# SECTION 12 STORMWATER MANAGEMENT

A comprehensive Stormwater Management Plan has been completed for the Project. The Project's Stormwater Management Plan (Exhibit 12-1 [Stormwater Management Plan]) addresses each of the criterion set forth in the MDEP Stormwater Management Rules, §§ 481–490. The Stormwater Management Plan utilizes level spreaders and buffers to treat stormwater runoff generated from the developed Project area.

The Project includes approximately 10,200 linear feet of gravel road improvements to Stream Road and Chase Pond Road; approximately 16,000 linear feet of new roads, including (i) a 2,300-foot-long access road off of Stream Road to provide access to two wind turbines in the northern part of the Project, (ii) an approximately 4,500-foot-long access road off of Stream Road to provide access to three wind turbines in the southeast part of the Project, and (iii) a 9,200-foot-long access road off of Chase Pond Road to provide access to six wind turbines in the western part of the Project. One of the onsite buildings will be refurbished and serve as the Project O&M building and the existing gravel road leading to this building will be repaired, as necessary. The Project substation will be located adjacent to Stream Road, and in accordance with MDEP policy, only the building areas are considered impervious and treated for water quality. The substation pad is graded to allow the runoff from two proposed control buildings to be collected and dispersed to a buffer through a stone level lip spreader. In addition, the Project includes two designs for an ADLS. The ADLS designs will include the construction of up to 1,725 linear feet of new roads to provide access to the radar tower pads. Utilities for the ADLS towers will be buried in up to 2,100 linear feet of existing logging roads, but the size and location of these roads will not be altered.

In summary, no increase in discharge rate from the Project area will be created and no adverse impacts to adjacent waterbodies and/or properties will occur upon the implementation of stormwater management design specifications. This Project achieves treatment for 100% of all impervious non-linear areas and over 76% of impervious linear features. The proposed development meets the standards for stormwater management in Title 38, section 420-D and has been designed to ensure the Project will not have an unreasonable adverse effect on surface water quality.

## Exhibits

- Exhibit 12-1 Stormwater Management Plan

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# EXHIBIT 12-1 STORMWATER MANAGEMENT PLAN

# Stormwater Management Plan

## Western Maine Renewable Energy Project
## Somerset County, Maine

*Prepared For:*

Western Maine Renewables, LLC

P.O. Box 1000
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*Prepared By:*

***Robert S. Cummings, P.E.***

June 2021

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# 1.0 INTRODUCTION

Western Maine Renewables, LLC, (Western Maine) a joint venture between Patriot Renewables, LLC and Cianbro Development Corporation, proposes to construct the Western Maine Renewable Energy Project, a 14 turbine utility-scale wind energy facility located in the Town of Moscow, Somerset County, Maine (Project). The proposed Project is located approximately 5 miles northeast of the center of the Village of Moscow, on land currently comprised of forested timberland and the remnants of a former United States Air Force (USAF) long-range, over-the-horizon backscatter radar transmitter station (USAF Radar Station). The wind facility will have an installed capacity of approximately 58.8 megawatts of electricity. The Project is designed to use Vestas V150-4.2 megawatt turbines and will include upgrades to existing roads and construction of new roads; aircraft detection lighting system (ADLS); a series of 34.5 kilovolt (kV) electrical collector lines among the turbines; a 34.5/115 kV Project substation; a 115 kV interconnection substation; and an Operations & Maintenance Building (O&M Building).

The Project includes approximately 10,200 linear feet of gravel road improvement and temporary widening on Stream Road and Chase Pond Road; approximately 16,000 linear feet of new roads, including (i) a 2,300-foot-long access road off of Stream Road to provide access to two wind turbine pads in the northern part of the Project, (ii) an approximately 4,500-foot-long access road off of Stream Road to provide access to three wind turbine pads in the southeast part of the Project , (iii) a 9,200-foot-long access road off of Chase Pond Road to provide access to six wind turbine pads in the western part of the Project. One of the existing buildings on the site will be refurbished and serve as the Project O&M Building and the existing gravel road leading to this building will be repaired, as necessary. The Project substation will be located adjacent to Stream Road. In addition, the Project includes the construction of up to 1,725 linear feet of new roads to access up to two ADLS towers.

The existing roads will be widened only temporarily for construction before being revegetated. All new access roads connecting the wind turbine pads will be built 38 feet wide to allow access for construction equipment and cranes needed to assemble the turbines. To minimize Project impacts, the access road and ridgeline road will be reduced to a final width of only 12 feet for operation of the Project, with the exception of periodic turnouts to allow for passing vehicles. The road base and cross sections will remain in place, but the temporary gravel road surfaces (12 feet and 20 feet wide, respectively) will be loamed and seeded and/or treated with an erosion control mulch to maintain these areas as vegetated meadow buffers. During operation of the Project, a crane or other heavy equipment may need to access the turbines for maintenance or repairs; however, if meadow buffer areas are disturbed during these maintenance activities, they will be restored following completion of the necessary repairs or maintenance. One exception to this is the two planned meadow buffers that will remain protected after Project completion.

## 1.2 Methodology

Natural Resources Conservation Service (NRCS) maps were used to obtain regional rainfall data. The Soil Conservation Services' Technical Release)-20 computer modeling method was used within HydroCAD® 9.10 to perform hydrologic and hydraulic calculations. This method accounts for existing soils and land use, topography, vegetative cover and proposed land use. The conditions of the Project site were evaluated to determine pre-development and post-development peak stormwater flows, drainage patterns, flow velocities, and other attributes of the site. These conditions were analyzed using data for a Type III, 24-hour storm distribution, with a frequency of occurrence of 25 years. Rainfall amounts for this storm are 4.7 inches. The HydroCAD calculations can be found in Attachment 1-1 "HydroCAD Calculations".

## 1.3 Topography and Vegetation

The Project area is comprised of forested timberland and the remnants of a former USAF long-range, over-the-horizon backscatter radar transmitter station (USAF Radar Station). Adjacent properties are generally undeveloped and used primarily for commercial timber harvesting operations. Following construction, approximately 36.4 acres of the 48.0 acres of impervious area temporarily created for gravel construction surfaces will be restored to permanent vegetative cover, resulting in approximately 11.6 acres of new, permanent impervious areas (12-foot-wide gravel roads, wind turbine foundations, and crane pads).

The Project area is comprised of two distinct areas. The eastern portion of the Project contains the remnants of the former USAF Radar Station. This area was previously developed, and the topography consists primarily of gradual grade changes with slopes ranging from 0 to 10 percent (%). Elevations generally range between 1280 feet above mean sea level in the vicinity of the turbine located farthest east of the Project to 1,400 feet above mean sea level in the vicinity of the wind turbine located farthest north of the Project. The vegetation cover in this area is divided into large open grassed and forested areas. The western portion of the Project consists of undeveloped forest land and commercial forestry operations with moderately steep to steep mountainside slopes. Elevations generally range between 1,300 feet above mean sea level to 1,510 feet above mean sea level in the vicinity of the highest turbine site located along the ridgeline. Slopes range from 0 to 60 %, but mostly occur at 30 % or less in the vicinity of the ridgeline access road and turbine sites. Forest stands in the Project area are typical of lands subject to commercial forestry operations. The Project area was assumed to be in good condition for the purpose of runoff calculations.

Wetlands, state and federal jurisdictional waterbodies, and numerous non-jurisdictional drainages were field delineated and mapped in the Project vicinity and impacts to these resources were avoided and minimized where possible.

## 1.4 Soils

Site-specific soils mapping, in conformance with Class B (High Intensity), Class D (Modified) and Class L (Linear) standards, was performed for the Project as outlined in the Attachment 1-2 "Soil Survey Report". The western portion of the site is comprised of steeper slopes and which is similar mountain and ridgeline slopes. This area is generally bedrock controlled, and consequently exhibits shallow to bedrock soil conditions. The side slopes tend to be comprised of deeper soils (i.e., +40 inches in depth), which are loam to sandy loam textured soils generally derived from glacial till sediments. These soils commonly exhibit a firm substratum that produces a perched groundwater table. The soil mapping units created with the soil survey data were overlaid on the engineering drawings and used for the stormwater analysis and design. For stormwater calculation purposes, the soils were grouped by Hydrologic Soils Group (HSG), drainage classifications defined by the NRCS. These groups are shown on the drainage plans in Attachment 1-3

"Pre-development and Post-development Stormwater Drainage Plans". The soils on the site are predominantly HSG C and D.

## 1.5 Stormwater Quality Best Management Practices

The Project was designed to comply with the requirements of Maine Department of Environmental Protection's (DEP's) best management practices (BMPs) for stormwater, identified in Maine DEP's *Stormwater Management for Maine* manual, published in January 2006. The Project design incorporates many of the BMPs contained in this manual, including level spreaders, ditch turnouts, and stone berms. The design also integrates features geared towards minimizing the effects on ground and surface water flow.

The General Standards, Section 4(B)(2) of the Chapter 500 Rules require that runoff from no less than 95% of the impervious area and no less than 80% of the developed area that is impervious or landscaped is controlled and treated using accredited BMPs. The linear features of the Project – the roads – in accordance with Section 4(B)(3)(c) of the General Standards will require treatment for no less than 75% of the runoff volume from the impervious area and no less than 50% of the developed area that is impervious or landscaped. The turbine pads and O&M Building are not considered linear and are required to meet 95% stormwater treatment. The substation pad is approximately 1.3 acres in size, and per Maine DEP regulations, only the building areas are considered impervious and need to be treated for water quality. The substation pad is graded to allow the runoff from two proposed buildings to be collected and dispersed to a buffer through a stone bermed level lip spreader. This Project achieves treatment for 100% of all impervious non-linear areas and over 76% of impervious linear features (see Attachment 1-7 "Schedule of Stormwater Best Management Practices").

## 1.6 Pre-Development Conditions

Stormwater runoff from the existing Project site is grouped into five large sub-catchments, covering approximately 6,096 acres as depicted in Attachment 1-3 "Pre-development and Post-development Stormwater Drainage Plans".

**Sub-catchment A** is located east of the Project and encompasses most of the former USAF Radar Station and forested land abutting Austin Stream. This drainage area includes approximately 2,140 acres. The area contains primarily HSG C and D soils. There are a several gravel roads and two existing buildings, large grassed areas with gradual slopes and undeveloped forested areas. The runoff curve number for this sub-catchment is 78 with a 25-year storm peak flow rate of 449.83 cubic feet per second (cfs).

**Sub-catchment B** is the largest sub-catchment area and is located west of the Project. This drainage area includes approximately 3,247 acres of wooded mountainside. The area contains primarily HSG D soils with smaller areas of HSG C soils scattered in the sub-catchment area. There are a few existing gravel and dirt roads in this drainage area including Chase Pond Road, but otherwise the area is undeveloped. The runoff curve number for this sub-catchment is 77 with a 25-year storm peak flow rate of 883.65 cfs.

**Sub-catchment C** is adjacent to Chase Pond. This drainage area includes approximately 289 acres of wooded mountainside. The area contains primarily HSG D soils. There are a few existing buildings and dirt roads, but otherwise the area is undeveloped. The runoff curve number for this sub-catchment is 77 with a 25-year storm peak flow rate of 140.67 cfs.

**Sub-catchment D** is adjacent to Mink Brook. This drainage area includes approximately 159 acres of wooded mountainside. The area contains primarily HSG D soils. There are a few gravel and dirt roads, but otherwise the area is undeveloped. The runoff curve number for this sub-catchment is 77 with a 25-year storm peak flow rate of 234.28 cfs.

**Sub-catchment E** is located directly west of sub-catchment D. This drainage area includes approximately 261 acres of wooded mountainside. The area contains primarily D soils. There are a few gravel and dirt roads, but otherwise the area is undeveloped. The runoff curve number for this sub-catchment is 77 with a 25-year storm peak flow rate of 225.95 cfs.

Refer to Attachments 1-1 "Hydrological Calculations" and 1-3 "Drainage Plans" for further descriptions of the various sub-catchment areas.

## 1.7 Post-Development Conditions

The Project's stormwater management low-impact development system was designed to mitigate the impacts of the proposed gravel roadways while maintaining simplicity in the design. This simplicity is important because it requires a minimum amount of maintenance to ensure its proper function, which in turn provides a higher probability of long-term effectiveness.

In general, there will be very little change in the runoff characteristics of the site after completion of the Project. Stormwater runoff of upgradient undisturbed areas will be intercepted by either a riprap ditch or riprap shoulder. This runoff will be encouraged to infiltrate through the blasted rock sub-base of the road. During larger storms, the stormwater is directed to culverts that outlet to level spreaders. The level spreaders then redistribute the water to resemble natural sheet flow. Pre-developed mountain side slopes have an approximate grade of 20% to 60%; however, the proposed roadside ditches will have a maximum slope of only 13%, enabling them to slow the upstream flow, thereby decreasing the runoff for areas intercepted by the roadway. While there will be a slight increase in overall runoff due to the roadway, it will generally be mitigated by this decrease in upstream runoff.

No significant changes in runoff are expected following development of the site. This is primarily due to the impervious area proposed in each sub-catchment being a relatively small percentage of the whole. For example, in Sub-catchment B (sub-catchment area with the most new impervious surface), 5.23 acres of new impervious surface are proposed, but that represents only 0.16% of the 3,247 acres of the watershed within the Project area, as shown in Table 1-1 "Existing and Post-Development Peak Flow Rates and Runoff Volumes".

A large portion of the Project site has thin soils over bedrock, which are typically conducive to producing large volumes of stormwater runoff. Because large mountainside watersheds already have large volumes of runoff, the increase in runoff due to construction of gravel roadways and turbine foundations would be minimal. Both the relatively small increase in impervious area and the minimal change in runoff volumes following construction contribute to insignificant changes in runoff characteristics post-construction. The HydroCAD® calculations (see Attachment 1-1 "HydroCAD® Calculations") also demonstrate that no significant changes to the rate or volume of runoff are anticipated from post-development site conditions.

Low-Impact Development (LID) is the general term used to describe a design strategy that minimizes disturbance and aims to maintain the pre-development hydrologic regime through the use of design techniques and BMPs. A combination of hydrologic functions such as runoff storage, infiltration, groundwater recharge, vegetation and buffer filtration, time of concentration, and sheet flow are preserved through the use of stormwater management BMPs, buffers, reduction of impervious surfaces, conservation of natural areas and control of runoff close to the source.

Traditionally, the impact of development to a watershed is measured in terms of increases in peak flow rates and changes in flow regimes. Conventional stormwater management methods direct all stormwater to channel-like flow. Through the use of ditches, storm drains, and other "end-of-pipe" controls, the stormwater is carried to detention ponds and other point sources of discharge as quickly as possible. The end-of-pipe system is designed for the larger and more infrequent events such as the 10- and 25-year storms. Such a system is not designed to manage smaller, more frequent events such as the 1- and 2-year events that make up 90–95% of all rainfall events. As a result, these smaller, more frequent storms over-drain a site managed by conventional stormwater practices and eventually erode natural streams, causing downstream pollution due to the rapidly transported pollutants. In contrast to conventional stormwater management methods, LID methods control stormwater at the point of collection. Instead of channeling the water to a detention pond, stormwater runoff is discharged in a more natural condition, as sheet flow. The Project objectives are to minimize disturbance and maintain a pre-development hydrology regime. The Project will replicate existing runoff conditions and drainage patterns through the use of a LID system, instead of using more conventional end-of-pipe systems.

The provisions of the Maine Stormwater Law and Site Location of Development Act typically require stormwater detention practices in order to meet the flooding standard required for large projects. Results of these analyses indicate that the Project will produce no increase in peak flow rates; therefore, Western Maine is requesting a waiver of the Flooding Standard per the General Standards, Section 4(E)(2)(b) of the Chapter 500 Rules.

## 1.8 Stormwater Calculations and Results

A post-development drainage analysis was performed to determine if the Project would increase runoff from the site, and therefore, require stormwater detention for a 25-year storm event.

Hydrologic soil group areas were identified for each watershed based upon the soil surveys and detailed in Attachment 1-2 "Soil Survey Report". The longest hydraulic travel length was identified for each of the three watersheds. Length and width of all existing roadways within the watershed boundaries were estimated and assumed to have a runoff curve number of 96, assuming gravel roadways (HSG D). All wooded areas were assumed to be in good condition.

Stormwater calculations assumed 12-foot-wide impervious roads, substation pad area, a 65- by 110-foot area for each gravel crane pad surrounding turbine foundations, an approximately 4,225-square-foot gravel apron for each turbine base. The post-development watershed areas are the same as the pre-development watershed areas. The time of concentration (TOC) was calculated but the TOC remained virtually the same in the in both pre- and post-development. Results of the stormwater runoff calculations are shown in Table 1-1.

**Table 1-1. Existing and Post-Development Peak Flow Rates and Runoff Volumes**

| | Watersheds | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| Watershed Area within Project Area (acres) | 2,140 | 3,247 | 289 | 159 | 261 |
| Increase in Impervious Area (acres) | 4.52 | 5.23 | 0.30 | 0.80 | 0.78 |
| Increase in Impervious Area (% of Total Watershed) | 0.21% | 0.16% | 0.10% | 0.50% | 0.30% |
| Existing Peak Flow Rate (cubic feet per second) | 450 | 884 | 141 | 234 | 226 |
| Existing Runoff Volume (acre-feet) | 263 | 515 | 54 | 31 | 51 |
| Post-Development Peak Flow Rate (cubic feet per second) | 450 | 883 | 141 | 234 | 226 |
| Post-Development Runoff Volume (acre-feet) | 263 | 514 | 54 | 31 | 51 |

## 1.9 Stormwater Quantity Management

The primary concept of the Project’s stormwater management system is to minimize the amount of water traveling over the newly created roadways. This will be accomplished by first intercepting the surface water flow on the uphill side of the roadway with a ditch that will be constructed along the upper edge of the road. Water will flow from the ditch through a culvert system, allowing the water to pass under the roadway. At the outlet of the culverts, level spreader systems will be provided to allow the flow to be disbursed downstream. In addition, at the naturally-occurring low points in the roadway where a fill is present, a stone and geotextile filtering system (commonly referred to as a rock sandwich) will be installed under the roadway sub-base to allow upgradient ground and surface waters to travel under the roadway unimpeded by the new construction. Similar to the rock sandwich, a rock maki section will be used in cut sections showing high water table or high runoff potential. In these sections, 1 foot of additional stone will be placed under the sub-base of the road and connected to the ditch’s sub-base. This extra layer of stone will encourage infiltration of the groundwater and surface water under the road. The rock sandwich and rock maki are examples of LID systems that take the focus away from concentrated flow. These two systems have the ability to deal with smaller runoff more naturally, but they are capable of handling larger storm events. This system will maintain flows as close to sheet flow as possible.

Frequent culverts, level spreaders, buffers and other erosion control measures will be used throughout the Project to control runoff and erosion. Culvert sizes, locations, and elevations are specified on the design drawings; however, final culvert locations may need to be adjusted slightly in the field based on site-specific conditions. The final locations and elevations of culverts will be noted and included on the as-built plans for the Project. Culvert sizing calculations are included in Attachment 1-4 "Culvert Sizing Calculations and Related HydroCAD® Reports" and a schedule is included in Attachment 1-5 "Schedule of Proposed Culverts".

Runoff from the final gravel roadway system will be directed to a forested buffer at least 35 feet wide or a meadow buffer at least 55 feet wide, with the upslope edges of these buffers beginning at the clearing limits or further downslope. Buffers outside of the clearing limits will be protected with deed restrictions. Meadow buffers within the original road widths will not be deed restricted as a crane may be needed at some point during the operation of the Project; any meadow buffers within the original road widths that are disturbed by a crane will be restored after the crane leaves the Project site. A sample deed restriction for forested buffers can be found in Attachment 1-6 "Sample Declaration of Restrictions for Forested Buffers". Buffers were sized using the *Stormwater Management for Maine* manual and in consultation with Maine DEP.

The peak flow rates and runoff volumes from the pre-development site conditions are not significantly affected by the proposed development as indicated by the post-development calculations. Based on these results, no flooding or adverse stormwater-related impacts are anticipated in association with development of the site. Although the Project will add impervious area, the overall runoff curve number remains the same for the pre-development and post-development conditions of the site. The increase in peak flow post-development will be insignificant for all storm events. Therefore, stormwater mitigation for water quantity is not required for this Project, per the *Stormwater Management for Maine* manual.

# 2.0 BASIC STANDARDS

## 2.1 Introduction

Soil erosion is the detachment of soil particles by water, ice, gravity, or wind. This is a naturally occurring process that also can be caused by human activities that involve soil disturbance. Soil erosion can lead to sedimentation when eroded soil particles are carried by water and deposited and can have adverse effects on aquatic and terrestrial natural resources.

The erosion potential for projects involving soil disturbance on mountainsides can be very high. Large watersheds comprised of steep slopes and shallow-to-bedrock soils (with a low capacity to absorb water) can result in unusually large volumes of runoff moving at high velocities. These factors can contribute to erosion of disturbed soils and lead to sedimentation downstream. However, the linear nature of the Project design, along with carefully designed stormwater management and erosion control measures, reduces the potential for substantive erosion and sedimentation downstream from the Project. In addition, Western Maine is proposing construction of the Project in smaller segments (as described in Section 2.2), thereby reducing the extent of exposed, disturbed soils at any given time. Western Maine plans to utilize Maine DEP's Third-Party Inspection Program and will contract an independent environmental inspector approved by the Maine DEP.

## 2.2 Construction of Roads, Turbine Pads, and Substation

Construction of all roads, turbine pads, and the substation shall be performed in accordance with design specifications, which have been developed to avoid changing the runoff characteristics, of adjacent undisturbed surroundings. It is best to construct the roads in the spring, summer, or fall. Winter construction also is possible; however, techniques for overwinter construction and stabilization, as explained in Section 2.5, shall be used. The roads will be constructed in segments. Each segment shall not exceed an area that can be stabilized within 1 week. While it is acceptable to clear vegetation from the entire road system in one effort, any further construction involving soil disturbance or grading must be done incrementally. Clearing is defined as the cutting and removing of over-story vegetative cover. After clearing, erosion control barriers must be installed. Only then can grubbing and earthwork commence. Grubbing is defined as the removal of grass, stumps, roots, shrubs, and low trees, and it is the initial action that exposes soils to erosive forces. Earthwork is defined as the movement of soil by mechanical means. Earthwork includes excavation, filling, shaping, trenching, placement of gravel, and grading. Sediments trapped by erosion control barriers will be removed during construction in accordance with Project specifications.

Each segment of road shall be properly finished and stabilized before removing the erosion control barriers. Temporary and permanent erosion and sedimentation control techniques proposed as part of the Project are described in the following sections.

## 2.3 Transmission Line Construction

Only existing roads will be used to access the transmission line during construction and no new impervious area will be created. The transmission line along Stream Road and the distribution line to the O&M Building and additional erosion control measures will be installed as necessary. The installation of the transmission and distribution lines will create very little chance of erosion as new soils should not be displaced and only poles need to be set and wire strung. However, erosion control methods will be implemented when needed, according to the following “toolbox” system (also found on Sheet C-411 of Western Maine’s Site Location of Development Act Application, Exhibit 1-1):

- In areas showing a high ground water table, or where a high-water table is suspected, timber matting should be used to avoid damaging the existing surface;
- In areas where there is a high possibility of erosion, erosion control barriers will be used;
- If underdrainage is opened during the course of construction, slash can be used to seal the rut; and
- Any area that is damaged during construction must be restored upon completion.

## 2.4 Temporary Erosion Control Measures

**Exposed soils shall be seeded, mulched, and stabilized.** Temporary seeding and mulching will be used to create temporary vegetated cover that will reduce erosion and sedimentation by stabilizing disturbed areas that will not be brought to final grade within 30 days and up to 1 year. This is the most efficient way to control sheet and rill erosion.

**Temporary Vegetation** planted in compliance with the Temporary Seeding Specifications in Table 1-2 will be applied to exposed soils that are not to be fine-graded within 30 days of grubbing or earthwork.

**Table 1-2. Temporary Seeding Specifications**

| Seed Type | Pounds of Seed per Acre | Seeding Depth | Recommended Seeding Dates | Remarks |
|---|---|---|---|---|
| Winter Rye | 112 | 1-1.5 inch (in.) | 8/15 – 10/15 | Good for fall seeding. Select a hardy species, such as Aroostook Rye. |
| Oats | 80 | 1-1.5 in. | 4/15 – 7/1<br>8/15 – 9/15 | Best for spring seeding. Early seeding will die when winter weather moves in, but mulch provides protection. |
| Annual Rye Grass | 40 | 0.25 in. | 4/15– 7/1 | Grows quickly but is of short duration. Use where appearance is important. With mulch, seeding may be done throughout growing season. |
| Sudan Grass | 40 | 0.5-1 in. | 5/15 – 8/15 | Good growth during hot summer periods. |
| Perennial Rye Grass | 40 | 0.25 in. | 8/15 – 9/15 | Good cover, longer lasting than annual rye grass. Mulching will allow seeding throughout growing season. |
| Dormant Seeding Mix<br>Winter Rye/Annual Rye | <br>112<br>40 | 1 in. | 10/15 – 4/15 | Refer to Temporary Mulching and/or Permanent Vegetation. |

Where soil has been compacted by construction operations, loosening the soil to a depth of 2 inches will occur before applying seed. Mulch will be applied over all seeded areas.

**Temporary Mulching** will be performed on exposed soils to protect them from erosion and aid the growth of vegetation. Hay or straw mulches, erosion control mix, and erosion control blankets can be used. Hay or straw mulches or erosion control mix can be applied to any disturbed slopes less than 2:1. Erosion control blankets or netted hay or straw mulches can be used to stabilize slopes between 2:1 and 1:1. Any slope greater than 2:1 that will not hold mulch, and seed will require riprap or other stabilization. The Project engineer, in consultation with the Third-Party Environmental Inspector, will determine the most practical mulch for each scenario at the site. In sensitive areas, such as within 100 feet of streams, wetlands, and in lake watersheds, temporary mulching must be applied within 7 days of exposing the soil and prior to storm events. In other areas, the time period can range from 14 to 30 days according to site conditions. Areas that have been seeded will be mulched immediately following seeding. Areas that cannot be seeded during the growing season (April 15–September 15) will be mulched for overwinter protection and will be seeded at the beginning of the next growing season. These areas will be mulched to a depth of 4 inches for the overwinter period. If permanent vegetation is desired, the mulch will be removed in the springtime, and the area will be seeded and re-mulched. Temporary mulching rates are shown in Table 1-3.

**Table 1-3. Temporary Mulching Schedules**

| Maximum Expected Interim Period[1] (Days) | Temporary Mulching[2] (Hay) |
|---|---|
| 0-7 (0-2) | None |
| 7-30 (2-14) | 2 bales per 1,000 square feet (sq.ft.) |
| 30-60 (14-30) | 2 bales per 1,000 sq.ft. |
| More than 7 days during winter season | 4 bales per 1,000 sq.ft. |

1. Values in parentheses indicates interim period for sensitive and critical areas. Interim Period is defined as any period where exposed soil is not actively being worked on.
2. Mulch application rates shall be doubled for winter construction.

**Hay or Straw Mulches** shall be applied at a rate of two bales per 1,000 square feet and shall cover 75% to 90% of ground surface. If the mulch is applied to slopes between 2:1 and 1:1, netting will be used to anchor the mulch. Netting can be jute, wood fiber, or plastic. Only clean straw mulch will be used within wetlands and within 25 feet of state or federal jurisdictional streams.

**Erosion Control Mix** mulch will be used to prevent erosion. This mulch will consist of primarily organic material and may include shredded bark, stump grindings, composted bark or other acceptable products in compliance with Project specifications. The erosion control mix will be used as a stand-alone reinforcement on slopes up to 2:1, frozen ground or forested areas, and at the edge of gravel parking areas and areas under construction. Erosion control mix shall not be used within jurisdictional wetlands or waterbodies. Erosion control mix composition shall meet the standards listed on Sheets C-310 and C-311 of Western Maine's Site Location of Development Act Application, Exhibit 1-1.

**Erosion Control Blankets** can be used for slopes steeper than 2:1. These blankets are a combination of mulch and netting designed to retain soil moisture and modify soil temperature. Erosion control blankets should be used on the base of grassed waterways, steep slopes, and on disturbed soils within 100 feet of lakes, streams, and wetlands during the growing season (April 15–September 15). During the late fall and winter seasons (September 15–April 15), blankets also should be added to side slopes of grassed waterways and moderate slopes, in addition to areas mentioned above.

**Topsoil** will be stockpiled uphill of erosion and sediment control barriers for reuse onsite. These stockpiles will be placed in areas of minimal erosion, such as flat surfaces. Stockpiles remaining for extended periods of time will be stabilized and surrounded by erosion control barriers.

**Stabilized Construction Exits** will reduce the amount of sediment tracked onto public roads. The Project will have one permanent exit at the entrance of the site on Stream Road. All Project roads will contain a road surface topped with inch and one half minus stone, and the two road exits will not have any additional stabilization. However, if Western Maine's engineer or a Third-Party Environmental Inspector determine that a stabilized construction exit is warranted, Western Maine will employ the appropriate protective measures.

**Maintenance** will be conducted on all erosion control elements as needed. All mulches must be inspected weekly, especially after significant rainstorm events. Significant rainstorm events are defined as rainfall of a 0.5 inch or more. If less than 90% of the soil surface is covered in mulch, additional mulch will be immediately added. Nets must be inspected after all rainstorm events for failure. If washouts occur, the nets will be reinstalled after damage to the slope has been repaired. These inspections will take place until 95% of the soil is vegetated with grass or stabilized with mulch.

## 2.5 Temporary Sediment Barriers

**Sediment barriers will be installed on the downhill side of all construction.** Erosion control mix berms and geosynthetic berms will be used to intercept and retain small amounts of sediment from disturbed and unprotected areas during access and ridgeline road construction. Silt fences, hay bales, or other means may be used as determined by the Third-Party Environmental Inspector. Sediment barriers will not be installed in areas of concentrated flow. Sediment barriers shall be installed prior to any soil disturbance in the contributing drainage area above them. Silt fences or hay bales will be used in areas where entrenchment and driving stakes are possible. Erosion control mix berms or continuous contained berms will be used where soil cover is shallow or ground is frozen. Sediment barriers will be doubled within 100 feet of any wetland. The Project engineer, in consultation with the Third-Party Environmental Inspector, will determine the most practical sediment barrier for each scenario at the site.

**Silt Fences** utilize synthetic filter fabrics. The synthetic fabric is attached with a series of 1-inch square hardwood stakes. The filter fabric will be a pervious sheet of propylene, nylon, polyester, or ethylene yarn. The filter fabric will contain ultraviolet inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0 degrees ($^{o}$) Fahrenheit (F) to 120$^{o}$F. The height of the silt fence shall not exceed 36 inches. If joints between the filter fabric are necessary, they will be spliced at stakes with an overlap of 6 inches. Stake spacing shall not exceed 6 feet. Ten (10) inches of the filter fabric shall be imbedded in a 4-inch-wide by 6-inch-deep trench located on the upgradient side of the barrier. The trench will then be backfilled and compacted over the filter fabric. Pre-fabricated silt fences are acceptable if installed to the manufacturer's standards.

**Hay Bales** will be placed in a single row, lengthwise along the contour, with ends tightly abutting adjacent hay bales. The hay bale barrier will be entrenched to a depth of 6 inches and backfilled. Soil backfill will be used to conform to the ground level on the downhill side and shall be built up against the uphill side of the barrier. At least two hardwood stakes shall be driven a minimum of 12 inches into the ground. The gaps between bales shall be wedged with hay to prevent water from leaking through the bales.

**Erosion Control Mix Berms** primarily consist of organic material and may include shredded bark, stump grindings, composted bark, or acceptable manufactured products. The mix will contain a well-graded mixture of particles and may contain rocks less than 4 inches in diameter. The mix also will abide by certain standards listed on Sheet C-410 of Western Maine's Site Location of Development Act Application, Exhibit 1-1. The erosion control mix berms must be placed along a relatively level contour. The barrier should be a minimum of 12 inches high, as measured on the uphill side of the barrier. These berms are very effective on frozen or heavily rooted ground. Erosion control berms will not be used within wetlands.

**Geosynthetic Berms** consist of a filter sock full of erosion control mix. The organic mix is placed in the synthetic tubular netting and performs as a sturdy sediment barrier. This method works well in areas where trenching is not possible, such as on frozen ground or bedrock outcrops. The detail is shown on Sheet C-410 of Western Maine's Site Location of Development Act Application, Exhibit 1-1.

**Maintenance** will be performed on all erosion control elements as needed. Sediment barriers will be inspected weekly and immediately after each significant rainfall event. They will be repaired if there is any sign of erosion or sedimentation below them. Damaged or degraded fabric on a silt fence will be replaced immediately. Sediment deposits should be removed after each storm event. They must be removed when deposits reach one-half the height of the barrier. Any sediment remaining after a barrier is no longer needed should be graded, prepared, and seeded.

## 2.6 Overwinter Construction and Stabilization

Overwinter construction and stabilization will be necessary if an area of construction has not been stabilized with a road gravel base, 75% mature vegetation cover, or riprap by November 15. The winter construction period is November 1 to April 15. Winter excavation and earthwork shall be conducted on no more than 1 acre of the site without stabilization at one time. Exposed areas are to be limited to areas (1) where work will occur within 15 days and (2) that can be mulched in 1 day prior to any snow event. Areas within 100 feet of any natural resource and lacking 75% mature vegetative cover shall be mulched by December 1 and protected with an erosion control cover. A double row of sediment barriers will be placed between the disturbed area and any natural resource during winter construction. When the ground is frozen, sediment barriers may consist of erosion control berms and continuous contained berms. Mulch application shall be doubled to four bales per 1,000 square feet of hay or straw mulch or a 4-inch layer of erosion control mix. Mulch will be applied after snow is removed to a 1-inch depth. All areas will be properly stabilized with anchored hay or straw or erosion control matting at the end of each day of final grading. Permanent seeding shall not be attempted by the contractor, unless advised by the engineer. Dormant seeding will be applied between October 15 and April 15 at the appropriate specified rates (Table 1-2).

**Site Stabilization Schedule Before Winter**

| | |
|---|---|
| **September 15** | All disturbed areas must be seeded and mulched.<br>All slopes will be stabilized, seeded, and mulched. All grass lined ditches must be stabilized with mulch or an erosion control blanket. |
| **October 1** | All disturbed areas to be protected with an annual grass must be seeded at a seeding rate of 3 pounds per 1,000 square feet and mulched. |
| **November 15** | All stone-lined ditches and channels must be constructed and stabilized.<br>All slopes requiring riprap must be constructed by this date. |

**December 1** All disturbed areas where the growth of vegetation fails to be at least 3 inches tall or at least 75% of the disturbed soil is covered by vegetation, must be protected for over-winter.

All disturbed areas shall be inspected in the spring. Any damaged spots will be repaired. Spring seeding will commence as shown in Table 1-4. An established vegetative cover means a minimum of 85% to 90% of an area is vegetated with vigorous growth.

## 2.7 Permanent Erosion Control Measures

**Permanent Vegetation** cover will be used on most disturbed areas to permanently stabilize the soil and reduce sediment and runoff. Spring seeding usually gives the best results for all seed mixes. Permanent seeding will be done 45 days prior to the first killing frost or, as an alternative to permanent seeding, dormant seeding can be utilized with mulch after the first killing frost and before snowfall. Permanent seeding will be applied in compliance with specifications provided in Table 1-4.

**Table 1-4. Permanent Seeding Specifications**

| September 15–May 15 (Over-winter) | | May 15–September 15 | |
|---|---|---|---|
| Seed Type | Percent by Weight | Seed Type | Percent by Weight |
| Winter Rye | 80% | Red Fescue | 50% |
| Red Fescue | 10% | Sheep Fescue | 25% |
| Sheep Fescue | 5% | Red Top | 5% |
| Red Top | 1% | White Clover | 10% |
| White Clover | 2% | Annual Rye | 10% |
| Annual Rye | 2% | | |

**Riprap Slope Stabilization** will be used on slopes between 1:1 and ½:1 and in areas where existing conditions require it. Riprap is a permanent, erosion-resistant ground cover constructed of large, loose, angular or sub-angular rounded stone. Riprap protects the soil from concentrated runoff and slows the velocity of runoff which enhances the potential for infiltration. The application of riprap is composed of three sections. Before riprap is added to a slope, the surface is to be covered with a geosynthetic filter fabric or a gravel filter blanket. Once the filter fabric or blanket is secured, it is covered with a layer of riprap. These layers are stabilized at the toe of the slope with larger entrenched stones. The riprap will have a mean size ($D_{50}$) of 6 inches. The riprap can be produced on-site using a rock crusher, as long as it meets Project specifications. Any slope receiving riprap stabilization will first be cleared of trees, stumps, and other brush. If fill is added to the area, it will be compacted to 95% determined by Standard Proctor Density. The geotextile filter fabric should be placed directly on the prepared slope. The edges should overlap and be entrenched at the upper and lower ends of the slope. The entrenched toe can be secured with larger stone. The fabric will be anchored to the slope according to the manufacturer's recommendations. The riprap will then be added to its full thickness in one operation. The finished slope shall not contain pockets of small stones or clusters of large stones. Hand placing may be necessary to achieve a good distribution.

Riprap-stabilized slopes require inspections in the spring, in the fall, and after severe storms during construction and operation of the Project. Severe slumping or sliding may indicate that the slope is failing internally. Careful inspection of the land located on both sides of the riprap is necessary because of the potential for erosion to be accelerated in these areas.

**Dust Control** is necessary when disturbed soils are exposed to wind. When the soil dries out dusty conditions can occur. Dust can cause off-site damage, be a health hazard to humans, wildlife and plant life, or become a traffic safety hazard. Dust will be reduced by using phasing of construction to minimize the area of disturbed land at one time. Mulching and vegetative cover also will be used to reduce dust, and rock crushers will utilize water sprays to control dust.

## 2.8 Permanent Erosion Control Devices

**Riprap Ditches** will be used to protect road surfaces from erosion and to slow runoff velocities. These riprap-lined ditches will be installed along the upgradient shoulder of proposed roads. Stormwater will be intercepted in these ditches, slowing runoff and preserving the condition of gravel roads. The ditch will be constructed in two layers. First, a layer of filter fabric is laid and secured, similar to riprap slope stabilization. Riprap is then added on the filter fabric cautiously. The riprap will be Maine Department of Transportation 703.29 Stone Ditch Protection specification and will have a $D_{50}$ of 6 inches (shown on Sheet C-310 of Western Maine's Site Location of Development Act Application, Exhibit 1-1). The riprap can be produced on-site using a rock crusher. The finished slope shall not contain pockets of small stone or clusters of large stones. Hand placing may be necessary to achieve a good distribution.

Rip rap ditches will be inspected semi-annually and appropriate maintenance such as removing sediment buildup, leaves, litter, or other debris from the bottom and side slopes, as well as repositioning stones to restore channel to original dimensions to be conducted as necessary.

**Pipes/Culverts** will be used to carry water from upgradient roadside ditches under the road. These culverts and pipes are spaced incrementally along the road to drain the stormwater based on flow anticipated stormwater flow characteristics and topographic conditions. The culverts vary between 12- and 36-inch pipes flared at both ends. Culvert inlets and outlets are detailed on Sheets C-303 and C-304 of Western Maine's Site Location of Development Act Application, Exhibit 1-1.

The inlet and outlet of all culverts and pipes will be inspected in the spring, in late fall, and after significant rain events. Sediment collected at these locations will be removed, as needed, after each inspection to maintain capacity of the culverts.

**Level Spreaders/Ditch Turnouts** are used at the outlet of culverts and ditches to convert concentrated flow into sheet flow. Sheet flow is more natural and reduces erosion and the movement of sediment. Level spreaders must be installed with 0% grade on the spreader lip to ensure a uniform distribution of flow. Each level spreader shall have a riprap receiving area with the capacity to pass the flow without erosion. The receiving area shall be stable prior to the construction of the level spreader. If a vegetative cover is required downgradient, level spreaders must be installed during the growing season. Level spreaders and ditch turnouts are detailed on Sheets C-403 and C-404 of Western Maine's Site Location of Development Act Application, Exhibit 1-1.

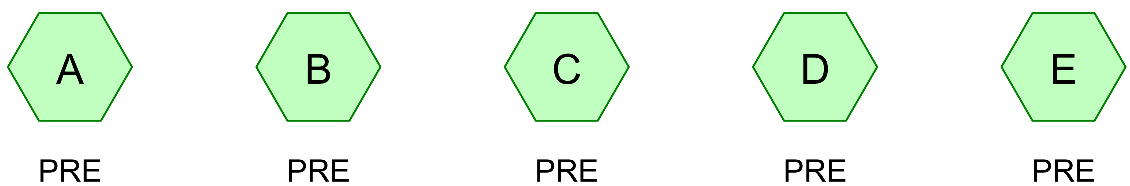
Level spreaders will be inspected in the spring, in late fall, and after significant rain events for signs of channelization or sedimentation. Damage to level spreaders or associated ditches will be repaired immediately. Level spreaders filled with sediment will be cleaned out regularly. Stones will be repositioned to restore original dimensions of the pool and create a uniform surface. Woody vegetation growing within the pool will be cut and removed.

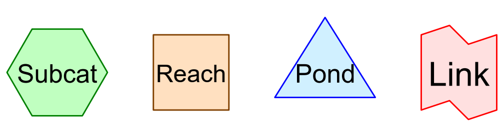
Erosion and sedimentation control plans were prepared for the Project and are incorporated into the civil design plans (see Western Maine's Site Location of Development Act Application, Exhibit 1-1). During construction, a variety of stabilization measures will be used to prevent sedimentation from soils due to wind and water action. The locations and details of proposed stabilization measures are illustrated in the drawings provided in the Project's civil design plans. All erosion control and stabilization measures have been designed to adequately address the requirements of the basic stabilization standards as defined in Chapter 500, *Stormwater Management Rules*. See Section 14, Basic Standards, of Western Maine's Site Location of Development Act Application for a detailed description of proposed erosion and sedimentation control practices.

## 2.9 Conclusions

The Project was designed to comply with the Basic Standards and General Standards of Maine's Stormwater Law. The post-development drainage analysis shows a negligible increase in runoff volume for a 25-year storm event. A series of BMPs and buffers have been incorporated into the design to replicate pre-development conditions. The Project's post-development drainage analysis shows no increase in peak flow rates; therefore, Western Maine is requesting a waiver from the Flooding Standard. The proposed LID BMPs and natural buffers will provide sufficient stormwater quantity and quality management without producing adverse impacts. A schedule of the proposed Project BMPs is provided in Attachment 1-7 "Schedule of Stormwater Best Management Practices". The proposed stormwater management system will be constructed and maintained in accordance with Maine DEP Standards and is designed to closely replicate pre-development stormwater conditions at the site, and therefore will not result in flooding or degradation of existing water quality in the Project area.

# ATTACHMENT 1-1 HYDROCAD® CALCULATIONS




**Routing Diagram for WMREP_PRE**
Prepared by {enter your company name here}, Printed 3/26/2021
HydroCAD® 10.10-4b s/n 02179 © 2020 HydroCAD Software Solutions LLC

## Rainfall Events Listing (selected events)

| Event# | Event Name | Storm Type | Curve | Mode | Duration (hours) | B/B | Depth (inches) | AMC |
|---|---|---|---|---|---|---|---|---|
| 1 | 25 Year 24-hr | Type III 24-hr | | Default | 24.00 | 1 | 4.70 | 2 |

## Ground Covers (all nodes)

| HSG-A (acres) | HSG-B (acres) | HSG-C (acres) | HSG-D (acres) | Other (acres) | Total (acres) | Ground Cover | Subcatchment Numbers |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.000 | 0.000 | 197.000 | 0.000 | 197.000 | 50-75% Grass cover, Fair | A |
| 0.000 | 0.000 | 0.000 | 35.000 | 0.000 | 35.000 | Gravel surface | A, B, C, D, E |
| 0.000 | 0.000 | 0.000 | 5,864.300 | 0.000 | 5,864.300 | Woods, Good | A, B, C, D, E |
| **0.000** | **0.000** | **0.000** | **6,096.300** | **0.000** | **6,096.300** | **TOTAL AREA** | |

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment A: PRE** Runoff Area=93,205,811 sf 0.00% Impervious Runoff Depth>1.47"
Flow Length=18,088' Tc=641.4 min CN=78 Runoff=449.83 cfs 262.754 af

**Subcatchment B: PRE** Runoff Area=3,247.155 ac 0.00% Impervious Runoff Depth>1.90"
Flow Length=25,422' Tc=437.8 min CN=77 Runoff=883.65 cfs 514.572 af

**Subcatchment C: PRE** Runoff Area=289.248 ac 0.00% Impervious Runoff Depth>2.25"
Flow Length=4,231' Tc=197.0 min CN=77 Runoff=140.67 cfs 54.230 af

**Subcatchment D: PRE** Runoff Area=159.240 ac 0.00% Impervious Runoff Depth>2.36"
Flow Length=1,330' Tc=34.3 min CN=77 Runoff=234.28 cfs 31.275 af

**Subcatchment E: PRE** Runoff Area=11,366,808 sf 0.00% Impervious Runoff Depth>2.33"
Flow Length=3,107' Tc=86.6 min CN=77 Runoff=225.95 cfs 50.588 af

**Total Runoff Area = 6,096.300 ac Runoff Volume = 913.420 af Average Runoff Depth = 1.80"**
**100.00% Pervious = 6,096.300 ac 0.00% Impervious = 0.000 ac**

## Summary for Subcatchment A: PRE

[47] Hint: Peak is 2704% of capacity of segment #5
[47] Hint: Peak is 2704% of capacity of segment #7
[47] Hint: Peak is 977% of capacity of segment #9

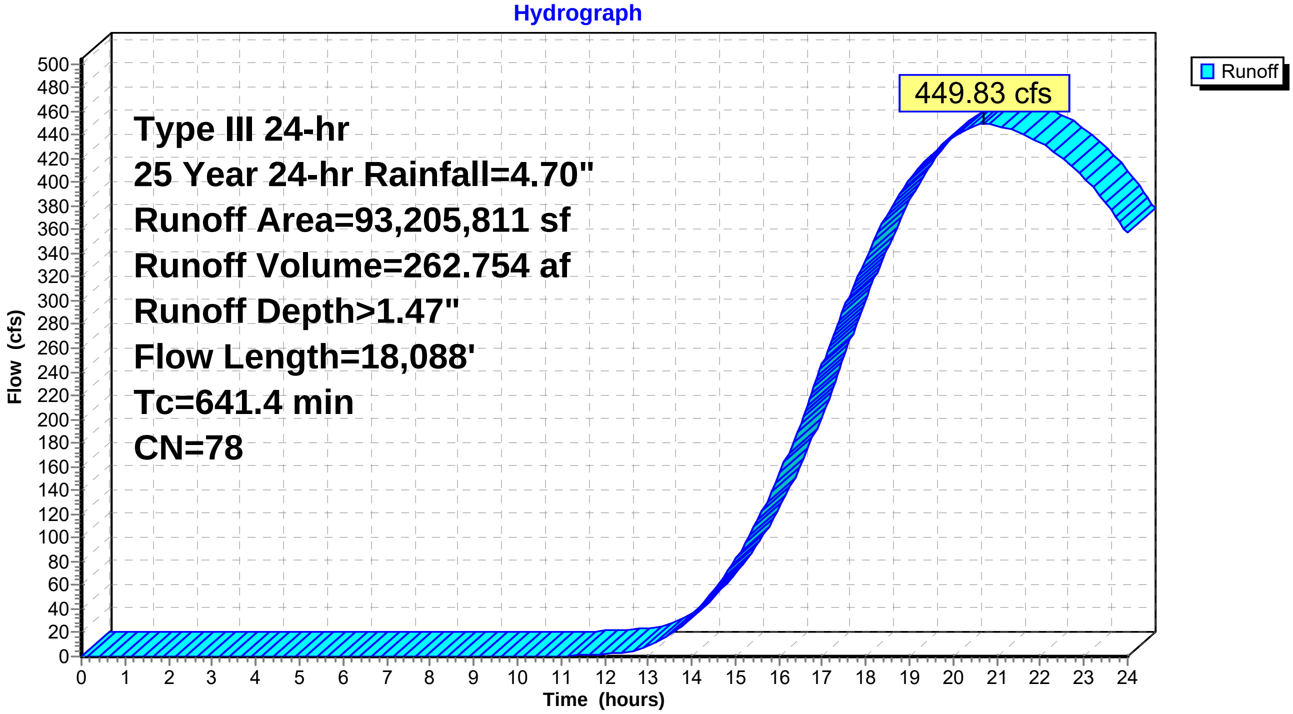
Runoff = 449.83 cfs @ 20.68 hrs, Volume= 262.754 af, Depth> 1.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 Year 24-hr Rainfall=4.70"

| Area (sf) | CN | Description |
|---|---|---|
| 84,276,011 | 77 | Woods, Good, HSG D |
| 348,480 | 96 | Gravel surface, HSG D |
| 8,581,320 | 84 | 50-75% Grass cover, Fair, HSG D |
| 93,205,811 | 78 | Weighted Average |
| 93,205,811 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.2 | 50 | 0.0100 | 0.12 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 3.40" |
| 42.9 | 1,888 | 0.0110 | 0.73 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 68.9 | 1,498 | 0.0210 | 0.36 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 42.3 | 1,540 | 0.0075 | 0.61 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.3 | 90 | 0.0200 | 5.30 | 16.64 | **Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.025 Corrugated metal |
| 95.9 | 1,640 | 0.0130 | 0.29 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 0.2 | 60 | 0.0200 | 5.30 | 16.64 | **Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.025 Corrugated metal |
| 249.3 | 4,580 | 0.0150 | 0.31 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 2.8 | 640 | 0.0150 | 3.84 | 46.03 | **Channel Flow,** Area= 12.0 sf Perim= 38.0' r= 0.32' n= 0.022 Earth, clean & straight |
| 119.9 | 3,010 | 0.0280 | 0.42 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 11.7 | 3,092 | 0.0600 | 4.41 | 1,058.27 | **Channel Flow,** Area= 240.0 sf Perim= 180.0' r= 1.33' n= 0.100 Earth, dense brush, high stage |
| 641.4 | 18,088 | Total | | | |

## Subcatchment A: PRE



## Summary for Subcatchment B: PRE

[47] Hint: Peak is 33726% of capacity of segment #3
[47] Hint: Peak is 2080% of capacity of segment #6
[47] Hint: Peak is 188% of capacity of segment #7
[47] Hint: Peak is 1657% of capacity of segment #8

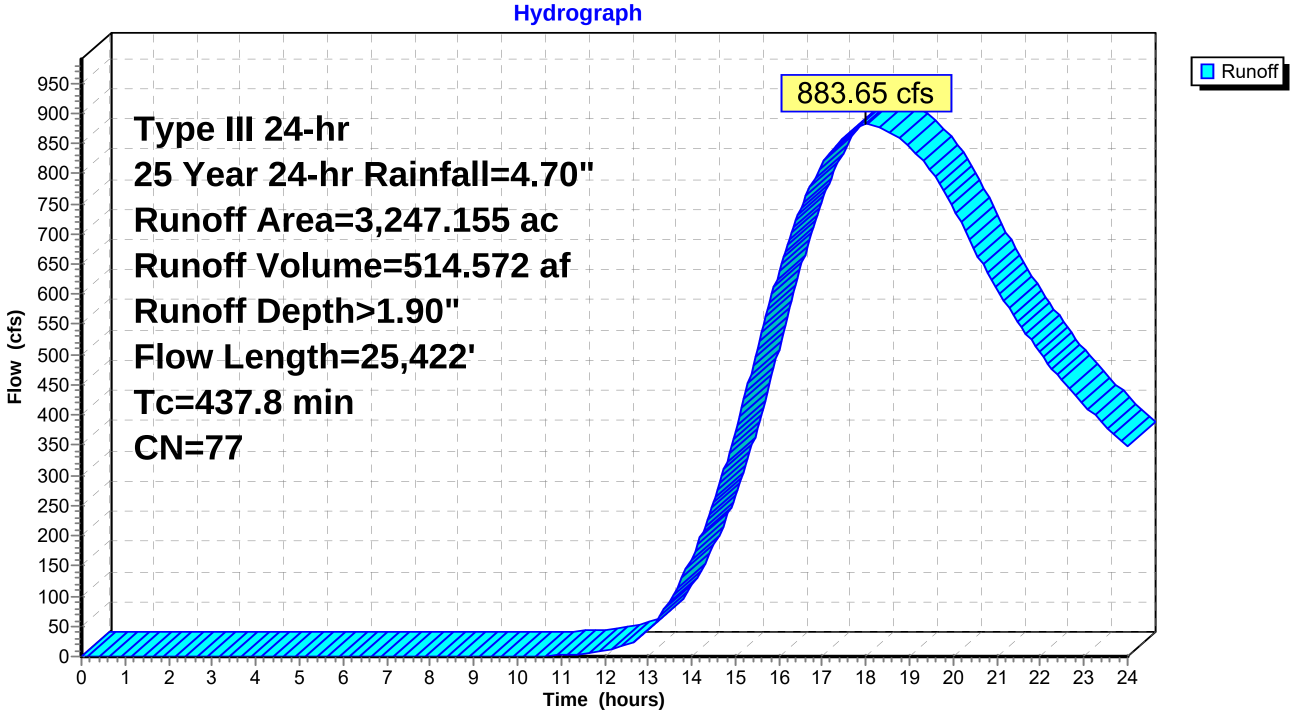
Runoff = 883.65 cfs @ 18.01 hrs, Volume= 514.572 af, Depth> 1.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 Year 24-hr Rainfall=4.70"

| Area (ac) | CN | Description |
|---|---|---|
| 3,228.155 | 77 | Woods, Good, HSG D |
| 19.000 | 96 | Gravel surface, HSG D |
| 3,247.155 | 77 | Weighted Average |
| 3,247.155 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.4 | 50 | 0.0600 | 0.06 | | **Sheet Flow,**<br>Woods: Dense underbrush n= 0.800 P2= 3.40" |
| 250.5 | 5,314 | 0.0200 | 0.35 | | **Shallow Concentrated Flow,**<br>Forest w/Heavy Litter Kv= 2.5 fps |
| 0.1 | 20 | 0.0200 | 3.34 | 2.62 | **Pipe Channel, CMP_Round 12"**<br>12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.025 Corrugated metal |
| 101.1 | 1,857 | 0.0150 | 0.31 | | **Shallow Concentrated Flow,**<br>Forest w/Heavy Litter Kv= 2.5 fps |
| 4.3 | 1,454 | | 5.67 | | **Lake or Reservoir,**<br>Mean Depth= 1.00' |
| 12.8 | 2,589 | 0.0150 | 3.37 | 42.49 | **Channel Flow,**<br>Area= 12.6 sf Perim= 30.4' r= 0.41'<br>n= 0.030 Stream, clean & straight |
| 0.0 | 30 | 0.0200 | 12.21 | 469.79 | **Pipe Channel, CMP_Round 84"**<br>84.0" Round Area= 38.5 sf Perim= 22.0' r= 1.75'<br>n= 0.025 Corrugated metal |
| 55.6 | 14,108 | 0.0420 | 4.23 | 53.33 | **Channel Flow,**<br>Area= 12.6 sf Perim= 30.4' r= 0.41'<br>n= 0.040 Winding stream, pools & shoals |
| 437.8 | 25,422 | Total | | | |

## Subcatchment B: PRE



## Summary for Subcatchment C: PRE

[47] Hint: Peak is 3645% of capacity of segment #4

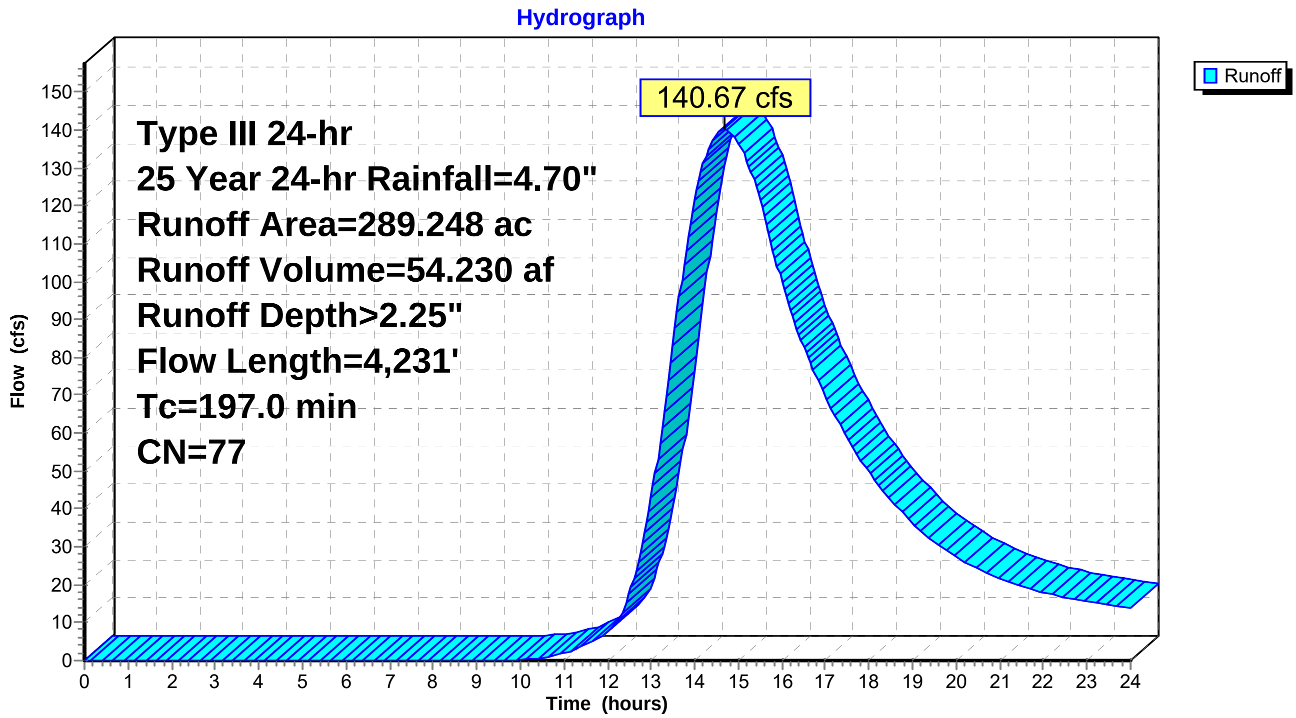
Runoff = 140.67 cfs @ 14.67 hrs, Volume= 54.230 af, Depth> 2.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 Year 24-hr Rainfall=4.70"

| Area (ac) | CN | Description |
|---|---|---|
| 283.248 | 77 | Woods, Good, HSG D |
| 6.000 | 96 | Gravel surface, HSG D |
| 289.248 | 77 | Weighted Average |
| 289.248 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 16.7 | 50 | 0.0350 | 0.05 | | **Sheet Flow,**<br>Woods: Dense underbrush n= 0.800 P2= 3.40" |
| 54.8 | 1,300 | 0.0250 | 0.40 | | **Shallow Concentrated Flow,**<br>Forest w/Heavy Litter Kv= 2.5 fps |
| 41.0 | 1,066 | 0.0300 | 0.43 | | **Shallow Concentrated Flow,**<br>Forest w/Heavy Litter Kv= 2.5 fps |
| 0.1 | 25 | 0.0100 | 4.91 | 3.86 | **Pipe Channel, CMP_Round 12"**<br>12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.012 Concrete pipe, finished |
| 84.4 | 1,790 | 0.0200 | 0.35 | | **Shallow Concentrated Flow,**<br>Forest w/Heavy Litter Kv= 2.5 fps |
| 197.0 | 4,231 | Total | | | |

## Subcatchment C: PRE



## Summary for Subcatchment D: PRE

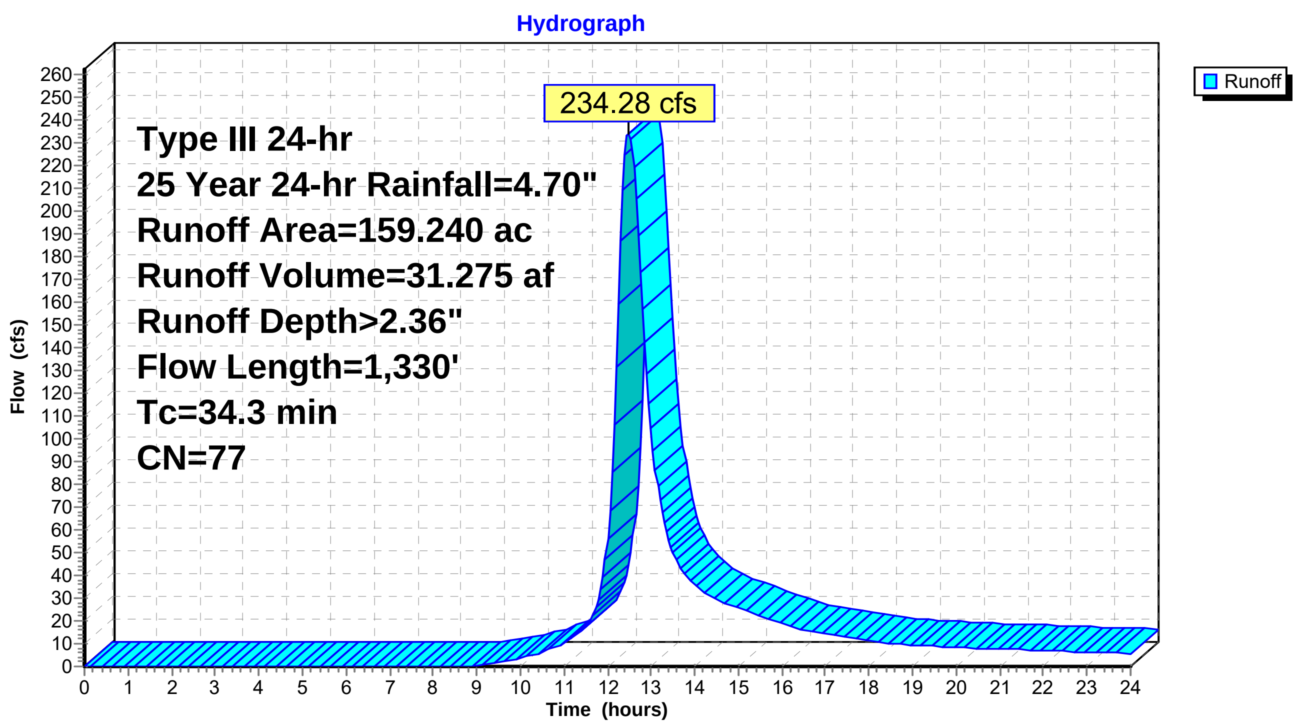
Runoff = 234.28 cfs @ 12.48 hrs, Volume= 31.275 af, Depth> 2.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 Year 24-hr Rainfall=4.70"

| Area (ac) | CN | Description |
|---|---|---|
| 158.240 | 77 | Woods, Good, HSG D |
| 1.000 | 96 | Gravel surface, HSG D |
| 159.240 | 77 | Weighted Average |
| 159.240 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 11.7 | 50 | 0.0850 | 0.07 | | **Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.40" |
| 6.9 | 320 | 0.0950 | 0.77 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 0.9 | 160 | 0.0950 | 3.08 | | **Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps |
| 14.8 | 800 | 0.1300 | 0.90 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 34.3 | 1,330 | Total | | | |

## Subcatchment D: PRE



## Summary for Subcatchment E: PRE

[47] Hint: Peak is 7041% of capacity of segment #4

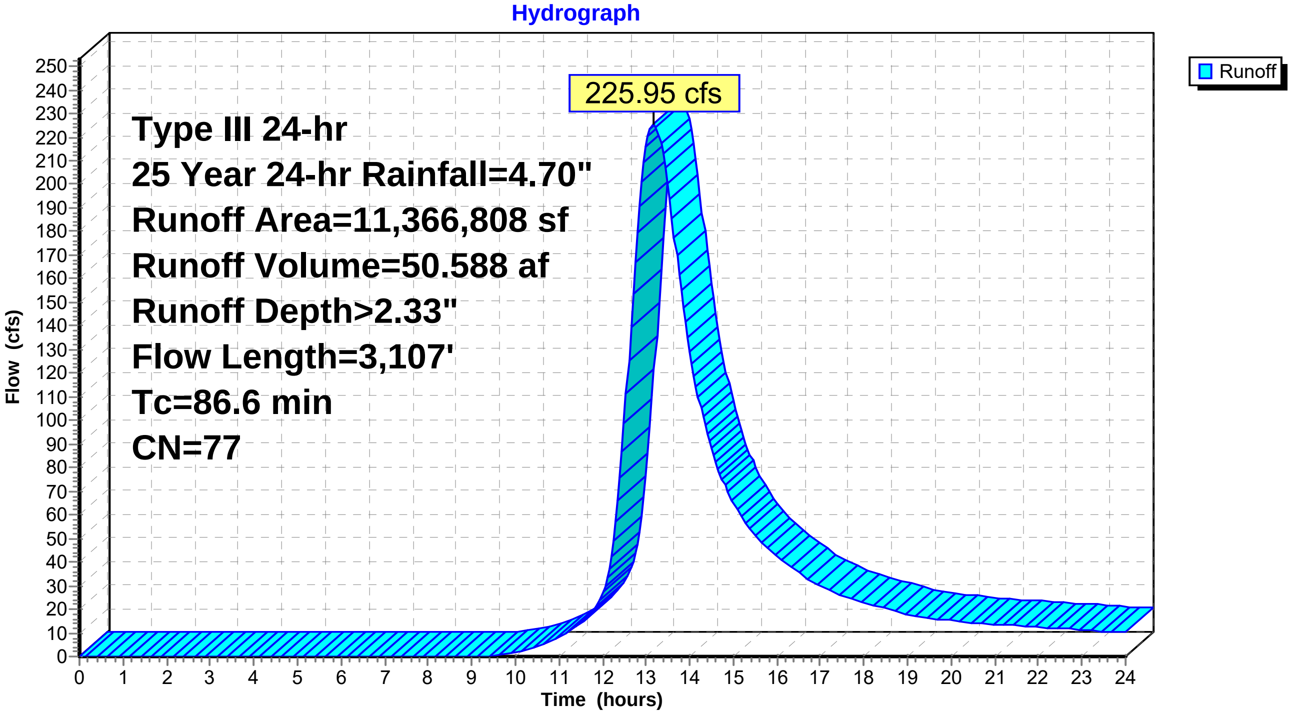
Runoff = 225.95 cfs @ 13.18 hrs, Volume= 50.588 af, Depth> 2.33"

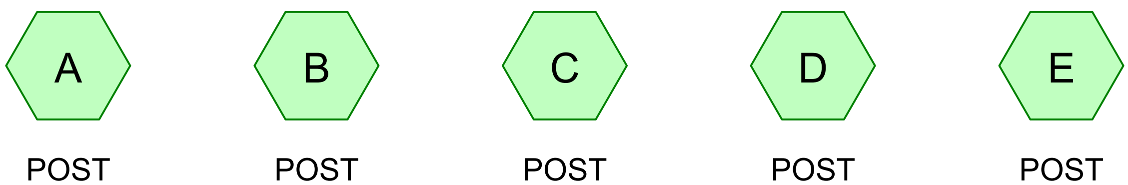
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 Year 24-hr Rainfall=4.70"

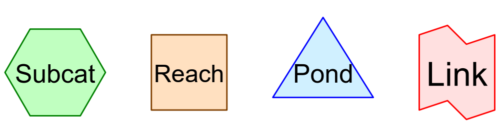
| Area (sf) | CN | Description |
|---|---|---|
| 11,323,248 | 77 | Woods, Good, HSG D |
| 43,560 | 96 | Gravel surface, HSG D |
| 11,366,808 | 77 | Weighted Average |
| 11,366,808 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 27.5 | 50 | 0.0100 | 0.03 | | **Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.40" |
| 19.3 | 580 | 0.0400 | 0.50 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 10.3 | 693 | 0.2000 | 1.12 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 0.1 | 20 | 0.0300 | 4.09 | 3.21 | **Pipe Channel, CMP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.025 Corrugated metal |
| 29.4 | 1,764 | 0.1600 | 1.00 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 86.6 | 3,107 | Total | | | |

## Subcatchment E: PRE






**Routing Diagram for WMREP_POST**
Prepared by {enter your company name here}, Printed 3/26/2021
HydroCAD® 10.10-4b s/n 02179 © 2020 HydroCAD Software Solutions LLC

## Rainfall Events Listing (selected events)

| Event# | Event Name | Storm Type | Curve | Mode | Duration (hours) | B/B | Depth (inches) | AMC |
|---|---|---|---|---|---|---|---|---|
| 1 | 25 Year 24-hr | Type III 24-hr | | Default | 24.00 | 1 | 4.70 | 2 |

## Ground Covers (all nodes)

| HSG-A (acres) | HSG-B (acres) | HSG-C (acres) | HSG-D (acres) | Other (acres) | Total (acres) | Ground Cover | Subcatchment Numbers |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.000 | 0.000 | 194.704 | 0.000 | 194.704 | 50-75% Grass cover, Fair | A |
| 0.000 | 0.000 | 0.000 | 46.337 | 0.000 | 46.337 | Gravel surface | A, B, C, D, E |
| 0.000 | 0.000 | 0.000 | 5,855.259 | 0.000 | 5,855.259 | Woods, Good | A, B, C, D, E |
| **0.000** | **0.000** | **0.000** | **6,096.300** | **0.000** | **6,096.300** | **TOTAL AREA** | |

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment A: POST** Runoff Area=93,205,811 sf 0.00% Impervious Runoff Depth>1.47"
Flow Length=18,088' Tc=641.4 min CN=78 Runoff=449.83 cfs 262.754 af

**Subcatchment B: POST** Runoff Area=3,247.155 ac 0.00% Impervious Runoff Depth>1.90"
Flow Length=25,472' Tc=438.1 min CN=77 Runoff=883.28 cfs 514.373 af

**Subcatchment C: POST** Runoff Area=12,599,643 sf 0.00% Impervious Runoff Depth>2.25"
Flow Length=4,231' Tc=197.0 min CN=77 Runoff=140.67 cfs 54.230 af

**Subcatchment D: POST** Runoff Area=6,936,494 sf 0.00% Impervious Runoff Depth>2.36"
Flow Length=1,330' Tc=34.3 min CN=77 Runoff=234.28 cfs 31.275 af

**Subcatchment E: POST** Runoff Area=11,366,808 sf 0.00% Impervious Runoff Depth>2.33"
Flow Length=3,107' Tc=86.6 min CN=77 Runoff=225.95 cfs 50.588 af

**Total Runoff Area = 6,096.300 ac Runoff Volume = 913.221 af Average Runoff Depth = 1.80"**
**100.00% Pervious = 6,096.300 ac 0.00% Impervious = 0.000 ac**

## Summary for Subcatchment A: POST

[47] Hint: Peak is 2704% of capacity of segment #5
[47] Hint: Peak is 2704% of capacity of segment #7
[47] Hint: Peak is 977% of capacity of segment #9

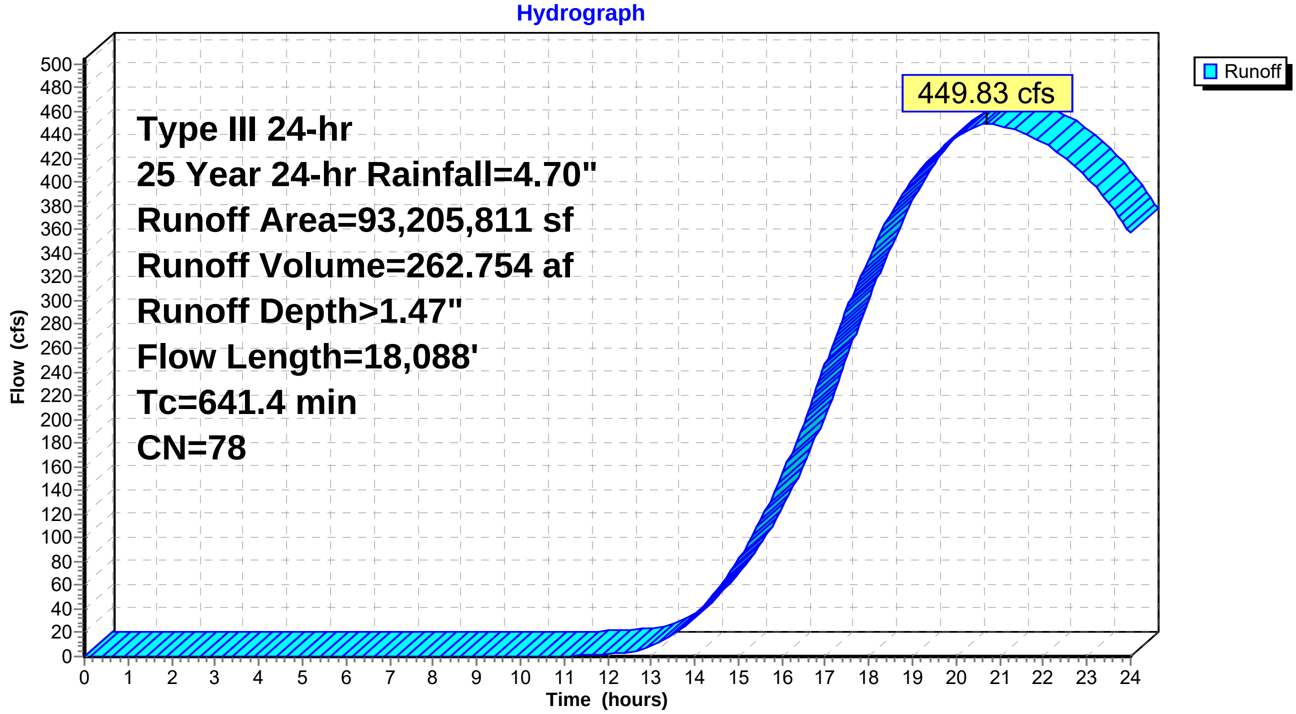
Runoff = 449.83 cfs @ 20.68 hrs, Volume= 262.754 af, Depth> 1.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 Year 24-hr Rainfall=4.70"

| Area (sf) | CN | Description |
|---|---|---|
| 84,191,011 | 77 | Woods, Good, HSG D |
| 348,480 | 96 | Gravel surface, HSG D |
| 8,481,320 | 84 | 50-75% Grass cover, Fair, HSG D |
| 185,000 | 96 | Gravel surface, HSG D |
| 93,205,811 | 78 | Weighted Average |
| 93,205,811 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.2 | 50 | 0.0100 | 0.12 | | **Sheet Flow,** Grass: Short n= 0.150 P2= 3.40" |
| 42.9 | 1,888 | 0.0110 | 0.73 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 68.9 | 1,498 | 0.0210 | 0.36 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 42.3 | 1,540 | 0.0075 | 0.61 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.3 | 90 | 0.0200 | 5.30 | 16.64 | **Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.025 Corrugated metal |
| 95.9 | 1,640 | 0.0130 | 0.29 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 0.2 | 60 | 0.0200 | 5.30 | 16.64 | **Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.025 Corrugated metal |
| 249.3 | 4,580 | 0.0150 | 0.31 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 2.8 | 640 | 0.0150 | 3.84 | 46.03 | **Channel Flow,** Area= 12.0 sf Perim= 38.0' r= 0.32' n= 0.022 Earth, clean & straight |
| 119.9 | 3,010 | 0.0280 | 0.42 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 11.7 | 3,092 | 0.0600 | 4.41 | 1,058.27 | **Channel Flow,** Area= 240.0 sf Perim= 180.0' r= 1.33' n= 0.100 Earth, dense brush, high stage |
| 641.4 | 18,088 | Total | | | |

## Subcatchment A: POST



## Summary for Subcatchment B: POST

[47] Hint: Peak is 33712% of capacity of segment #3
[47] Hint: Peak is 2079% of capacity of segment #6
[47] Hint: Peak is 1800% of capacity of segment #7
[47] Hint: Peak is 1656% of capacity of segment #8

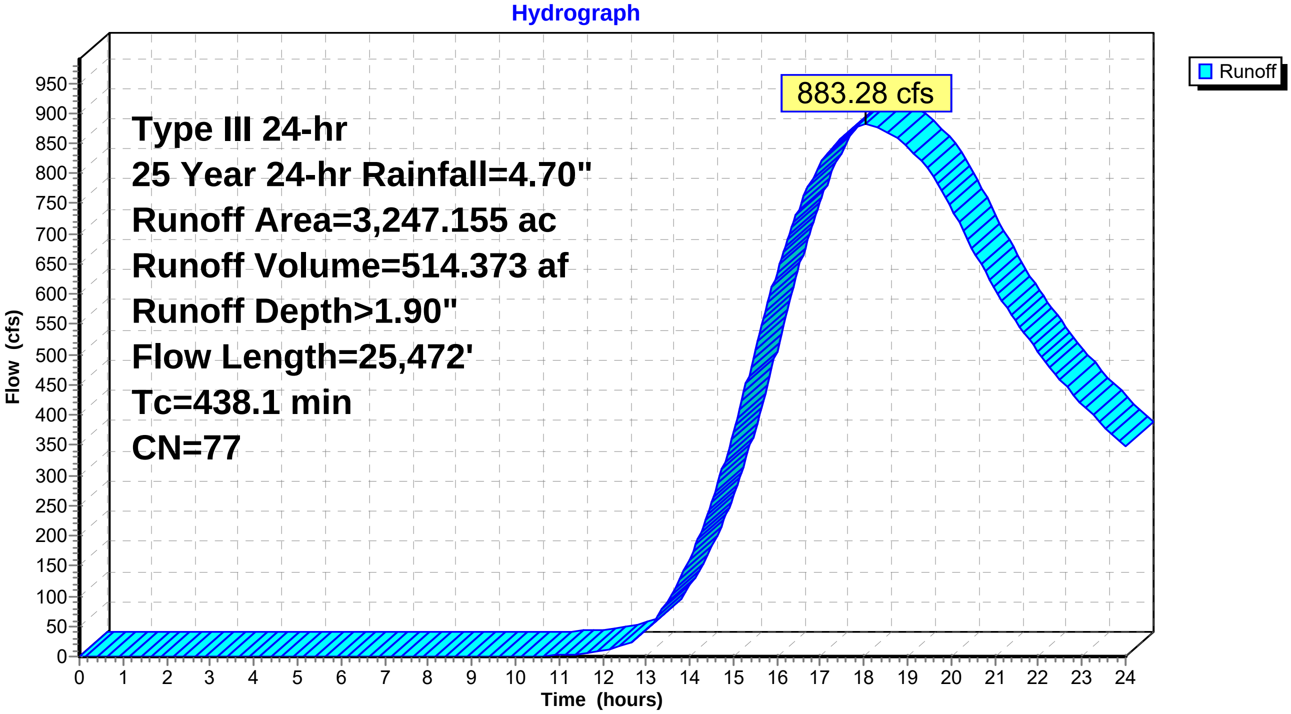
Runoff = 883.28 cfs @ 18.02 hrs, Volume= 514.373 af, Depth> 1.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 Year 24-hr Rainfall=4.70"

| | Area (ac) | CN | Description |
|---|---|---|---|
| | 3,222.925 | 77 | Woods, Good, HSG D |
| | 19.000 | 96 | Gravel surface, HSG D |
| * | 5.230 | 96 | Gravel surface, HSG D (new impervious) |
| | 3,247.155 | 77 | Weighted Average |
| | 3,247.155 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.4 | 50 | 0.0600 | 0.06 | | **Sheet Flow,**<br>Woods: Dense underbrush n= 0.800 P2= 3.40" |
| 250.5 | 5,314 | 0.0200 | 0.35 | | **Shallow Concentrated Flow,**<br>Forest w/Heavy Litter Kv= 2.5 fps |
| 0.1 | 20 | 0.0200 | 3.34 | 2.62 | **Pipe Channel, CMP_Round 12"**<br>12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.025 Corrugated metal |
| 101.1 | 1,857 | 0.0150 | 0.31 | | **Shallow Concentrated Flow,**<br>Forest w/Heavy Litter Kv= 2.5 fps |
| 4.3 | 1,454 | | 5.67 | | **Lake or Reservoir,**<br>Mean Depth= 1.00' |
| 12.8 | 2,589 | 0.0150 | 3.37 | 42.49 | **Channel Flow,**<br>Area= 12.6 sf Perim= 30.4' r= 0.41'<br>n= 0.030 Stream, clean & straight |
| 0.3 | 80 | 0.0200 | 3.89 | 49.07 | **Channel Flow,**<br>Area= 12.6 sf Perim= 30.4' r= 0.41'<br>n= 0.030 Stream, clean & straight |
| 55.6 | 14,108 | 0.0420 | 4.23 | 53.33 | **Channel Flow,**<br>Area= 12.6 sf Perim= 30.4' r= 0.41'<br>n= 0.040 Winding stream, pools & shoals |
| 438.1 | 25,472 | Total | | | |

## Subcatchment B: POST



## Summary for Subcatchment C: POST

[47] Hint: Peak is 3645% of capacity of segment #4

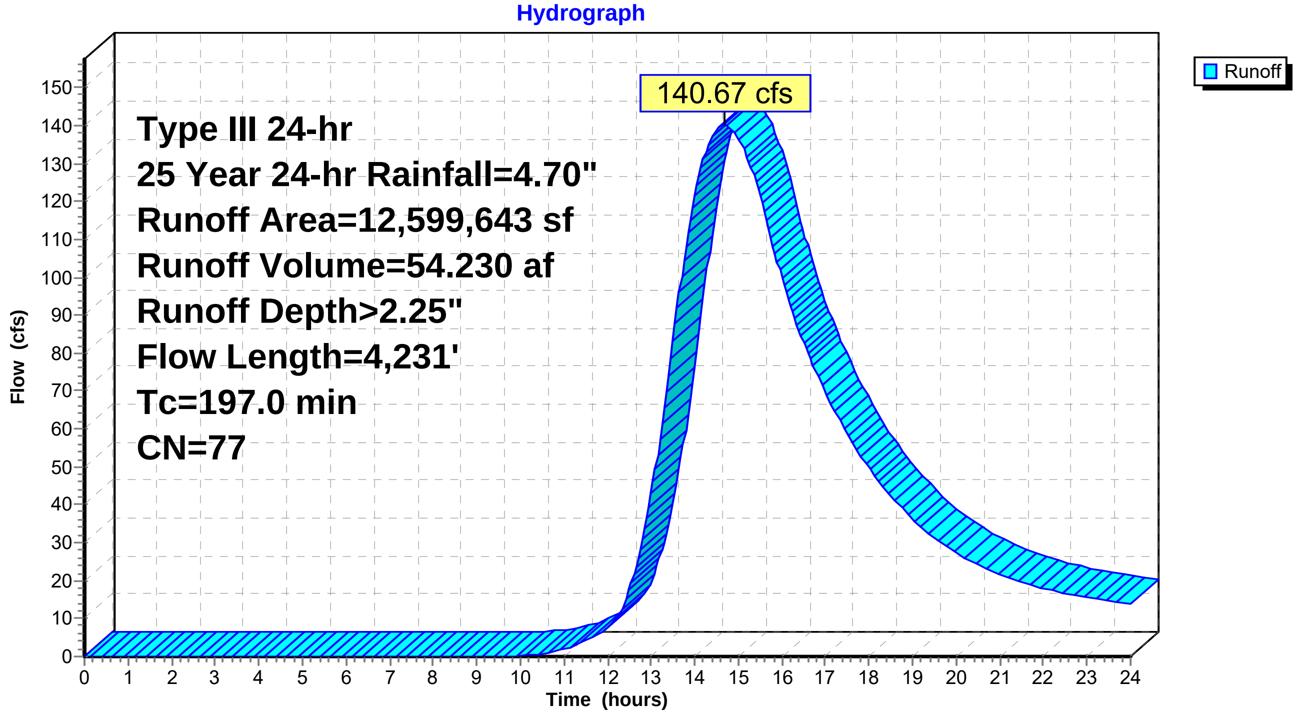
Runoff = 140.67 cfs @ 14.67 hrs, Volume= 54.230 af, Depth> 2.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 Year 24-hr Rainfall=4.70"

| Area (sf) | CN | Description |
|---|---|---|
| 12,325,302 | 77 | Woods, Good, HSG D |
| 261,360 | 96 | Gravel surface, HSG D |
| 12,981 | 96 | Gravel surface, HSG D |
| 12,599,643 | 77 | Weighted Average |
| 12,599,643 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 16.7 | 50 | 0.0350 | 0.05 | | **Sheet Flow,**<br>Woods: Dense underbrush n= 0.800 P2= 3.40" |
| 54.8 | 1,300 | 0.0250 | 0.40 | | **Shallow Concentrated Flow,**<br>Forest w/Heavy Litter Kv= 2.5 fps |
| 41.0 | 1,066 | 0.0300 | 0.43 | | **Shallow Concentrated Flow,**<br>Forest w/Heavy Litter Kv= 2.5 fps |
| 0.1 | 25 | 0.0100 | 4.91 | 3.86 | **Pipe Channel, CMP_Round 12"**<br>12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.012 Concrete pipe, finished |
| 84.4 | 1,790 | 0.0200 | 0.35 | | **Shallow Concentrated Flow,**<br>Forest w/Heavy Litter Kv= 2.5 fps |
| 197.0 | 4,231 | Total | | | |

## Subcatchment C: POST



## Summary for Subcatchment D: POST

[47] Hint: Peak is 6070% of capacity of segment #3

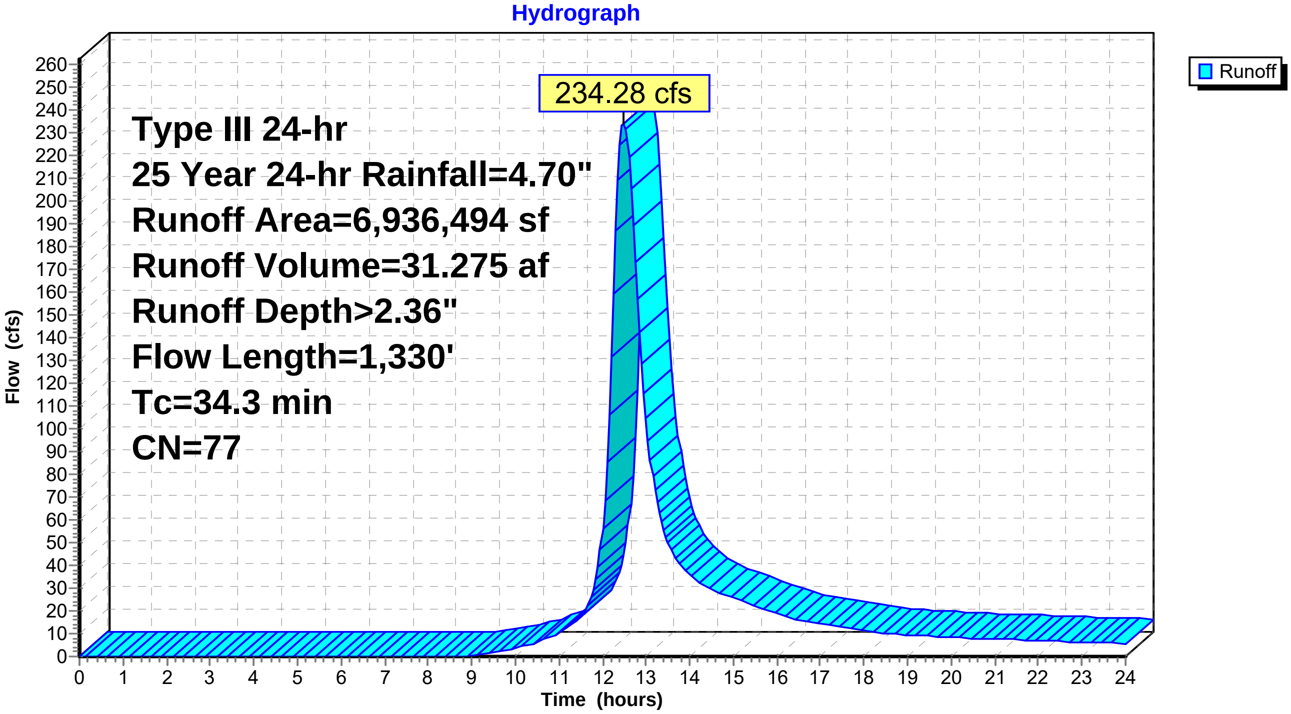
Runoff = 234.28 cfs @ 12.48 hrs, Volume= 31.275 af, Depth> 2.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 Year 24-hr Rainfall=4.70"

| Area (sf) | CN | Description |
|---|---|---|
| 6,858,914 | 77 | Woods, Good, HSG D |
| 43,560 | 96 | Gravel surface, HSG D |
| 34,020 | 96 | Gravel surface, HSG D |
| 6,936,494 | 77 | Weighted Average |
| 6,936,494 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 11.7 | 50 | 0.0850 | 0.07 | | **Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.40" |
| 6.9 | 320 | 0.0950 | 0.77 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 0.1 | 20 | 0.0100 | 4.91 | 3.86 | **Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished |
| 0.8 | 140 | 0.0950 | 3.08 | | **Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps |
| 14.8 | 800 | 0.1300 | 0.90 | | **Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps |
| 34.3 | 1,330 | Total | | | |

## Subcatchment D: POST



## Summary for Subcatchment E: POST

[47] Hint: Peak is 7041% of capacity of segment #4

Runoff = 225.95 cfs @ 13.18 hrs, Volume= 50.588 af, Depth> 2.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 Year 24-hr Rainfall=4.70"

| Area (sf) | CN | Description |
|---|---|---|
| 11,289,248 | 77 | Woods, Good, HSG D |
| 43,560 | 96 | Gravel surface, HSG D |
| 34,000 | 96 | Gravel surface, HSG D |
| 11,366,808 | 77 | Weighted Average |
| 11,366,808 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 27.5 | 50 | 0.0100 | 0.03 | | **Sheet Flow,**<br>Woods: Dense underbrush n= 0.800 P2= 3.40" |
| 19.3 | 580 | 0.0400 | 0.50 | | **Shallow Concentrated Flow,**<br>Forest w/Heavy Litter Kv= 2.5 fps |
| 10.3 | 693 | 0.2000 | 1.12 | | **Shallow Concentrated Flow,**<br>Forest w/Heavy Litter Kv= 2.5 fps |
| 0.1 | 20 | 0.0300 | 4.09 | 3.21 | **Pipe Channel, CMP_Round 12"**<br>12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.025 Corrugated metal |
| 29.4 | 1,764 | 0.1600 | 1.00 | | **Shallow Concentrated Flow,**<br>Forest w/Heavy Litter Kv= 2.5 fps |
| 86.6 | 3,107 | Total | | | |

## Subcatchment E: POST