers
973.3 cy Field
616.0 cy Stone



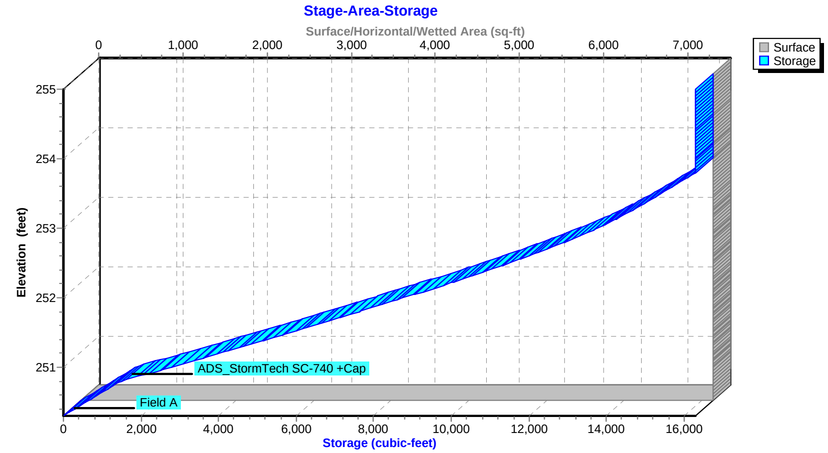
Pond 30P: REAR



Pond 30P: REAR



Pond 30P: REAR

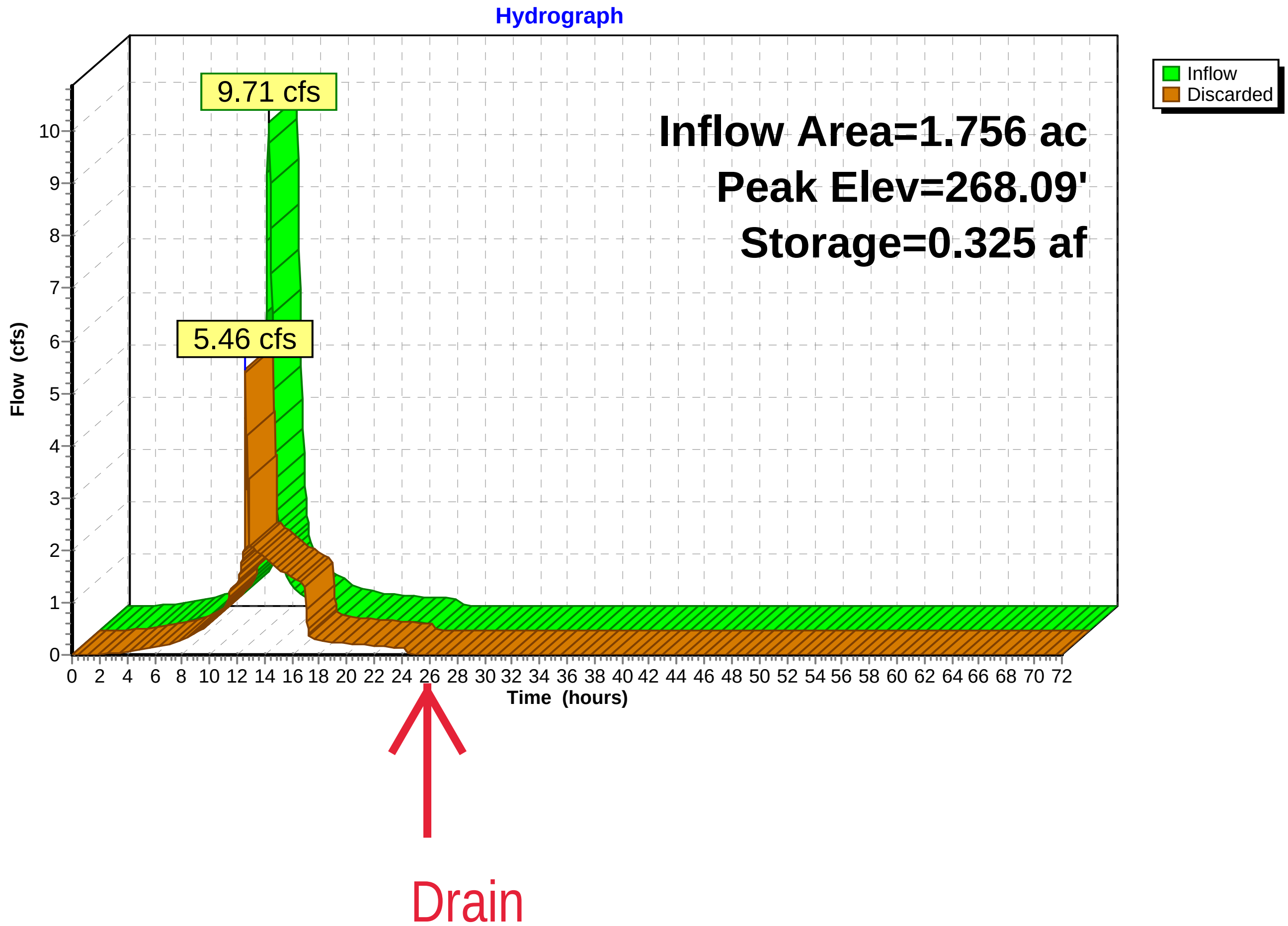


LEVEL
DESIGN GROUP

72-hr Drawdown

249 SOUTH STREET UNIT 1 PLAINVILLE MA 02762
TEL508 695 2221 FAX508 695 2219 CONTACT@LEVELDG.COM LEVELDG.COM

Pond 30P: REAR



LEVEL
DESIGN GROUP

TSS Removal

249 SOUTH STREET UNIT 1 PLAINVILLE MA 02762
TEL 508 695 2221 FAX 508 695 2219 CONTACT@LEVELDG.COM LEVELDG.COM

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: Front parking, parking along Fisher

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Street Sweeping	0.05	**1.00**	0.05	0.95
CDS Treatment	0.82	0.95	0.779	0.171

Total TSS Removal = 82.9%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: Factory Square
Prepared By: DRC
Date: 9-15-21

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

TSS Removal Calculation Worksheet

Location: New Parking-Rear

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Street Sweeping	0.05	**1.00**	0.05	0.95
Hydro-Int (NJCAT)	0.50	0.95	0.475	0.475
Infiltration basin (subsurface)	0.80	0.475	0.38	0.095

Total TSS Removal = 90%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: Factory Square
Prepared By: DRC
Date: 9-15-2021

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

LEVEL
DESIGN GROUP

OPERATION AND MAINTENANCE PLAN

FOR

FACTORY SQUARE
3, 5 & 7 FISHER STREET
(AM 278 PARCEL 16)
FRANKLIN, MASSACHUSETTS

JULY 1, 2021

Prepared By:

Level Design Group, L.L.C.
249 South Street, Unit 1
Plainville, MA 02762

Prepared For:

K Fisher Street LLC
1 Fisher Street
Franklin, MA 02052

LDG Project No.:
1899.00

The proposed Stormwater Management System is designed to function properly provided that routine maintenance is performed. It is the responsibility during construction and until final development of the site and/or property and the formation of an Association to be formed that the Owner and Developer, Rick Kaplan (or any other future Owner/Developer), shall be responsible for the long-term maintenance to provide the required maintenance outlined in this plan for the site infiltration systems as well as the remainder of the on-site storm drainage system.

Upon completion of construction and the formation of the Association, maintenance of driveways, catch basins, and the stormwater appurtenances required to ensure that sedimentation and pollution is controlled and that storm water detention and infiltration capacity is sustained are the on-going responsibility of the Association to ensure the proper functioning of these facilities. The connection point of the site drainage system is a Town Drainage system which is currently to be maintained by the Town of Franklin to maintain flow from Alpine Row. The following maintenance practices will be used:

DRIVEWAYS & PARKING AREAS

Spring Maintenance
Driveways and Parking Areas are to be swept monthly to remove sand which has accumulated. Sand shall be removed from the site and legally disposed of.

Summer & Fall Maintenance
Leaves and debris which accumulates within the Driveways and Parking Areas during the summer and fall shall be collected and legally disposed of.

Winter Maintenance & Snow Removal
Snow removal within Driveways and Parking Area shall be stockpiled in the designated Snow Stockpile Areas outside of the traveled driveways. These areas should be located within or adjacent to the parking surface and should drain to the stormwater management system. Under no circumstances shall snow be directed onto abutting parcels or into the on-site resource areas (wetlands, wetland buffer zone, and riverfront areas).

Estimated Yearly Cost $1,000.00 (not including cost for snow plowing)

GUTTERS AND DOWNSPOUTS

Summer & Fall Maintenance
Leaves and debris which accumulates within the gutters during the summer and fall shall be collected and legally disposed of. Excessive water shall not be introduced to clean the gutters and the downspouts, and materials shall be collected so as not to clog the subsurface basin.

Estimated Yearly Cost $500.00

CATCH BASINS

Catch basins shall be inspected and cleaned four times per year or when the sumps are 50% full.

Spring Maintenance
Catch basins require the removal of sediment each spring. This procedure is comprised of removing the catch basin grate followed by removal of sediment trapped in the structure with a clamshell shovel. The outlet pipe from the catch basin shall be inspected and any obstructions are to be removed. The sediment and debris removed from the catch basin shall be legally disposed of.

Fall Maintenance
Catch basin grates shall be cleared of leaves and debris so they may function properly.

Estimated Yearly Cost *$2,000.00*

CDS and VortSentry Stormwater Treatment Units or approved equal

The Units should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit, i.e., unstable soils or heavy winter sanding will cause the treatment chamber to fill more quickly, but regular sweeping will slow accumulation.

Inspection
Inspection is the key to effective maintenance and is easily performed. Pollutant deposition and transport may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (i.e. spring and fall) however more frequent inspections may be necessary in equipment washdown areas and in climates where winter sanding operations may lead to rapid accumulations of a large volume of sediment. It is useful and often required as part of a permit to keep a record of each inspection. A simple inspection and maintenance log form for doing so is available for download at www.ContechES.com/stormwater

The Units should be cleaned when the sediment has accumulated to a depth of two feet in the treatment chamber. This determination can be made by taking two measurements with a stadia rod or similar measuring device; one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the distance given in Table 2, the Units should be maintained to ensure effective treatment.

Cleaning
Cleaning of the Units should be done during dry weather conditions when no flow is entering the system. Cleanout of the Units with a vacuum truck is generally the most effective and convenient method of excavating pollutants from the system. Simply remove the manhole cover and insert the vacuum hose into the sump. All pollutants can be removed from this one access point from the surface with no requirements for Confined Space Entry. In installations where the risk of petroleum spills is

small, liquid contaminants may not accumulate as quickly as sediment. However, an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use adsorbent pads, which solidify the oils. These are usually much easier to remove from the unit individually, and less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Floating trash can be netted out if you wish to separate it from the other pollutants. Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure proper safety precautions. If anyone physically enters the unit, Confined Space Entry procedures need to be followed. Disposal of all material removed from the CDS Units should be done is accordance with local regulations. In many locations, disposal of evacuated sediments may be handled in the same manner as disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

SUBSURFACE INFILTRATION SYSTEM

Once the system has gone online, inspections should occur after every storm event accumulating greater than 1 inch of rainfall for the first year to ensure proper stabilization and function. Attention should be paid to how long water remains standing in the chambers after a storm. Thereafter, the system should be inspected at least twice per year. Observations and measurements shall be made from the observation ports provided. Important items to check for include: differential settlement, cracking, erosion or leakage. If the system appears to be clogged or not functioning properly at any time, the system is to be flushed in accordance with the 10 year maintenance procedure listed below. Sediment should be removed from the system as necessary. Removal procedures should not take place until the pipes in the system are thoroughly dry. A vacuum truck is usually the most effective and convenient method. If the sediment has traveled past the reach of the vacuum truck the system shall be thoroughly flushed with water, a fire hose or the like is typically the most effective method of flushing. The manhole downstream of this process shall be plugged and sediment collected at this point.

If inspection of the inflow point indicates sediments are accumulating, removal of sediment within the basin may be required. Remove sediments from the catch basin discharge pipes which outlet into the basin. Sediment shall be flushed from the basin at least once every 10 years. Sediments should be flushed and captured on the outlet side of the basin prior to discharge. If the sediment has traveled past the reach of a vacuum truck the system shall be thoroughly flushed with water, a fire hose or the like is typically the most effective method of flushing. The manhole downstream of this process shall be plugged and sediment collected at this point. Sediment which is removed shall be legally disposed of.

The system shall be monitored at several intervals during and after a small and large rainfall event to ensure runoff is detained. Inlet and outlet pipes shall be kept free of obstructions. Any material obstructing the pipes shall be removed and legally disposed of.

Estimated Yearly Cost $1,000.00

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LEVEL
DESIGN GROUP

PUBLIC SAFETY FEATURES

Many of the Public Safety Features of the Stormwater Management System are incorporated into its design. The infiltration basins are located below the surface which provides a greater level of safety over surface basins.

Despite all the well-designed safety features within the Stormwater Management System all components of the system must be properly maintained to be effective. All maintenance procedures detailed above must be done on schedule and documented. Standing or stagnant water provides mosquito-breeding habitat and increases the potential for disease transmission. The basins are designed to fully infiltrate within 72 hours after a storm even which will prevent standing water from becoming a safety hazard. Routine monitoring for and management of mosquito-breeding conditions by qualified maintenance staff is required during the peak breading season between April and September ensure that unforeseen conditions do not develop.

While risks can be mitigated through proper design and maintenance, it is impossible to entirely eliminate risk. Therefore, education regarding stormwater management facilities and their inherent risks is valuable and should be a part of every community's activities. Employees and tenants of the adult retirement community shall be given an overview of the Stormwater System and which areas to avoid. Public participation also increases the level of maintenance as community members can notify staff if a component of the stormwater system is not functioning properly.

249 SOUTH STREET UNIT 1 PLAINVILLE MA 02762
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STORMWATER MANAGEMENT OPREATOIN AND MAINTENANCE LOG

It is the responsibility of the site operator, Property Owner and/or Association to provide the maintenance of the Stormwater Management System Maintenance in accordance with any and all permits issued by the Town of Franklin. The log form below is a template and shall be reproduced as needed. Copies of all log forms shall be kept on file for a minimum of three years from the date of inspection.

Name of Inspector:
Date and Time of Inspection:
Weather Conditions:

Stormwater BMP	Observations	Action Required

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LONG TERM POLLUTION PREVENTION PLAN

FOR

FACTORY SQUARE

3, 5 & 7 FISHER STREET

(AM 278 PARCEL 16)

FRANKLIN, MASSACHUSETTS

JULY 1, 2021

Prepared By:

Level Design Group, L.L.C.

249 South Street, Unit 1

Plainville, MA 02762

Prepared For:

K Fisher Street LLC

1 Fisher Street

Franklin, MA 02052

LDG Project No.:

1899.00

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<u>GOOD HOUSEKEEPING PRACTICES</u>

It is the responsibility of the Owner/Developer, Rick Kaplan (or any other future Owner/Developer), to provide for maintenance of the parking areas and the storm drainage system until the site. The responsible party shall utilize good housekeeping practices as outlined in the Operation and Maintenance Plan required for the maintenance of the Stormwater Management System.

<u>PROVISIONS FOR STORAGE OF MATERIALS AND WASTE PRODUCTS INSIDE OR UNDER COVER</u>

The storage of hazardous materials and waste is prohibited from being stored outdoor at the site. Any hazardous materials shall be stored under cover.

<u>VEHICLE WASHING CONTROLS</u>

Outdoor vehicle washing is allowed only for occupants of the condominium development for non-commercial vehicles owned by the residents of the units. No commercial vehicle washing operations is allowed in this area.

<u>REQUIREMENTS FOR ROUTINE INSPECTION AND MAINTENANCE OF STORMWATER BMPS</u>

The Owner / Operator shall keep a Maintenance Log Sheets of scheduled tasks outlined Operation and Maintenance Plan.

<u>SPILL PREVENTION AND RESPONSE PLANS</u>

The risk of significant spills requiring action at this site is limited and will most likely be associated with motor vehicle use or maintenance. In the event of a significant spill contact:

> Massachusetts Department of Environmental Protection 24-hour emergency response notification line – (888) 304-1133

<u>PROVISIONS FOR MAINTENANCE OF LAWNS, GARDENS, AND OTHER LANDSCAPED AREAS</u>

The use of chemical fertilizers shall not be used on-site. If chemical fertilizers are required to be used, the fertilizers must be worked into the soil to prevent washouts and stormwater contamination of fertilizers.

<u>REQUIREMENTS FOR STORAGE AND USE OF FERTILIZERS, HERBICIDES, AND PESTICIDES</u>

If fertilizers, herbicides, and pesticides are to be used and stored on site they are to be stored in their original containers and keep in a dry, safe area where children do not have access to.

REQUIREMENTS FOR SNOW PLOWING AND STORAGE

Snow plowing within the site shall be performed by a licensed contractor. Snow is to be directed to identify snow storage areas as detailed in the Operation and Maintenance Plan. Under no circumstance shall snow be pushed into or dumped into the on-site wetland and pond areas.

PROVISIONS SOLID WASTE MANAGEMENT

Solid waste and recycling is to be disposed in designated areas in enclosed receptacles with covers and hauled by private certified waste management service operators. Solid waste management systems shall be inspected and maintained in accordance with state, local, and federal solid waste management regulations.

EMERGENCY AND REGULATORY CONTACTS

Franklin Fire Department:	911 / (508) 528-2323
Franklin Police Department:	911 / (508) 528-1212
Massachusetts Department of Environmental Protection – Southeast Regional Office:	(508) 946-2700
United State Environmental Protection Agency:	(617) 918-1111

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Illicit Discharge Statement

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Illicit Discharge Statement

For
FACTORY SQUARE
3, 5 & 7 FISHER STREET
(AM 278 PARCEL 16)
FRANKLIN, MASSACHUSETTS

All illicit discharges to the Stormwater Management System are prohibited. The Stormwater Management System is the system for conveying, treating, and infiltrating stormwater. Illicit discharges to Stormwater Management Systems are discharges that are not entirely comprised of stormwater, but do not include discharges from the following activities or facilities:

- Firefighting
- Water Line Flushing
- Potable Water Sources
- Landscape Irrigation
- Potable Water Sources
- Uncontaminated Groundwater
- Air-conditioning Condensation
- Dechlorinated Water from Swimming Pools
- Water used for street washing
- Water used for clean residential buildings without detergents
- Foundation Drains

The site will be operated and maintained in accordance with the Operation and Maintenance Plan dated July 5, 2021 prepared by Level Design Group, LLC.

I,_______________________ ***(Applicant)*** do hereby agree to comply with requirements set forth within the Illicit Discharge Statement and will not knowingly discharge illicit materials to the stormwater management system once it is brought online **upon** completion of construction.

Signature:____________________________________ Date: __________________

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