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Preliminary Plan Enclosures
VOLUME IV

- Stormwater Analysis Report, 12/2/22
- Soil Erosion & Sediment Control Report, 12/2/22
- Long-Term Operation & Maintenance Report, 12/2/22

Stormwater Analysis Report

12/2/22

Stormwater Analysis Report
Bristol Yarn Mill

Thames and Hope Street
Bristol, RI

Brady Sullivan Properties, LLC

670 North Commercial Street
Manchester, NH

December 2, 2022

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Project No. 20061150.A22

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Bristol Yarn Mill

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1 Introduction

Fuss & O'Neill, Inc. prepared this Stormwater Analysis Report for Brady Sullivan Properties, LLC for the Bristol Yarn Mill redevelopment project in Bristol, Rhode Island. The project proposes to renovate and restore an historic mill complex for residential apartments, commercial spaces, amenity space, and a an internal parking garage. The project also includes the rehabilitation of a single-family home, a two-family home, and an off-site parking lot on the east side of Thames Street. Additional improvements include a public access walkway along the shoreline, landscaping, sidewalk repairs and replacement, utility services, and a commercial parking lot.

The existing and proposed hydrologic conditions of the project site were analyzed to understand the effects of stormwater runoff from the proposed development to the surrounding area and Bristol Harbor. This report describes the methodology used to design the project's stormwater management system to comply with the Rhode Island Stormwater Management, Design, and Installation Rules (250-RICR-150-10-8), the Rhode Island Stormwater Design and Installation Standards Manual (RISDISM), and the Rhode Island Coastal Resources Management Council's Coastal Resources Management Program (CRMP) Section 1.3.1.F "Treatment of sewage and stormwater" (650-RICR-20-00-1).

2 Pre-Development Conditions

The Bristol Yarn Mill building site includes five parcels identified by the Bristol Tax Assessor as Lots 42, 60, 61, 62, and 73 of Plat 10, totaling 3.27 acres located in the Waterfront Planned Unit Development (WPUD) district. The mill site is bordered by Bristol Harbor to the west, Thames Street to the east, Constitution Street to the south, and Bristol Firemen's Memorial Park to the North. The proposed surface parking lot site includes nine parcels identified by the Bristol Tax Assessor as Lots 41, 43, 44, 49, 50, 68, 71, 74, and 76 of Plat 10, totaling 1.50 acres split between the waterfront and downtown districts. The parking lot site is bordered by Thames Street to the west, residential properties to the north and south, and businesses to the east on Hope Street.

The Yarn Mill site is occupied by the Robin Rug mill complex consisting of a five-story brick building which covers approximately 1.92 acres of the site. West of the mill complex is grass area that slopes towards a riprap revetment along the harbor. At the northern end of the mill site is a paved loading and parking area surrounded by buildings on three sides. This area slopes very gradually towards the alley to the north of the mill site. 39% of the mill complex roof currently drains to the combined sewer in Thames Street while other roof areas discharge to the grass area west of the building, discharge to Thames Street where there is no drainage infrastructure along the mill's frontage, or into a storm drain in Constitution Street which has a deteriorating outfall in the Bristol Harbor seawall.

The future surface parking lot site is currently a paved parking area in the north end, and the rest of the site is an unpaved parking area consisting of gravel and lawn. The lawn and gravel lots are bordered by arborvitaes along the southern and eastern property boundary and a few mature deciduous trees near the property boundaries at the north, central, and south end of the property. The parking lot site slopes toward Thames Street where a portion runoff is collected by catch basins at the intersection of Church Street and Thames Street and discharged out to Bristol Harbor through a RIDOT outfall identified as

DOT-NARR116 on the RIDEM Environmental Resource Map. A Site Location Map is provided as *Figure 1*.

There are no stormwater treatment or collection systems on any of the properties that comprise the project site. The existing municipal storm drainage systems provide little to no treatment in the drop inlet type catch basins, which are not consistent with the RISDISM's guidelines for pre-treatment structures.

2.1 Soil and Groundwater

Based on the Natural Resources Conservation Service's (NRCS) web soil survey, the mill site is underlain primarily by urban land, commonly referred to as "fill." The proposed off-site parking lot site on the east side of Thames Street is underlain by Newport urban land complex, which has a hydrologic soil group (HSG) classification of "C" based on the majority soil component, Newport.

Fuss & O'Neill observed one test pit at the mill site and four test pits at the parking lot site, and performed infiltration tests in two of the test pits at the parking lot site. The test pits were excavated to depths of between approximately six and eleven feet below the ground surface. The soil texture, color, horizon depths, and evidence of saturation (in the forms of infiltration, physical saturation, and the presence of redoximorphic features) were logged in each of the test pits.

Fill soils were present in Test Pit (TP) 1 and TP2, which are in the vicinity of the proposed stormwater management system in the northern parking lot. The soils below the fill soils were silt loam and loamy sand. Redoximorphic features were encountered in TP1 and TP2 at approximately 3.5 feet and 0.83 feet below grade, respectively. The soils in TP3 and the vicinity of the proposed stormwater management system for the southern parking lot, were found to be silt loam underlain by sandy loam. Redoximorphic features in TP3 were encountered at an approximate 2.25 feet below grade. Fill was present in TP5 on the west side of the mill building and was composed of loamy sand containing shells, bricks, and shale. Redoximorphic features in TP5 were encountered at two feet below grade. The results of the soil evaluation and infiltration testing can be found in *Appendix F*.

2.2 Flood Hazard and Resource Areas

The western shoreline of the mill site borders Bristol Harbor (RI0007026E-01C), which is within the Upper East Passage Subwatershed on the Rhode Island Department of Environmental Management (RIDEM) Environmental Resource Map, and part of the Narragansett Bay Watershed. The project site is not within a Natural Heritage Area and does not contain coastal or freshwater wetlands.

Bristol Harbor is classified by RIDEM as Water Quality Classification SB and an Impairment Category 2. According to the Rhode Island Water Quality Regulations, a Water Quality Classification SB are waters designated for primary and secondary contact recreational activities, shellfish harvesting for controlled relay and depuration, and fish and wildlife habitat. Class SB waters are considered to have good aesthetic value and be suitable for aquacultural uses other than shellfish for direct human consumption. An Impairment Category 2 indicates that some uses are fully supported but there is insufficient data available to assess other uses. Bristol Harbor is not on RIDEM's 303(d) list of impaired waters.

The mill site lies primarily within Zone VE, an area with a 1% or greater chance of flooding and an additional hazard associated with storm waves, based on the Federal Emergency Management Agency (FEMA) Flood Map Number 44001C0014H effective July 7, 2014. The parking lot on the east side of Thames Street is located within Zone AE, an area with a 1% or greater chance of flooding, and Zone X, 0.2% annual chance flood hazard and areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile. The base flood elevation (BFE) is 14 feet (NAVD88) within Zone VE and 12 feet within Zone AE.

2.3 Pre-Development Subwatersheds

The pre-development site consists of ten (10) subwatersheds, described below.

- *Subwatershed 1A* is 0.64 acres of mill complex roof. Runoff from the roof is collected in roof drains that are connected to a catch basin in Constitution Street. The catch basin is connected to the Constitution Street storm drain with an outfall to Bristol Harbor through a seawall at the west end of Constitution Street.

- *Subwatershed 2A* includes 0.61 acres of land to the west of the mill complex. This subwatershed includes grass and gravel areas between the mill buildings and the riprap revetment coastal feature along Bristol Harbor. The subwatershed also includes a 0.02-acre section of pitched roof with no gutter and a portion of the paved parking area on the abutting Bristol Elks Lodge property to the southwest of the mill complex. Runoff from this subwatershed flows west to Bristol Harbor.

- *Subwatershed 2B* is 0.49 acres of mill complex roof. Runoff is collected by gutters and downspouts then discharged to the grass area west of the mill complex and flows to Bristol Harbor.

- *Subwatershed 3A* is the area of pavement between the mill buildings at the northern end of the site. This subwatershed is 0.27 acres consisting of paved area with 0.06 acres of mill complex roof. Runoff from the roof is collected in a gutter and discharged to the paved area through a downspout. Runoff from the paved area flows toward the alley north of the mill complex and flows west to Bristol Harbor.

- *Subwatershed 4A* contains a total of 2.29 acres between Thames Street and Hope Street. The northwest portion of the subwatershed is a paved parking area while the rest of the subwatershed is lawn and gravel parking areas with small buildings bordering the streets at the edges of the watershed. Runoff flows west to the curbed gutter in Thames Street then north to a catch basin at the intersection of Church Street and Thames Street. The catch basin is connected to the Church Street storm drain which discharges through an outfall to Bristol Harbor through a seawall west of the intersection of Church Street and Thames Street.

- *Subwatershed 4B* is 0.06 acres of mill complex roof along Thames Street that pitches towards the road. Runoff from this subwatershed is collected in a gutter and discharged directly to the Thames Street sidewalk through downspouts. Flow from these downspouts travels north along Thames Street to the catch basin at the intersection of Church Street and Thames Street. The catch basin is connected to the Church Street storm drain which discharges through an outfall to Bristol Harbor through a seawall west of the intersection of Church Street and Thames Street.

- *Subwatershed 5A* is a 0.09-acre building located in the northwest corner of the mill complex. Runoff from this building is collected by a gutter and discharges into the Thames Street sanitary sewer.
- *Subwatershed 5B* is 0.15 acres of mill complex roof in the northeast corner of the site. Runoff from the roof is connected to the Thames Street sanitary sewer.
- *Subwatershed 5C* is 0.23 acres of mill complex roof south of the paved parking area in Subwatershed 3A. Runoff from the roof is connected to the Thames Street sanitary sewer.
- *Subwatershed 5D* is 0.28 acres of mill complex roof on the southern end of the site. Runoff from the roof is connected to the Thames Street sanitary sewer.

The subwatershed areas are depicted on *Figure 2: Pre-Development Subwatershed Map*. Pre-development peak flow rates generated by each subwatershed for the Water Quality, 1-, 10-, 25-, and 100-year storm events are included in *Appendix A* of this report. Supporting documentation and hydrologic calculations are included in *Appendix B*.

3 Post-Development Conditions

The renovated mill complex will include residential apartments, commercial spaces, amenity space on the first floor, and a parking garage on the basement level. A public walkway with pervious pavers will be constructed along the Bristol Harbor shoreline. The area west of the public walkway will be restored with native coastal plantings up to the inland limit of the riprap revetment. Benches, shade trees, light bollards, a rain garden, and a synthetic turf dog run will also be constructed in the open space west of the mill complex. A portion of the mill building's roof runoff will be treated by a rain garden.

The non-historic building located in the northwest corner of the site (pre-development Subwatershed 4A) will be razed. This building area and the adjacent paved area to the east will be converted into a commercial parking lot with sidewalks, access to the basement parking level, an electrical transformer, and solid waste storage containers.

A paved parking lot will be constructed for tenants of the project on the east side of Thames Street in the existing assemblage of paved, gravel, and grass parking areas. The paved parking lot will cover most of the open areas on this portion of the project site. The parking lot will have driveway access from Thames Street and a concrete pedestrian walkway connection to Hope Street. The parking lot improvements will also include landscaped islands, supplemental and replacement fences, stormwater collection and management systems, lighting, and will retain the existing arborvitaes along the southern and eastern property boundary and the few mature deciduous trees within or on the property boundary.

The existing single-family home and two-family home on the east side of Thames Street within the project site will be rehabilitated and will retain these three residential units as part of the project. The homes will share access and parking within the adjacent parking lot.

3.1 Post-Development Subwatersheds

The total watershed area and the subwatershed points of analysis have been maintained for the Post-Development hydrologic analysis. The post-development subwatersheds are described in detail below.

- *Subwatershed 1A:* Cover conditions in this 0.06 acre subwatershed will remain unchanged from pre-development conditions. Runoff from this pitched roof will continue to be collected by a gutter but discharges to the proposed storm drain in Thames Street through internal plumbing rather than surface discharged to the sidewalk.

- *Subwatershed 1B:* This subwatershed is 0.07 acres of land in the northeast corner of the surface parking lot site. This area includes a section of the parking lot and the lawn buffer surrounding it. Runoff from this subwatershed is collected by a catch basin on the northern edge of the parking lot and conveyed to an oil/water separator. Flow from the oil/water separator enters Subsurface Filtration System 1 where it filters through sand media within the lined system and collects in an underdrain. The underdrain is connected to the proposed storm drain in Thames Street and discharged to Bristol Harbor. Runoff from storm events larger than the water quality storm will bypass the oil/water separator and subsurface filtration system and will flow directly into the Thames Street storm drain.

- *Subwatershed 1C:* This 0.13-acre subwatershed includes a portion of the northern paved parking lot, buffer lawn area and half of a shed's roof located on a neighboring property. Runoff from this subwatershed is collected by a catch basin located in the northwest corner of the parking lot and discharged to Tree Filter 1. Filtered stormwater is collected in an underdrain and discharged to the proposed Thames Street storm drain. Runoff from storms events larger than the water quality storm will bypass the tree filter and flow directly to the Thames Street storm drain.

- *Subwatershed 1D:* This subwatershed consists of a portion of the northern parking lot and a landscape island totaling 0.14 acres. Runoff from this subwatershed is collected by a catch basin the southwest corner of the northern parking lot and discharged to Tree Filter 2. Filtered stormwater is collected in an underdrain and discharged to the proposed Thames Street storm drain. During storm events larger than the water quality storm, water will bypass the tree filter and flow directly into the Thames Street storm drain.

- *Subwatershed 1E:* This 0.31-acre subwatershed includes portions of the existing buildings along Hope Street on abutting properties, lawn areas within the project surface parking lot site, and the surface parking area east of subwatershed 1D. Runoff from this subwatershed flows across the parking lot to a catch basin along the southern edge of the northern parking area. The catch basin is connected to an oil/water separator for additional pre-treatment then discharged to Subsurface Filtration System 1. Stormwater is filtered through a lined sand media bed and collected by an underdrain then discharged to the proposed storm drain in Thames Street. Runoff from storm events larger than the water quality storm will bypass the treatment train and flow directly into the Thames Street storm drain.

- *Subwatershed 1F:* This subwatershed contains most of the proposed southern parking lot, buffer lawn areas, driveways, and roofs on abutting properties. This 0.67-acre subwatershed drains to a catch basin in the northwest corner of the southern parking lot. The catch basin is connected to an oil/water separator for additional pre-treatment then discharged to Subsurface Filtration System 2. Stormwater is filtered through a lined sand media bed and collected by an underdrain then discharged to the proposed storm drain in Thames Street. Runoff from storm events larger than the water quality storm will bypass the treatment train and flow directly into the Thames Street storm drain.

- *Subwatershed 1G:* This subwatershed is 0.06 acres of the southern parking lot area will drain to a catch basin near the southern driveway entrance. Runoff from the catch basin will flow through an oil/water separator before entering Subsurface Filtration System 2 where it will filter through the lined, sand media filter and be collected by an underdrain. Flow from the underdrain will be directed to the proposed storm drain in Thames Street and discharge into Bristol Harbor. Runoff from storm events larger than the water quality storm will bypass the treatment train and flow directly into the Thames Street storm drain.

- *Subwatershed 1H:* This subwatershed is the 0.15-acre section of mill roof area located in the northeast corner of the mill site. The roof drains will be disconnected from the sanitary sewer system and redirected to the proposed storm drain in Thames Street.

- *Subwatershed 1I:* This subwatershed contains 0.26 acres of mill complex roof located south of the northern entrances to the mill's parking garage. A portion of this subwatershed currently discharges to the sanitary sewer system and will be disconnected. Runoff from this roof area will be collected by roof drains that will discharge to the proposed storm drain in Thames Street.

- *Subwatershed 1J:* This subwatershed is 0.66 acres of mill complex roof located in the center of the mill site. Runoff from this roof area will be collected by roof drains that will discharge to the proposed storm drain in Thames Street.

- *Subwatershed 1K:* This 0.48-acre area of roof is located on the southern end of the mill building site. Runoff from this subwatershed will be collected by roof drains and connected to Tree Filter 3. Runoff will flow through the soil media in the lined tree filter and will be collected by an underdrain and discharged to the proposed storm drain in Constitution Street. Runoff from storm events larger than the 0.5-inch storm will bypass the tree filter and flow directly into the Constitution Street storm drain.

- *Subwatershed 2A:* This 0.56-acre subwatershed is the area west of the mill complex. This area includes pervious paver walkways, landscaping, coastal buffer restoration, synthetic turf dog run, and a gravel and paved parking area to the south operated by the Elks Lodge. Runoff from this subwatershed flows to Bristol Harbor.

- *Subwatershed 2B:* This 0.32-acre subwatershed includes a 0.28-acre section of mill complex roof and a rain garden to the west of the building. Runoff from the roof area will be collected in gutters and discharged to a lined rain garden which discharges to Bristol Harbor through an underdrain and drain basin overflow structure. If the outlet structure fails and the rain garden overtops, runoff will flow over the pervious walkway and coastal buffer to Bristol Harbor.

- *Subwatershed 3A:* This subwatershed is the 0.31-acre area in the northern end of the mill that consists of a commercial parking lot, dumpster enclosures, and a transformer bordered by three buildings. Runoff from this subwatershed will flow across the commercial parking area and enter one of two trench drains. Flow from the trench drains will then enters stone-lined channels composed of bioretention soil mix media and shrub plantings. Runoff that is not infiltrated or removed through evapotranspiration will discharge to the alley along the north end of the site and flow into Bristol Harbor. More substantial stormwater treatment options are not feasible due to the site's poor soils, shallow groundwater table, relatively flat topography, low elevation in relation to Bristol Harbor, and lack of infrastructure.

- *Subwatershed 4A:* This 0.85-acre subwatershed is the portion of pre-development subwatershed 4A that is not collected by the parking lot stormwater management system. Runoff will continue to flow to Thames Street where it will be conveyed along the gutter line to catch basins at the intersection of Church Street and Thames Street. These catch basins are connected to the storm drain in Church Street that discharges to Bristol Harbor.

Subwatershed areas are depicted on *Figure 3: Post-Development Subwatershed Map.*

3.2 Stormwater Management System

The stormwater management system has been designed according to the Minimum Stormwater Management Standards of the Rhode Island Stormwater Management, Design, and Installation Rules, RISDISM, and CRP Section 1.3.1.F to the maximum extent practicable under the Minimum Standard 6 Redevelopment. The historic neighborhood and the project site in an urbanized area of Bristol presents constraints for the siting and construction of stormwater management practices due to: the close proximity of buildings to each other and public infrastructure; limited available land around the historic mill building; limited space adjacent to public utilities; low topographic relief and elevation with respect to mean high water; a protected shoreline feature bordering the project site; and private and public lands not owned or controlled by the project's proponent surrounding the project site. The soil conditions also constrain the practical and feasible use of many types of stormwater treatment practices due to the shallow depth to estimated seasonal high groundwater, the presence of fill materials, and the poor permeability in the substratum.

In consideration of these constraints, the design approach for this project focuses on maximizing the treatment of stormwater runoff from the site to avoid potential impacts to water quality in Bristol Harbor or flooding impacts to private property and public infrastructure. Instead of infiltration practices, the project uses several types of filter systems to achieve the applicable water quality standards.

The filter systems have been selected for each location based on the specific constraints and context of the installation area and are lined to prevent intercepting the groundwater table.

The required water quality treatment volume (WQv) for the development is calculated using the redevelopment standard where 0.5 an inch of runoff shall be treated from existing impervious surfaces such as the mill's roof and existing paved parking areas and 1 inch of runoff from new impervious surfaces shall be treated. The total WQv required to be treated is 6,345 cubic feet. The filter systems proposed that have been designed in accordance with the RISDISM provide treatment for 4,381 cubic feet of runoff. Three retrofitted filter systems including two stone channels and the rain garden provide treatment but since they do not meet the design criteria from the RISDISM the WQv provided is not credited. A portion of the surface parking lot, which was paved in the pre-development condition, could not be captured for treatment and discharges to Bristol Harbor as it does today.

Approximately 0.73 acres of the 1.92 acre mill roof area, or 62% of the roof area, will be disconnected from the Thames Street sanitary sewer system. The remaining area discharges without treatment to Bristol Harbor in the pre-development condition. The proposed improvements will provide 0.5 inch WQv using tree filters to treat 0.48 acres or 25% of the mill roof area. Runoff from 0.28 acres of the mill roof is discharged to a retrofitted rain garden on the west side of the mill. This system does not conform to the design standards for a bioretention basin due to the limited depth of filter media but will provide some treatment to the roof runoff. The remaining 1.16 acres of roof area will not receive treatment once the project is completed, but the runoff's water quality will improve since the stormwater will be routed within the storm drain out to Bristol Harbor versus discharged to the surface of Thames Street to pick up additional contaminants as it does in the pre-development condition.

The major components of the proposed stormwater management system components are described in detail below.

3.2.1 Subsurface Filtration Systems

The project proposes to construct two (2) subsurface filtration systems under the surface parking lot on the east side of Thames Street. Due to the shallow groundwater encountered during test pits, both subsurface filtration systems are lined and have underdrains to collect the filtered runoff. The subsurface infiltration systems are designed to treat the 1 inch WQv for the contributing impervious area within the surface parking lot. Both subsurface infiltration systems are only required to treat 0.5 inch WQv from existing impervious areas and 1 inch WQv from new impervious areas, but the systems have been designed to exceed the required volumes to compensate for the runoff not captured from the surface parking lot and roof area.

Subsurface Filtration System 1 is located in the center of the northern parking area. It consists of 20 StormTech SC-310 chambers with 12 inches of side and end stone and 6 inches of base and cover stone. Below the stone base is an 18-inch sand bed underlain by an 8-inch pea gravel layer. The entire system is lined with an impermeable HDPE geomembrane. A 6-inch perforated PVC underdrain pipe is within the bottom pea gravel layer to collect filtered runoff.

Two catch basins at the north and south edges of the northern parking area will convey runoff from the surface parking lot to the proposed system. Pretreatment will be provided by deep-sump catch basins and an oil/water separator. This system is sized to store and treat 1-inch of runoff from the contributing impervious area, which twice the 0.5 inches of runoff treatment that is required for this previously paved, redevelopment area. During storm events larger than the water quality event, flow will bypass the oil/water separator and subsurface filtration system. During these events, water will be conveyed to the proposed Thames Street storm drain through a diversion structure (DMH-1) upstream of the oil/water separator.

Subsurface Filtration System 2 is located in the southern parking area and consists of 30 StormTech SC-310 chambers with 12 inches of side and end stone and 6 inches of base and cover stone. Below the stone base is an eighteen-inch sand bed underlain by a 12-inch pea gravel layer. The entire system is lined with an impermeable HDPE geomembrane and a 6-inch perforated PVC underdrain pipe is included within the pea gravel layer. Two catch basins located on the west side of the southern parking area will convey runoff from the parking lot to the proposed system.

Pretreatment will be provided by deep-sump catch basins and an oil/water separator. This system is sized to store and treat 1-inch of runoff from the contributing impervious area. This area of the lot was not previously paved and requires treatment of the full water quality storm event runoff volume. During storm events larger than the water quality event, flow will bypass the oil/water separator and subsurface filtration system within a diversion structure upstream of the oil/water separator and will be conveyed to the proposed Thames Street storm drain.

3.2.2 Tree Filters

The project proposes three (3) tree filter systems, two of which will treat runoff from the parking lot on the east side of Thames Street and the third will treat roof runoff. Due to the shallow groundwater at the site, there is not enough separation between the bottom of the proposed system and groundwater to infiltrate runoff according to the RISDISM. All three tree filter systems are lined with underdrains to provide treatment through filtration and vegetation uptake. The tree filters were sized to treat the 0.5 inch WQv from contributing impervious areas, all of which were previously impervious.

Tree Filter 1 is located in the northwest corner of the northern parking area and consists of 28 1X Silva Cells arranged around one tree. Inside the Silva Cells is a 7-inch ponding layer and a 10-inch soil media layer. Beneath the Silva Cells is a 4-inch gravel subbase. The entire system is lined with an impermeable liner and a 6-inch perforated PVC underdrain is within the gravel subbase.

A catch basin in the northwest corner of the parking lot will convey runoff from the parking lot to the proposed tree filter. Stormwater will be distributed throughout the ponding layer of the tree filter in a 6-inch perforated underdrain that discharges to the proposed Thames Street storm drain. During storm events larger than the water quality storm, stormwater will bypass the tree filter from the catch basin to the Thames Street storm drain.

Tree Filter 2 is located in the southwest corner of the northern parking area and consists of 23 1X Silva Cells arranged around one tree. The system is designed the same as Tree Filter 1. A catch basin in the southwest corner of the parking lot will convey runoff from the parking lot to the proposed tree filter along with direct precipitation. Stormwater from the catch basin initially discharges into a distribution pipe within the tree filter. Once distribution pipe is inundated, stormwater bypasses the catch basin to the proposed Thames Street storm drain. Bypass of the tree filter was designed to occur during storm events larger than the water quality storm.

Tree Filter 3 is located in the Constitution Street sidewalk south of the mill complex and consists of 69 1X Silva Cells arranged around three trees with the same basic construction as Tree Filters 1 and 2. Stormwater from the underdrain is conveyed to a drain manhole in the proposed Constitution Street storm drain upstream of the outfall to Bristol Harbor. An 18-inch roof drain will convey runoff from the southern-most roof area to the tree filter. Stormwater will be distributed throughout the ponding layer of the tree filter through several 6-inch perforated pipes connected to the distribution pipe. Tree Filter 3 is designed to provide treatment for 0.5-inch of runoff from the existing roof area. During storm events larger than the 0.5-inch storm event, runoff will back up within the distribution pipe and discharge through a 12 inch HDPE overflow pipe to the drain manhole upstream of the Constitution Street outfall.

3.2.3 Stone Channels

The project proposes two (2) stone channels near the commercial use parking lot at the north end of the Mill complex, which is composed of asphalt paved parking and loading area and a non-historic building that will be razed. The stone channels are designed to provide treatment for runoff from the commercial parking lot. This area does not have significant elevation changes and is surrounded by existing historic buildings and contains both poor soils and shallow groundwater. Runoff from the existing area flows untreated to the alley at the north end of the property. The alley is used to access Bristol's Maritime Center.

Stone Channel 1, along the western edge of the parking lot, has a long trench drain with a grate that collects sheet flow and discharges it to the stone channel through three outlet pipes. The trench drain will provide pre-treatment and facilitation sediment removal during maintenance. Stone Channel 2 also receives flow from the parking lot and conveys runoff through a solid-cover trench drain within the adjacent sidewalk. Both stone channels discharge to the alley to the north of the mill complex.

Both stone channels are three feet wide with 6-inches of river stone above 6-inches of bioretention media and 12 inches of bioretention media on the sides of the riverstone to support planted vegetation along the channel. The stone channels are not lined to promote infiltration, but the groundwater table is estimated to be at or just below the bottom of the channels. Therefore, no credits have been calculated for groundwater recharge or infiltration. These systems provide treatment to runoff through filtration, but do not meet the RI Stormwater Management, Design and Installation Rules to qualify as water quality swales.

3.2.4 Rain Garden

The project proposes one rain garden located to the west of the mill complex. The rain garden is lined with an impermeable HDPE membrane due to its proximity to the building's foundation, high groundwater, and poor infiltrating soils and fill materials. A drain basin collects and conveys treated and bypassed flow from the rain garden under the pervious paver walkway to an outfall within the coastal buffer area, upgradient of the riprap revetment. Discharge from the outfall go directly into Bristol Harbor. The rain garden has 1.5 feet of bioretention media and a 6-inch perforated PVC underdrain set on the liner surrounded by 6 inches of pea gravel to collect and discharge filtered runoff out through the drain basin to the outfall. The drain basin is 12 inches in diameter and has a grate top to collect overflow runoff when the ponding depth exceeds 0.2 feet.

The system is designed as a retrofit to provide treatment for some of the mill's roof runoff. The rain garden is sized to store and treat slightly less than the 0.5-inch WQv from 12,155 square feet of contributing roof area.

4 Hydrologic Analysis Results

The NRCS TR-20 Method was used to determine peak flow rates and volumes generated by each subwatershed for the Water Quality, 1-, 10-, 25-, and 100-year storm events. The design rainfall depths of a 24-hour, Type 3 storm distribution, for Bristol County were used in the analysis and are provided in *Table 1*, below. Supporting documentation of the hydrologic analysis is included in *Appendices B* and *C*. Hydrologic Results are included in Table 5-1 within *Appendix A*.

Table 1: Design Rainfall Depths

24-Hour (Type III) Rainfall Depths for Bristol County (inches)[1]			
WQ-Storm[2]	1-Year	10-Year	100-Year
1.2	2.8	4.9	8.6

Peak runoff rates from all subwatersheds will decrease during the water quality storm. Peak runoff rates from Subwatersheds 1 and 2 will increase for the 1-, 10-, 25-, and 100-year storms. Peak runoff rates from Subwatershed 3 will decrease for the 1-,10-, 25-, and 100-year storms as impervious surfaces in the subwatershed will be reduced. There will be no flow from Subwatershed 4 under post-development conditions, as all roof drains currently connected to the Thames Street sanitary sewer system will be redirected to the Thames Street storm drain. Peak runoff rate increases for Subwatersheds 1 and 2 are due to the pre-development Subwatershed 4 roof areas being redirected to these subwatersheds.

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[1] *Rhode Island Stormwater Design and Installation Standards Manual, March 2015, Table 3-1 – Design Rainfall Amounts for Rhode Island.*

[2] *Rainfall depth that produces 1-inch of runoff from impervious surfaces.*

5 Minimum Stormwater Standards

The Site has been designed to comply with the applicable Minimum Standards in the RI Stormwater Management, Design and Installation Rules. The following paragraphs summarize the measures implemented to conform to the Standards.

- **Standard 1: LID Site Planning and Design**
  LID site planning and design strategies were utilized to the maximum extent practical in order to reduce the generation of stormwater runoff volume for the project. The Stormwater Management Checklist, provided in *Appendix A*, provides a list of LID strategies proposed for this project. Key LID strategies incorporated include:

  - **Minimize site clearing and grading activities:** The construction Site within the depicted limit of disturbance consists of previously altered land. Grading and clearing have been minimized to the extent practicable.

- **Standard 2: Groundwater Recharge**
  Groundwater recharge is not provided by the systems proposed due to the shallow groundwater encountered on the site. All proposed filtering BMPs are lined to restrict inflow of groundwater.

- **Standard 3: Water Quality**
  The required WQv for the Site was calculated in accordance with Section 8.9 and 8.12 of the RI Stormwater Management, Design and Installation Rules. The total WQv required is 6,348 cubic feet. The proposed stormwater BMPs will provide a cumulative 4,381 cubic feet WQv treated, plus unaccounted treatment volume for from the retrofitted stone channels and rain garden. The Site constraints including the limited available land around the historic mill building, low topographic relief and elevation with respect to mean high water, shoreline feature, shallow depth to estimated seasonal high groundwater, the presence of fill materials, and the poor permeability in the substratum provided challenging parameters for siting and designing compliant stormwater treatment systems to reach the required WQv. Therefore, this standard was met to the maximum extent practicable. Refer to *Appendix D* for water quality volume calculations.

- **Standard 4: Conveyance and Natural Channel Protection**
  The project meets the RI Stormwater Management, Design and Installation Rules definition of Redevelopment, and therefore is not required to address channel protection. Although a channel protection volume has not been calculated, the stormwater management system and closed-conduit drainage system have been sized to safely convey flows for the 25-year, 24-hour, Type III storm event as required by the Town of Bristol's stormwater standards.

- **Standard 5: Overbank Flood Protection**
  The project meets the RI Stormwater Management, Design and Installation Rules definition of Redevelopment, and therefore is not required to address overbank flood protection. The stormwater management system components and drainage pipes have been designed to safely

convey runoff from the contributing subwatersheds areas for the 25-year, 24-hour, Type III storm event. See Section 4 for Hydrologic Analysis.

- **Standard 6: Redevelopment and Infill Projects**
  The project disturbs greater than 10,000 square feet of impervious area on previously developed land, with more than 40-percent existing impervious cover, and thus meets the definition of a Redevelopment project defined by this minimum standard. Therefore, only Minimum Standards 2, 3, and 7 through 11 apply. However, LID Site Design Strategies, Channel Protection, and Flood Protection have also been addressed to the maximum extent practicable.

  The stormwater treatment approach aims to exceed treatment requirements where on-site space is available and retrofit BMPs in the most constrained locations. The surface parking lot was the least constrained location so the two subsurface infiltration systems are sized for the 1 inch WQv from the contributing impervious area, when treatment for only 0.5 inch of runoff is required for the 9,899 square feet of existing impervious area to be disturbed. The two tree filters in the northern portion of the surface parking lot exceed the required 0.5 inch WQv for the contributing area, maximize the available subsurface space without encroaching under the travel lanes, and maximize the catchment area. Runoff from 7,912 square feet of disturbed impervious area is the only portion of the surface parking lot not captured by the proposed BMPs. The BMPs to treat the surface parking lot provide 77% of the cumulative water quality treatment volume provided and credited for the project.

  All the constraints outlined in the Water Quality section above severely impact the available site locations and design parameters of potential BMPs on the mill site's five parcels. Three retrofitted BMPs were designed to provide treatment for runoff from the commercial parking area on the north side of the mill and 14% of the mill roof area. Tree Filter 3 provides treatment for 0.5 inch WQv generated from 25% of the mill roof area. This system was designed in accordance with the RISDISM, but is not located within the Town owned right-of-way off of Constitution Street. 39% of the mill roof area will receive treatment prior to discharging to Bristol Harbor.

- **Standard 7: Pollution Prevention**
  Short-term pollution prevention practices to be utilized during construction are outlined in the Soil Erosion & Sediment Control Report (SESC Report) under separate cover. Long-term pollution prevention practices are outlined in the Long-Term Operation & Maintenance Report under separate cover.

- **Standard 8: Land Uses with Higher Potential Pollutant Loads**
  The project does not propose any uses that comprise a Land Use with Higher Potential Pollutant Loads.

- **Standard 9: Illicit Discharges**
  This project does not propose or included any illicit discharges to the municipal or private stormwater system. Existing stormwater discharges to the sanitary sewer will be disconnected. In addition, the Bristol Water Pollution Control Department has required an inspection of all

sewer and storm drain connections to ensure there are no stormwater discharges to the municipal sewer.

- **Standard 10: Construction Erosion and Sedimentation Control**
  Erosion and sediment control practices are depicted on the Site Plans and contained in a Soil Erosion and Sediment Control (SESC) Report has also been prepared under separate cover. Measures include, but are not limited to, inlet protection, sediment barriers at the site perimeter, and a construction access.

- **Standard 11: Operation and Maintenance**
  A Long-Term Operation and Maintenance Report has been prepared and is provided under separate cover.

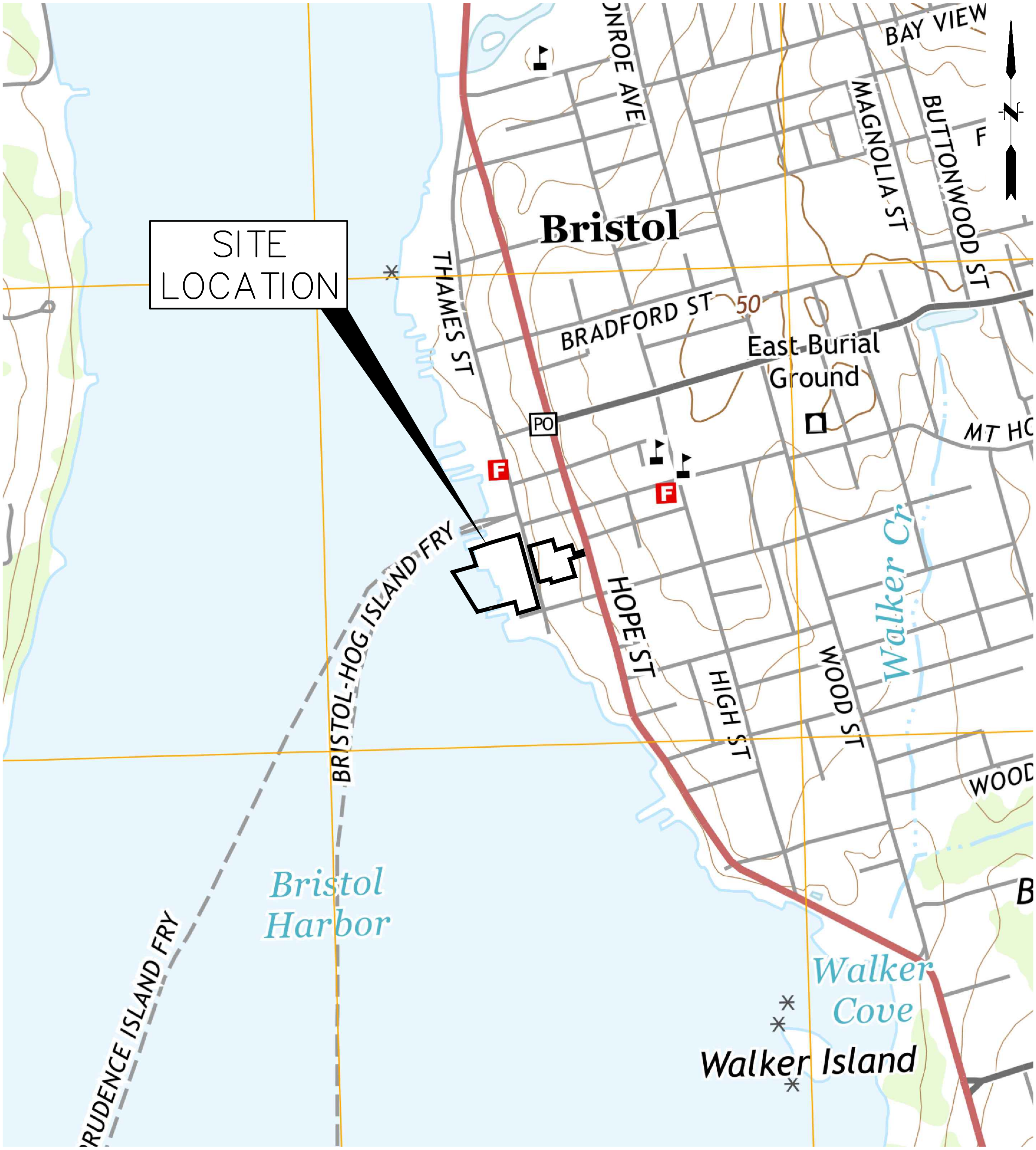
6 Summary

The proposed project has been designed to satisfy the requirements of the Rhode Island Stormwater Management, Design, and Installation Rules to the maximum extent practicable under the Minimum Standard 6 Redevelopment and the RISDISM. The required water quality treatment for the proposed site development was met to the maximum extent practicable considering the building massing and proximity to public infrastructure; limited developable land around the historic mill building; limited locations for discharging stormwater; low topographic relief and elevation with respect to mean high water; a protected shoreline feature bordering the project site; and private and public lands not owned or controlled by the project's proponent surrounding the project site. The soil conditions also limited the type and capability of BMPs due to the shallow depth to estimated seasonal high groundwater, the presence of fill materials, and the poor permeability.

Under pre-development conditions, stormwater runoff from the project site, including its open space, roofs, and parking and loading areas, does not receive treatment before it is discharged to Bristol Harbor or the Thames Street sanitary sewer. The proposed project will eliminate all stormwater connections from 32,453 square feet of mill roof area to the sanitary sewer and provides treatment for 39% of the existing mill complex's roof runoff through the retrofitted rain garden and Tree Filter 3. The development will provide formalize parking within the surface parking lot and will provide shade trees to minimize heat effects from the additional impervious area. Another project benefit will replacing the failing outfall in the seawall on the west end of Constitution Street and adding a tide gate to protect the infrastructure upstream.

The proposed stormwater management system includes two subsurface filtration systems, two oil/water separators, three tree filters, two stone channels, a rain garden, diversion structures, trench drains, and catch basins to provide treatment for the mill complex roof and the parking lots that will serve its residents and businesses. The BMPs designed in accordance with the RISDISM will treat 69% of the required WQv. The stormwater treatment systems that are retrofitted and designed to provide water quality treatment will improve the water quality discharged into Bristol Harbor and reduce inflow and infiltration to Bristol's municipal sewer system and the Water Pollution Control Facility.

Figures



REFERENCE:

THIS MAP WAS PREPARED FROM THE FOLLOWING 2015 USGS TOPOGRAPHIC MAPS OF RHODE ISLAND. SOURCE: THE RHODE ISLAND GEOGRAPHIC INFORMATION SYSTEM (RIGIS).

SCALE:
HORZ.: 1"= 1000'
VERT.:
DATUM:
HORZ.:
VERT.:
0 500 1000
GRAPHIC SCALE

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401.861.3070
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BRADY SULLIVAN PROPERTIES, LLC.

LOCATION MAP
BRISTOL YARN MILL

125 THAMES STREET BRISTOL, RHODE ISLAND

PROJ. No.: 20061150.A11
DATE: NOVEMBER 2022

FIGURE 1

File: \\private\DFS\CadProj\DWG\P2006\1150\A22\Civil\Figures\20061150A22_LOC01-USGS.dwg Layout: FIGURE 1 Plotted: 2022-11-07 12:25 PM Saved: 2022-11-04 3:54 PM User: kmccombs
PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB/CTB: FO HALF.STB
MS VIEW:
LAYER STATE:

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SEAL

SEAL

SCALE:
HORZ.: 1"= 40'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NADV88
40 20 0 40
GRAPHIC SCALE

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BRADY SULLIVAN PROPERTIES, LLC

PRE-DEVELOPMENT SUBWATERSHED MAP

BRISTOL YARN MILL

125 THAMES STREET BRISTOL, RHODE ISLAND

PROJ. No.: 20061150.A22
DATE: NOVEMBER 29, 2022

FIG. 2

File Path: J:\DWG\P2006\1150\A22\Civil\Figures\20061150A22_DRA01.dwg Layout: FIG. 2 Plotted: Wed, November 30, 2022 - 1:44 PM User: ajohnson
Plotter: NONE CTB File: FO.STB
MS VIEW:
LAYER STATE:

File Path: J:\DWG\P2006\1150\A22\Civil\Figures\20061150A22_DRA01.dwg Layout: FIG. 3 Plotted: Wed, November 30, 2022 - 1:45 PM User: ajohnson
Plotter: NONE CTB File: FO.STB

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SEAL

SEAL

SCALE:
HORZ.: 1"= 40'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NADV88

40 20 0 40
GRAPHIC SCALE

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BRADY SULLIVAN PROPERTIES, LLC

POST-DEVELOPMENT SUBWATERSHED MAP

BRISTOL YARN MILL

125 THAMES STREET BRISTOL, RHODE ISLAND

PROJ. No.: 20061150.A22
DATE: NOVEMBER 29, 2022

FIG. 3

Appendix A

Stormwater Management Checklist

APPENDIX A: STORMWATER MANAGEMENT PLAN CHECKLIST AND LID PLANNING REPORT – STORMWATER DESIGN SUMMARY

PROJECT NAME **Bristol Yarn Mill Redevelopment**	**(RIDEM USE ONLY)**
TOWN **Bristol**	**STW/WQC File #:**
BRIEF PROJECT DESCRIPTION: Redevelopment of a historic waterfront mill building into a 127 residential apartment building with apartments on upper three floors, commercial and amenity space on the first floor, and parking in the basement. Exterior improvements include a parking lot for residential parking across Thames Street, stormwater management, utility improvements for the building, waterfront public access, and landscaping throughout the mill and parking lot sites.	**Date Received:**

Stormwater Management Plan (SMP) Elements – Minimum Standards

When submitting a SMP,[1] submit four separately bound documents: Appendix A Checklist; Stormwater Site Planning, Analysis and Design Report with Plan Set/Drawings; Soil Erosion and Sediment Control (SESC) Plan, and Post Construction Operations and Maintenance (O&M) Plan. Please refer to Suggestions to Promote Brevity.

Note: **All stormwater construction projects must create a Stormwater Management Plan (SMP). However, not every element listed below is required per the** RIDEM Stormwater Rules **and the** RIPDES Construction General Permit (CGP)**. This checklist will help identify the required elements to be submitted with an Application for Stormwater Construction Permit & Water Quality Certification.**

PART 1. PROJECT AND SITE INFORMATION

PROJECT TYPE (Check all that apply)				
☒ Residential	☒ Commercial	☐ Federal	☐ Retrofit	☒ Restoration
☐ Road	☐ Utility	☐ Fill	☐ Dredge	☐ Mine
☐ Other (specify):				

SITE INFORMATION
☒ Vicinity Map

INITIAL DISCHARGE LOCATION(S): The WQv discharges to: (You may choose more than one answer if several discharge points are associated with the project.)

☐ **Groundwater**	☒ **Surface Water**	☐ **MS4**
☐ GAA	☐ Isolated Wetland	☐ RIDOT
☐ GA	☒ Named Waterbody	☐ RIDOT Alteration Permit is Approved
☐ GB	☐ Unnamed Waterbody Connected to Named Waterbody	☐ Town
		☐ Other (specify):

ULTIMATE RECEIVING WATERBODY LOCATION(S): Include pertinent information that applies to both WQ_v and flow from larger storm events including overflows. Choose all that apply, and repeat table for each waterbody.

☐ Groundwater or Disconnected Wetland	☐ SRWP		
☒ Waterbody Name: Bristol Harbor	☐ Coldwater	☐ Warmwater	☐ Unassessed
☒ Waterbody ID: RI0007026E-01C	☐ 4th order stream of pond 50 acres or more		
☐ TMDL for:	☐ Watershed of flood prone river (e.g., Pocasset River)		
☐ Contributes to a priority outfall listed in the TMDL	☐ Contributes stormwater to a public beach		
☐ 303(d) list – Impairment(s) for:	☒ Contributes to shellfishing grounds		

[1] Applications for a Construction General Permit that do not require any other permits from RIDEM and will disturb less than 5 acres over the entire course of the project do not need to submit a SMP. The Appendix A checklist must still be submitted.

PROJECT HISTORY		
☐ RIDEM Pre- Application Meeting	Meeting Date:	☐ Minutes Attached
☒ Municipal Master Plan Approval	Approval Date: May 12, 022	☒ Minutes Attached
☐ Subdivision Suitability Required	Approval #:	
☐ Previous Enforcement Action has been taken on the property	Enforcement #:	

FLOODPLAIN & FLOODWAY See Guidance Pertaining to Floodplain and Floodways	
☒ Riverine 100-year floodplain: **FEMA FLOODPLAIN FIRMETTE** has been reviewed and the 100-year floodplain is on site	
☒ Delineated from FEMA Maps	
NOTE: Per Rule 250-RICR-150-10-8-1.1(B)(5)(d)(3), provide volumetric floodplain compensation calculations for cut and fill/displacement calculated by qualified professional	
☐ Calculated by Professional Engineer	
☐ Calculations are provided for cut vs. fill/displacement volumes proposed within the 100-year floodplain	Amount of Fill (CY): Amount of Cut (CY):
☐ Restrictions or modifications are proposed to the flow path or velocities in a floodway	
☐ Floodplain storage capacity is impacted	
☐ Project area is not within 100-year floodplain as defined by RIDEM	

CRMC JURISDICTION
☒ CRMC Assent required
☒ Property subject to a Special Area Management Plan (SAMP). If so, specify which SAMP: Metro Bay-see attached CRMC letter
☐ Sea level rise mitigation has been designed into this project

LUHPPL IDENTIFICATION - MINIMUM STANDARD 8:			
1. OFFICE OF Land Revitalization and Sustainable Materials Management (OLRSMM)			
	☒ Known or suspected releases of HAZARDOUS MATERIAL are present at the site (Hazardous Material is defined in Rule 1.4(A)(33) of 250-140-30-1 of the RIDEM Rules and Regulations for Investigation and Remediation of Hazardous Materials (the Remediation Regulations))		**RIDEM CONTACT:** Michelle McLarney 401-222-2797 x277-7158 Site ID: SR-02-2085
	☒ Known or suspected releases of PETROLEUM PRODUCT are present at the site (Petroleum Product as defined in Rule 1.5(A)(84) of 250-140-25-1 of the RIDEM Rules and Regulations for Underground Storage Facilities Used for Regulated Substances and Hazardous Materials)		Michelle McLarney 401-222-2797 x277-7158 Site ID: SR-02-2085
	☒ This site is identified on the RIDEM Environmental Resources Map as one of the following regulated facilities		**SITE ID#:**
		☐ CERCLIS/Superfund (NPL)	
		☒ State Hazardous Waste Site (SHWS)	SR-02-2085
		☐ Environmental Land Usage Restriction (ELUR)	
		☐ Leaking Underground Storage Tank (LUST)	
		☐ Closed Landfill	
Note: If any boxes in 1 above are checked, the applicant must contact the RIDEM OLRSMM Project Manager associated with the Site to determine if subsurface infiltration of stormwater is allowable for the project. Indicate if the infiltration corresponds to "Red," "Yellow" or "Green" as described in Section 3.2.8 of the RISDISM Guidance (Subsurface Contamination Guidance). Also, note and reference approval in PART 3, Minimum Standard 2: Groundwater Recharge/Infiltration**.**			
2. PER MINIMUM STANDARD 8 of RICR 8.14.C.1-6 "LUHPPLS," THE SITE IS/HAS:			
	☐ Industrial Site with RIPDES MSGP, except where No Exposure Certification exists. http://www.dem.ri.gov/programs/water/permits/ripdes/stormwater/status.php		
	☐ Auto Fueling Facility (e.g., gas station)		
	☐ Exterior Vehicles Service, Maintenance, or Equipment Cleaning Area		

	☐ Road Salt Storage and Loading Areas (exposed to rainwater)	
	☐ Outdoor Storage and Loading/Unloading of Hazardous Substances	
3.	**STORMWATER INDUSTRIAL PERMITTING**	
	☐ The site is associated with existing or proposed activities that are considered Land Uses with Higher Potential Pollutant Loads (LUHPPLS) (see RICR 8.14.C)	Activities: Sector:
	☐ Construction is proposed on a site that is subject to THE MULTI-SECTOR GENERAL PERMIT (MSGP) UNDER RULE 31(B)15 OF THE RIPDES REGULATIONS.	MSGP permit #
	☐ Additional stormwater treatment is required by the MSGP Explain:	

REDEVELOPMENT STANDARD – MINIMUM STANDARD 6		
☒ Pre Construction Impervious Area		
See Attached Redevelopment Calc Table	☒ Total Pre-Construction Impervious Area (**TIA**)	
	☒ Total Site Area (**TSA**)	
	☒ Jurisdictional Wetlands (**JW**)	
	☒ Conservation Land (**CL**)	
☒ Calculate the Site Size (defined as contiguous properties under same ownership)		
	☒ Site Size (**SS**) = (**TSA**) – (**JW**) – (**CL**)	
	☐ (**TIA**) / (**SS**) =	☒ (**TIA**) / (**SS**) >**0.4**?
☒ YES, Redevelopment		

PART 2. LOW IMPACT DEVELOPMENT ASSESSMENT – MINIMUM STANDARD 1

(NOT REQUIRED FOR REDEVELOPMENT OR RETROFITS)
This section may be deleted if not required.

Note: A written description must be provided specifying why each method is not being used or is not applicable at the Site. Appropriate answers may include:

- Town requires … (state the specific local requirement)
- Meets Town's dimensional requirement of …
- Not practical for site because …
- Applying for waiver/variance to achieve this (pending/approved/denied)
- Applying for wavier/variance to seek relief from this (pending/approved/denied)

A) PRESERVATION OF UNDISTURBED AREAS, BUFFERS, AND FLOODPLAINS	**IF NOT IMPLEMENTED, EXPLAIN HERE**
☒ Sensitive resource areas and site constraints are identified (required) ☒ Local development regulations have been reviewed (required) ☒ All vegetated buffers and coastal and freshwater wetlands will be protected during and after construction ☒ Conservation Development or another site design technique has been incorporated to protect open space and pre-development hydrology. **Note:** If Conservation Development has been used, check box and skip to Subpart C ☒ As much natural vegetation and pre-development hydrology as possible has been maintained	The Mill's waterside frontage is currently an overgrown, unused buffer. This will remain open space, but be improved to provide public access with a pervious paver walkway. A natural buffer planted with native coastal vegetation will be maintained between the public access path and the riprap revetment coastal feature.

B) LOCATE DEVELOPMENT IN LESS SENSITIVE AREAS AND WORK WITH THE NATURAL LANDSCAPE CONDITIONS, HYDROLOGY, AND SOILS ☐ Development sites and building envelopes have been appropriately distanced from wetlands and waterbodies ☐ Development and stormwater systems have been located in areas with greatest infiltration capacity (e.g., soil groups A and B) ☐ Plans show measures to prevent soil compaction in areas designated as Qualified Pervious Areas (QPA's) ☐ Development sites and building envelopes have been positioned outside of floodplains ☒ Site design positions buildings, roadways and parking areas in a manner that avoids impacts to surface water features ☒ Development sites and building envelopes have been located to minimize impacts to steep slopes (≥15%) ☐ Other (describe):	The existing sites are very gradually sloped, which was not modified significantly in the post development conditions. All improvements on the waterfront property do not increase impervious cover or impact the existing riprap revetment coastal feature. Soils are very poor on site with high groundwater table so all BMPs proposed are lined.
C) MINIMIZE CLEARING AND GRADING ☒ Site clearing has been restricted to <u>minimum area needed</u> for building footprints, development activities, construction access, and safety. ☒ Site has been designed to position buildings, roadways, and parking areas in a manner that minimizes grading (cut and fill quantities) ☒ Protection for stands of trees and individual trees and their root zones to be preserved has been specified, and such protection extends at least to the tree canopy drip line(s) ☐ Plan notes specify that public trees removed or damaged during construction shall be replaced with equivalent	Most trees and vegetation on the propose parking lot parcels are maintained to provide screening from abutters and shading to the parking lot. Several trees in the center of the proposed lot were not mature and had to be removed to accommodate an efficient parking lot layout. Additional tree plantings within the parking lot are provided to enhance screening and shading.
D) REDUCE IMPERVIOUS COVER ☒ Reduced roadway widths (≤22 feet for ADT ≤ 400; ≤ 26 feet for ADT 400 - 2,000) ☒ Reduced driveway areas (length minimized via reduced ROW width (≤ 45 ft.) and/or reduced (or absolute minimum) front yard setback; width minimized to ≤ 9 ft. wide one lane; ≤ 18 ft. wide two lanes; shared driveways; pervious surface) ☒ Reduced building footprint: Explain approach: Existing Mill building was developed in phases with several adjoining structures. One concrete masonry block building, which is not historic, in the northwest corner of the site will be demolished to reduce the overall building footprint. ☒ Reduced sidewalk area (≤ 4 ft. wide; one side of the street; unpaved path; pervious surface) ☐ Reduced cul-de-sacs (radius < 45 ft; vegetated island; alternative turn-around) ☒ Reduced parking lot area: Explain approach ☐ Use of pervious surfaces for driveways, sidewalks, parking areas/overflow parking areas, etc. ☐ Minimized impervious surfaces (project meets or is less than maximum specified by Zoning Ordinance) ☐ Other (describe):	A wavier was requested and approved by the Town to reduce the width of parking spaces and drive aisles. Pervious walkways are proposed on the west side of the property for the public access along the waterfront. Landscaped islands are incorporated into the parking lot to break up the impervious area and provide areas for landscape buffers.

E) DISCONNECT IMPERVIOUS AREA ☒ Impervious surfaces have been disconnected, and runoff has been diverted to QPAs to the maximum extent possible ☐ Residential street edges allow side-of-the-road drainage into vegetated open swales ☒ Parking lot landscaping breaks up impervious expanse AND accepts runoff ☐ Other (describe):	Landscaped islands are incorporated into the parking lot to break up the impervious area and provide areas for landscape buffers. Some existing downspouts were directed to discharge to the sidewalk on Thames Street and is now directed to a rain garden and tree filter.
F) MITIGATE RUNOFF AT THE POINT OF GENERATION ☒ Small-scale BMPs have been designated to treat runoff as close as possible to the source	BMPs were located to collect and treat water close to the
G) PROVIDE LOW-MAINTENANCE NATIVE VEGETATION ☒ Low-maintenance landscaping has been proposed using native species and cultivars ☒ Plantings of native trees and shrubs in areas previously cleared of native vegetation are shown on site plan ☐ Lawn areas have been limited/minimized, and yards have been kept undisturbed to the maximum extent practicable on residential lots	Native and low-maintenance trees and plantings have been selected for the parking lot landscaping. Coastal plantings from the CRMC coastal buffer planting guide.
H) RESTORE STREAMS/WETLANDS ☐ Historic drainage patterns have been restored by removing closed drainage systems, daylighting buried streams, and/or restoring degraded stream channels and/or wetlands ☐ Removal of invasive species ☐ Other	

PART 3. SUMMARY OF REMAINING STANDARDS

GROUNDWATER RECHARGE – MINIMUM STANDARD 2		
YES	**NO**	
☐	☒	The project has been designed to meet the groundwater recharge standard.
☐	☒	If "No," the justification for groundwater recharge criterion waiver has been explained in the Narrative (e.g., threat of groundwater contamination or physical limitation), if applicable (see RICR 8.8.D);
☐	☒	Your waiver request has been explained in the Narrative, if applicable.
☐	☒	Is this site identified as a Regulated Facility in Part 1, Minimum Standard 8: LUHPPL Identification?
☐	☐	If "Yes," has approval for infiltration by the OLRSMM Site Project Manager, per Part 1, Minimum Standard 8, been requested?

TABLE 2-1: Summary of Recharge (see RISDISM Section 3.3.2)
(Add or Subtract Rows as Necessary)

Design Point	**Impervious Area Treated (sq ft)**	**Total Re_v Required (cu ft)**	**LID Stormwater Credits (see RISDISM Section 4.6.1)** / **Portion of Re_v directed to a QPA (cu ft)**	**Recharge Required by Remaining BMPs (cu ft)**	**Recharge Provided by BMPs (cu ft)**
DP-1:					
DP-2:					

DP-3:					
DP-4:					
TOTALS:					

Notes:

1. Only BMPs listed in RISDISM Table 3-5 “List of BMPs Acceptable for Recharge” may be used to meet the recharge requirement.
2. Recharge requirement must be satisfied for each waterbody ID.

☒ Indicate where the pertinent calculations and/or information for the above items are provided (i.e., name of report/document, page numbers, appendices, etc.):

Waiver is requested due to high groundwater table which is tidally influenced, poor soils, and poor infiltration rates. The Stormwater analysis report provides details on subsurface investigations and findings.

WATER QUALITY – MINIMUM STANDARD 3		
YES	NO	
☐	☒	Does this project meet or exceed the required water quality volume WQv (see RICR 8.9.E-I)?
☒	☐	Is the proposed final impervious cover greater than 20% of the disturbed area (see RICR 8.9.E-I)?
☒	☐	If "Yes," either the Modified Curve Number Method or the Split Pervious/Impervious method in Hydro-CAD was used to calculate WQv; or,
☒	☐	If "Yes," either TR-55 or TR-20 was used to calculate WQv; and,
☐	☐	If "No," the project meets the minimum WQv of 0.2 watershed inches over the entire disturbed area.
☐	☐	Not Applicable
☐	☐	Does this project meet or exceed the ability to treat required water quality flow WQf (see RICR 8.9.I.1-3)?
☐	☒	Does this project propose an increase of impervious cover to a receiving water body with impairments? If "Yes," please indicate below the method that was used to address the water quality requirements of no further degradation to a low-quality water.
☐	☒	RICR 8.36. A Pollutant Loading Analysis is needed and has been completed.
☐	☒	The Water Quality Guidance Document (Water Quality Goals and Pollutant Loading Analysis Guidance for Discharges to Impaired Waters) has been followed as applicable.
☐	☒	BMPs are proposed that are on the approved technology list . If "Yes," please provide all required worksheets from the manufacturer.
☐	☒	Additional pollutant-specific requirements and/or pollutant removal efficiencies are applicable to the site as the result of a TMDL, SAMP, or other watershed-specific requirements. If "Yes," please describe:

TABLE 3-1: Summary of Water Quality (see RICR 8.9)					
Design Point and WB ID	**Impervious area treated (sq ft)**	**Total WQ_v Required (cu ft)**	**LID Stormwater Credits** (see RICR 8.18) **WQv directed to a QPA (cu ft)**	**Water Quality Treatment Remaining (cu ft)**	**Water Quality Provided by BMPs (cu ft)**
DP-1:					
DP-2:					
DP-3:					
DP-4:					
TOTALS:					

Notes:
1. Only BMPs listed in RICR 8.20 and 8.25 or the Approved Technologies List of BMPs is Acceptable for Water Quality treatment.
2. For each Design Point, the Water Quality Volume Standard must be met for each Waterbody ID.

☒ YES ☐ NO	This project has met the setback requirements for each BMP. If "No," please explain:

☒ Indicate where the pertinent calculations and/or information for the above items are provided (i.e., name of report/document, page numbers, appendices, etc.):

See attached Table 3-1 in Appendix A of the Stormwater Analysis Report

CONVEYANCE AND NATURAL CHANNEL PROTECTION (RICR 8.10) – MINIMUM STANDARD 4			
YES	**NO**		
☒	☐	Is this standard waived? If "Yes," please indicate one or more of the reasons below:	
		☒	The project directs discharge to a large river (i.e., 4th-order stream or larger. See RISDISM Appendix I for State-wide list and map of stream orders), bodies of water >50.0 acres in surface area (i.e., lakes, ponds, reservoirs), or tidal waters.
		☐	The project is a small facility with impervious cover of less than or equal to 1 acre.
		☐	The project has a post-development peak discharge rate from the facility that is less than 2 cfs for the 1-year, 24-hour Type III design storm event (prior to any attenuation). (Note: LID design strategies can greatly reduce the peak discharge rate).
☐	☐	Conveyance and natural channel protection for the site have been met. If "No,' explain why:	

TABLE 4-1: Summary of Channel Protection Volumes (see RICR 8.10)					
Design Point	**Receiving Water Body Name**	**Coldwater Fishery? (Y/N)**	**Total CPv Required (cu ft)**	**Total CPv Provided (cu ft)**	**Average Release Rate Modeled in the 1-yr storm (cfs)**
DP-1:					
DP-2:					
DP-3:					
DP-4:					
TOTALS:					
Note: The Channel Protection Volume Standard must be met in each waterbody ID.					
☐ YES ☐ NO	The CPv is released at roughly a uniform rate over a 24-hour duration (see examples of sizing calculations in Appendix D of the RISDISM).				
☐ YES ☐ NO	Do additional design restrictions apply resulting from any discharge to cold-water fisheries; If "Yes," please indicate restrictions and solutions below.				
☒ Indicate below where the pertinent calculations and/or information for the above items are provided (i.e., name of report/document, page numbers, appendices, etc.). See attached Table 4-1 in Appendix A of the Stormwater Analysis Report					

<table>
<tr><th colspan="4">OVERBANK FLOOD PROTECTION (RICR 8.11) AND OTHER POTENTIAL HIGH FLOWS – MINIMUM STANDARD 5</th></tr>
<tr><td>YES</td><td>NO</td><td colspan="2"></td></tr>
<tr><td>☒</td><td>☐</td><td colspan="2">Is this standard waived? If yes, please indicate one or more of the reasons below:</td></tr>
<tr><td></td><td></td><td>☒

☐</td><td>The project directs discharge to a large river (i.e., 4th-order stream or larger. See Appendix I for state-wide list and map of stream orders), bodies of water >50.0 acres in surface area (i.e., lakes, ponds, reservoirs), or tidal waters.
A Downstream Analysis (see RICR 8.11.D and E) indicates that peak discharge control would not be beneficial or would exacerbate peak flows in a downstream tributary of a particular site (e.g., through coincident peaks).</td></tr>
<tr><td>☐</td><td>☒</td><td colspan="2">Does the project flow to an MS4 system or subject to other stormwater requirements?
If "Yes," indicate as follows:</td></tr>
<tr><td></td><td></td><td>☐
☐</td><td>RIDOT
Other (specify):</td></tr>
<tr><td colspan="4"><u>Note</u>: The project could be approved by RIDEM but not meet RIDOT or Town standards. RIDOT's regulations indicate that post-volumes must be less than pre-volumes for the 10-yr storm at the design point entering the RIDOT system. If you have not already received approval for the discharge to an MS4, please explain below your strategy to comply with RIDEM and the MS4.</td></tr>
<tr><td></td><td></td><td colspan="2">Indicate below which model was used for your analysis.
☐ TR-55 ☐ TR-20 ☐ HydroCAD ☐ Bentley/Haestad ☐ Intellisolve
☐ Other (Specify):</td></tr>
<tr><td>YES</td><td>NO</td><td colspan="2"></td></tr>
<tr><td>☐</td><td>☐</td><td colspan="2">Does the drainage design demonstrate that flows from the 100-year storm event through a BMP will safely manage and convey the 100-year storm? If "No," please explain briefly below and reference where in the application further documentation can be found (i.e., name of report/document, page numbers, appendices, etc.):</td></tr>
<tr><td>☒
☒
☒</td><td>☐
☐
☐</td><td colspan="2">Do off-site areas contribute to the sub-watersheds and design points? If "Yes,"
Are the areas modeled as "present condition" for both pre- and post-development analysis?
Are the off-site areas shown on the subwatershed maps?</td></tr>
<tr><td>☒</td><td>☐</td><td colspan="2">Does the drainage design confirm safe passage of the 100-year flow through the site for off-site runoff?</td></tr>
<tr><td>☐</td><td>☒</td><td colspan="2">Is a Downstream Analysis required (see RICR 8.11.E.1)?</td></tr>
<tr><td>☒</td><td>☐</td><td colspan="2">Calculate the following:</td></tr>
<tr><td></td><td></td><td>☒</td><td>Area of disturbance within the sub-watershed (areas)</td></tr>
<tr><td></td><td></td><td>☒</td><td>Impervious cover (%)</td></tr>
<tr><td>☐</td><td>☒</td><td colspan="2">Is a dam breach analysis required (earthen embankments over six (6) feet in height, or a capacity of 15 acre-feet or more, and contributes to a significant or high hazard dam)?</td></tr>
<tr><td>☐</td><td>☒</td><td colspan="2">Does this project meet the overbank flood protection standard?</td></tr>
</table>

Table 5-1 Hydraulic Analysis Summary								
Subwatershed (Design Point)	**1.2" Peak Flow** (cfs) **		**1-yr Peak Flow** (cfs)		**10-yr Peak Flow** (cfs)		**100-yr Peak Flow** (cfs)	
	Pre (cfs)	Post (cfs)	Pre (cfs)	Post (cfs)	Pre (cfs)	Post (cfs)	Pre (cfs)	Post (cfs)
DP-1:								
DP-2:								
DP-3:								
DP-4:								
TOTALS:								

** Utilize modified curve number method or split pervious /impervious method in HydroCAD.

Note: The hydraulic analysis must demonstrate no impact to each individual subwatershed DP unless each DP discharges to the same wetland or water resource.

Indicate as follows where the pertinent calculations and/or information for the items above are provided	**Name of report/document, page numbers, appendices, etc.**
Existing conditions analysis for each subwatershed, including curve numbers, times of concentration, runoff rates, volumes, and water surface elevations showing methodologies used and supporting calculations.	Stormwater Analysis Report – Appendix B
Proposed conditions analysis for each subwatershed, including curve numbers, times of concentration, runoff rates, volumes, water surface elevations, and routing showing the methodologies used and supporting calculations.	Stormwater Analysis Report – Appendix C
Final sizing calculations for structural stormwater BMPs, including contributing drainage area, storage, and outlet configuration.	Stormwater Analysis Report – Appendix C & Appendix D
Stage-storage, inflow and outflow hydrographs for storage facilities (e.g., detention, retention, or infiltration facilities).	Stormwater Analysis Report – Appendix C

Table 5-2 Summary of Best Management Practices												
BMP ID	**DP #**	**BMP Type** (e.g., bioretention, tree filter)	**BMP Functions**					**Bypass Type**	**Horizontal Setback Criteria are met per RICR 8.21.B.10, 8.22.D.11, and 8.35.B.4**		
			Pre-Treatment (Y/N/ NA)	Re_v	WQ_v	CP_v (Y/N/ NA)	Overbank Flood Reduction (Y/N/NA)	External (E) Internal (I) or NA	Yes/ No	Technical Justification (Design Report page number)	Distance Provided
		TOTALS:	See attached Table 5-2 in Appendix A of the Stormwater Analysis Report								

Table 5.3 Summary of Soils to Evaluate Each BMP									
			Soils Analysis for Each BMP						
DP #	**BMP ID**	**BMP Type** (e.g., bioretention, tree filter)	Test Pit ID# and Ground Elevation		SHWT Elevation (ft)	Bottom of Practice Elevation* (ft)	Separation Distance Provided (ft)	Hydrologic Soil Group (A, B, C, D)	Exfiltration Rate Applied (in/hr)
			Primary	Secondary					
		TOTALS:	See attached Table 5-3 in Appendix A of the Stormwater Analysis Report						
* For underground infiltration systems (UICs) bottom equals bottom of stone, for surface infiltration basins bottom equals bottom of basin, for filters bottom equals interface of storage and top of filter layer									

LAND USES WITH HIGHER POTENTIAL POLLUTANTS LOADS (LUHPPLs) – MINIMUM STANDARD 8			
YES	**NO**	**N/A**	
☐	☐	☒	Describe any LUHPPLs identified in Part 1, Minimum Standard 8, Section 2. If not applicable, continue to Minimum Standard 9.
☐	☐	☐	Are these activities already covered under an MSGP? If “No,” please explain if you have applied for an MSGP or intend to do so?
☐	☐	☒	List the specific BMPs that are proposed for this project that receive stormwater from LUHPPL drainage areas. These BMP types must be listed in RISDISM Table 3-3, “Acceptable BMPs for Use at LUHPPLs.” Please list BMPs:
☐	☐	☐	Additional BMPs, or additional pretreatment BMP’s if any, that meet RIPDES MSGP requirements; Please list BMPs:
			Indicate below where the pertinent calculations and/or information for the above items are provided (i.e., name of report/document, page numbers, appendices, etc.).

ILLICIT DISCHARGES – MINIMUM STANDARD 9			
Illicit discharges are defined as unpermitted discharges to Waters of the State that do not consist entirely of stormwater or uncontaminated groundwater, except for certain discharges identified in the RIPDES Phase II Stormwater General Permit.			
YES	**NO**	**N/A**	
☐	☐	☒	Have you checked for illicit discharges?
☐	☐	☐	Have any been found and/or corrected? If “Yes,” please identify.
☐	☐	☐	Does your report explain preventative measures that keep non-stormwater discharges out of the Waters of the State (during and after construction)?

SOIL EROSION AND SEDIMENT CONTROL (SESC) – MINIMUM STANDARD 10				
YES	**NO**	**N/A**		
☒	☐	☐	Have you included a Soil Erosion and Sediment Control Plan Set and/or Complete Construction Plan Set?	
☒	☐	☐	Have you provided a **separately-bound** document based upon the SESC Template? If yes, proceed to Minimum Standard 11 (the following items can be assumed to be addressed).	
			If "No," include a document with your submittal that addresses the following elements of an SESC Plan:	
			☒	Soil Erosion and Sediment Control Plan Project Narrative, including a description of how the fifteen (15) Performance Criteria have been met:
			☒	Provide Natural Buffers and Maintain Existing Vegetation
			☒	Minimize Area of Disturbance
			☒	Minimize the Disturbance of Steep Slopes
			☒	Preserve Topsoil
			☒	Stabilize Soils
			☒	Protect Storm Drain Inlets
			☒	Protect Storm Drain Outlets
			☒	Establish Temporary Controls for the Protection of Post-Construction Stormwater Control Measures
			☒	Establish Perimeter Controls and Sediment Barriers
			☒	Divert or Manage Run-On from Up-Gradient Areas
			☒	Properly Design Constructed Stormwater Conveyance Channels
			☒	Retain Sediment On-Site
			☒	Control Temporary Increases in Stormwater Velocity, Volume, and Peak Flows
			☒	Apply Construction Activity Pollution Prevention Control Measures
			☒	Install, Inspect, and Maintain Control Measures and Take Corrective Actions
			☒	Qualified SESC Plan Preparer's Information and Certification
			☒	Operator's Information and Certification; if not known at the time of application, the Operator must certify the SESC Plan upon selection and prior to initiating site activities
			☒	Description of Control Measures, such as Temporary Sediment Trapping and Conveyance Practices, including design calculations and supporting documentation, as required

STORMWATER MANAGEMENT SYSTEM OPERATION, MAINTENANCE, AND POLLUTION PREVENTION PLAN – MINIMUM STANDARDS 7 AND 9		
Operation and Maintenance Section		
YES	**NO**	
☒	☐	Have you minimized all sources of pollutant contact with stormwater runoff, to the maximum extent practicable?
☒	☐	Have you provided a **separately-bound** Operation and Maintenance Plan for the site and for all of the BMPs, and does it address each element of RICR 8.17 and RISDISM Appendix C and E?
☒	☐	Lawn, Garden, and Landscape Management meet the requirements of RISDISM Section G.7? If "No," why not?
☒	☐	Is the property owner or homeowner's association responsible for the stormwater maintenance of all BMP's? If "No," you must provide a legally binding and enforceable maintenance agreement (see RISDISM Appendix E, page 26) that identifies the entity that will be responsible for maintenance of the stormwater. Indicate where this agreement can be found in your report (i.e., name of report/document, page numbers, appendices, etc.).
☒	☐	Do you anticipate that you will need legal agreements related to the stormwater structures? (e.g. off-site easements, deed restrictions, covenants, or ELUR per the Remediation Regulations). If "Yes," have you obtained them? Or please explain your plan to obtain them:

☐	☒	Is stormwater being directed from public areas to private property? If "Yes," note the following: Note: This is not allowed unless a funding mechanism is in place to provide the finances for the long-term maintenance of the BMP and drainage, or a funding mechanism is demonstrated that can guarantee the long-term maintenance of a stormwater BMP by an individual homeowner.
Pollution Prevention Section		
☐	☒	Designated snow stockpile locations?
☒	☐	Trash racks to prevent floatables, trash, and debris from discharging to Waters of the State?
☒	☐	Asphalt-only based sealants?
☒	☐	Pet waste stations? (Note: If a receiving water has a bacterial impairment, and the project involves housing units, then this could be an important part of your pollution prevention plan).
☒	☐	Regular sweeping? Please describe:
☒	☐	De-icing specifications, in accordance with RISDISM Appendix G. (NOTE: If the groundwater is GAA, or this area contributes to a drinking water supply, then this could be an important part of your pollution prevention plan).
☒	☐	A prohibition of phosphate-based fertilizers? (Note: If the site discharges to a phosphorus impaired waterbody, then this could be an important part of your pollution prevention plan).

PART 4. SUBWATERSHED MAPPING AND SITE-PLAN DETAILS

Existing and Proposed Subwatershed Mapping (REQUIRED)			
YES	**NO**		
☒	☐	Existing and proposed drainage area delineations	
☒	☐	Locations of all streams and drainage swales	
☒	☐	Drainage flow paths, mapped according to the DEM *Guidance for Preparation of Drainage Area Maps* (included in RISDISM Appendix K)	
☒	☐	Complete drainage area boundaries; include off-site areas in both mapping and analyses, as applicable	
☒	☐	Logs of borings and/or test pit investigations along with supporting soils/geotechnical report	
☒	☐	Mapped seasonal high-water-table test pit locations	
☒	☐	Mapped locations of the site-specific borings and/or test pits and soils information from the test pits at the locations of the BMPs	
☒	☐	Mapped locations of the BMPs, with the BMPs consistently identified on the Site Construction Plans	
☐	☒	Mapped bedrock outcrops adjacent to any infiltration BMP	
☒	☐	Soils were logged by a:	
		☐	DEM-licensed Class IV soil evaluator Name:
		☒	RI-registered P.E. Name: Christina Viera, PE

Subwatershed and Impervious Area Summary				
Subwatershed (area to each design point)	**First Receiving Water ID or MS4**	**Area Disturbed (units)**	**Existing Impervious (units)**	**Proposed Impervious (units)**
DP-1:				
DP-2:				
DP-3:				
DP-4:				
TOTALS:	See attached Subwatershed and Impervious Area Table in Appendix A of the Stormwater Analysis Report			

Site Construction Plans (Indicate that the following applicable specifications are provided)		
YES	**NO**	
☒	☐	Existing and proposed plans (scale not greater than 1" = 40') with North arrow
☒	☐	Existing and proposed site topography (with 1 or 2-foot contours); 10-foot contours accepted for off-site areas
☒	☐	Boundaries of existing predominant vegetation and proposed limits of clearing
☒	☐	Site Location clarification
☒	☐	Location and field-verified boundaries of resource protection areas such as: ► freshwater and coastal wetlands, including lakes and ponds ► coastal shoreline features Perennial and intermittent streams, in addition to Areas Subject to Storm Flowage (ASSFs)
☒	☐	All required setbacks (e.g., buffers, water-supply wells, septic systems)
☒	☐	Representative cross-section and profile drawings, and notes and details of structural stormwater management practices and conveyances (i.e., storm drains, open channels, swales, etc.), which include: ► Location and size of the stormwater treatment practices (type of practice, depth, area). Stormwater treatment practices (BMPs) must have labels that correspond to RISDISM Table 5-2; ► Design water surface elevations (applicable storms); ► Structural details of outlet structures, embankments, spillways, stilling basins, grade-control structures, conveyance channels, etc.; ► Existing and proposed structural elevations (e.g., inverts of pipes, manholes, etc.); ► Location of floodplain and, if applicable, floodway limits and relationship of site to upstream and downstream properties or drainage that could be affected by work in the floodplain; ► Planting plans for structural stormwater BMPs, including species, size, planting methods, and maintenance requirements of proposed planting
☒	☐	Logs of borings and/or test pit investigations along with supporting soils/geotechnical report and corresponding water tables
☐	☒	Mapping of any OLRSMM-approved remedial actions/systems (including ELURs)
☒	☐	Location of existing and proposed roads, buildings, and other structures including limits of disturbance; ► Existing and proposed utilities (e.g., water, sewer, gas, electric) and easements; ► Location of existing and proposed conveyance systems, such as grass channels, swales, and storm drains, and location(s) of final discharge point(s) (wetland, waterbody, etc.); ► Cross sections of roadways, with edge details such as curbs and sidewalks; ► Location and dimensions of channel modifications, such as bridge or culvert crossings
☐	☒	Locations, cross sections, and profiles of all stream or wetland crossings and their method of stabilization

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Redevelopment Evaluation Summary (Minimum Standard 6)

(In accordance with Section 3.2.6 RISDISM Redevelopment Criteria Guidance)

1) Determine if project meets the RISDISM defintion of Redevelopment.

a. Does project disturb a total of 10,000 SF or more of existing impervious area? **Yes**

b. Is existing impervious cover greater than 40-percent? **Yes**

(TIA) / (SS) = ***0.71***

154,685	SF	Total pre-development Impervious Area (TIA)
219,398	SF	Total Site Area (TSA)
-	SF	Jurisdictional Wetlands (JW)
-	SF	Conservation Land (CL)
219,398	SF	Site Size (SS=TSA-JW-CL)

***Project meets the RISDISM defintion for redevelopment and qualifies for reduced water quality and recharge requirements.**

2) Calculate required stormwater Site Treatment Area (STA)

51,224 SF

93,024	SF	DI (Disturbed Impervious*)
-4,712	SF	NIP (Net Increased Pervious)

*existing mill complex roof included in disturbed impervious per CRMC

3) Calculate required Water Quality Volume (WQv) in accordance with Section 3.3.3 of the RISDISM.

WQ_v = ***6,348 cf***

***See Summary of Water Quality Table for required WQv calculation. Required WQv shall be treated by on-site structural BMPs and LID practices. See BMP Stormwater Treatment table.**

Table 2-1 - Summary of Recharge (Section 3.3.2)

Subwatershed Name	Post-Development Impervious Area (square feet)	Recharge Factor[1]	Total Required Recharge Volume (Re_v) (cubic feet)	LID Stormwater Credits		Recharge Required by Remaining BMPs (cubic feet)	Recharge Provided by BMPs (cubic feet)
				Impervious Area Directed to QPA (square feet)	Recharge Credit Applied (cubic feet)		
Subwatershed 1	111,377	N/A	0	0	0	0	0
Subwatershed 2	20,125	N/A	0	0	0	0	0
Subwatershed 3	13,461	N/A	0	0	0	0	0
Subwatershed 4	17,414	N/A	0	0	0	0	0
Subwatershed 5	0	N/A	0	0	0	0	0
Totals	162,377	-	0	0	0	0	0

Notes:

1. In accordance with RISDISM Table 3-4 Recharge Factors Based on Hydrologic Soil Group (HSG)

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Table 3-1 - Summary of Water Quality (Section 3.3.3)

Subwatershed Name	Impervious Subwatershed Area (square feet)	Total Required Water Quality Volume (WQ_v) [1] (cubic feet)	LID Stormwater Credits		Water Quality Treatment Required by Remaining BMPs (cubic feet)	Water Quality Provided by BMPs (cubic feet)
			Impervious Area Directed to QPA (square feet)	Water Quality Credit Applied (cubic feet)		
Subwatershed 1	111,377	4,953	0	0	4,953	4,381
Subwatershed 2	20,125	541	0	0	541	0
Subwatershed 3	13,461	437	0	0	437	0
Subwatershed 4	17,414	417	0	0	417	0
Subwatershed 5	0	0	0	0	0	0
Totals	**162,377**	**6,348**	**0**	**0**	**6,348**	**4,381**

Notes:

1. Required water quality volume is calculated as 1" of runoff from new impervious surfaces on the site and 0.5" of runoff from disturbed impervious and the mill complex roof.

Table 4-1 - Summary of Channel Protection Volumes (Section 3.3.4)

Drainage Point	Receiving Water Body Name	Coldwater Fishery?	Required Channel Protection Volume (CP_v) (acre-feet)	Provided Channel Protection Volume (CP_v) (acre-feet)	Release Rate Modeled in the 2-year storm (cfs)
Subwatershed 1	Bristol Harbor	No	0	0	11.90
Subwatershed 2	Bristol Harbor	No	0	0	3.04
Subwatershed 3	Bristol Harbor	No	0	0	1.02
Subwatershed 4	Bristol Harbor	No	0	0	2.15
Subwatershed 5	Bristol Harbor	No	0	0	0.00
Totals	-	-	0	0	18.11

Notes:

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Table 5-1 - Summary of Hydrologic Analysis

Subwatershed Name	Subwatershed Area [1] (acre)	Water Quality (1.2") Peak Flow		1-Year Storm Peak Flow		10-Year Storm Peak Flow		100-Year Storm Peak Flow	
		Pre (cfs)	Post (cfs)	Pre (cfs)	Post (cfs)	Pre (cfs)	Post (cfs)	Pre (cfs)	Post (cfs)
Subwatershed 1	2.99	1.04	2.65	2.56	9.42	4.53	17.89	7.98	33.00
Subwatershed 2	0.89	0.86	0.70	2.30	2.43	4.33	5.01	8.02	9.86
Subwatershed 3	0.31	0.46	0.32	1.14	0.85	2.01	1.60	3.54	2.95
Subwatershed 4	0.85	1.57	0.50	5.57	1.72	11.56	3.56	22.48	6.94
Subwatershed 5	0.00	1.21	0.00	2.97	0.00	5.25	0.00	9.25	0.00
Totals	5.04	5.14	4.17	14.54	14.42	27.68	28.06	51.27	52.75

Notes:

1. Post-Development Subwatersheds Used

Table 5-2 - Summary of Best Management Practices (BMPs)

Subwatershed Name	Best Management Practice Name	Best Management Practice Functions (cubic feet)				Overbank Flood Reduction	Internal Bypass	Horizontal Setback[1]	
		Pre-treatment	Recharge	Water Quality	Channel Protection			Distance (feet)	From Constraint (feet)
Subwatershed 1B & 1E	Subsurface Filtration System 1	0	0	1,112	0	No	Yes	N/A	N/A
Subwatershed 1F & 1G	Subsurface Filtration System 2	0	0	1,658	0	No	Yes	N/A	N/A
Subwatershed 1C	Tree Filter 1	0	0	310	0	No	Yes	N/A	N/A
Subwatershed 1D	Tree Filter 2	0	0	288	0	No	Yes	N/A	N/A
Subwatershed 1K	Tree Filter 3	0	0	1,013	0	No	Yes	N/A	N/A
Total	-	0	0	4,381	0	-	-	-	-

Notes:

1. In accordance with RISDISM Table 7-2 Minimum Horizontal Setbacks from Infiltration Facilities

Table 5-3 - Summary of Soil Evaluation

Subwatershed Name	Best Management Practice Name	Test Pit No.	Top of BMP Elevation (ft)	SHWT Elevation (ft)	Separation Distance (ft)	Hydrologic Soil Group	Exfiltration Rate Applied (in/hr)
Subwatershed 1B & 1E	Subsurface Filteration System 1	1	9.66	6.90	N/A	C	0.00
Subwatershed 1B & 1E	Subsurface Filteration System 1	2	9.66	10.26	N/A	C	0.00
Subwatershed 1F & 1G	Subsurface Filteration System 2	3	9.30	11.15	N/A	C	0.00
Subwatershed 1F & 1G	Subsurface Filteration System 2	4	9.30	12.25	N/A	C	0.00
Subwatershed 2B	Rain Garden	5	7.00	5.50	N/A	C	0.00

Notes:

1. See Curve Number Calculation tables.
2. See Best Management Practice (BMP) Sizing Calculations.

Subwatershed Summary

Subwatershed Name	Pre-Development Subwatershed Area (acre)	Post-Development Subwatershed Area (acre)	Receiving Water Body ID or MS4	Area Disturbed (acres)	Existing Impervious (acres)	Proposed Impervious (acres)
Subwatershed 1	0.63	2.99	RI0007026E-01C	0.63	0.64	2.56
Subwatershed 2	1.08	0.89	RI0007026E-01C	1.08	0.72	0.46
Subwatershed 3	0.26	0.31	RI0007026E-01C	0.26	0.26	0.24
Subwatershed 4	2.34	0.85	RI0007026E-01C	1.57	1.20	0.40
Subwatershed 5	0.73	0.00	RI0007026E-01C	0.73	0.73	0.00
Total	5.04	5.04		4.27	3.55	3.66

Notes:

1. See Curve Number Calculation tables.
2. See Best Management Practice (BMP) Sizing Calculations.

State of Rhode Island
Coastal Resources Management Council
Oliver H. Stedman Government Center
4808 Tower Hill Road, Suite 3
Wakefield, RI 02879-1900

(401) 783-3370
Fax (401) 783-2069

RHODE ISLAND COASTAL RESOURCES MANAGEMENT COUNCIL
REPORT OF FINDINGS -- PRELIMINARY DETERMINATION

STATEMENT OF LIMITATIONS

The contents of this staff determination report shall be valid only for the period on and preceding the date of this report. This report is neither an approval nor denial of the subject proposal. It is an evaluation of CRMC regulations in effect as of 27 July 2022 as they pertain to the below stated proposal, including preliminary staff recommendations.

Modifications to the below stated proposal may, upon the discretion of the CRMC, render this determination null and void.

APPLICANT INFORMATION

NAME: **Russ Russ Realty** **CRMC FILE NO.** D2022-05-126
LOCATION/POLE: 125 Thames Street
CITY/TOWN: Bristol **PLAT:** 10 **LOT:** 41,42,43,44,49,50,60,61,62,68,

CONTACT PERSON(S) & ADDRESS:

Russ Russ Realty
P.O Box 656
Bristol, RI 02809

Also send to:

Brady Sullivan Properties
670 North Commercial St
Manchester NH 03101

PRELIMINARY REVIEW INFORMATION

PROPOSAL: Redevelopment of historic structure, including offsite parking

PLAN(S) REVIEWED: "Brady Sullivan Properties, LLC, Master Plan, Bristol Yarn Mill, Alternative Parking Plan, 125 Thames Street, Bristol…" dated April 13, 2021 and unstamped by Fuss & O'Neill.

INVESTIGATOR: T. Silvia **DATE/TIME:** 6/14/22 PM

MEASUREMENTS & OBSERVATIONS: Confirmed existing conditions, noted offsite parking areas

PREVIOUS CRMC ACTIONS FOR SITE: 76-11-12 Town (cxld), 79-9-26 revetment/fill; 85-7-52 addition; 03-5-49 mtce; 10-8-49 demo/restoration; 19-11-78 Town MPL/upland work

Preliminary Buffer and Setback Requirements:
SETBACK (ref. Section 1.1.7 Red Book): 50'
BUFFER (ref. Section 1.1.9 Red Book): varies, Urban Coastal Greenway (UCG)

NAME: **Russ Russ Realty**
CRMC FILE NUMBER: **D 2022-05-126**

Note: **Setbacks** apply to "construction related activities" including filling, removing, and grading (ref: Section 1.3.1(B) Red Book). The coastal program requires a minimum setback of either 50', or the buffer zone width plus 25' (whichever is greater). Work within this minimum setback will require a variance per Section 1.1.5 of the Red Book. All variances must be requested in writing. No construction or construction related work shall occur within the required setback (exemptions include structural shoreline protection, outfalls and water dependant uses). Work within the required setback may require a Category "B" review (public notice and decision by the full coastal council) and would likely result in adverse CRMC staff recommendations to the Coastal Council during the review process.

Buffer zones are areas that must be retained in, or allowed to revert to, "an undisturbed natural condition." All structures (excluding accessory structures) should be setback a minimum of 25' from the buffer zone to allow for access, fire protection and maintenance without infringement into the buffer.

If applicable, the plan must show "area of land within 50 feet" in accordance with Rule 5.04 of The Rules and Regulations Governing the Protection and Management of Freshwater Wetlands in the Vicinity of the Coast (the Rules), and label this area as a "buffer zone" in accordance with Rule 5.14. In addition, no activities (such as: drainage, grading, filling, etc.) may affect the freshwater wetland or the buffer zone. Where such alterations occur, or are proposed, an application shall be submitted in accordance with CRMC's Freshwater Wetland Rules.

Coastal Hazard: In accordance with Section 1.1.10, the applicant is encouraged to utilize CRMC's "STORMTOOLS" mapping feature to better understand the impact of current and future Sea Level Rise and Storms on the subject property. Also, in accordance with Section 1.1.6(I), the applicant is required to complete a "Coastal Hazards Worksheet" to further understand the impact of climate change on a proposal (http://www.crmc.ri.gov/coastalhazardapp.html). While the RICRMP does not yet require structures to be designed for SLR scenarios, the applicant should consider SLR, Climate Change, and design life expectations in design planning.

Coastal feature verification shall be valid for one-year from the date of this Determination or until an erosion event (e.g., due to storm event, landslide, man-induced alteration, etc.) occurs that alters the coastal feature.

SUMMARY OF FINDINGS

CRMC JURISDICTION: Yes **TYPE WATER: 5; Comm/Recreational Harbors, Bristol Harbor**
For the purpose of this review the coastal feature(s) shall be the manmade shoreline and the inland edge of coastal(s) feature shall be the top of the riprap revetment and/or edge of outfall headwall.

Applicability of Red Book and SAM Plans (as amended):
Red Book Sections: 1.1.7, 1.1.9, 1.1.10, 1.1.11, 1.2.1(E), 1.2.2(F), 1.3.1 (A), 1.3.1(B), 1.3.1(C), 1.3.1(D), 1.3.1(F), 1.3.1(G), 1.3.5, 1.3.6, 1.8
SAMP: N/A, however Metro Bay SAMP UCG guidelines recommended for the site

STAFF CONCERNS/COMMENTS/INFORMATION REQUIREMENTS:

1) Staff is familiar with the project site from past permit reviews. The parcel consists of a historic mill building running down Thames Street, bordered by the Bristol County Elks, US Coast Guard Station and Town of Bristol on its other sides. The existing development is setback less than 20' from the coastal feature in some locations and existing lawn/debris is located in the area, which is fenced to the north separating it from the Town's marina facilities.

2) The current proposal is to redevelop the mill into a mixed use residential (127 units) and commercial structure, with offsite parking/stormwater/landscaping improvements located on the east side of Thames St, in addition to interior parking facilities located below the Base Flood Elevation (BFE). All equipment and livable space will be located above BFE. The applicant is advised that a Coastal Hazard Analysis (CHA) is required for this project and should use its results in its designs moving forward.

3) Stormwater runoff from existing roofed areas will receive treatment and all new driveway and

parking surfaces will require treatment. Bioretention is proposed seaward of the existing building. All stormwater management shall meet the requirements of the RI Stormwater Installation and Design Standards Manual and supporting drainage details and calculations are required. An Operations and Management (O&M) plan is required as part of the Assent application.

4) All new work (including stormwater BMPs, filling/removing/grading and exterior buildings) are subject to the 50' construction setback. Variances are required where this cannot be met (ref. Section 1.1.7).

5) For commercial development, buffer zones are based on the residential guidance of the Redbook Section 1.1.11, however in this locale, it is clear the full buffer zone cannot be accommodated. Due to its historic nature and existing location, staff concurs with the applicant's request to use the guidance contained within the Metro Bay SAMP's UCG for designing a restorative buffer zone for the site.

6) Additionally, both the UCG and Section 1.3.6 require a public access plan for new subdivisions. The proposed design is supported by staff and could include further amenities to offset variance requests, such as signage and public parking as well as working with the Town to connect along the Lot 70 border, linking much of the remaining shoreline along this side of the downtown harbor for continuous public access. A public access deed restriction will be required as part of this project as well as a conservation easement and future ownership (HOA?) documentation.

7) A local building official signoff (including Town zoning as applicable) is required for this project and it is staff's understanding there may be forth coming objection to this project during CRMC's required 30day public notice period, based on the comments received during local review. The applicant shall provide a written response to any comments received during CRMC notice period.

8) Future development of the waterside of this parcel will be subject to separate CRMC PD application process as well as the requirements of Section 1.3.1(D) and US ACOE review.

9) The RIHPHC provides comment on CRMC projects and has submitted a response indicated that they will need additional information/review of the project during future Assent submittal unless they are reviewing the project under a separate federal tax credit process. Please continue to work directly with the RIPHPC during formulation of this project.

10) Overall, provided the stormwater management, buffer zone and public access components are addressed, the project appears likely to receive favorable staff recommendations. A public notice and possible public hearing may be required for this project.

SIGNATURE: ____________________ STAFF BIOLOGIST

Town of Bristol, Rhode Island

Planning Board

10 Court Street
Bristol, RI 02809
www.bristolri.gov
401-253-7000

DECISION OF BRISTOL PLANNING BOARD

Bristol Yarn Mill – Major Land Development

Master Plan

OWNERS: Russ-Realty Co., Russell Karian, Sentier Realty, and Karian Realty, Co.

APPLICANT: Brady Sullivan Properties, LLC

PROPERTY ADDRESS: 125 Thames Street

PLAT 10 LOTS 41, 42, 43, 44, 49, 50, 60, 61, 62, 68, 71, 73, 74, and 76

Motion:

"The Bristol Planning Board hereby acknowledges the applicant's agreement to an extension of time frame on the action on the Master Plan for the Bristol Yarn Mill (a/k/a Robin Rug) for an additional 60 days to bring the deadline for action to June 21, 2022, and grants conditional approval to the Master Plan as revised April 13, 2022 submitted on April 14, 2022, and recommends to the Town Council that the 2008 Change of Zone conditions and ordinance text also be amended to allow a density of 127 residential units and 6,300 square foot of commercial space along with parking spaces being 9' wide in lieu of the required 10' wide and to allow single – striped parking spaces in the interior parking lot (see plan entitled "Master Plan Bristol Yarn Mill – Alternative Parking Plan") on the east side of Thames Street on Plat 10 Lots 41, 43, 44, 49, 50, 68, 71, 73, 74, and 76."

Approval is based upon the following findings of fact and conclusions of law.

I. Procedural History

1. In 2008, the Town Council approved a conditional Change of Zoning Map to apply the Waterfront – Urban Rehab Land Development "Urban Rehab Land Development" (a/k/a Waterfront Planned Unit Development) zone to the mill property at 125 Thames Street, Plat 10, Lots 42, 60, 61, and 62. Along with the Change of Zoning Map in 2008, the Town Council revised the Zoning Ordinance (Section 28-284 (d)(2) to provide a mix of residential and commercial uses with a residential density of 1 unit per 2,250 square feet of gross floor area. According to the Town of Bristol Tax Assessor's records, the subject mill building contains 296,717 square feet of gross floor area (not including the basement

and the concrete building being demolished) which allows a residential density of 131 dwelling units. However, when the Town Council applied the Zone to the property, they conditioned the approval on a maximum density of 98 units, along with eight (8) other development conditions relative to public access to the waterfront, affordable housing, commercial space, water-related uses, traffic study, infrastructure mitigation, off-site parking, and existing historic buildings.

2. The 2008 Town Council adopted changes to the Zoning Ordinance Section 28-284 (d)(2) specific to this property and also granted a Change of Zoning Map with conditions. These original zone change conditions run with the land and apply to this proposal.
3. In June 2010, the Planning Board granted Master Plan approval with conditions to the original proposal; however, that approval has expired.
4. In May 2021, a concept review application was submitted by Brady Sullivan Properties, LLC as the applicant. A public Site Visit was held on June 8, 2021 and a concept review meeting with the Planning Board was held on June 10, 2021.
5. On October 15, 2021, Brady Sullivan Properties, LLC, as the applicant, submitted a Master Plan application, along with a petition to change certain conditions of the 2008 zone map change. The Master Plan application proposed a residential density of 151 units and a commercial use square footage of 6,300 in the mill. A petition to change the zone map from Waterfront and Downtown on the surface parking lot property, located opposite the mill on the east side of Thames Street, to the Waterfront Planned Unit Development was also submitted and later withdrawn.
6. The application was re-submitted on November 19, 2021 to address missing requisites and the application was certified complete on December 22, 2021. Planning Board action was needed by March 22, 2022 unless an extension was mutually agreed upon. Two extensions were mutually agreed upon bringing the deadline for Planning Board action to June 21, 2022.
7. The applicant requested a waiver of the architectural renderings which were then submitted on March 3, 2022. The applicant also requested a waiver of the draft legal documents which will be submitted at the preliminary phase; therefore, a waiver is not applicable.
8. A Technical Review Committee meeting on the Master Plan application was held on December 22, 2021.
9. A duly advertised public information meeting was held on January 13, 2022 and continued to February 10, 2022 and March 10, 2022.
10. One member of the Planning Board, Charles Millard, recused himself from consideration of the application. First Alternate Planning Board Member Brian Clark participated in lieu of Mr. Millard
11. Following the March 10, 2022 meeting, the applicant revised the plans as to the residential density from 151 to 130 units and made revisions to the surface parking plan.
12. The Planning Board held a special meeting on March 16, 2022. The result of this meeting was a 5-0 vote of the Planning Board to direct the Solicitor and the Planner to draft a motion to deny, unless the applicant agreed to a continuance in order to revise its plans. Following this meeting, the applicant revised the plans for a density of 127 units and made

further revisions to the surface parking lot plan to eliminate any small car parking spaces and increase the buffer to the neighboring properties.

13. The public information meeting was then re-advertised and re-opened on April 14, 2022.
14. The Director of Community Development recommended approval of the revised plans with the density of 127 units subject to several conditions, including that the applicant convey the parking lot on the northeast corner of Church and Thames Streets to the Town for public parking to satisfy the 10% requirement for land area to be allocated to public or institutional use in Section 28-284 (g).
15. Upon receipt of this recommendation, the applicant revised the surface parking plan to create additional tandem parking spaces and 9' wide small car spaces, while keeping a buffer greater than the minimum required along the abutting properties; and, agreed that the parking on the corner of Church and Thames Street (Plat 10, Lot 32) be would be deeded to the Town. The Director of Community Development recommended approval of the alternate parking plan.
16. John McCoy, Esq. and John Rego, Esq. appeared as legal counsel on behalf of the Applicant. Several witnesses were presented in support of the application.
17. Members of the public were also present at each of the public informational meetings and provided testimony in support and in opposition of the proposed development for the Board's consideration. Written comments in support and in opposition to the proposed development were also received and entered into the record.
18. At the Planning Board's April 14, 2022 meeting, a motion was passed on a 3-2 vote to direct the Director of Community Development and the Town Solicitor to draft a motion for approval along with recommendations to the Town Council for changes to the conditions of the 2008 zone change.

II. Project Description

1. The proposed project is described on the plans prepared by Fuss and O'Neill entitled Bristol Yarn Mill Master Plan, Shawn Martin, P.E. Sheets G1.01- G1.02, C1.01-C1.03, revised November 19, 2021 as noted on the cover sheet G.1.01, and as further amended on a plan entitled Bristol Yarn Mill Master Plan Alternative Parking Plan, dated April 13, 2021 [*sic – the correct date is April 13, 2022*]. Said Alternative Parking Plan depicts 151 offsite parking spaces 9' wide by 18' long and a total parking count of 299 spaces for the proposed development. Included with the Master Plan are plans entitled Topographic and Boundary Survey prepared by Charles E. Lent, Registered Professional Surveyor of Control Point Associates, Sheets 1-3, dated October 1, 2021.
2. The subject Mill building property is located at 125 Thames Street and includes surface parking lot parcels which extend from Thames Street to Hope Street on : Plat 10, Lots 41, 42, 43, 44, 49, 50, 60, 61, 62, 68, 71, 73, 74, and 76.
3. The mill buildings will be renovated for the proposed 127 residential units and 6,300 square feet of commercial spaces. The rehabilitation and reuse of the buildings will be in accordance with the guidelines of the RI Historical Preservation and Heritage Commission and the Bristol Historic District Commission. None of the historic buildings are intended to be removed and no additions or significant modifications to the existing buildings are

proposed. Only the non-contributing concrete masonry block building located near the Bristol Maritime Center is planned to be razed for the project.

4. The property includes residential dwellings on Thames Street (a duplex and a single family) as well as 2 commercial buildings on Hope Street and 2 apartments over one of the commercial buildings. The uses of these buildings are proposed to remain as existing. The residential dwellings on Thames Street will be dedicated as off-site affordable housing units.
5. The project includes 11 parking spaces on the north side of the mill for the commercial uses, 137 parking spaces within the mill building and 151 parking spaces in the surface parking lot on the east side of Thames Street for the residential units. In the Waterfront Zoning District, the Zoning Ordinance allows for 50% of the required parking to be small car parking spaces. However, all of the parking spaces in the surface parking lot are proposed to be 9' wide versus the required 10' width. The interior parking spaces are varying in width due to the columns with the standard spaces 9' wide and the small car spaces 8' wide. The exterior surface parking lot will have double striped parking spaces; however, the interior parking spaces will not be double striped.
6. The subject Mill building property is located on the east side of Bristol Harbor adjacent to the Town's Maritime Center.
7. The property is also within the Downtown Historic District and subject to the jurisdiction of the Coastal Resources Management Council.
8. The project contains a segment of the Town's harbor walk that will extend from the Maritime Center on the north to the property of the Elk's Lodge on the South. The applicant has agreed to partner with the Town in the Town's negotiations to extend the walkway to Constitution Street.
9. The proposal for 127 units is consistent with the residential density of the zoning ordinance at 1 unit per 2,336 which is greater than the 2,250 square feet of gross floor area required; however, this density would still require an amendment to the original change of zone conditions by the Town Council.
10. Along with the density modification to the original change of zone from 98 units to 127 units, the applicant is requesting that the minimum commercial space be modified from the required 22,000 square feet of area to 6,300 square feet of area and that the standard parking spaces be 9' wide in lieu of the required 10' width and the interior parking lot small car spaces be 8' wide in lieu of the required 9' wide and none of the interior parking spaces to be double striped

III. Findings of Fact and Conclusions of Law

The Board approves this application for the following reasons:

1. The proposed development is consistent with the purpose and objectives of the Urban Rehab Land Development, as set forth in Section 28-284 "Land Development Projects – Urban Rehab Land Development Project" because it rehabilitates an under-utilized and inefficient historic structure and it rehabilitates the urban waterfront. It encourages a design that is

friendly to pedestrians, protects the existing built environment and character which imparts a sense of place to the community while allowing beneficial new uses and rejuvenation, safeguards the physical fabric of the community from neglect and decay and prevents incongruous re-development, provides an appropriate change of use that is compatible with the architecture of the buildings on site and the surrounding neighborhood, and it enhances public access to the waterfront.

2. The proposed development is consistent with the approved 2016 Comprehensive Plan which includes the following references:
    a. In the Economic Developmetn Element, Action Item #ED-C-3 states that the Town should continue to work with the owner of Robin Rug property to encourage and facilitate the completion of the development proposal for a mixed use development-residential and commercial.
    b. Land Use Element – Section 3 references this property and the proposed conversion of the property into a mixed use development with residential uses on the upper floors with commercial and parking on the first floors. (Page 45)
    c. Land Use Element – Section 3 states that the Urban Rehab and Waterfront PUD which is intended to encourage the rehabilitation of and reuse of deteriorated, underutilized, and inefficient historic and/or nonconforming structures of conservation concern to the Town
    d. Future Land Use Map designates this property as "Waterfront PUD – waterfront mixed use commercial and residential"
    e. The Housing Element references the proposed Adaptive Re-use of the Robin Rug and the proposed affordable housing with the statement "While these units have not yet been built, they were a condition of the zone change for the re-use of the mill."
3. The proposal complies with the density requirements in the Zoning Ordinance of Section 28-284 (d)(2)).
4. The proposal complies with the conditions of the Town Council Zone Change of 2008 other than to the density and the amount of commercial space which will need further Town Council action to amend both the zone map and the ordinance text. The density of the proposed development is not a substantive increase in density, complies with the Zoning Ordinance, and is appropriate for the site.
5. The Town Council Zone Change of 2008 set the requirements for affordable housing to be provided with a minimum of 10% and a maximum of 20% of the units by either off-site, on-site, or fee-in-lieu. Twenty units (15% of 127 units) are to be for Low-Moderate Income Housing with three of the units to be in existing dwellings on Lot 49 (existing 2 family dwelling) and Lot 50 (existing 1 family dwelling) and the balance to be fee-in-lieu (17 x $40,000 = $680,000) to be paid to the Town and placed in an affordable housing trust fund.
6. The proposal provides more parking than required by the Zoning Ordinance. The required parking is 144 parking spaces and the proposal provides a total of 299 spaces.

7. The proposal provides a greater buffer between the surface parking area and the abutting residential properties than required by the Zoning Ordinance. The Zoning Ordinance requires

a minimum buffer width of 3' (Section 28-251 (10)), and the proposal provides buffers that range from 5 to25' wide.

8. The proposal includes the dedication of the existing parking lot at the corner of Church and Thames to the Town of Bristol for public parking to partially satisfy the 10% requirement for Public/Institutional uses per Section 28-284(g). Additional public space is a public walkway from Hope Street and the public access easement along the waterfront where a walkway is proposed.
9. Off-site parking is permitted in accordance with Section 28-255 and will be deed restricted to be connected with the mill building. The off-site parking design, lighting, drainage, fencing buffering and landscaping details, will be reviewed by the Planning Board as part of the Major Land Development preliminary application. The requirement of this Section for a separate TRC review is deemed met by the Planning Board review.
10. The proposal is consistent with the provisions of the Zoning Ordinance, including Section 28-284 d (2). As stated in this section of the Zoning, the Planning Board may allow the provision of otherwise allowed nonresidential uses in alternate locations within the building in lieu of the required retail and restaurant uses on the first floor within 50' of the front lot line. The Planning Board may also reduce the gross floor area of such required nonresidential uses by 20 %. When the change of zone was granted in 2008, the Town Council required 22,000 square feet of commercial space. The current proposal is 6,300 square feet of commercial. The Planning Board may reduce the amount by 20%; however, this reduction is greater and will require an amendment to the 2008 Change of Zone conditions.
11. There will be no significant negative environmental impacts from the proposed development as shown on the plan with all required conditions for approval including requirements for permits from the Coastal Resources Management Council, FEMA compliance for flood proofing and flood mitigation, compliance with the review by the Water Pollution and Control Facility (see letter of 12/24/21), maintenance of the proposed drainage by the owner, and compliance with any requirements of the Phase 1 and Phase 2 Environmental Site Assessments.

12. Sufficient evidence was presented to satisfy the required criteria for Master Plan approval including a Phase 1 Environmental Site Assessment, agreement for compliance with the requirements of the Bristol Water Pollution Control Facility that all stormwater currently going into the Town sewer will be removed, engineered plans that provide drainage mitigation to demonstrate that there will be no significant negative impacts on the health and safety of current or future residents of the community, subject to the conditions.

13. The proposed development will not result in the creation of individual lots which such physical constraints to development that building on those lots according to pertinent regulations and building standards would be impracticable because no new lots are being created.

14. The proposed development will have adequate and permanent physical access to a public street (Thames Street).
15. Section 28-284 (d)(1) of the Zoning Ordinance is not applicable, since the section of the ordinance that controls this proposal is Section 28-284(d)(2).
16. The proposed development is consistent with each of the general purposes of Article 1 of the Bristol Subdivision and Development Review Regulations as follows:
    a. It was processed in accordance with the process set forth in the Regulations which provide for the orderly, thorough, and expeditious review of land developments;
    b. It promotes high quality and appropriate design and construction of land development projects because it is a redevelopment and rehabilitation of an existing historic waterfront mill such that the building is preserved and restored;
    c. It promotes the protection of the existing natural and built environment and the mitigation of all significant negative impacts on the existing environment, with the conditions of approval, because it is a redevelopment of the historic waterfront mill; there will not be any new buildings; it includes water quality measures for the drainage; it eliminates existing infiltration into the sewer system; and it provides enhanced buffering and screening from the existing parking lot to the abutting properties;
    d. It promotes a land development that is well integrated into the surrounding neighborhood with regard to natural and built features and it concentrates the development in areas which can best support intensive use because of natural characteristics and existing infrastructure because it is a re-development project in an existing mill building with improvements to an existing surface parking lot with existing utilities that have the capacity for the re-development;
    e. It reflects the intent of the Bristol Comprehensive Plan with regard to the physical character of the various neighborhood and planning areas of the Town because it is a redevelopment of an existing mill building that actually establishes the existing character of the neighborhood area;
    f. The proposal was reviewed by the Planning Board's Technical Review Committee and the various Town department heads and local agencies including the Bristol County Water Authority;
    g. The proposal dedicates public land, impact mitigation, and payment in lieu thereof that is based on clear documentation of needs because it complies with the required set aside of public land area including walkways, a harbor walk, as identified in the Comprehensive Plan, and properties for public parking.
    h. The project sites improvements to allow for maximum protection of critical landscapes and resources as they relate to Bristol's historic and cultural values because it is the re-development of an existing historic mill building in the National Register Historic District and the improvement of the existing surface parking lot rather than new "greenfield" development.
    i. The project continues the Town's historic policy of providing public access to the water because it includes a public harbor walk along the Bristol Harbor shoreline

along the west side of the mill property from the Bristol Maritime Center to the Bristol Elks Lodge;

j. It was processed in accordance with the regulations which set forth the procedures for review and approval;
k. The project promotes sustainable development practices because it re-develops an existing historic mill, located in the downtown, provides pedestrian connectivity and also provides opportunities for alternative transportation use including public bus, bicycle and boat.

17. Subject to the following Conditions:
    A. Change of conditions of the 2008 Town Council zoning map approval and ordinance text including residential and commercial density uses as well as modification to the width of the parking spaces and the double striping on the interior parking spaces.
    B. Dedication by deed of the parking lot on the northeast corner of Church and Thames Street, Plat 10, Lot 32 to the Town of Bristol for public parking as required by the zoning that there be 10% of the land area to be set aside for public institutional uses as required by Section 28-284 (g).
    C. Connection of the public walkway to the Maritime Center.
    D. A Traffic Study to include counts to be taken in the Summer months (June, July, August, or September), and be subject to the peer review of the Planning Board's consultant engineer, with the review fee to be reimbursed by the applicant in accordance with the regulations;
    E. A revised Fiscal Impact Study subject to the peer review of a consultant selected by the Planning Board with review fee to be reimbursed by the applicant in accordance with the regulations;
    F. Deed restrictions on both the mill building property and the surface parking lot across from the mill so that the parking is connected to the mill and cannot be separately conveyed;
    G. Deed restrictions, running to the Town of Bristol, on the surface parking lot that no structures be built on this property;
    H. Parking spaces in the surface parking lot to be double striped.
    I. All services to the residential units will be private including recycling and garbage pick-up, snow plowing, driveway and drainage maintenance. This shall be a deed covenant in Land Evidence Records.

Recorded May 16,2022 at 03:25PM
Melissa Cordeiro Town Clerk

Motion by Boardmember Anthony Murgo, Seconded by Boardmember Armand Bilotti.
Voting in Favor: Boardmembers Squatrito, Murgo, Bilotti
Voting Against: Boardmember Katz and Alternate Boardmember Clark.
Motion passes.

Being a decision of the Bristol Planning Board on May 12, 2022.

By: Diane M. Williamson, Diane M. Williamson, Administrative Officer
Date: May 16, 2022

Appendix B

Pre-Development Hydrologic Analysis

Pre-Development Curve Numbers

Subwatershed No. 1A						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	28,011	100.00%	98.00
Totals				**28,011**	**100.00%**	**98.00**

Subwatershed No. 2A						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	838	3.17%	3.11
Pavement	N/A	N/A	98	4,848	18.36%	18.00
Gravel	N/A	C	89	4,386	16.61%	14.79
Grass	Fair	C	79	16,327	61.85%	48.86
Totals				**26,399**	**100.00%**	**84.75**

Subwatershed No. 2B						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	21,421	100.00%	98.00
Totals				**21,421**	**100.00%**	**98.00**

Subwatershed No. 3A						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	2,443	20.74%	20.33
Pavement	N/A	N/A	98	9,335	79.26%	77.67
Totals				**11,778**	**100.00%**	**98.00**

Subwatershed No. 4A						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	11,818	11.85%	11.62
Pavement	N/A	N/A	98	30,755	30.85%	30.23
Gravel	N/A	C	89	6,923	6.94%	6.18
Grass	Fair	C	79	50,197	50.35%	39.78
Totals				**99,693**	**100.00%**	**87.81**

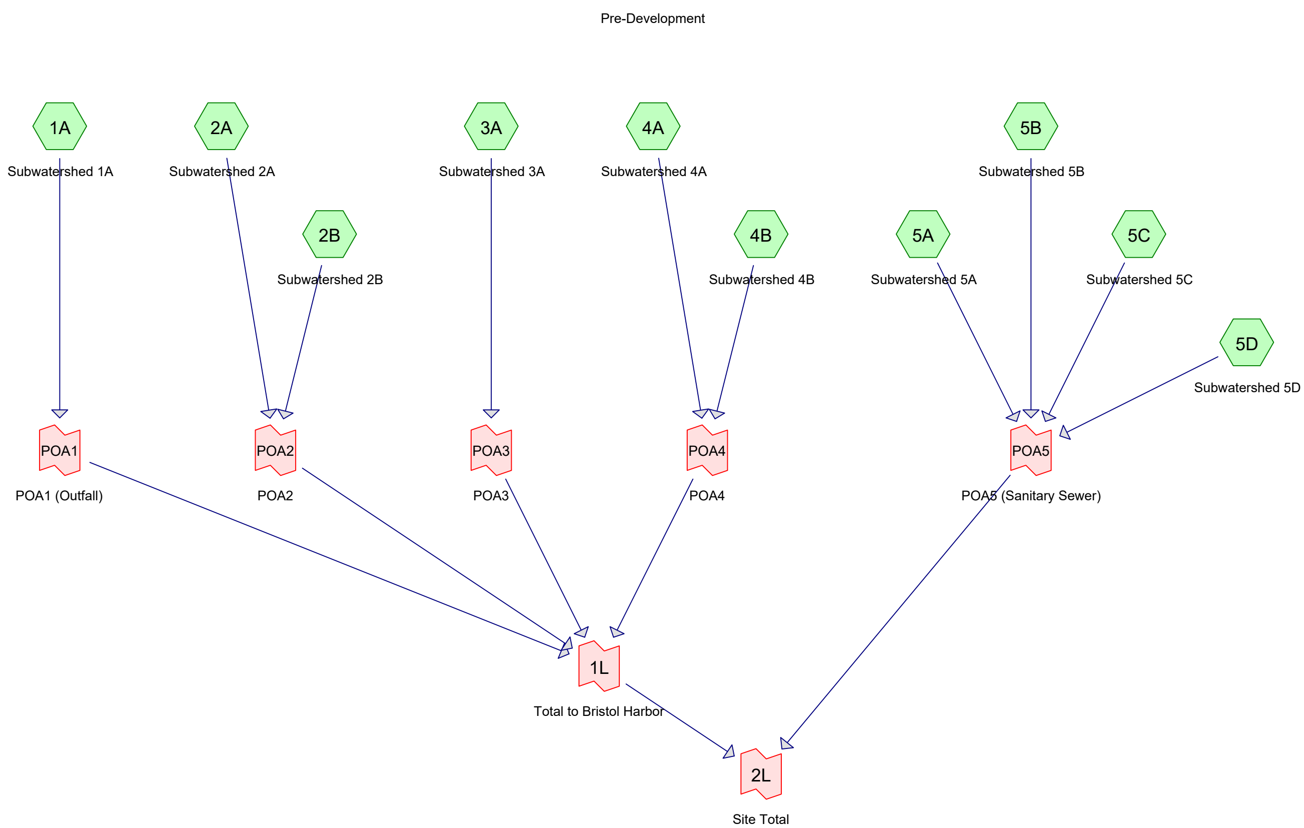
Subwatershed No. 4B						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	2,561	100.00%	98.00
Totals				**2,561**	**100.00%**	**98.00**

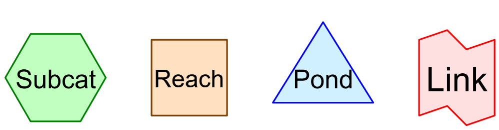
Subwatershed No. 5A						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	3,776	100.00%	98.00
Totals				**3,776**	**100.00%**	**98.00**

Subwatershed No. 5B						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	6,715	100.00%	98.00
Totals				**6,715**	**100.00%**	**98.00**

Subwatershed No. 5C						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	9,956	100.00%	98.00
Totals				**9,956**	**100.00%**	**98.00**

Subwatershed No. 5D						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	12,006	100.00%	98.00
Totals				**12,006**	**100.00%**	**98.00**





Routing Diagram for Bristol Yarn Mill
Prepared by Fuss & O'Neill, Printed 11/29/2022
HydroCAD® 10.20-2d s/n 01614 © 2021 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-Yr	Type II 24-hr		Default	24.00	1	2.80	2
2	10-Yr	Type II 24-hr		Default	24.00	1	4.90	2
3	25-Yr	Type II 24-hr		Default	24.00	1	6.10	2
4	100-Yr	Type II 24-hr		Default	24.00	1	8.60	2
5	WQ	Type II 24-hr		Default	24.00	1	1.20	2

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
50,197	79	50-75% Grass cover, Fair, HSG C (4A)
16,327	74	>75% Grass cover, Good, HSG C (2A)
6,923	89	Gravel roads, HSG C (4A)
4,386	96	Gravel surface, HSG C (2A)
44,938	98	Paved parking, HSG C (2A, 3A, 4A)
99,545	98	Roofs, HSG C (1A, 2A, 2B, 3A, 4A, 4B, 5A, 5B, 5C, 5D)
222,316	**92**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
222,316	HSG C	1A, 2A, 2B, 3A, 4A, 4B, 5A, 5B, 5C, 5D
0	HSG D	
0	Other	
222,316		**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1A: Subwatershed 1A Runoff Area=28,011 sf 100.00% Impervious Runoff Depth>0.98"
Tc=5.0 min CN=0/98 Runoff=1.04 cfs 2,299 cf

Subcatchment 2A: Subwatershed 2A Runoff Area=26,399 sf 21.54% Impervious Runoff Depth>0.32"
Flow Length=120' Slope=0.0080 '/' Tc=23.5 min CN=79/98 Runoff=0.16 cfs 694 cf

Subcatchment 2B: Subwatershed 2B Runoff Area=21,421 sf 100.00% Impervious Runoff Depth>0.98"
Tc=5.0 min CN=0/98 Runoff=0.80 cfs 1,758 cf

Subcatchment 3A: Subwatershed 3A Runoff Area=11,778 sf 100.00% Impervious Runoff Depth>0.99"
Flow Length=288' Tc=2.6 min CN=0/98 Runoff=0.46 cfs 967 cf

Subcatchment 4A: Subwatershed 4A Runoff Area=99,693 sf 42.70% Impervious Runoff Depth>0.51"
Flow Length=882' Tc=10.3 min CN=80/98 Runoff=1.53 cfs 4,216 cf

Subcatchment 4B: Subwatershed 4B Runoff Area=2,561 sf 100.00% Impervious Runoff Depth>0.99"
Flow Length=366' Tc=3.0 min CN=0/98 Runoff=0.10 cfs 210 cf

Subcatchment 5A: Subwatershed 5A Runoff Area=3,776 sf 100.00% Impervious Runoff Depth>0.98"
Tc=5.0 min CN=0/98 Runoff=0.14 cfs 310 cf

Subcatchment 5B: Subwatershed 5B Runoff Area=6,715 sf 100.00% Impervious Runoff Depth>0.98"
Tc=5.0 min CN=0/98 Runoff=0.25 cfs 551 cf

Subcatchment 5C: Subwatershed 5C Runoff Area=9,956 sf 100.00% Impervious Runoff Depth>0.98"
Tc=5.0 min CN=0/98 Runoff=0.37 cfs 817 cf

Subcatchment 5D: Subwatershed 5D Runoff Area=12,006 sf 100.00% Impervious Runoff Depth>0.98"
Tc=5.0 min CN=0/98 Runoff=0.45 cfs 985 cf

Link 1L: Total to Bristol Harbor Inflow=3.68 cfs 10,145 cf
Primary=3.68 cfs 10,145 cf

Link 2L: Site Total Inflow=4.88 cfs 12,809 cf
Primary=4.88 cfs 12,809 cf

Link POA1: POA1 (Outfall) Inflow=1.04 cfs 2,299 cf
Primary=1.04 cfs 2,299 cf

Link POA2: POA2 Inflow=0.86 cfs 2,452 cf
Primary=0.86 cfs 2,452 cf

Link POA3: POA3 Inflow=0.46 cfs 967 cf
Primary=0.46 cfs 967 cf

Link POA4: POA4 Inflow=1.57 cfs 4,427 cf
Primary=1.57 cfs 4,427 cf

Link POA5: POA5 (Sanitary Sewer)

Inflow=1.21 cfs 2,664 cf
Primary=1.21 cfs 2,664 cf

Total Runoff Area = 222,316 sf Runoff Volume = 12,809 cf Average Runoff Depth = 0.69"
35.01% Pervious = 77,833 sf 64.99% Impervious = 144,483 sf

Summary for Subcatchment 1A: Subwatershed 1A

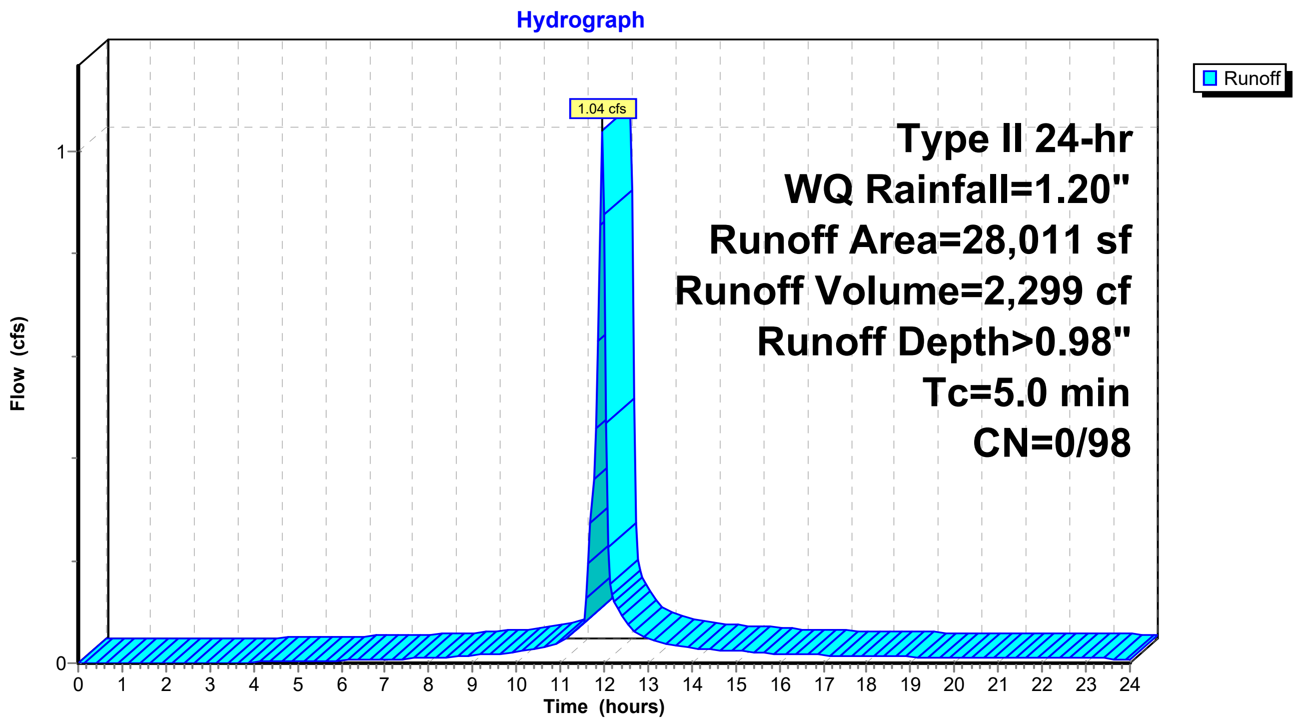
Runoff = 1.04 cfs @ 11.95 hrs, Volume= 2,299 cf, Depth> 0.98"
Routed to Link POA1 : POA1 (Outfall)

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
28,011	98	Roofs, HSG C
28,011	98	100.00% Impervious Area

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

Subcatchment 1A: Subwatershed 1A



Summary for Subcatchment 2A: Subwatershed 2A

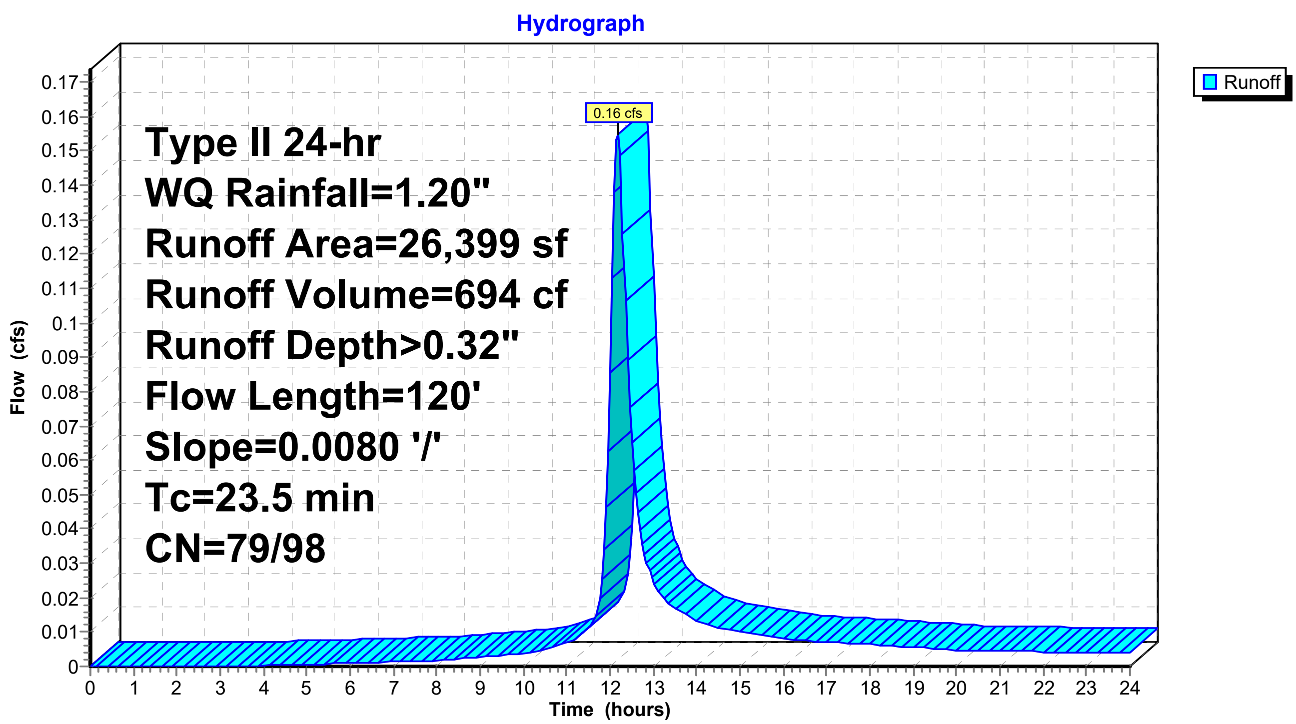
Runoff = 0.16 cfs @ 12.18 hrs, Volume= 694 cf, Depth> 0.32"
Routed to Link POA2 : POA2

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
838	98	Roofs, HSG C
4,848	98	Paved parking, HSG C
4,386	96	Gravel surface, HSG C
16,327	74	>75% Grass cover, Good, HSG C
26,399	83	Weighted Average
20,713	79	78.46% Pervious Area
5,686	98	21.54% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.5	120	0.0080	0.09		**Sheet Flow, Lawn** Grass: Dense n= 0.240 P2= 3.30"

Subcatchment 2A: Subwatershed 2A



Summary for Subcatchment 2B: Subwatershed 2B

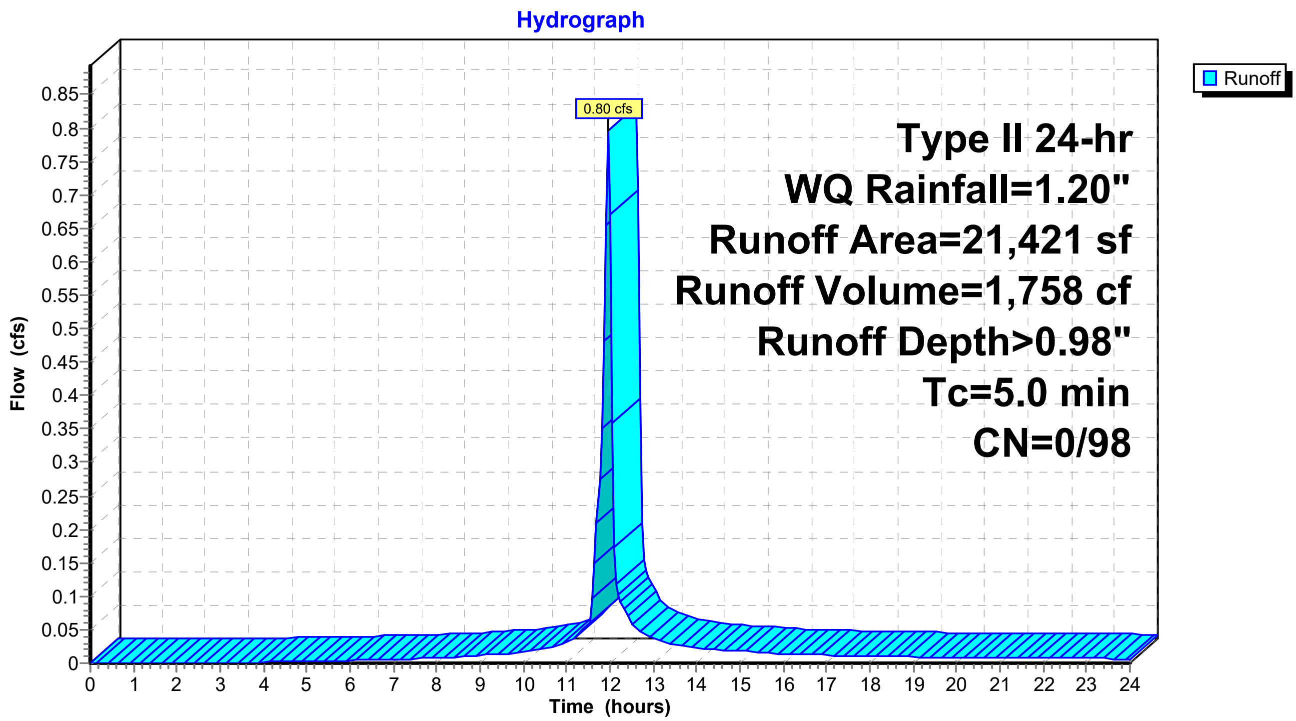
Runoff = 0.80 cfs @ 11.95 hrs, Volume= 1,758 cf, Depth> 0.98"
Routed to Link POA2 : POA2

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
21,421	98	Roofs, HSG C
21,421	98	100.00% Impervious Area

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

Subcatchment 2B: Subwatershed 2B



Summary for Subcatchment 3A: Subwatershed 3A

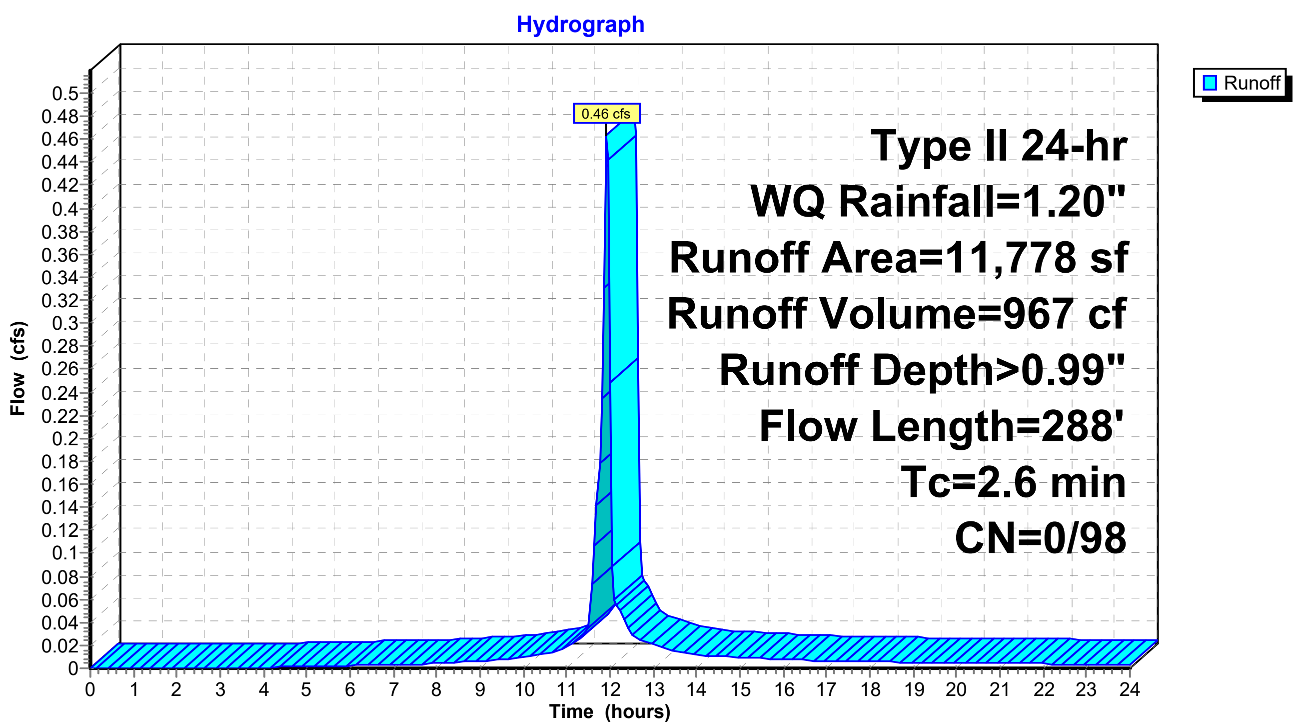
Runoff = 0.46 cfs @ 11.93 hrs, Volume= 967 cf, Depth> 0.99"
Routed to Link POA3 : POA3

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
2,443	98	Roofs, HSG C
9,335	98	Paved parking, HSG C
11,778	98	Weighted Average
11,778	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	18	0.2000	2.49		**Sheet Flow, Sloped Roof** Smooth surfaces n= 0.011 P2= 3.30"
2.5	270	0.0080	1.82		**Shallow Concentrated Flow, Paved Parking Lot** Paved Kv= 20.3 fps
2.6	288	Total			

Subcatchment 3A: Subwatershed 3A



Summary for Subcatchment 4A: Subwatershed 4A

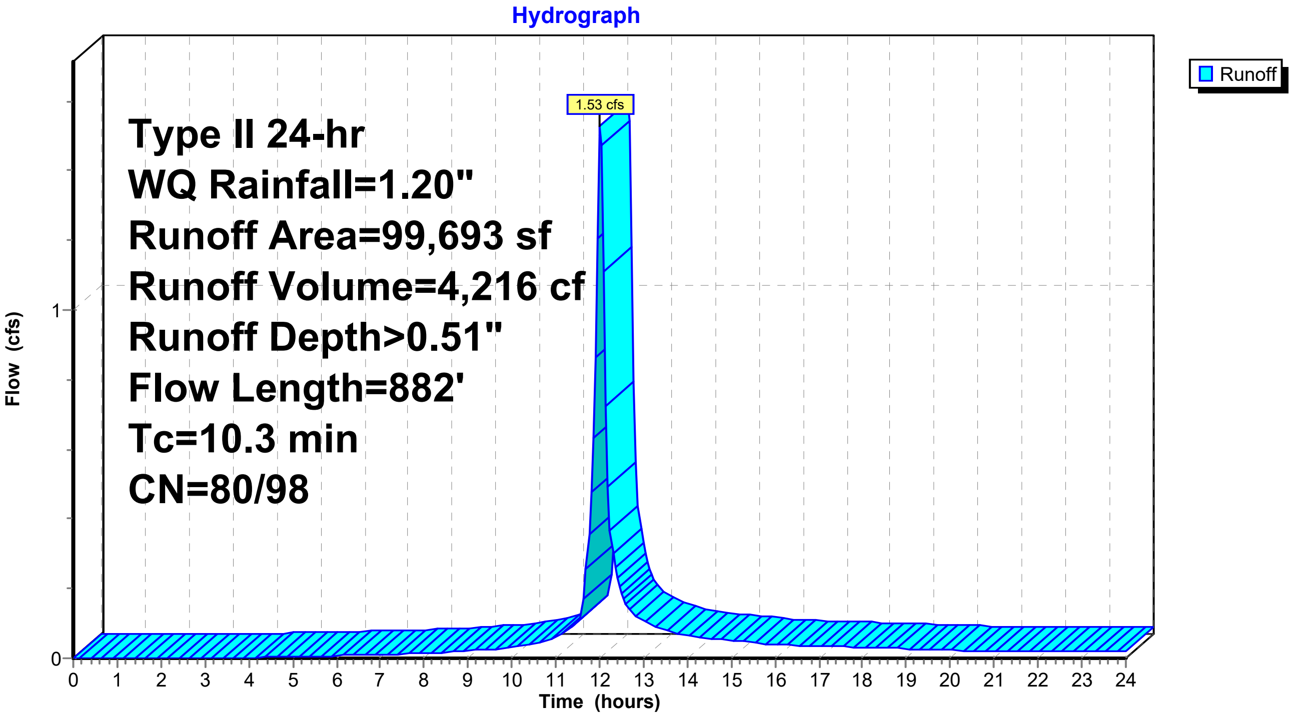
Runoff = 1.53 cfs @ 12.02 hrs, Volume= 4,216 cf, Depth> 0.51"
Routed to Link POA4 : POA4

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
11,818	98	Roofs, HSG C
30,755	98	Paved parking, HSG C
6,923	89	Gravel roads, HSG C
50,197	79	50-75% Grass cover, Fair, HSG C
99,693	88	Weighted Average
57,120	80	57.30% Pervious Area
42,573	98	42.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	17	0.2000	2.46		**Sheet Flow, Sloped Roof** Smooth surfaces n= 0.011 P2= 3.30"
4.5	42	0.0600	0.15		**Sheet Flow, Lawn** Grass: Dense n= 0.240 P2= 3.30"
1.0	110	0.0400	1.88		**Sheet Flow, Gravel** Smooth surfaces n= 0.011 P2= 3.30"
1.0	195	0.0250	3.21		**Shallow Concentrated Flow, Paved Parking Lot** Paved Kv= 20.3 fps
2.8	254	0.0054	1.49		**Shallow Concentrated Flow, Thames Street** Paved Kv= 20.3 fps
0.9	264	0.0050	4.77	18.98	**Pipe Channel, Storm Drain** 27.0" Round Area= 4.0 sf Perim= 7.1' r= 0.56' n= 0.015 Concrete sewer w/manholes & inlets
10.3	882	Total			

Subcatchment 4A: Subwatershed 4A



Summary for Subcatchment 4B: Subwatershed 4B

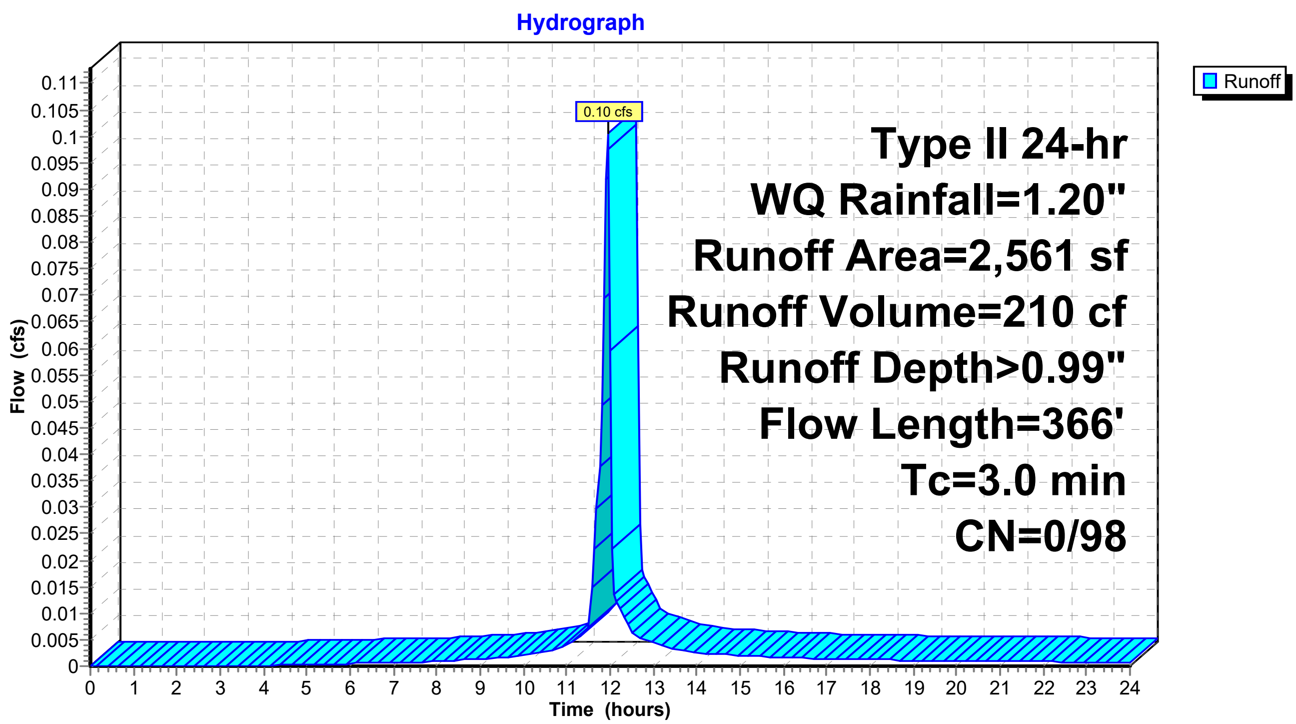
Runoff = 0.10 cfs @ 11.93 hrs, Volume= 210 cf, Depth> 0.99"
Routed to Link POA4 : POA4

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
2,561	98	Roofs, HSG C
2,561	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	18	0.2000	2.49		**Sheet Flow, Sloped Roof** Smooth surfaces n= 0.011 P2= 3.30"
1.8	135	0.0040	1.28		**Shallow Concentrated Flow, Thames Street** Paved Kv= 20.3 fps
1.1	213	0.0050	3.21	2.52	**Pipe Channel, Storm Drain** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Clay tile
3.0	366	Total			

Subcatchment 4B: Subwatershed 4B



Summary for Subcatchment 5A: Subwatershed 5A

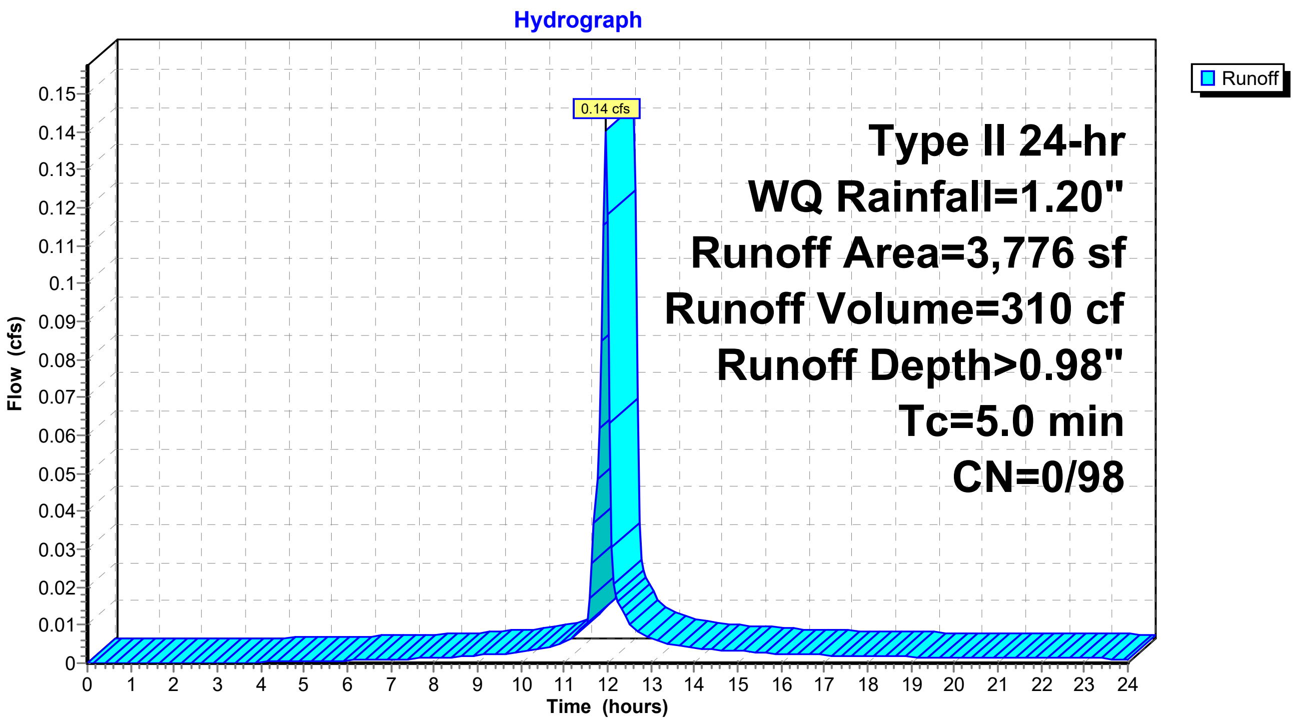
Runoff = 0.14 cfs @ 11.95 hrs, Volume= 310 cf, Depth> 0.98"
Routed to Link POA5 : POA5 (Sanitary Sewer)

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
3,776	98	Roofs, HSG C
3,776	98	100.00% Impervious Area

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

Subcatchment 5A: Subwatershed 5A



Summary for Subcatchment 5B: Subwatershed 5B

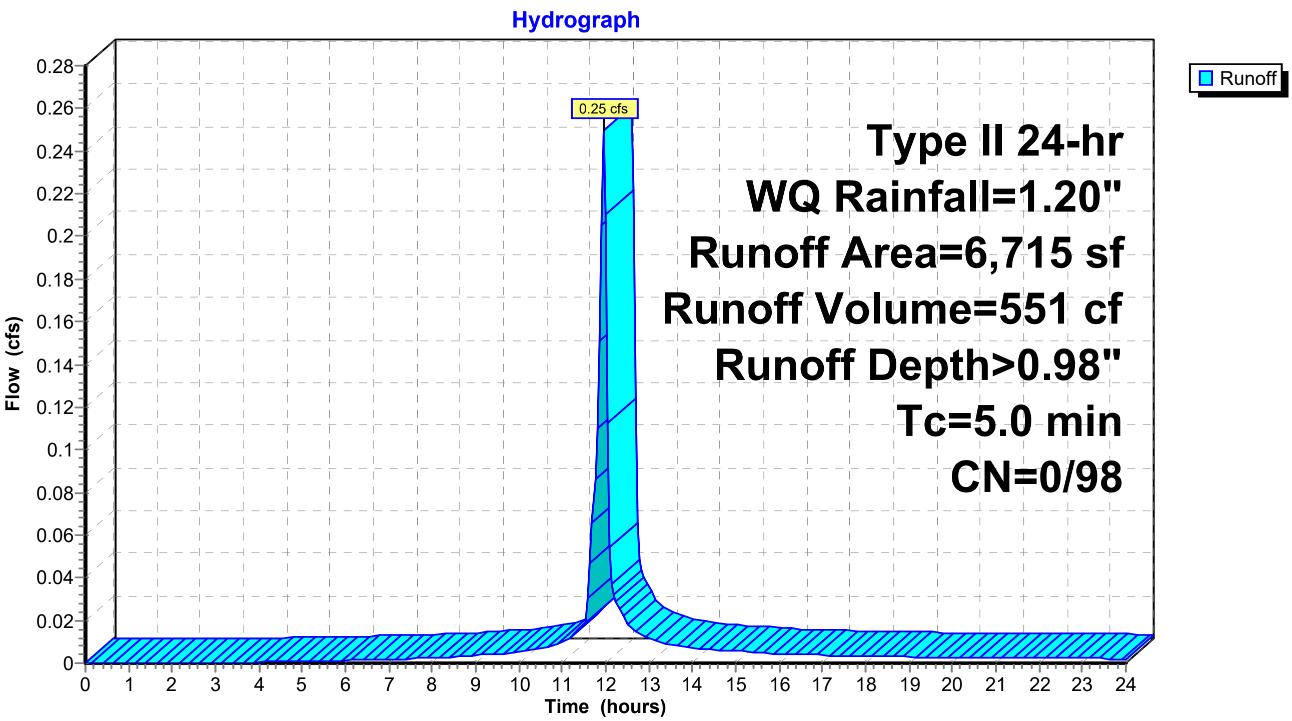
Runoff = 0.25 cfs @ 11.95 hrs, Volume= 551 cf, Depth> 0.98"
Routed to Link POA5 : POA5 (Sanitary Sewer)

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
6,715	98	Roofs, HSG C
6,715	98	100.00% Impervious Area

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

Subcatchment 5B: Subwatershed 5B



Summary for Subcatchment 5C: Subwatershed 5C

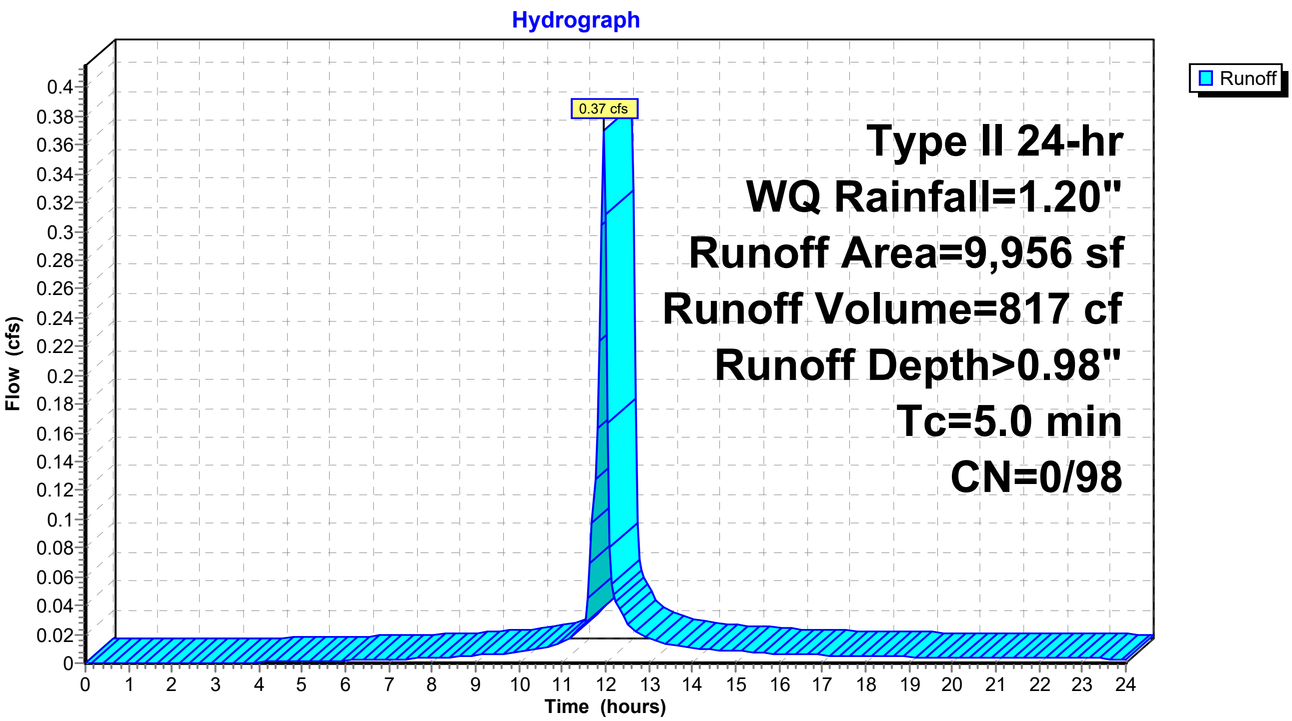
Runoff = 0.37 cfs @ 11.95 hrs, Volume= 817 cf, Depth> 0.98"
Routed to Link POA5 : POA5 (Sanitary Sewer)

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
9,956	98	Roofs, HSG C
9,956	98	100.00% Impervious Area

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

Subcatchment 5C: Subwatershed 5C



Summary for Subcatchment 5D: Subwatershed 5D

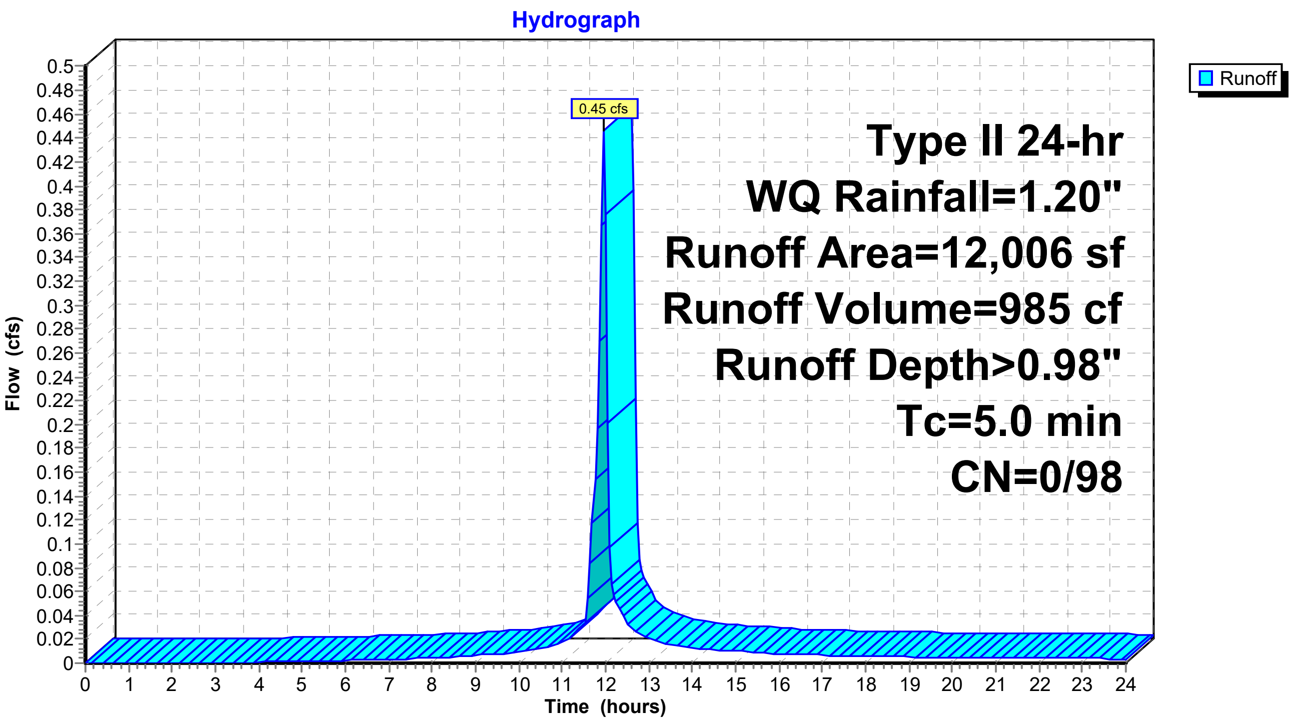
Runoff = 0.45 cfs @ 11.95 hrs, Volume= 985 cf, Depth> 0.98"
Routed to Link POA5 : POA5 (Sanitary Sewer)

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
12,006	98	Roofs, HSG C
12,006	98	100.00% Impervious Area

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

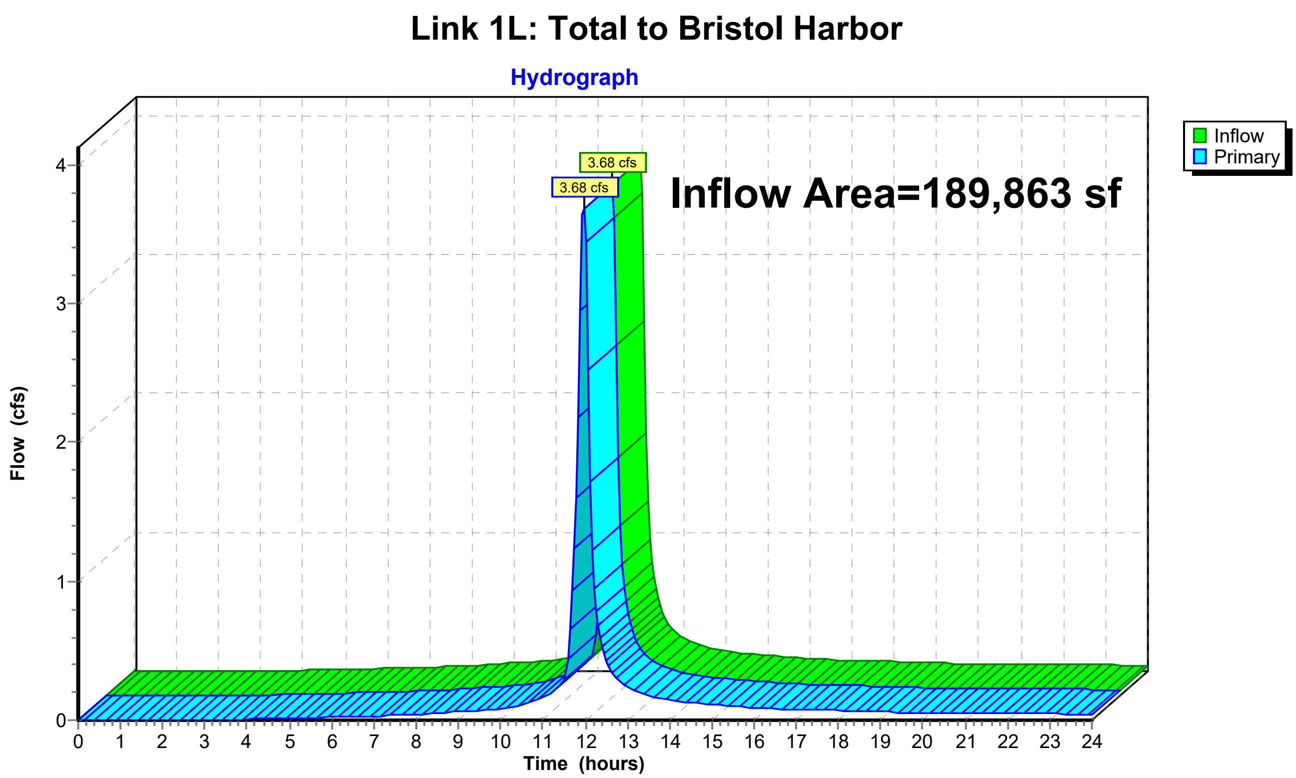
Subcatchment 5D: Subwatershed 5D



Summary for Link 1L: Total to Bristol Harbor

Inflow Area = 189,863 sf, 59.01% Impervious, Inflow Depth > 0.64" for WQ event
Inflow = 3.68 cfs @ 11.96 hrs, Volume= 10,145 cf
Primary = 3.68 cfs @ 11.96 hrs, Volume= 10,145 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 2L : Site Total

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

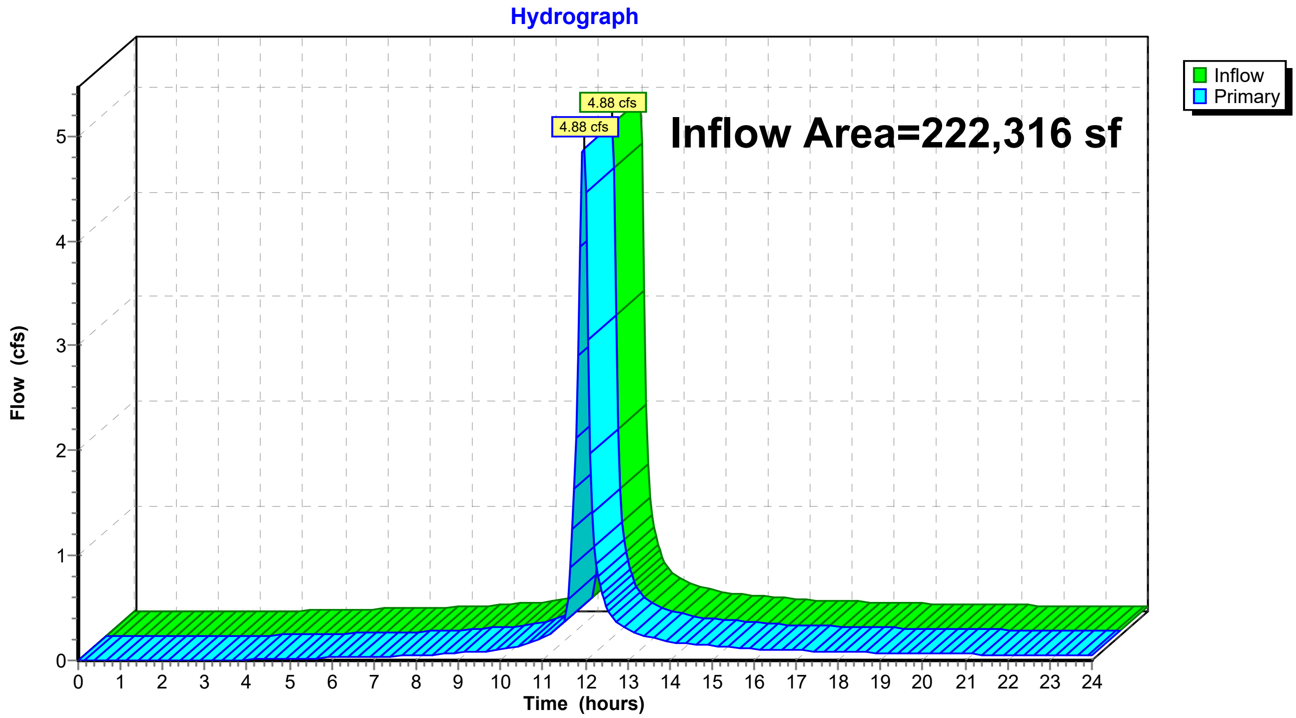


Summary for Link 2L: Site Total

Inflow Area =	222,316 sf, 64.99% Impervious,	Inflow Depth > 0.69"	for WQ event
Inflow =	4.88 cfs @ 11.96 hrs, Volume=	12,809 cf	
Primary =	4.88 cfs @ 11.96 hrs, Volume=	12,809 cf, Atten= 0%, Lag= 0.0 min	

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 2L: Site Total

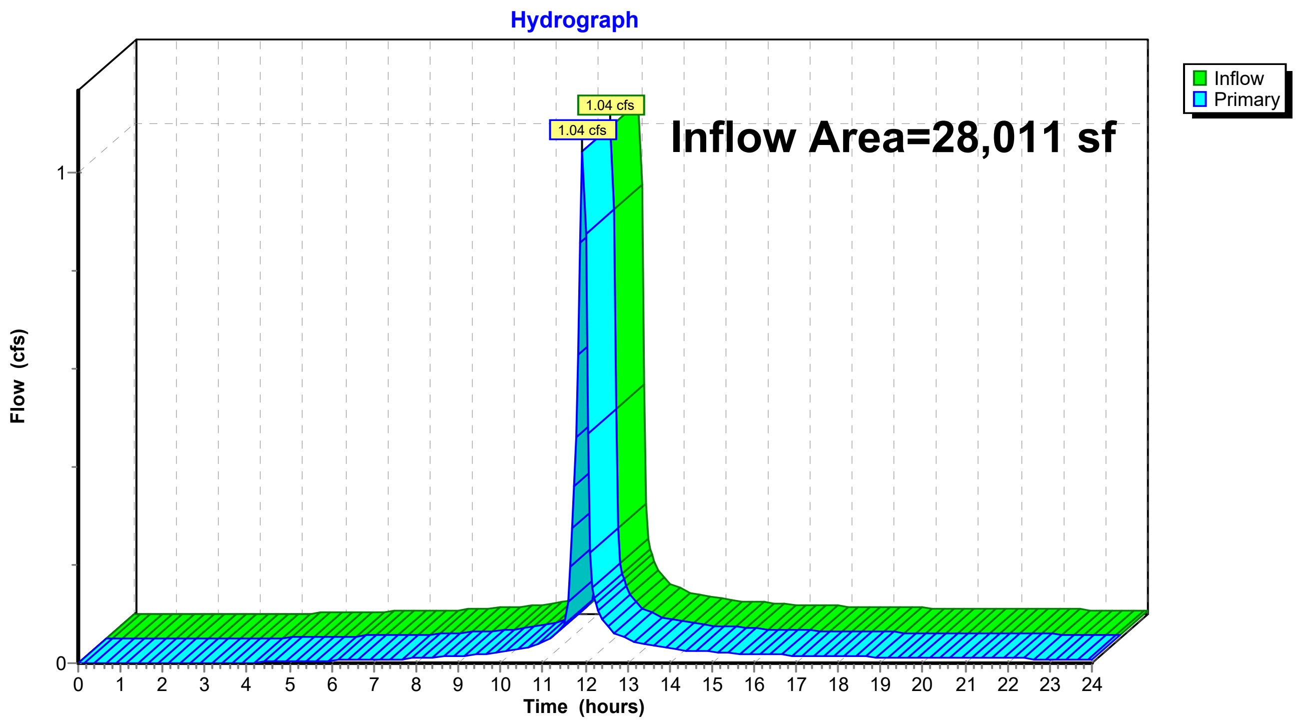


Summary for Link POA1: POA1 (Outfall)

Inflow Area = 28,011 sf,100.00% Impervious, Inflow Depth > 0.98" for WQ event
Inflow = 1.04 cfs @ 11.95 hrs, Volume= 2,299 cf
Primary = 1.04 cfs @ 11.95 hrs, Volume= 2,299 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 1L : Total to Bristol Harbor

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

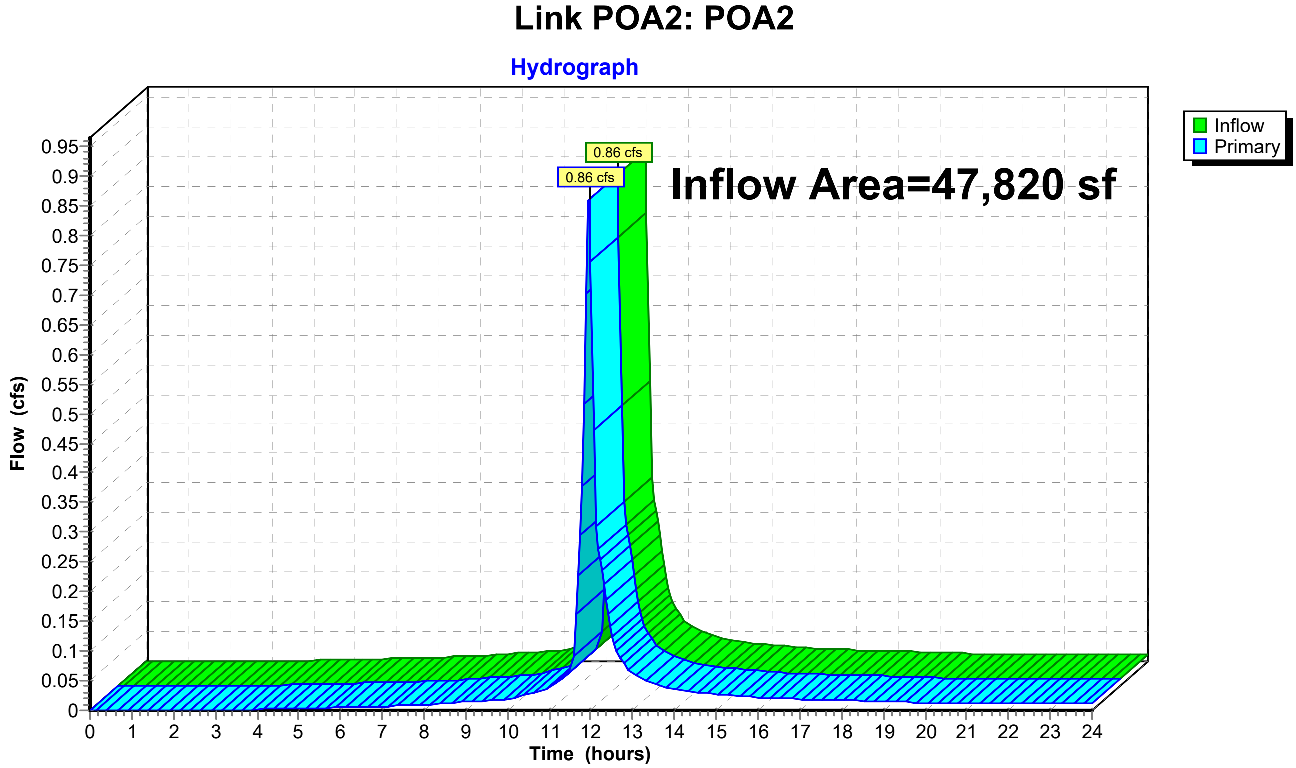
Link POA1: POA1 (Outfall)



Summary for Link POA2: POA2

Inflow Area = 47,820 sf, 56.69% Impervious, Inflow Depth > 0.62" for WQ event
Inflow = 0.86 cfs @ 11.96 hrs, Volume= 2,452 cf
Primary = 0.86 cfs @ 11.96 hrs, Volume= 2,452 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 1L : Total to Bristol Harbor

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

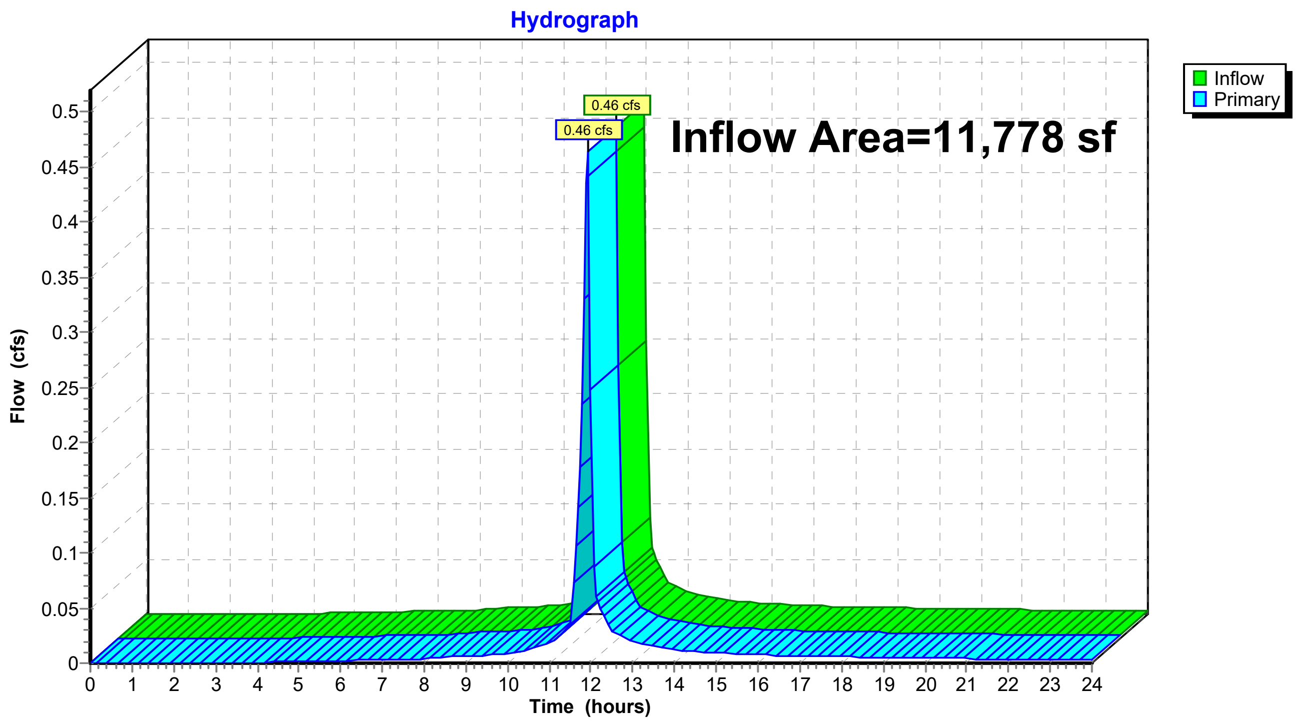


Summary for Link POA3: POA3

Inflow Area = 11,778 sf,100.00% Impervious, Inflow Depth > 0.99" for WQ event
Inflow = 0.46 cfs @ 11.93 hrs, Volume= 967 cf
Primary = 0.46 cfs @ 11.93 hrs, Volume= 967 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 1L : Total to Bristol Harbor

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA3: POA3

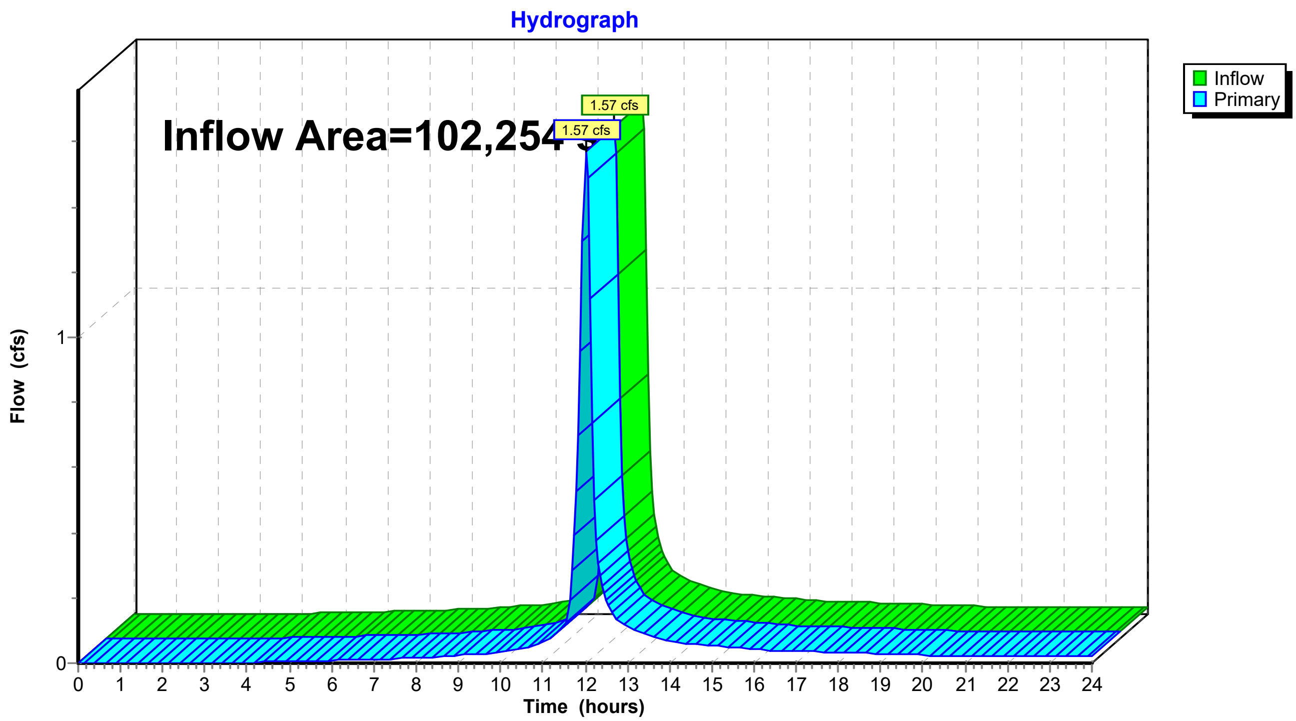


Summary for Link POA4: POA4

Inflow Area = 102,254 sf, 44.14% Impervious, Inflow Depth > 0.52" for WQ event
Inflow = 1.57 cfs @ 12.01 hrs, Volume= 4,427 cf
Primary = 1.57 cfs @ 12.01 hrs, Volume= 4,427 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 1L : Total to Bristol Harbor

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA4: POA4



Summary for Link POA5: POA5 (Sanitary Sewer)

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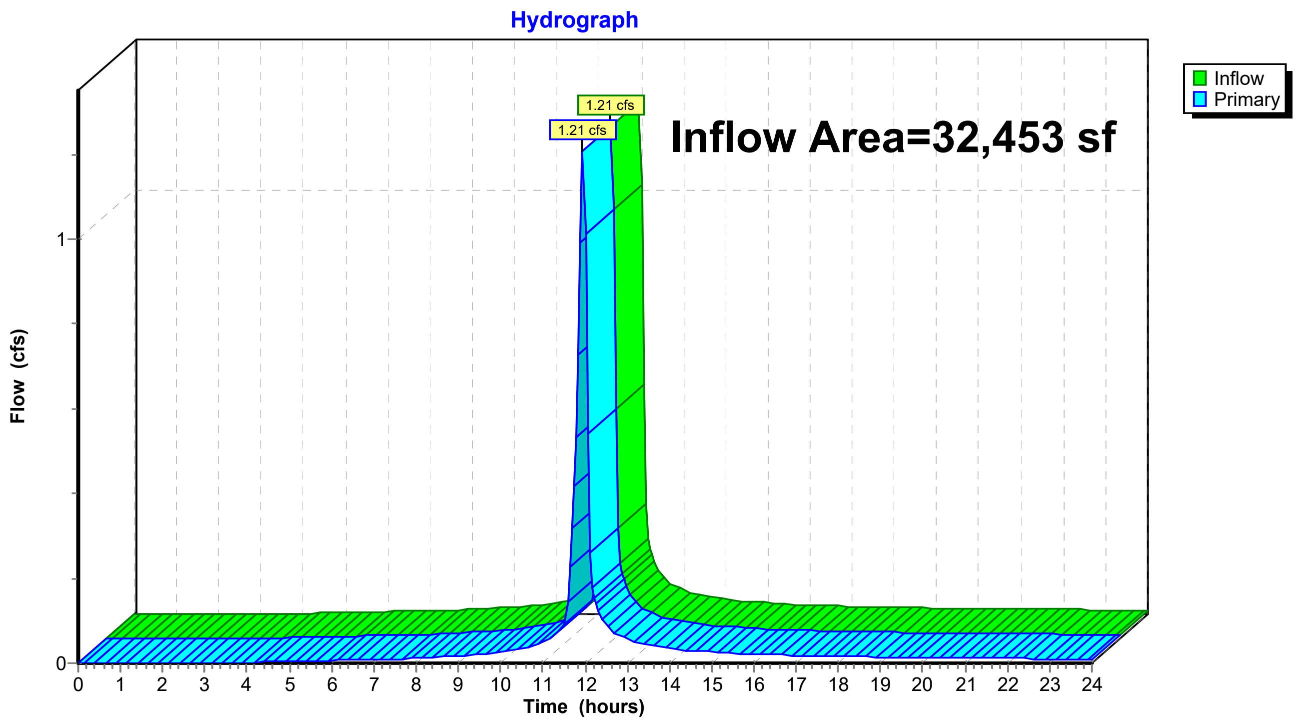
Inflow Area =         32,453 sf,100.00% Impervious,  Inflow Depth >  0.98"   for  WQ event
Inflow      =      1.21 cfs @  11.95 hrs,  Volume=           2,664 cf
Primary     =      1.21 cfs @  11.95 hrs,  Volume=           2,664 cf,  Atten= 0%,  Lag= 0.0 min
    Routed to Link 2L : Site Total
```

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA5: POA5 (Sanitary Sewer)



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment1A: Subwatershed1A Runoff Area=28,011 sf 100.00% Impervious Runoff Depth>2.57"
Tc=5.0 min CN=0/98 Runoff=2.56 cfs 5,993 cf

Subcatchment2A: Subwatershed2A Runoff Area=26,399 sf 21.54% Impervious Runoff Depth>1.36"
Flow Length=120' Slope=0.0080 '/' Tc=23.5 min CN=79/98 Runoff=0.79 cfs 3,002 cf

Subcatchment2B: Subwatershed2B Runoff Area=21,421 sf 100.00% Impervious Runoff Depth>2.57"
Tc=5.0 min CN=0/98 Runoff=1.96 cfs 4,583 cf

Subcatchment3A: Subwatershed3A Runoff Area=11,778 sf 100.00% Impervious Runoff Depth>2.57"
Flow Length=288' Tc=2.6 min CN=0/98 Runoff=1.14 cfs 2,521 cf

Subcatchment4A: Subwatershed4A Runoff Area=99,693 sf 42.70% Impervious Runoff Depth>1.73"
Flow Length=882' Tc=10.3 min CN=80/98 Runoff=5.45 cfs 14,332 cf

Subcatchment4B: Subwatershed4B Runoff Area=2,561 sf 100.00% Impervious Runoff Depth>2.57"
Flow Length=366' Tc=3.0 min CN=0/98 Runoff=0.25 cfs 548 cf

Subcatchment5A: Subwatershed5A Runoff Area=3,776 sf 100.00% Impervious Runoff Depth>2.57"
Tc=5.0 min CN=0/98 Runoff=0.35 cfs 808 cf

Subcatchment5B: Subwatershed5B Runoff Area=6,715 sf 100.00% Impervious Runoff Depth>2.57"
Tc=5.0 min CN=0/98 Runoff=0.61 cfs 1,437 cf

Subcatchment5C: Subwatershed5C Runoff Area=9,956 sf 100.00% Impervious Runoff Depth>2.57"
Tc=5.0 min CN=0/98 Runoff=0.91 cfs 2,130 cf

Subcatchment5D: Subwatershed5D Runoff Area=12,006 sf 100.00% Impervious Runoff Depth>2.57"
Tc=5.0 min CN=0/98 Runoff=1.10 cfs 2,569 cf

Link 1L: Total to Bristol Harbor Inflow=10.77 cfs 30,980 cf
Primary=10.77 cfs 30,980 cf

Link 2L: Site Total Inflow=13.69 cfs 37,923 cf
Primary=13.69 cfs 37,923 cf

Link POA1: POA1 (Outfall) Inflow=2.56 cfs 5,993 cf
Primary=2.56 cfs 5,993 cf

Link POA2: POA2 Inflow=2.30 cfs 7,586 cf
Primary=2.30 cfs 7,586 cf

Link POA3: POA3 Inflow=1.14 cfs 2,521 cf
Primary=1.14 cfs 2,521 cf

Link POA4: POA4 Inflow=5.57 cfs 14,880 cf
Primary=5.57 cfs 14,880 cf

Link POA5: POA5 (Sanitary Sewer) Inflow=2.97 cfs 6,944 cf
Primary=2.97 cfs 6,944 cf

Total Runoff Area = 222,316 sf Runoff Volume = 37,923 cf Average Runoff Depth = 2.05"
35.01% Pervious = 77,833 sf 64.99% Impervious = 144,483 sf

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment1A: Subwatershed1A Runoff Area=28,011 sf 100.00% Impervious Runoff Depth>4.66"
Tc=5.0 min CN=0/98 Runoff=4.53 cfs 10,879 cf

Subcatchment2A: Subwatershed2A Runoff Area=26,399 sf 21.54% Impervious Runoff Depth>3.12"
Flow Length=120' Slope=0.0080 '/' Tc=23.5 min CN=79/98 Runoff=1.85 cfs 6,861 cf

Subcatchment2B: Subwatershed2B Runoff Area=21,421 sf 100.00% Impervious Runoff Depth>4.66"
Tc=5.0 min CN=0/98 Runoff=3.47 cfs 8,319 cf

Subcatchment3A: Subwatershed3A Runoff Area=11,778 sf 100.00% Impervious Runoff Depth>4.66"
Flow Length=288' Tc=2.6 min CN=0/98 Runoff=2.01 cfs 4,576 cf

Subcatchment4A: Subwatershed4A Runoff Area=99,693 sf 42.70% Impervious Runoff Depth>3.59"
Flow Length=882' Tc=10.3 min CN=80/98 Runoff=11.34 cfs 29,844 cf

Subcatchment4B: Subwatershed4B Runoff Area=2,561 sf 100.00% Impervious Runoff Depth>4.66"
Flow Length=366' Tc=3.0 min CN=0/98 Runoff=0.44 cfs 995 cf

Subcatchment5A: Subwatershed5A Runoff Area=3,776 sf 100.00% Impervious Runoff Depth>4.66"
Tc=5.0 min CN=0/98 Runoff=0.61 cfs 1,467 cf

Subcatchment5B: Subwatershed5B Runoff Area=6,715 sf 100.00% Impervious Runoff Depth>4.66"
Tc=5.0 min CN=0/98 Runoff=1.09 cfs 2,608 cf

Subcatchment5C: Subwatershed5C Runoff Area=9,956 sf 100.00% Impervious Runoff Depth>4.66"
Tc=5.0 min CN=0/98 Runoff=1.61 cfs 3,867 cf

Subcatchment5D: Subwatershed5D Runoff Area=12,006 sf 100.00% Impervious Runoff Depth>4.66"
Tc=5.0 min CN=0/98 Runoff=1.94 cfs 4,663 cf

Link 1L: Total to Bristol Harbor Inflow=20.96 cfs 61,475 cf
Primary=20.96 cfs 61,475 cf

Link 2L: Site Total Inflow=26.08 cfs 74,079 cf
Primary=26.08 cfs 74,079 cf

Link POA1: POA1 (Outfall) Inflow=4.53 cfs 10,879 cf
Primary=4.53 cfs 10,879 cf

Link POA2: POA2 Inflow=4.33 cfs 15,181 cf
Primary=4.33 cfs 15,181 cf

Link POA3: POA3 Inflow=2.01 cfs 4,576 cf
Primary=2.01 cfs 4,576 cf

Link POA4: POA4 Inflow=11.56 cfs 30,839 cf
Primary=11.56 cfs 30,839 cf

Link POA5: POA5 (Sanitary Sewer)

Inflow=5.25 cfs 12,604 cf
Primary=5.25 cfs 12,604 cf

Total Runoff Area = 222,316 sf Runoff Volume = 74,079 cf Average Runoff Depth = 4.00"
35.01% Pervious = 77,833 sf 64.99% Impervious = 144,483 sf

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment1A: Subwatershed1A Runoff Area=28,011 sf 100.00% Impervious Runoff Depth>5.86"
Tc=5.0 min CN=0/98 Runoff=5.65 cfs 13,675 cf

Subcatchment2A: Subwatershed2A Runoff Area=26,399 sf 21.54% Impervious Runoff Depth>4.20"
Flow Length=120' Slope=0.0080 '/' Tc=23.5 min CN=79/98 Runoff=2.49 cfs 9,237 cf

Subcatchment2B: Subwatershed2B Runoff Area=21,421 sf 100.00% Impervious Runoff Depth>5.86"
Tc=5.0 min CN=0/98 Runoff=4.32 cfs 10,457 cf

Subcatchment3A: Subwatershed3A Runoff Area=11,778 sf 100.00% Impervious Runoff Depth>5.86"
Flow Length=288' Tc=2.6 min CN=0/98 Runoff=2.51 cfs 5,752 cf

Subcatchment4A: Subwatershed4A Runoff Area=99,693 sf 42.70% Impervious Runoff Depth>4.71"
Flow Length=882' Tc=10.3 min CN=80/98 Runoff=14.82 cfs 39,154 cf

Subcatchment4B: Subwatershed4B Runoff Area=2,561 sf 100.00% Impervious Runoff Depth>5.86"
Flow Length=366' Tc=3.0 min CN=0/98 Runoff=0.54 cfs 1,251 cf

Subcatchment5A: Subwatershed5A Runoff Area=3,776 sf 100.00% Impervious Runoff Depth>5.86"
Tc=5.0 min CN=0/98 Runoff=0.76 cfs 1,843 cf

Subcatchment5B: Subwatershed5B Runoff Area=6,715 sf 100.00% Impervious Runoff Depth>5.86"
Tc=5.0 min CN=0/98 Runoff=1.36 cfs 3,278 cf

Subcatchment5C: Subwatershed5C Runoff Area=9,956 sf 100.00% Impervious Runoff Depth>5.86"
Tc=5.0 min CN=0/98 Runoff=2.01 cfs 4,860 cf

Subcatchment5D: Subwatershed5D Runoff Area=12,006 sf 100.00% Impervious Runoff Depth>5.86"
Tc=5.0 min CN=0/98 Runoff=2.42 cfs 5,861 cf

Link 1L: Total to Bristol Harbor Inflow=26.92 cfs 79,526 cf
Primary=26.92 cfs 79,526 cf

Link 2L: Site Total Inflow=33.29 cfs 95,369 cf
Primary=33.29 cfs 95,369 cf

Link POA1: POA1 (Outfall) Inflow=5.65 cfs 13,675 cf
Primary=5.65 cfs 13,675 cf

Link POA2: POA2 Inflow=5.52 cfs 19,694 cf
Primary=5.52 cfs 19,694 cf

Link POA3: POA3 Inflow=2.51 cfs 5,752 cf
Primary=2.51 cfs 5,752 cf

Link POA4: POA4 Inflow=15.09 cfs 40,405 cf
Primary=15.09 cfs 40,405 cf

Link POA5: POA5 (Sanitary Sewer)

Inflow=6.55 cfs 15,843 cf
Primary=6.55 cfs 15,843 cf

Total Runoff Area = 222,316 sf Runoff Volume = 95,369 cf Average Runoff Depth = 5.15"
35.01% Pervious = 77,833 sf 64.99% Impervious = 144,483 sf

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 1A: Subwatershed 1A Runoff Area=28,011 sf 100.00% Impervious Runoff Depth>8.35"
Tc=5.0 min CN=0/98 Runoff=7.98 cfs 19,502 cf

Subcatchment 2A: Subwatershed 2A Runoff Area=26,399 sf 21.54% Impervious Runoff Depth>6.53"
Flow Length=120' Slope=0.0080 '/' Tc=23.5 min CN=79/98 Runoff=3.84 cfs 14,369 cf

Subcatchment 2B: Subwatershed 2B Runoff Area=21,421 sf 100.00% Impervious Runoff Depth>8.35"
Tc=5.0 min CN=0/98 Runoff=6.11 cfs 14,914 cf

Subcatchment 3A: Subwatershed 3A Runoff Area=11,778 sf 100.00% Impervious Runoff Depth>8.36"
Flow Length=288' Tc=2.6 min CN=0/98 Runoff=3.54 cfs 8,204 cf

Subcatchment 4A: Subwatershed 4A Runoff Area=99,693 sf 42.70% Impervious Runoff Depth>7.10"
Flow Length=882' Tc=10.3 min CN=80/98 Runoff=22.09 cfs 59,019 cf

Subcatchment 4B: Subwatershed 4B Runoff Area=2,561 sf 100.00% Impervious Runoff Depth>8.36"
Flow Length=366' Tc=3.0 min CN=0/98 Runoff=0.77 cfs 1,784 cf

Subcatchment 5A: Subwatershed 5A Runoff Area=3,776 sf 100.00% Impervious Runoff Depth>8.35"
Tc=5.0 min CN=0/98 Runoff=1.08 cfs 2,629 cf

Subcatchment 5B: Subwatershed 5B Runoff Area=6,715 sf 100.00% Impervious Runoff Depth>8.35"
Tc=5.0 min CN=0/98 Runoff=1.91 cfs 4,675 cf

Subcatchment 5C: Subwatershed 5C Runoff Area=9,956 sf 100.00% Impervious Runoff Depth>8.35"
Tc=5.0 min CN=0/98 Runoff=2.84 cfs 6,932 cf

Subcatchment 5D: Subwatershed 5D Runoff Area=12,006 sf 100.00% Impervious Runoff Depth>8.35"
Tc=5.0 min CN=0/98 Runoff=3.42 cfs 8,359 cf

Link 1L: Total to Bristol Harbor Inflow=39.42 cfs 117,792 cf
Primary=39.42 cfs 117,792 cf

Link 2L: Site Total Inflow=48.40 cfs 140,387 cf
Primary=48.40 cfs 140,387 cf

Link POA1: POA1 (Outfall) Inflow=7.98 cfs 19,502 cf
Primary=7.98 cfs 19,502 cf

Link POA2: POA2 Inflow=8.02 cfs 29,283 cf
Primary=8.02 cfs 29,283 cf

Link POA3: POA3 Inflow=3.54 cfs 8,204 cf
Primary=3.54 cfs 8,204 cf

Link POA4: POA4 Inflow=22.48 cfs 60,802 cf
Primary=22.48 cfs 60,802 cf

Link POA5: POA5 (Sanitary Sewer) Inflow=9.25 cfs 22,595 cf
Primary=9.25 cfs 22,595 cf

Total Runoff Area = 222,316 sf Runoff Volume = 140,387 cf Average Runoff Depth = 7.58"
35.01% Pervious = 77,833 sf 64.99% Impervious = 144,483 sf

Appendix C

Post-Development Hydrologic Analysis

Post-Development Curve Numbers

Subwatershed No. 1A						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	2,561	100.00%	98.00
Totals				**2,561**	**100.00%**	**98.00**

Subwatershed No. 1B						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Pavement	N/A	N/A	98	1,903	64.16%	62.88
Grass	Fair	C	79	1,063	35.84%	28.31
Totals				**2,966**	**100.00%**	**91.19**

Subwatershed No. 1C						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	252	4.60%	4.51
Pavement	N/A	N/A	98	4,450	81.26%	79.64
Grass	Fair	C	79	774	14.13%	11.17
Totals				**5,476**	**100.00%**	**95.31**

Subwatershed No. 1D						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Pavement	N/A	N/A	98	4,624	73.95%	72.47
Grass	Fair	C	79	1,629	26.05%	20.58
Totals				**6,253**	**100.00%**	**93.05**

Subwatershed No. 1E						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	2,627	19.65%	19.26
Pavement	N/A	N/A	98	7,522	56.26%	55.14
Grass	Fair	C	79	3,220	24.09%	19.03
Totals				**13,369**	**100.00%**	**93.42**

Subwatershed No. 1F						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	3,412	11.72%	11.48
Pavement	N/A	N/A	98	13,791	47.36%	46.41
Grass	Fair	C	79	11,919	40.93%	32.33
Totals				**29,122**	**100.00%**	**90.22**

Subwatershed No. 1G						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Pavement	N/A	N/A	98	2,407	89.12%	87.33
Grass	Fair	C	79	294	10.88%	8.60
Totals				**2,701**	**100.00%**	**95.93**

Subwatershed No. 1H						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	6,697	100.00%	98.00
Totals				**6,697**	**100.00%**	**98.00**

Subwatershed No. 1I						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	11,506	100.00%	98.00
Totals				**11,506**	**100.00%**	**98.00**

Subwatershed No. 1J						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	28,538	100.00%	98.00
Totals				**28,538**	**100.00%**	**98.00**

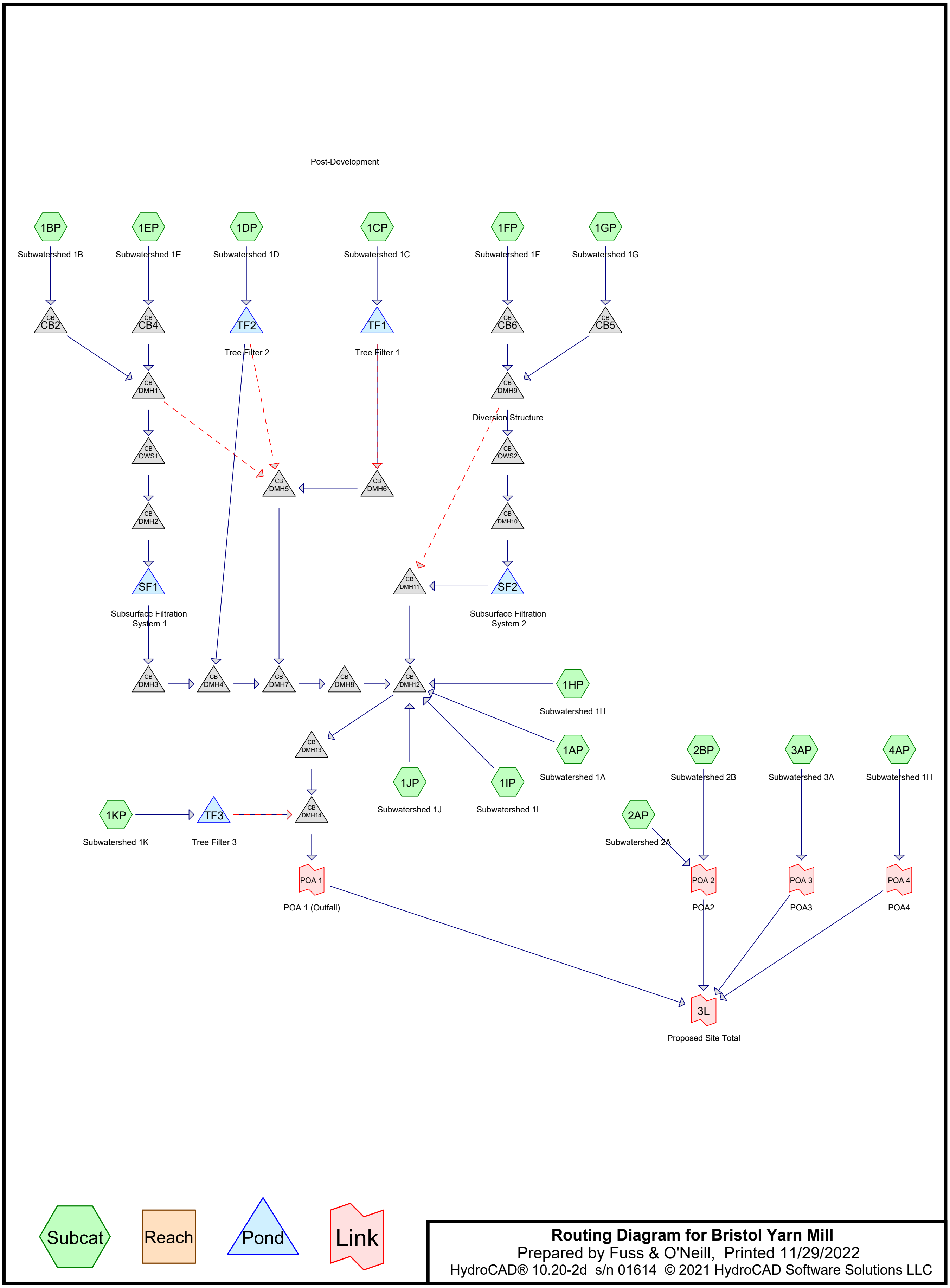
Subwatershed No. 1K						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	21,087	100.00%	98.00
Totals				**21,087**	**100.00%**	**98.00**

Subwatershed No. 2A						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	838	3.44%	3.37
Pavement	N/A	N/A	98	4,867	19.99%	19.59
Gravel	N/A	C	96	2,266	9.31%	8.93
Grass	Good	C	74	16,377	67.26%	49.77
Totals				**24,348**	**100.00%**	**81.67**

Subwatershed No. 2B						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	12,154	85.48%	83.77
Grass	Good	C	74	2,065	14.52%	10.75
Totals				**14,219**	**100.00%**	**94.51**

Subwatershed No. 3A						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	106	0.79%	0.77
Pavement	N/A	N/A	98	10,375	77.07%	75.53
Grass	Good	C	74	2,980	22.14%	16.38
Totals				**13,461**	**100.00%**	**92.69**

Subwatershed No. 4A						
Cover Description	**Condition**	**Soil Group**	**CN No.**	**Area (square feet)**	**% Total Area**	**Composite CN No.**
Roofs	N/A	N/A	98	4,399	11.86%	11.62
Pavement	N/A	N/A	98	13,015	35.09%	34.38
Grass	Fair	C	79	19,680	53.05%	41.91
Totals				**37,094**	**100.00%**	**87.92**



Routing Diagram for Bristol Yarn Mill
Prepared by Fuss & O'Neill, Printed 11/29/2022
HydroCAD® 10.20-2d s/n 01614 © 2021 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-Yr	Type II 24-hr		Default	24.00	1	2.80	2
2	10-Yr	Type II 24-hr		Default	24.00	1	4.90	2
3	25-Yr	Type II 24-hr		Default	24.00	1	6.10	2
4	100-Yr	Type II 24-hr		Default	24.00	1	8.60	2
5	WQ	Type II 24-hr		Default	24.00	1	1.20	2

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
38,579	79	50-75% Grass cover, Fair, HSG C (1BP, 1CP, 1DP, 1EP, 1FP, 1GP, 4AP)
21,422	74	>75% Grass cover, Good, HSG C (2AP, 2BP, 3AP)
2,266	96	Gravel surface, HSG C (2AP)
62,954	98	Paved parking, HSG C (1BP, 1CP, 1DP, 1EP, 1FP, 1GP, 2AP, 3AP, 4AP)
94,177	98	Roofs, HSG C (1AP, 1CP, 1EP, 1FP, 1HP, 1IP, 1JP, 1KP, 2AP, 2BP, 3AP, 4AP)
219,398	**92**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
219,398	HSG C	1AP, 1BP, 1CP, 1DP, 1EP, 1FP, 1GP, 1HP, 1IP, 1JP, 1KP, 2AP, 2BP, 3AP, 4AP
0	HSG D	
0	Other	
219,398		**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment1AP: Subwatershed1A Runoff Area=2,561 sf 100.00% Impervious Runoff Depth>0.98"
Tc=5.0 min CN=0/98 Runoff=0.10 cfs 210 cf

Subcatchment1BP: Subwatershed1B Runoff Area=2,966 sf 64.16% Impervious Runoff Depth>0.68"
Flow Length=104' Tc=2.2 min CN=79/98 Runoff=0.08 cfs 168 cf

Subcatchment1CP: Subwatershed1C Runoff Area=5,476 sf 85.87% Impervious Runoff Depth>0.87"
Flow Length=180' Tc=2.7 min CN=79/98 Runoff=0.19 cfs 395 cf

Subcatchment1DP: Subwatershed1D Runoff Area=6,253 sf 73.95% Impervious Runoff Depth>0.76"
Flow Length=200' Tc=4.6 min CN=79/98 Runoff=0.18 cfs 398 cf

Subcatchment1EP: Subwatershed1E Runoff Area=13,369 sf 75.91% Impervious Runoff Depth>0.78"
Flow Length=266' Tc=4.1 min CN=79/98 Runoff=0.40 cfs 869 cf

Subcatchment1FP: Subwatershed1F Runoff Area=29,122 sf 59.07% Impervious Runoff Depth>0.64"
Flow Length=264' Tc=7.5 min CN=79/98 Runoff=0.63 cfs 1,544 cf

Subcatchment1GP: Subwatershed1G Runoff Area=2,701 sf 89.12% Impervious Runoff Depth>0.89"
Flow Length=72' Slope=0.0300 '/' Tc=0.8 min CN=79/98 Runoff=0.10 cfs 201 cf

Subcatchment1HP: Subwatershed1H Runoff Area=6,697 sf 100.00% Impervious Runoff Depth>0.98"
Tc=5.0 min CN=0/98 Runoff=0.25 cfs 550 cf

Subcatchment1IP: Subwatershed1I Runoff Area=11,506 sf 100.00% Impervious Runoff Depth>0.98"
Tc=5.0 min CN=0/98 Runoff=0.43 cfs 944 cf

Subcatchment1JP: Subwatershed1J Runoff Area=28,538 sf 100.00% Impervious Runoff Depth>0.98"
Tc=5.0 min CN=0/98 Runoff=1.06 cfs 2,342 cf

Subcatchment1KP: Subwatershed1K Runoff Area=21,087 sf 100.00% Impervious Runoff Depth>0.98"
Tc=5.0 min CN=0/98 Runoff=0.79 cfs 1,731 cf

Subcatchment2AP: Subwatershed2A Runoff Area=24,348 sf 23.43% Impervious Runoff Depth>0.31"
Flow Length=128' Tc=1.4 min CN=77/98 Runoff=0.26 cfs 626 cf

Subcatchment2BP: Subwatershed2B Runoff Area=14,219 sf 85.48% Impervious Runoff Depth>0.85"
Tc=5.0 min CN=74/98 Runoff=0.45 cfs 1,008 cf

Subcatchment3AP: Subwatershed3A Runoff Area=13,461 sf 77.86% Impervious Runoff Depth>0.78"
Flow Length=229' Tc=11.9 min CN=74/98 Runoff=0.32 cfs 874 cf

Subcatchment4AP: Subwatershed1H Runoff Area=37,094 sf 46.95% Impervious Runoff Depth>0.53"
Flow Length=1,052' Tc=15.9 min CN=79/98 Runoff=0.50 cfs 1,645 cf

Pond CB2: Peak Elev=8.69' Inflow=0.08 cfs 168 cf
6.0" Round Culvert n=0.013 L=62.0' S=0.0050 '/' Outflow=0.08 cfs 168 cf

Pond CB4: Peak Elev=9.03' Inflow=0.40 cfs 869 cf
6.0" Round Culvert n=0.013 L=61.0' S=0.0051 '/' Outflow=0.40 cfs 869 cf

Pond CB5: Peak Elev=9.79' Inflow=0.10 cfs 201 cf
6.0" Round Culvert n=0.013 L=14.0' S=0.0050 '/' Outflow=0.10 cfs 201 cf

Pond CB6: Peak Elev=10.05' Inflow=0.63 cfs 1,544 cf
18.0" Round Culvert n=0.013 L=28.0' S=0.0050 '/' Outflow=0.63 cfs 1,544 cf

Pond DMH1: Peak Elev=8.67' Inflow=0.48 cfs 1,037 cf
Primary=0.48 cfs 1,037 cf Secondary=0.00 cfs 0 cf Outflow=0.48 cfs 1,037 cf

Pond DMH10: Peak Elev=8.01' Inflow=0.67 cfs 1,745 cf
18.0" Round Culvert n=0.012 L=3.0' S=0.0000 '/' Outflow=0.67 cfs 1,745 cf

Pond DMH11: Peak Elev=4.68' Inflow=0.37 cfs 1,732 cf
18.0" Round Culvert n=0.013 L=121.0' S=0.0051 '/' Outflow=0.37 cfs 1,732 cf

Pond DMH12: Peak Elev=3.84' Inflow=2.51 cfs 7,596 cf
30.0" Round Culvert n=0.013 L=187.0' S=0.0030 '/' Outflow=2.51 cfs 7,596 cf

Pond DMH13: Peak Elev=3.18' Inflow=2.51 cfs 7,596 cf
30.0" Round Culvert n=0.013 L=139.0' S=0.0030 '/' Outflow=2.51 cfs 7,596 cf

Pond DMH14: Peak Elev=2.65' Inflow=2.65 cfs 9,308 cf
30.0" Round Culvert n=0.011 L=65.0' S=0.0031 '/' Outflow=2.65 cfs 9,308 cf

Pond DMH2: Peak Elev=8.35' Inflow=0.48 cfs 1,037 cf
12.0" Round Culvert n=0.013 L=1.0' S=0.0000 '/' Outflow=0.48 cfs 1,037 cf

Pond DMH3: Peak Elev=5.41' Inflow=0.41 cfs 1,029 cf
18.0" Round Culvert n=0.013 L=87.0' S=0.0051 '/' Outflow=0.41 cfs 1,029 cf

Pond DMH4: Peak Elev=4.85' Inflow=0.44 cfs 1,425 cf
8.0" Round Culvert n=0.013 L=24.0' S=0.0071 '/' Outflow=0.44 cfs 1,425 cf

Pond DMH5: Peak Elev=4.48' Inflow=0.04 cfs 392 cf
12.0" Round Culvert n=0.013 L=24.0' S=0.0050 '/' Outflow=0.04 cfs 392 cf

Pond DMH6: Peak Elev=4.94' Inflow=0.04 cfs 392 cf
8.0" Round Culvert n=0.013 L=68.0' S=0.0050 '/' Outflow=0.04 cfs 392 cf

Pond DMH7: Peak Elev=4.52' Inflow=0.47 cfs 1,817 cf
18.0" Round Culvert n=0.013 L=5.0' S=0.0080 '/' Outflow=0.47 cfs 1,817 cf

Pond DMH8: Peak Elev=4.15' Inflow=0.47 cfs 1,817 cf
18.0" Round Culvert n=0.013 L=125.0' S=0.0050 '/' Outflow=0.47 cfs 1,817 cf

Pond DMH9: Diversion Structure Peak Elev=9.43' Inflow=0.67 cfs 1,745 cf
Primary=0.67 cfs 1,745 cf Secondary=0.00 cfs 0 cf Outflow=0.67 cfs 1,745 cf

Pond OWS1: Peak Elev=8.37' Inflow=0.48 cfs 1,037 cf
12.0" Round Culvert n=0.013 L=7.0' S=0.0057 '/' Outflow=0.48 cfs 1,037 cf

Pond OWS2: Peak Elev=8.75' Inflow=0.67 cfs 1,745 cf
18.0" Round Culvert n=0.013 L=3.0' S=0.0067 '/' Outflow=0.67 cfs 1,745 cf

Pond SF1: Subsurface Filtration System 1 Peak Elev=5.74' Storage=111 cf Inflow=0.48 cfs 1,037 cf
6.0" Round Culvert n=0.010 L=2.0' S=0.0050 '/' Outflow=0.41 cfs 1,029 cf

Pond SF2: Subsurface Filtration System 2 Peak Elev=5.72' Storage=359 cf Inflow=0.67 cfs 1,745 cf
Outflow=0.37 cfs 1,732 cf

Pond TF1: Tree Filter 1 Peak Elev=6.13' Storage=124 cf Inflow=0.19 cfs 395 cf
Primary=0.04 cfs 392 cf Secondary=0.00 cfs 0 cf Outflow=0.04 cfs 392 cf

Pond TF2: Tree Filter 2 Peak Elev=5.98' Storage=126 cf Inflow=0.18 cfs 398 cf
Primary=0.05 cfs 397 cf Secondary=0.00 cfs 0 cf Outflow=0.05 cfs 397 cf

Pond TF3: Tree Filter 3 Peak Elev=3.88' Storage=617 cf Inflow=0.79 cfs 1,731 cf
Primary=0.14 cfs 1,713 cf Secondary=0.00 cfs 0 cf Outflow=0.14 cfs 1,713 cf

Link 3L: Proposed Site Total Inflow=3.92 cfs 13,461 cf
Primary=3.92 cfs 13,461 cf

Link POA 1: POA 1 (Outfall) Inflow=2.65 cfs 9,308 cf
Primary=2.65 cfs 9,308 cf

Link POA 2: POA2 Inflow=0.70 cfs 1,634 cf
Primary=0.70 cfs 1,634 cf

Link POA 3: POA3 Inflow=0.32 cfs 874 cf
Primary=0.32 cfs 874 cf

Link POA 4: POA4 Inflow=0.50 cfs 1,645 cf
Primary=0.50 cfs 1,645 cf

Total Runoff Area = 219,398 sf Runoff Volume = 13,506 cf Average Runoff Depth = 0.74"
28.38% Pervious = 62,267 sf 71.62% Impervious = 157,131 sf

Summary for Subcatchment 1AP: Subwatershed 1A

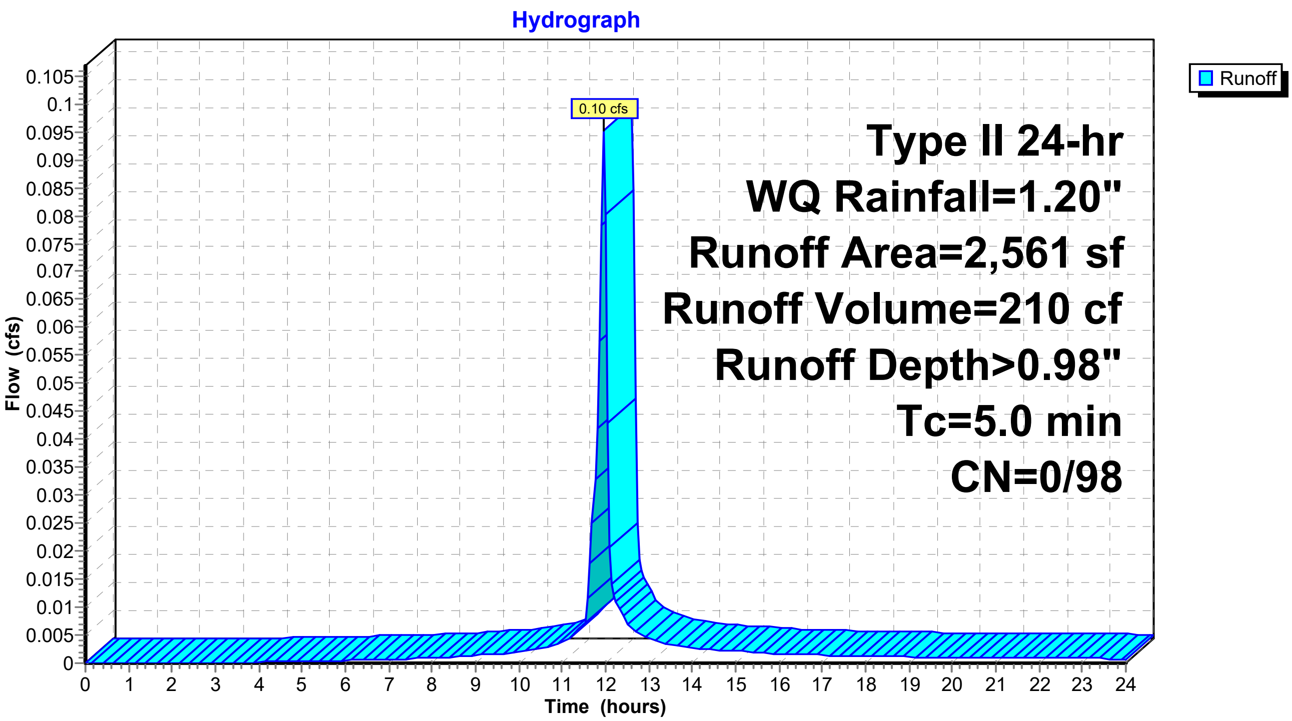
Runoff = 0.10 cfs @ 11.95 hrs, Volume= 210 cf, Depth> 0.98"
Routed to Pond DMH12 :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
2,561	98	Roofs, HSG C
2,561	98	100.00% Impervious Area

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

Subcatchment 1AP: Subwatershed 1A



Summary for Subcatchment 1BP: Subwatershed 1B

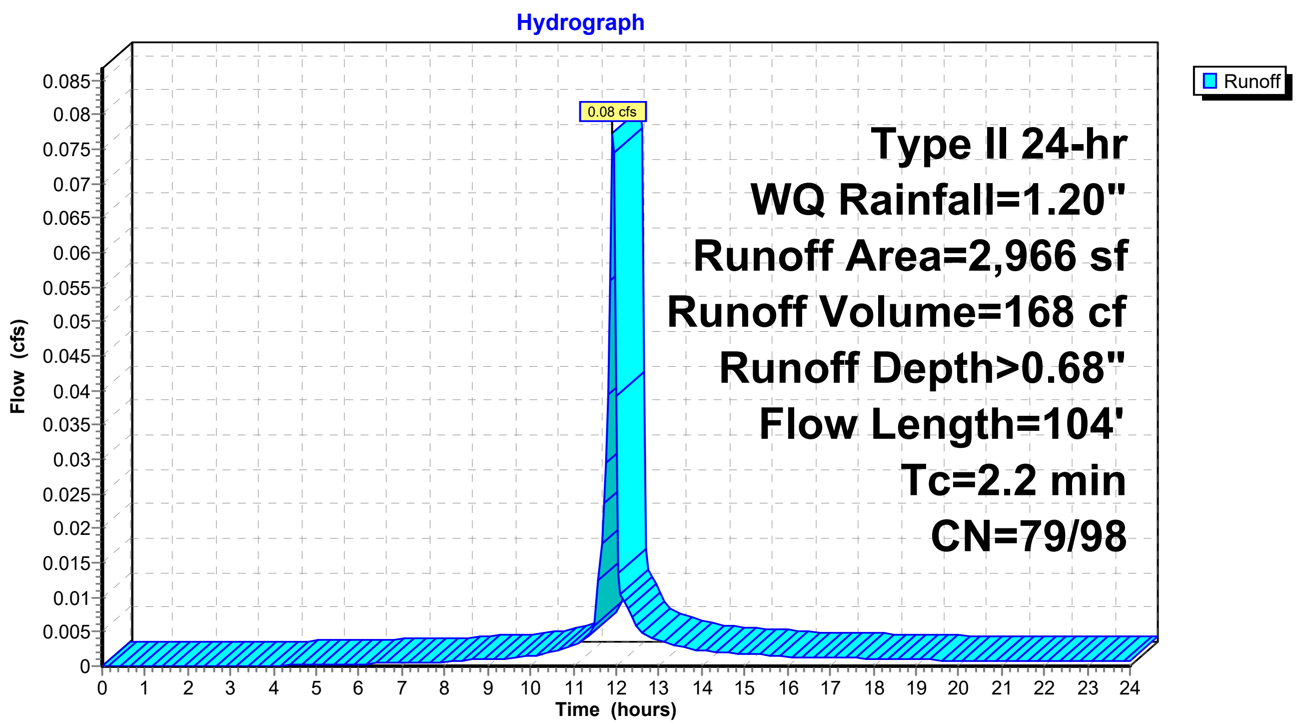
Runoff = 0.08 cfs @ 11.92 hrs, Volume= 168 cf, Depth> 0.68"
Routed to Pond CB2 :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
1,903	98	Paved parking, HSG C
1,063	79	50-75% Grass cover, Fair, HSG C
2,966	91	Weighted Average
1,063	79	35.84% Pervious Area
1,903	98	64.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	14	0.0600	0.18		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.30"
0.9	90	0.0330	1.67		**Sheet Flow, Paved Parking Lot** Smooth surfaces n= 0.011 P2= 3.30"
2.2	104	Total			

Subcatchment 1BP: Subwatershed 1B



Summary for Subcatchment 1CP: Subwatershed 1C

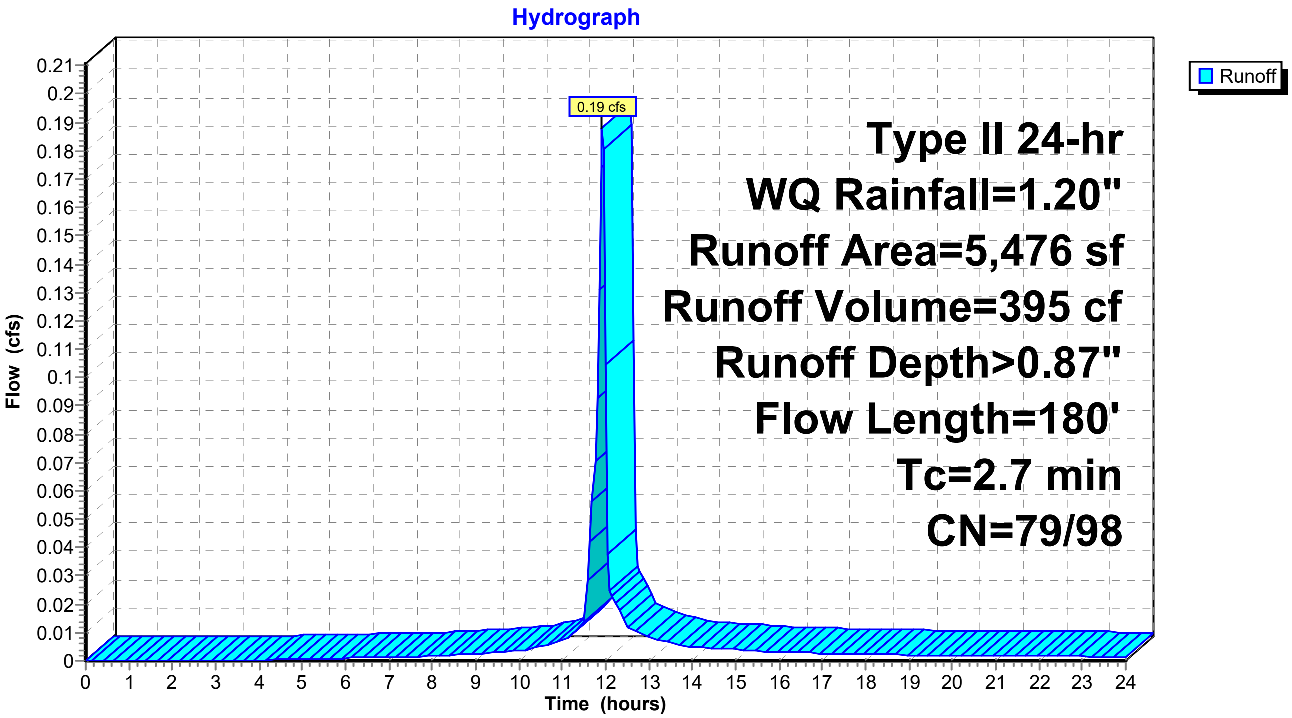
Runoff = 0.19 cfs @ 11.93 hrs, Volume= 395 cf, Depth> 0.87"
Routed to Pond TF1 : Tree Filter 1

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
252	98	Roofs, HSG C
4,450	98	Paved parking, HSG C
774	79	50-75% Grass cover, Fair, HSG C
5,476	95	Weighted Average
774	79	14.13% Pervious Area
4,702	98	85.87% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.5	18	0.0700	0.20		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.30"
0.8	82	0.0330	1.64		**Sheet Flow, Paved Parking Lot** Smooth surfaces n= 0.011 P2= 3.30"
0.4	80	0.0330	3.69		**Shallow Concentrated Flow, Paved Parking Lot** Paved Kv= 20.3 fps
2.7	180	Total			

Subcatchment 1CP: Subwatershed 1C



Summary for Subcatchment 1DP: Subwatershed 1D

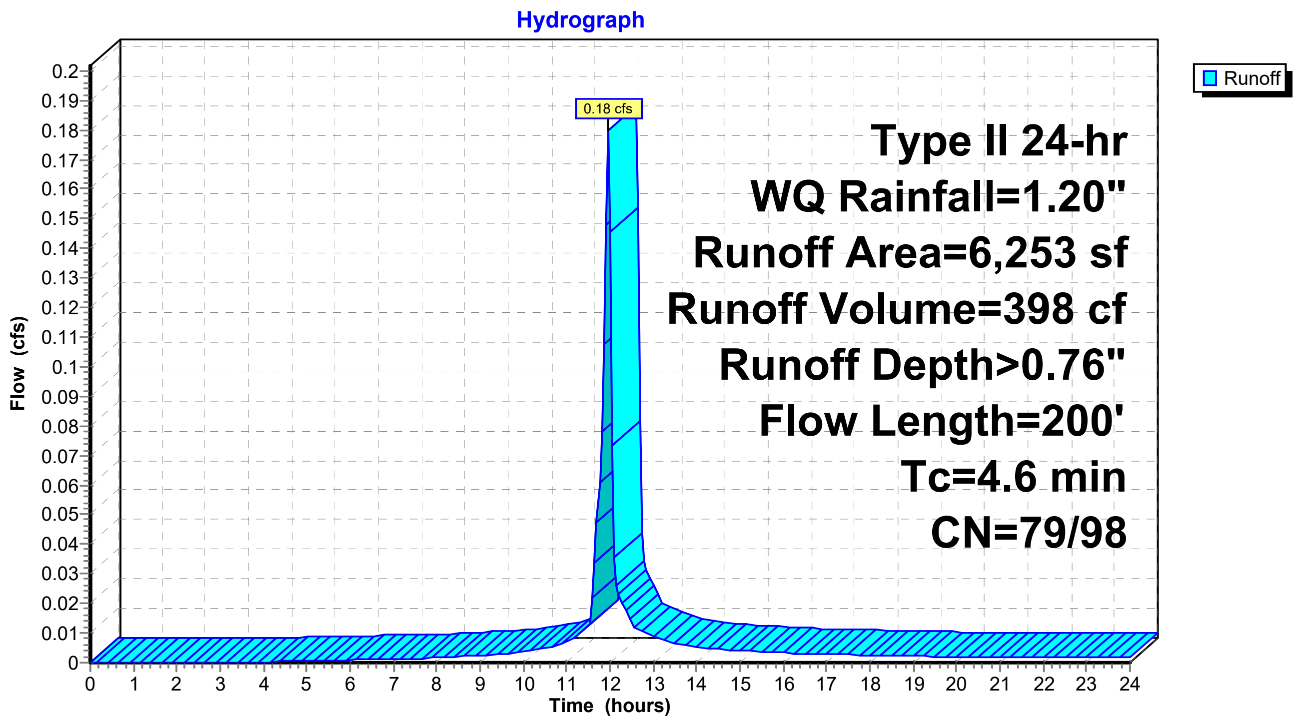
Runoff = 0.18 cfs @ 11.95 hrs, Volume= 398 cf, Depth> 0.76"
Routed to Pond TF2 : Tree Filter 2

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
4,624	98	Paved parking, HSG C
1,629	79	50-75% Grass cover, Fair, HSG C
6,253	93	Weighted Average
1,629	79	26.05% Pervious Area
4,624	98	73.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	40	0.0400	0.19		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.30"
0.6	60	0.0330	1.54		**Sheet Flow, Paved Parking Lot** Smooth surfaces n= 0.011 P2= 3.30"
0.5	100	0.0330	3.69		**Shallow Concentrated Flow, Paved Parking Lot** Paved Kv= 20.3 fps
4.6	200	Total			

Subcatchment 1DP: Subwatershed 1D



Summary for Subcatchment 1EP: Subwatershed 1E

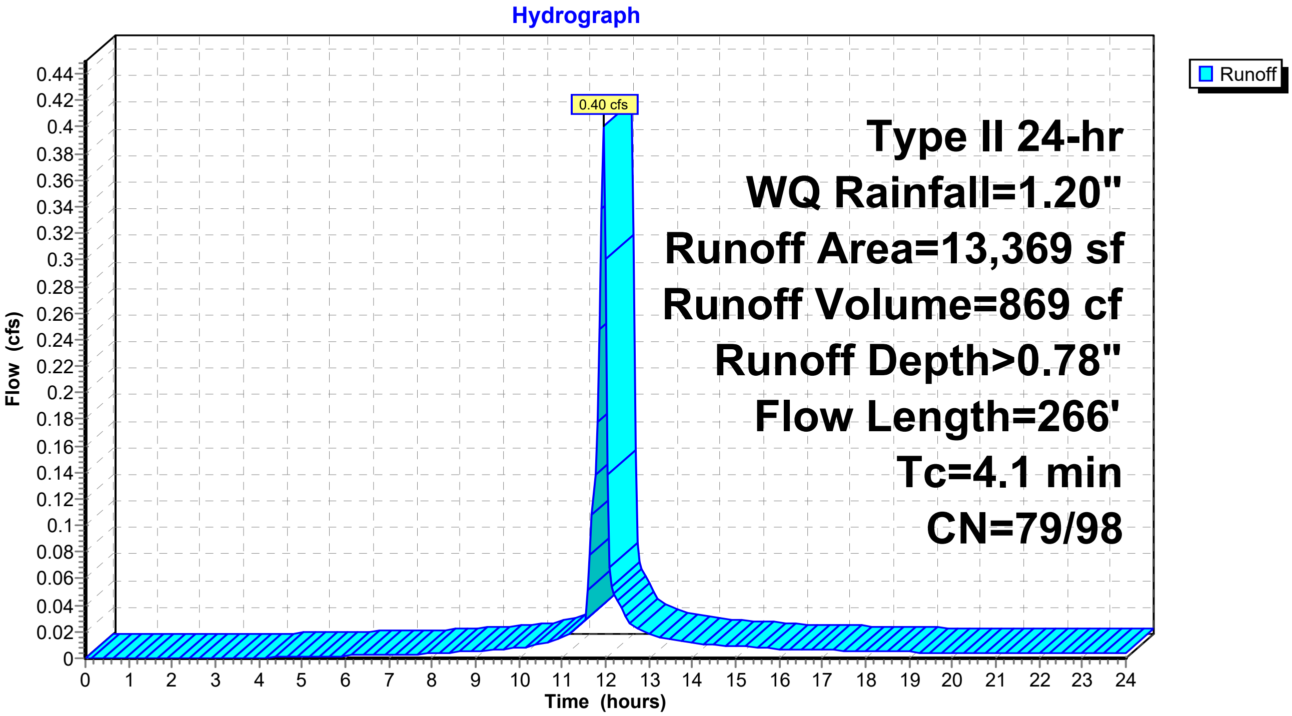
Runoff = 0.40 cfs @ 11.94 hrs, Volume= 869 cf, Depth> 0.78"
Routed to Pond CB4 :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
2,627	98	Roofs, HSG C
7,522	98	Paved parking, HSG C
3,220	79	50-75% Grass cover, Fair, HSG C
13,369	93	Weighted Average
3,220	79	24.09% Pervious Area
10,149	98	75.91% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.1	18	0.2000	2.49		**Sheet Flow, Sloped Roof** Smooth surfaces n= 0.011 P2= 3.30"
2.8	33	0.0500	0.20		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.30"
0.6	49	0.0300	1.42		**Sheet Flow, Paved Parking Lot** Smooth surfaces n= 0.011 P2= 3.30"
0.2	51	0.0300	3.52		**Shallow Concentrated Flow, Paved Parking Lot** Paved Kv= 20.3 fps
0.1	40	0.0500	4.54		**Shallow Concentrated Flow, Paved Parking Lot** Paved Kv= 20.3 fps
0.3	75	0.0330	3.69		**Shallow Concentrated Flow, Paved Parking Lot** Paved Kv= 20.3 fps
4.1	266	Total			

Subcatchment 1EP: Subwatershed 1E



Summary for Subcatchment 1FP: Subwatershed 1F

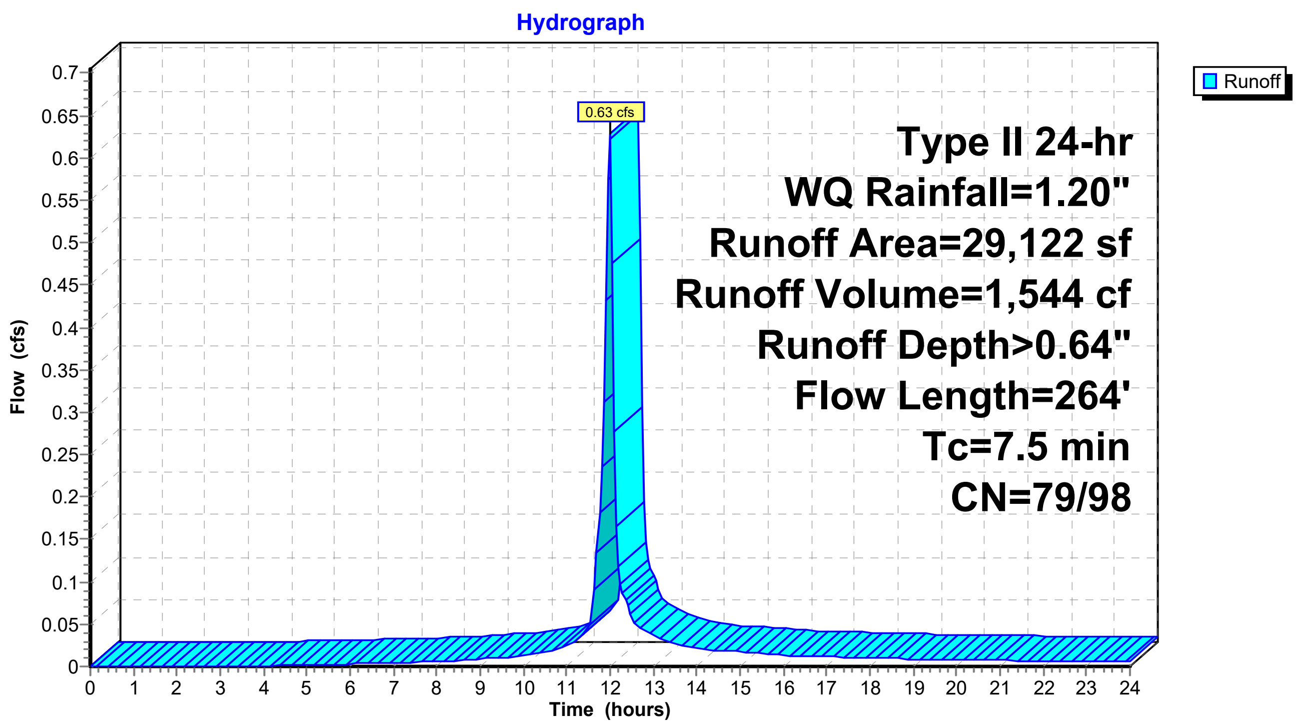
Runoff = 0.63 cfs @ 11.99 hrs, Volume= 1,544 cf, Depth> 0.64"
Routed to Pond CB6 :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
3,412	98	Roofs, HSG C
13,791	98	Paved parking, HSG C
11,919	79	50-75% Grass cover, Fair, HSG C
29,122	90	Weighted Average
11,919	79	40.93% Pervious Area
17,203	98	59.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.7	100	0.0500	0.25		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.30"
0.1	14	0.0500	1.57		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
0.7	150	0.0300	3.52		**Shallow Concentrated Flow, Paved Parking Lot** Paved Kv= 20.3 fps
7.5	264	Total			

Subcatchment 1FP: Subwatershed 1F



Summary for Subcatchment 1GP: Subwatershed 1G

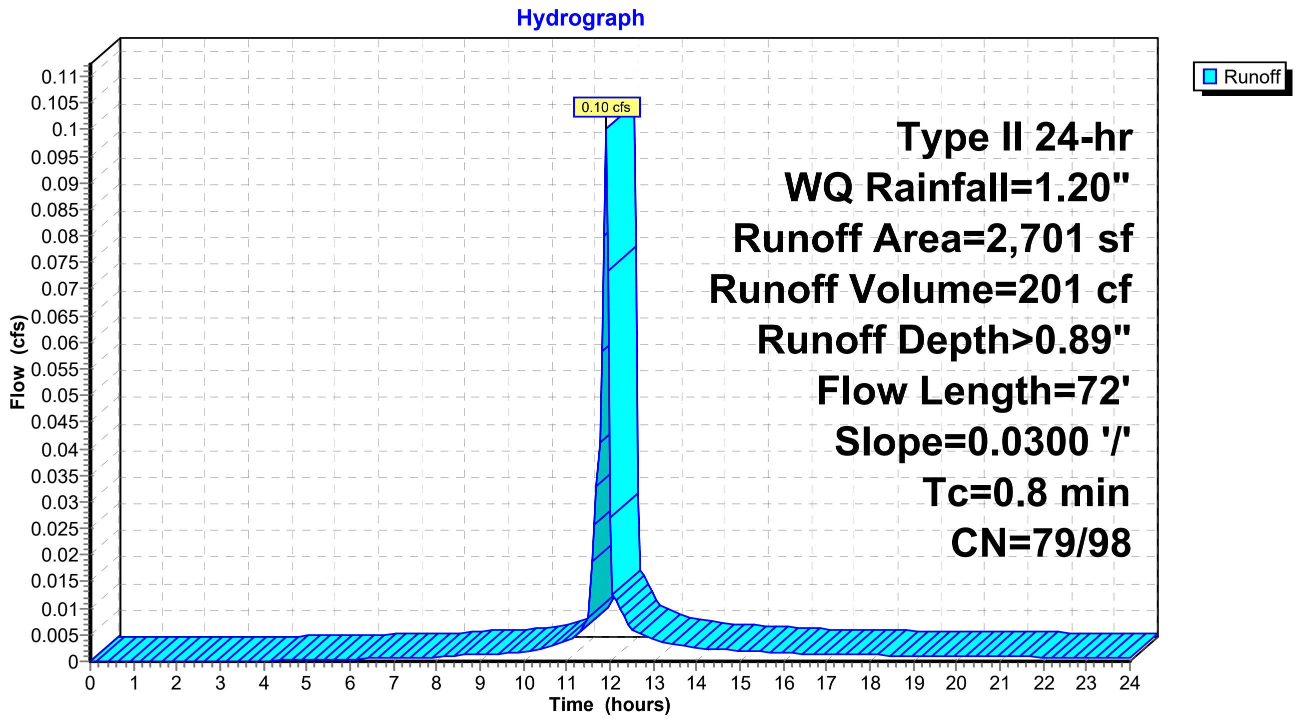
Runoff = 0.10 cfs @ 11.90 hrs, Volume= 201 cf, Depth> 0.89"
Routed to Pond CB5 :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
2,407	98	Paved parking, HSG C
294	79	50-75% Grass cover, Fair, HSG C
2,701	96	Weighted Average
294	79	10.88% Pervious Area
2,407	98	89.12% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	72	0.0300	1.54		**Sheet Flow, Paved Parking Lot** Smooth surfaces n= 0.011 P2= 3.30"

Subcatchment 1GP: Subwatershed 1G



Summary for Subcatchment 1HP: Subwatershed 1H

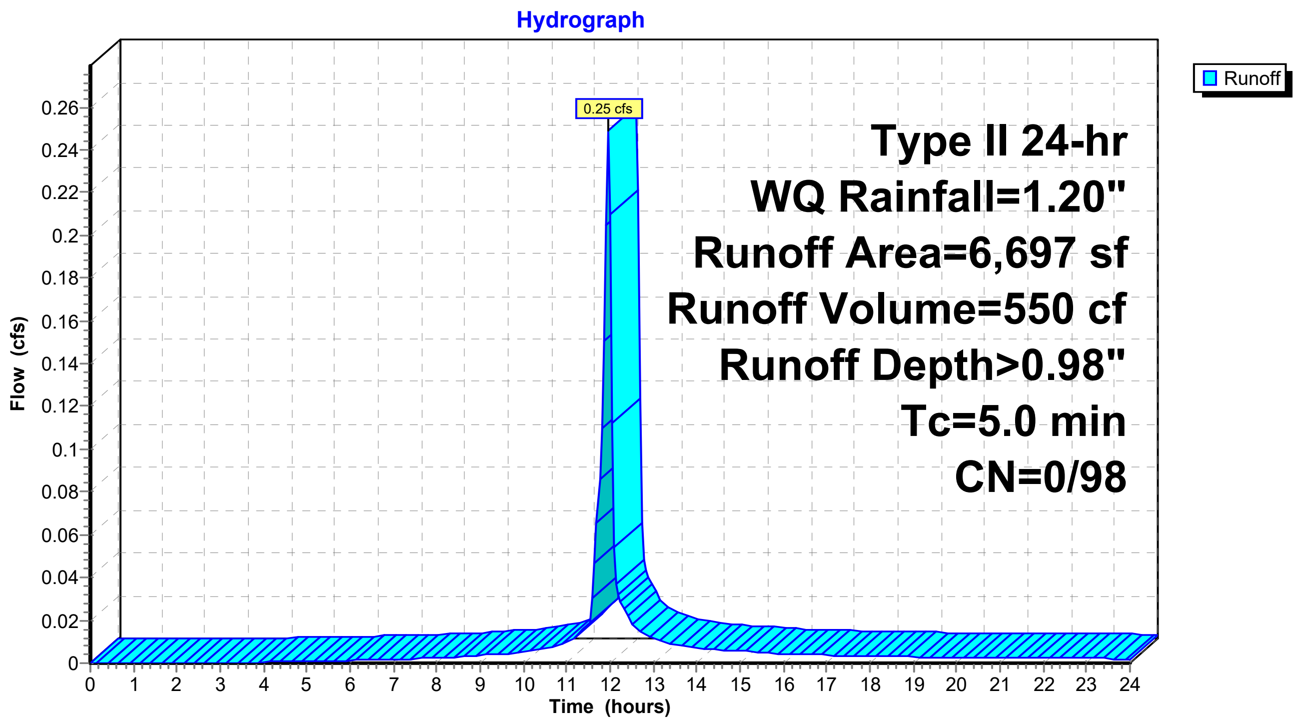
Runoff = 0.25 cfs @ 11.95 hrs, Volume= 550 cf, Depth> 0.98"
Routed to Pond DMH12 :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
6,697	98	Roofs, HSG C
6,697	98	100.00% Impervious Area

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

Subcatchment 1HP: Subwatershed 1H



Summary for Subcatchment 1IP: Subwatershed 1I

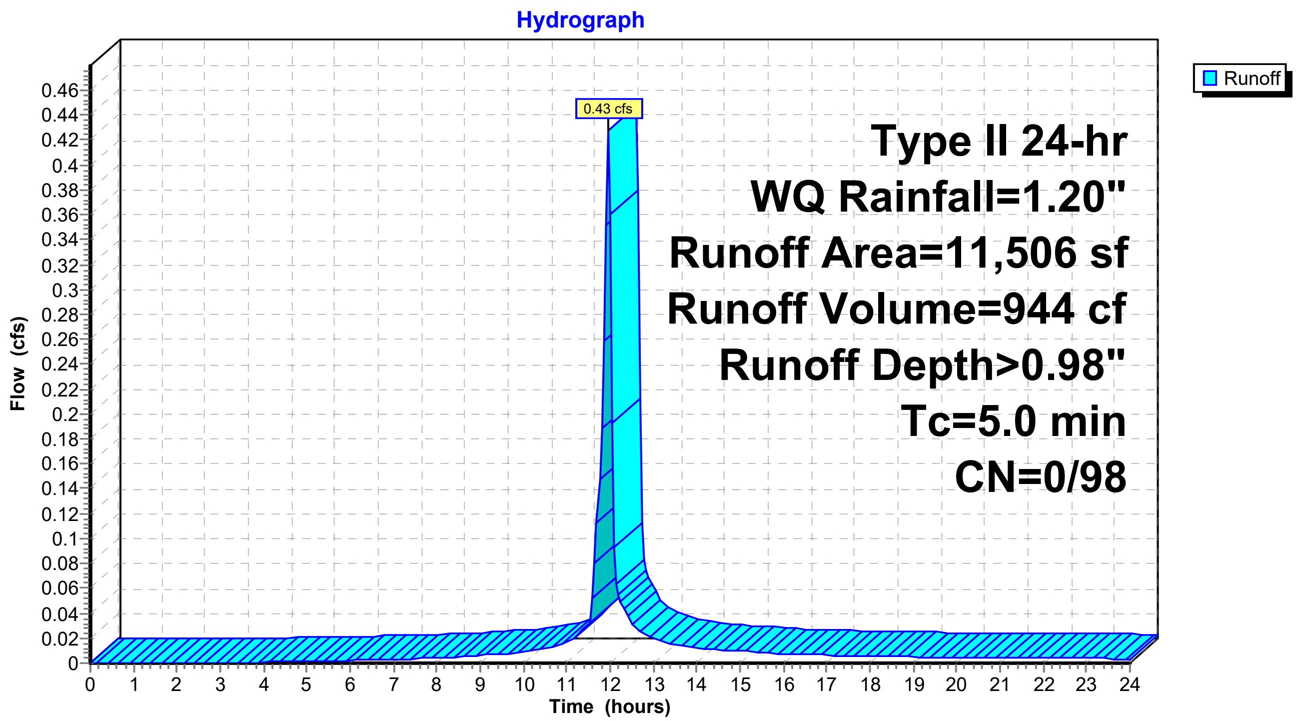
Runoff = 0.43 cfs @ 11.95 hrs, Volume= 944 cf, Depth> 0.98"
Routed to Pond DMH12 :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
11,506	98	Roofs, HSG C
11,506	98	100.00% Impervious Area

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

Subcatchment 1IP: Subwatershed 1I



Summary for Subcatchment 1JP: Subwatershed 1J

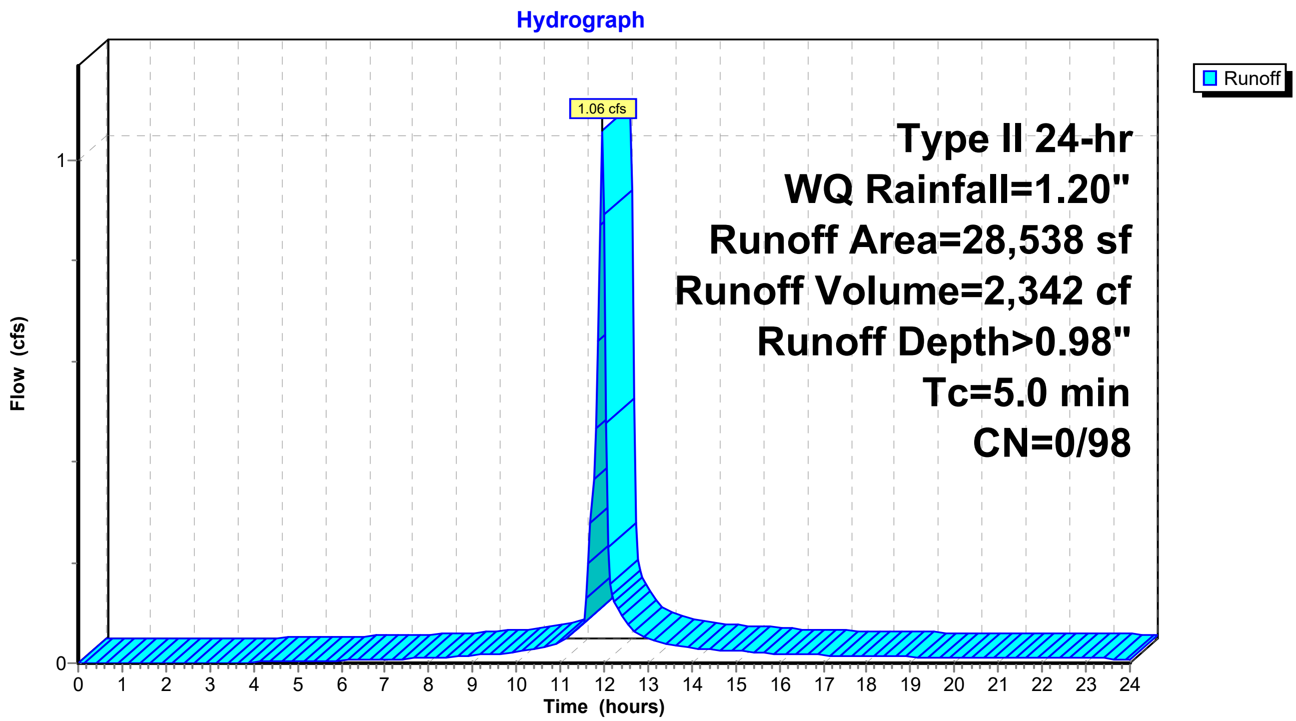
Runoff = 1.06 cfs @ 11.95 hrs, Volume= 2,342 cf, Depth> 0.98"
Routed to Pond DMH12 :

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
28,538	98	Roofs, HSG C
28,538	98	100.00% Impervious Area

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

Subcatchment 1JP: Subwatershed 1J



Summary for Subcatchment 1KP: Subwatershed 1K

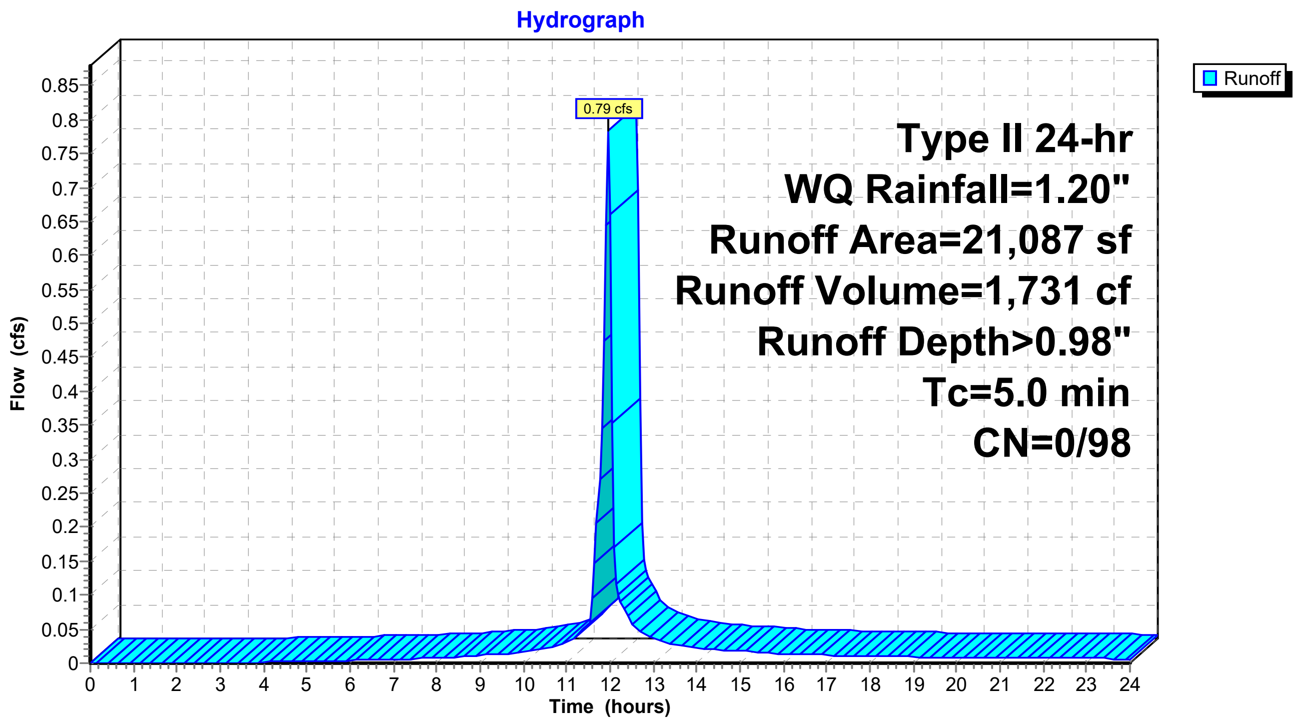
Runoff = 0.79 cfs @ 11.95 hrs, Volume= 1,731 cf, Depth> 0.98"
Routed to Pond TF3 : Tree Filter 3

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
21,087	98	Roofs, HSG C
21,087	98	100.00% Impervious Area

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

Subcatchment 1KP: Subwatershed 1K



Summary for Subcatchment 2AP: Subwatershed 2A

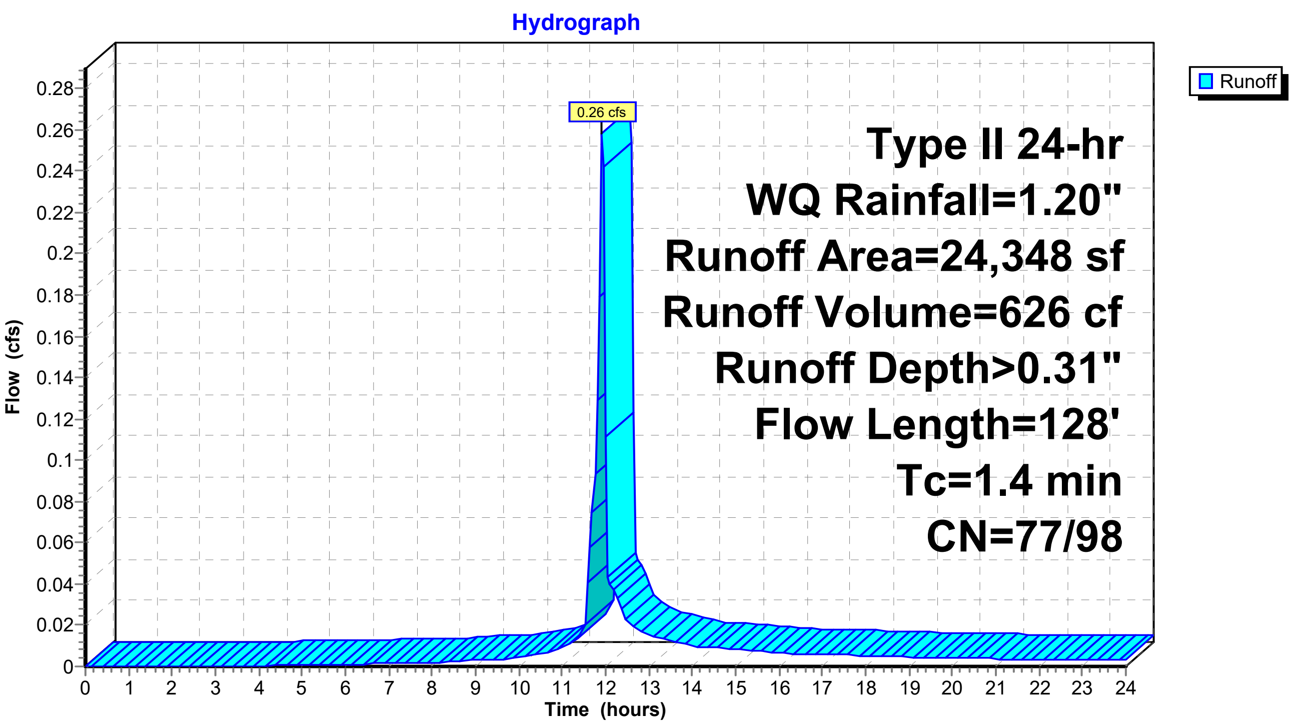
Runoff = 0.26 cfs @ 11.92 hrs, Volume= 626 cf, Depth> 0.31"
Routed to Link POA 2 : POA2

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
16,377	74	>75% Grass cover, Good, HSG C
2,266	96	Gravel surface, HSG C
838	98	Roofs, HSG C
4,867	98	Paved parking, HSG C
24,348	82	Weighted Average
18,643	77	76.57% Pervious Area
5,705	98	23.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	42	0.0100	0.89		**Sheet Flow, Walkway** Smooth surfaces n= 0.011 P2= 3.30"
0.6	86	0.0050	2.45	0.85	**Pipe Channel,** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.013 Corrugated PE, smooth interior
1.4	128	Total			

Subcatchment 2AP: Subwatershed 2A



Summary for Subcatchment 2BP: Subwatershed 2B

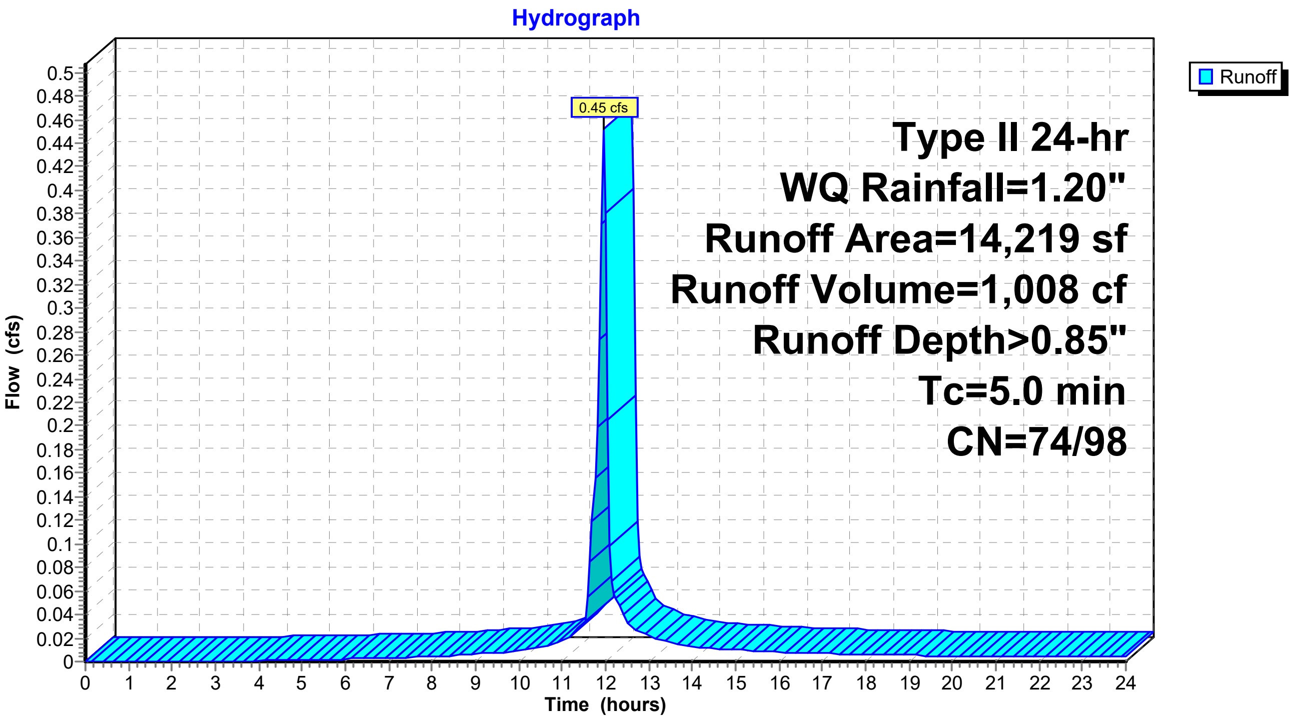
Runoff = 0.45 cfs @ 11.95 hrs, Volume= 1,008 cf, Depth> 0.85"
Routed to Link POA 2 : POA2

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
12,154	98	Roofs, HSG C
2,065	74	>75% Grass cover, Good, HSG C
14,219	95	Weighted Average
2,065	74	14.52% Pervious Area
12,154	98	85.48% Impervious Area

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

Subcatchment 2BP: Subwatershed 2B



Summary for Subcatchment 3AP: Subwatershed 3A

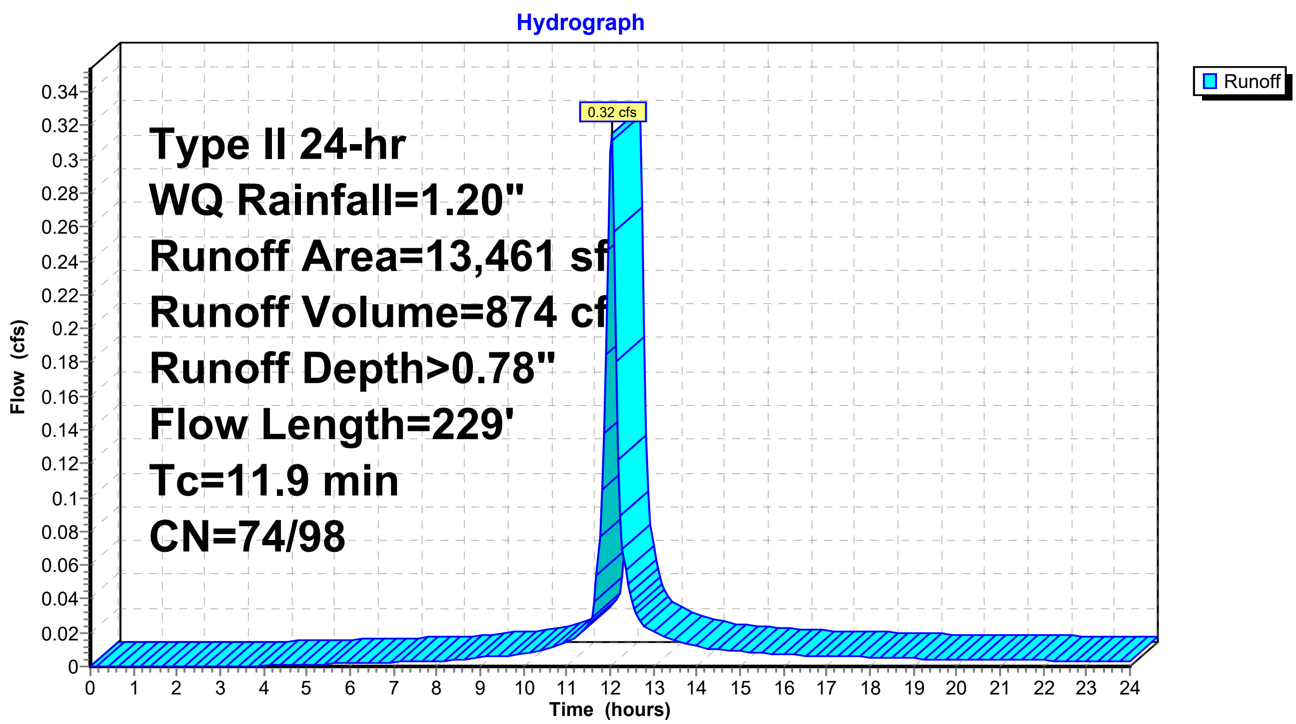
Runoff = 0.32 cfs @ 12.03 hrs, Volume= 874 cf, Depth> 0.78"
Routed to Link POA 3 : POA3

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
10,375	98	Paved parking, HSG C
2,980	74	>75% Grass cover, Good, HSG C
106	98	Roofs, HSG C
13,461	93	Weighted Average
2,980	74	22.14% Pervious Area
10,481	98	77.86% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.2	76	0.0100	0.12		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.30"
0.8	98	0.0100	2.03		**Shallow Concentrated Flow, Paved Parking Lot** Paved Kv= 20.3 fps
0.9	55	0.0050	1.06		**Shallow Concentrated Flow, Dry Swale** Grassed Waterway Kv= 15.0 fps
11.9	229	Total			

Subcatchment 3AP: Subwatershed 3A



Summary for Subcatchment 4AP: Subwatershed 1H

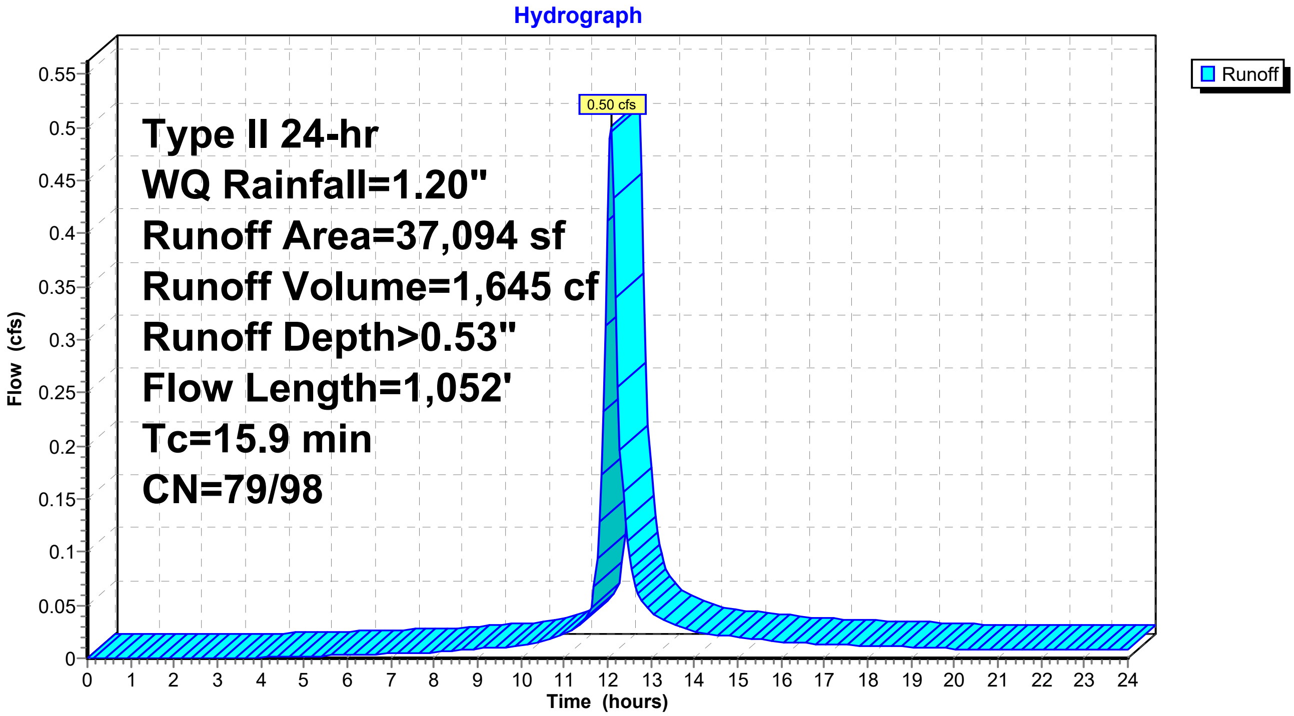
Runoff = 0.50 cfs @ 12.08 hrs, Volume= 1,645 cf, Depth> 0.53"
Routed to Link POA 4 : POA4

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr WQ Rainfall=1.20"

Area (sf)	CN	Description
4,399	98	Roofs, HSG C
13,015	98	Paved parking, HSG C
19,680	79	50-75% Grass cover, Fair, HSG C
37,094	88	Weighted Average
19,680	79	53.05% Pervious Area
17,414	98	46.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.92		**Sheet Flow, Driveway** Smooth surfaces n= 0.011 P2= 3.30"
5.5	50	0.0200	0.15		**Sheet Flow, Grass** Grass: Short n= 0.150 P2= 3.30"
3.9	230	0.0200	0.99		**Shallow Concentrated Flow, Grass** Short Grass Pasture Kv= 7.0 fps
0.4	75	0.0300	3.52		**Shallow Concentrated Flow, Paved Driveway** Paved Kv= 20.3 fps
4.3	383	0.0054	1.49		**Shallow Concentrated Flow, Thames Street** Paved Kv= 20.3 fps
0.9	264	0.0050	4.77	18.98	**Pipe Channel, Storm Drain** 27.0" Round Area= 4.0 sf Perim= 7.1' r= 0.56' n= 0.015 Concrete sewer w/manholes & inlets
15.9	1,052	Total			

Subcatchment 4AP: Subwatershed 1H



Summary for Pond CB2:

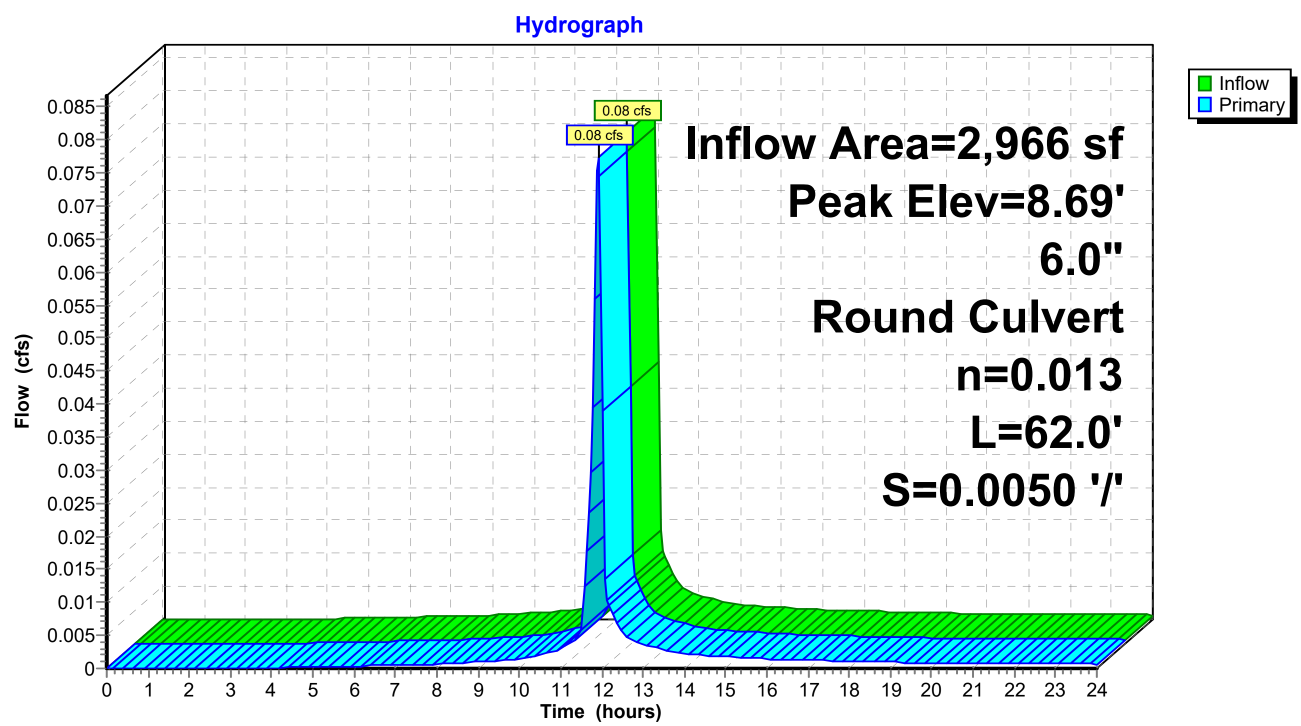
Inflow Area = 2,966 sf, 64.16% Impervious, Inflow Depth > 0.68" for WQ event
Inflow = 0.08 cfs @ 11.92 hrs, Volume= 168 cf
Outflow = 0.08 cfs @ 11.92 hrs, Volume= 168 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.08 cfs @ 11.92 hrs, Volume= 168 cf
Routed to Pond DMH1 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 8.69' @ 11.92 hrs
Flood Elev= 10.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	8.49'	**6.0" Round Culvert** L= 62.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 8.49' / 8.18' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf

Primary OutFlow Max=0.07 cfs @ 11.92 hrs HW=8.69' (Free Discharge)
1=Culvert (Barrel Controls 0.07 cfs @ 1.54 fps)

Pond CB2:



Summary for Pond CB4:

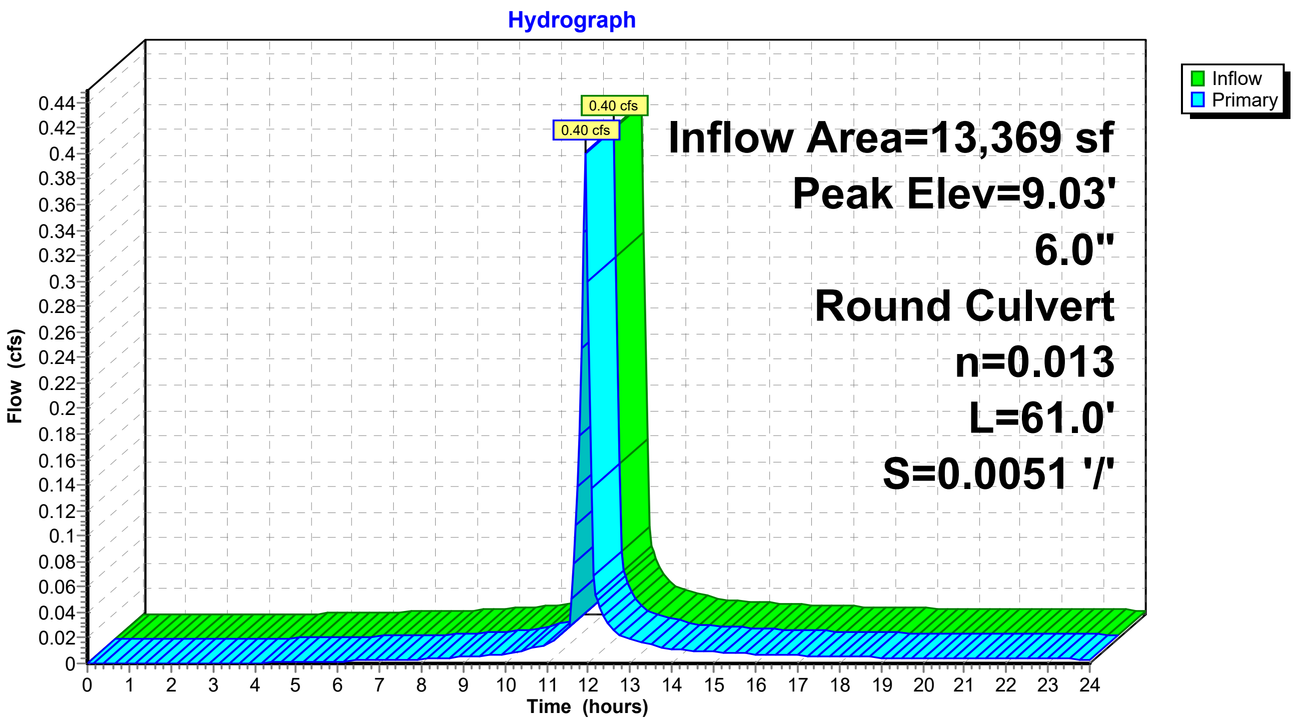
Inflow Area = 13,369 sf, 75.91% Impervious, Inflow Depth > 0.78" for WQ event
Inflow = 0.40 cfs @ 11.94 hrs, Volume= 869 cf
Outflow = 0.40 cfs @ 11.94 hrs, Volume= 869 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.40 cfs @ 11.94 hrs, Volume= 869 cf
Routed to Pond DMH1 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 9.03' @ 11.94 hrs
Flood Elev= 12.75'

Device	Routing	Invert	Outlet Devices
#1	Primary	8.49'	**6.0" Round Culvert** L= 61.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 8.49' / 8.18' S= 0.0051 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf

Primary OutFlow Max=0.39 cfs @ 11.94 hrs HW=9.02' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.39 cfs @ 2.34 fps)

Pond CB4:



Summary for Pond CB5:

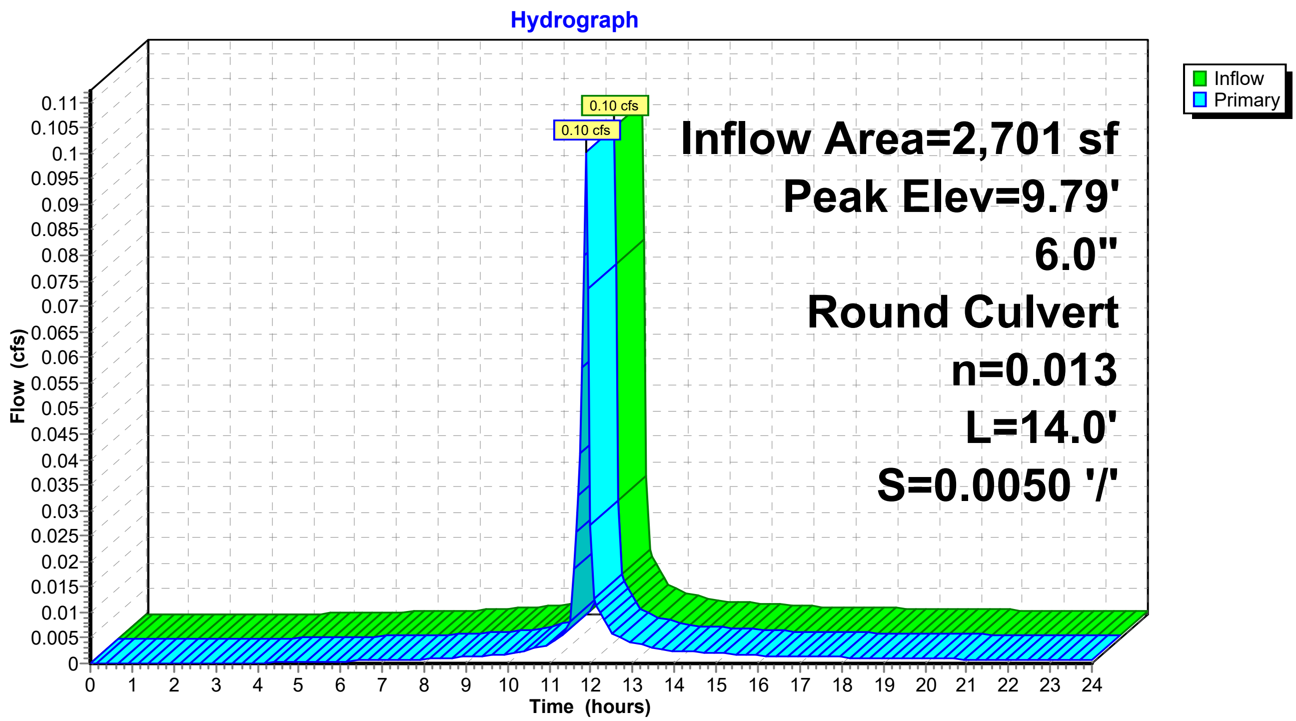
Inflow Area = 2,701 sf, 89.12% Impervious, Inflow Depth > 0.89" for WQ event
Inflow = 0.10 cfs @ 11.90 hrs, Volume= 201 cf
Outflow = 0.10 cfs @ 11.90 hrs, Volume= 201 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.10 cfs @ 11.90 hrs, Volume= 201 cf
Routed to Pond DMH9 : Diversion Structure

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 9.79' @ 11.90 hrs
Flood Elev= 12.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	9.56'	**6.0" Round Culvert** L= 14.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 9.56' / 9.49' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf

Primary OutFlow Max=0.10 cfs @ 11.90 hrs HW=9.79' (Free Discharge)
1=Culvert (Barrel Controls 0.10 cfs @ 1.63 fps)

Pond CB5:



Summary for Pond CB6:

Inflow Area =	29,122 sf,	59.07% Impervious,	Inflow Depth > 0.64"	for WQ event		
Inflow =	0.63 cfs @	11.99 hrs,	Volume=	1,544 cf		
Outflow =	0.63 cfs @	11.99 hrs,	Volume=	1,544 cf,	Atten= 0%,	Lag= 0.0 min
Primary =	0.63 cfs @	11.99 hrs,	Volume=	1,544 cf		

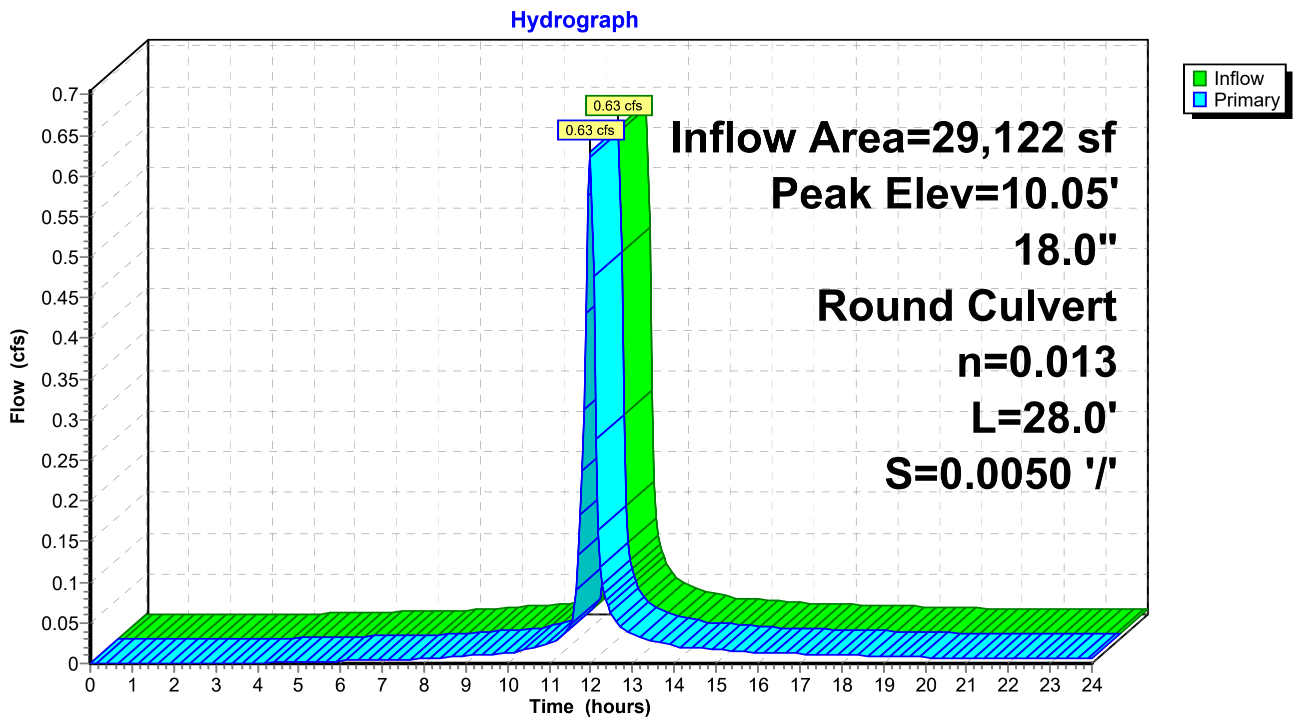
Routed to Pond DMH9 : Diversion Structure

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 10.05' @ 11.99 hrs
Flood Elev= 12.17'

Device	Routing	Invert	Outlet Devices
#1	Primary	9.63'	**18.0" Round Culvert** L= 28.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 9.63' / 9.49' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=0.61 cfs @ 11.99 hrs HW=10.04' (Free Discharge)
↑**1=Culvert** (Barrel Controls 0.61 cfs @ 2.35 fps)

Pond CB6:



Summary for Pond DMH1:

Inflow Area = 16,335 sf, 73.78% Impervious, Inflow Depth > 0.76" for WQ event
Inflow = 0.48 cfs @ 11.94 hrs, Volume= 1,037 cf
Outflow = 0.48 cfs @ 11.94 hrs, Volume= 1,037 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.48 cfs @ 11.94 hrs, Volume= 1,037 cf
Routed to Pond OWS1 :
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond DMH5 :

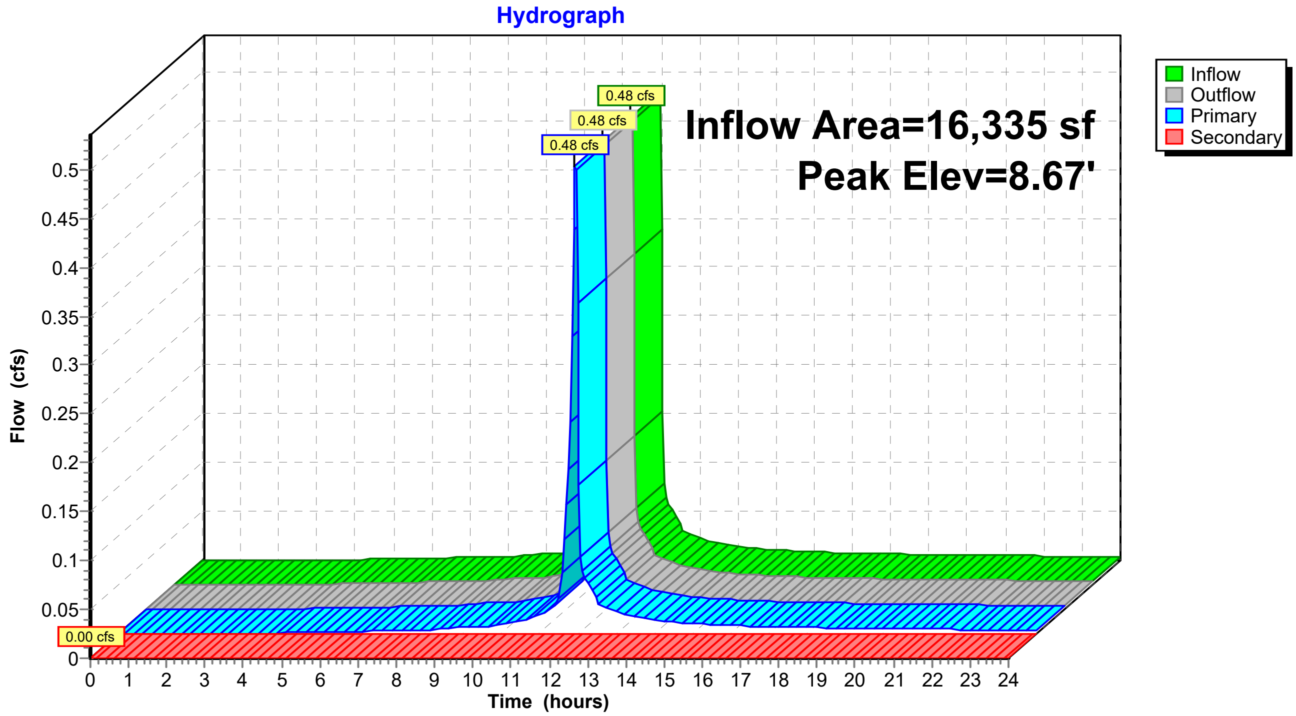
Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 8.67' @ 11.94 hrs
Flood Elev= 8.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	8.17'	**8.0" Round Culvert** L= 3.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 8.17' / 8.15' S= 0.0067 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf
#2	Secondary	8.96'	**12.0" Round Culvert** L= 66.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 8.96' / 5.66' S= 0.0500 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.46 cfs @ 11.94 hrs HW=8.66' (Free Discharge)
└─**1=Culvert** (Barrel Controls 0.46 cfs @ 2.36 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=8.17' (Free Discharge)
└─**2=Culvert** (Controls 0.00 cfs)

Pond DMH1:


Hydrograph
Inflow
Outflow
Primary
Secondary
0.48 cfs
0.48 cfs
0.48 cfs
0.00 cfs
Inflow Area=16,335 sf
Peak Elev=8.67'
Flow (cfs)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (hours)

Summary for Pond DMH10:

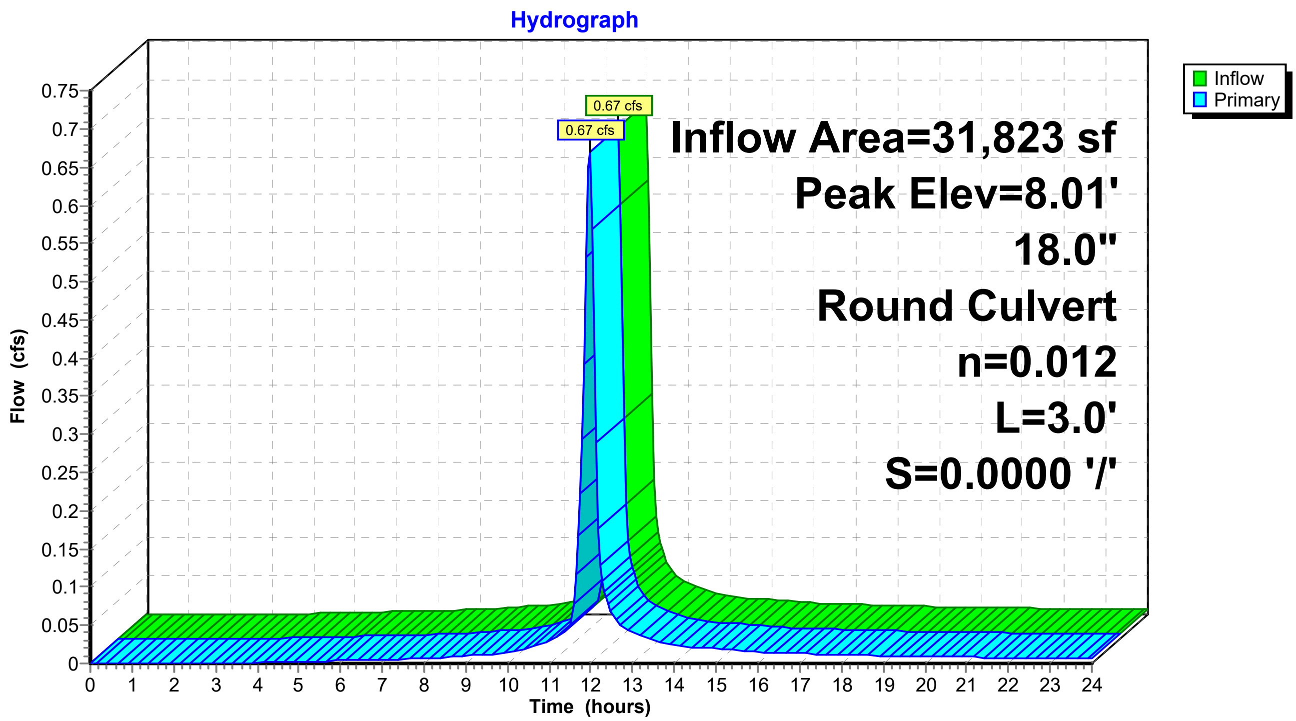
Inflow Area = 31,823 sf, 61.62% Impervious, Inflow Depth > 0.66" for WQ event
Inflow = 0.67 cfs @ 11.98 hrs, Volume= 1,745 cf
Outflow = 0.67 cfs @ 11.98 hrs, Volume= 1,745 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.67 cfs @ 11.98 hrs, Volume= 1,745 cf
Routed to Pond SF2 : Subsurface Filtration System 2

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 8.01' @ 11.98 hrs
Flood Elev= 12.80'

Device	Routing	Invert	Outlet Devices
#1	Primary	7.55'	**18.0" Round Culvert** L= 3.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 7.55' / 7.55' S= 0.0000 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=0.65 cfs @ 11.98 hrs HW=8.01' (Free Discharge)
1=Culvert (Barrel Controls 0.65 cfs @ 2.14 fps)

Pond DMH10:



Summary for Pond DMH11:

Inflow Area =	31,823 sf,	61.62% Impervious,	Inflow Depth > 0.65"	for WQ event	
Inflow =	0.37 cfs @	12.08 hrs,	Volume=	1,732 cf	
Outflow =	0.37 cfs @	12.08 hrs,	Volume=	1,732 cf,	Atten= 0%, Lag= 0.0 min
Primary =	0.37 cfs @	12.08 hrs,	Volume=	1,732 cf	

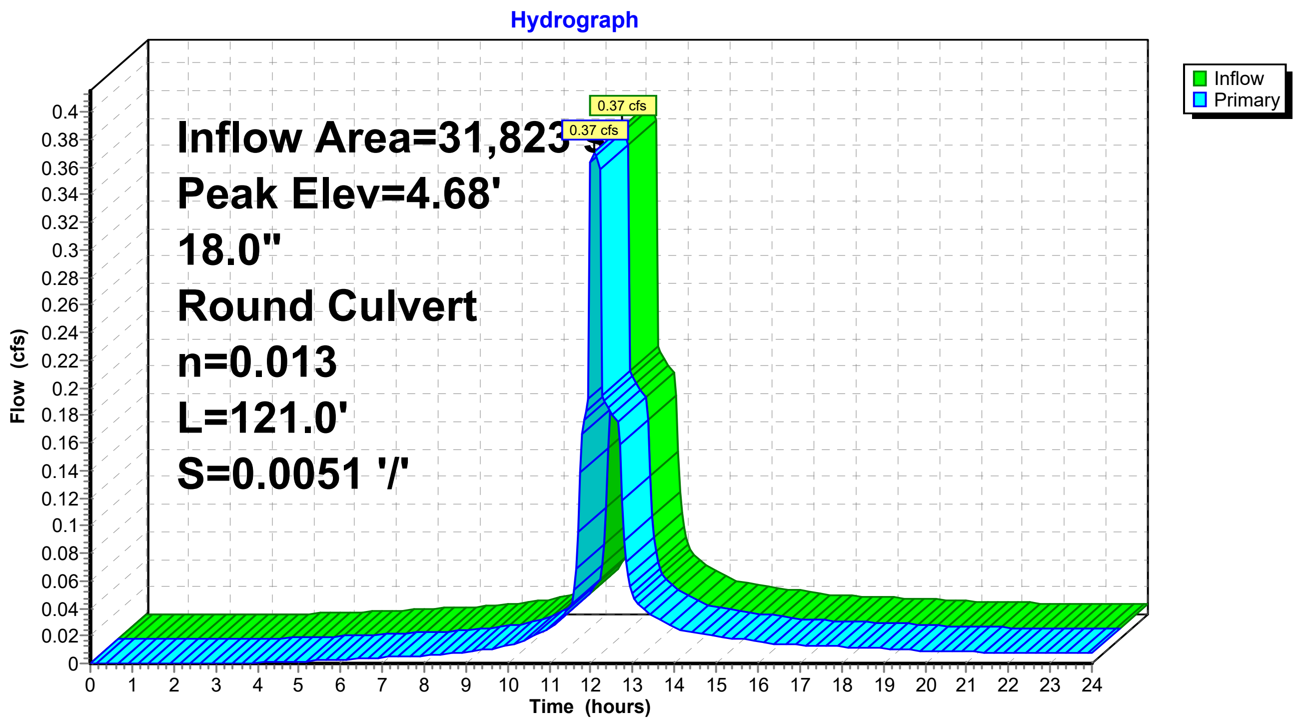
Routed to Pond DMH12 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 4.68' @ 12.08 hrs
Flood Elev= 12.85'

Device	Routing	Invert	Outlet Devices
#1	Primary	4.38'	**18.0" Round Culvert** L= 121.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 4.38' / 3.76' S= 0.0051 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=0.36 cfs @ 12.08 hrs HW=4.68' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.36 cfs @ 2.15 fps)

Pond DMH11:



Summary for Pond DMH12:

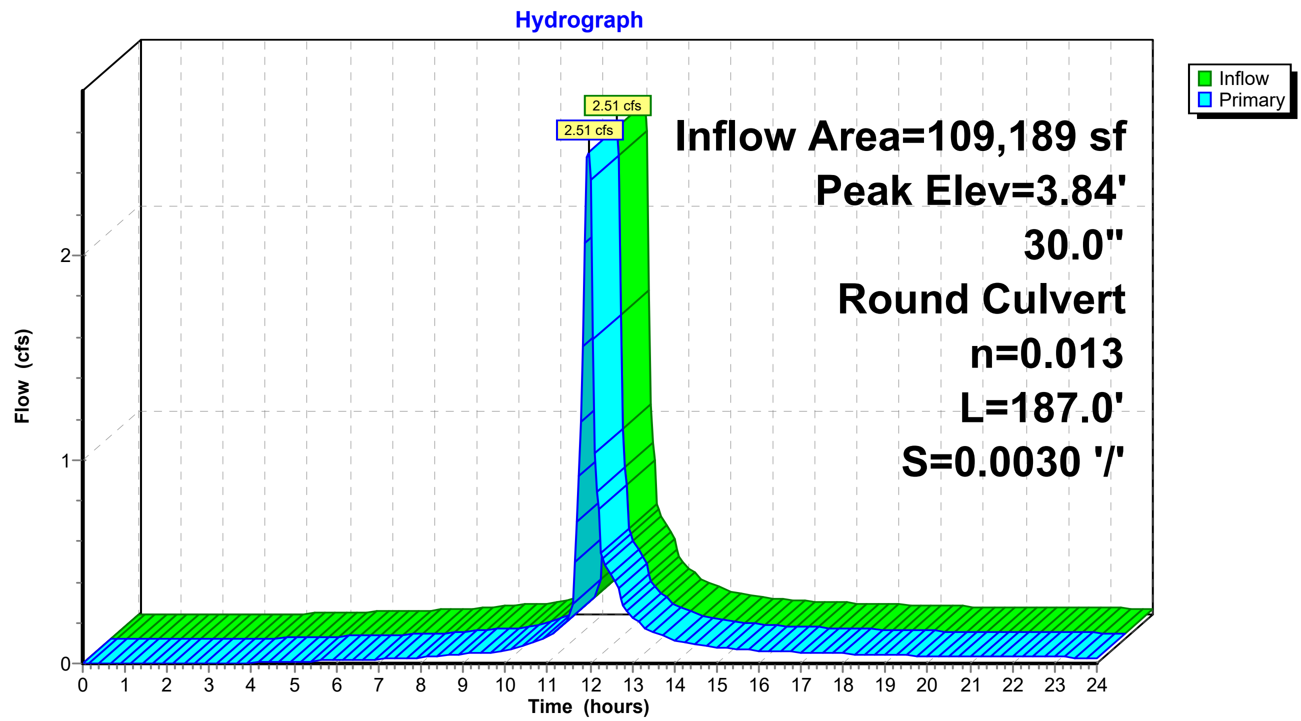
Inflow Area = 109,189 sf, 82.69% Impervious, Inflow Depth > 0.83" for WQ event
Inflow = 2.51 cfs @ 11.96 hrs, Volume= 7,596 cf
Outflow = 2.51 cfs @ 11.96 hrs, Volume= 7,596 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.51 cfs @ 11.96 hrs, Volume= 7,596 cf
Routed to Pond DMH13 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 3.84' @ 11.96 hrs
Flood Elev= 8.85'

Device	Routing	Invert	Outlet Devices
#1	Primary	3.08'	**30.0" Round Culvert** L= 187.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3.08' / 2.52' S= 0.0030 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=2.45 cfs @ 11.96 hrs HW=3.83' (Free Discharge)
└**1=Culvert** (Barrel Controls 2.45 cfs @ 2.96 fps)

Pond DMH12:



Summary for Pond DMH13:

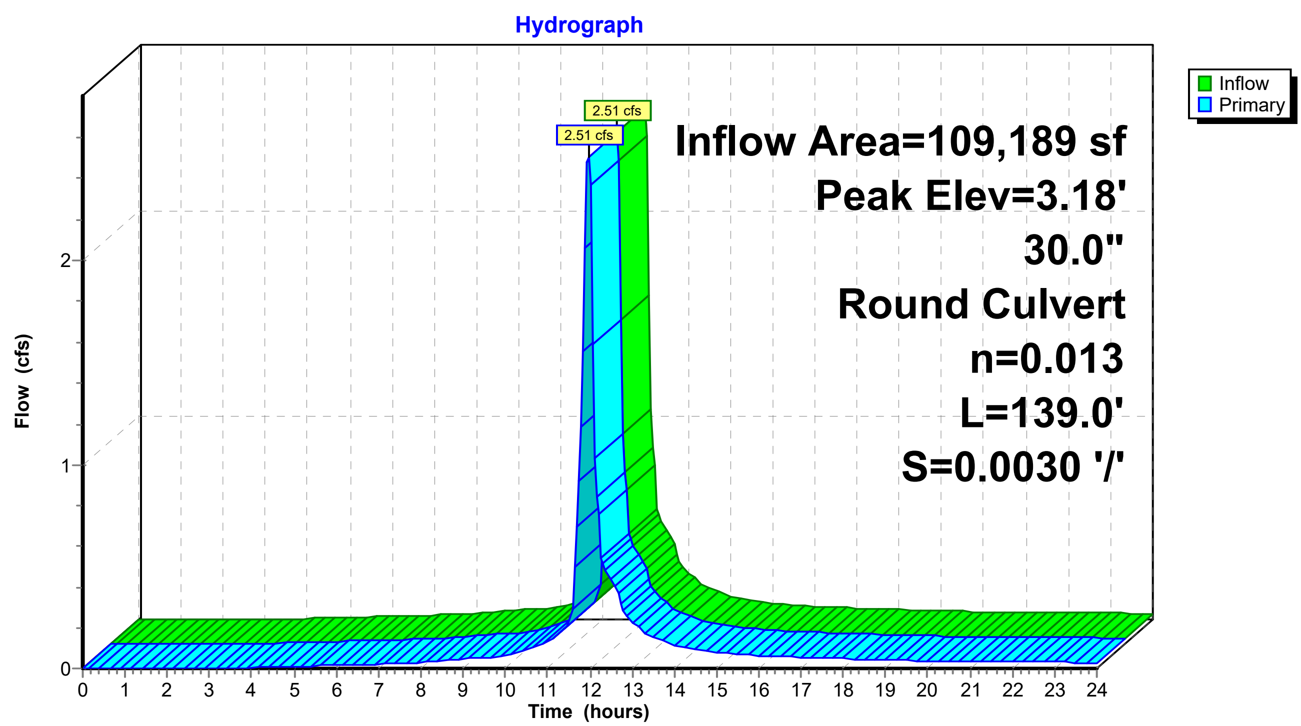
Inflow Area = 109,189 sf, 82.69% Impervious, Inflow Depth > 0.83" for WQ event
Inflow = 2.51 cfs @ 11.96 hrs, Volume= 7,596 cf
Outflow = 2.51 cfs @ 11.96 hrs, Volume= 7,596 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.51 cfs @ 11.96 hrs, Volume= 7,596 cf
Routed to Pond DMH14 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 3.18' @ 11.96 hrs
Flood Elev= 9.75'

Device	Routing	Invert	Outlet Devices
#1	Primary	2.42'	**30.0" Round Culvert** L= 139.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 2.42' / 2.00' S= 0.0030 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=2.45 cfs @ 11.96 hrs HW=3.17' (Free Discharge)
└─**1=Culvert** (Barrel Controls 2.45 cfs @ 2.96 fps)

Pond DMH13:



Summary for Pond DMH14:

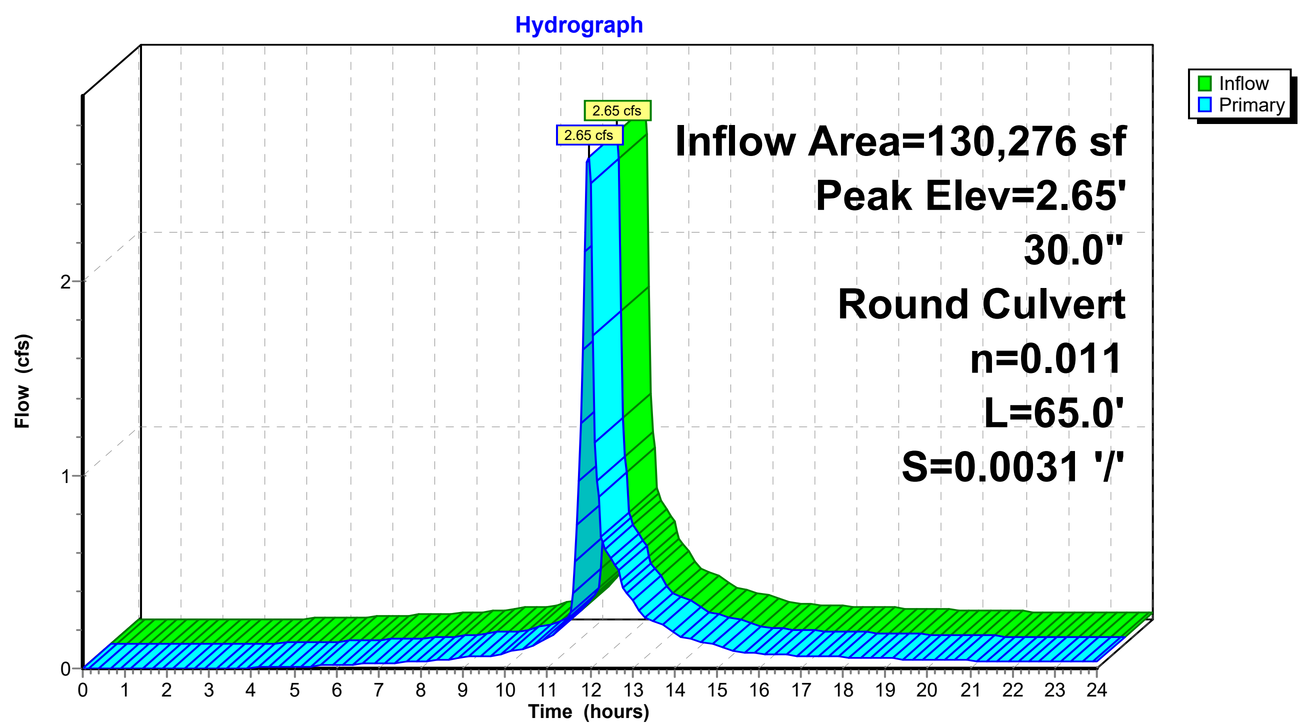
Inflow Area = 130,276 sf, 85.49% Impervious, Inflow Depth > 0.86" for WQ event
Inflow = 2.65 cfs @ 11.97 hrs, Volume= 9,308 cf
Outflow = 2.65 cfs @ 11.97 hrs, Volume= 9,308 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.65 cfs @ 11.97 hrs, Volume= 9,308 cf
Routed to Link POA 1 : POA 1 (Outfall)

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 2.65' @ 11.97 hrs
Flood Elev= 9.75'

Device	Routing	Invert	Outlet Devices
#1	Primary	1.90'	**30.0" Round Culvert** L= 65.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 1.90' / 1.70' S= 0.0031 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 4.91 sf

Primary OutFlow Max=2.58 cfs @ 11.97 hrs HW=2.64' (Free Discharge)
└─**1=Culvert** (Barrel Controls 2.58 cfs @ 3.15 fps)

Pond DMH14:



Summary for Pond DMH2:

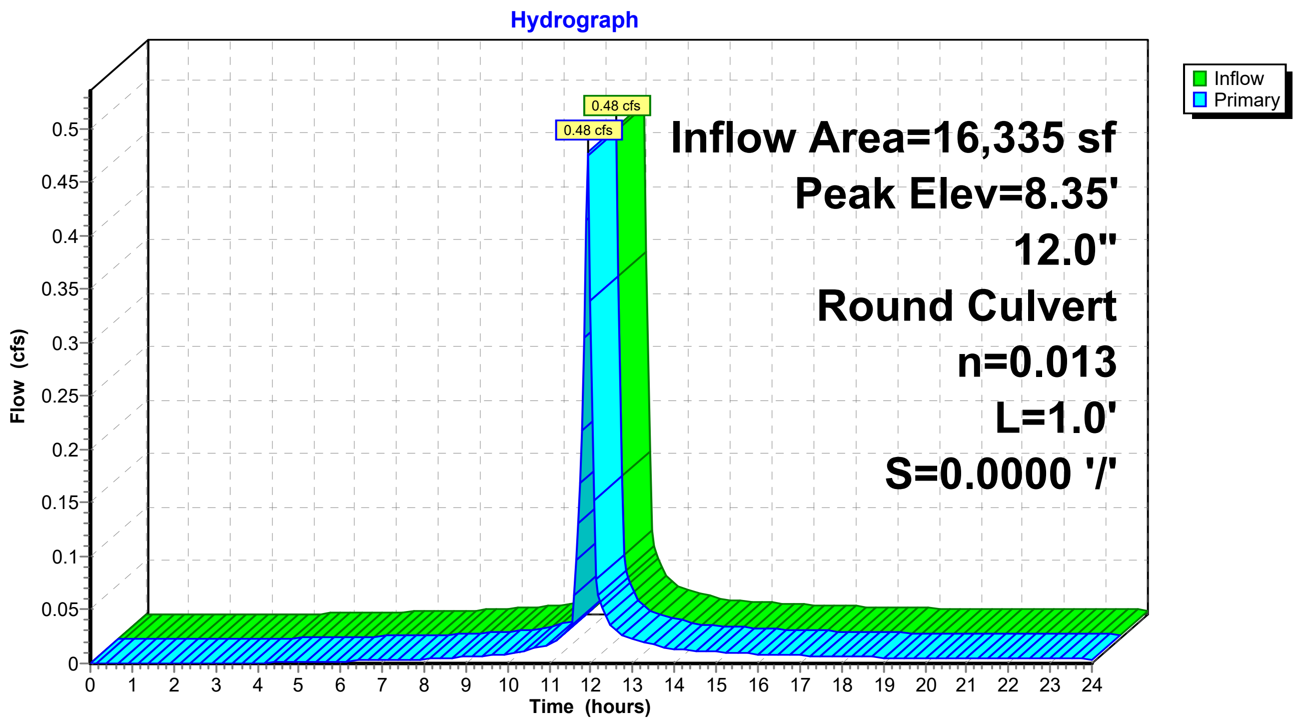
Inflow Area = 16,335 sf, 73.78% Impervious, Inflow Depth > 0.76" for WQ event
Inflow = 0.48 cfs @ 11.94 hrs, Volume= 1,037 cf
Outflow = 0.48 cfs @ 11.94 hrs, Volume= 1,037 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.48 cfs @ 11.94 hrs, Volume= 1,037 cf
Routed to Pond SF1 : Subsurface Filtration System 1

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 8.35' @ 11.94 hrs
Flood Elev= 8.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	7.91'	**12.0" Round Culvert** L= 1.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 7.91' / 7.91' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.46 cfs @ 11.94 hrs HW=8.34' (Free Discharge)
└─**1=Culvert** (Barrel Controls 0.46 cfs @ 2.11 fps)

Pond DMH2:



Summary for Pond DMH3:

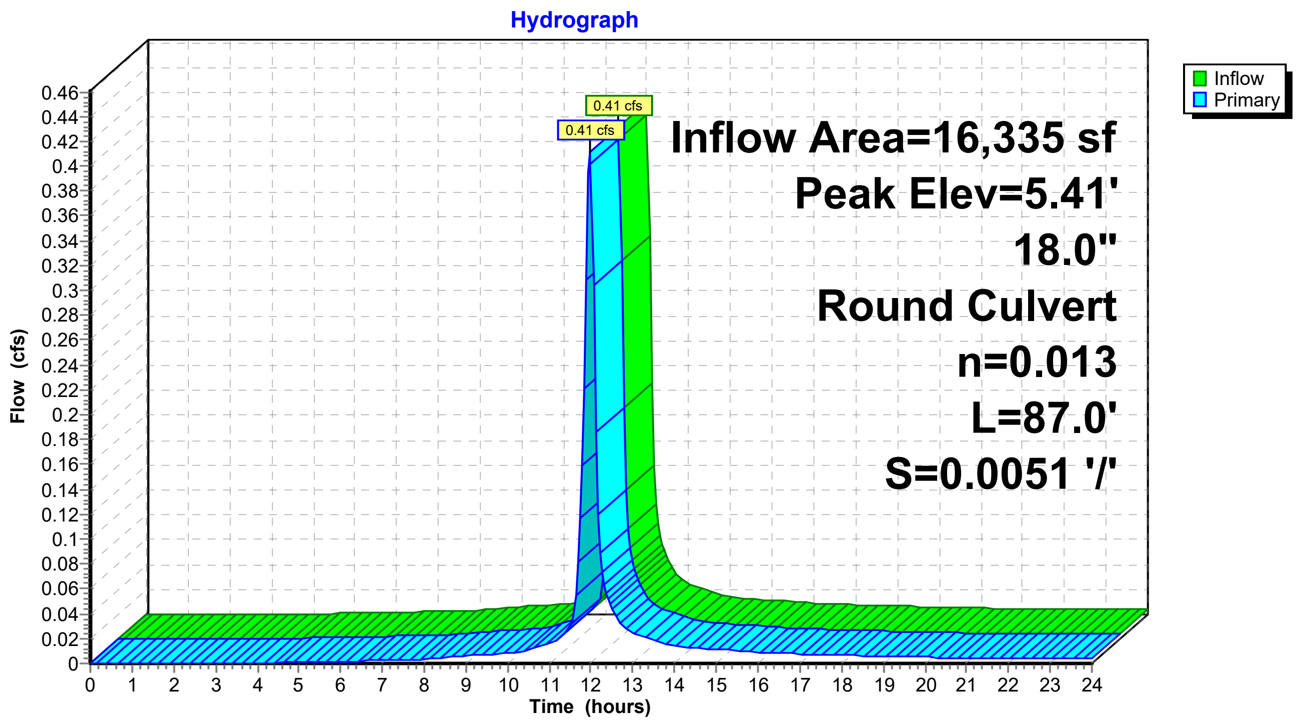
Inflow Area = 16,335 sf, 73.78% Impervious, Inflow Depth > 0.76" for WQ event
Inflow = 0.41 cfs @ 11.98 hrs, Volume= 1,029 cf
Outflow = 0.41 cfs @ 11.98 hrs, Volume= 1,029 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.41 cfs @ 11.98 hrs, Volume= 1,029 cf
Routed to Pond DMH4 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 5.41' @ 11.98 hrs
Flood Elev= 10.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	5.09'	**18.0" Round Culvert** L= 87.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 5.09' / 4.65' S= 0.0051 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=0.40 cfs @ 11.98 hrs HW=5.41' (Free Discharge)
└─**1=Culvert** (Barrel Controls 0.40 cfs @ 2.18 fps)

Pond DMH3:



Summary for Pond DMH4:

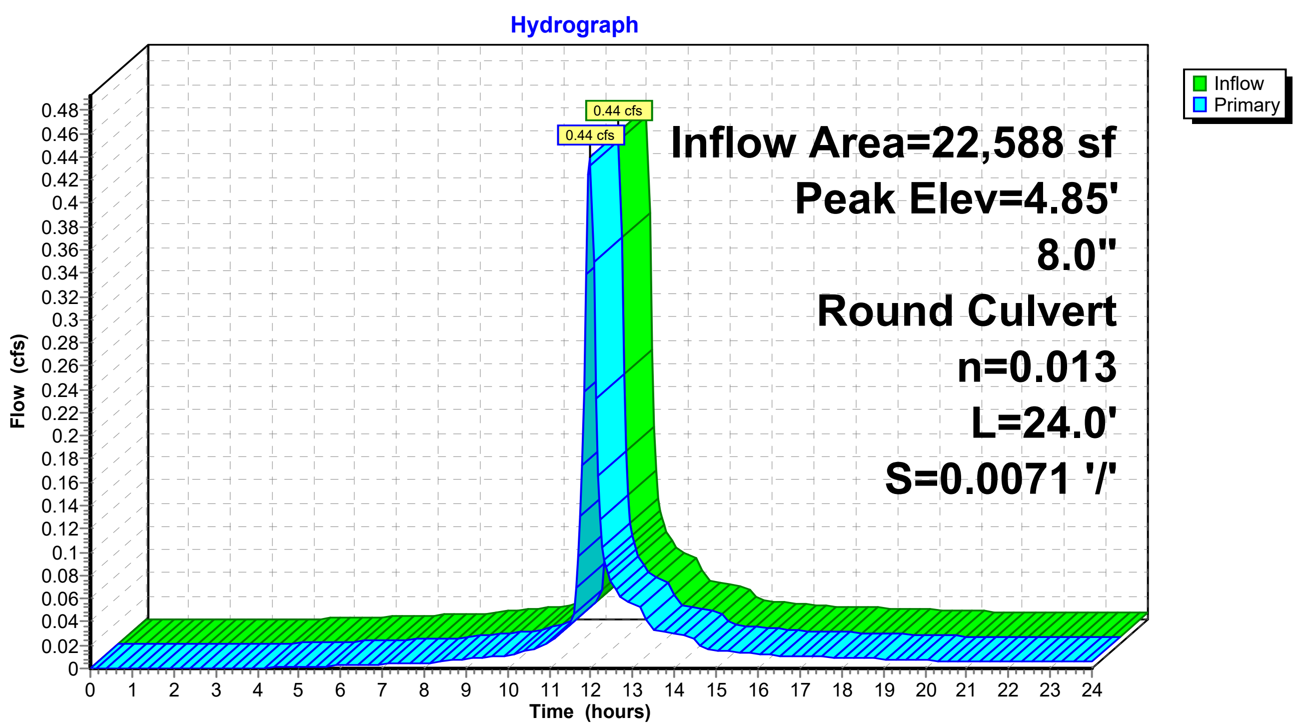
Inflow Area = 22,588 sf, 73.83% Impervious, Inflow Depth > 0.76" for WQ event
Inflow = 0.44 cfs @ 11.98 hrs, Volume= 1,425 cf
Outflow = 0.44 cfs @ 11.98 hrs, Volume= 1,425 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.44 cfs @ 11.98 hrs, Volume= 1,425 cf
Routed to Pond DMH7 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 4.85' @ 11.98 hrs
Flood Elev= 8.29'

Device	Routing	Invert	Outlet Devices
#1	Primary	4.41'	**8.0" Round Culvert** L= 24.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 4.41' / 4.24' S= 0.0071 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Primary OutFlow Max=0.43 cfs @ 11.98 hrs HW=4.84' (Free Discharge)
↑**1=Culvert** (Barrel Controls 0.43 cfs @ 2.52 fps)

Pond DMH4:



Summary for Pond DMH5:

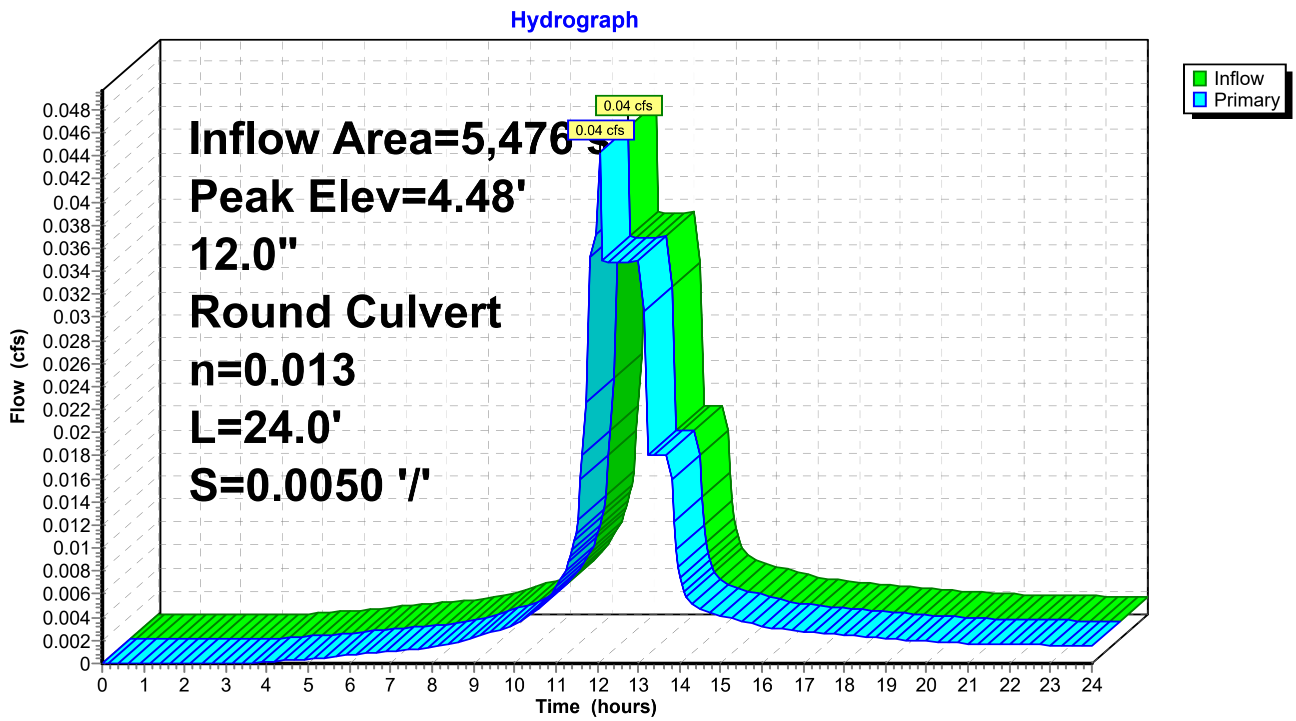
Inflow Area = 5,476 sf, 85.87% Impervious, Inflow Depth > 0.86" for WQ event
Inflow = 0.04 cfs @ 12.05 hrs, Volume= 392 cf
Outflow = 0.04 cfs @ 12.05 hrs, Volume= 392 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.04 cfs @ 12.05 hrs, Volume= 392 cf
Routed to Pond DMH7 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 4.48' @ 12.05 hrs
Flood Elev= 9.42'

Device	Routing	Invert	Outlet Devices
#1	Primary	4.36'	**12.0" Round Culvert** L= 24.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 4.36' / 4.24' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.04 cfs @ 12.05 hrs HW=4.48' (Free Discharge)
└─**1=Culvert** (Barrel Controls 0.04 cfs @ 1.19 fps)

Pond DMH5:



Summary for Pond DMH6:

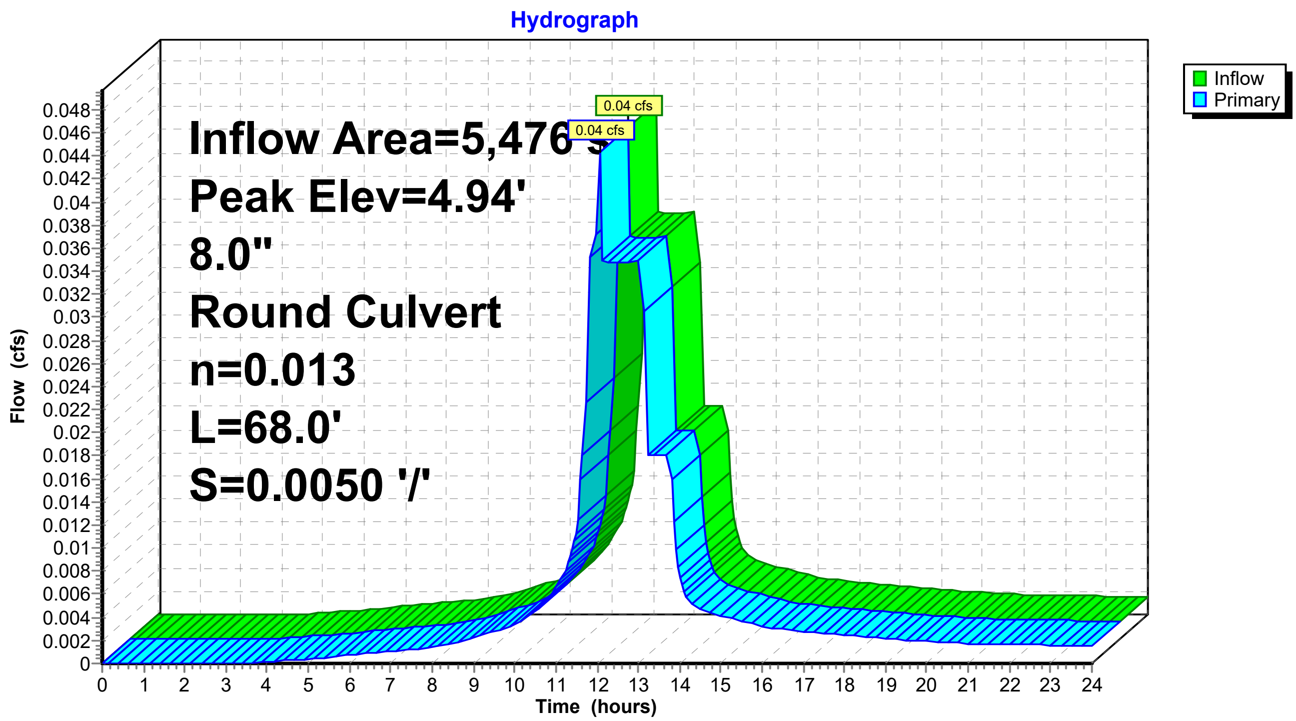
Inflow Area = 5,476 sf, 85.87% Impervious, Inflow Depth > 0.86" for WQ event
Inflow = 0.04 cfs @ 12.05 hrs, Volume= 392 cf
Outflow = 0.04 cfs @ 12.05 hrs, Volume= 392 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.04 cfs @ 12.05 hrs, Volume= 392 cf
Routed to Pond DMH5 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 4.94' @ 12.05 hrs
Flood Elev= 9.42'

Device	Routing	Invert	Outlet Devices
#1	Primary	4.80'	**8.0" Round Culvert** L= 68.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 4.80' / 4.46' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Primary OutFlow Max=0.04 cfs @ 12.05 hrs HW=4.94' (Free Discharge)
1=Culvert (Barrel Controls 0.04 cfs @ 1.28 fps)

Pond DMH6:



Summary for Pond DMH7:

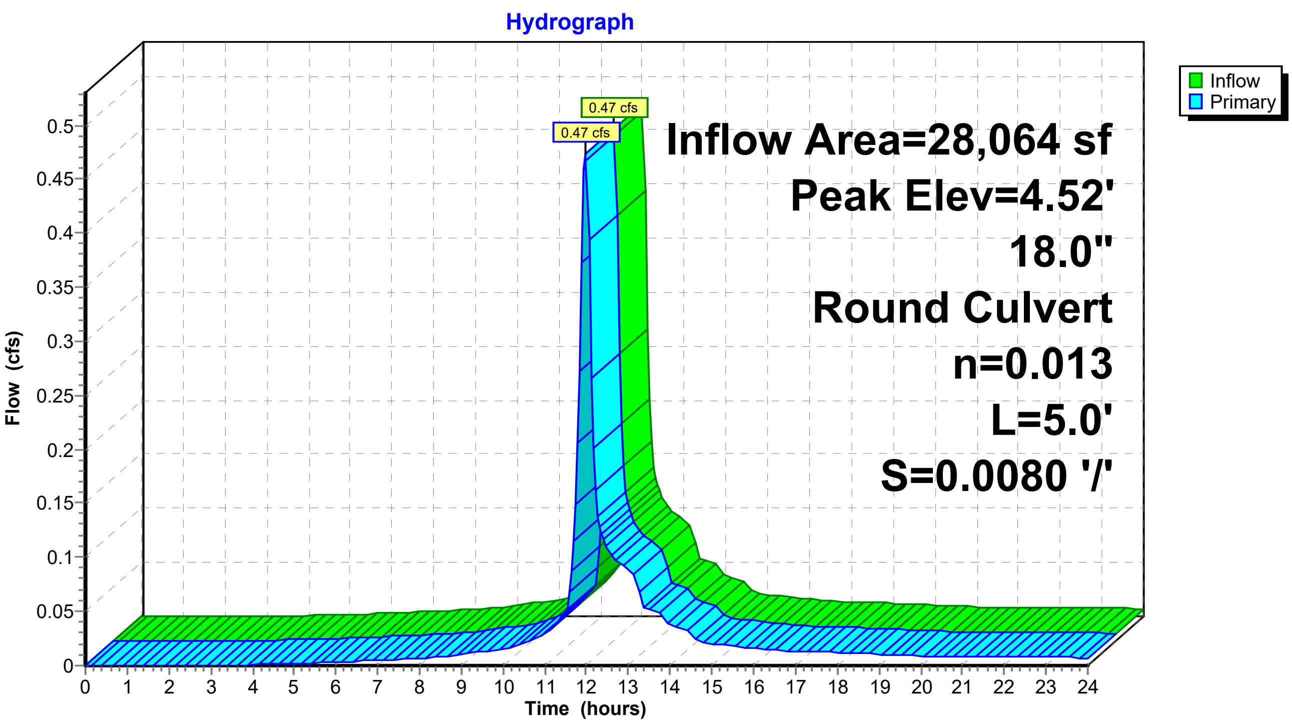
Inflow Area = 28,064 sf, 76.18% Impervious, Inflow Depth > 0.78" for WQ event
Inflow = 0.47 cfs @ 11.98 hrs, Volume= 1,817 cf
Outflow = 0.47 cfs @ 11.98 hrs, Volume= 1,817 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.47 cfs @ 11.98 hrs, Volume= 1,817 cf
Routed to Pond DMH8 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 4.52' @ 11.98 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	4.14'	**18.0" Round Culvert** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 4.14' / 4.10' S= 0.0080 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=0.46 cfs @ 11.98 hrs HW=4.52' (Free Discharge)
1=Culvert (Barrel Controls 0.46 cfs @ 2.00 fps)

Pond DMH7:



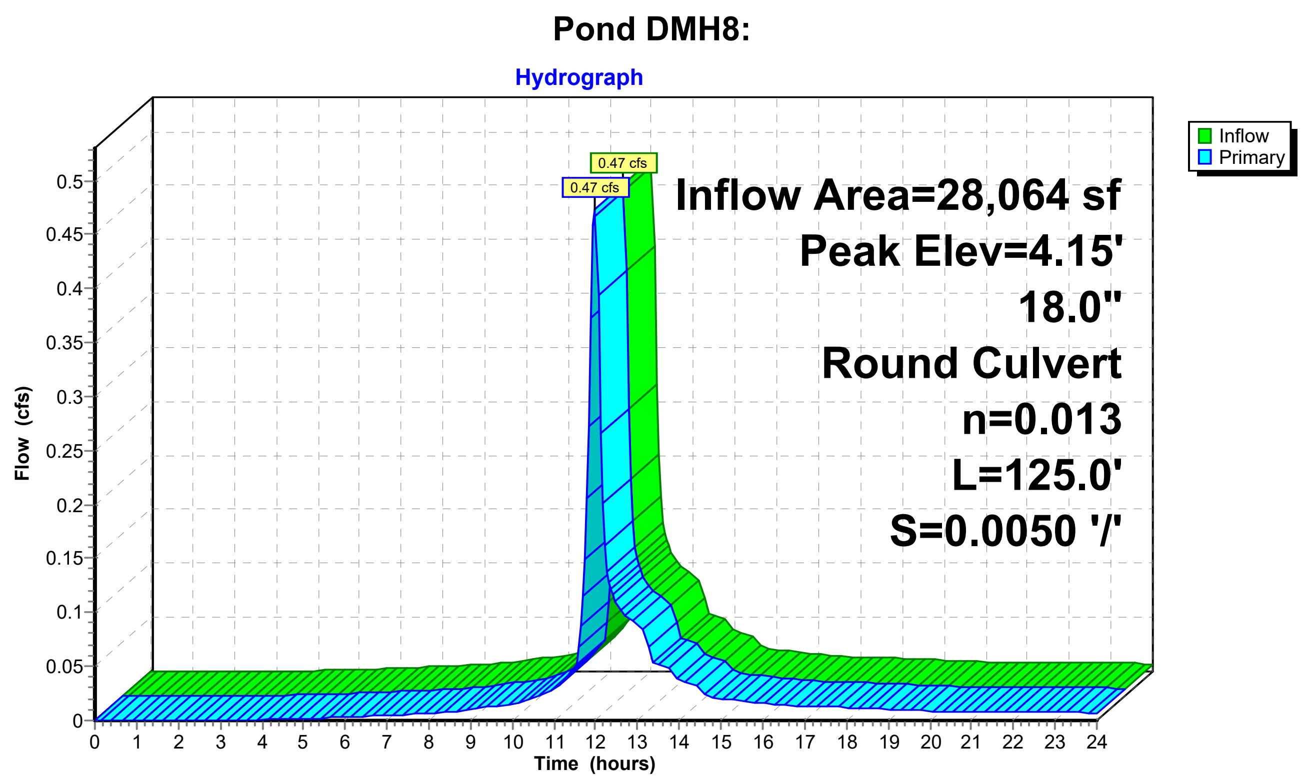
Summary for Pond DMH8:

Inflow Area = 28,064 sf, 76.18% Impervious, Inflow Depth > 0.78" for WQ event
Inflow = 0.47 cfs @ 11.98 hrs, Volume= 1,817 cf
Outflow = 0.47 cfs @ 11.98 hrs, Volume= 1,817 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.47 cfs @ 11.98 hrs, Volume= 1,817 cf
Routed to Pond DMH12 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 4.15' @ 11.98 hrs
Flood Elev= 8.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	3.80'	**18.0" Round Culvert** L= 125.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3.80' / 3.18' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=0.46 cfs @ 11.98 hrs HW=4.14' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.46 cfs @ 2.28 fps)



Summary for Pond DMH9: Diversion Structure

Inflow Area = 31,823 sf, 61.62% Impervious, Inflow Depth > 0.66" for WQ event
Inflow = 0.67 cfs @ 11.98 hrs, Volume= 1,745 cf
Outflow = 0.67 cfs @ 11.98 hrs, Volume= 1,745 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.67 cfs @ 11.98 hrs, Volume= 1,745 cf
Routed to Pond OWS2 :
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond DMH11 :

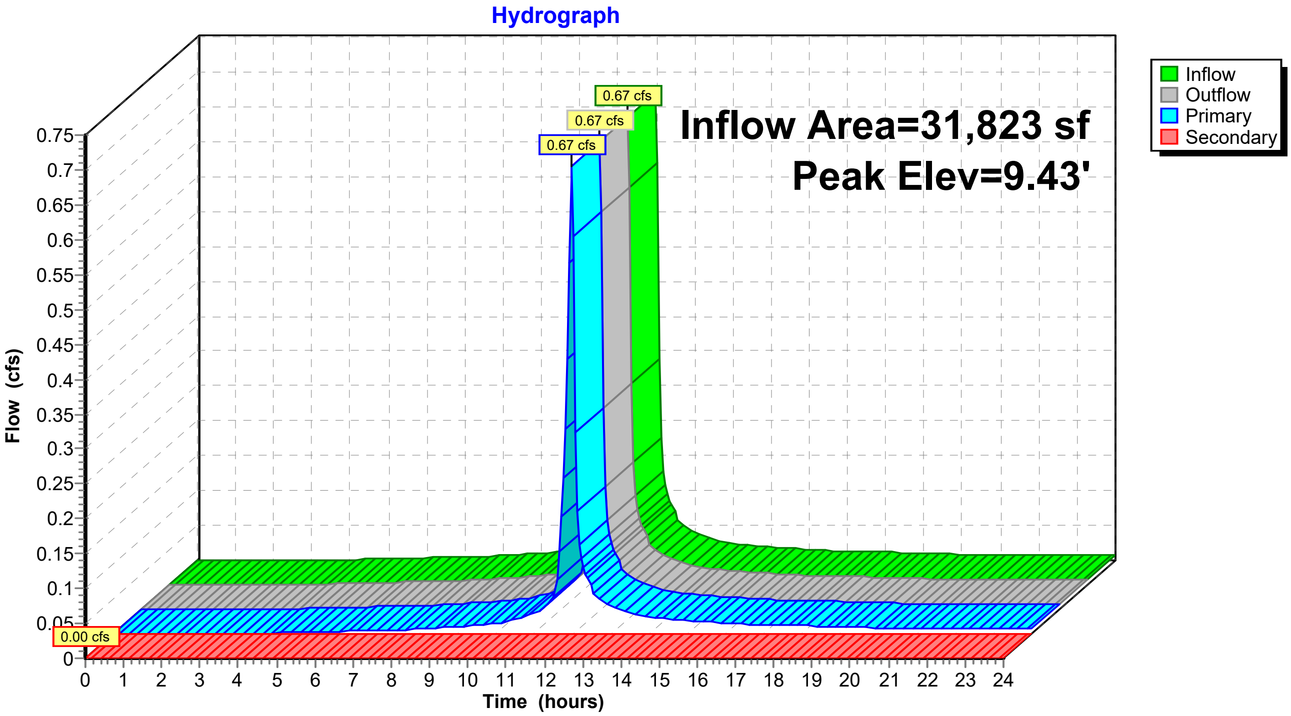
Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 9.43' @ 11.98 hrs
Flood Elev= 13.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	8.82'	**8.0" Round Culvert** L= 3.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 8.82' / 8.80' S= 0.0067 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf
#2	Secondary	9.49'	**18.0" Round DIVERSION** L= 14.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.49' / 8.09' S= 0.1000 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=0.65 cfs @ 11.98 hrs HW=9.42' (Free Discharge)
1=Culvert (Barrel Controls 0.65 cfs @ 2.59 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=8.82' (Free Discharge)
2=DIVERSION (Controls 0.00 cfs)

Pond DMH9: Diversion Structure



Summary for Pond OWS1:

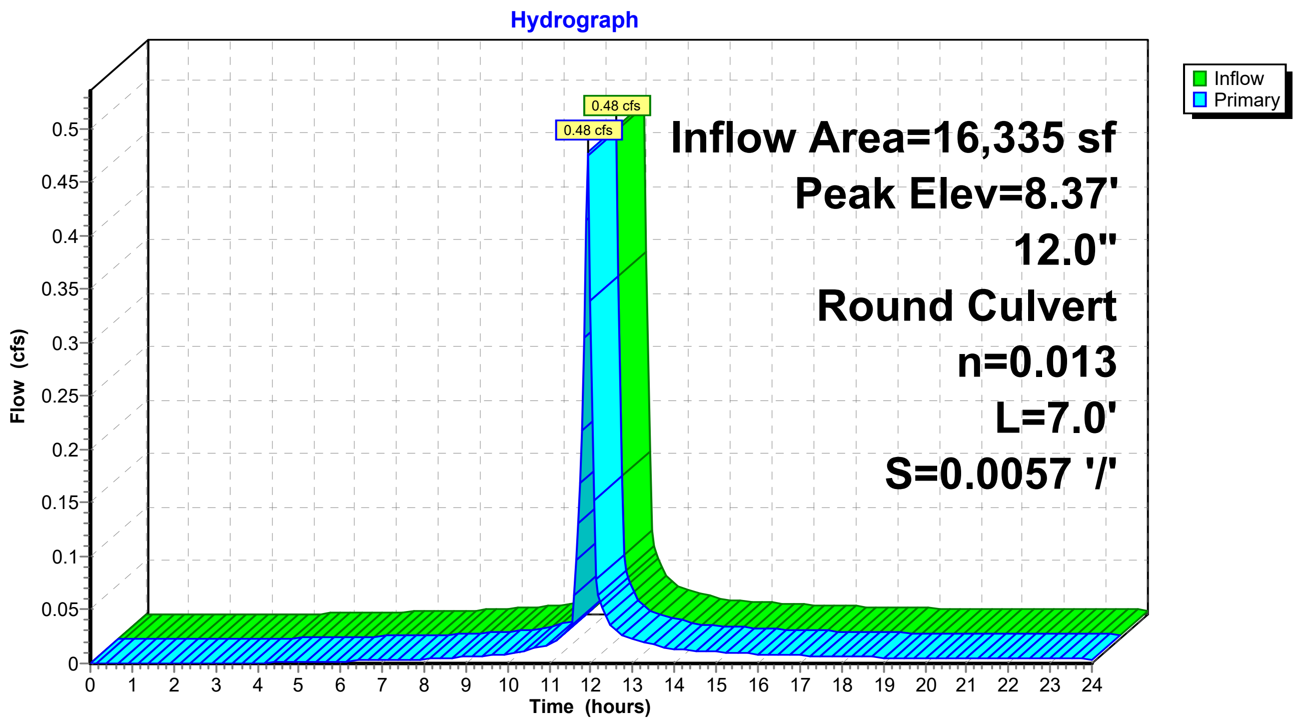
Inflow Area = 16,335 sf, 73.78% Impervious, Inflow Depth > 0.76" for WQ event
Inflow = 0.48 cfs @ 11.94 hrs, Volume= 1,037 cf
Outflow = 0.48 cfs @ 11.94 hrs, Volume= 1,037 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.48 cfs @ 11.94 hrs, Volume= 1,037 cf
Routed to Pond DMH2 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 8.37' @ 11.94 hrs
Flood Elev= 11.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	7.95'	**12.0" Round Culvert** L= 7.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 7.95' / 7.91' S= 0.0057 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.46 cfs @ 11.94 hrs HW=8.36' (Free Discharge)
└─**1=Culvert** (Barrel Controls 0.46 cfs @ 2.23 fps)

Pond OWS1:



Summary for Pond OWS2:

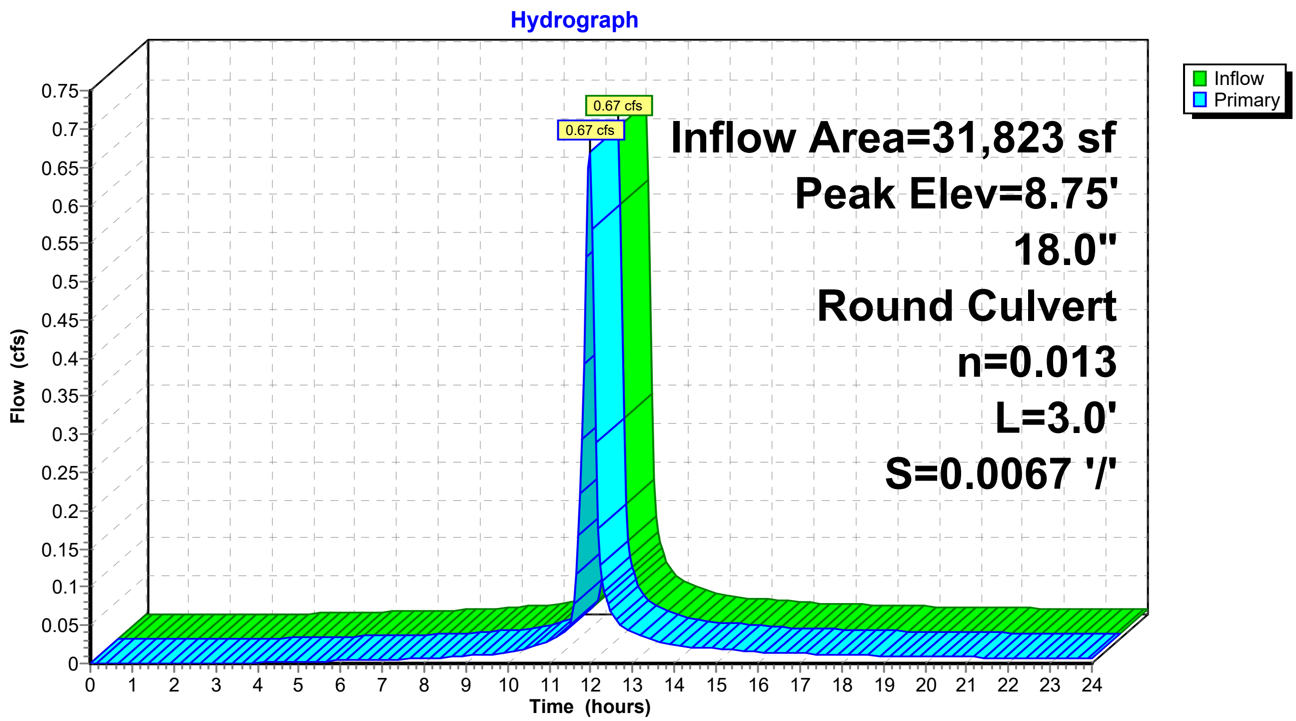
Inflow Area = 31,823 sf, 61.62% Impervious, Inflow Depth > 0.66" for WQ event
Inflow = 0.67 cfs @ 11.98 hrs, Volume= 1,745 cf
Outflow = 0.67 cfs @ 11.98 hrs, Volume= 1,745 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.67 cfs @ 11.98 hrs, Volume= 1,745 cf
Routed to Pond DMH10 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 8.75' @ 11.98 hrs
Flood Elev= 12.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	8.30'	**18.0" Round Culvert** L= 3.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 8.30' / 8.28' S= 0.0067 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=0.65 cfs @ 11.98 hrs HW=8.74' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.65 cfs @ 2.26 fps)

Pond OWS2:



Summary for Pond SF1: Subsurface Filtration System 1

Inflow Area = 16,335 sf, 73.78% Impervious, Inflow Depth > 0.76" for WQ event
Inflow = 0.48 cfs @ 11.94 hrs, Volume= 1,037 cf
Outflow = 0.41 cfs @ 11.98 hrs, Volume= 1,029 cf, Atten= 14%, Lag= 2.3 min
Primary = 0.41 cfs @ 11.98 hrs, Volume= 1,029 cf
Routed to Pond DMH3 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 5.74' @ 11.98 hrs Surf.Area= 576 sf Storage= 111 cf

Plug-Flow detention time= 14.6 min calculated for 1,029 cf (99% of inflow)
Center-of-Mass det. time= 9.2 min (792.4 - 783.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	7.33'	346 cf	**14.83'W x 38.80'L x 2.33'H Field A** 1,343 cf Overall - 295 cf Embedded = 1,048 cf x 33.0% Voids
#2A	7.83'	295 cf	**ADS_StormTech SC-310 +Cap** x 20 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 20 Chambers in 4 Rows
#3	5.83'	346 cf	**SAND (Prismatic)** Listed below (Recalc) 864 cf Overall x 40.0% Voids
#4	5.16'	127 cf	**PEA GRAVEL (Prismatic)** Listed below (Recalc) 386 cf Overall x 33.0% Voids
		1,114 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
5.83	576	0	0
7.33	576	864	864

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
5.16	576	0	0
5.83	576	386	386

Device	Routing	Invert	Outlet Devices
#1	Primary	5.16'	**6.0" Round Culvert** L= 2.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 5.16' / 5.15' S= 0.0050 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.20 sf

Primary OutFlow Max=0.40 cfs @ 11.98 hrs HW=5.73' (Free Discharge)
└─**1=Culvert** (Barrel Controls 0.40 cfs @ 2.23 fps)

Pond SF1: Subsurface Filtration System 1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-310 +Cap (ADS StormTech®SC-310 with cap length)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

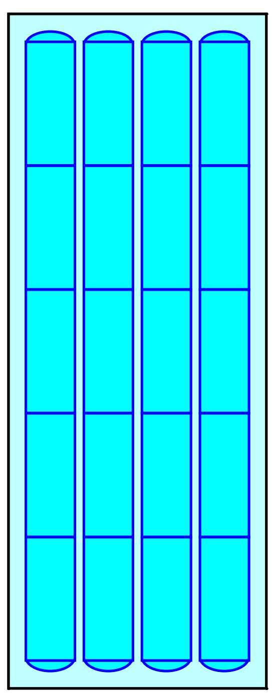
5 Chambers/Row x 7.12' Long +0.60' Cap Length x 2 = 36.80' Row Length +12.0" End Stone x 2 = 38.80' Base Length
4 Rows x 34.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 14.83' Base Width
6.0" Stone Base + 16.0" Chamber Height + 6.0" Stone Cover = 2.33' Field Height

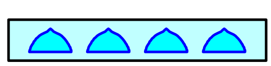
20 Chambers x 14.7 cf = 294.8 cf Chamber Storage

1,342.9 cf Field - 294.8 cf Chambers = 1,048.1 cf Stone x 33.0% Voids = 345.9 cf Stone Storage

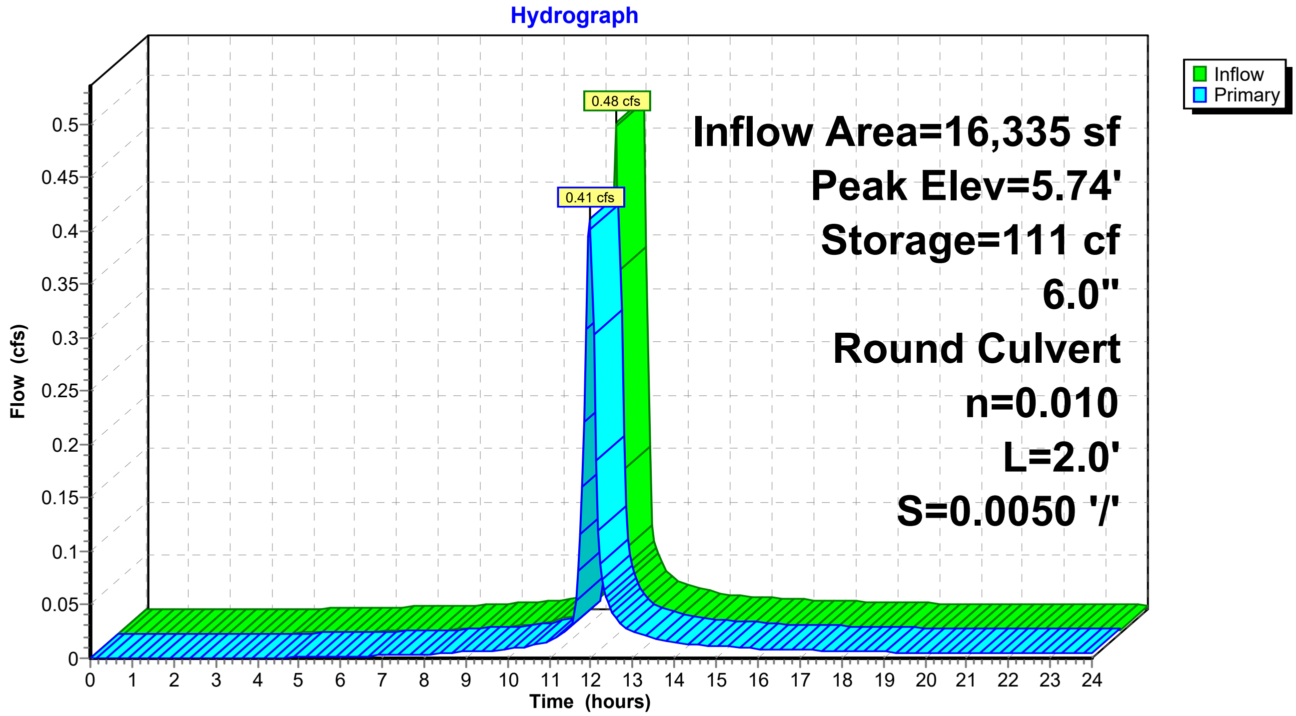
Chamber Storage + Stone Storage = 640.7 cf = 0.015 af
Overall Storage Efficiency = 47.7%
Overall System Size = 38.80' x 14.83' x 2.33'

20 Chambers
49.7 cy Field
38.8 cy Stone





Pond SF1: Subsurface Filtration System 1



Summary for Pond SF2: Subsurface Filtration System 2

Inflow Area = 31,823 sf, 61.62% Impervious, Inflow Depth > 0.66" for WQ event
Inflow = 0.67 cfs @ 11.98 hrs, Volume= 1,745 cf
Outflow = 0.37 cfs @ 12.08 hrs, Volume= 1,732 cf, Atten= 45%, Lag= 6.3 min
Primary = 0.37 cfs @ 12.08 hrs, Volume= 1,732 cf
Routed to Pond DMH11 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 5.72' @ 12.08 hrs Surf.Area= 1,668 sf Storage= 359 cf
Flood Elev= 12.00' Surf.Area= 2,502 sf Storage= 1,820 cf

Plug-Flow detention time= 19.4 min calculated for 1,728 cf (99% of inflow)
Center-of-Mass det. time= 14.4 min (804.7 - 790.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	6.97'	602 cf	**21.50'W x 38.80'L x 2.33'H Field A** 1,946 cf Overall - 442 cf Embedded = 1,504 cf x 40.0% Voids
#2A	7.47'	442 cf	**ADS_StormTech SC-310 +Cap** x 30 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 30 Chambers in 6 Rows
#3	5.47'	500 cf	**SAND (Prismatic)** Listed below (Recalc) 1,251 cf Overall x 40.0% Voids
#4	4.47'	275 cf	**PEA GRAVEL (Prismatic)** Listed below (Recalc) 834 cf Overall x 33.0% Voids
		1,820 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
5.47	834	0	0
6.97	834	1,251	1,251

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.47	834	0	0
5.47	834	834	834

Device	Routing	Invert	Outlet Devices
#1	Primary	4.47'	**6.0" Round UNDERDRAIN** L= 18.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 4.47' / 4.38' S= 0.0050 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf
#2	Device 1	4.47'	**8.270 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.01'

Primary OutFlow Max=0.37 cfs @ 12.08 hrs HW=5.71' (Free Discharge)
└──**1=UNDERDRAIN** (Passes 0.37 cfs of 0.74 cfs potential flow)
  └──**2=Exfiltration** (Controls 0.37 cfs)

Pond SF2: Subsurface Filtration System 2 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-310 +Cap (ADS StormTech®SC-310 with cap length)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

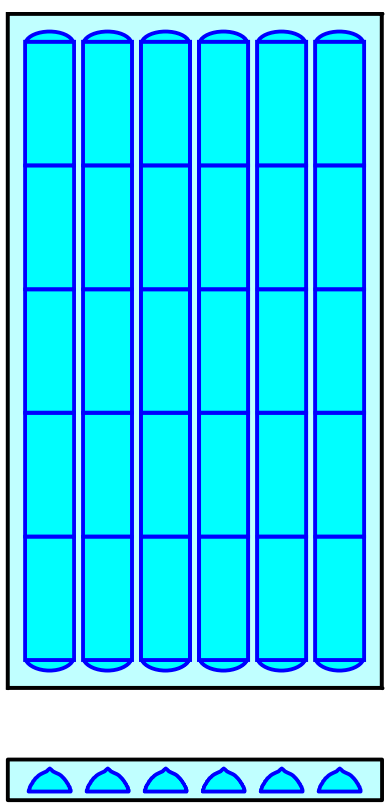
5 Chambers/Row x 7.12' Long +0.60' Cap Length x 2 = 36.80' Row Length +12.0" End Stone x 2 = 38.80' Base Length
6 Rows x 34.0" Wide + 6.0" Spacing x 5 + 12.0" Side Stone x 2 = 21.50' Base Width
6.0" Stone Base + 16.0" Chamber Height + 6.0" Stone Cover = 2.33' Field Height

30 Chambers x 14.7 cf = 442.3 cf Chamber Storage

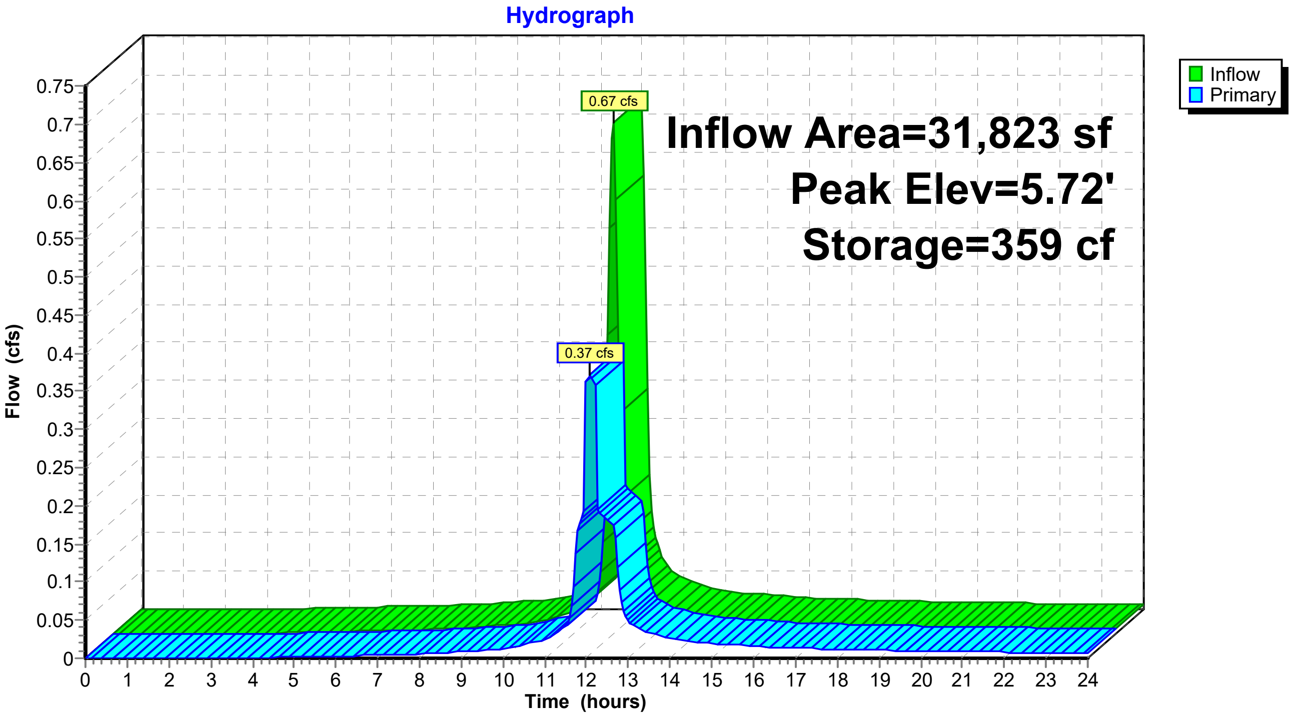
1,946.5 cf Field - 442.3 cf Chambers = 1,504.2 cf Stone x 40.0% Voids = 601.7 cf Stone Storage

Chamber Storage + Stone Storage = 1,043.9 cf = 0.024 af
Overall Storage Efficiency = 53.6%
Overall System Size = 38.80' x 21.50' x 2.33'

30 Chambers
72.1 cy Field
55.7 cy Stone



Pond SF2: Subsurface Filtration System 2



Summary for Pond TF1: Tree Filter 1

Inflow Area = 5,476 sf, 85.87% Impervious, Inflow Depth > 0.87" for WQ event
Inflow = 0.19 cfs @ 11.93 hrs, Volume= 395 cf
Outflow = 0.04 cfs @ 12.05 hrs, Volume= 392 cf, Atten= 76%, Lag= 7.3 min
Primary = 0.04 cfs @ 12.05 hrs, Volume= 392 cf
Routed to Pond DMH6 :
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond DMH6 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 6.13' @ 12.06 hrs Surf.Area= 624 sf Storage= 124 cf

Plug-Flow detention time= 30.4 min calculated for 391 cf (99% of inflow)
Center-of-Mass det. time= 25.9 min (804.7 - 778.7)

Volume	Invert	Avail.Storage	Storage Description
#1	6.14'	156 cf	**Ponding Storage (Prismatic)** Listed below (Recalc)
#2	5.31'	85 cf	**Soil Media (Prismatic)** Listed below (Recalc) 259 cf Overall x 33.0% Voids
#3	4.97'	35 cf	**Gravel Subbase (Prismatic)** Listed below (Recalc) 106 cf Overall x 33.0% Voids
#4	4.97'	5 cf	**6.0" Round Underdrain** L= 25.0'
#5	6.14'	27 cf	**Catch Basin (Prismatic)** Listed below (Recalc)
		309 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
6.14	312	0	0
6.64	312	156	156

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
5.31	312	0	0
6.14	312	259	259

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.97	312	0	0
5.31	312	106	106

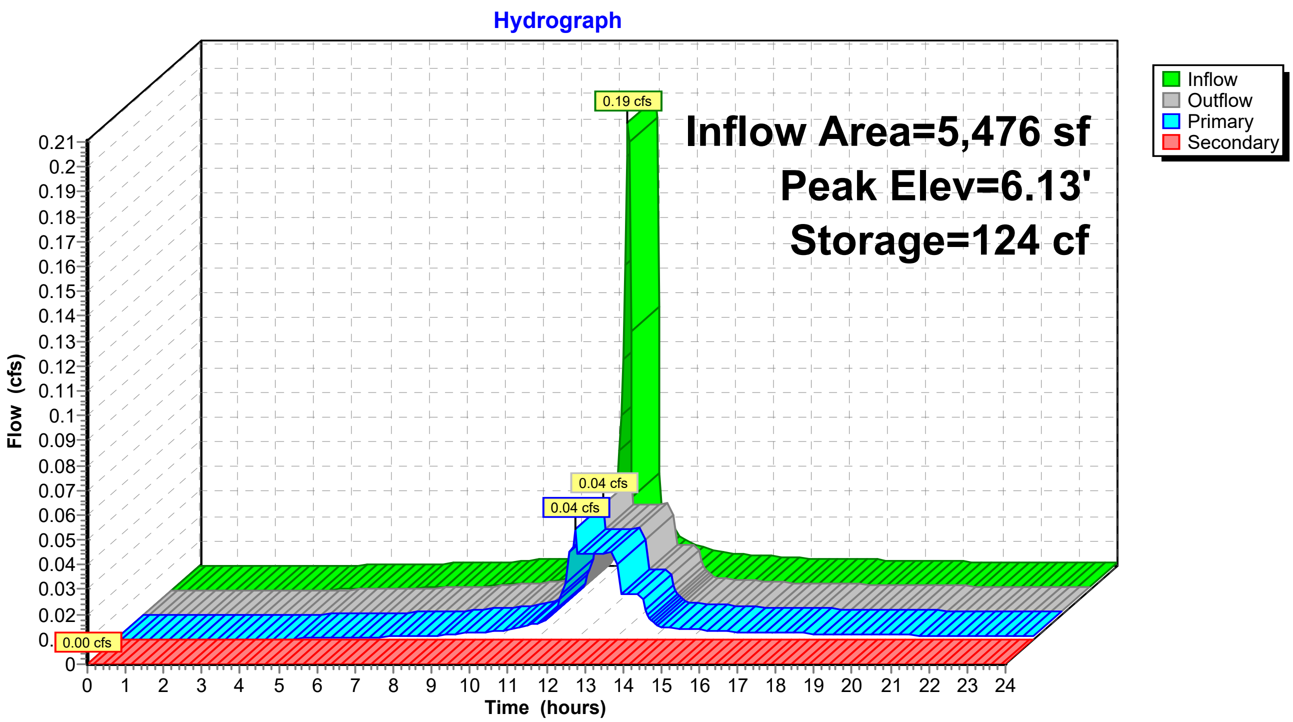
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
6.14	12	0	0
8.43	12	27	27

Device	Routing	Invert	Outlet Devices
#1	Primary	4.97'	**6.0" Round Culvert** L= 14.0' Ke= 0.600 Inlet / Outlet Invert= 4.97' / 4.90' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Device 1	4.97'	**2.410 in/hr Exfiltration over Surface area**
#3	Secondary	6.43'	**8.0" Round Culvert** L= 18.7' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 6.43' / 5.60' S= 0.0444 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf

Primary OutFlow Max=0.03 cfs @ 12.05 hrs HW=6.13' (Free Discharge)
└─**1=Culvert** (Passes 0.03 cfs of 0.82 cfs potential flow)
  └─**2=Exfiltration** (Exfiltration Controls 0.03 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=4.97' (Free Discharge)
└─**3=Culvert** (Controls 0.00 cfs)

Pond TF1: Tree Filter 1



Summary for Pond TF2: Tree Filter 2

Inflow Area = 6,253 sf, 73.95% Impervious, Inflow Depth > 0.76" for WQ event
Inflow = 0.18 cfs @ 11.95 hrs, Volume= 398 cf
Outflow = 0.05 cfs @ 12.05 hrs, Volume= 397 cf, Atten= 74%, Lag= 6.1 min
Primary = 0.05 cfs @ 12.05 hrs, Volume= 397 cf
Routed to Pond DMH4 :
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond DMH5 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 5.98' @ 12.09 hrs Surf.Area= 825 sf Storage= 126 cf

Plug-Flow detention time= 30.2 min calculated for 397 cf (100% of inflow)
Center-of-Mass det. time= 28.1 min (811.9 - 783.8)

Volume	Invert	Avail.Storage	Storage Description
#1	5.96'	136 cf	**Ponding Storage (Prismatic)** Listed below (Recalc)
#2	5.13'	74 cf	**Soil Media (Prismatic)** Listed below (Recalc) 225 cf Overall x 33.0% Voids
#3	4.63'	44 cf	**Gravel Subbase (Prismatic)** Listed below (Recalc) 136 cf Overall - 3 cf Embedded = 132 cf x 33.0% Voids
#4	4.63'	3 cf	**6.0" Round Underdrain** Inside #3 L= 17.0'
#5	5.96'	31 cf	**Catch Basin (Prismatic)** Listed below (Recalc)
		288 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
5.96	271	0	0
6.46	271	136	136

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
5.13	271	0	0
5.96	271	225	225

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.63	271	0	0
5.13	271	136	136

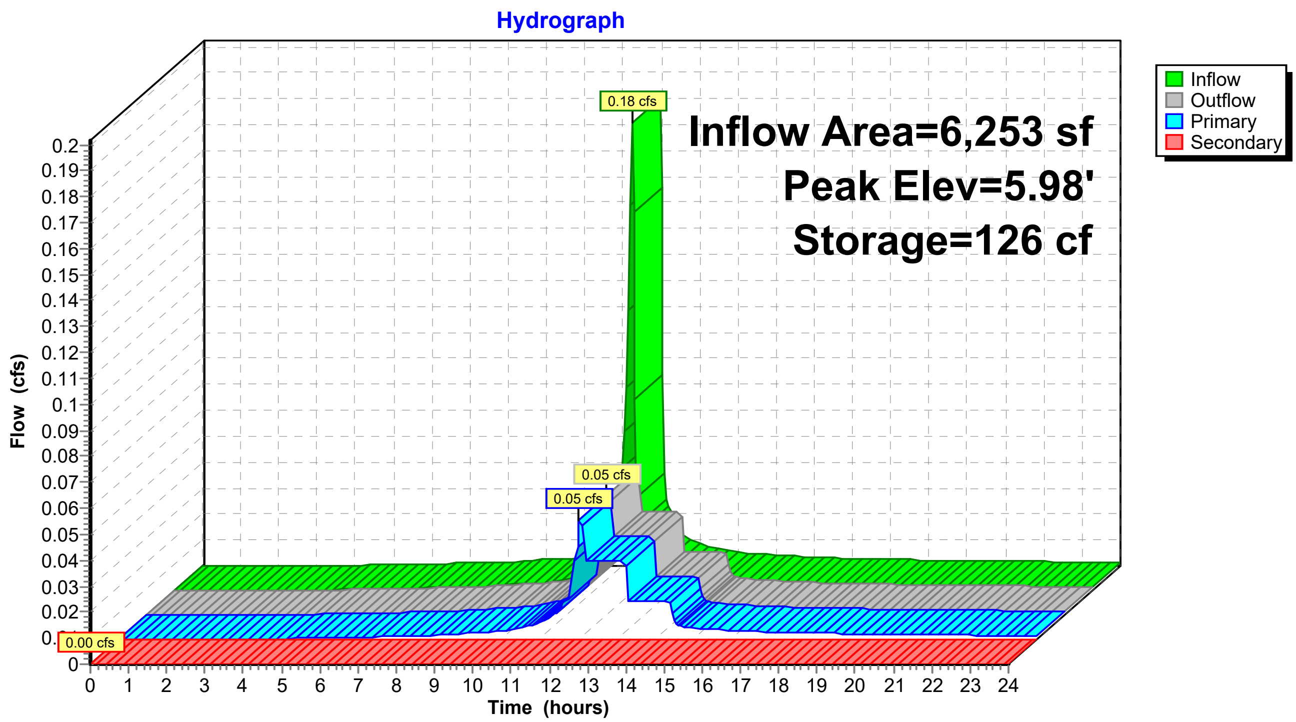
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
5.96	12	0	0
8.55	12	31	31

Device	Routing	Invert	Outlet Devices
#1	Primary	4.63'	**6.0" Round Culvert** L= 3.0' Ke= 0.600 Inlet / Outlet Invert= 4.63' / 4.44' S= 0.0633 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Device 1	4.63'	**2.410 in/hr Exfiltration over Surface area**
#3	Secondary	6.50'	**6.0" Round Culvert** L= 32.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 6.50' / 6.34' S= 0.0050 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf

Primary OutFlow Max=0.05 cfs @ 12.05 hrs HW=5.97' (Free Discharge)
└**1=Culvert** (Passes 0.05 cfs of 0.93 cfs potential flow)
  └**2=Exfiltration** (Exfiltration Controls 0.05 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=4.63' (Free Discharge)
└**3=Culvert** (Controls 0.00 cfs)

Pond TF2: Tree Filter 2



Summary for Pond TF3: Tree Filter 3

Inflow Area = 21,087 sf,100.00% Impervious, Inflow Depth > 0.98" for WQ event
Inflow = 0.79 cfs @ 11.95 hrs, Volume= 1,731 cf
Outflow = 0.14 cfs @ 11.95 hrs, Volume= 1,713 cf, Atten= 83%, Lag= 0.0 min
Primary = 0.14 cfs @ 11.95 hrs, Volume= 1,713 cf
Routed to Pond DMH14 :
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond DMH14 :

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 3.88' @ 12.14 hrs Surf.Area= 2,421 sf Storage= 617 cf

Plug-Flow detention time= 46.7 min calculated for 1,709 cf (99% of inflow)
Center-of-Mass det. time= 39.9 min (817.2 - 777.3)

Volume	Invert	Avail.Storage	Storage Description
#1	3.61'	177 cf	**18.0" Round Distribution Pipe**-Impervious L= 100.0'
#2	3.60'	448 cf	**Ponding Storage (Prismatic)**Listed below (Recalc)
#3	2.77'	211 cf	**Soil Media (Prismatic)**Listed below (Recalc) 641 cf Overall x 33.0% Voids
#4	2.27'	145 cf	**Gravel Subbase (Prismatic)**Listed below (Recalc) 439 cf Overall x 33.0% Voids
#5	2.27'	22 cf	**6.0" Round Underdrain** L= 112.0'
		1,003 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
3.60	772	0	0
4.18	772	448	448

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2.77	772	0	0
3.60	772	641	641

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2.27	877	0	0
2.77	877	439	439

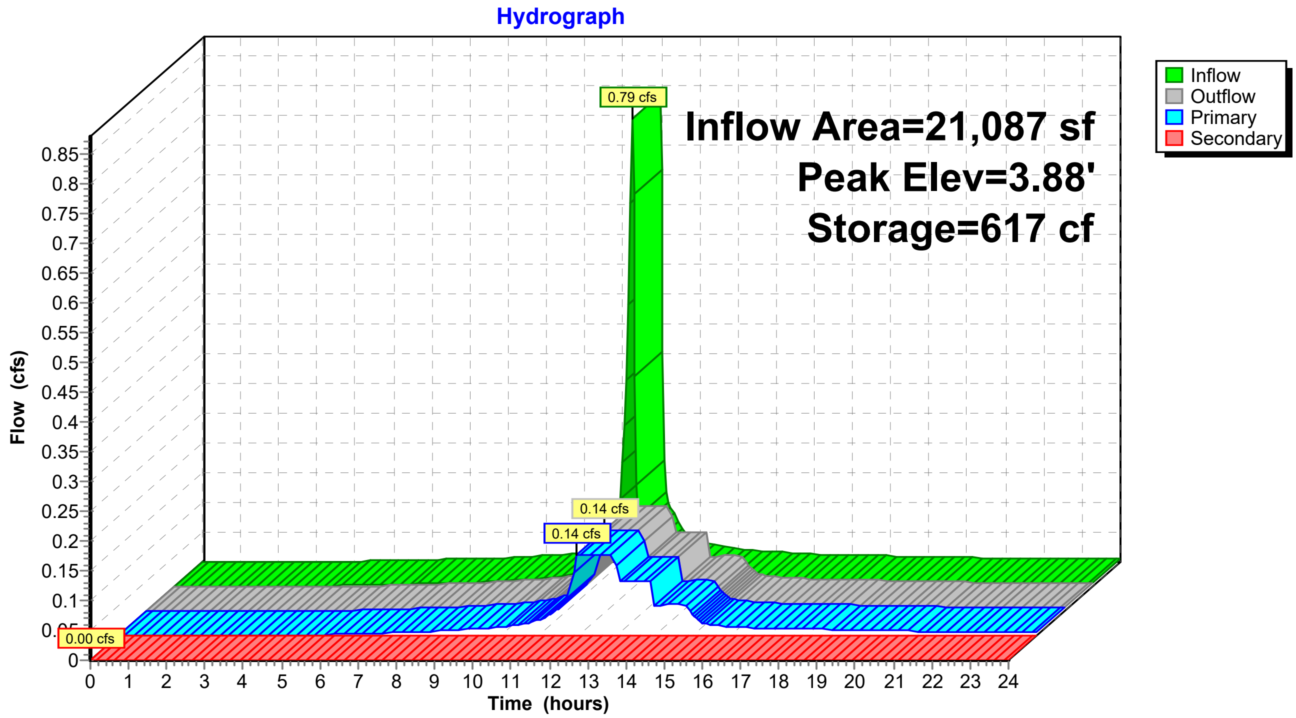
Device	Routing	Invert	Outlet Devices
#1	Primary	2.27'	**6.0" Round Underdrain** L= 2.0' Ke= 0.600 Inlet / Outlet Invert= 2.27' / 2.26' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf
#2	Device 1	2.27'	**2.410 in/hr Exfiltration over Surface area**
#3	Secondary	4.11'	**12.0" Round Overflow from Distribution Pipe** L= 7.0' CPP, projecting, no headwall, Ke= 0.900

Inlet / Outlet Invert= 4.11' / 3.62' S= 0.0700 '/' Cc= 0.900
n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.14 cfs @ 11.95 hrs HW=3.65' (Free Discharge)
└─**1=Underdrain** (Passes 0.14 cfs of 0.94 cfs potential flow)
  └─**2=Exfiltration** (Exfiltration Controls 0.14 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=2.27' (Free Discharge)
└─**3=Overflow from Distribution Pipe** (Controls 0.00 cfs)

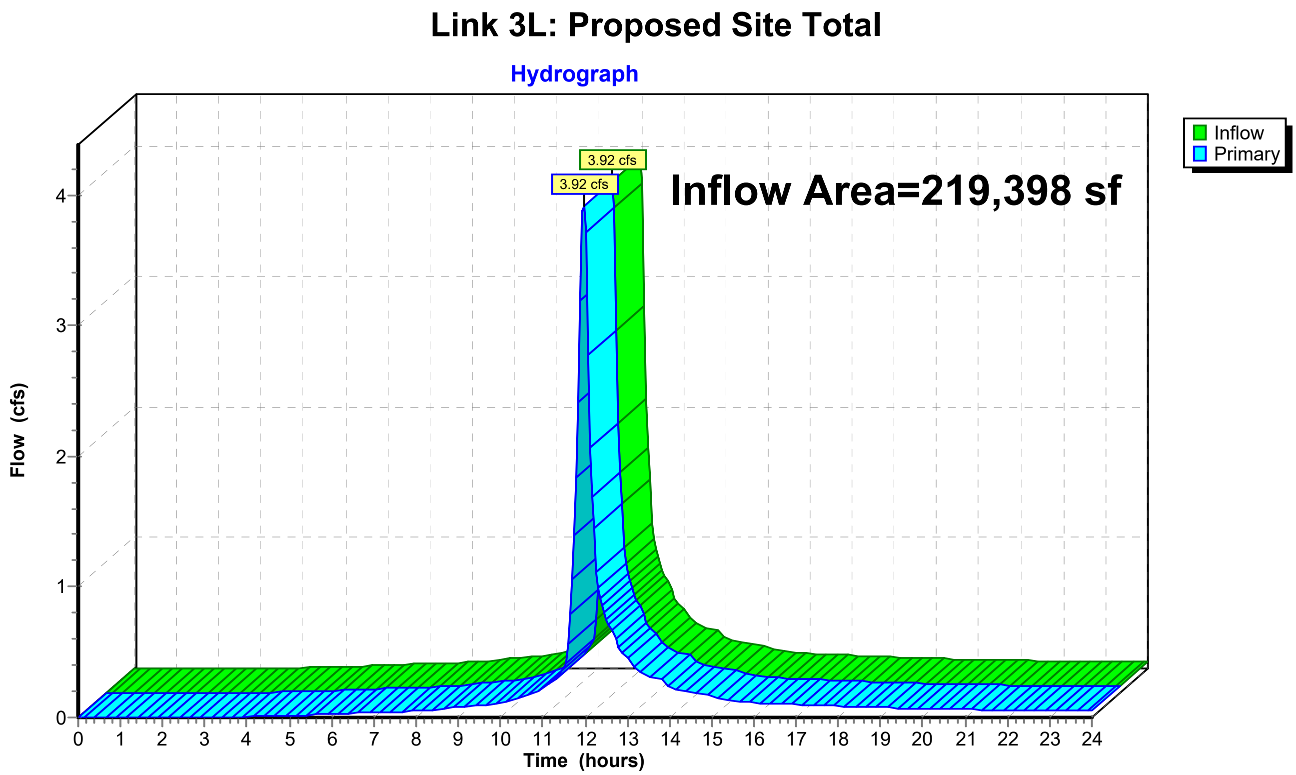
Pond TF3: Tree Filter 3



Summary for Link 3L: Proposed Site Total

Inflow Area = 219,398 sf, 71.62% Impervious, Inflow Depth > 0.74" for WQ event
Inflow = 3.92 cfs @ 11.97 hrs, Volume= 13,461 cf
Primary = 3.92 cfs @ 11.97 hrs, Volume= 13,461 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

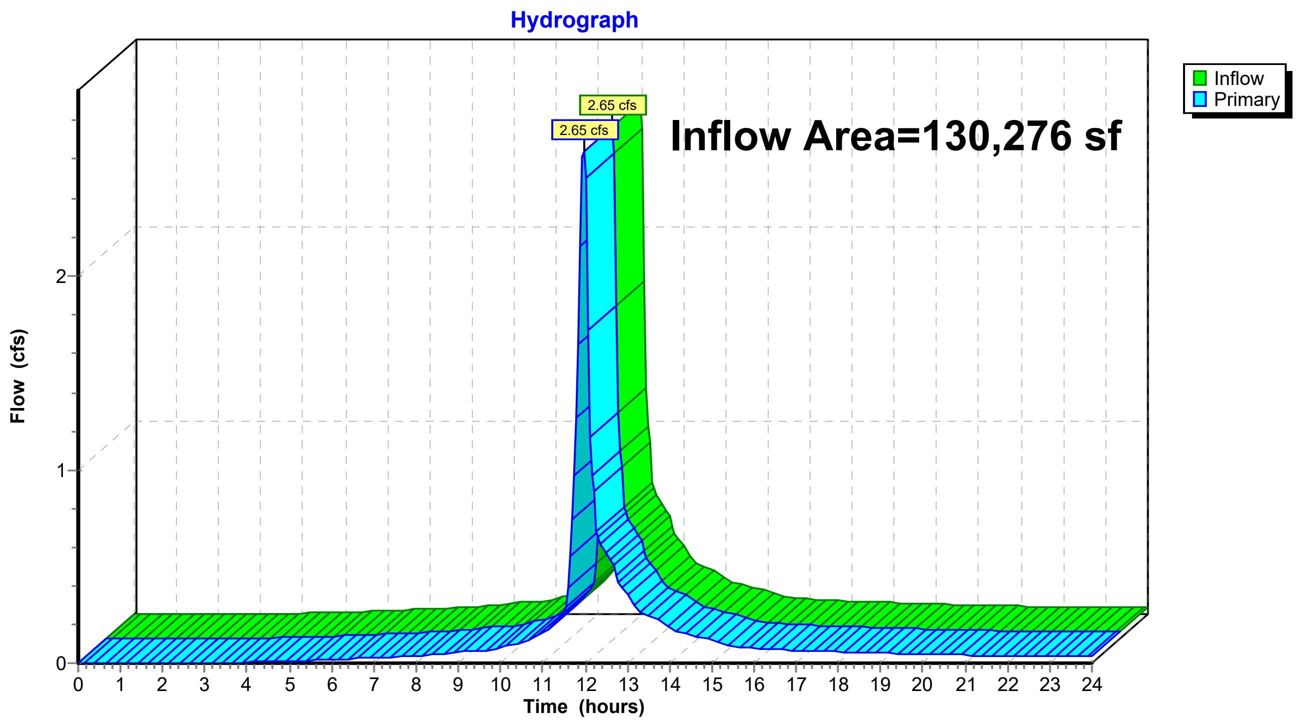


Summary for Link POA 1: POA 1 (Outfall)

Inflow Area = 130,276 sf, 85.49% Impervious, Inflow Depth > 0.86" for WQ event
Inflow = 2.65 cfs @ 11.97 hrs, Volume= 9,308 cf
Primary = 2.65 cfs @ 11.97 hrs, Volume= 9,308 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 3L : Proposed Site Total

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA 1: POA 1 (Outfall)

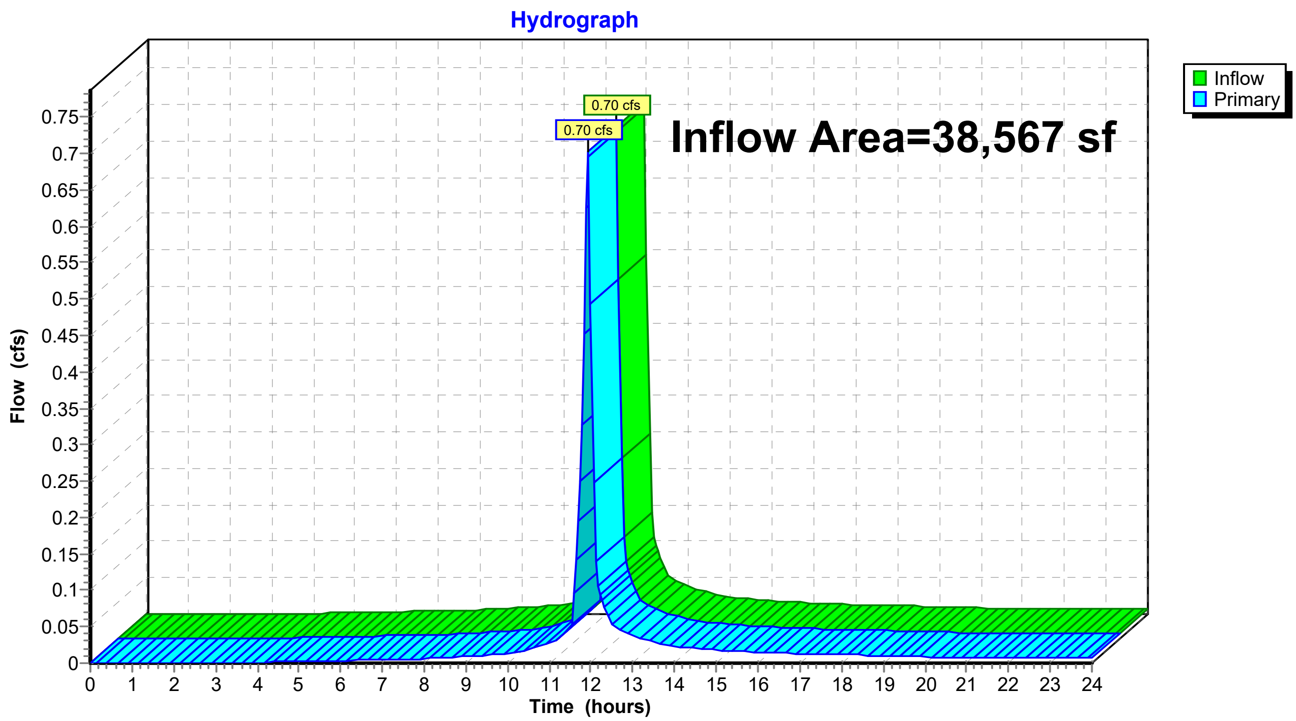


Summary for Link POA 2: POA2

Inflow Area = 38,567 sf, 46.31% Impervious, Inflow Depth > 0.51" for WQ event
Inflow = 0.70 cfs @ 11.94 hrs, Volume= 1,634 cf
Primary = 0.70 cfs @ 11.94 hrs, Volume= 1,634 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 3L : Proposed Site Total

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA 2: POA2

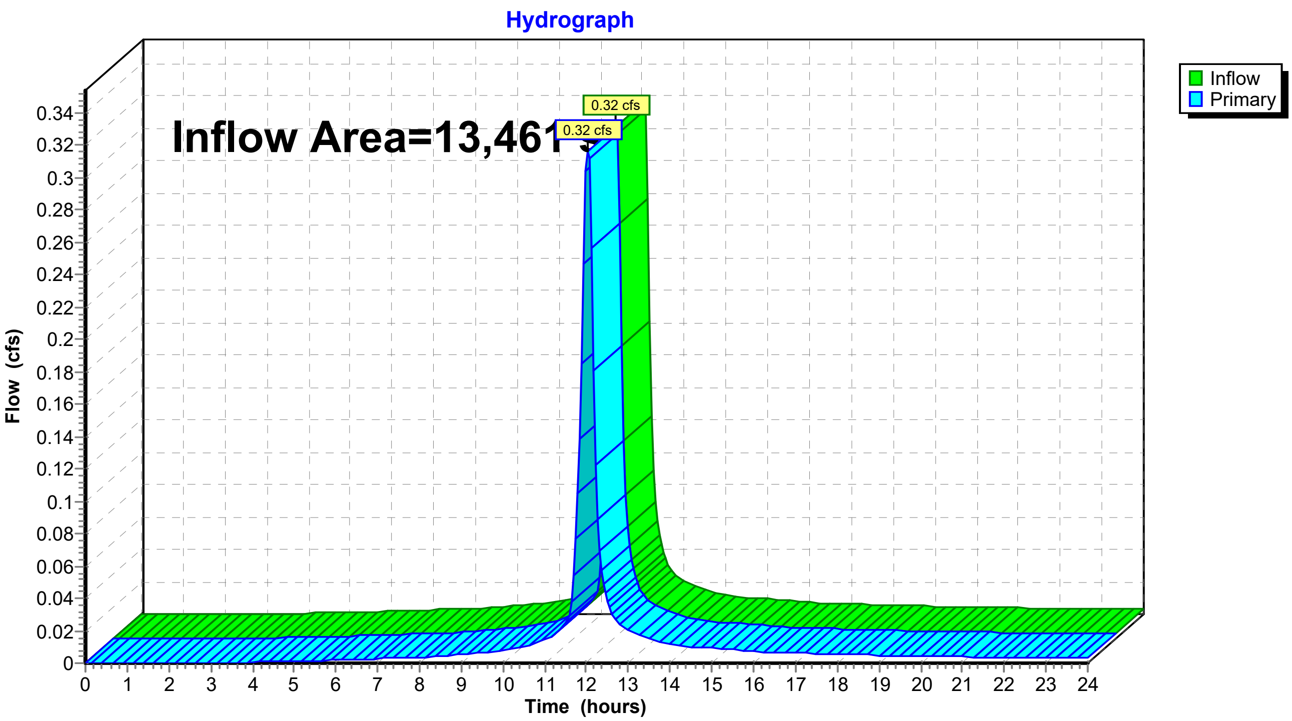


Summary for Link POA 3: POA3

Inflow Area = 13,461 sf, 77.86% Impervious, Inflow Depth > 0.78" for WQ event
Inflow = 0.32 cfs @ 12.03 hrs, Volume= 874 cf
Primary = 0.32 cfs @ 12.03 hrs, Volume= 874 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 3L : Proposed Site Total

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA 3: POA3

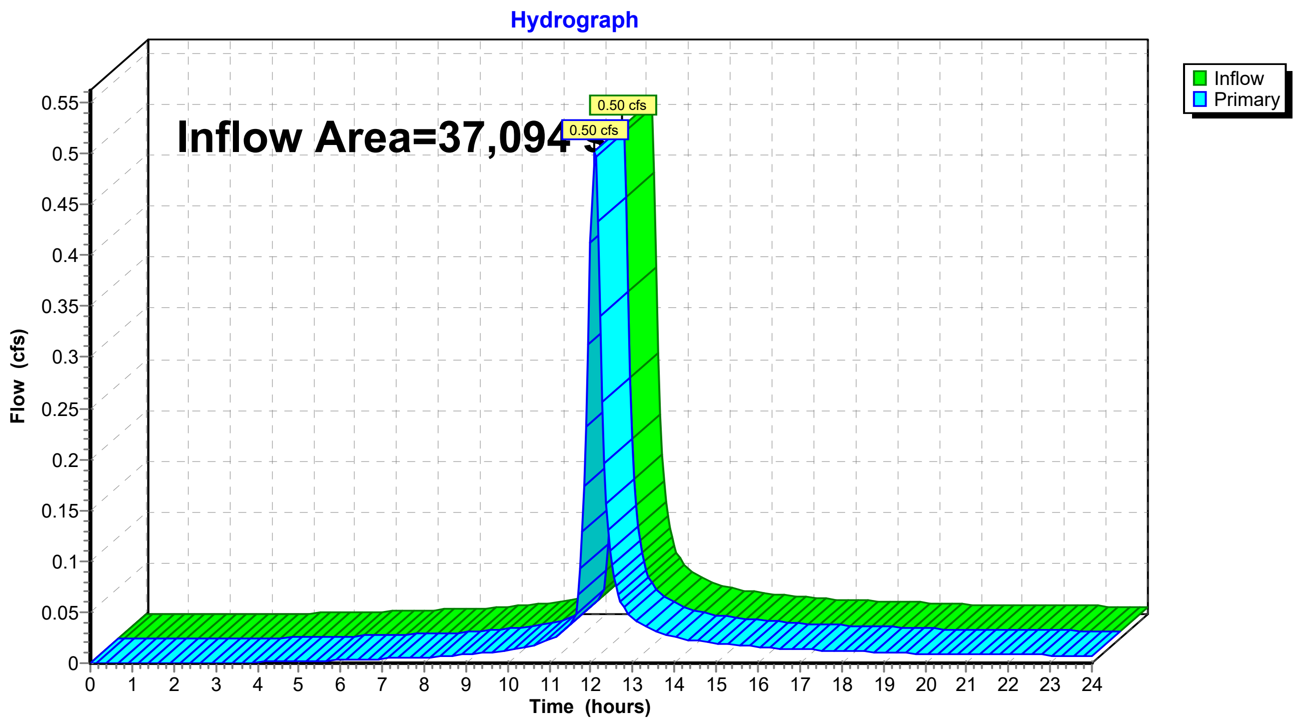


Summary for Link POA 4: POA4

Inflow Area = 37,094 sf, 46.95% Impervious, Inflow Depth > 0.53" for WQ event
Inflow = 0.50 cfs @ 12.08 hrs, Volume= 1,645 cf
Primary = 0.50 cfs @ 12.08 hrs, Volume= 1,645 cf, Atten= 0%, Lag= 0.0 min
Routed to Link 3L : Proposed Site Total

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link POA 4: POA4



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment1AP: Subwatershed1A Runoff Area=2,561 sf 100.00% Impervious Runoff Depth>2.57"
Tc=5.0 min CN=0/98 Runoff=0.23 cfs 548 cf

Subcatchment1BP: Subwatershed1B Runoff Area=2,966 sf 64.16% Impervious Runoff Depth>2.02"
Flow Length=104' Tc=2.2 min CN=79/98 Runoff=0.23 cfs 500 cf

Subcatchment1CP: Subwatershed1C Runoff Area=5,476 sf 85.87% Impervious Runoff Depth>2.35"
Flow Length=180' Tc=2.7 min CN=79/98 Runoff=0.49 cfs 1,074 cf

Subcatchment1DP: Subwatershed1D Runoff Area=6,253 sf 73.95% Impervious Runoff Depth>2.17"
Flow Length=200' Tc=4.6 min CN=79/98 Runoff=0.50 cfs 1,131 cf

Subcatchment1EP: Subwatershed1E Runoff Area=13,369 sf 75.91% Impervious Runoff Depth>2.20"
Flow Length=266' Tc=4.1 min CN=79/98 Runoff=1.10 cfs 2,452 cf

Subcatchment1FP: Subwatershed1F Runoff Area=29,122 sf 59.07% Impervious Runoff Depth>1.94"
Flow Length=264' Tc=7.5 min CN=79/98 Runoff=1.93 cfs 4,714 cf

Subcatchment1GP: Subwatershed1G Runoff Area=2,701 sf 89.12% Impervious Runoff Depth>2.40"
Flow Length=72' Slope=0.0300 '/' Tc=0.8 min CN=79/98 Runoff=0.26 cfs 541 cf

Subcatchment1HP: Subwatershed1H Runoff Area=6,697 sf 100.00% Impervious Runoff Depth>2.57"
Tc=5.0 min CN=0/98 Runoff=0.61 cfs 1,433 cf

Subcatchment1IP: Subwatershed1I Runoff Area=11,506 sf 100.00% Impervious Runoff Depth>2.57"
Tc=5.0 min CN=0/98 Runoff=1.05 cfs 2,462 cf

Subcatchment1JP: Subwatershed1J Runoff Area=28,538 sf 100.00% Impervious Runoff Depth>2.57"
Tc=5.0 min CN=0/98 Runoff=2.61 cfs 6,106 cf

Subcatchment1KP: Subwatershed1K Runoff Area=21,087 sf 100.00% Impervious Runoff Depth>2.57"
Tc=5.0 min CN=0/98 Runoff=1.93 cfs 4,512 cf

Subcatchment2AP: Subwatershed2A Runoff Area=24,348 sf 23.43% Impervious Runoff Depth>1.32"
Flow Length=128' Tc=1.4 min CN=77/98 Runoff=1.34 cfs 2,674 cf

Subcatchment2BP: Subwatershed2B Runoff Area=14,219 sf 85.48% Impervious Runoff Depth>2.31"
Tc=5.0 min CN=74/98 Runoff=1.18 cfs 2,735 cf

Subcatchment3AP: Subwatershed3A Runoff Area=13,461 sf 77.86% Impervious Runoff Depth>2.17"
Flow Length=229' Tc=11.9 min CN=74/98 Runoff=0.85 cfs 2,434 cf

Subcatchment4AP: Subwatershed1H Runoff Area=37,094 sf 46.95% Impervious Runoff Depth>1.75"
Flow Length=1,052' Tc=15.9 min CN=79/98 Runoff=1.72 cfs 5,423 cf

Pond CB2: Peak Elev=8.86' Inflow=0.23 cfs 500 cf
6.0" Round Culvert n=0.013 L=62.0' S=0.0050 '/' Outflow=0.23 cfs 500 cf

Pond CB4: Peak Elev=11.76' Inflow=1.10 cfs 2,452 cf
6.0" Round Culvert n=0.013 L=61.0' S=0.0051 '/' Outflow=1.10 cfs 2,452 cf

Pond CB5: Peak Elev=9.96' Inflow=0.26 cfs 541 cf
6.0" Round Culvert n=0.013 L=14.0' S=0.0050 '/' Outflow=0.26 cfs 541 cf

Pond CB6: Peak Elev=10.39' Inflow=1.93 cfs 4,714 cf
18.0" Round Culvert n=0.013 L=28.0' S=0.0050 '/' Outflow=1.93 cfs 4,714 cf

Pond DMH1: Peak Elev=9.14' Inflow=1.33 cfs 2,952 cf
Primary=1.23 cfs 2,925 cf Secondary=0.10 cfs 27 cf Outflow=1.33 cfs 2,952 cf

Pond DMH10: Peak Elev=8.23' Inflow=1.41 cfs 4,891 cf
18.0" Round Culvert n=0.012 L=3.0' S=0.0000 '/' Outflow=1.41 cfs 4,891 cf

Pond DMH11: Peak Elev=4.94' Inflow=1.23 cfs 5,229 cf
18.0" Round Culvert n=0.013 L=121.0' S=0.0051 '/' Outflow=1.23 cfs 5,229 cf

Pond DMH12: Peak Elev=4.40' Inflow=7.15 cfs 20,913 cf
30.0" Round Culvert n=0.013 L=187.0' S=0.0030 '/' Outflow=7.15 cfs 20,913 cf

Pond DMH13: Peak Elev=3.74' Inflow=7.15 cfs 20,913 cf
30.0" Round Culvert n=0.013 L=139.0' S=0.0030 '/' Outflow=7.15 cfs 20,913 cf

Pond DMH14: Peak Elev=3.42' Inflow=9.42 cfs 25,396 cf
30.0" Round Culvert n=0.011 L=65.0' S=0.0031 '/' Outflow=9.42 cfs 25,396 cf

Pond DMH2: Peak Elev=8.64' Inflow=1.23 cfs 2,925 cf
12.0" Round Culvert n=0.013 L=1.0' S=0.0000 '/' Outflow=1.23 cfs 2,925 cf

Pond DMH3: Peak Elev=5.57' Inflow=0.87 cfs 2,911 cf
18.0" Round Culvert n=0.013 L=87.0' S=0.0051 '/' Outflow=0.87 cfs 2,911 cf

Pond DMH4: Peak Elev=5.14' Inflow=0.92 cfs 3,860 cf
8.0" Round Culvert n=0.013 L=24.0' S=0.0071 '/' Outflow=0.92 cfs 3,860 cf

Pond DMH5: Peak Elev=4.99' Inflow=1.01 cfs 1,275 cf
12.0" Round Culvert n=0.013 L=24.0' S=0.0050 '/' Outflow=1.01 cfs 1,275 cf

Pond DMH6: Peak Elev=5.29' Inflow=0.48 cfs 1,069 cf
8.0" Round Culvert n=0.013 L=68.0' S=0.0050 '/' Outflow=0.48 cfs 1,069 cf

Pond DMH7: Peak Elev=4.96' Inflow=1.92 cfs 5,135 cf
18.0" Round Culvert n=0.013 L=5.0' S=0.0080 '/' Outflow=1.92 cfs 5,135 cf

Pond DMH8: Peak Elev=4.52' Inflow=1.92 cfs 5,135 cf
18.0" Round Culvert n=0.013 L=125.0' S=0.0050 '/' Outflow=1.92 cfs 5,135 cf

Pond DMH9: Diversion Structure Peak Elev=9.89' Inflow=2.04 cfs 5,255 cf
Primary=1.41 cfs 4,891 cf Secondary=0.63 cfs 364 cf Outflow=2.04 cfs 5,255 cf

Pond OWS1: Peak Elev=8.66' Inflow=1.23 cfs 2,925 cf
12.0" Round Culvert n=0.013 L=7.0' S=0.0057 '/' Outflow=1.23 cfs 2,925 cf

Pond OWS2: Peak Elev=8.96' Inflow=1.41 cfs 4,891 cf
18.0" Round Culvert n=0.013 L=3.0' S=0.0067 '/' Outflow=1.41 cfs 4,891 cf

Pond SF1: Subsurface Filtration System 1 Peak Elev=6.78' Storage=345 cf Inflow=1.23 cfs 2,925 cf
6.0" Round Culvert n=0.010 L=2.0' S=0.0050 '/' Outflow=0.87 cfs 2,911 cf

Pond SF2: Subsurface Filtration System 2 Peak Elev=7.63' Storage=1,045 cf Inflow=1.41 cfs 4,891 cf
Outflow=0.67 cfs 4,865 cf

Pond TF1: Tree Filter 1 Peak Elev=6.87' Storage=290 cf Inflow=0.49 cfs 1,074 cf
Primary=0.05 cfs 914 cf Secondary=0.43 cfs 155 cf Outflow=0.48 cfs 1,069 cf

Pond TF2: Tree Filter 2 Peak Elev=7.28' Storage=273 cf Inflow=0.50 cfs 1,131 cf
Primary=0.05 cfs 949 cf Secondary=0.52 cfs 179 cf Outflow=0.57 cfs 1,128 cf

Pond TF3: Tree Filter 3 Peak Elev=5.12' Storage=1,003 cf Inflow=1.93 cfs 4,512 cf
Primary=0.14 cfs 3,433 cf Secondary=2.15 cfs 1,050 cf Outflow=2.29 cfs 4,483 cf

Link 3L: Proposed Site Total Inflow=13.50 cfs 38,662 cf
Primary=13.50 cfs 38,662 cf

Link POA 1: POA 1 (Outfall) Inflow=9.42 cfs 25,396 cf
Primary=9.42 cfs 25,396 cf

Link POA 2: POA2 Inflow=2.43 cfs 5,409 cf
Primary=2.43 cfs 5,409 cf

Link POA 3: POA3 Inflow=0.85 cfs 2,434 cf
Primary=0.85 cfs 2,434 cf

Link POA 4: POA4 Inflow=1.72 cfs 5,423 cf
Primary=1.72 cfs 5,423 cf

Total Runoff Area = 219,398 sf Runoff Volume = 38,738 cf Average Runoff Depth = 2.12"
28.38% Pervious = 62,267 sf 71.62% Impervious = 157,131 sf

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment1AP: Subwatershed1A Runoff Area=2,561 sf 100.00% Impervious Runoff Depth>4.66"
Tc=5.0 min CN=0/98 Runoff=0.41 cfs 995 cf

Subcatchment1BP: Subwatershed1B Runoff Area=2,966 sf 64.16% Impervious Runoff Depth>3.96"
Flow Length=104' Tc=2.2 min CN=79/98 Runoff=0.44 cfs 980 cf

Subcatchment1CP: Subwatershed1C Runoff Area=5,476 sf 85.87% Impervious Runoff Depth>4.39"
Flow Length=180' Tc=2.7 min CN=79/98 Runoff=0.89 cfs 2,002 cf

Subcatchment1DP: Subwatershed1D Runoff Area=6,253 sf 73.95% Impervious Runoff Depth>4.15"
Flow Length=200' Tc=4.6 min CN=79/98 Runoff=0.94 cfs 2,164 cf

Subcatchment1EP: Subwatershed1E Runoff Area=13,369 sf 75.91% Impervious Runoff Depth>4.19"
Flow Length=266' Tc=4.1 min CN=79/98 Runoff=2.06 cfs 4,670 cf

Subcatchment1FP: Subwatershed1F Runoff Area=29,122 sf 59.07% Impervious Runoff Depth>3.86"
Flow Length=264' Tc=7.5 min CN=79/98 Runoff=3.81 cfs 9,371 cf

Subcatchment1GP: Subwatershed1G Runoff Area=2,701 sf 89.12% Impervious Runoff Depth>4.45"
Flow Length=72' Slope=0.0300 '/' Tc=0.8 min CN=79/98 Runoff=0.47 cfs 1,002 cf

Subcatchment1HP: Subwatershed1H Runoff Area=6,697 sf 100.00% Impervious Runoff Depth>4.66"
Tc=5.0 min CN=0/98 Runoff=1.08 cfs 2,601 cf

Subcatchment1IP: Subwatershed1I Runoff Area=11,506 sf 100.00% Impervious Runoff Depth>4.66"
Tc=5.0 min CN=0/98 Runoff=1.86 cfs 4,469 cf

Subcatchment1JP: Subwatershed1J Runoff Area=28,538 sf 100.00% Impervious Runoff Depth>4.66"
Tc=5.0 min CN=0/98 Runoff=4.62 cfs 11,083 cf

Subcatchment1KP: Subwatershed1K Runoff Area=21,087 sf 100.00% Impervious Runoff Depth>4.66"
Tc=5.0 min CN=0/98 Runoff=3.41 cfs 8,190 cf

Subcatchment2AP: Subwatershed2A Runoff Area=24,348 sf 23.43% Impervious Runoff Depth>3.04"
Flow Length=128' Tc=1.4 min CN=77/98 Runoff=3.11 cfs 6,162 cf

Subcatchment2BP: Subwatershed2B Runoff Area=14,219 sf 85.48% Impervious Runoff Depth>4.32"
Tc=5.0 min CN=74/98 Runoff=2.16 cfs 5,113 cf

Subcatchment3AP: Subwatershed3A Runoff Area=13,461 sf 77.86% Impervious Runoff Depth>4.13"
Flow Length=229' Tc=11.9 min CN=74/98 Runoff=1.60 cfs 4,631 cf

Subcatchment4AP: Subwatershed1H Runoff Area=37,094 sf 46.95% Impervious Runoff Depth>3.62"
Flow Length=1,052' Tc=15.9 min CN=79/98 Runoff=3.56 cfs 11,187 cf

Pond CB2: Peak Elev=9.10' Inflow=0.44 cfs 980 cf
6.0" Round Culvert n=0.013 L=62.0' S=0.0050 '/' Outflow=0.44 cfs 980 cf

Pond CB4: Peak Elev=19.51' Inflow=2.06 cfs 4,670 cf
6.0" Round Culvert n=0.013 L=61.0' S=0.0051 '/' Outflow=2.06 cfs 4,670 cf

Pond CB5: Peak Elev=10.18' Inflow=0.47 cfs 1,002 cf
6.0" Round Culvert n=0.013 L=14.0' S=0.0050 '/' Outflow=0.47 cfs 1,002 cf

Pond CB6: Peak Elev=10.76' Inflow=3.81 cfs 9,371 cf
18.0" Round Culvert n=0.013 L=28.0' S=0.0050 '/' Outflow=3.81 cfs 9,371 cf

Pond DMH1: Peak Elev=9.49' Inflow=2.50 cfs 5,650 cf
Primary=1.67 cfs 5,288 cf Secondary=0.83 cfs 363 cf Outflow=2.50 cfs 5,650 cf

Pond DMH10: Peak Elev=8.32' Inflow=1.78 cfs 8,735 cf
18.0" Round Culvert n=0.012 L=3.0' S=0.0000 '/' Outflow=1.78 cfs 8,735 cf

Pond DMH11: Peak Elev=5.29' Inflow=2.93 cfs 10,336 cf
18.0" Round Culvert n=0.013 L=121.0' S=0.0051 '/' Outflow=2.93 cfs 10,336 cf

Pond DMH12: Peak Elev=5.07' Inflow=14.57 cfs 39,270 cf
30.0" Round Culvert n=0.013 L=187.0' S=0.0030 '/' Outflow=14.57 cfs 39,270 cf

Pond DMH13: Peak Elev=4.42' Inflow=14.57 cfs 39,270 cf
30.0" Round Culvert n=0.013 L=139.0' S=0.0030 '/' Outflow=14.57 cfs 39,270 cf

Pond DMH14: Peak Elev=4.13' Inflow=17.89 cfs 47,421 cf
30.0" Round Culvert n=0.011 L=65.0' S=0.0031 '/' Outflow=17.89 cfs 47,421 cf

Pond DMH2: Peak Elev=8.79' Inflow=1.67 cfs 5,288 cf
12.0" Round Culvert n=0.013 L=1.0' S=0.0000 '/' Outflow=1.67 cfs 5,288 cf

Pond DMH3: Peak Elev=5.65' Inflow=1.19 cfs 5,269 cf
18.0" Round Culvert n=0.013 L=87.0' S=0.0051 '/' Outflow=1.19 cfs 5,269 cf

Pond DMH4: Peak Elev=5.45' Inflow=1.24 cfs 6,703 cf
8.0" Round Culvert n=0.013 L=24.0' S=0.0071 '/' Outflow=1.24 cfs 6,703 cf

Pond DMH5: Peak Elev=5.54' Inflow=2.63 cfs 3,084 cf
12.0" Round Culvert n=0.013 L=24.0' S=0.0050 '/' Outflow=2.63 cfs 3,084 cf

Pond DMH6: Peak Elev=5.56' Inflow=0.90 cfs 1,996 cf
8.0" Round Culvert n=0.013 L=68.0' S=0.0050 '/' Outflow=0.90 cfs 1,996 cf

Pond DMH7: Peak Elev=5.36' Inflow=3.79 cfs 9,787 cf
18.0" Round Culvert n=0.013 L=5.0' S=0.0080 '/' Outflow=3.79 cfs 9,787 cf

Pond DMH8: Peak Elev=4.87' Inflow=3.79 cfs 9,787 cf
18.0" Round Culvert n=0.013 L=125.0' S=0.0050 '/' Outflow=3.79 cfs 9,787 cf

Pond DMH9: Diversion Structure Peak Elev=10.27' Inflow=3.97 cfs 10,373 cf
Primary=1.78 cfs 8,735 cf Secondary=2.19 cfs 1,639 cf Outflow=3.97 cfs 10,373 cf

Pond OWS1: Peak Elev=8.81' Inflow=1.67 cfs 5,288 cf
12.0" Round Culvert n=0.013 L=7.0' S=0.0057 '/' Outflow=1.67 cfs 5,288 cf

Pond OWS2: Peak Elev=9.05' Inflow=1.78 cfs 8,735 cf
18.0" Round Culvert n=0.013 L=3.0' S=0.0067 '/' Outflow=1.78 cfs 8,735 cf

Pond SF1: Subsurface Filtration System 1 Peak Elev=7.96' Storage=621 cf Inflow=1.67 cfs 5,288 cf
6.0" Round Culvert n=0.010 L=2.0' S=0.0050 '/' Outflow=1.19 cfs 5,269 cf

Pond SF2: Subsurface Filtration System 2 Peak Elev=9.01' Storage=1,720 cf Inflow=1.78 cfs 8,735 cf
Outflow=0.79 cfs 8,697 cf

Pond TF1: Tree Filter 1 Peak Elev=7.16' Storage=294 cf Inflow=0.89 cfs 2,002 cf
Primary=0.05 cfs 1,385 cf Secondary=0.85 cfs 611 cf Outflow=0.90 cfs 1,996 cf

Pond TF2: Tree Filter 2 Peak Elev=8.31' Storage=285 cf Inflow=0.94 cfs 2,164 cf
Primary=0.05 cfs 1,434 cf Secondary=0.94 cfs 726 cf Outflow=0.98 cfs 2,160 cf

Pond TF3: Tree Filter 3 Peak Elev=5.75' Storage=1,003 cf Inflow=3.41 cfs 8,190 cf
Primary=0.14 cfs 5,077 cf Secondary=3.18 cfs 3,074 cf Outflow=3.32 cfs 8,151 cf

Link 3L: Proposed Site Total Inflow=26.27 cfs 74,515 cf
Primary=26.27 cfs 74,515 cf

Link POA 1: POA 1 (Outfall) Inflow=17.89 cfs 47,421 cf
Primary=17.89 cfs 47,421 cf

Link POA 2: POA2 Inflow=5.01 cfs 11,275 cf
Primary=5.01 cfs 11,275 cf

Link POA 3: POA3 Inflow=1.60 cfs 4,631 cf
Primary=1.60 cfs 4,631 cf

Link POA 4: POA4 Inflow=3.56 cfs 11,187 cf
Primary=3.56 cfs 11,187 cf

Total Runoff Area = 219,398 sf Runoff Volume = 74,621 cf Average Runoff Depth = 4.08"
28.38% Pervious = 62,267 sf 71.62% Impervious = 157,131 sf

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment1AP: Subwatershed1A Runoff Area=2,561 sf 100.00% Impervious Runoff Depth>5.86"
Tc=5.0 min CN=0/98 Runoff=0.52 cfs 1,250 cf

Subcatchment1BP: Subwatershed1B Runoff Area=2,966 sf 64.16% Impervious Runoff Depth>5.11"
Flow Length=104' Tc=2.2 min CN=79/98 Runoff=0.57 cfs 1,263 cf

Subcatchment1CP: Subwatershed1C Runoff Area=5,476 sf 85.87% Impervious Runoff Depth>5.56"
Flow Length=180' Tc=2.7 min CN=79/98 Runoff=1.13 cfs 2,539 cf

Subcatchment1DP: Subwatershed1D Runoff Area=6,253 sf 73.95% Impervious Runoff Depth>5.31"
Flow Length=200' Tc=4.6 min CN=79/98 Runoff=1.20 cfs 2,769 cf

Subcatchment1EP: Subwatershed1E Runoff Area=13,369 sf 75.91% Impervious Runoff Depth>5.36"
Flow Length=266' Tc=4.1 min CN=79/98 Runoff=2.62 cfs 5,966 cf

Subcatchment1FP: Subwatershed1F Runoff Area=29,122 sf 59.07% Impervious Runoff Depth>5.00"
Flow Length=264' Tc=7.5 min CN=79/98 Runoff=4.91 cfs 12,133 cf

Subcatchment1GP: Subwatershed1G Runoff Area=2,701 sf 89.12% Impervious Runoff Depth>5.63"
Flow Length=72' Slope=0.0300 '/' Tc=0.8 min CN=79/98 Runoff=0.59 cfs 1,268 cf

Subcatchment1HP: Subwatershed1H Runoff Area=6,697 sf 100.00% Impervious Runoff Depth>5.86"
Tc=5.0 min CN=0/98 Runoff=1.35 cfs 3,269 cf

Subcatchment1IP: Subwatershed1I Runoff Area=11,506 sf 100.00% Impervious Runoff Depth>5.86"
Tc=5.0 min CN=0/98 Runoff=2.32 cfs 5,617 cf

Subcatchment1JP: Subwatershed1J Runoff Area=28,538 sf 100.00% Impervious Runoff Depth>5.86"
Tc=5.0 min CN=0/98 Runoff=5.76 cfs 13,932 cf

Subcatchment1KP: Subwatershed1K Runoff Area=21,087 sf 100.00% Impervious Runoff Depth>5.86"
Tc=5.0 min CN=0/98 Runoff=4.26 cfs 10,294 cf

Subcatchment2AP: Subwatershed2A Runoff Area=24,348 sf 23.43% Impervious Runoff Depth>4.10"
Flow Length=128' Tc=1.4 min CN=77/98 Runoff=4.18 cfs 8,327 cf

Subcatchment2BP: Subwatershed2B Runoff Area=14,219 sf 85.48% Impervious Runoff Depth>5.48"
Tc=5.0 min CN=74/98 Runoff=2.73 cfs 6,495 cf

Subcatchment3AP: Subwatershed3A Runoff Area=13,461 sf 77.86% Impervious Runoff Depth>5.28"
Flow Length=229' Tc=11.9 min CN=74/98 Runoff=2.03 cfs 5,920 cf

Subcatchment4AP: Subwatershed1H Runoff Area=37,094 sf 46.95% Impervious Runoff Depth>4.74"
Flow Length=1,052' Tc=15.9 min CN=79/98 Runoff=4.65 cfs 14,644 cf

Pond CB2: Peak Elev=9.52' Inflow=0.57 cfs 1,263 cf
6.0" Round Culvert n=0.013 L=62.0' S=0.0050 '/' Outflow=0.57 cfs 1,263 cf

Pond CB4: Peak Elev=26.14' Inflow=2.62 cfs 5,966 cf
6.0" Round Culvert n=0.013 L=61.0' S=0.0051 '/' Outflow=2.62 cfs 5,966 cf

Pond CB5: Peak Elev=10.35' Inflow=0.59 cfs 1,268 cf
6.0" Round Culvert n=0.013 L=14.0' S=0.0050 '/' Outflow=0.59 cfs 1,268 cf

Pond CB6: Peak Elev=10.95' Inflow=4.91 cfs 12,133 cf
18.0" Round Culvert n=0.013 L=28.0' S=0.0050 '/' Outflow=4.91 cfs 12,133 cf

Pond DMH1: Peak Elev=9.67' Inflow=3.18 cfs 7,229 cf
Primary=1.82 cfs 6,547 cf Secondary=1.36 cfs 682 cf Outflow=3.18 cfs 7,229 cf

Pond DMH10: Peak Elev=8.35' Inflow=1.92 cfs 10,828 cf
18.0" Round Culvert n=0.012 L=3.0' S=0.0000 '/' Outflow=1.92 cfs 10,828 cf

Pond DMH11: Peak Elev=5.47' Inflow=3.96 cfs 13,358 cf
18.0" Round Culvert n=0.013 L=121.0' S=0.0051 '/' Outflow=3.96 cfs 13,358 cf

Pond DMH12: Peak Elev=5.41' Inflow=18.53 cfs 49,930 cf
30.0" Round Culvert n=0.013 L=187.0' S=0.0030 '/' Outflow=18.53 cfs 49,930 cf

Pond DMH13: Peak Elev=4.75' Inflow=18.53 cfs 49,930 cf
30.0" Round Culvert n=0.013 L=139.0' S=0.0030 '/' Outflow=18.53 cfs 49,930 cf

Pond DMH14: Peak Elev=4.53' Inflow=22.80 cfs 60,181 cf
30.0" Round Culvert n=0.011 L=65.0' S=0.0031 '/' Outflow=22.80 cfs 60,181 cf

Pond DMH2: Peak Elev=8.84' Inflow=1.82 cfs 6,547 cf
12.0" Round Culvert n=0.013 L=1.0' S=0.0000 '/' Outflow=1.82 cfs 6,547 cf

Pond DMH3: Peak Elev=5.67' Inflow=1.26 cfs 6,525 cf
18.0" Round Culvert n=0.013 L=87.0' S=0.0051 '/' Outflow=1.26 cfs 6,525 cf

Pond DMH4: Peak Elev=5.51' Inflow=1.31 cfs 8,213 cf
8.0" Round Culvert n=0.013 L=24.0' S=0.0071 '/' Outflow=1.31 cfs 8,213 cf

Pond DMH5: Peak Elev=5.97' Inflow=3.58 cfs 4,290 cf
12.0" Round Culvert n=0.013 L=24.0' S=0.0050 '/' Outflow=3.58 cfs 4,290 cf

Pond DMH6: Peak Elev=5.96' Inflow=1.13 cfs 2,532 cf
8.0" Round Culvert n=0.013 L=68.0' S=0.0050 '/' Outflow=1.13 cfs 2,532 cf

Pond DMH7: Peak Elev=5.56' Inflow=4.81 cfs 12,503 cf
18.0" Round Culvert n=0.013 L=5.0' S=0.0080 '/' Outflow=4.81 cfs 12,503 cf

Pond DMH8: Peak Elev=5.04' Inflow=4.81 cfs 12,503 cf
18.0" Round Culvert n=0.013 L=125.0' S=0.0050 '/' Outflow=4.81 cfs 12,503 cf

Pond DMH9: Diversion Structure Peak Elev=10.46' Inflow=5.11 cfs 13,401 cf
Primary=1.92 cfs 10,828 cf Secondary=3.19 cfs 2,573 cf Outflow=5.11 cfs 13,401 cf

Pond OWS1: Peak Elev=8.86' Inflow=1.82 cfs 6,547 cf
12.0" Round Culvert n=0.013 L=7.0' S=0.0057 '/' Outflow=1.82 cfs 6,547 cf

Pond OWS2: Peak Elev=9.09' Inflow=1.92 cfs 10,828 cf
18.0" Round Culvert n=0.013 L=3.0' S=0.0067 '/' Outflow=1.92 cfs 10,828 cf

Pond SF1: Subsurface Filtration System 1 Peak Elev=8.26' Storage=743 cf Inflow=1.82 cfs 6,547 cf
6.0" Round Culvert n=0.010 L=2.0' S=0.0050 '/' Outflow=1.26 cfs 6,525 cf

Pond SF2: Subsurface Filtration System 2 Peak Elev=19.18' Storage=1,820 cf Inflow=1.92 cfs 10,828 cf
Outflow=1.68 cfs 10,785 cf

Pond TF1: Tree Filter 1 Peak Elev=7.41' Storage=297 cf Inflow=1.13 cfs 2,539 cf
Primary=0.05 cfs 1,629 cf Secondary=1.08 cfs 903 cf Outflow=1.13 cfs 2,532 cf

Pond TF2: Tree Filter 2 Peak Elev=9.11' Storage=288 cf Inflow=1.20 cfs 2,769 cf
Primary=0.05 cfs 1,687 cf Secondary=1.15 cfs 1,076 cf Outflow=1.19 cfs 2,764 cf

Pond TF3: Tree Filter 3 Peak Elev=6.52' Storage=1,003 cf Inflow=4.26 cfs 10,294 cf
Primary=0.14 cfs 5,912 cf Secondary=4.13 cfs 4,340 cf Outflow=4.26 cfs 10,251 cf

Link 3L: Proposed Site Total Inflow=33.71 cfs 95,568 cf
Primary=33.71 cfs 95,568 cf

Link POA 1: POA 1 (Outfall) Inflow=22.80 cfs 60,181 cf
Primary=22.80 cfs 60,181 cf

Link POA 2: POA2 Inflow=6.57 cfs 14,823 cf
Primary=6.57 cfs 14,823 cf

Link POA 3: POA3 Inflow=2.03 cfs 5,920 cf
Primary=2.03 cfs 5,920 cf

Link POA 4: POA4 Inflow=4.65 cfs 14,644 cf
Primary=4.65 cfs 14,644 cf

Total Runoff Area = 219,398 sf Runoff Volume = 95,688 cf Average Runoff Depth = 5.23"
28.38% Pervious = 62,267 sf 71.62% Impervious = 157,131 sf

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment1AP: Subwatershed1A Runoff Area=2,561 sf 100.00% Impervious Runoff Depth>8.35"
Tc=5.0 min CN=0/98 Runoff=0.73 cfs 1,783 cf

Subcatchment1BP: Subwatershed1B Runoff Area=2,966 sf 64.16% Impervious Runoff Depth>7.54"
Flow Length=104' Tc=2.2 min CN=79/98 Runoff=0.83 cfs 1,863 cf

Subcatchment1CP: Subwatershed1C Runoff Area=5,476 sf 85.87% Impervious Runoff Depth>8.03"
Flow Length=180' Tc=2.7 min CN=79/98 Runoff=1.61 cfs 3,666 cf

Subcatchment1DP: Subwatershed1D Runoff Area=6,253 sf 73.95% Impervious Runoff Depth>7.76"
Flow Length=200' Tc=4.6 min CN=79/98 Runoff=1.73 cfs 4,043 cf

Subcatchment1EP: Subwatershed1E Runoff Area=13,369 sf 75.91% Impervious Runoff Depth>7.80"
Flow Length=266' Tc=4.1 min CN=79/98 Runoff=3.78 cfs 8,695 cf

Subcatchment1FP: Subwatershed1F Runoff Area=29,122 sf 59.07% Impervious Runoff Depth>7.41"
Flow Length=264' Tc=7.5 min CN=79/98 Runoff=7.21 cfs 17,992 cf

Subcatchment1GP: Subwatershed1G Runoff Area=2,701 sf 89.12% Impervious Runoff Depth>8.11"
Flow Length=72' Slope=0.0300 '/' Tc=0.8 min CN=79/98 Runoff=0.84 cfs 1,826 cf

Subcatchment1HP: Subwatershed1H Runoff Area=6,697 sf 100.00% Impervious Runoff Depth>8.35"
Tc=5.0 min CN=0/98 Runoff=1.91 cfs 4,663 cf

Subcatchment1IP: Subwatershed1I Runoff Area=11,506 sf 100.00% Impervious Runoff Depth>8.35"
Tc=5.0 min CN=0/98 Runoff=3.28 cfs 8,011 cf

Subcatchment1JP: Subwatershed1J Runoff Area=28,538 sf 100.00% Impervious Runoff Depth>8.35"
Tc=5.0 min CN=0/98 Runoff=8.13 cfs 19,869 cf

Subcatchment1KP: Subwatershed1K Runoff Area=21,087 sf 100.00% Impervious Runoff Depth>8.35"
Tc=5.0 min CN=0/98 Runoff=6.01 cfs 14,682 cf

Subcatchment2AP: Subwatershed2A Runoff Area=24,348 sf 23.43% Impervious Runoff Depth>6.42"
Flow Length=128' Tc=1.4 min CN=77/98 Runoff=6.44 cfs 13,027 cf

Subcatchment2BP: Subwatershed2B Runoff Area=14,219 sf 85.48% Impervious Runoff Depth>7.93"
Tc=5.0 min CN=74/98 Runoff=3.92 cfs 9,402 cf

Subcatchment3AP: Subwatershed3A Runoff Area=13,461 sf 77.86% Impervious Runoff Depth>7.70"
Flow Length=229' Tc=11.9 min CN=74/98 Runoff=2.95 cfs 8,642 cf

Subcatchment4AP: Subwatershed1H Runoff Area=37,094 sf 46.95% Impervious Runoff Depth>7.12"
Flow Length=1,052' Tc=15.9 min CN=79/98 Runoff=6.94 cfs 22,022 cf

Pond CB2: Peak Elev=10.45' Inflow=0.83 cfs 1,863 cf
6.0" Round Culvert n=0.013 L=62.0' S=0.0050 '/' Outflow=0.83 cfs 1,863 cf

Pond CB4: Peak Elev=45.03' Inflow=3.78 cfs 8,695 cf
6.0" Round Culvert n=0.013 L=61.0' S=0.0051 '/' Outflow=3.78 cfs 8,695 cf

Pond CB5: Peak Elev=10.72' Inflow=0.84 cfs 1,826 cf
6.0" Round Culvert n=0.013 L=14.0' S=0.0050 '/' Outflow=0.84 cfs 1,826 cf

Pond CB6: Peak Elev=11.37' Inflow=7.21 cfs 17,992 cf
18.0" Round Culvert n=0.013 L=28.0' S=0.0050 '/' Outflow=7.21 cfs 17,992 cf

Pond DMH1: Peak Elev=10.13' Inflow=4.60 cfs 10,558 cf
Primary=2.14 cfs 9,069 cf Secondary=2.46 cfs 1,489 cf Outflow=4.60 cfs 10,558 cf

Pond DMH10: Peak Elev=8.41' Inflow=2.19 cfs 15,051 cf
18.0" Round Culvert n=0.012 L=3.0' S=0.0000 '/' Outflow=2.19 cfs 15,051 cf

Pond DMH11: Peak Elev=6.49' Inflow=8.19 cfs 19,767 cf
18.0" Round Culvert n=0.013 L=121.0' S=0.0051 '/' Outflow=8.19 cfs 19,767 cf

Pond DMH12: Peak Elev=6.54' Inflow=27.07 cfs 72,289 cf
30.0" Round Culvert n=0.013 L=187.0' S=0.0030 '/' Outflow=27.07 cfs 72,289 cf

Pond DMH13: Peak Elev=5.81' Inflow=27.07 cfs 72,289 cf
30.0" Round Culvert n=0.013 L=139.0' S=0.0030 '/' Outflow=27.07 cfs 72,289 cf

Pond DMH14: Peak Elev=5.56' Inflow=33.00 cfs 86,837 cf
30.0" Round Culvert n=0.011 L=65.0' S=0.0031 '/' Outflow=33.00 cfs 86,837 cf

Pond DMH2: Peak Elev=8.94' Inflow=2.14 cfs 9,069 cf
12.0" Round Culvert n=0.013 L=1.0' S=0.0000 '/' Outflow=2.14 cfs 9,069 cf

Pond DMH3: Peak Elev=5.70' Inflow=1.41 cfs 9,042 cf
18.0" Round Culvert n=0.013 L=87.0' S=0.0051 '/' Outflow=1.41 cfs 9,042 cf

Pond DMH4: Peak Elev=5.66' Inflow=1.45 cfs 11,169 cf
8.0" Round Culvert n=0.013 L=24.0' S=0.0071 '/' Outflow=1.45 cfs 11,169 cf

Pond DMH5: Peak Elev=7.08' Inflow=5.67 cfs 7,026 cf
12.0" Round Culvert n=0.013 L=24.0' S=0.0050 '/' Outflow=5.67 cfs 7,026 cf

Pond DMH6: Peak Elev=6.77' Inflow=1.60 cfs 3,658 cf
8.0" Round Culvert n=0.013 L=68.0' S=0.0050 '/' Outflow=1.60 cfs 3,658 cf

Pond DMH7: Peak Elev=6.01' Inflow=7.01 cfs 18,195 cf
18.0" Round Culvert n=0.013 L=5.0' S=0.0080 '/' Outflow=7.01 cfs 18,195 cf

Pond DMH8: Peak Elev=5.44' Inflow=7.01 cfs 18,195 cf
18.0" Round Culvert n=0.013 L=125.0' S=0.0050 '/' Outflow=7.01 cfs 18,195 cf

Pond DMH9: Diversion Structure Peak Elev=10.85' Inflow=7.50 cfs 19,818 cf
Primary=2.19 cfs 15,051 cf Secondary=5.30 cfs 4,767 cf Outflow=7.50 cfs 19,818 cf

Pond OWS1: Peak Elev=8.96' Inflow=2.14 cfs 9,069 cf
12.0" Round Culvert n=0.013 L=7.0' S=0.0057 '/' Outflow=2.14 cfs 9,069 cf

Pond OWS2: Peak Elev=9.15' Inflow=2.19 cfs 15,051 cf
18.0" Round Culvert n=0.013 L=3.0' S=0.0067 '/' Outflow=2.19 cfs 15,051 cf

Pond SF1: Subsurface Filtration System 1 Peak Elev=8.97' Storage=979 cf Inflow=2.14 cfs 9,069 cf
6.0" Round Culvert n=0.010 L=2.0' S=0.0050 '/' Outflow=1.41 cfs 9,042 cf

Pond SF2: Subsurface Filtration System 2 Peak Elev=34.28' Storage=1,820 cf Inflow=2.19 cfs 15,051 cf
Outflow=3.01 cfs 15,001 cf

Pond TF1: Tree Filter 1 Peak Elev=8.09' Storage=305 cf Inflow=1.61 cfs 3,666 cf
Primary=0.05 cfs 2,098 cf Secondary=1.54 cfs 1,559 cf Outflow=1.60 cfs 3,658 cf

Pond TF2: Tree Filter 2 Peak Elev=11.54' Storage=288 cf Inflow=1.73 cfs 4,043 cf
Primary=0.05 cfs 2,127 cf Secondary=1.63 cfs 1,880 cf Outflow=1.68 cfs 4,006 cf

Pond TF3: Tree Filter 3 Peak Elev=8.41' Storage=1,003 cf Inflow=6.01 cfs 14,682 cf
Primary=0.14 cfs 7,314 cf Secondary=5.82 cfs 7,234 cf Outflow=5.96 cfs 14,548 cf

Link 3L: Proposed Site Total Inflow=49.20 cfs 139,930 cf
Primary=49.20 cfs 139,930 cf

Link POA 1: POA 1 (Outfall) Inflow=33.00 cfs 86,837 cf
Primary=33.00 cfs 86,837 cf

Link POA 2: POA2 Inflow=9.86 cfs 22,429 cf
Primary=9.86 cfs 22,429 cf

Link POA 3: POA3 Inflow=2.95 cfs 8,642 cf
Primary=2.95 cfs 8,642 cf

Link POA 4: POA4 Inflow=6.94 cfs 22,022 cf
Primary=6.94 cfs 22,022 cf

Total Runoff Area = 219,398 sf Runoff Volume = 140,186 cf Average Runoff Depth = 7.67"
28.38% Pervious = 62,267 sf 71.62% Impervious = 157,131 sf

Appendix D

BMP Sizing Calculations

FUSS & O'NEILL

Subsurface Filtration System 1

1) Calculated Water Quality Volume (WQ_v) in accordance with Section 3.3.3

Subwatershed 1B & 1E

Cover Description	WQv Treatment Depth Required	Area (S.F.)
New Impervious Surfaces	1"	3,127
Disturbed Impervious Surfaces	0.5"	*6,298*
Off-Site Impervious Surfaces	0	*2,627*

Required Water Quality Volume= **523 cf**

2) Calculated Required Storage Volume in accordance with Section 5.5 (75% of WQv for Filtering Systems)

Req. Storage= WQv*0.75= **392 cf**

3) Calculated Storage Volume

Chamber Type:	StormTech SC-310	
Rows of Chambers:	4	
Chambers per Row:	5	
Total Number of Chambers:	20	
Storage Volume per Chamber:	14.7	cf
Total Storage Volume in Chambers:	294	cf
System Width:	14.83	ft
System Length:	38.80	ft
System Area:	575.40	sf
Stone Bed Height (incl chambers):	2.33	ft
Stone Voids	33%	
Stone Bed Storage Volume*:	345	cf

*Volume of chambers embedded in stone subtracted from stone bed storage volume

Sand Bed Height:	1.5	ft
Sand Voids:	40%	
Sand Bed Storage Volume:	345	cf
Pea Gravel Layer Height:	0.67	ft
Pea Gravel Voids:	33%	
Pea Gravel Layer Storage Volume:	127	cf
Total System Storage:	**1,112**	**cf** (Chambers+Stone Bed+Sand Bed+Pea Gravel Layer)
% of Req. WQv Stored:	**213%**	

FUSS & O'NEILL

Subsurface Filtration System 2

1) Calculated Water Quality Volume (WQ_v) in accordance with Section 3.3.3

Subwatershed 1F & 1G

Cover Description	WQv Treatment Depth Required	Area (S.F.)
New Impervious Surfaces	1"	12,597
Disturbed Impervious Surfaces	0.5"	*3,601*
Off-Site Impervious Surfaces	0	*3,412*

Req. Water Quality Volume (WQv)= **1,200 cf**

2) Calculated Required Storage Volume in accordance with Section 5.5 (75% of WQv for Filtering Systems)

Req. Storage= WQv*0.75= **900 cf**

3) Calculated Storage Volume

Chamber Type:	StormTech SC-310	
Rows of Chambers:	6	
Chambers per Row:	5	
Total Number of Chambers:	30	
Storage Volume per Chamber:	14.7	cf
Total Storage Volume in Chambers:	441	cf
System Width:	21.5	ft
System Length:	38.8	ft
System Area:	834.2	sf
Stone Bed Height (incl chambers):	2.33	ft
Stone Voids	33%	
Stone Bed Storage Volume*:	496	cf

*Volume of chambers embedded in stone subtracted from stone bed storage volume

Sand Bed Height:	1.5	ft
Sand Voids:	40%	
Sand Bed Storage Volume:	501	cf
Pea Gravel Layer Height:	0.8	ft
Pea Gravel Voids:	33%	
Pea Gravel Layer Storage Volume:	220	cf
Total System Storage:	**1,658**	**cf** (Chambers+Stone Bed+Sand Bed+Pea Gravel Layer)
% of Req. WQv Stored:	**138%**	

FUSS & O'NEILL

Tree Filter 1

1) Calculated Water Quality Volume (WQ_v) in accordance with Section 3.3.3

Subwatershed 1C

Cover Description	WQv Treatment Depth Required	Area (S.F.)
New Impervious Surfaces	1"	0
Disturbed Impervious Surfaces	0.5"	*4,450*
Off-Site Impervious Surfaces	0	*252*

Req. Water Quality Volume (WQv)= **185 cf**

2) Calculated Required Storage Volume in accordance with Section 5.5 (75% of WQv for Filtering Systems)

Req. Storage= WQv*0.75= **139 cf**

3) Calculated Storage Volume

Chamber Type:	Silva Cell 1X	
Total Number of Chambers:	28	
System Area:	328	sf
Tree Root Ball Area:	16	sf
Filter Area*:	312	sf
Ponding Layer Height:	0.58	ft
Ponding Layer Storage Volume:	190	cf
Soil Media Layer Height:	0.83	ft
Soil Media Voids:	33%	
Sand Bed Storage Volume:	85	cf

*Filter Area= System Area - Tree Root Ball Area

Gravel Subbase Height:	0.33	ft
Gravel Subbase Voids:	33%	
Gravel Subbase Storage Volume:	34	cf

Underdrian Length:	25	ft
Underdrain Diameter:	6	in
Underdrain Storage Volume:	**5**	**cf**

Total System Storage:	**310**	**cf**	(Ponding+Media+Gravel Subbase+Underdrain)
% of WQv Stored:	**167%**		

Tree Filter 2

1) Calculated Water Quality Volume (WQ_v) in accordance with Section 3.3.3

Subwatershed 1D

Cover Description	WQv Treatment Depth Required	Area (S.F.)
New Impervious Surfaces	1"	0
Disturbed Impervious Surfaces	0.5"	*4,624*
Off-Site Impervious Surfaces	0	*0*

Req. Water Quality Volume (WQv)= **193 cf**

2) Calculated Required Storage Volume in accordance with Section 5.5 (75% of WQv for Filtering Systems)

Req. Storage= WQv*0.75= **145 cf**

3) Calculated Storage Volume

Chamber Type:	Silva Cell 1X	
Total Number of Chambers:	23	
System Area:	287	sf
Tree Root Ball Area:	16	sf
Filter Area*:	271	sf
Ponding Layer Height:	0.58	ft
Ponding Layer Storage Volume:	166	cf
Soil Media Layer Height:	0.83	ft
Soil Media Voids:	33%	
Sand Bed Storage Volume:	74	cf

*Filter Area= System Area - Tree Root Ball Area

Gravel Subbase Height:	0.5	ft
Gravel Subbase Voids:	33%	
Gravel Subbase Storage Volume:	45	cf

Underdrian Length:	17	ft
Underdrain Diameter:	6	in
Underdrain Storage Volume:	**3**	**cf**

Total System Storage: **288** **cf** (Ponding+Media+Gravel Subbase+Underdrain)

% of WQv Stored: **150%**

Tree Filter 3

1) Calculated Water Quality Volume (WQ_v) in accordance with Section 3.3.3

Subwatershed 1K

Cover Description	WQv Treatment Depth Required	Area (S.F.)
New Impervious Surfaces	1"	0
Disturbed Impervious Surfaces	0.5"	*21,087*
Off-Site Impervious Surfaces	0	*0*

Req. Water Quality Volume (WQv)= **879 cf**

2) Calculated Required Storage Volume in accordance with Section 5.5 (75% of WQv for Filtering Systems)

Req. Storage= WQv*0.75= **659 cf**

3) Calculated Storage Volume

Chamber Type:	Silva Cell 1X	
Total Number of Chambers:	69	
System Area:	820	sf
Tree Root Balls Area:	48	sf
Filter Area*:	772	sf
Ponding Layer Height:	0.58	ft
Ponding Layer Storage Volume:	476	cf
Soil Media Layer Height:	0.83	ft
Soil Media Voids:	33%	
Sand Bed Storage Volume:	211	cf

*Filter Area= System Area - Tree Root Ball Area

Gravel Subbase Height:	0.5	ft
Gravel Subbase Voids:	33%	
Gravel Subbase Storage Volume:	127	cf
Underdrian Length:	112	ft
Underdrain Diameter:	6	in
Underdrain Storage Volume:	**22**	**cf**
Distribution Pipe Length:	112	ft
Distribution Pipe Diameter:	18	in
Distribution Pipe Storage Volume:	**177**	**cf**

Total System Storage:	**1,013**	**cf**	(Ponding+Media+Gravel Subbase +Underdrain+Distribution Pipe)
% of Req. WQv Stored:	**115%**		

PIPE SEGMENT			DRAINAGE AREA		TIME (min)		RUNOFF 25-Year Storm		PROPOSED PIPE DESIGN VARIABLES										
U/S Struct.	Pipe	D/S Struct.	Increment CA	CA	Tc	Time In Section	Intensity (In/Hr)	Design Flow (Cfs)	Diam (In.)	Length (Ft.)	Slope (Ft./Ft.)	Manning Coeff.	Capacity (Cfs)	Full Flow Velocity (Fps)	Depth (Ft.)	Design Velocity (Fps.)	Angle	Hydraulic Radius
DMH-8	to	DMH-12						4.81	18	125	0.005	HDPE 0.013	7.44	4.2	0.89	4.5	2.77	0.41
DMH-12	to	DMH-13						18.53	30	187	0.003	HDPE 0.013	22.52	4.6	1.77	5.1	2.29	0.74
DMH-14	to	Outfall						22.80	30	65	0.003	RCP 0.011	26.61	5.4	1.82	6.1	2.19	0.75
12" DB	to	Outfall						2.73	12	35	0.010	HDPE 0.013	3.57	4.5	0.67	5.0	2.45	0.29

Appendix E

NRCS Soils Report and Test Pit Logs

Soil Map—State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties
(Bristol Yarn Mill)

Map Scale: 1:1,410 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 20, 40, 80, 120

Feet: 0, 50, 100, 200, 300

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 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 1:12,000.

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: State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties
Survey Area Data: Version 22, Sep 12, 2022

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

Date(s) aerial images were photographed: Data not available.

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
NP	Newport-Urban land complex	1.5	35.3%
Ur	Urban land	2.7	62.8%
Ws	Water, saline	0.1	1.9%
Totals for Area of Interest		**4.4**	**100.0%**

Map Unit Description

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named, soils that are similar to the named components, and some minor components that differ in use and management from the major soils.

Most of the soils similar to the major components have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Some minor components, however, have properties and behavior characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

Report—Map Unit Description

State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties

NP—Newport-Urban land complex

Map Unit Setting

National map unit symbol: 9lvx

Elevation: 0 to 280 feet
Mean annual precipitation: 44 to 50 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 115 to 211 days
Farmland classification: Not prime farmland

Map Unit Composition

Newport and similar soils: 40 percent
Urban land: 30 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Newport

Setting

Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy lodgment till derived from metamorphic and sedimentary rock

Typical profile

Ap - 0 to 8 inches: silt loam
Bw - 8 to 24 inches: channery silt loam
Cd - 24 to 65 inches: channery silt loam

Properties and qualities

Slope: 1 to 15 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 23 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: F144AY007CT - Well Drained Dense Till Uplands
Hydric soil rating: No

Description of Urban Land

Setting

Parent material: Human transported material

Typical profile

R - 0 to 6 inches: variable

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydric soil rating: No

Minor Components

Udorthents

Percent of map unit: 10 percent
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Poquonock

Percent of map unit: 10 percent
Landform: Ground moraines, drumlins
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Birchwood

Percent of map unit: 5 percent
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Pittstown

Percent of map unit: 5 percent
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Ur—Urban land

Map Unit Setting

National map unit symbol: 9lxk
Elevation: 0 to 810 feet
Mean annual precipitation: 44 to 50 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 100 to 211 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Parent material: Human transported material

Minor Components

Udorthents

Percent of map unit: 5 percent
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Canton

Percent of map unit: 2 percent
Landform: Hills
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Pittstown

Percent of map unit: 2 percent
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Charlton

Percent of map unit: 2 percent
Landform: Hills
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Merrimac

Percent of map unit: 1 percent
Landform: Terraces, outwash plains, kames
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Newport

Percent of map unit: 1 percent
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Sudbury

Percent of map unit: 1 percent
Landform: Terraces, outwash plains
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Sutton

Percent of map unit: 1 percent
Landform: Drainageways, depressions
Down-slope shape: Concave, linear
Across-slope shape: Concave
Hydric soil rating: No

Ws—Water, saline

Map Unit Setting

National map unit symbol: bqv1
Elevation: 0 to 20 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Water, saline: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Minor Components

Beaches, sandy surface

Percent of map unit: 5 percent
Landform: Barrier beaches, back-barrier beaches, shores, beaches
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Riser
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: Unranked

Data Source Information

Soil Survey Area: State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties
Survey Area Data: Version 22, Sep 12, 2022

Test Pit # 1

Project Name:	Bristol Yarn Mill
Project Number:	20061150.A22
Date:	July 26, 2022
Time:	8:45 AM
Logged By:	Christina Viera, PE
Checked By:	

Contractor:	DaPonte
Operator:	
Backfill:	Native

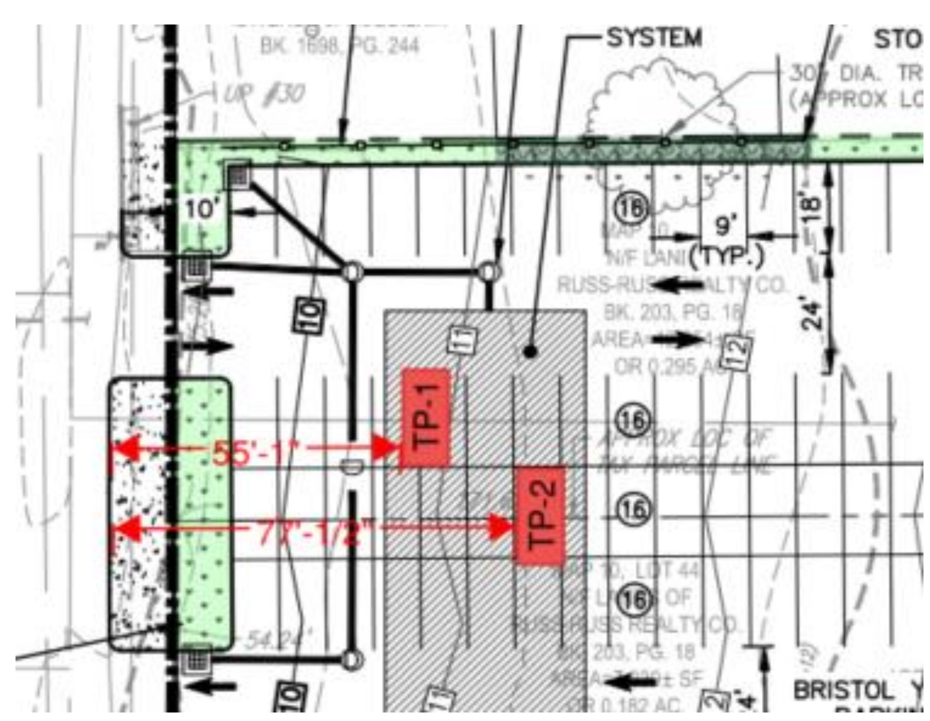
DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0-2"	Asphalt						
2"-9"	Fill	Gravelly Sand					
9"-43"	Fill	Contains brick and stone					
43"-53"	C1	Silt Loam	Gley 4/10Y	10YR 5/6 30%, 43"	5%	SAB	Firm
53"-69"	C2	Loam	2.5YR 4/4	5YR 4/6 60%, 53"	5%	SAB	Fairly firm
69"-96"	C3	Loamy Sand	7.5YR 2.5/1	None visible	10% pebbles	SAB	Fairly firm

APPROX. SURFACE EL:	10.50
DIMENSIONS OF PIT:	4'X12'
TOTAL DEPTH:	96"
DEPTH TO BEDROCK:	not encountered
DEPTH TO MOTTLING:	43"
DEPTH TO ROOTS:	N/A
DEPTH TO WATER:	96"
ESHGT ELEVATION:	6.9
METHOD OF SAMPLE COLLECTION:	Bags

COMMENTS:

Redox may be due to restrictive soils

TEST PIT SKETCH:



Test Pit # 2

Project Name:	Bristol Yarn Mill
Project Number:	20061150.A22
Date:	July 26, 2022
Time:	9:45AM
Logged By:	Christina Viera, PE
Checked By:	

Contractor:	DaPonte
Operator:	
Backfill:	Native

FUSS & O'NEILL

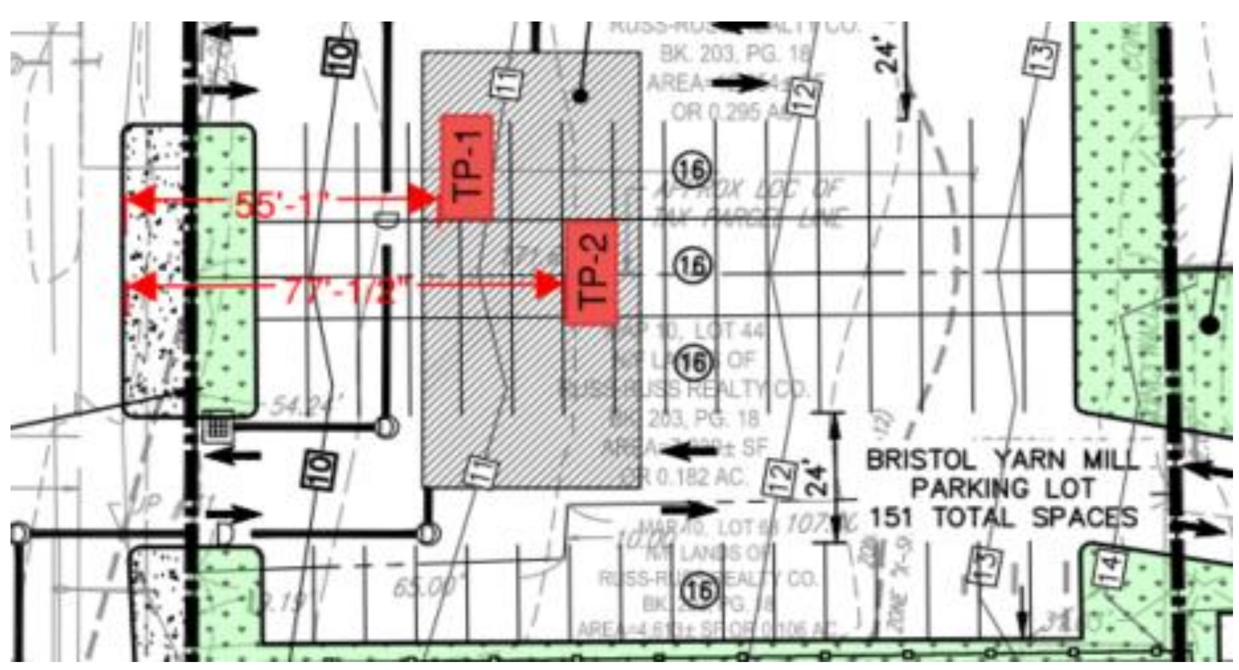
DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0-2"	Asphalt						
2"-7"	Fill	Sand/Gravel					
7"-17"	Fill	Loamy Sand	10YR 2/2	7.5YR 4/6 8% , 10"	60%	massive	loose
17"-43"	Fill	Silt Loam	Gley 4/10Y	10YR 5/6 15% , 17"	5%	SAB	firm
43"-62"	C1	Sandy Loam	2.5YR 3/2	2.5YR 3/6 50% , 43"	10%	SAB	fairly firm
62"-96"	C2	Sandy Loam	2.5YR 4/2	None visible	50% pebbles	SAB	fairly firm

APPROX. SURFACE EL:	11.1
DIMENSIONS OF PIT:	4'X12'
TOTAL DEPTH:	96"
DEPTH TO BEDROCK:	Not encountered
DEPTH TO MOTTLING:	10"
DEPTH TO ROOTS:	N/A
DEPTH TO WATER:	94"
ESHGT ELEVATION:	
METHOD OF SAMPLE COLLECTION:	Bags

COMMENTS:

Redox may be due to restrictive soils.
Pockets of dark brown/gray silty clay at 30" on east wall and at 24" on west wall.
Fill to 48" on north face.

TEST PIT SKETCH:



Test Pit # 3

Project Name:	Bristol Yarn Mill
Project Number:	20061150.A22
Date:	July 26, 2022
Time:	11:30 AM
Logged By:	Christina Viera, PE
Checked By:	

Contractor:	DaPonte
Operator:	
Backfill:	Native

FUSS & O'NEILL

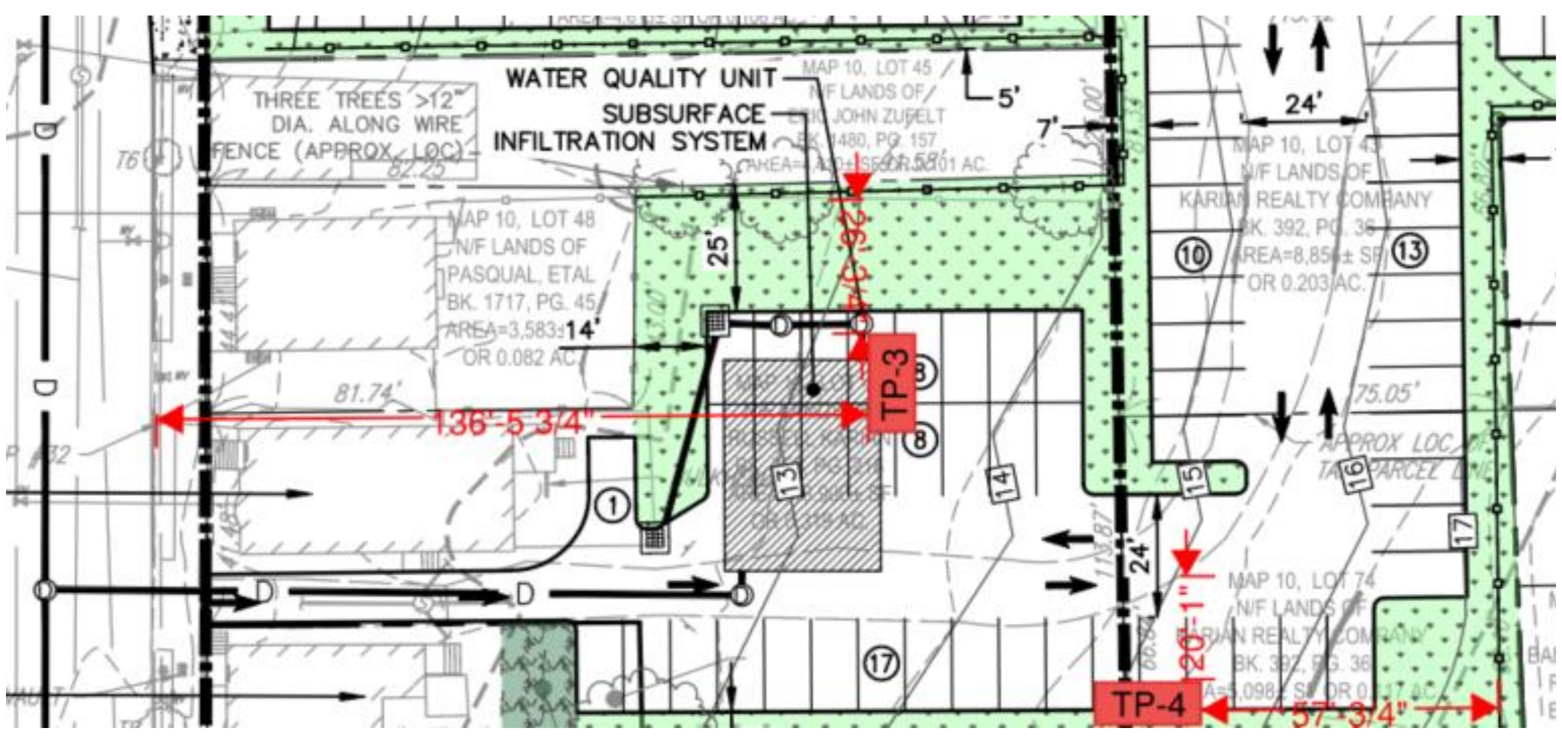
DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0-6"	Fill	-					
6"-24"	Ap	Silt Loam	7.5YR 2.5/1	-	40% pebbles, cobbles	massive	firm
24"-40"	B	Silt Loam	10YR 3/2	5YR 4/6 27", 15%	20%	SAB	fairly firm
40"-72"	C1	Silt Loam	7.5YR 5/1	5YR 5/3 40", 50%	20%	SAB	fairly firm
72"-98"	C2	Sandy Loam	2.5YR 2.5/1	-	30% pebble	SAB	fairly firm
98"-132"	Unable to sample- assumed same as above						

APPROX. SURFACE EL:	13.40
DIMENSIONS OF PIT:	4'X12'
TOTAL DEPTH:	132"
DEPTH TO BEDROCK:	Not encountered
DEPTH TO MOTTLING:	27"
DEPTH TO ROOTS:	6"
DEPTH TO WATER:	120"
ESHGT ELEVATION:	11.15
METHOD OF SAMPLE COLLECTION:	Bags

COMMENTS:

Redox may be due to restrictive soils.
Bottom of C1 horizon varied across test pit.

TEST PIT SKETCH:



Test Pit # 4

Project Name:	Bristol Yarn Mill
Project Number:	20061150.A22
Date:	July 26, 2022
Time:	1:15 PM
Logged By:	Christina Viera, PE
Checked By:	

Contractor:	DaPonte
Operator:	
Backfill:	Native

FUSS & O'NEILL

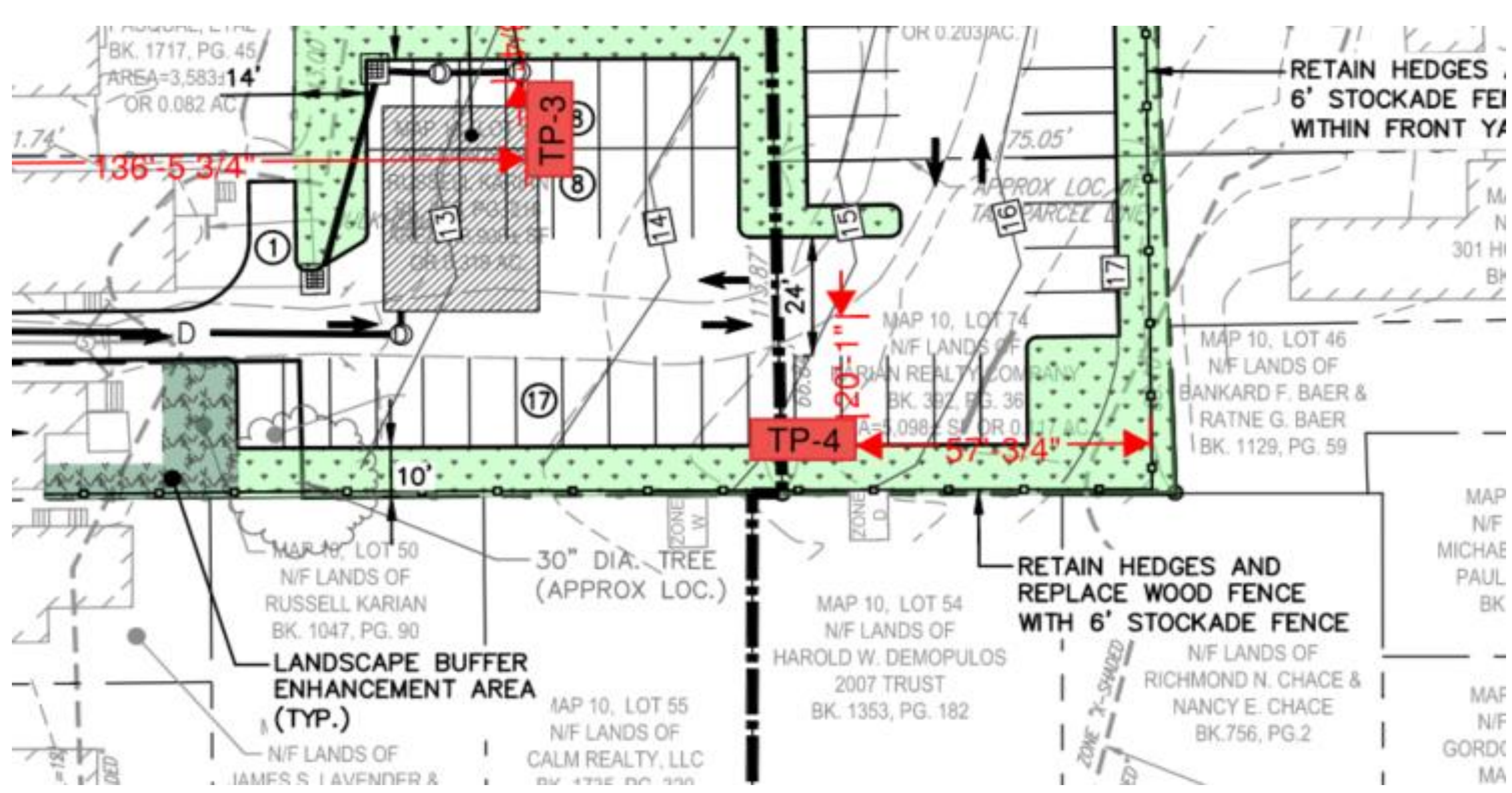
DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0-4"	O						
4"-26"	Ap	Silt Loam	2.5YR 5/1	-	5% pebble	SAB	fairly firm
26"-52"	B	Silt Loam	2.5YR 4/3	Concentrations: 5YR 5/6, Depletions: 2.5YR 5/1, 45" , 60%	5%	SAB	fairly firm
52"-62"	C1	Sandy Loam	2.5YR 2.5/1	-	30%	SAB	fairly firm
62"-84"	C2	Sand	2.5YR 4/1	-	30% (4" bands of pebbles & cobbles within horizon)	SG	loose
84"-132"	C3	Unable to sample. Appeared to be gravelly sand with 50% course fragments including large cobbles (~6")					

APPROX. SURFACE EL:	16.00
DIMENSIONS OF PIT:	4'X12'
TOTAL DEPTH:	132"
DEPTH TO BEDROCK:	Not encountered
DEPTH TO MOTTLING:	45"
DEPTH TO ROOTS:	6"
DEPTH TO WATER:	Not encountered
ESHGT ELEVATION:	12.25
METHOD OF SAMPLE COLLECTION:	Bags

COMMENTS:

Redox may be due to restrictive soils.

TEST PIT SKETCH:



Test Pit # 5

Project Name:	Bristol Yarn Mill
Project Number:	20061150.A22
Date:	July 26, 2022
Time:	2:30 PM
Logged By:	Christina Viera, PE
Checked By:	

Contractor:	DaPonte
Operator:	
Backfill:	Native

FUSS & O'NEILL

DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0"-72"	Fill	Loamy Sand	7.5YR 2.5/1	2.5YR 3/6 24", 10%	60%	massive	firm

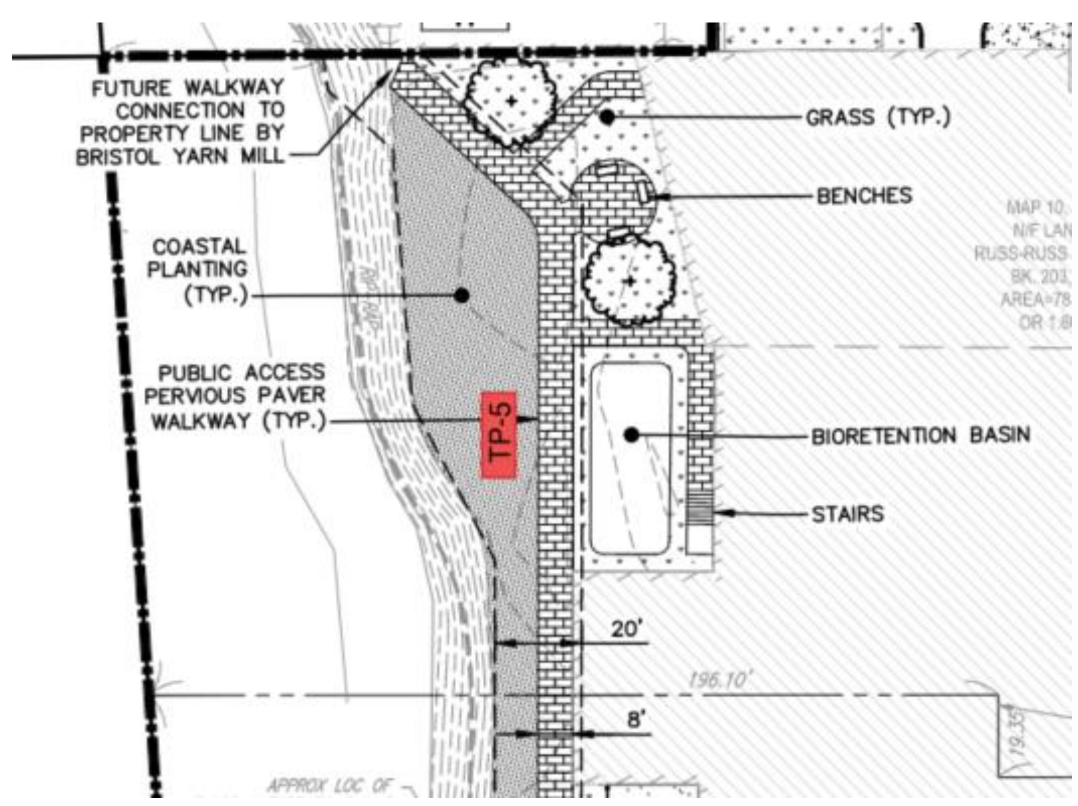
APPROX. SURFACE EL:	7.50
DIMENSIONS OF PIT:	4'X12'
TOTAL DEPTH:	72"
DEPTH TO BEDROCK:	Not encountered
DEPTH TO MOTTLING:	24"
DEPTH TO ROOTS:	6"
DEPTH TO WATER:	Not encountered
ESHGT ELEVATION:	5.5
METHOD OF SAMPLE COLLECTION:	None

COMMENTS:

Fill contains shells, stones, shale. Bricks observed near bottom of pit.

Redox could be around trees.

TEST PIT SKETCH:



Infiltration Test No. 1

Project Name:	Bristol Yarn Mill
Project Number:	20061150.A22
Date:	July 26, 2022
Time:	9:18 AM
Logged By:	Rebecca Meyers
Checked By:	Christina Viera, PE

Contractor:	DaPonte
Operator:	
Backfill:	Native

FUSS & O'NEILL

FIELD CONDITIONS

Soil Type	Silt loam
Test Pit No.	1
Depth	4'-5"
Ground Temp	Not Tested
Liquid Temp	Not Tested
Weather	Sunny, 27 Deg C
Filling Device Capacity	1 Gallon
Type of Liquid	Water
pH	Not Tested
Inner Ring Diameter	2.25"
Outer Ring Diameter	3.75"

INITIAL SATURATION

Incremental Time (min)	Incremental Depth (in)	Rate (in/hr)
0.65	4.00	369.23
12.00	0.00	0.00

Notes:
- Until relatively consistent readings.
- In slow soils, saturate for 15 minutes.

INFILTRATION TESTS

Incremental Time (min)	Incremental Depth (in)	Incremental Rate (in/hr)
15.00	0.00	0.00
15.00	0.00	0.00
15.00	0.06	0.25
15.00	0.06	0.25
Average Infiltration Rate:		0.25

Notes:
- Read every 15 minutes for a minimum of 3 tests.
- Must have 3 consecutive readings that are the same before test is finished.
- For fast soils, increase read frequency, or time how long it takes to get from 1" to 3".

COMMENTS: - See Test Pit Location Map for test pit locations

Infiltration Test No. 2

Project Name:	Bristol Yarn Mill
Project Number:	20061150.A22
Date:	July 26, 2022
Time:	11:30 AM
Logged By:	Rebecca Meyers
Checked By:	Christina Viera, PE

Contractor:	DaPonte
Operator:	
Backfill:	Native

FUSS & O'NEILL

FIELD CONDITIONS

Soil Type	Silt loam
Test Pit No.	3
Depth	4'-5"
Ground Temp	Not Tested
Liquid Temp	Not Tested
Weather	Sunny, 27 Deg C
Filling Device Capacity	1 Gallon
Type of Liquid	Water
pH	Not Tested
Inner Ring Diameter	2.25"
Outer Ring Diameter	3.75"

INITIAL SATURATION

Incremental Time (min)	Incremental Depth (in)	Rate (in/hr)
15.00	0.00	0.00

Notes:
- Until relatively consistent readings.
- In slow soils, saturate for 15 minutes.

INFILTRATION TESTS

Incremental Time (min)	Incremental Depth (in)	Incremental Rate (in/hr)
15.00	0.00	0.00
15.00	0.13	0.50
15.00	0.13	0.50
Average Infiltration Rate:		0.50

Notes:
- Read every 15 minutes for a minimum of 3 tests.
- Must have 3 consecutive readings that are the same before test is finished.
- For fast soils, increase read frequency, or time how long it takes to get from 1" to 3".

COMMENTS: - See Test Pit Location Map for test pit locations

Soil Erosion & Sediment Control Report

12/2/22

Soil Erosion and Sediment Control Report
Bristol Yarn Mill

Thames and Hope Street
Bristol, RI

Brady Sullivan Properties, LLC

670 North Commercial Street
Manchester, NH

December 2, 2022

FUSS & O'NEILL

317 Iron Horse Way, Suite 204
Providence, RI 02908

Project No. 20061150.A22

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125 Thames Street

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End of Report

A Site Location Map
B Site Preparation Plan
C RIPDES General Permit (included in Field Copy of SESC Report)
D SESC Report Inspection Report and Instructions
E SESC Report Corrective Actions Log
F SESC Report Amendments Log

1 Project Narrative

1.1 Introduction

Fuss & O'Neill, Inc. has prepared this Soil Erosion and Sediment Control (SESC) Report for construction activities associated with the Bristol Yarn Mill redevelopment project in Bristol, Rhode Island. The project includes the renovation of the existing mill building and construction of an off-site surface parking lot on the opposite side of Thames Street. The purpose of this SESC Report is to describe the erosion and sedimentation controls that shall be employed during construction of the project, and to provide appropriate maintenance measures for the controls.

This project is defined as a "construction activity" in the General Permit for the Rhode Island Discharge Elimination System (RIPDES) Stormwater Discharge Associated with Construction Activity. The contractor shall be responsible for implementing all elements of the erosion and sedimentation control measures defined within this SESC Report during construction and comply with terms and conditions of the General Permit and the Soil Erosion, Runoff, and Sediment Control Ordinance, Chapter 29 of the Bristol Rhode Island Code of Ordinances. The property owner shall be responsible thereafter. The project will not be considered complete until all disturbed areas have been satisfactorily stabilized, any erosion that has occurred on-site has been repaired, and all temporary erosion and sedimentation controls have been removed.

The SESC Report shall be stored and maintained on-site at all times during the extent of coverage under the General Permit. A copy of the General Permit is provided in *Appendix C*.

1.2 Project Description

The redevelopment of the Bristol Yarn Mill includes the renovation of the existing mill buildings to include residential apartments, commercial spaces, amenity space on the first floor, and a parking garage in the basement level. Exterior improvements include an off-site surface parking lot on the opposite side of Thames Street, a small commercial parking lot on the mill site, public access path along the Bristol Harbor shoreline, landscaping, and emergency vehicle access. The project's stormwater management system consists of tree filters, a rain garden, two subsurface filtration systems, catch basins, diversion structure, trench drains, dry swales, and oil/water separators.

1.3 Site Conditions

The Bristol Yarn Mill site is bordered by Bristol Harbor to the West, Thames Street to the East, and Constitution Street to the South. The yarn mill property is identified by the Bristol Tax Assessor as Lots 42, 60, 61, 62, and 73 of Plat 10 and is located in the waterfront PUD district. The site of the proposed parking lot is located east of Thames Street and is bordered by residential properties and businesses. The parking lot property is identified by the Bristol Tax Assessor as Lots 41, 43, 44, 49, 50, 68, 71, 74, and 76 of Plat 10 and is located in the waterfront and downtown districts. A Site Location Map is provided in *Appendix A*.

The Site is currently occupied by the Robin Rug Mill complex consisting of a four-story brick building which covers most of the site. There is a grassed area to the west of the mill buildings that slopes gradually towards a riprap revetment along Bristol Harbor. There is a paved area between the buildings in the northern portion of the property which slopes very gradually towards the north to an alley way. The site of the proposed parking lot is currently occupied by a paved parking area in the northwest corner and unpaved gravel parking and lawn throughout the rest of the site. The parking lot site slopes towards Thames Street.

According to the Natural Resources Conservation Service's (NRCS) Web Soil Survey, the Site is underlain primarily by urban land which has been assumed to be classified as hydrologic soil group (HSG) "C" based on test pit and infiltration test investigations. The proposed off-site parking area is underlain by Newport urban land complex, which is also classified as hydrologic soil group (HSG) "C".

Based on the Rhode Island Department of Environmental Management (RIDEM) Environmental Resource Map, the Site is located in the Upper East Passage Subwatershed, which is part of the Narragansett Bay Watershed. The site is not located within a Natural Heritage Area. There are no wetlands on the property. The building site lies primarily within Zone VE, an area with a 1% or greater chance of flooding and an additional hazard associated with storm waves, based on the Federal Emergency Management Agency (FEMA) Flood Map Number 44001C0014H effective July 7, 2014. The surface parking lot is located within Zone AE, an area with a 1% or greater chance of flooding, and Zone X, 0.2% annual chance flood hazard and areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile. The base flood elevation (BFE) for the site area within Zone VE is 14 feet (NAVD88) and 12 feet for the site area within Zone AE.

1.4 Construction Sequence

Refer to the General Notes and Legend sheet CN-001.

2 Erosion and Sedimentation Control

Temporary and permanent structural and nonstructural practices shall be implemented throughout the project to minimize erosion of soils from the disturbed site. These measures are proposed to provide protection against erosion and sedimentation both during and after construction. Erosion and sedimentation controls shall be continually monitored to ensure proper function. Additional controls shall be installed if conditions warrant and when directed by the property owner, representative of the property owner, or RIDEM.

Erosion and sediment control measures shall be constructed in accordance with the Rhode Island Soil Erosion and Sediment Control Handbook with latest addenda and revisions.

2.1 Vegetative Practices

- **Temporary Vegetative Cover**: Temporary vegetative cover shall be applied to exposed soils and stockpiles that have not yet reached finished grade as soon as possible, but not more than 14 days after the construction activity in that area has temporarily ceased, unless the activity is to resume within 21 days. Temporary vegetative cover shall be installed as outlined in the Rhode

Island Soil Erosion and Sediment Control Handbook between the following recommended seeding dates: April 1 to June 15 and August 15 to September 30. Temporary vegetative cover shall consist of 60% of Annual or Perennial Ryegrass and 40% of Millet or Sudangrass or 100% of Winter Rye. Optimum seeding dates for Millet and Sudangrass are between May 15 and July 15. Annual or Perennial Ryegrass shall be planted at a rate of 1.5 pounds per 1,000 square feet, Winter Rye shall be planted at a rate of 2.5 pounds per 1,000 square feet, and Millet or Sudangrass shall be planted at a rate of 1.0 pound per 1,000 square feet.

- **Mulching**: If seeding cannot be completed immediately or within the recommended seeding dates, temporary mulching will be used to protect exposed soils and stockpiles until construction activities resume or until the next seeding period. Straw mulch, wood fiber mulch, and hydromulch are recommended. Wood fiber mulch should not be used alone in the winter or during hot, dry weather. Straw mulch shall be anchored immediately after spreading to prevent wind-blowing. Mulch anchoring should also be used on slopes greater than three (3) percent and concentrated flow areas such as diversion and waterway channels.

  All mulches shall be inspected periodically, particularly after rainstorms, to check for rill erosion. Where erosion is observed, additional mulch shall be applied. If netting is used, the net should be inspected after rainstorms for dislocation or failure. If washouts or breakage occur, the net shall be reinstalled as necessary after repairing damage to slope. Inspections should take place until grasses are firmly established. Grass is considered to be firmly established at a minimum height of three (3) inches.

2.2 Structural Practices

- **Inlet Protection**: Silt sacks and/or wattle barriers shall be installed for on-site and off-site catch basins and curb inlets that may be subject to sedimentation prior to permanent stabilization of the disturbed site.

- **Construction Accesses:** Construction accesses shall be installed at all locations where construction vehicles will exit the site as depicted on the plans. If locations are relocated, the Engineer shall be informed and new construction access shall be constructed in accordance with the detail. All vehicle traffic entering or exiting the project site shall pass over the construction entrances to reduce the tracking or flowing of sediment onto the surrounding roadways.

- **Wattles**: Wattles shall be installed as shown on the plans. Wattles may be used intermittently within the limit of disturbance to minimize the areas of exposed soils contributing runoff.

2.3 Other Controls

- **Dust Control**: Dust control is proposed to prevent blowing and movement of dust from exposed soil surfaces and to reduce the presence of dust which may cause off-site damage or pose a hazard to the health of humans, wildlife, and plants. Dust control may include, but is not limited to, application of water, mulch, and/or crushed stone or coarse gravel to exposed topsoil. Water should be applied at an average application rate of one gallon of water per square yard of exposed area. The exact number of applications and amount of water used shall be based upon field and weather conditions water should not be used if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.

- **Waste Disposal:** All waste containers shall be covered to avoid contact with wind and precipitation. Materials which could be a potential source of stormwater pollution such as gasoline, diesel fuel, hydraulic oil, etc., shall be stored at the end of each day in a storage trailer or covered location and taken off-site and properly disposed of. All types of waste generated at this site shall be disposed of in a manner consistent with State Law and/or regulations.

- **Street Sweeping:** The contractor is responsible for sweeping adjacent walks and roadway(s) during and at the completion of construction. Paved areas should be inspected and swept prior to rain events. Trash, sediment, and construction debris within the street shall be removed and disposed of in accordance with applicable local, state, and federal guidelines and regulations.

- **Staging and Stockpiling:** Stockpiles of any construction material shall not be located outside the designated staging area. Stockpiles shall not have side slopes greater than 30%, and stockpiles of erodible material shall be seeded and ringed with perimeter controls specified in the Rhode Island Soil Erosion and Sediment Control Handbook. Excavated soil will be loaded into a dump truck or containers staged outside of the excavation work area. If soil needs to be stockpiled on-Site prior to disposal, it will be placed on and covered by polyethylene sheeting in a dedicated staging location. Migrated stockpiled materials shall not be swept or washed onto impervious surfaces or into any drainage inlet.

  All chemicals and/or hazardous waste material must be stored properly and legally in covered areas, with containment systems constructed in or around the storage areas. Areas must be designated for materials delivery and storage.

- **Designated Washing and Fueling Areas:** Fueling, maintenance, and washing of vehicles and equipment should be conducted off-site when feasible. If any of these activities occur on-site, they shall take place in designated areas approved by the engineer in order to prevent pollutants from being discharged to surface or ground waters. Absorbent spill cleanup materials shall be made available on-site. Designated fueling and maintenance areas shall be located away from catch basins and shall protected with berms and dikes from run-on, run-off, and to contain spills.

- **Good Housekeeping**: The project site shall provide for the minimization of exposure of construction debris (including, but not limited to, insulation, wiring, paints and paint cans, solvents, wall board, etc.) to precipitation by means of disposal and/or proper shelter or cover. In addition, construction waste shall be properly disposed of in order to avoid exposure to precipitation at the end of each working day.

3 Maintenance

The Contractor is responsible for the maintenance and/or replacement of all temporary and permanent erosion and sedimentation control devices and Best Management Practices (BMPs) to ensure proper operation throughout the life of the project. The Contractor is responsible for the maintenance of permanent measures until construction of the project is completed. The Owner is responsible thereafter.

3.1 Inlet Protection

Silt sacks and straw bales installed in and around drain inlets shall be inspected at least once every seven (7) calendar days and within 24 hours after any storm event which generates at least 0.25 inches of rainfall per 24-hour period and/or after a significant amount of runoff. Silt sacks should be inspected for tears in the fabric barrier and replaced immediately upon discovery of failure. Sediment removal shall be performed in accordance with the manufacturer's instructions. Straw bale inlet protection should be replaced once every month until the area is stabilized.

3.2 Construction Accesses

All proposed construction accesses shall be maintained in a condition that will prevent tracking or flowing of sediment onto the surrounding roadways. This will require periodic top dressing with additional stone or additional length as conditions demand and repair or replacement of any measures used to trap sediment. All sediment spilled, dropped, washed, or tracked onto the surrounding roadways shall be removed immediately.

3.3 Dust Control

It shall be the Contractor's responsibility to control dust and take all necessary measures to ensure all roads are maintained in a dust free condition at all times throughout the life of the contract. The contractor shall provide a water truck on the site for the duration of the site construction, or until exposed soils are protected from wind or water erosion. Repetitive treatments shall be applied as necessary.

3.4 Wattles

Inspection shall be made after each storm event and repair or replacement shall be made promptly as needed. Accumulated sediment shall be removed when sediment behind the wattles reaches one-half of the original height of the barrier. Wattles that are deteriorated or otherwise ineffective shall be replaced.

4 Spill Prevention and Control

4.1 Prohibited Discharges

In accordance with Part III.J.2.a of the RIPDES Construction General Permit, the following discharges are prohibited at the construction site:

- Contaminated groundwater, unless authorized by DEM.
- Wastewater from washout of concrete, unless the discharge is contained and managed appropriately.
- Wastewater from washout of stucco, paint, form release oils, curing compounds, and other construction materials.
- Fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance.
- Soaps or solvents used in vehicle and equipment washing.
- Toxic or hazardous substances from a spill or other release.

4.2 Spill Prevention and Response Procedure

Any inadvertent or deliberate discharge of waste oil or any other pollutant to the stormwater disposal system requires immediate notification to the RIDEM Oil Pollution Control Program at (401) 277-2284, as per the Oil Pollution Control Regulations. During non-working hours, notification of spills can be made to the RIDEM Division of Enforcement at (401) 277-3070 (the 24-hour emergency response phone number).

Any incident of groundwater contamination resulting from the improper discharge of pollutants to the stormwater disposal system shall be the responsibility of the property owner as well as any other parties that the RIDEM determines to be responsible for the contamination. Pursuant to State Laws and Regulations, the RIDEM may require the property owner and other responsible parties to remediate any incidents that may adversely impact groundwater quality.

The Owner shall create a maintenance log, showing the date, time, name of inspector, inspection comments, and any actions taken. The Owner shall be responsible for remediating incidents that adversely impact groundwater quality.

4.3 Control of Allowable Non-Stormwater Discharges

If allowable non-storm water discharges occur at the site, such discharges shall be visually observed and recorded as outlined in accordance with Part II of the General Permit in Appendix C. The list of potential sources of allowable non-stormwater discharges for this project is as follows:

- Discharge from vehicle wash-down where no detergents are used
- The use of water to control dust

- Watering of temporary or permanent vegetative cover
- Pumping of uncontaminated groundwater to a temporary dewatering basin
- Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred (unless all spilled materials have been removed) and where detergents are not used.

5 Inspection

All stormwater control measures, disturbed areas, areas used for the storage of materials that are exposed to precipitation (including soil stockpiles), discharge locations, and locations where vehicles enter and exit the site, shall be inspected by or under the supervision of the permittee at least once every seven (7) calendar days and within 24 hours after any storm event that generates at least 0.25 inches of rainfall per 24 hour period and/or after a significant amount of runoff. The site shall be inspected for evidence of, or the potential for, pollutants entering the waters of the State or a separate storm sewer system. All BMPs shall be maintained to prevent uncontrolled releases of measurable amounts of sediment or sediment laden water from traveling beyond the limits of disturbance.

If an inspection reveals a discharge of sediments to the waters of the State or a separate storm sewer system, the permittee shall notify the RIDEM of the nature of the discharge, the measures taken to clean up the discharge, and the measures taken to prevent future releases. Based on the results of the inspections, this SESC Report shall be revised as appropriate, but in no case later than seven calendar days following the inspection. Such modifications shall provide for implementation of any changes to the SESC Report within seven calendar days following the inspection.

A report summarizing the scope of the inspection, name(s), and titles of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the SESC Plan, and actions shall be made and retained as part of the SESC Report for at least five years from the date that the site has undergone final stabilization. Reports shall identify any incidents of non-compliance. Where a report does not identify any incidents of noncompliance, the report shall contain a certification that the site is in compliance with the SESC Report and this permit. The report shall be signed in accordance with Part V. G. of the General Permit which has been included in *Appendix C*.

5.1 Corrective Actions

If, in the opinion of the designated site inspector, corrective action is required, the inspector shall inform the site operator that corrective action is necessary. The site operator must make all necessary repairs whenever maintenance of the erosion and pollution controls is required. Non-compliance issues shall be addressed no later than seven (7) calendar days from the date of inspection.

In accordance with the SESC Report, the site operator shall commence with the requisite cleaning and maintenance measures no later than the next consecutive calendar day after receiving notification from the designated site inspector, and shall aggressively and expeditiously perform such cleaning and maintenance work until the original problem is remedied.

The corrective action log contained in each inspection report must be completed, signed, and dated by the site operator once all necessary repairs have been completed.

6 Party Certifications

(Prior to site disturbance, during pre-construction meeting, all parties must sign this certification statement before construction may begin.)

All parties working at the project site are required to comply with the Soil Erosion and Sedimentation Control (SESC) Report for any work that is performed on-site. The site owner, site operator, contractors and sub-contractors are encouraged to advise all employees working on this project of the requirements of the SESC Report. A copy of the SESC Report may be obtained by contacting the site owner or site operator.

The site owner and site operator and each subcontractor engaged in activities at the construction site that could impact stormwater must be identified and sign the following certification statement.

I acknowledge that I have read and understand the terms and conditions of the SESC Report for the above designated project and agree to follow the practices described herein.

Applicant/Owner SESC Contact

Company:
Name and Title:
Address: ______________________________
City, State, Zip Code: Signature/Date
Telephone:
E-mail:

Contractor (Site Operator)

Company:
Name and Title:
Address: ______________________________
City, State, Zip Code: Signature/Date
Telephone:
E-mail:

Designated Site Inspector

Company:
Name and Title:
Address: ______________________________
City, State, Zip Code: Signature/Date
Telephone:
E-mail:

SESC Report Contact

Fuss & O'Neill, Inc.
Shawn M. Martin, PE
317 Iron Horse Way, Suite 204 ______________________________
Providence RI 02908 Signature/Date
401-861-3070
smartin@fando.com

7 Operator Certification

(Prior to site disturbance, during pre-construction meeting, all Operator must sign this certification statement before construction may begin.)

I certify under penalty of law that this document and all attachments were prepared under the direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete.

I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I am aware that it is the responsibility of the owner/operator to implement and amend the SESC Report as appropriate in accordance with the requirements of the RIPDES Construction General Permit.

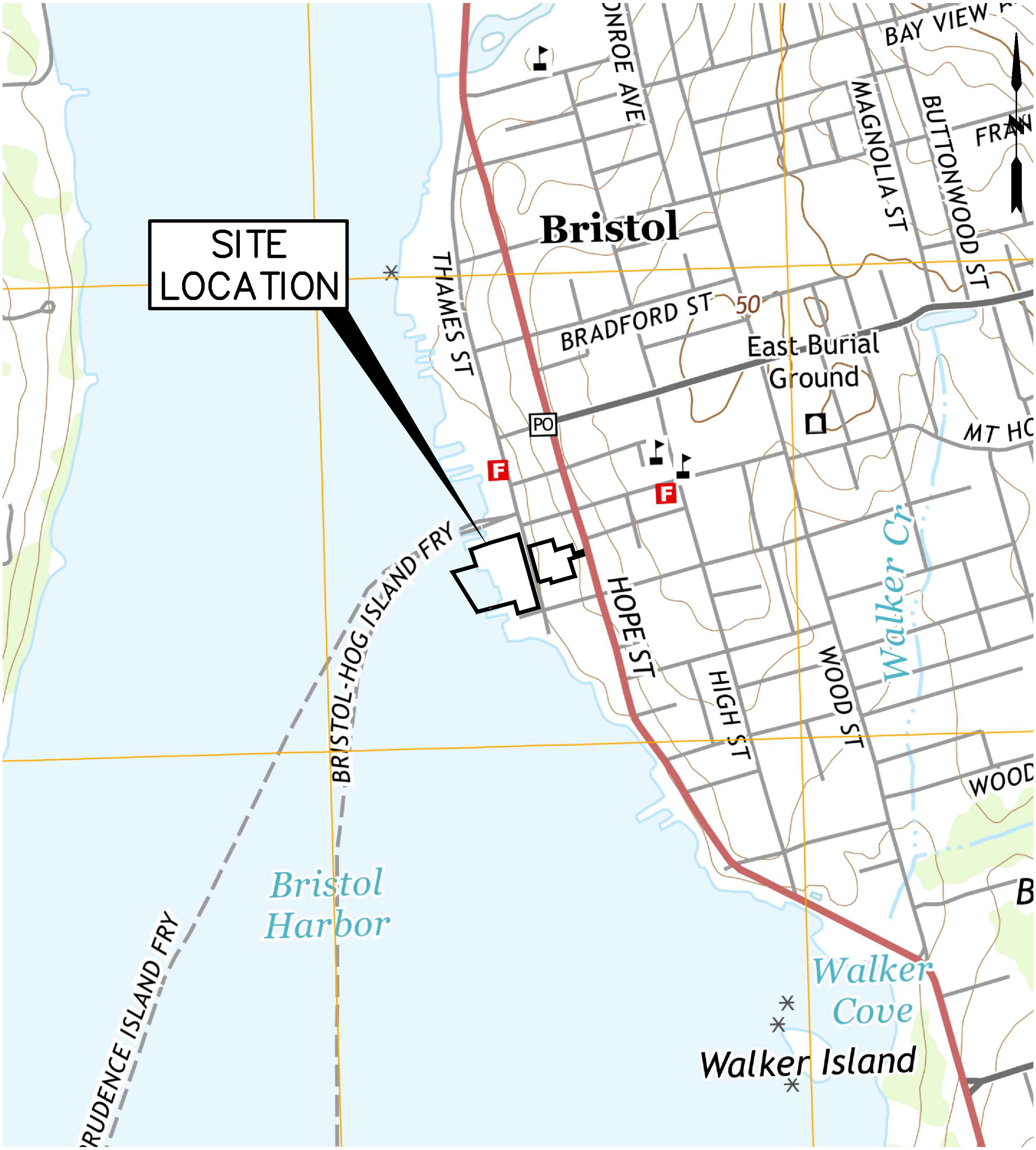
______________________________ ________________

Operator Signature: Date

Contractor Representative:
Contractor Title:
Contractor Company Name:

Appendix A

Site Location Map



REFERENCE:

THIS MAP WAS PREPARED FROM THE FOLLOWING 2015 USGS TOPOGRAPHIC MAPS OF RHODE ISLAND. SOURCE: THE RHODE ISLAND GEOGRAPHIC INFORMATION SYSTEM (RIGIS).

SCALE:	FUSS & O'NEILL 317 IRON HORSE WAY, SUITE 204 PROVIDENCE, RI 02908 401.861.3070 www.fando.com	BRADY SULLIVAN PROPERTIES, LLC. BRISTOL YARN MILL PROJECT LOCATION MAP 125 THAMES STREET BRISTOL, RHODE ISLAND	PROJ. No.: 20061150.A22 DATE: MAY 2022 FIGURE 1
HORZ.: 1"= 1000' VERT.: DATUM: HORZ.: VERT.: 0 500 1000 GRAPHIC SCALE			

Appendix B

Site Preparation Plan and Details

PLANNING BOARD APPROVAL	
PLANNING BOARD CHAIR OR DESIGNEE	DATE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SEAL

SHAWN M. MARTIN
No. 7487
REGISTERED PROFESSIONAL ENGINEER (CIVIL)
12/6/22

SEAL

SCALE:
HORZ.: 1"= 40'
VERT.:
DATUM:
HORZ.:NAD 1983
VERT.:NAD 1988
40 20 0 40
GRAPHIC SCALE

FUSS & O'NEILL
317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

BRADY SULLIVAN PROPERTIES, LLC

SOIL EROSION AND SEDIMENTATION CONTROL PLAN

BRISTOL YARN MILL

125 THAMES STREET BRISTOL, RHODE ISLAND

PROJ. No.: 20061150.A22
DATE: NOVEMBER 29, 2022

CE-101

SHEET 7 OF 26

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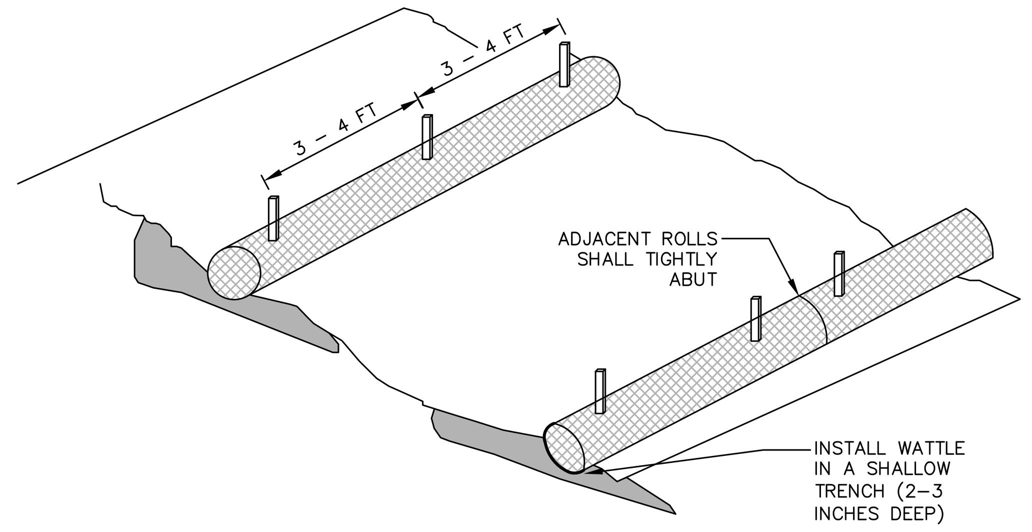
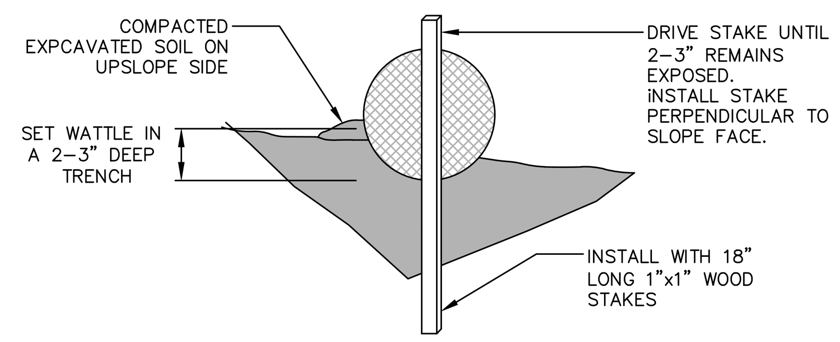


TYPICAL WATTLE INSTALLATION GUIDE

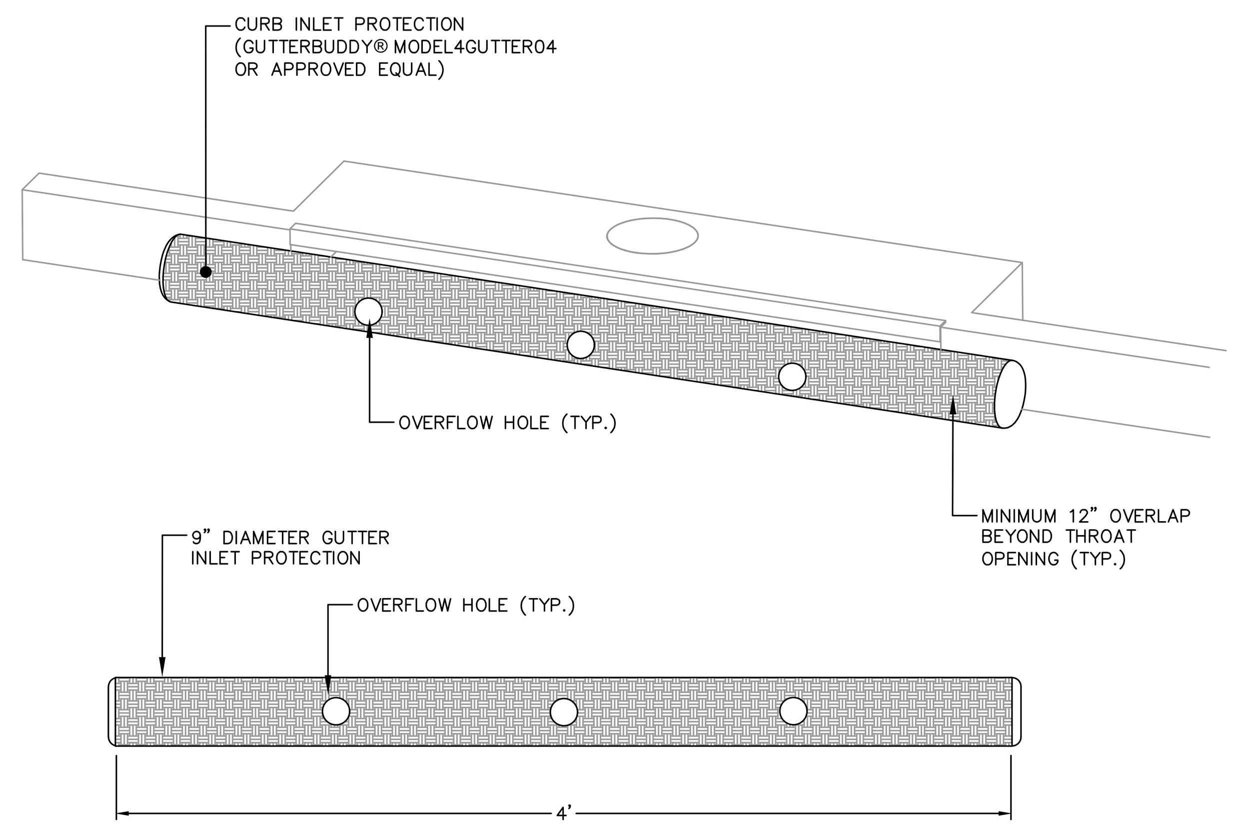


ENTRENCHMENT

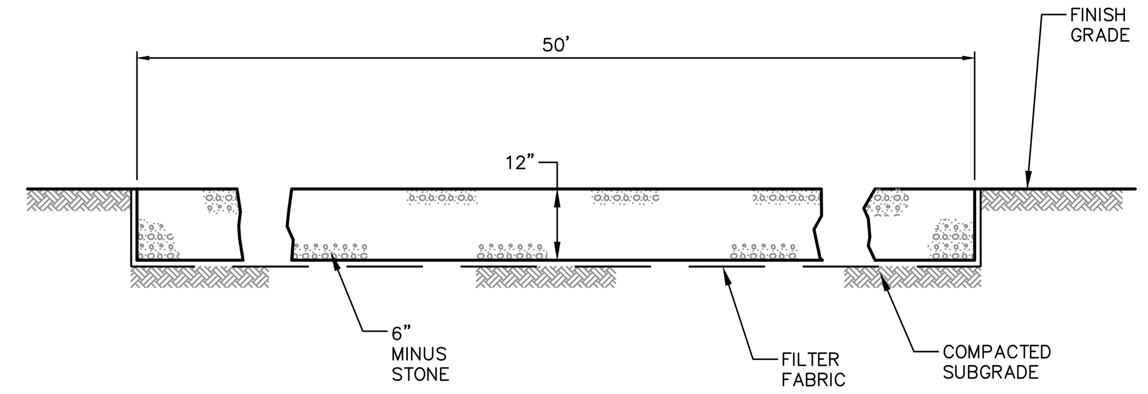
NOTES:

1. WATTLES SHALL BE TRENCHED APPROXIMATE 2–3 INCHES AND STAKED SUCH THAT WATTLES DIRECTLY CONTACT SOIL AND PRECLUDE UNDERMINING OR BLOWOUTS. THE TRENCH SHALL BE APPROXIMATELY 9 INCHES WIDE. STAKES SHALL BE DRIVEN THROUGH THE CENTER OF THE WATTLE AT A SPACING OF 3–4 FEET ON CENTER AND NO GREATER THAN 6" FROM THE EACH END OF THE WATTLE. STAKES SHALL BE 1–INCH BY 1–INCH WOODEN STAKES WITH A LENGTH OF 18 INCHES. COMPACT SOIL EXCAVATED TO CREATE TRENCH ON UPHILL SIDE SIDE.
2. ENDS OF ADJACENT WATTLES SHALL BE TIGHTLY BUTTED OR OVERLAPPED SO THAT NO OPENING EXISTS FOR WATER TO PASS THROUGH. WATTLES SHALL BE FREE OF DAMAGE OR DEFECTS WHEN DELIVERED TO THE SHIPPER. NO VEHICLES SHALL BE DRIVEN OVER WATTLES.
3. WATTLES SHALL BE 12–INCH SEDIMAX–FR™ FILTRATION ROLL MANUFACTURED BY NORTH AMERICAN GREEN, OR APPROVED EQUAL.

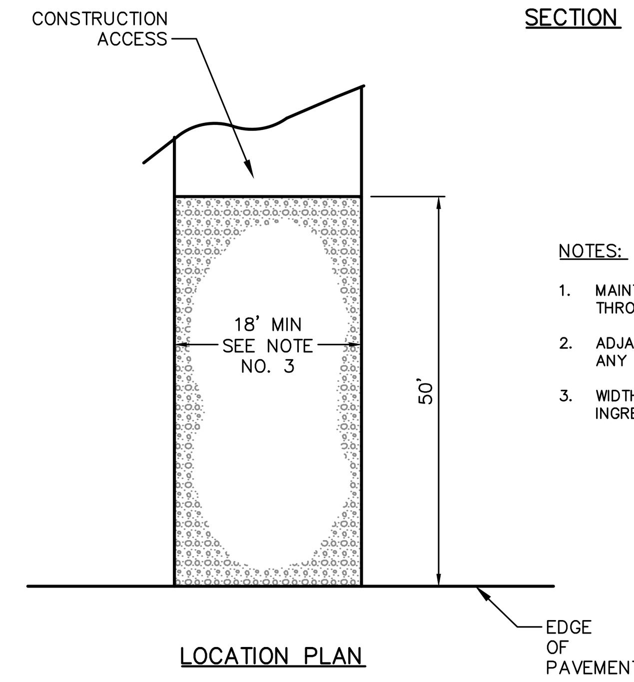
WATTLES
NOT TO SCALE



CURB INLET PROTECTION
NOT TO SCALE



SECTION

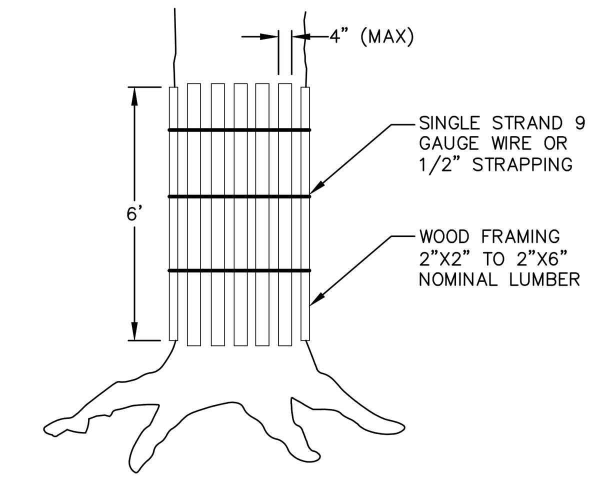


LOCATION PLAN

NOTES:

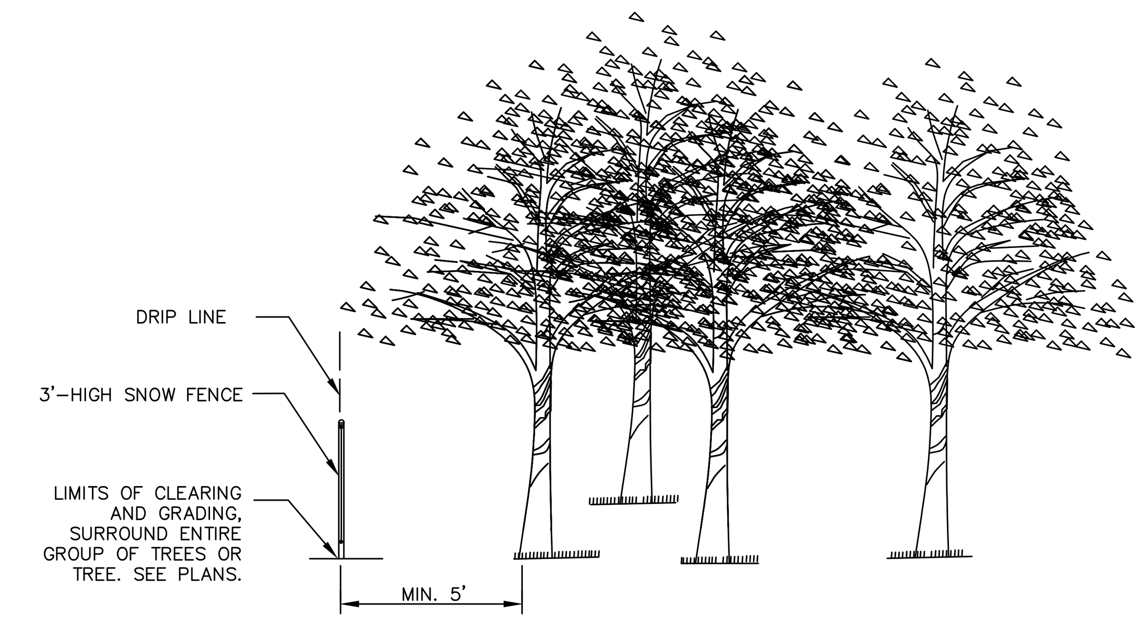
1. MAINTAIN ANTI–TRACKING APRON IN GOOD CONDITION THROUGHOUT CONSTRUCTION PERIOD.
2. ADJACENT ROADWAY SHALL BE SWEPT DAILY TO REMOVE ANY MATERIAL THAT MAY BE TRACKED ONTO PAVEMENT.
3. WIDTH OF APRON SHALL NOT BE LESS THAN WIDTH OF INGRESS OR EGRESS.

CONSTRUCTION ACCESS
NOT TO SCALE



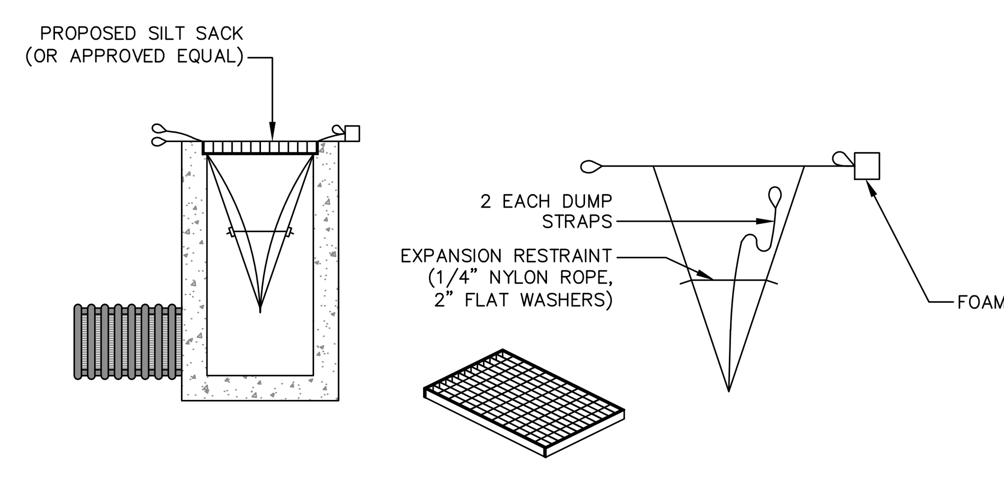
NOTE:
SHALL BE IN ACCORDANCE WITH SECTION L.11 OF THE STANDARD SPECIFICATIONS.

INDIVIDUAL TREE



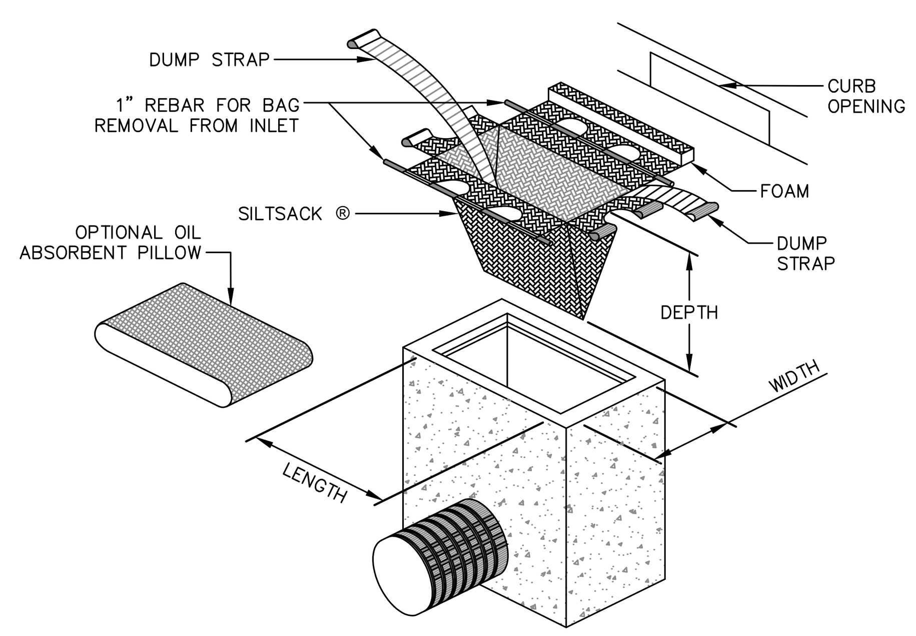
GROUPING OF TREES

TREE PROTECTION
NOT TO SCALE

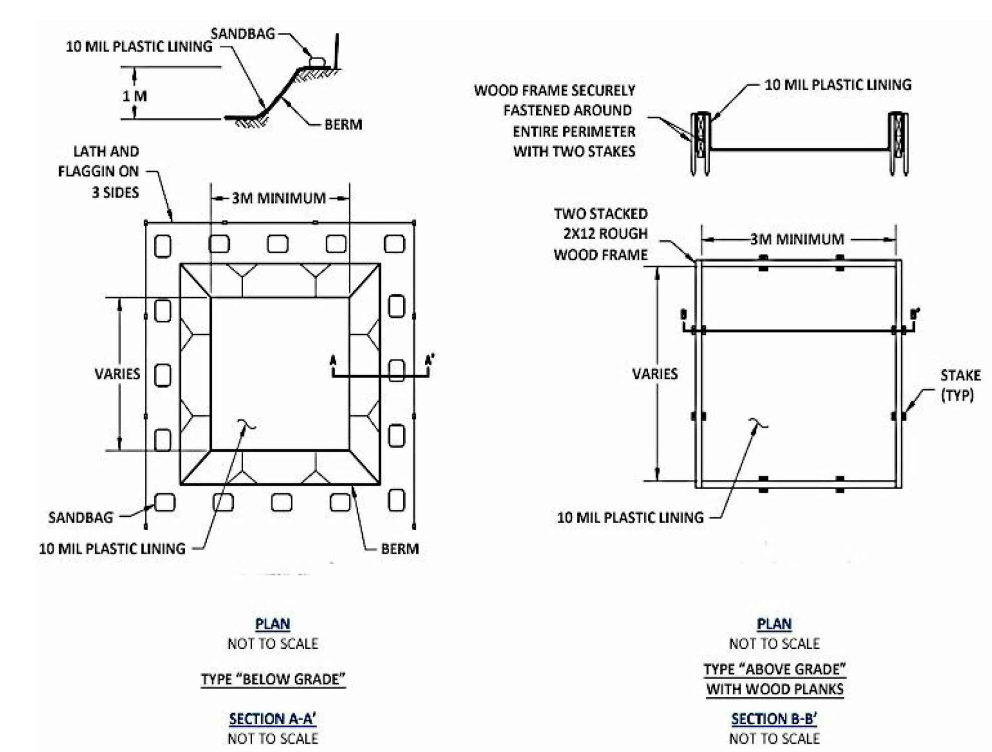


INSTALLATION DETAIL

BAG DETAIL



CATCH BASIN INLET PROTECTION
NOT TO SCALE

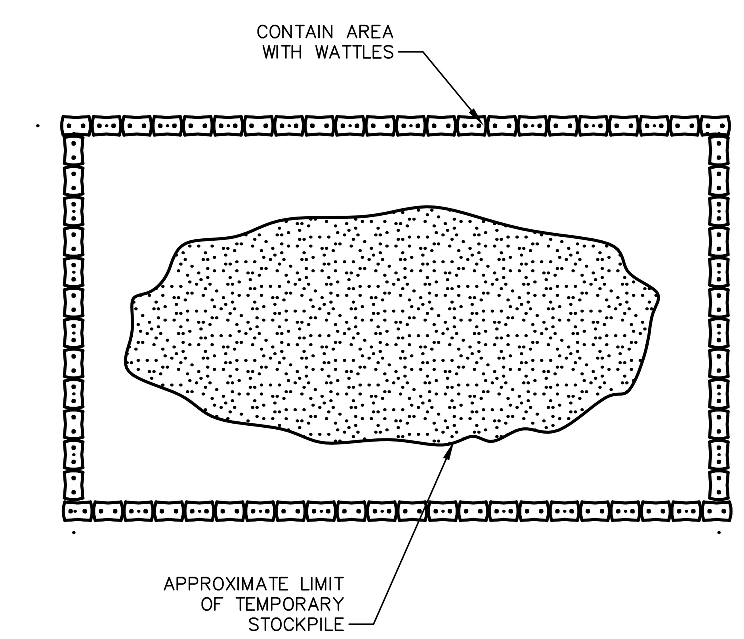


NOTES:

1. ACTUAL LAYOUT DETERMINED IN THE FIELD.
2. FOR REFERENCE PURPOSES ONLY. NOT FOR CONSTRUCTION PURPOSES.

REFERENCE:
RHODE ISLAND SOIL EROSION AND SEDIMENT CONTROL HANDBOOK, ISSUED 1989 (REVISED 2014)

TEMPORARY CONCRETE WASHOUT FACILITY
NOT TO SCALE



TEMPORARY SOIL STOCKPILE
NOT TO SCALE

PLANNING BOARD APPROVAL

PLANNING BOARD CHAIR OR DESIGNEE   DATE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SEAL
SHAWN M. MARTIN
No. 7487
REGISTERED PROFESSIONAL ENGINEER (CIVIL)
12/6/22

SEAL

SCALE:
HORZ.: AS NOTED
VERT.:
DATUM:
HORZ.:
VERT.:
0
GRAPHIC SCALE

FUSS & O'NEILL
317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

BRADY SULLIVAN PROPERTIES, LLC

CIVIL DETAILS

BRISTOL YARN MILL

125 THAMES STREET   BRISTOL, RHODE ISLAND

PROJ. No.: 20061150.A22
DATE: NOVEMBER 29, 2022

CD-501

SHEET 16 OF 26

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MS VIEW:
LAYER STATE:

Appendix C

RIPDES General Permit
(included in Field Copy of SESC Report)

Appendix D

SESC Report Inspection Report and Instructions

SESC Plan Inspection Report Instructions

For all projects with at least one (1) acre of soil disturbance, the site owner and operator are required to develop and comply with a site specific Soil Erosion and Sediment Control Plan (SESC Plan) in order to remain in compliance with the Rhode Island Pollutant Discharge Elimination System (RIPDES) General Permit for Stormwater Discharges Associated with Construction Activity (RIPDES Construction General Permit).

This inspection report template has been provided by RIDEM for use by the site operator and designated inspector to document the erosion, runoff, and sediment control conditions at the construction site. It should be customized to meet the requirements in the RIPDES Construction General Permit and the site specific SESC Plan.

Using the Inspection Report

This inspection report is designed to be customized according to the control measures and conditions at the site. On a copy of the site plan, number all stormwater control measures and areas of the site that will be inspected. Include both structural (basins, outlet protection, swales, etc.) and non-structural (construction entrances, perimeter barriers, trash areas, etc.) control measures and areas that will be inspected. Also, identify all point source discharges/outfalls, areas of highly erosive soils, and the priority natural resource areas (i.e. streams, wetlands, mature trees, etc). List each control measure or area to be inspected separately in the site-specific control measure section of the inspection report.

Complete any items that will remain constant, such as the project information and control measure locations and descriptions. Then, print out multiple copies of this customized inspection report to use during the inspections.

When conducting the inspection, walk the site by following the site map and numbered control measure locations for inspection. Also note whether the overall site issues have been addressed. Customize this list according to the conditions at the site.

Minimum Monitoring and Reporting Requirements

All stormwater control measures, disturbed areas, areas used for the storage of materials that are exposed to precipitation (including unstabilized soil stockpiles), discharge locations, and locations where vehicles enter or exit the site must be inspected at least once every seven (7) calendar days and within twenty-four (24) hours after any storm event, which generates at least 0.25-inches of precipitation per twenty four (24) hour period and/or after a significant amount of runoff or snowmelt. An appropriate rain gauge (as may be found on www.wunderground.com or www.nws.noaa.gov (or similar sites)) must be identified and utilized for the determination of the storm events.

General Notes

- A separate inspection report will be prepared for each inspection.
- The Inspection Reference Number shall be a combination of the RIPDES Permit Authorization Number - consecutively numbered inspections. ex/ Inspection reference number for the **4**th inspection of a project would be: RIR10####-**4**
- Each report will be signed and dated by the inspector and forwarded to the site operator within 24 hours of the inspection.
- Each report will be signed and dated by the site operator and returned to the inspector within 24 hours of receipt.
- It is the responsibility of the site operator to maintain a copy of the SESC Plan, copies of all completed inspection reports, and amendments as part of the SESC Plan documentation at the site during construction.

Corrective Actions

If the SESC Plan Inspection determines that corrective actions are necessary to install or repair control measures, the resultant actions taken must be documented by the site operator. The actions must be recorded in the Corrective Action Log attached to each SESC Plan inspection form. If the site operator disagrees with the corrective action recommendations, it must be documented, with justifiable reasons, in the Corrective Action Log, as well.

Amendments

All SESC Plan Amendments, except minor non-technical revisions, must be approved by the site owner and site operator. The revision must be recorded in the Record of Amendments Log Sheet within the SESC Plan, and dated red-line drawings and/or a detailed written description of the revision must be appended to the SESC Plan. Inspection forms must be revised to reflect all amendments. Update the *Revision Date* and the *Version #* in the footer of the report to reflect amendments made.

The SESC Plan shall be amended whenever there is a change in design, construction, operation, maintenance or other procedure, which has a significant effect on the potential for the discharge of pollutants, or if the SESC Plan proves to be ineffective in achieving its objectives.

******Remember that the regulations are performance-oriented. Even if best management practices are installed on a site according to the approved plan, the site is only in compliance when erosion, runoff, sedimentation, and pollution are effectively controlled.******

SESC Plan Inspection Report

Project Information			
Name			
Location			
DEM Permit No.			
Site Owner	Name	Phone	Email
Site Operator	Name	Phone	Email
Inspection Information			
Inspector Name	Name	Phone	Email
Inspection Date		**Start/End Time**	
Inspection Type ❑ Weekly ❑ Pre-storm event ❑ During storm event ❑ Post-storm event ❑ Other			
Weather Information			
Last Rain Event Date: Duration (hrs): Approximate Rainfall (in):			
Rain Gauge Location & Source:			
Weather at time of this inspection:			

<u>Check statement that applies then sign and date below:</u>

☐ **I, as the designated Inspector, certify that this site has been inspected and is in compliance with the site SESC Plan and the RIPDES Construction General Permit.**

☐ **I, as the designated Inspector, certify that this site has been inspected and I have made the determination that the site requires corrective actions before it will be compliant with the site SESC Plan and the RIPDES Construction General Permit. The required corrective actions are noted within this inspection report.**

Inspector:	Print Name	Signature	Date

The Site Operator (identified in the permit application) acknowledges the receipt of this SESC Plan inspection report, and understands the requirements set forth in the RIPDES Construction General Permit regarding the implementation and maintenance of erosion, runoff, and sedimentation controls and pollution prevention measures.

Operator:	Print Name	Signature	Date

Site-specific Control Measures

Number the structural and non-structural stormwater control measures identified in the SESC Plan on the site map and list them below (add as necessary). Bring a copy of this inspection form and numbered site map with you during your inspections. This list will help ensure that you are inspecting all required control measures at your site.

FILL THIS TABLE USING THE SESC PLAN TABLES 2.13 & 3.14.

	Location/Station	Control Measure Description	Installed & Operating Properly?	Assoc. Photo/ Figure #	Corrective Action Needed (Yes or No; if 'Yes', please detail action required)
1			❑Yes ❑No		
2			❑Yes ❑No		
3			❑Yes ❑No		
4			❑Yes ❑No		
5			❑Yes ❑No		
6			❑Yes ❑No		
7			❑Yes ❑No		
8			❑Yes ❑No		
9			❑Yes ❑No		
10			❑Yes ❑No		
11			❑Yes ❑No		
12			❑Yes ❑No		
13			❑Yes ❑No		
14			❑Yes ❑No		
15			❑Yes ❑No		

	Location/Station	Control Measure Description	Installed & Operating Properly?	Assoc. Photo/ Figure #	Corrective Action Needed (Yes or No; if 'Yes', please detail action required)
16			❑Yes ❑No		
17			❑Yes ❑No		
18			❑Yes ❑No		
19			❑Yes ❑No		
20			❑Yes ❑No		
21			❑Yes ❑No		
22			❑Yes ❑No		
23			❑Yes ❑No		
24			❑Yes ❑No		
25			❑Yes ❑No		
26			❑Yes ❑No		
27			❑Yes ❑No		
28			❑Yes ❑No		
29			❑Yes ❑No		
30			❑Yes ❑No		

(add more as necessary)

Overall Site Issues

Below are some general site issues that should be assessed during inspections. Please customize this list as needed for conditions at the site. If item is not applicable, please note why.

	Location/Station		Assoc. Photo/ Figure #	Corrective Action Needed (If 'Yes', please detail action required and include location/station)
1	Have Limits of Disturbance been properly marked and maintained?	❑Yes ❑No ❑ N/A		
2	Have perimeter controls and sediment barriers been adequately installed and maintained?	❑Yes ❑No ❑ N/A		
3	Are storm drain inlets properly protected?	❑Yes ❑No ❑ N/A		
4	Are natural resource areas (e.g., streams, wetlands, trees, etc.) protected with barriers or similar best management practices (BMPs)?	❑Yes ❑No ❑ N/A		
5	Have graveled access entrance and exit drives and parking areas been installed and maintained?	❑Yes ❑No ❑ N/A		
6	Have sediment controls been installed on all steep side slopes and down slopes that are disturbed, especially those adjacent to property lines, drainage conveyances/inlets or water bodies?	❑Yes ❑No ❑ N/A		
7	Are all steep slopes and disturbed areas not actively being worked properly stabilized?	❑Yes ❑No ❑ N/A		
8	Have soils been stabilized where final grading is complete and land disturbance activities have permanently ceased?	❑Yes ❑No ❑ N/A		
9	Have soils been stabilized where land disturbance activities have been halted temporarily and are not planned to resume within the next fourteen (14) days?	❑Yes ❑No ❑ N/A		
10	Have soil/gravel stockpiles been stabilized or isolated?	❑Yes ❑No ❑ N/A		
11	Are building materials which possess an elevated pollution potential stored inside or under cover?	❑Yes ❑No ❑ N/A		
12	Are stockpiles of construction wastes properly covered or disposed of to reduce exposure?	❑Yes ❑No ❑ N/A		
13	Are washout facilities (e.g. paint, concrete) available, clearly marked, and maintained?	❑Yes ❑No ❑ N/A		

	Location/Station		Assoc. Photo/ Figure #	Corrective Action Needed (If 'Yes', please detail action required and include location/station)
14	Are vehicle and equipment fueling, cleaning, and maintenance areas free of spills, leaks, or any other deleterious material?	❑Yes ❑No ❑ N/A		
15	Are hazardous materials spill kits in place and are there enough materials as prescribed in the SESC Plan to adequately prevent spills from entering any stormwater drainage systems?	❑Yes ❑No ❑ N/A		
16	Have provisions been made for wind erosion and dust control?	❑Yes ❑No ❑ N/A		
17	Have areas of obvious erosion/channelization been repaired?	❑Yes ❑No ❑ N/A		
18	Are receiving conveyance systems and receiving waters at discharge points free of sediment deposition?	❑Yes ❑No ❑ N/A		
19	Is there evidence of sediment being tracked into the street or off-site?	❑Yes ❑No ❑ N/A		
20	Are non-stormwater discharges (e.g., wash water, dewatering) properly controlled?	❑Yes ❑No ❑ N/A		
21	Are post-construction stormwater practices protected from sedimentation prior to final stabilization and bringing them online?	❑Yes ❑No ❑ N/A		
22	Are infiltrating stormwater practices and qualifying pervious areas protected during construction activities to avoid compacting soil?	❑Yes ❑No ❑ N/A		
23	(Other)	❑Yes ❑No ❑ N/A		

(add more as necessary)

General Field Comments:

Photos:
(Associated photos – each photo should be dated and have a unique identification # and written description indicating where it is located within the project area. If a close up photo is required, it should be preceded with a photo including both the detail area and some type of visible fixed reference point. Photos should be annotated with Station numbers and other identifying information where needed.)

Photo #:	Station:
(insert Photo here)	Description:

Photo #:	Station:
(insert Photo here)	Description:

Photo #:	Station:
(insert Photo here)	Description:

Photo #:	Station:
(insert Photo here)	Description:

Photo #:	Station:
(insert Photo here)	Description:

Photo #:	Station:
(insert Photo here)	Description:

(add more as necessary)

Corrective Action Log

TO BE FILLED OUT BY SITE OPERATOR

Describe repair, replacement, and maintenance of control measures, actions taken, date completed, and note the person that completed the work.

	Location/Station	Corrective Action	Date Completed	Person Responsible

Operator Signature: **Date:**

Appendix E

SESC Report Corrective Actions Log

PROJECT: ***INSPECTION DATE:***

Corrective Action Log

TO BE FILLED OUT BY SITE OPERATOR

Describe repair, replacement, and maintenance of control measures, actions taken, date completed, and note the person that completed the work.

	Location/Station	Corrective Action	Date Completed	Person Responsible

Operator Signature:		**Date:**

Appendix F

SESC Report Amendments Log

PROJECT:

SESC Plan Amendment Log

Describe amendment(s) to be made to the SESC Plan, the date, and the person/title making the amendment. ALL amendments must be made by Site Operator and approved by the Site Owner.

#	Amendment Date	Description of Amendment	Amended by: Person/Title	Site Owner Must Initial
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Long-Term Operation & Maintenance Report

12/2/22

Long-Term Operation and Maintenance Report
Bristol Yarn Mill

Thames and Hope Street
Bristol, RI

Brady Sullivan Properties, LLC

670 North Commercial Street
Manchester, NH

December 2,2022

FUSS & O'NEILL

317 Iron Horse Way, Suite 204
Providence, RI 02908

Project No. 20061150.A22

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Bristol Yarn Mill

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1 Site Location Map

Appendices End of Report

A BMP Location Map
B Operation, Maintenance, and Management Inspection Checklists
C Sample Maintenance Agreement
D Silva Cell Operation and Maintenance Manual

1 Introduction

The purpose of this Long-Term Operation and Maintenance Report (O&M Report) is to outline the requirements for stormwater source control and pollution prevention for the Bristol Yarn Mill Redevelopment in Bristol, Rhode Island. The proposed project includes the renovation of the existing mill buildings to include residential apartments, commercial spaces, amenity space, and a parking garage on the basement level. Improvements also include an off-site parking lot on the opposite side of Thames Street along with site improvements which include public access along the shoreline and stormwater improvements. The project's stormwater management system consists of tree filters, a rain garden, two subsurface filtration systems, catch basins, trench drains, stone channels, and an oil/water separator. The site's long-term requirements include following proper site operation procedures and implementing an inspection and maintenance program to ensure the success and minimize the deterioration of the stormwater system over time. The Contractor is responsible for implementing this O&M Report during construction. The Owner is responsible thereafter. Maintenance operations shall be funded by the Owner. In the event the facility becomes owned by different entities, this Long-Term Operation and Maintenance Report shall be transferred to the future owners/operators.

2 Pollution Prevention

The following pollution prevention activities shall be conducted to minimize potential impacts on stormwater runoff quality. The Contractor is responsible for all activities during construction. The Owner is responsible thereafter.

2.1 Good Housekeeping

Good housekeeping shall be implemented to minimize the impacts to area by pollutants, soil, and fugitive sediment. The site shall be kept in good working order. Trash shall be kept in covered containers (i.e., dumpsters) to prevent waste from escaping. Fugitive litter that is deposited on the site shall be removed and placed in a proper enclosed container.

2.2 Spill Procedures

Any discharge of waste oil or other pollutant to the drainage systems shall be reported immediately to the RIDEM Groundwater Discharge Permitting Program. The owner will be responsible for any incident of groundwater contamination resulting from the improper discharge of pollutants to the drainage system and may be required by RIDEM to remediate incidents that may impact groundwater quality. Should property ownership be transferred, the subsequent owner will be informed of the legal responsibilities associated with operation of the drainage system, as indicated above.

2.3 Material Disposal

All waste material, trash, and debris shall be removed from the site and disposed of in accordance with applicable local, state, and federal guidelines and regulations.

- Materials and equipment necessary for spill cleanup will be kept in material storage areas. Equipment and materials will include but not be limited to brooms, dust pans, mops, rags, gloves, goggles, kitty litter, sand, sawdust, and plastic and metal trash containers specifically for this purpose.
- Spills will be cleaned up immediately after discovery.
- Spills of toxic or hazardous material will be reported to the appropriate State and local government agency, regardless of size.

2.4 Snow Management

Stormwater runoff caused by snow melt must be properly managed to prevent erosion and pollution. Snow management operations can vary depending on current weather patterns, available equipment, and previous storm events. Below is a general description of how snow will be managed on the site.

- Keep pedestrian and emergency routes cleared. Ensure stockpiles do not obstruct sight lines at driveway or road intersections.
- Snow removed from the parking areas will be stockpiled in the landscaped areas.
- Snow is not to be pushed or dumped into the catch basins, stone channels, rain garden, or tree filters.
- If additional on-site storage is needed, snow may be temporarily stockpiled in the parking spaces.
- Snow will be stockpiled onsite until the available capacity is exceeded, at which point it will be loaded into trucks and properly disposed of at an off-site location.

3 Inspection and Maintenance Requirements for Permanent Stormwater Controls

The following inspection and maintenance activities shall be conducted to ensure the success and minimize the deterioration of the stormwater system over time. A map depicting the location of the components of the stormwater management system is provided in *Appendix A*. Checklists to assist with the inspection and maintenance activities are provided in *Appendix B*. A Sample Stormwater Facility Maintenance Agreement is provided in *Appendix C*.

3.1 Subsurface Filtration Systems

3.1.1 Post-Construction Inspections

The subsurface filtration systems shall be inspected after every storm event larger than one inch in the first six months following construction.

3.1.2 Semi-Annual Inspection

Subsurface chambers may be inspected through manhole or optical inspection port. Remove any debris that could clog the systems. Check for standing water or other evidence of clogging by accumulated sediments. If the average sediment depth exceeds six (6) inches, cleanout is required. Any oil or grease found during inspection should be cleaned with oil absorption pads and disposed in an approved location. Refer to the StormTech Isolator Row O&M Manual, *Appendix D*, for additional subsurface infiltration system maintenance information. The StormTech chambers shall be maintained in accordance with the manufacturer's guidelines.

3.2 Tree Filters

Tree filter cells shall be repaired if the facility shows signs of damage from excessive loading, nearby construction, or other external source. Any damaged component (frame or deck) of the cells shall be replaced according to the manufacturer's instructions, and the system shall be reconstructed per the construction documents and the manufacturer's installation guidelines. The cell frames and decks shall not be cut, drilled into, or modified during any installation, inspection, or maintenance activity to the tree filter or adjacent infrastructure. Utility work adjacent to, below, or within the limits of the tree filter facility shall be performed according to manufacturer's instructions.

Tree openings shall be inspected at least once per spring and fall, and after every storm event greater than 2.7 inches over a 24-hour period (major storms). Inspections shall include checking for standing water or other evidence of clogging by accumulated sediments, debris, and/or trash. Accumulated sediment, debris, or trash on the surface shall be removed as needed.

Inlet and outlet structures shall be inspected at least annually and after major storms. Any blockages preventing water from being properly directed into or out of the filter free facility shall be removed, and the pipes shall be cleaned as needed. Distribution pipes and underdrain pipes shall be inspected annually. Any blockages in the pipes should be removed.

Trees shall be pruned as needed for safety reasons, to promote healthy growth, and to avoid conflicts with adjacent infrastructure. Pruning should be performed by a landscape professional with pruning experience and per the guidance of a certified arborist. Trees should be inspected for safety once per spring and fall, and after major storms. Tree health should inspected every spring and fall and remedied as needed. Every four to five years, trees should be inspected for girdling roots, and any girdling roots should be removed. Once annually, the tree should be inspected for soil or mulch on the root collar. The facility should be weeded as necessary on a monthly basis. Herbicides and pesticides should not be used. Mulch should be applied/replenished after weeding and as necessary to cover bare spots and areas with a mulch depth less than two inches. Vegetation should be watered as needed.

Refer to the Silva Cell Operation and Maintenance Manual, *Appendix D*, for additional tree filter system maintenance information. The Silva Cell chambers shall be maintained in accordance with the manufacturer's guidelines.

3.3 Rain Garden

3.3.1 Post-Construction Inspections

During the six months immediately after construction, the rain garden shall be inspected following at least the first two precipitation events of at least 1.0 inch to ensure that the system is functioning properly. Thereafter, inspections shall be conducted on an annual basis and after storm events of greater than or equal the 1-year, 24-hour Type III precipitation event.

Vegetation shall be watered once every two to three days for first two months, then sporadically after establishment during the first year after installation. If droughty, watering after the initial year may be required.

If the surface of the rain garden becomes clogged to the point that standing water is observed on the surface 36 hours after precipitation events, remove accumulated sediment or till the surface to breakup any hard-packed soil and then vegetate. Trash and debris shall be removed as necessary.

3.3.2 Monthly Periodic Inspections

The rain garden shall be inspected monthly for evidence for vegetation health and the presence of trash (e.g., litter, debris, etc.). Trash deposited on the surface of the rain garden shall be removed manually and shall be disposed of in accordance with applicable local, state, and federal guidelines and regulations. Mowing shall occur when vegetation reaches a height of 12" (typically two (2) to twelve (12) times per year).

3.3.3 Annual Inspection

The annual inspection of the basin should include checking for standing water or other evidence of clogging by accumulated sediments, checking inlets and outlets for signs of erosion and damage, checking the overflow structures for blockage and structural integrity, and checking the slopes of the basins for erosion or gullying.

Sediment shall be removed from the rain garden when the accumulation exceeds one inch or when there is evidence that the infiltration capacity has been significantly reduced. Sediment and debris must be removed manually with rakes rather than heavy equipment to avoid compacting. Removed sediments shall be dewatered (if necessary) and disposed of in an acceptable manner.

The top few inches of soil shall be removed and replaced with fresh material when the filtering capacity of the filter diminishes substantially (i.e., when water ponds on the surface of the filter bed for more than 48 hours). If discolored material is found below this removed surface then that material should also be removed and replaced until all discolored material has been removed. The removed sediments shall be disposed in an acceptable manner at an approved and permitted location.

Pruning or replacement of woody vegetation should occur when dead or dying vegetation is observed. Separation of herbaceous vegetation rootstock should occur when over-crowding is observed, or approximately once every 3 years. If at least 50 percent vegetation coverage is not established after two years, a reinforcement planting should be performed. The mulch layer should be replenished (to the original design depth) every other year, as directed by inspection reports. The previous mulch layer should be removed, and properly disposed of, or roto-tilled into the soil surface.

3.4 Stone Channel

3.4.1 Post-Construction Inspections

The stone channel shall be inspected after every storm event larger than one-inch in the first six months following construction. During the six months immediately after construction, the stone channel shall be inspected following at least the first two precipitation events of at least 1.0 inch to ensure that the system is functioning properly. Thereafter, inspections shall be conducted on an annual basis and after storm events of greater than or equal the 1-year, 24-hour Type III precipitation event.

Vegetation shall be watered once every two to three days for first two months, then sporadically after establishment during the first year after installation. If droughty, watering after the initial year may be required. If at least 50 percent vegetation coverage is not established after the first growing season, reinforcement planting should be installed.

If the surface of the swale becomes clogged to the point that standing water is observed on the surface 36 hours after precipitation events, remove accumulated sediment or remove stone and till the surface to breakup any hard-packed soil and then replace the stone. Trash and debris shall be removed as necessary.

3.4.2 Monthly inspection

The stone channel shall be inspected monthly for vegetation health and the presence of trash (e.g., litter, debris, etc.). Trash deposited on the surface of the stone channel shall be removed manually and shall be disposed of in accordance with applicable local, state, and federal guidelines and regulations. Mowing shall occur when vegetation reaches a height of 10" maximum. Trash and debris shall be removed upon discovery and disposed of in accordance with applicable local, state, and federal guidelines and regulations.

3.4.3 Annual Inspections

The stone channel shall be inspected annually and after every storm event greater than 2.7 inches over a 24-hour period. Inspections shall include checking for standing water or other evidence of clogging by accumulated sediments, and checking the slopes of the swales for erosion or gullying.

Materials deposited on the surface of the swales (e.g., trash and litter) should be removed manually. Sediment shall be removed from the swales when the accumulation exceeds one inch or when there is evidence that the infiltration capacity has been significantly reduced. The river stone shall be removed, sediment shall be cleaned, and the river stone shall be replaced when the filtering capacity of the filter diminishes substantially (ie., when water ponds on the surface of the filter bed for more than 48 hours). If discolored material is found below the removed stone, then that material should also be removed and replaced until all discolored material has been removed. Sediment and debris must be removed manually with rakes rather than heavy equipment to avoid compacting.

Stone channel shall be inspected for clogging on an annual basis or when water ponds on the surface of the stone channel for more than 48 hours. Removed sediments shall be dewatered (if necessary) and disposed of in an acceptable manner. Any areas within the extents of the swales that are subject to erosion or gullying shall be replenished with the original design material and re-vegetated according to design drawings.

At least every five years, the stone within the bottom of stone channel should be removed, and the sediment shall be scraped from the soil surface to restore the original cross section and infiltration rate, and the stone should be washed and replaced.

3.5 Oil/Water Separators

Oil/water separators shall be inspected at least monthly and after major storms. If the average sediment depth exceeds six (6) inches or is within six (6) inches of the outlet pipe, cleanout is required. Separators shall be cleaned at least quarterly and particularly in the fall before the first storm of the wet season. Typical cleaning includes removal of accumulated oil and grease, floatables, and sediment using a vacuum truck or other catch basin cleaning equipment. The outlet pipe of the separator must be blocked during cleaning operations.

Any oil or grease found during inspection shall be cleaned with oil absorption pads and disposed in an approved location. Polluted water or sediments removed from oil/water separators shall be disposed of in accordance with all applicable local, state, and federal laws and regulations

3.6 Drainage Structures

3.6.1 Post-Construction Inspections

Immediately prior to the end of construction and acceptance by the Owner, the Contractor shall clean all drainage structures.

3.6.2 Quarterly Inspections

Once construction is complete and has been accepted by the Owner, all drainage structures shall be inspected four times per year, at minimum. Sediment shall be removed at least twice per year, or when the depth reaches half the height between the bottom of the structure and the lowest pipe invert elevation. Inspections shall include checking for debris, sediment, and hydrocarbons, and structural integrity or damage. Deficiencies must be corrected immediately. Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations. Grates shall not be welded to the frame so the structures can be easily inspected and maintained.

3.7 Paved Area Maintenance

3.7.1 Post-Construction Inspections

The Contractor shall sweep the paved areas at the completion of construction. Snow shall not be dumped into the catch basins, stone channels, rain garden, or tree filters. Sand may be used as an abrasive to provide traction on the paved surfaces during winter months, if necessary. Accumulated sand shall be removed and disposed of in accordance with applicable local, state, and federal guidelines and regulations. It is not expected that sand will be stored onsite. However, if sand is stored onsite in the future, stockpiles shall be covered to prevent exposure to precipitation. Deicing chemicals should not be stored at the site. If chemicals are stored at the site, they shall be secured from vandalism and protected from exposure to precipitation.

3.7.2 Annual Inspections

The Owner shall sweep a minimum of once per year thereafter with a vacuum sweeper. The Owner shall sweep more frequently should conditions warrant it necessary. Trash, sediment, and debris collected shall be disposed in accordance with applicable local, state, and federal guidelines and regulations.

3.8 Landscaped Areas

Lawn areas will be mowed during the growing seasons as required to maintain a health stand of vegetation. This is typically once a week but can vary depending on weather conditions. If bagged, grass clippings are to be removed from the site and legally disposed of at an off-site location.
Fertilizers, if required for the maintenance of lawn areas, shall not be phosphorus-based, and will be applied only in the amounts recommended by the manufacturer. If kept on site, fertilizers will be stored in a covered area. The contents of any partially used bags of fertilizer will be transferred to a sealable plastic bin to avoid spills.

4 Party Certification

All parties working at the site are required to comply with the Long-Term Operation and Management Report (O&M) for any work that is performed on-site. The site owner is encouraged to advise all employees working on this site of the requirements of the O&M Report. A copy of the O&M Report may be obtained by contacting the site owner.

The site owner must sign the following certification statement.

I acknowledge that I have read and understand the terms and conditions of the O&M Report for the above designated project and agree to follow the practices described herein.

Owner

Brady Sullivan Properties, LLC
670 North Commercial Street
Manchester, NH 03101
603-622-6223

____
Signature/Date

Designated Site Inspector

Company:
Name and Title:
Address:
City, State, Zip Code:
Telephone:
E-mail:

____
Signature/Date

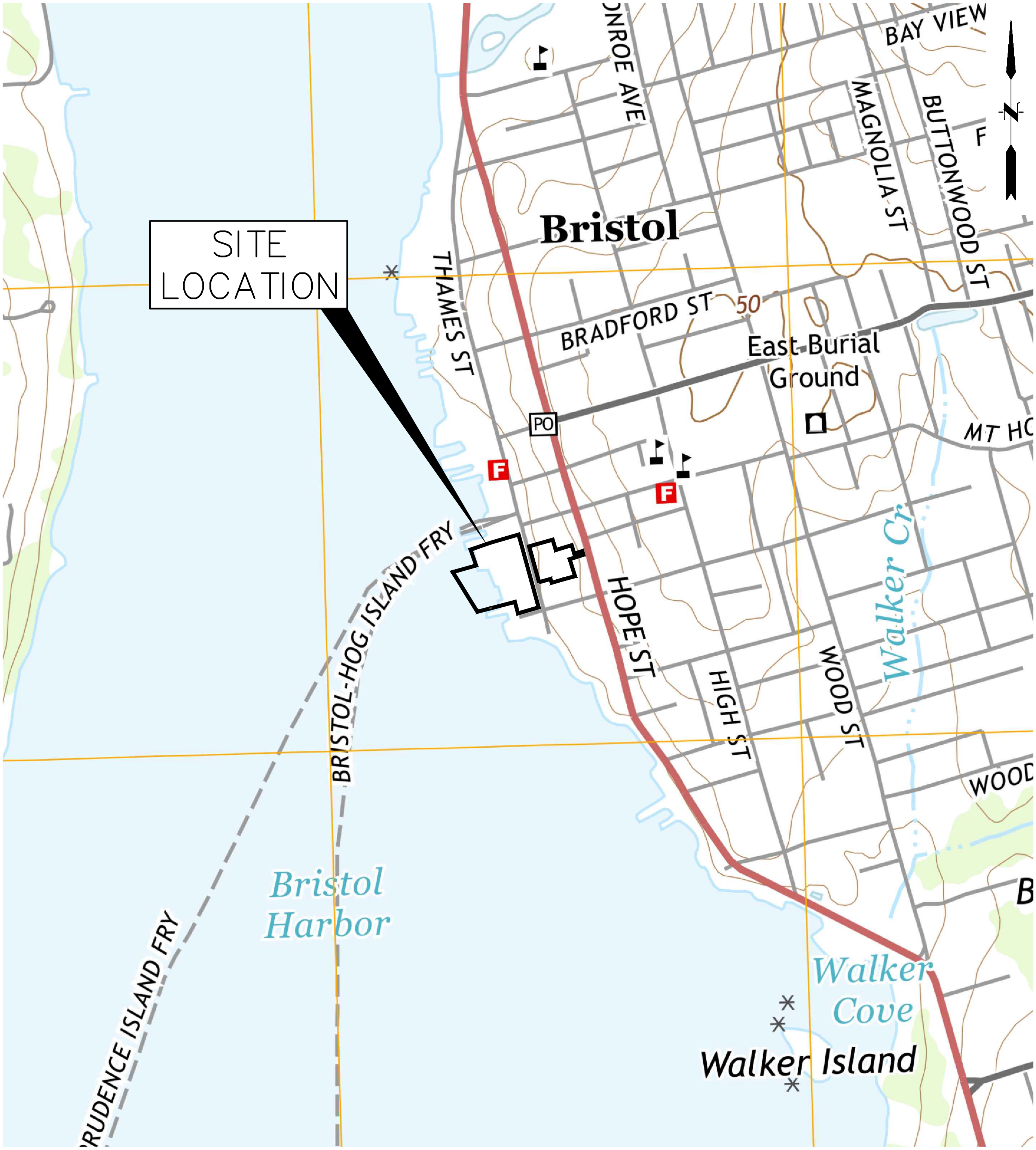
O&M Report Contact

Fuss & O'Neill, Inc.
Shawn M. Martin, PE
317 Iron Horse Way, Suite 204
Providence RI 02908
401-861-3070
smartin@fando.com

____
Signature/Date

Figure

Site Location Map



REFERENCE:

THIS MAP WAS PREPARED FROM THE FOLLOWING 2015 USGS TOPOGRAPHIC MAPS OF RHODE ISLAND. SOURCE: THE RHODE ISLAND GEOGRAPHIC INFORMATION SYSTEM (RIGIS).

SCALE:
HORZ.: 1"= 1000'
VERT.:
DATUM:
HORZ.:
VERT.:
0 500 1000
GRAPHIC SCALE

FUSS & O'NEILL
317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

BRADY SULLIVAN PROPERTIES, LLC.

LOCATION MAP
BRISTOL YARN MILL

125 THAMES STREET BRISTOL, RHODE ISLAND

PROJ. No.: 20061150.A11
DATE: NOVEMBER 2022

FIGURE 1

File: \\private\DFS\CadProj\DWG\P2006\1150\A22\Civil\Figures\20061150A22_LOC01-USGS.dwg Layout: FIGURE 1 Plotted: 2022-11-07 12:25 PM Saved: 2022-11-04 3:54 PM User: kmccombs
PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB/CTB: FO HALF.STB
MS VIEW: LAYER STATE:

Appendix A

BMP Location Map

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SEAL

SEAL

SCALE:
HORZ.: 1"= 30'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NADV88

30 15 0 30
GRAPHIC SCALE

FUSS & O'NEILL
317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

BRADY SULLIVAN PROPERTIES, LLC

BMP LOCATION MAP

BRISTOL YARN MILL

125 THAMES STREET BRISTOL, RHODE ISLAND

PROJ. No.: 20061150.A22
DATE: NOVEMBER 29, 2022

FIG. 4

Appendix B

Operations, Maintenance, and Management Inspection Checklists

Operation, Maintenance, and Management Inspection Checklists
Master Checklist
Bristol Yarn Mill

Inspection Year: ______________

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Subsurface Filtration Systems												
Semi-Annual Inspection												
Sediment Removal (as required)												
Tree Filters												
Inspect for and Remove Trash (monthly)												
Prune and Weed (as required)												
Annual Inspection												
Rain Garden												
Inspect for and Remove Trash (monthly)												
Mow (as required)												
Annual Inspection												
Stone Channels												
Inspect for and Remove Trash (monthly)												
Mow (as required)												
Annual Inspection												
Oil/Water Separators												
Monthly Inspection												
Sediment Removal (quarterly or as required)												
Landscape												
Inspect for and Remove Trash (monthly)												
Mow and prune (as required)												
Annual Inspection												
Drainage Structures												
Quarterly Inspection												
Sediment removal (twice annually)												
Pavement												
Inspect for and Remove Trash (monthly)												
Snow Plowing/Removal (as required)												
Annual Inspection												

Operation, Maintenance, and Management Inspection Checklists
Subsurface Filtration System
Bristol Yarn Mill

Inspector Name: ______________________________

Type of Inspection (Circle One):

Inspection Date: ______________________________

Semi-Annual

Reviewed By: ______________________________

Review Date: ______________________________

____

No.	Monthly	Annual	Item	Criteria	Satisfactory	Unsatisfactory	Notes
1			Sediment	Depth of Sediment in system is less than six (6) inches.			
2			Clogging	System appears to be draining freely and not clogged.			
3			Oil/Grease	Oil or grease cleaned with oil absorption pads and disposed			

Operation, Maintenance, and Management Inspection Checklists
Tree Filters
Bristol Yarn Mill

Inspector Name: ______________________________

Type of Inspection (Circle One):

Inspection Date: ______________________________

Semi-Annual

Reviewed By: ______________________________

Review Date: ______________________________

____

No.	Monthly	Annual	Item	Criteria	Satisfactory	Unsatisfactory	Notes
1			Trash/Debris	Tree filter and contributing areas are free of debris, litter, and waste.			
2			Vegetation	Dead or dying vegetation has been removed and replaced. Pruning is not required. Weeds are not present.			
3			Outlet	Outlet manhole is not discharging stormwater during storm events of less than 1.2 inches of rainfall.			

4			Clogging	There is no evidence of clogging in inlet and outlet pipes.			
5			Tree Grate	Tree opening does not require expansion. Tree grate is level and securely fastened to frame.			
6			Sediment	Tree pit is clean of sediment.			
7			Dewatering	There is no evidence of standing water.			

Operation, Maintenance, and Management Inspection Checklists
Rain Garden
Bristol Yarn Mill

Inspector Name: ______________________________

Inspection Date: ______________________________

Reviewed By: ______________________________

Review Date: ______________________________

Type of Inspection (Circle One):

Semi-Annual

____

No.	Monthly	Annual	Item	Criteria	Satisfactory	Unsatisfactory	Notes
1			Trash/Debris	Basin is free of debris, litter, and waste.			
2			Turf	Grass has not reached a height at which it cannot support its own weight			
3			Sediment	Depth of Sediment is less than one inch.			

4			Clogging	Basins appears to be draining freely and not clogged.			
5			Overflow Structures	Overflow structures are free of blockage and are structurally sound			
6			Erosion	There are no signs of erosion and scouring.			
7			Vegetation	Vegetation is satisfactorily pruned to remove any dead material. Rootstocks are not overcrowded.			

Operation, Maintenance, and Management Inspection Checklists
Stone Channels
Bristol Yarn Mill

Inspector Name: ______________________________

Inspection Date: ______________________________

Reviewed By: ______________________________

Review Date: ______________________________

Type of Inspection (Circle One):

Semi-Annual

____

No.	Monthly	Annual	Item	Criteria	Satisfactory	Unsatisfactory	Notes
1			Trash/Debris	Swale is free of debris, litter, and waste.			
2			Turf	Grass has not reached a height at which it cannot support its own weight			
3			Sediment	Depth of Sediment is less than one inch.			

4			Clogging	Basins appears to be draining freely and not clogged.			
6			Erosion	There are no signs of erosion and scouring.			
7			Vegetation	Vegetation is satisfactorily pruned to remove any dead material. Rootstocks are not overcrowded.			

Operation, Maintenance, and Management Inspection Checklists
Oil/Water Separator
Bristol Yarn Mill

Inspector Name: ____

Inspection Date: ____

Reviewed By: ____

Review Date: ____

Type of Inspection (Circle One):

Quarterly

Structure Name:

____

No.	Monthly	Quarterly	Item	Criteria	Satisfactory	Unsatisfactory	Notes
1			Trash/Debris	Structure is free of debris, litter, and waste.			
2			Sediment	Depth of sediment is less than six inches, more than six inches below the outlet pipe, and has been removed within the last three months.			
3			Concrete Surfaces	Concrete surfaces are structurally sound and have negligible spalling and cracking.			

4			Clogging	There is no evidence of clogging in inlet and outlet pipes.			
5			Oil and Grease	Structure is free of accumulated oil and grease.			

Operation, Maintenance, and Management Inspection Checklists
Landscape Areas
Bristol Yarn Mill

Inspector Name: ______________________________

Inspection Date: ______________________________

Reviewed By: ______________________________

Review Date: ______________________________

Type of Inspection (Circle One):

Monthly Annual

____

No.	Monthly	Annual	Item	Criteria	Satisfactory	Unsatisfactory	Notes
1			Trash/Debris	Landscape is free of debris, litter, and waste.			
2			Turf	Grass has not reached an unaesthetic height and no fertilizer is needed..			
3			Vegetation	Vegetation is satisfactorily pruned to remove any dead material.			

Operation, Maintenance, and Management Inspection Checklists
Drainage Structures
Bristol Yarn Mill

Inspector Name: ________________________________ **Type of Inspection (Circle One):**

Inspection Date: ________________________________ Quarterly

Reviewed By: ________________________________ **Structure Name:**

Review Date: ________________________________ ________________________________

No.	Quarterly	Item	Criteria	Satisfactory	Unsatisfactory	Notes
1		Trash/Debris	Structure is free of debris, litter, and waste.			
2		Sediment	Depth of sediment is less than half the height between the bottom of the structure and the lowest pipe invert elevation and has been removed within the last six months.			
3		Concrete Surfaces	Concrete surfaces are structurally sound and have negligible spalling and cracking.			

Appendix C

Sample Maintenance Agreement

Sample Stormwater Facility Maintenance Agreement

THIS AGREEMENT, made and entered into this ___ day of _________, 20___, by and between (Insert Full Name of Owner) ____ hereinafter called the "Landowner", and the [Local Jurisdiction], hereinafter called the "[Town/City]". WITNESSETH, that WHEREAS, the Landowner is the owner of certain real property described as (Tax Map/Parcel Identification Number) __________________________ as recorded by deed in the land records of [Local Jurisdiction] Deed Book __________ Page __________, hereinafter called the "Property".

WHEREAS, the Landowner is proceeding to build on and develop the property; and WHEREAS, the Site Plan/Subdivision Plan known as ________________________________, (Name of Plan/Development) hereinafter called the "Plan", which is expressly made a part hereof, as approved or to be approved by the [Town/City], provides for detention of stormwater within the confines of the property; and

WHEREAS, the [Town/City] and the Landowner, its successors and assigns, including any homeowners association, agree that the health, safety, and welfare of the residents of [Local Jurisdiction] require that on-site stormwater management facilities be constructed and maintained on the Property; and

WHEREAS, the [Town/City] requires that on-site stormwater management facilities as shown on the Plan be constructed and adequately maintained by the Landowner, its successors and assigns, including any homeowners association.

NOW, THEREFORE, in consideration of the foregoing premises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto agree as follows:

1. The on-site stormwater management facilities shall be constructed by the Landowner, its successors and assigns, in accordance with the plans and specifications identified in the Plan.
2. The Landowner, its successors and assigns, including any homeowners association, shall adequately maintain the stormwater management facilities in accordance with the required Operation and Maintenance Plan. This includes all pipes, channels or other conveyances built to convey stormwater to the facility, as well as all structures, improvements, and vegetation provided to control the quantity and quality of the stormwater. Adequate maintenance is herein defined as good working condition so that these facilities are performing their design functions. The Stormwater Best Management Practices Operation, Maintenance and Management Checklists are to be used to establish what good working condition is acceptable to the [Town/City].

3. The Landowner, its successors and assigns, shall inspect the stormwater management facility and submit an inspection report annually. The purpose of the inspection is to assure safe and proper functioning of the facilities. The inspection shall cover the entire facilities, berms, outlet structure, basin areas, access roads, etc. Deficiencies shall be noted in the inspection report.
4. The Landowner, its successors and assigns, hereby grant permission to the [Town/City], its authorized agents and employees, to enter upon the Property and to inspect the stormwater management facilities whenever the [Town/City] deems necessary. The purpose of inspection is to follow-up on reported deficiencies and/or to respond to citizen complaints. The [Town/City] shall provide the Landowner, its successors and assigns, copies of the inspection findings and a directive to commence with the repairs if necessary.
5. In the event the Landowner, its successors and assigns, fails to maintain the stormwater management facilities in good working condition acceptable to the [Town/City], the [Town/City] may enter upon the Property and take <u>whatever steps necessary</u> to correct deficiencies identified in the inspection report and to charge the costs of such repairs to the Landowner, its successors and assigns. This provision shall not be construed to allow the [Town/City] to erect any structure of permanent nature on the land of the Landowner outside of the easement for the stormwater management facilities. It is expressly understood and agreed that the [Town/City] is under no obligation to routinely maintain or repair said facilities, and in no event shall this Agreement be construed to impose any such obligation on the [Town/City].
6. The Landowner, its successors and assigns, will perform the work necessary to keep these facilities in good working order as appropriate. In the event a maintenance schedule for the stormwater management facilities (including sediment removal) is outlined on the approved plans, the schedule will be followed.
7. In the event the [Town/City] pursuant to this Agreement, performs work of any nature, or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like, the Landowner, its successors and assigns, shall reimburse the [Town/City] upon demand, within thirty (30) days of receipt thereof for all actual costs incurred by the [Town/City] hereunder.
8. This Agreement imposes no liability of any kind whatsoever on the [Town/City] and the Landowner agrees to hold the [Town/City] harmless from any liability in the event the stormwater management facilities fail to operate properly.
9. This Agreement shall be recorded among the land records of [Local Jurisdiction] and shall constitute a covenant running with the land, and shall be binding on the Landowner, its administrators, executors, assigns, heirs and any other successors in interests, including any homeowners association.

WITNESS the following signatures and seals:

____

Company/Corporation/Partnership Name (Seal)

By: ____

____
(Type Name and Title)

The foregoing Agreement was acknowledged before me this ____ day of
____________, 20___, by
____
___.

____
NOTARY PUBLIC
My Commission Expires: ____________

By: ____
____
(Type Name and Title)

The foregoing Agreement was acknowledged before me this ____ day of
____________, 20___, by
____
___.

____
NOTARY PUBLIC
My Commission Expires: ____________

Approved as to Form:
___________________________ __________
[Town/City] Attorney Date

Appendix D

Silva Cell Operation and Maintenance Manual

deeproot

SILVA CELL
OPERATIONS AND MAINTENANCE MANUAL

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1.0 Acknowledgments

There are many dedicated, brilliant people working on the challenge of creating healthier, more sustainable, and more efficient cities. We believe the most successful of these places will be those grounded in the principle that nature and engineering can coexist successfully. Soil, urban trees, and sustainable stormwater management are at the core of this effort. We wish to express our tremendous appreciation and gratitude to the many researchers and practitioners whose work we have relied on to inform the guidelines contained in this manual. Thank you to the following people for their specific contributions.

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Nathalie Shanstrom, Kestrel Design Group
James Urban, Urban Trees + Soils

2.0 Introduction

Silva Cells are a modular suspended pavement system that provides soil volume to support large tree growth and provides stormwater management through interception, storage, evapotranspiration, and pollutant uptake. When filled with soil media of suitable depth and quality, Silva Cells also promote filtration of stormwater runoff through the soil media and infiltration of treated runoff into native site soils, making them a versatile Low Impact Development (LID) Best Management Practice (BMP).

In March 2013, the Washington State Department of Ecology approved Silva Cells as functionally equivalent to bioretention (Ecology 2013a). This approval allows designers in Washington State to design Silva Cells to fully or partially satisfy minimum stormwater requirements for LID, water quality treatment, and flow control in accordance with the National Pollutant Discharge Elimination System (NPDES) Municipal Separated Storm Sewer System (MS4) permit (NPDES stormwater permit). Similar approvals are in place in Montgomery County, Maryland; St. Louis, Missouri; Calgary, Alberta; and North Vancouver, British Columbia. Additional approvals are currently pending in other areas across the United States and Canada as of the date of this manual.

When Silva Cells are installed as part of a permanent stormwater management system to meet stormwater permit requirements, they should be maintained as required by the local jurisdiction for maintenance of stormwater and LID BMPs.

The remainder of this section discusses the purpose of this document, applicable permit requirements, how this manual is intended to be used, and important definitions. Section 3 presents key maintenance considerations, maintenance guidelines, equipment and materials lists, and skills and staffing needs to accomplish the recommended maintenance. Section 4 discusses the repair of Silva Cell facilities. Section 5 discusses programmatic and administrative guidance, while Section 6 provides a list of additional resources relating to LID BMP design, inspection, operation, and maintenance and Section 7 provides a list of additional resources with relevant information on stormwater and LID BMP maintenance.

2.1 Purpose

This document provides guidance to assist owners and operators of Silva Cell facilities with planning and implementation of maintenance to promote long-term system performance in accordance with the design intent. These recommendations should be considered as general guidelines, not requirements, and they should be reviewed and adapted as appropriate to develop site-specific maintenance plans based on the specific design configuration of a given site.

2.2 Permit Requirements

Silva Cells may be designed and installed as LID BMPs that fully or partially satisfy applicable soil and/or stormwater requirements for new or redevelopment projects. Check the local permit requirements to determine whether such requirements apply to your project.

While Silva Cells can be designed as LID BMPs, they can also be used to promote large, healthy trees in dense urban environments, without the intent of formally managing stormwater runoff. In such cases, stormwater permit requirements would not apply.

2.3 How to Use this Manual

Operations and maintenance guidelines are provided in Section 3.0, organized in three subsections, as follows:

- Subsection 3.1 Key Maintenance Considerations - Provides details regarding maintenance activities that should be considered to maintain function of the facility.
- Subsection 3.2 Key Operations to Preserve Facility Function - Discusses the functions of the BMP that need to be preserved to maintain the intended performance.
- Subsection 3.3 Maintenance Guidelines - Provides information that can be used to develop a site specific maintenance plan.

Successful use of this manual requires understanding of the design intent, site and as-built conditions, and knowledge of applicable permit requirements (Section 2.2).

2.4 Definitions

Definitions for important terms used throughout this manual are as follows:

- Best management practices (BMPs) - Activities, practices, procedures, structural features, or products that are designed to reduce the risk of causing adverse impacts to downstream water bodies.
- Drawdown Time - The time it takes water from a given runoff event to completely drain through an infiltration BMP, typically measured from the end of the event to the time the water level in the system returns to baseflow conditions.
- Infiltration – Percolation of stormwater runoff into soil media or native site soils.
- Low Impact Development (LID) - A development approach that manages stormwater by working with nature and the existing site conditions in a manner that will reduce or prevent adverse impacts to the site or downstream environment.
- Macropores – Large, free-draining soil pores, oftentimes found between aggregates or near tree roots.

3.0 Maintaining Silva Cells

This section identifies key component design functions and maintenance considerations, provides guidance on inspection and maintenance activities and recommended frequencies, lists needed equipment and materials, and discusses skills and staff needed to perform the recommended maintenance.

3.1 Key Component Design Function and Maintenance Considerations

Key components of the Silva Cell system include the inlet structures, distribution pipes, the modular Silva Cell units and frames, fill soils, underdrain pipe, flow control structures, trees/vegetation, and surface treatments. Intended general design functions and maintenance considerations for each of these key components are discussed below.

3.1.1 Inlet system

Silva Cell inlet systems can be designed to allow stormwater runoff to flow into the facility in a number of ways. Water can sheet flow from adjacent hardened surfaces, infiltrate via overlying or adjacent permeable surfaces, flow through curb cuts, or be piped from a catch basin, roof drains, or yard drains.

However the inlet system(s) are configured, they must be properly sized and maintained to allow stormwater runoff from the intended contributing drainage area to enter the facility. Key maintenance considerations include providing pre-treatment through temporary erosion and sedimentation control measures in the tributary drainage basin during construction and long-term pre-treatment through stabilization of open soil areas in the tributary basin with plants or mulch and maintenance of inlet capacity by removing sediment, trash, and debris from inlets and the contributing drainage area.

3.1.2 Distribution Pipe

Some installations may include a distribution pipe to distribute inflows across the surface of the facility. Distribution pipes are typically 4- to 8-inch-diameter (100- to 200-millimeter-diameter) perforated or slotted pipes installed on top of or within the soil media. Maintenance activities should preserve the ability of the pipe to distribute the water effectively by removing clogs and repairing or replacing cracked or broken pipes as needed.

3.1.3 Irrigation Systems

If the Silva Cells have been designed to include irrigation, follow the manufacturer instructions for operating and maintaining your chosen irrigation system. Also see the section above (3.1.2) if the irrigation system is passive and includes distribution pipes.

3.1.4 Silva Cell Modular Units

Silva Cell modular units are made from fiberglass-reinforced, chemically-coupled, impact-modified polypropylene with galvanized steel tubes. DeepRoot provides a 20-year warranty for the Silva Cell product, which is included for reference in Appendix A. Each module provides a 92% void volume, which is backfilled with a specified type and depth of soil media (Section 3.1.5) to support tree growth and promote stormwater management.

When used in a typical pedestrian application, the Silva Cell system has an estimated design life of approximately 100 years (DeepRoot 2014). The units themselves are not expected to require maintenance within that design life duration when properly designed and installed.

3.1.5 Soil Media

The soil media filled within the Silva Cell units (Section 3.1.4) performs critical functions of supporting tree growth and managing stormwater runoff. Organic matter in the soil media is important for both of these functions; because it helps trees build soil structure, provides a nutrient reservoir, and increases soil water holding capacity. In order to preserve a healthy balance of soil organic matter and soil biology, excess soil compaction must be prevented and proper drainage through the system must be maintained.

Silva Cells protect soils under pavement from excessive compaction by providing a post and beam structure that supports the pavement, allowing the soil media backfill to be lightly compacted. The lightly compacted soil media creates a healthy rooting environment for trees, which deliver increasing amounts of organic content to the soil system as the roots grow and decay. Stormwater inputs also deliver nutrients, such as nitrogen and phosphorus, helping to maintain soil organic matter over time.

Routine maintenance of the soil media is generally not needed provided the installation process of the cell and soil has been carried out correctly and the inlet (Section 3.1.1) and distribution (Section 3.1.2) systems are properly designed, installed, and maintained.

3.1.6 Underdrain Pipe and Flow Control Devices

Silva Cells may include underdrains when infiltration of treated stormwater runoff into native soil is not feasible or not desirable. Underdrains may be located at the bottom of the facility, or may be elevated to promote nitrogen removal and peak flow detention, depending on the design intent.

Typically, underdrain systems consist of 6- or 8-inch-diameter (100- to 200-millimeter-diameter) perforated or slotted pipe. The pipe may be installed in an aggregate filter blanket layer or may be wrapped with a geotextile liner for separation. Proper design and specification of the aggregate filter blanket or geotextile liner is critical to minimizing or preventing fines from the soil media or the native site soils from clogging the pipe.

Some underdrains may be designed with flow control devices (e.g., orifii or upturned elbows) to enhance nitrogen removal, detain peak flows, increase infiltration, or some combination thereof. These flow control devices should be maintained to prevent clogging and allow treated flows to discharge to the downstream conveyance system or receiving water as intended by design.

3.1.7 Trees / Vegetation

Silva Cells fundamentally promote tree growth, and are typically designed with one or more trees that are planted either in the facility or next to the facility in a way that allows the roots to grow into the soil media. Properly designed Silva Cells provide the needed soil volume and quality, water flow, and air flow to allow the trees to reach their true mature size.

As healthy trees grow, their canopies provide increasing capacity over time for interception, storage, and evapotranspiration. As the roots grow, they increase the trees' ability to uptake stormwater and associated pollutants and enhance infiltration by maintaining macropores in the soil column. Maintaining the trees as part of the Silva Cell system is therefore important to the overall performance of the facility over time. See Table 1 for recommended maintenance activities and schedule.

Trees and vegetation adapted to site conditions, such as climate, hydrology, and soil type, should be selected wherever possible to reduce chemical inputs and reduce or eliminate the need for watering. Proper design, installation, and maintenance of the inlet system (Section 3.1.2) and distribution system (Section 3.1.3) are also important to maintaining trees and vegetation properly watered. Similarly, proper design, installation, and maintenance of the underdrain pipe and flow control devices are important to maintaining desired watering regimes and draw-down rates.

3.1.8 Surface Treatment

Silva Cells can be designed to provide structural support for a variety of surface treatment types, including hard surfaces (e.g., permeable or impermeable asphalt, concrete, pavers, etc.) or natural surfaces (e.g., soil, lawn, vegetation). Surface treatments should be maintained in accordance with manufacturer recommendations and local jurisdiction requirements (i.e., pertaining to sidewalks, roadways, etc.), as applicable.

3.2 Maintenance Guidelines

The following table provides a breakdown of recommended routine inspection and maintenance activities and frequencies, conditions that trigger non-routine maintenance, and the associated recommended non-routine (triggered) maintenance activities for key Silva Cell components.

Table 1: Silva Cell Maintenance Guidelines

Component	Recommended Frequency		Inspection Activity	Condition when Maintenance is Triggered	Recommended Maintenance Actions
	Inspection	Routine Maintenance			
Silva Cell Units					
Frames (or base and posts) and Deck	As needed	None	Not Applicable	Facility shows signs of damage from external source (i.e., excessive loading from the surface, nearby construction, or similar)	Repair damaged component (refer to the Protection and Maintenance section of the Silva Cell Operations Manual included in Appendix B, pages 9-11).
Tree Opening	Spring, Fall, and after major storms	As needed	Check for clogging, standing water, sediment, trash, and debris	Evidence of clogging, standing water, accumulation of sediment, debris, or trash	As needed.
Inlets/Outlets/Pipes					
Inlet/outlet structures	Annually	After major storms	Check that the structures are operating properly	Water is not being directed properly to or out of the Silva Cell facility	Remove any blockages and clean pipe as needed.
Energy dissipation component at inlet (if applicable)	Annually	After major storms	Check that the energy dissipation is working correctly	Where applicable – Energy dissipation (i.e., splash block, rock, or cobbles) is removed or missing and concentrated flows are being directed into the facility improperly	Replace or restore the energy dissipation component of the facility to the original design.
Flow restrictor (if applicable)	Annually	After major storms	Check that the flow restrictor is operating properly	Water is not passing through the flow restrictor per the design flow rate	Remove material causing the blockage and repair component as needed.
Distribution pipes	Annually	Annually	Check that the distribution pipes are allowing water to distribute properly	Water is not being distributed within the facility per design	Remove blockages from pipes (e.g., jet clean, rotary cut roots/debris).
Underdrain pipes	Annually	Annually	Check that the underdrain pipes are	Water is not being drained through the underdrain pipes per design	Remove blockages from pipes (e.g., jet clean, rotary cut roots/debris).

Component	Recommended Frequency		Inspection Activity	Condition when Maintenance is Triggered	Recommended Maintenance Actions
	Inspection	Routine Maintenance			
Trees/Vegetation					
Tree	Biannually	As needed	Check need for pruning	Tree requires pruning for safety reasons, to promote healthy growth or to prevent the tree from growing in an undesirable manner.	Prune tree as needed for safety to promote healthy growth and to avoid conflicts with adjacent features (i.e., power lines, clearances from buildings or sidewalk, or similar). Pruning should be performed by a landscape professional that has experience pruning trees and per the guidance of an arborist certified by the International Society of Arboriculture.
	Spring, Fall, and after major storms	As needed	Check tree safety	Signs of potential danger include broken, dead, or hanging branches, cracks, fungi, cavities, weak trunk or branch unions	Remove components of the facility above the frames and decks in a manner that minimizes damage to the facility. Use HydroVac and hand tools to remove soil if soil removal is needed. Cut and remove roots as directed by an arborist. Do not cut or damage frames. Install new tree and Silva Cell components as needed to restore the facility to its designed configuration.
	Spring and Fall	As needed	Check tree health	Check tree for mower and weed whip damage, vandal damage, and animal damage. Inspect leaves, branches, crown and trunk for signs of insect or disease problems	Diagnose cause of problem: e.g. mower and weed whip damage, vandal damage, animal damage, over- or under-watering, pest or disease, soil problems, etc., and remedy.
	Every 4-5 years	As needed	Check for girdling roots	Girdling roots are found	Remove girdling roots.
	Annually	As needed	Check for soil or mulch on root collar	There is soil or mulch on the root collar	Clean soil or mulch off root collar until the first set of roots is found, take care not to harm roots.
	Annually	As needed	Check safety	Tree is dying, dead, diseased, or has become a safety hazard	Remove components of the facility above the frames and decks in a manner that minimized damage to the facility. Use HydroVac and hand tools to remove soil. Cut and remove roots as directed by an arborist. Do not cut or damage frames (or base and posts). Install new tree and Silva Cell components as needed to restore the facility to its designed configuration. Refer to the Protection and Maintenance section of the Silva Cell Operations Manual included in Appendix B.

Component	Recommended Frequency		Inspection Activity	Condition when Maintenance is Triggered	Recommended Maintenance Actions
	Inspection	Routine Maintenance			
Tree					
Vegetation	Biannually	As needed	Check tree health	Dying, dead, or unhealthy plants	Remove and replace dying, dead or unhealthy plants.
Weeds	Monthly	Monthly	Check for weeds	Weeds present in the facility	Remove weeds as necessary. Noxious weeds should be removed in accordance with local standards. Avoid using herbicides and pesticides in an effort to protect water quality.
Mulch	Monthly	After weeding	Check much coverage	Mulch layer has bare spots or a depth less than two inches (50 mm).	Cover bare spots and replenish mulch as required.
Watering		As needed	Not applicable	Tree/vegetation shows signs of being deprived of water or watering is anticipated during prolonged dry periods	Water frequency will vary depending on species, climate, and site conditions. Water appropriately to maintain a health of the tree or vegetation. Ensure water is reaching the entire soil column and perimeter, not just the tree opening.
Pest Control					
Nuisance Animals	Biannually	As needed	Check for signs of damage from animals	Damage or erosion caused by animals	Remove/reduce the item that is attracting the nuisance animals. Consider placing decoy predator species or pet waste bag stations to promote responsible activities.
Insects	Biannually or as needed	As needed	Check the presence of insects and or insect nests	Tree/vegetation shows signs of wilting, chewing of bark, spotting, or other indicators appropriate for the region.	Remove diseased or dead plants. Remove or reduce the source attracting the insects if possible. Follow the pest management procedures appropriate for the region.
Surface Treatment					
Hard Surfaces (i.e., permeable or impermeable concrete, asphalt, pavers, or grid systems)	Annually	As needed	See applicable manufacturer recommendations.		
Permeable Surfaces (i.e., vegetated areas)					

3.3 Equipment and Materials

The text box to the right provides a list of equipment and materials that may be needed to perform maintenance and inspection activities. The list should be reviewed and approved by the Silva Cell owner or operator and should be modified as appropriate for the specific installation. For instance, if the installation does not have a planter strip area, weeding equipment may not be needed. Similarly, if underdrains are not included, vactor, water jets, and pressure washing equipment may not be needed, etc.

3.4 Skills and Staffing

The skills and staff required to inspect and maintain Silva Cells will vary depending on the size of the installation, complexity of the system, surface treatment, and site constraints. Routine maintenance and inspection activities for the above-ground features will generally be similar to that of a street tree, planter strip, or sidewalk. Routine maintenance for the below-ground features will generally be similar to that of an underdrain or footing drain system.

The Table 2 summarizes the staffing resources that may be required for routine maintenance and inspection activities:

- Safety Equipment – As appropriate for the site (i.e., high visibility vest, gloves, long pants, boots, traffic control equipment, etc.)
- Inspection Equipment
  - Camera
  - Tape measure
  - Manhole key and lifter to open manhole, cleanout, or inspection port lids
  - Flashlight
  - Field report sheet
  - Inspection records and photos from previous inspections
  - As-built information
  - Manufacturers' product information
  - Method of inspecting pipes and structure without entering them (i.e., camera or mirror on an extendable pole)
  - Equipment to measure drawdown time (i.e., stopwatch, measuring stick, water source, and hose)
- Maintenance Equipment
  - Broom, rake, and shovel
  - Weeding equipment
  - Bucket, wheelbarrow, garbage/leaf bags, and tarp
  - Tree trimming and pruning equipment
  - Hand tools
  - Plumbing snake
  - Vactor truck
  - Water jet
  - Pressure washer
- Maintenance Material
  - Pipe repair material
  - Replacement pipe material per the original design
  - Replacement surface material (i.e., pavers, asphalt, concrete, or natural material)

Equipment and materials that may be needed to perform typical maintenance and inspection activities. Adapted from the Western Washington Low Impact Development (LID) Operation and Maintenance (O&M) Guidance Document (Ecology 2013b).

Table 2: Skills and Staffing Table

Maintenance Activity	Staff Skills
Landscaping	Staff must have appropriate landscaping skills, including plant care, watering, and weeding, based on the trees/vegetation present; staff must have the ability to identify plants, weeds, and invasive weed species and have knowledge of the timing of weed seeding and growing periods.
Pruning and tree care	Staff conducting pruning and tree care activates should be a certified arborist or have equivalent training.
Pest Management	Staff conducting pest management activities must be able to identify pests applicable to the region and be familiar with methods to address those issues.
Erosion Control	Staff must have general knowledge of identifying sources of erosion, prevention methods, and removal methods.
Drainage System Maintenance	Staff inspecting drainage system must have general knowledge of the drainage system components included in the facility, specific knowledge of how the facility was built and its intended to function, and maintenance history. Staff preforming maintenance activities must be trained to operate the specialized equipment to conduct those activities (i.e., jet cleaning, root cutting, vactoring, CCTV inspection).

4.0 Repairing Silva Cells

As the Silva Cell is a system that interacts with other infrastructure, repairs to adjacent elements, such as paving surfaces or utilities and services, must be undertaken with an understanding of the site-specific installation. Repairs to all system components and adjacent or nearby elements should be done per local guidelines and individual manufacturer directions, as applicable.

Each Silva Cell stack is independent of the Silva Cell stack adjacent to it. Therefore, if an individual stack is disturbed, the entire system is generally not expected to be compromised.

Examples of repair processes are provided in the Tree Planting Solutions for Hard Boulevard Surfaces Best Practices Manual, included in Appendix B. This manual documents two demonstration projects conducted by the City of Toronto, in which they field-tested a water main break scenario and a gas lateral and riser installed through Silva Cells. In both cases, the Silva Cells were found to pose no significant hindrance to their utility work.

Section IV of the Silva Cell Operations Manual (DeepRoot 2011), included in Appendix C, provides general information on how to protect installed Silva Cell systems, manage utilities in the vicinity of installed systems, repair or replace overlying pavement, and remove or replace Silva Cells and trees as needed.

5.0 Programmatic and Administrative Guidance

This section discusses regulatory requirements for LID BMP maintenance (if applicable) and the available programs and tools to help with implementation.

5.1 Regulatory Requirements for LID BMP Maintenance Programs

As discussed above, this manual provides general maintenance guidelines that can be adapted to site specific maintenance plans based on given site conditions. If Silva Cells are installed as part of a permanent stormwater management plan to meet minimum stormwater requirements for new or redevelopment, local requirements for maintaining LID BMPs would apply. Consult the local standards and requirements to determine the maintenance requirements that will need to be addressed.

5.2 Tools for Implementing an LID Maintenance Program

A range of administrative tools can be used to assist jurisdictions in implementing required maintenance activities for stormwater BMPs, such as Silva Cells. The tools vary depending on jurisdiction requirements, but may include (Ecology 2013b):

- Stormwater requirements (i.e., Code, manual, ordinance)
- Legal agreements between private or public owners and the regulatory agency (i.e. access easements, property maintenance covenants, or transfer of ownership)
- Maintenance requirements specified as part of the design process
- Financial liability measures
- Record keeping and tracking requirements
- Inspection and maintenance checklists
- Inspection and maintenance schedules
- Mapping
- Owner education (public or private)

6.0 Additional Resources

The following resources provide additional information on maintenance of LID facilities applicable to Silva Cells.

- Western Washington Low Impact Development Operations and Maintenance Guidance Document http://www.ecy.wa.gov/programs/wq/stormwater/municipal/LID/TRAINING/OperationsAndMaintenance.html
- LID Technical Guidance Manual for Puget Sound http://www.wastormwatercenter.org/files/library/lid-manual-2012-final-secure.pdf
- International Society of Arboriculture http://www.isa-arbor.com/education/publications/index.aspx

- EPA's Integrated Pest Management (IPM) principles site http://www.epa.gov/pesticides/factsheets/ipm.htm
- Water Environment Research Foundation (WERF) BMP and LID Whole Life Cost Tool http://www.werf.org/c/KnowledgeAreas/Stormwater/ProductsToolsnonWERF/BMP_and_LID_Whole_Li.aspx
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Appendix A

DeepRoot Warranty

DeepRoot® warrants to the original purchaser of its Silva CellTM product that such product will be free from defects in materials and workmanship, and perform to DeepRoot's written specifications for the warranted product, when installed and used as specifically provided in the product's installation guidelines for a period of 20 years from the date of purchase. This warranty does not cover wear from normal use, or damage caused by abuse, mishandling, alterations, improper installation and/or assembly, accident, misuse, or lack of reasonable care of the product. This warranty does not apply to events and conditions beyond DeepRoot's control, such as ground subsidence or settlement, earthquakes and other natural events, acts of third parties, and/or Acts of God. If this warranty is breached, DeepRoot® will provide a replacement product. Incurred costs, such as labor for removal of the original product, installation of replacement product, and the cost of incidental or other materials or expenses are not covered under this warranty.

DEEPROOT® MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, AND SPECIFICALLY DISCLAIMS THE WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. DEEPROOT® SHALL NOT BE LIABLE EITHER IN TORT OR IN CONTRACT FOR ANY DIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOST PROFITS, LOST REVENUES, LOSS OF USE, OR ANY BREACH OF ANY EXPRESS OR IMPLIED WARRANTY.

Some states do not allow the exclusion of incidental or consequential damages, so the above limitations and exclusions may not apply to you. This Warranty gives you specific legal rights, and you may also have other legal rights, which vary from state to state, or in Canada, from province to province.

Appendix B

City of Toronto Tree Planting Solutions
in Hard Boulevard Surfaces;
Best Practices Manual

Project # A21065
Date February 8, 2013
Recipient City of Toronto
Submitted by DTAH, Lead Consultant
ARUP, Engineering
James Urban, Urban Trees + Soils

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Acknowledgments

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Earthco Soil Mixtures

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* Please note: Appendix B contains excerpts from the City of Toronto's
Tree Planting Solutions in Hard Boulevard Surfaces Best Practices Manual.
For full document with all content please contact the Urban Forestry Department at 311@toronto.ca

Executive Summary

The City of Toronto has established a goal to increase both the number and size of its street trees (*Toronto Street Trees: Guide to Standard Planting Options*, April 2010). The City aims to grow large-canopy trees in hard boulevard surfaces that have a complete 40+ year life span and are 40 cm in diameter at breast height.

This manual examines and provides cost-efficient options to reach this goal.

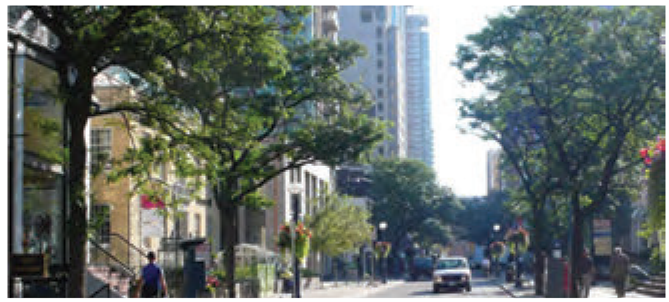
Downtown streetscapes are harsh environments for trees, and many do not survive or never grow to a large canopy size. Large-canopy trees provide enormous climatic, environmental, health, aesthetic and psychological benefits. There is room for considerable improvement in the quality of the urban forest in downtown streetscapes and this report examines how this can be done.

Section 1 of this report, the Introduction, defines 'criteria for success' for urban tree planting in Toronto, and sets the tone for the manual and its future implementation.

Section 2 provides fundamental principles for growing large trees. At minimum, trees require 20 to 30 m3 of soil each in order to grow to maturity. In order to achieve this, integration of soil/root zones with utilities is proposed to reach the target soil volume under urban sidewalks. Larger openings in the pavement also help to increase longevity. Cost savings are achieved by eliminating unnecessary hardware and designing structural concrete to withstand the load of occasional snowploughs and service vehicles, but not firetrucks.

Sections 3 and 4 provide various technical solutions that have been developed as part of this manual. They address both new and retrofit construction and repair techniques to respond to a variety of site-specific requirements such as sidewalk width, public realm condition, and infrastructure arrangement for a range of budgets.

Section 5 evaluates essential material components that are required for successful tree growth in an urban streetscape. These are tree opening area materials such as mulch; flexible plastic mesh bark protectors; passive rainwater harvesting and distribution; and root zone ID markers to prevent construction damage.



Sidewalk trees on Yorkville Ave.

Section 6 offers insightful information to ensure that each planted tree has the best opportunity to thrive. Horticultural topics such as tree preservation, installation and maintenance, tree species suitability, nursery stock quality and soil specific requirements are discussed.

Lastly, Section 7 documents two demonstration projects where the City of Toronto and consultants field-tested a number of the tree planting construction methods. A water main break scenario was recreated and a gas lateral and riser were installed through soil cells. In both cases, the soil cells posed no significant hindrance to utility work.

The Appendices include construction drawings, specifications, cost estimates, letters of product availability, responses to City comments and the street tree precedents review.

Section 3 Types

Section 4 Arrangements	3.5m min. sidewalk width			5.7m min. sidewalk width
	TYPE 1: Pavement Bridge		TYPE 2: On-Grade Pavement Over Soil Cells	TYPE 3: Open Planter
	1A	1B		
Growing Medium Trench	X	X	X	
Open Planter with Curb Edge				X

Compatibility between types identified in Section 3 and arrangements identified in Section 4.

3.0 Construction Methods & Repair Regimes

Three different systems for tree planting in sidewalks are laid out in this section. They form the basis for the proposed City of Toronto tree planting details that accompany this report in the Appendices. In addition, this section makes recommendations for hybrid solutions and retrofits and dealing with sub-standard sidewalk conditions.

3.1 Type-1: Pavement bridge system

A structural pavement surface or subsurface spans between supporting ends over the growing medium trench. Reinforced precast and cast-in-place concrete panels provide the 'bridge'. Refer to the T-1A and T-1B Construction Drawings in Appendix A.

3.2 Type-2: Soil cells system

Modular rigid soil cells support a pavement system above the growing medium. The pavement surface and base can be built directly on top of the hard deck of the soil cells. Refer to T-2 Construction Drawings in Appendix A.

3.3 Type-3: Open planter system

There is no paving around the tree base. Where there is space for this system on the sidewalk, it is the most cost-efficient option available for growing large urban trees. Refer to T-3 Construction Drawings in Appendix A.

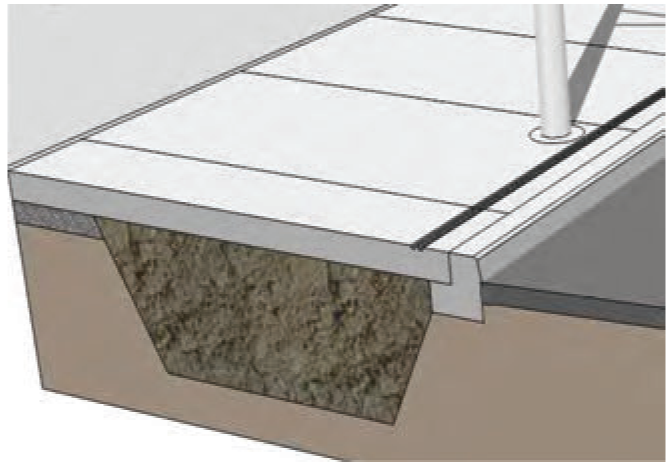
3.4 Hybrid solution and retrofits

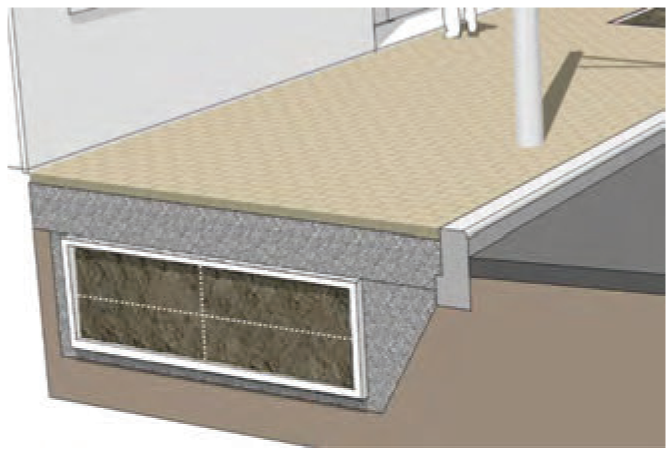
The street is not rebuilt wholesale, just one or two trees in a block may be affected.

3.5 Sub-standard sidewalk conditions

Conditions where the existing space or utility constraints are such that the standards advocated in this report are not achievable.

Note: In the following descriptions for utility compatibility with various construction methods, review is based upon the general feasibility of working with such utilities and repairs. Ultimately, individual utility companies and City departments will have to reach an agreement for the access and repair of the various conditions generated, and the responsibility thereof. The recommendations in this report are intended to provide a framework for these policy decisions to be made.


3.1 Type 1: Pavement bridge system

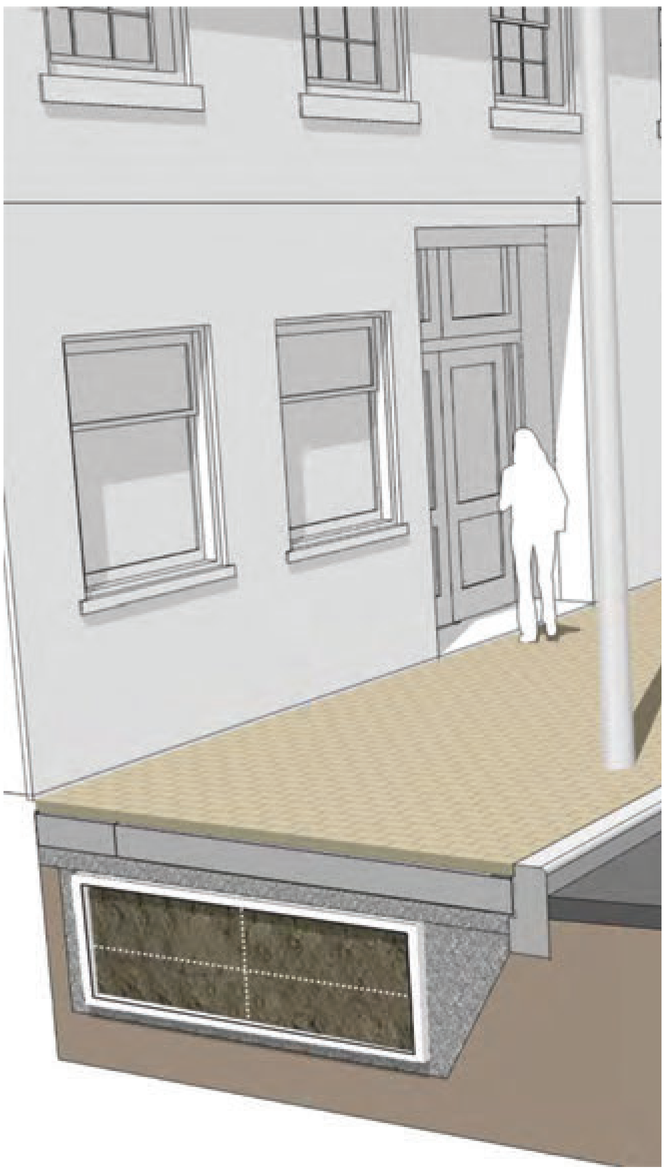

3.2 Type 2: Soil cells system


3.3 Type 3: Open planter system

3.2 Type-2: Soil Cell System

On-grade pavement over soil cells allows for traditional pavement on-grade on top of the soil cell assembly and has been used in a number of pilot projects in Toronto and other North American cities. This system requires utility companies and City agencies to become comfortable with the concept of a modular support system, and will require a new protocol to include removal and replacement of the soil cells.

Construction Drawings T-2 in Appendix A provides details on this system.



Type 2: On-grade pavement over soil cells

Construction

Space allotted for root zone and foundation are excavated out, and a compacted granular base is installed for the soil cells. Soil cells are installed per manufacturer's instructions. The pavement system is installed with granular base above the soil cells. The new paving can be installed in a similar way to any on-grade pavement system.

Utility access

Where there is concrete, the pavement is sawcut. Where there is unit paving, the pavers are removed. Filter fabric is peeled back, and soil cells are removed and set aside. In frozen conditions, the soil cells may be removed forcibly with an excavator, requiring them to be replaced with new soil cells prior to repairing surface paving. Once soil cells are removed, the utility is accessed via excavation of planting soil or granular below.

Repair

After the utility is backfilled with granular to the underside of the root zone and compacted, soil cells are reinstalled per manufacturer's instructions. Filter fabric is laid down on top of replaced soil cells, then pavement system is made good either temporarily or permanently.

Recommended utilities compatible with root zone

On-grade pavement over soil cells is generally compatible with utilities below the root zone, ideally where frequent access is not anticipated. Some shallower utilities may be compatible for placement within root zone/soil cell zone depending on agreement with the utility company concerned such as gas or hydro laterals.

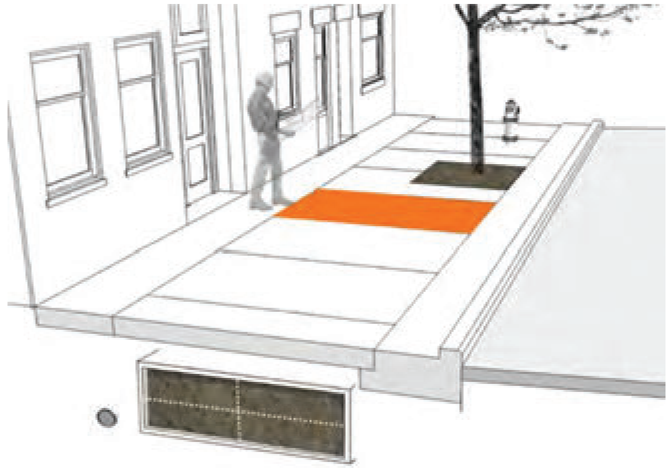
- Utilities below root zones:
- New generation storm line (concrete)
- New generation sanitary line (concrete)
- Concrete-encased hydro duct, combined data
- District energy
- Pressurized water main
- Gas (main or lateral)
- Bare conduit (street lighting, telephone, etc.)

Surface finish

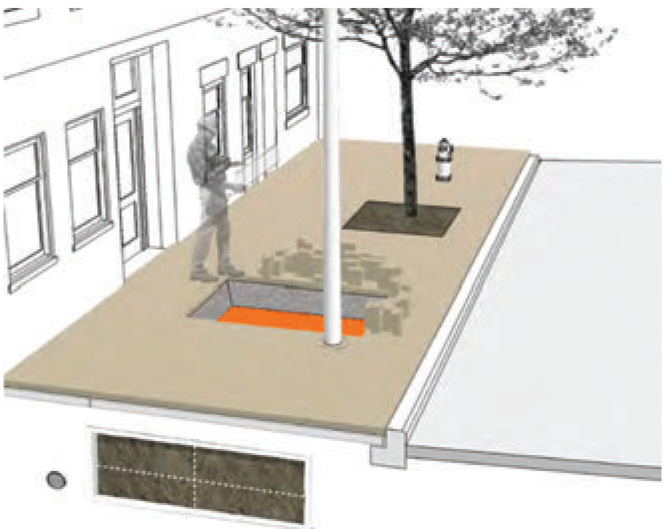
Since the structural support is provided by the soil cells, the pavement system can be any type or finish such as concrete or unit paving over concrete.

Pros / cons

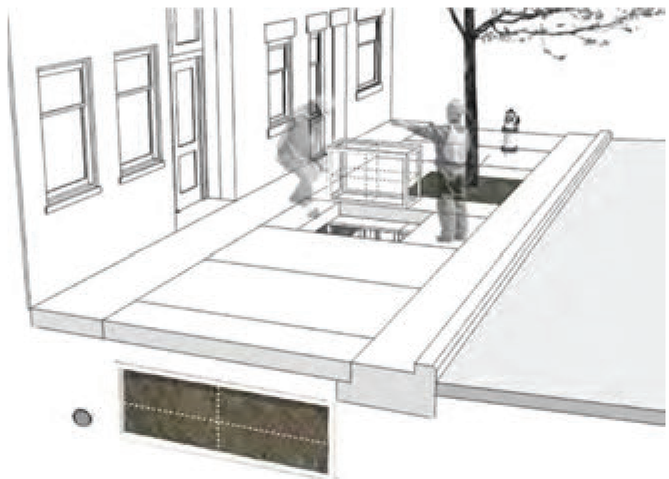
If the work crew is comfortable removing and replacing soil cells, the access and repair procedure is similar to current practices. The pavement system is equivalent to an on-grade construction. It can be repaired as a permanent repair or a temporary two-stage repair.



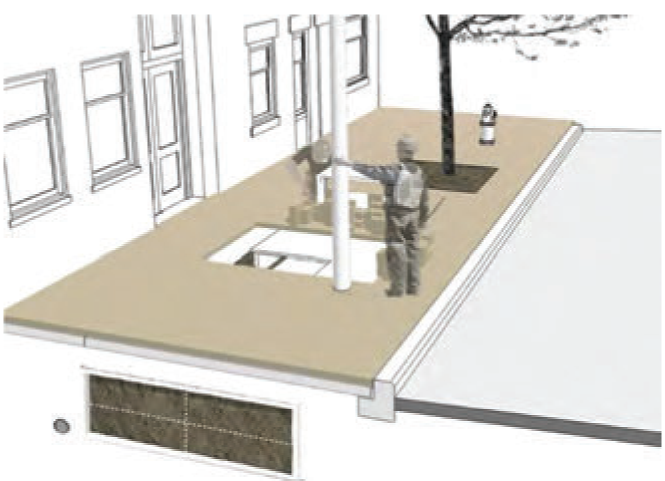
Utility access, step 1



Utility access with pavers, step 1



Utility access, step 2



Utility access with pavers, step 2

Utility access, step 3

7.0 Demonstration Projects

The consultants and the City organized a soil cell testing exercise at the City of Toronto's Nashdene Yard in Scarborough with utility stakeholders Toronto Water and Enbridge Gas. New utility installation and repair of existing utilities under soil cells was recreated at the Yard:

7.1 Toronto Water utility access exercise

Toronto Water recreated an "emergency scenario" in the middle of winter (Feb. 24, 2012). The scenario involved bursting a water main and testing the effects of water leaking on the soil cell system.

7.2 Enbridge Gas lateral line and riser installation

Enbridge Gas tested access through soil cells to install a gas lateral line.

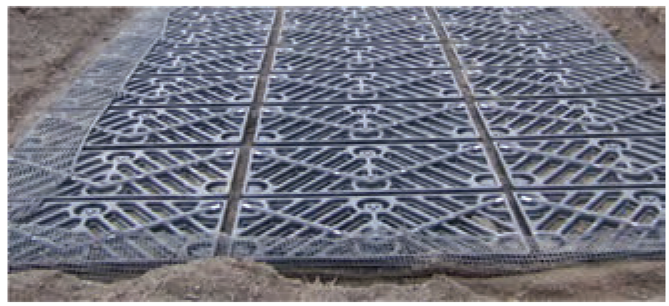
7.3 Bloor St. W. at Dovercourt Rd. and Concord Ave. demonstration project

A further on-site demonstration project was proposed. However, it was decided not to be implemented as part of this study, due to a larger upcoming resurfacing project in the area.

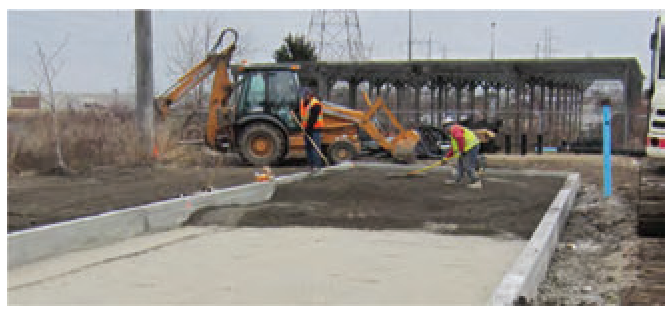
Note: The soil cell product used at Nashdene Yard was Silva Cells, manufactured by DeepRoot Green Infrastructure, LLC.

Nashdene Yard location, Scarborough.

Soil cell trench filled with soil.



Soil cell decking system.



Backfill installation on top of deck.

Finished installation.

7.1 Toronto Water Utility Access Exercise

Description of the exercise

The cold weather conditions, at -4°C (-10°C with wind chill) provided Toronto Water field personnel a good test for working with soil cells in adverse conditions.

The exercise began at 8:00 am with an on-site briefing where the demonstration project coordinators and Toronto Water personnel discussed the different activities and the order of execution. Water was then turned on into the installed water pipe which was capped on both ends and pre-cut during its installation under the soil cell system. Water fed from a hydrant at 414 kPa ran for approximately three minutes before it started to come out through the already saturated soil adjacent to the demonstration sidewalk. After the water valve was shut off, the following activities took place:

Concrete sidewalk pavement was removed

- Concrete pavement was saw cut into blocks that could later be removed by a backhoe.
- Removal of concrete and granular 'A' base below concrete paving.
- Crew located a geotextile layer that was installed below the granular 'A' and on top of the soil cell top frame deck; the geotextile was cut to expose the soil cell deck.
- Manual removal of two of six soil cell top decks were set aside for re-installation.

Water pipe cut.

Sawcutting concrete pavement.

Water introduced - water bursting out of saturated soil adjacent to installation.

Mechanical removal of pavement to expose soil cell decking system.

Manual removal of two decks, unscrewed and set aside for future re-installation.

Excavation below bottom of soil cells to daylight water pipe.

Mechanical removal of soil cells.

Excavation below bottom of soil cells to daylight water pipe.

Mechanical removal of soil cells, soil and sub-base

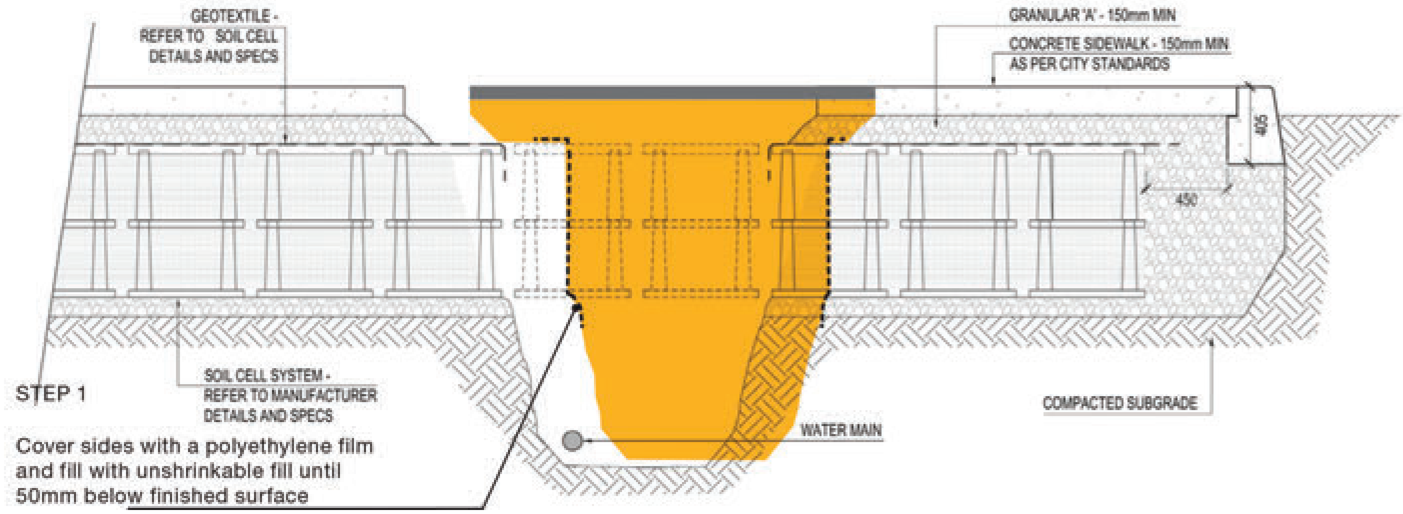
- Backhoe was used to dig out and through soil cells and soil.
- Water pipe was daylighted.

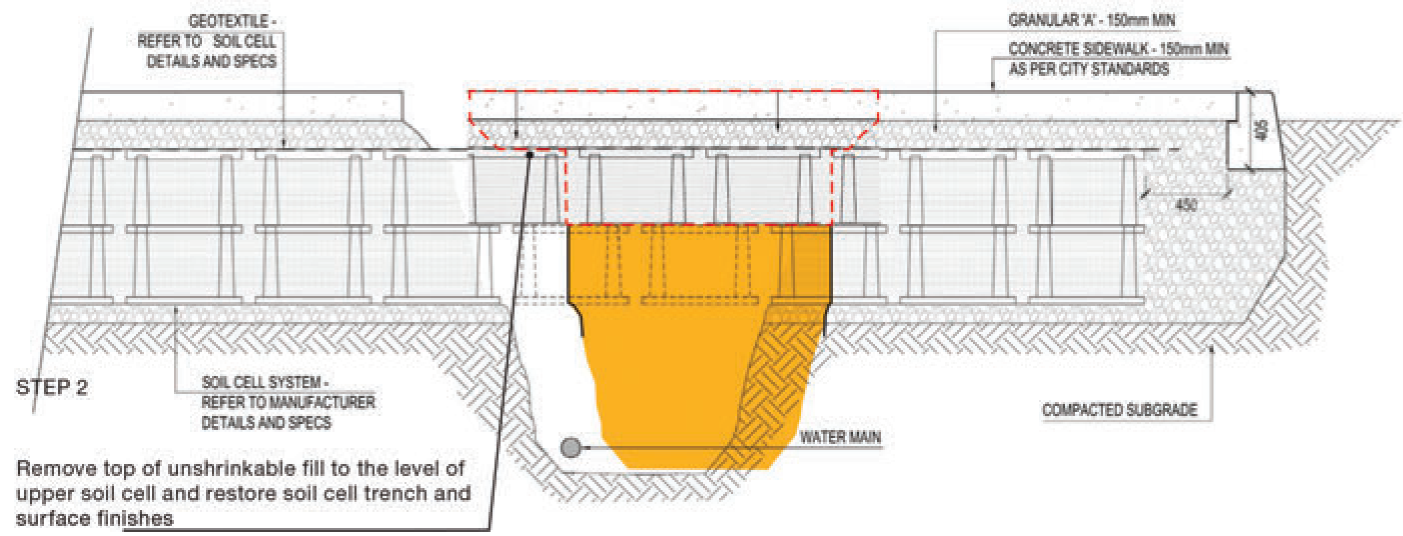
Repair

- The dug trench was temporarily repaired afterwards with unshrinkable fill up to finished grade.
- Weeks later, unshrinkable fill was broken up to the bottom of the first layer of soil cells to restore the cells and surface finishes to the original condition.

Conclusions of the Toronto Water exercise

Once the soil cells were removed, the stakeholders discussed the outcome and lessons learned from the exercise. It was concluded that Toronto Water can easily access its infrastructure through the soil cell system under extreme conditions using the same methods they currently have in place in either a planned or emergency situation. The exercise allayed their concerns that the soil cells would be a hindrance in their field work. Further discussions of a vertical minimum clearance between the utility and the bottom of the soil cells are expected.





7.2 Enbridge Gas Lateral Line and Riser Installation

Description of the exercise

The exercise began at 9:00 am at Nashdene Yard in Scarborough on a late-May day that was partly cloudy and warm. A gas lateral with a long riser was installed under a sidewalk cross-section of unit paving and soil cells. Using a mole with the shortest torpedo hammerhead at 1 .0 m length, the 25 mm gas line was bored through the growing medium and adjacent subgrade. Excavation was only necessary at each end of the gas lateral. For longer horizontal drilling, a directional drill is used which has greater directional control. Enbridge usually uses a torpedo mole for downtown work, which requires less excavation and can be used for horizontal drilling through sidewalk cross-sections. It can drill through tree roots and is only blocked by large rocks. The following took place:

Setting the direction and starting point of the horizontal boring

- Mock building and road sides of the sidewalk were designated for the purposes of this exercise.
- Unit pavers and granular base were removed to locate and confirm the cell deck edge. The torpedo was set to drill horizontally between the soil cell frame legs from the side.
- The crew dug down two cells deep between the building side and the cell, until there was enough room to slide the riser through. Where there is not enough room to dig behind the cell, the cell can be removed to install the riser.
- In alignment with the pit dug at the building end, another pit was dug down approximately 1.2m deep at the road end of the lateral.

Directional boring

- The torpedo was first set to begin at the building side where the riser would be placed. The torpedo did not make it out at the road side because it had great difficulty going from soft material to hard material (i.e.. growing medium to hard clay subgrade) as it does not have enough friction to propel it forward.
- The torpedo was reset to begin on the road side. It bored through the road subgrade then through the soft growing medium and came out at the building side.

Removal of pavers and granular base.


Geotextile is cut through centre of cell deck.


Digging down approximately two cells deep at both lateral ends.

Pulling the lateral through, attaching and setting the riser

- The torpedo was removed and the lateral pipe was attached to the hose end and pulled through.
- The riser was fused to the pipe end and pulled through and set at the correct elevation.
- Granular was backfilled into the cavity.

Torpedo emerges through growing medium and cell decks on the imaginary building side.

Torpedo set to begin at the imaginary building end of the lateral line.

After false start on imaginary building end, torpedo is reset at road end.

Torpedo and hose are pulled up and out of the pit.

Pulling the lateral through the cells and growing medium.

End of lateral at building end.

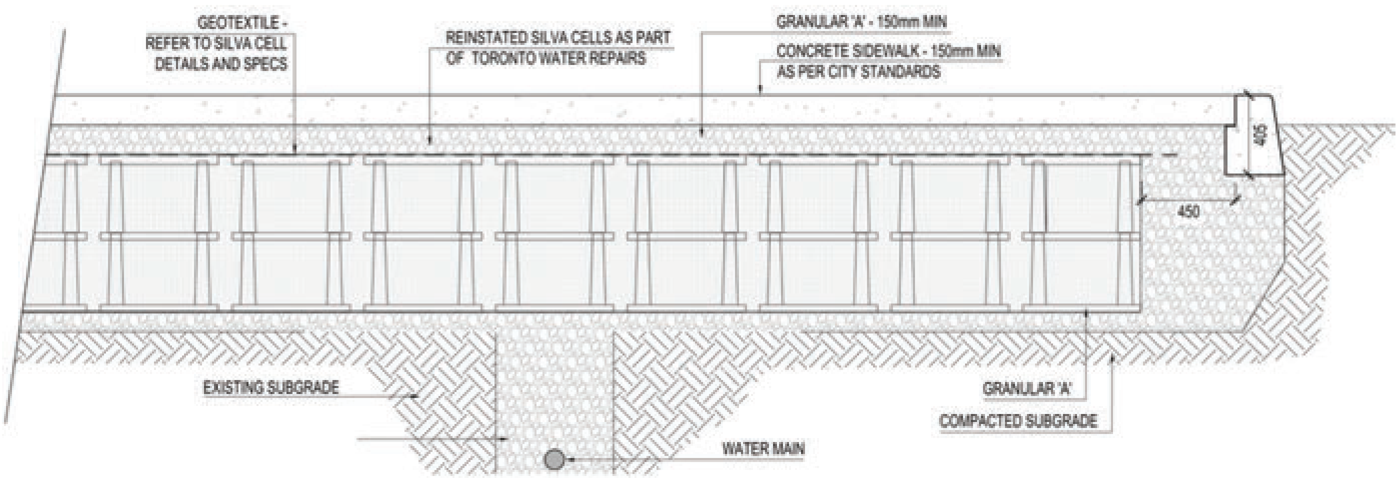
Cover over the cell deck with the cut geotextile and add an overlapping layer of geotextile on top.

Riser is attached and pulled through.

Backfill and ensure riser is set correctly. Conclusions of the Enbridge Gas exercise

Conclusions of the Enbridge Gas exercise

It was concluded that the soil cells pose no obstruction to the installation of a gas lateral and riser. The work is essentially the same as current sidewalk conditions with a few extra considerations. The crew must locate the boundary of the cell frame to set the torpedo to go between the cell deck legs and not collide into them. The crew must be mindful that the growing medium is easily permeable and that the torpedo bores move easily from hard to soft matter and not the other way around. Paving removal need only be limited to where the riser needs to go and the area needed to slide it into place. Where there is enough room between the soil cells and building face to excavate and install the riser, paving on top of the cells could stay intact.



Appendix C

Protection and Maintenance

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Notes: Each Silva Cell stack is independent of the Silva Cell stack adjacent to it – therefore if individual Silva Cells are disturbed, the entire system is not compromised.

Silva Cell frames (or base and posts) and decks should at no time be cut, drilled into, or otherwise structurally modified during any installaion, inspection or maintenance procedure. Any damaged Silva Cell frames (or base and posts) or decks shall be replaced.

1.0 Protection of The Silva Cell System

To help avoid future disturbance of the Silva Cell system the location of the system should be accurately recorded at the time of construction and incorporated into an as-built drawing.

If possible register the location of the Silva Cell system with the local One-Call utility locating program.

Accurately locate the limits of the Silva Cell system prior to any future excavation in the area. (Some types of underground utility locating equipment, such as ground penetrating radar, are capable of detecting Silva Cells and may be used to locate the limits of the system. Contact a professional utility locating contractor for more information).

Utility warning tape/ribbon and locating wires can also be incorporated into the system and are recommended.

2.0 Utility Installation, Maintenance, Relocation or Replacement within Silva Cell System

If the Silva Cell system is accidentally unearthed by future excavation in the area, cease the excavation immediately and consult the as-built drawings to determine the limits of the system.

Using hand tools only, expose the impacted portion of the Silva Cell system and carefully inspect the Silva Cell frames (or base and posts) and decks for any signs of damage or cracking.

Replace any damaged Silva Cell frames (or base and posts) or decks and reconstruct any disturbed portion of the system as per DeepRoot's installation Guidelines.

The Silva Cell system supports vehicle loading equal to 32,000 lbs (14,500 kg) per axle, which allows use in areas that accommodate 3 - 4 axle vehicles such as those used for emergency, delivery, and maintenance. Generally meets AASHTO HS-20 (USA), CSA-S6, 87.5 and OBC 54KN (Canada), and BS EN 1991-1-1:2002 and BS EN 1991-1-2:2003 (UK) loading standards when used with standard paving profiles.

Throughout this document, where H-20 loading is referred to, this is shorthand for the loading standards described above.

To prevent damage to underlying Silva Cells, ensure that machinery operated on the paving above does not exceed loading as described above. Do not operate any machinery over the Silva Cell system without paving being in place.

3.0 Utilities and Accessing The Silva Cell System

The Silva Cell system can be easily accessed for utility installation, maintenance, relocation, replacement, etc. using the following procedure.

First, locate the limits of the Silva Cell system.

Carefully remove the existing pavement. Take care to not operate machinery exceeding H-20 loading on any of the surrounding pavement supported by the system. Do not operate any machinery over the Silva Cell system once the pavement has been removed.

Using hand tools remove the aggregate base course and expose the underlying geotextile fabric. If working near the perimeter of the system there will be also be approximately 12″ (30.5 cm) of geogrid that is folded over and attached to the cell decks. Cut the geotextile fabric as needed to allow for the removal of Cell decks. If Geogrid is encountered, detach it from cell decks and fold it back as well. Do not cut the Silva Cell frames (or base and posts) or decks. Remove the Silva Cell decks by removing the four corner screws and set it aside. Remove the soil from inside the frames using hand tools only or a HydroVac. (If the existing soil is to be reused, store it separately to ensure that it does not become contaminated with other spoil material. Otherwise dispose of the soil and replace it with soil meeting the requirements specified for the project. All soil must be inspected and approved prior to reinstallation.) Carefully remove any of the frames (or base and posts) needed to complete utility work. Upon completion of the utility work visually inspect the surrounding exposed Silva Cell parts and remove any of those showing signs of damage or cracking. Restore the disturbed portion of the system using one of the two following methods:

Method 1:

Replace the Silva Cell frames (or base and posts), soil and decks as required per Silva Cell installation details and specifications. Re-wrap geogrid over decks with an overlap at cut seam. Restore the aggregate base course and pavement. Re-use only Silva Cell frames (or base and posts) and decks that have been thoroughly inspected and found to be free of damage or cracking. Replace any parts showing signs of damage or cracking with new.

Method 2:

Structurally bridge the gap with 1 1⁄2″ (3.8 cm) clear stone. Install geogrid around the perimeter of the area from which the Silva Cells were removed per DeepRoot's construction guidelines. Fill inside void area with 1 1⁄2″ (3.8 cm) clear stone up to the level of the adjacent Silva Cell decks. Cover the stone with geotextile fabric making sure to overlap the existing geotextile fabric by a minimum of 2 feet on all sides. Restore the aggregate base course and pavement.

4.0 Pavement Repair or Replacement over Silva Cell System

When the existing pavement over a Silva Cell system is to be replaced by a different type of pavement, refer to the Silva Cell standard details and specifications. A change in surface materials may require a change in the depth of the underlying aggregate base course.

5.0 Adding Silva Cells to The System/Removing Silva Cells from The System

To make changes to the size of the Silva Cell system, locate the limits of the system. Carefully remove the pavement taking care to ensure that no machinery which exceeds H-20 loading is operated on pavement supported by the Silva Cells and that no machinery is operated over the Silva Cells once the pavement has been removed. Using hand tools remove the aggregate base and expose the underlying geotextile fabric. Cut the geotextile fabric as needed to visually confirm the limits of the Silva Cells. Excavate to no closer than 1′ (30.5 cm) of the limits of the Silva Cells. Using hand tools, expose the geogrid which wraps the perimeter of the system. Cut and fold back the geogrid as needed to add or remove cells. If adding to the system, install the new Cells per Silva Cell specifications. Ensure that the gap between the existing Silva Cell frames (or base and posts) and the new Silva Cell frames does not exceed the 3” (7.6 cm) maximum. If removing frames (or base and posts) or decks, re-install the geogrid along the new perimeter of the Silva Cell system and backfill along the new limits of excavation per Silva Cell specifications.

6.0 Tree Replacement

Tree replacement may be necessary based upon unforeseen or severe site, climate or circumstantial conditions. Limit disturbance area as possible. Ensure all equipment meets H-20 loading requirements.

Remove any structure at the tree opening (tree grate, etc.) Remove mulch and any excess soil from above tree root package. Do not damage Silva Cell frames (or base and posts) or decks. Remove soil using hand tools only or HydroVac and set aside. If hand dug, ensure clean storage of soil material by excavating into contained/isolated location and cover during utility work. Soil must be inspected and approved prior to reinstallation.

Consult a certified arborist to remove tree. If necessary to cut tree roots from main root package, do not cut Silva Cell frames (or base and posts) or decks. Remove tree root package from planting bed. If using construction equipment to remove tree, ensure meeting of H-20 loading requirements.

Prior to planting new tree, install additional planting soil, to the depths indicated, within the tree opening adjacent to paving supported by Silva Cells. Assure that the planting soil under the tree root package is compacted to approximately 85-90% to prevent settlement of the root package. The planting soil within the tree opening shall be the same soil as in the adjacent Silva Cells. See Silva Cell specifications for further detail. Replace root barrier.

Plant tree according to owner specifications or at the direction of consulting arborist. Cover the planting soil finished grade with 2” (5cm) of mulch per Silva Cell specifications.

When a large portion of a Silva Cell installation is to be removed, first locate the area of disturbance. Limit disturbance area as possible. Ensure all equipment meets H-20 loading requirements.

Remove paving and aggregate base course. Carefully cut geotextile to allow for removal of Cell decks. Ensure at least 18” (45.7 cm) overlap into new limits of excavation. Do not cut Silva Cell frames or decks. Unfold geogrid from Cell decks and carefully fold away from Silva Cell frames (or base and posts). Remove Silva Cell decks by removing screws and set aside. Remove soil using hand tools only or HydroVac and set aside. If hand dug, ensure clean storage of soil material by excavating into contained/isolated location and cover during utility work. Soil must be inspected and approved prior to reinstallation Remove anchoring spikes from Cell base and set aside. If geotextile is at base of system, carefully cut geotextile at least 6” (15.2 cm) within new limits of excavation.

Install aggregate base course and paving, ensuring no damage to Silva Cells or other installation components.

7.0 Additional Silva Cells to be Installed Adjacent to Existing Installation

When additional Silva Cells are to be installed adjacent to an existing Silva Cell system, first locate the area of disturbance. Limit disturbance area as possible. Ensure all equipment meets H-20 loading requirements.

Excavate up to 12” (30.5 cm) from existing Silva Cells. Excavated remaining 12” (30.5 cm) by hand. Cut geogrid from face of existing Silva Cell system. Do not cut Silva Cell frames (or base and posts) or decks.

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