Drainage Pilot Study for Shandon Neighborhood Final Report

Department of Utilities & Engineering

Columbia, South Carolina

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FUSS & O'NEILL

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Executive Summary

The Shandon-Rosewood Watershed (Watershed) is an urbanized, residential area that experiences severe flooding in five intersections during moderate and large storm events. Intersections of concern include:

- Wheat Street-Amherst Avenue,
- Monroe Street-Ravenel Street,
- Heyward Street-Ravenel Street,
- Shandon Street-Wilmot Avenue and
- Monroe Street-Maple Street intersections.

Initial analysis of area infrastructure shows the flooding is due to large expanses of hardscape (roads, sidewalks, roofs, etc.) served by a storm drain network that is undersized for the need. Storm drains surcharge as they are overloaded with large volumes of runoff causing them to flood onto the road.

May 2011 Proposed Improvements

A conventional approach to solve these drainage problems was evaluated as part of a study completed in May 2011. General recommendations of the May 2011 report include increasing pipe sizes and installing parallel drainage systems.

Implementing a conventional drainage approach to solve this problem has several disadvantages including:

- Conventional retrofits can be quite costly. We understand that the initial estimate for conventional retrofits in the May 2011 report were more than $11 million. These cost estimates do not include costs of temporary or permanent construction easements. They also do not include engineering.
- Discharge of additional flows of stormwater may create flooding or other problems in down-gradient areas. Conventional fixes will need to be continued through such areas to avoid simply pushing flood water backups downstream.

Given the costs and disadvantages, a nonconventional approach should be considered as an alternative. This report focuses on the use of "green stormwater infrastructure" as an alternative to the conventional stormwater management approach proposed in May 2011.

Proposed Green Infrastructure Improvements

Green infrastructure, as discussed in this report, relies on infiltration as a way to mimic conditions of undeveloped land and abate flooding that sometimes results from intensive development. Green stormwater infrastructure presents a number of useful advantages:

- Green infrastructure is typically more cost effective than constructing conventional drainage infrastructure as it avoids more/larger pipes.

- By imitating natural hydrology, green infrastructure improves base flow and eliminates potential for increased downstream flooding.
- Infiltration provides stormwater treatment and mitigates stormwater pollution problems, which might otherwise require control via expensive treatment practices.
- Unlike conventional infrastructure retrofits, green infrastructure improvements can be installed incrementally, as opportunity presents across the watershed.

Pilot Study Areas

Two pilot areas have been selected for analysis in the Shandon-Rosewood Watershed. The pilot areas were selected due to the proximity of intersections with reported significant flooding. The pilot areas discussed in this report include:

- The ***East Pilot Area***, consisting of two blocks and bounded by Blossom Street, Chatham Avenue, Wheat Street and Capitol Place.
- The ***West Pilot Area***, encompassing two blocks, bounded by Wilmont Avenue, Holly Street, Duncan Street and Woodrow Street.

Proposed Green Infrastructure Improvements

We selected porous pavement, subsurface infiltration, and bioretention for modeling and feasibility analysis based the design criteria and on the following observations related to our review of available data, onsite investigation, and characteristics of candidate BMPs or green infrastructure improvements:

- Due to the limited space available within the roadway right-of-way to accommodate the size of above-grade green infrastructure improvements (e.g. bioretention basins) necessary to handle yard and roadway runoff generated during the 10-year storm, bioretention could not be used as the sole improvement. However, bioretention could be used in combination with other BMPs or green infrastructure improvements as a solution to the flooding problem.
- Subsurface storage BMPs, such as stone trenches/reservoir bases, infiltration chambers, and/or modular storage units, in combination with porous pavement appear to be the only green infrastructure improvements with large enough capacity to manage a significant fraction of the the flow generated during the 10-year storm given the constraints.

Opinions of Costs for Pilot Areas

Proposed green infrastructure improvements were sized to manage all of the runoff from the 10-year frequency storm for both pilot areas. The following tables summarize these costs for construction only.

Opinion of Cost for Green Infrastructure Controls by Street in the East Pilot Area

Street	Subtotal	Contingency (20%)	Total Cost	Upper Cost Range Limit (+30%)	Lower Cost Range Limit (-15%)
Amherst Avenue	$237,000	$47,000	$284,000	$369,000	$241,000
Wheat Street	$391,000	$78,000	$469,000	$609,000	$399,000
Capitol Place	$44,000	$9,000	$53,000	$69,000	$45,000
Blossom Street	$70,000	$14,000	$84,000	$109,000	$71,000
Chatham Avenue	$76,000	$15,000	$91,000	$118,000	$77,000
East Pilot Area Total	$818,000	$163,000	$981,000	$1,275,000	$833,000

Opinion of Cost for Green Infrastructure Controls by Street in the West Pilot Area

Street	Subtotal	Contingency (20%)	Total Cost	Upper Cost Range Limit (+30%)	Lower Cost Range Limit (-15%)
Maple Street	$230,000	$46,000	$276,000	$359,000	$235,000
Duncan Street	$452,000	$90,000	$542,000	$705,000	$461,000
Woodrow Street	$44,000	$9,000	$53,000	$69,000	$45,000
Holly Street	$39,000	$8,000	$47,000	$61,000	$40,000
Wilmot Avenue	$227,000	$45,000	$272,000	$354,000	$231,000
West Pilot Area Total	$992,000	$198,000	$1,190,000	$1,547,000	$1,011,000

These costs do not include engineering (consistent with the May 2011 report). Approximately 15% would be typically budgted for engineering, Adding engineering would increase total costs from to $2.17 to $2.5 million.

Modeling to Evaluate Watershed-Wide Benefits

As part of Fuss & O'Neill's drainage pilot study, the XP-SWMM models prepared as part of the May 2011 report were converted to EPA SWMM version 5.0.022. The EPA SWMM model is widely-accepted in the public and private sectors, the software is non-proprietary, and the code is open-source, ensuring that the results of the hydrologic and hyraulic model can be transferred easily, modified, or re-run if needed. EPA SWMM also allows LID controls to be directly modeled if desired. The converted models were run with a 10-year, 24-hour design storm, consistent with the May 2011 report.

Modeling demonstartes that removal of the pilot areas alone will not be adequate to solve flooding problems at the intersections of concern. However, implementation of green infrastructure in other portions of the watershed would solve these flooding problems. The additional areas that need to be managed in each subwatershed is described in the following paragraphs:

East Branch Subwatershed

- 37.5 acres of the East Branch Subwatershed must be managed to eliminate flooding at all three problem intersections in the East Branch Subwatershed for the 10-year frequency storm. This is approximately 3.0 times the area of the East Pilot Area.

West Branch Subwatershed

- 35.3 acres of the subwatershed must be managed to eliminate the flooding at the two problem intersections in the West Branch Subwatershed. This is approximately 2.7 times the area of the West Pilot Area.

To develop order of magnitude costs for the East and West Branch Subwatersheds, we computed a straight-line extrapolation of cost of East and West Pilot Areas (respectively) based on ratio of the size of each pilot area to its subwatershed.

Based on Fuss & O'Neill's modeling in the East Branch Subwatershed, runoff generated by approximately 37.5 acres of this subwatershed must be managed to eliminate flooding at the three problem intersections. Since this is approximately 3.0 times the area of the East Pilot Area (which is approximately 12.5 acres), we estimate that the overall cost to eliminate flooding in the East Branch would be approximately $2,943,000 ($3,387,000 with engineering and other fees).

Based on Fuss & O'Neill's modeling in the West Branch of the Shandon-Rosewood Watershed, runoff generated by approximately 35.3 acres of this subwatershed must be managed to eliminate the flooding at the two problem intersections. Since this is approximately 2.7 times the area of the West Pilot Area (which is approximately 12.8 acres), we estimate that the overall coset to eliminate flooding in the West Branch would be approximately $3,213,000 ($3,695,000 with engineering and other fees).

For comparison purposes, it is our opinion that it would cost the City approximately $6,156,000 in total (without engineering) to construct green infrastructure improvements to eliminate flooding at the five problem intersections in the Shandon-Rosewood Watershed during storm events up to, and including, the 10-year, 24 hour storm event. This is about 50% of the total cost approximated by the May 2011 report (approximately $11,800,000) to eliminate flooding at these intersections by conventional methods.

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1 Project Background

1.1 Flooding Issues

The Shandon-Rosewood Watershed (Watershed) is more than 750 acres in size. This urbanized, residential area experiences severe flooding in five intersections during moderate and large storm events. Intersections of concern include:

- Wheat Street-Amherst Avenue,
- Monroe Street-Ravenel Street,
- Heyward Street-Ravenel Street,
- Shandon Street-Wilmot Avenue and
- Monroe Street-Maple Street intersections.

Initial analysis of area infrastructure shows the flooding is due to large expanses of hardscape (roads, sidewalks, roofs, etc.) served by a storm drain network that is undersized for the need. Storm drains surcharge as they are overloaded with large volumes of runoff causing them to flood onto the road. (See *Figure 1*.)

Figure 1—Currently, storm drains in the Shandon Neighborhood are undersized to handle significant rain events.

1.2 Purpose

This feasibility report aims to develop a conceptual solution to the flooding and drainage problems in two pilot areas of the Shandon-Rosewood Watershed. The completed conceptual solution will be used to judge feasibility of implementation both in the pilot areas and other areas of the Watershed. Clearly, the concept solution must be technically and financially sound to realize successful implementation.

Prior to Fuss & O'Neill's involvement, a hydrologic model of the Watershed was prepared utilizing XP-SWMM, which was documented in a report dated May 2011. Recommendations identified in that report focused on conventional drainage improvements to reduce the flooding in the Shandon-Rosewood Neighborhood. General recommendations of the May 2011 report include increasing pipe sizes and installing parallel drainage systems.

Implementing a conventional drainage approach to solve this problem has several disadvantages. The list below notes some of the more significant disadvantages:

- Conventional retrofits can be quite costly. We understand that the initial estimate for conventional retrofits in the May 2011 report were more than $11 million.
- Cost estimates do not include costs of temporary or permanent construction easements. They also do not include engineering.

- Replacement of buried drain lines will probably conflict with other existing buried utilities, which will likely create inconvenience for neighborhood residents and add cost to the overall project.
- Discharge of additional flows of stormwater may create flooding or other problems in down-gradient areas. Conventional fixes will need to be continued through such areas to avoid simply pushing flood water backups downstream.

Given the costs and disadvantages, a nonconventional approach should be considered as an alternative. This report focuses on the use of "green stormwater infrastructure" as an alternative to the conventional stormwater management approach proposed in May 2011.

1.3 The Green Stormwater Infrastructure Alternative

An alternative to conventional improvements is to use a green infrastructure approach (see *Figure 2*, below). ***Green infrastructure***, as discussed in this report, relies on infiltration as a way to mimic conditions of undeveloped land and abate flooding that sometimes results from intensive development. Commonly, green infrastructure is used to solve stormwater quality (i.e., pollution) problems; however, it also presents enormous utility for control of stormwater quantity (i.e., flooding) problems. Green stormwater infrastructure presents a number of useful advantages:

- Green infrastructure is typically more cost effective than constructing conventional drainage infrastructure as it avoids more/larger pipes.
- By imitating natural hydrology, green infrastructure improves base flow and eliminates potential for increased downstream flooding.
- Infiltration provides stormwater treatment and mitigates stormwater pollution problems, which might otherwise require control via expensive treatment practices.
- Unlike conventional infrastructure retrofits, green infrastructure improvements can be installed incrementally, as opportunity presents across the watershed.

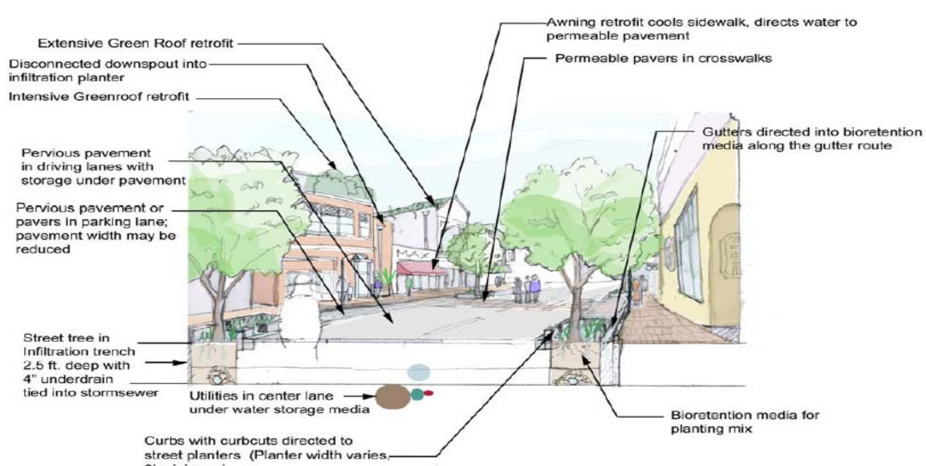

Figure 2—Green infrastructure in an idealized urban streetscape. Source: Evaulation of Connecticut's Stormwater General Permits Alternatives for Incorporation of Low Impact Development, Fuss & O'Neill, 2011.

1.4 Study Area and Pilot Areas Selected

Two pilot areas have been selected for analysis in the Shandon-Rosewood Watershed (see *Figures 3* (next page) and *4* (next page)). The pilot areas were selected due to located near areas with significant flooding..

The pilot areas discussed in this report include:

- The ***East Pilot Area***, consisting of two blocks and bounded by Blossom Street, Chatham Avenue, Wheat Street and Capitol Place. This pilot area can be further broken up into subareas referred to as East-Blossom and East-Wheat. East Blossom is the northern half of the East Pilot Area and East-Wheat is the southern portion.
- The ***West Pilot Area***, encompassing two blocks, bounded by Wilmont Avenue, Holly Street, Duncan Street and Woodrow Street. West-Woodrow is a subdivision of the West Pilot Area bounded by Wilmont Street, Maple Street, Duncan Street and Woodrow Street. West-Holly is bounded by Wilmont Avenue, Holly Street, Duncan Street and Maple Street. Both the West-Woodrow and West Holly subsidiary areas correspond to the footprints of street blocks.

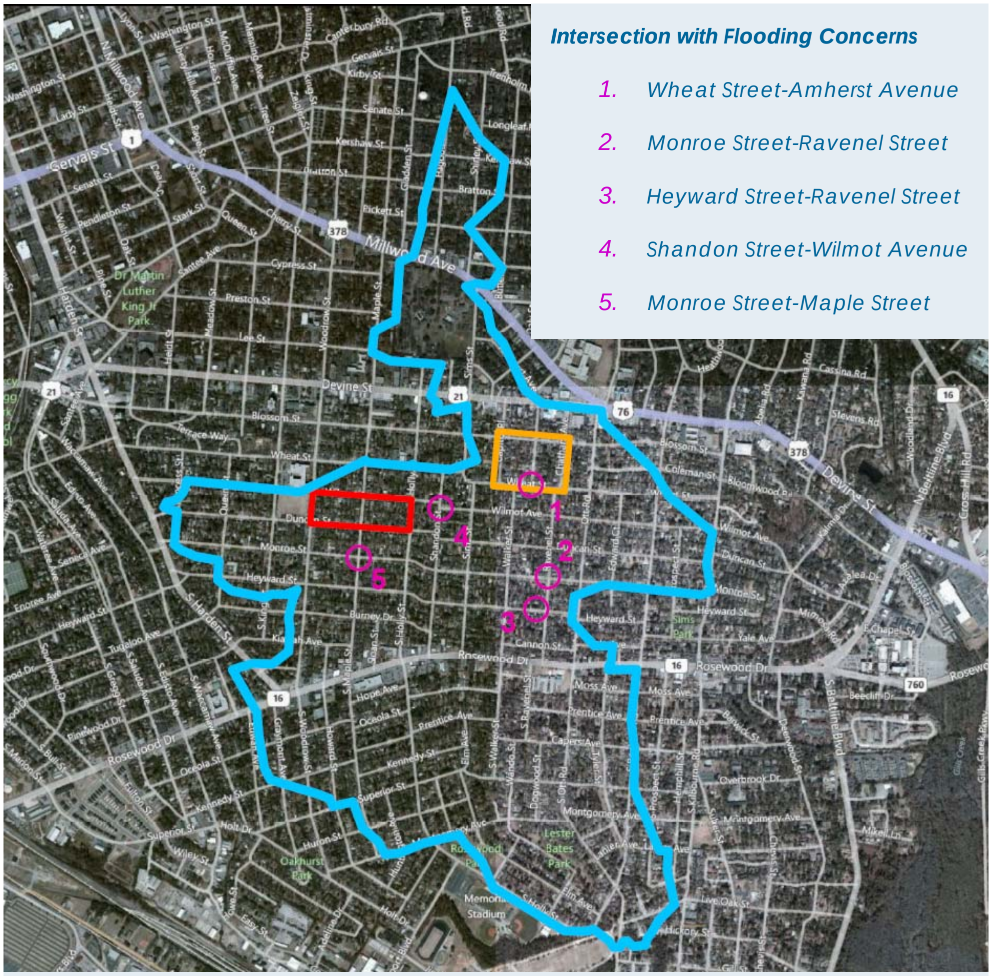

Figure 3—Location of Shandon-Rosewood Watershed. Intersections with historic flooding problems identified.

Figure 4—Approximate location of East (orange) and West (red) Pilot Areas.

1.5 Report Structure

The remainder of this report discusses:

- Design criteria considered for feasibility analysis
- Available data on infrastructure and hydrology
- Onsite investigation of soils
- Hydrologice evaluation of contributing watersheds
- Candidate retrofit alternatives
- Conceptual design of stormwater controls in the pilot areas
- Watershedwide benefits of proposed retrofits
- Implementation plan

2 Design Criteria

The feasibility analysis of green infrastructure provided in this report relies on certain measurable and qualitative criteria in order that designs proposed achieve specific objectives and adhere to regulatory requirements. *Table 1* (below) provides a summary of the design criteria that we used.

Table 1
Summary of Design Criteria and Approach to Feasibility Analysis

Design Criteria	Feasibility Analysis Consideration
Volumetric storage and discharge capacity	• BMP must have capacity to manage the volume and flow generated by the 10-year storm.
Depth to groundwater and soil type	• BMP must have capacity to maintain separation distance to the seasonal high groundwater table of 2 feet. • Underlying soils with minimum infiltration rate of 0.5 inches per hour.
Installation setting	• BMP must be appropriate for a suburban neighborhood setting. • BMPs cannot damage existing trees along ROW unless trees are diseased or otherwise determined acceptable for removal. • Existing curbing must remain. • Ability to park on streets must remain.
Fiscal impact and neighborhood disturbance	• BMP must minimize fiscal impact to the City through reduced infrastructure cost. • BMP must avoid unnecessary disturbance of existing roads and subsurface utilities.

Design Criteria	Feasibility Analysis Consideration
Operation and maintenance	• BMP must present relatively low cost and maintenance need. • Public Works has broom type street sweepers and vacuum trucks. Parks and Recreation would maintain street trees and periodic cleaning of bioretention areas. Private owners would be responsible for providing seasonal maintenance of rain gardens, just as they are at present for lawn mowing.

The remainder of this section of the report discusses the purpose and intent behind each design criterion.

2.1 Volumetric Storage and Discharge Capacity

Properly designed BMPs must have the capacity to store and discharge a large enough volume of stormwater to prevent flooding of both the stormwater catchment they serve and down-gradient areas. For the purposes of this study, a 10-year design storm was utilized to both size controls and evlauate the ability of green infrastructure controls to reduce flooding in problem areas. A 10-year storm analysis is consistent with the analysis completed as part of the May 2011 report.

We understand that the City ideally would like to control the 25-year[1] frequency storm for the flooding problem at the Maple/Monroe intersection because it sits in a depression. For the purposes of this study, sizing controls to manage a 25-year storm was not considered as it would be consistent with the analysis in the May 2011 conventional drainage report.

2.2 Depth to Groundwater and Soil Type

For green stormwater infrastructure to properly discharge to groundwater, separation must be maintained between the depth of subsurface discharge and seasonal high groundwater.[2] The *South Carolina DHEC Storm Water Management BMP Field Manual* (DHEC, 2005) requires a separation distance of at least 6-inches between the bottom of an infiltration BMP and the seasonal high groundwater table. For purposes of conceptual design, we maintained a more conservative separation distance of two feet.

The proposed green infrastructure approach also requires that soils beneath a BMP can accept the stormwater design flow[3] over a relatively short period of time (generally 24 to 48 hours). A

[1] The 25-year storm refers to a 24-hour precipitation event having a probable recurrence interval of 25 years (or a 1 in 25 chance of occurring any given year). Such storms have predictable rainfall depths and generate predictable runoff volumes and peak flows.

[2] Seasonal high groundwater commonly refers to the shallowest depth to free groundwater experienced at a given location within a typical year.

[3] The volume of stormwater runoff generated by the storm event that has been selected for design purposes (e.g., 10-year storm).

soil's ability to accept water is referred to as its hydraulic conductivity and design flow rate through soil is referred to as infiltration rate. To ensure the capacity of soil to accept water is not exceeded by discharge from BMPs, BMPs are generally designed with assumed infiltration rates of half of the soil's hydraulic conductivity.

2.3 Installation Setting

As shown in *Figure 5* (right), the Shandon-Rosewood Neighborhoods present a certain well-kept suburban aesthetic that the residents intend to maintain. Therefore, we have chosen infrastructure retrofits that we believe will fit in well with the existing setting. BMPs proposed take two basic forms—either buried and out of sight; or landscaped with low-growth vegetation.

Figure 5—Example of homes and roadside landscaping in the Shandon-Rosewood Neighborhood.

2.4 Fiscal Impact and Neighborhood Disturbance

The May 2011 conventional infrastructure study for the Shandon-Rosewood Neighborhood estimated a cost of more than $11 million for stormwater drainage upgrades. This conventional approach to drainage upgrade did not account for cost associated with temporary and permanent construction easements which would significantly increase the cost to implement this project. In order to avoid unnecessary fiscal impact and neighborhood disturbance proposed BMPs must minimize excavation of roadways and conflicts with subsurface utility lines—natural gas lines at depth 18 inches below surface; water at 36 inches below surface, and storm drains and sanitary sewer at 48 inches below surface. A green infrastructure approach has more flexibility, minimizes the need to disturb existing subsurface infrastructure and can achieve project objectives with fewer installations around the Watershed.

2.5 Operation and Maintenance Requirements

All BMPs require some maintenance to function properly over their lifecycle. Notwithstanding, owners of BMPs usually favor BMPs with less intensive management requirements. Therefore, the BMPs presented in this report have been selected with a preference for lesser operation and maintenance need.

3 Review of Available Data

3.1 Topography

Fuss & O'Neill utilized two-foot contouring for the City of Columbia obtained from the Richland County GIS database. This topographical information was utilized to delineate subwatersheds to proposed controls. Contour mapping was also used to calculate various slope information that was considered in the selection process for green infrastructure controls.

3.2 Utility Infrastructure

Some utility infrastructure locations were included in the GIS files provided by Richland County GIS. The City of Columbia, South Carolina also made archived prints documenting utility locations available for Fuss & O'Neill's review. Additionally, the May 2011 report included drainage structure mapping. By reviewing these mapping sources, Fuss & O'Neill was able to determine the most feasible locations for installation of green infrastructure controls while limiting disturbance to existing utilities.

3.3 Soil Survey

We used the *Custom Soil Resource Report for Richland County, South Carolina* (2010) as a source for general soils information for the study area. This information allowed us to make general feasibility determinations regarding the practicability of green infrastructure in the pilot areas. It also allowed us to identify strong candidate locations for BMPs.

A soil resource report for Richland County, SC can be found in *Appendix A*. Based on the *Custom Soil Resource Report for Richland County, South Carolina*, the East Pilot Area is underlain by Fuquay-Urban land complex (FyB) and Orangeburg-Urban land complex (OgB). FyB typically consists of well drained Fuquay soils and areas of urban land and is classified as hydrologic soil group (HSG) B soil (also referred to as type B soil). OgB consists of well drained Orangeburg soils and areas of urban land and is also classified as a type B soil. The West Pilot Area is underlain solely by OgB. Type B soils are appropriate for infiltration BMPs.

3.4 Previous Studies

In May 2011, Cox & Dinkins provided the City of Columbia, South Carolina with a report entitled *Mapping and Analysis of the Shandon-Rosewood Watershed and Associated Storm Drainage Collection System Network*. The included a survey of the City's storm drainage structures and pipes within the Shandon-Rosewood Watershed and provided the City with a project map locating these assets. The study also developed XP-SWMM models for existing conditions within the Shandon-Rosewood Watershed that were further refined into the East and West Branch Subwatersheds. This XP-SWMM model was utilized to identify areas of underperformance in both the east and west branch stormwater collection systems, from which were developed conceptual recommendations for improvements to the stormwater pipe network.

Fuss & O'Neill used the drainage mapping to help in selecting the most feasible locations for future green infrastructure controls. The XP-SWMM model from the same report was converted to SWMM 5 to serve as an existing conditions model in order to measure the reduction in flooding provided by green infrastructure controls. This *Drainage Pilot Study Report* has also included the water elevation profiles that would result if the May 2011 conceptual recommendations were implemented. These were used to compare to the water elevation profiles resulting from the installation of green infrastructure controls.

4 Field Review

As part of this project we conducted several days of field investigation. The general purpose of our investigation was twofold—(1) observe general conditions in the neighborhood that might contribute to flooding; and (2) conduct an investigation of pilot area soils.

4.1 Improper Yardwaste Management

Figure 6—Fugitive yard waste may interfere with proper stormwater drainage and presents a maintenance issue for alternatives proposed in this study.

Currently, residents leave yardwaste in loose piles in the parking lanes of streets for municipal pickup. The City of Columbia (City) has a truck that scoops the yardwaste from the roadway and carries it away for disposal. Occasionally, residents leave piles of yardwaste on the grassed road shoulders, but the truck's scooping arm is not designed to remove yardwaste from landscaped areas as it tends to gouge the soil. In order to avoid damage of landscaping in road shoulders, yardwaste may remain uncollected alongside the road. Yardwaste left behind in storm events can wash into and clog drainage structures (see *Figure 6*, left). Although, yardwaste clogs are unlikely to *cause* backup onto roadways (i.e., flooding), they do interfere with proper drainage. Additionally, particulate organic matter (e.g., bits of leaves) will likely present a maintenance issue for the green infrastructure alternatives proposed in this study. Beyond the drain-related problems, fugitive yard waste may create traffic hazards.

4.2 Onsite Soil Investigation

Fuss & O'Neill staff mobilized to the Watershed on November 7-8, 2011 to excavate test pits and determine the lithology, hydraulic conductivity and depth to groundwater at six locations (three for each pilot area). An onsite soil investigation was conducted to precisely determine soil data and depth to seasonal high groundwater table at the candidate sites for BMP installation. At three of these locations stand pipes were installed to observe depth to groundwater over the course of several months (see *Figure 7*, next page). Hydraulic conductivity was obtained using a Turf-Tec double ring infiltrometer installed to depths of 18-24 inches below the ground surface and depths to groundwater were determined by installing one inch diameter PVC standpipes ten feet below ground surface.

A summary of methodology and findings for the six test pits is provided in *Sections 4.1* and *4.2* (below). *Figures 8* and *9* (see page 12) map the test pit locations and summarize approximate depths to groundwater and hydraulic conductivity obtained at each test pit location.

4.2.1 East Pilot Area

The East Pilot Area includes Test Pits 3, 4, and 6. Findings at each of these three test pits are provided below:

- **Test Pit 3**—was installed approximately 35 feet west of the Amherst Avenue and Wheat Street intersection in the northern right-of-way (ROW) of Wheat Street. This pit was excavated to a depth of 10 feet. The hydraulic conductivity for Test Pit 3 stabilized at approximately 20.3 inches/hour. The depth to water was determined to be approximately 7.8 feet below ground surface (bgs).
- **Test Pit 4**—was installed approximately 90 feet west of the Chatham Avenue and Blossom Street intersection in the northern ROW of Blossom Street. A water main was encountered at 3 feet bgs and carefully avoided during the remainder of excavation. The hydraulic conductivity for Test Pit 4 was determined to be approximately 28 inches/hour. Groundwater was not encountered during the period of observation.
- **Test Pit 6**—was installed approximately 35 feet east of the Capitol Place and Blossom Street intersection in the southern ROW of Blossom Street. A utility of unknown type was encountered at approximately 2 feet bgs, running perpendicular to Blossom Street. The hydraulic conductivity for Test Pit 6 was determined to be approximately 21 inches/hour. Water was not observed within the excavated pit during construction and a standpipe was not installed.

Figure 7—Installation of a stand pipe for measuring depth to groundwater.

4.2.2 West Pilot Area

The West Pilot Area includes Test Pits 1 and 5. Findings at each of these test pits are provided below:

- **Test Pit 1**—was installed approximately 50 feet south of the Wilmot Avenue-Woodrow Street Intersection in the eastern ROW of Woodrow Street. The hydraulic conductivity for Test Pit 1 was determined to be approximately 9.0 inches/hour. From 0-7 feet bgs, this test pit consisted of predominantly silt with sand. Between 7 and 10 feet, a hard compressed clay was encountered. Water was not observed within the excavated pit during construction and a standpipe was not installed.
- **Test Pit 5**—was installed approximately 275 feet east of the Maple Street-Wilmot Avenue Intersection in the northern ROW of Wilmot Street. The soil observed between 1 and 10 feet bgs appears to be fill material. The hydraulic conductivity for Test Pit 5 was determined to be approximately 23.8 inches/hour. Water was not observed within the excavated pit during construction and a standpipe was not installed.

We also conducted a test pit investigation in the area of the Maple Street-Monroe Street Intersection (just outside the West Pilot Area). Findings from Test Pit 2 are provided below:

- **Test Pit 2**—was installed approximately 30 feet west of the Maple Street-Monroe Street intersection in the northern ROW of Monroe Street. At 2 feet bgs, water was observed leaching from the walls of the test pit. All soils were saturated from 2-10 feet bgs. The hydraulic conductivity for Test Pit 2 was determined to be approximately 0.8 inches/hour. Depth to groundwater was determined to be 1.3 feet bgs.

Figure 8—East Pilot Area Test Pit Locations and Findings

Figure 9—West Pilot Area Test Pit Locations and Findings

5 Hydrologic Evaluation of Contributing Watersheds

Fuss & O'Neill's hydrologic evaluation of the East and West Pilot Areas included three major tasks: (1) delineating subwatershed areas within each pilot study area, (2) defining subwatershed hydrologic parameters, and (3) establishing a hydrologic model accounting for subwatershed hydrologic connectivity.

5.1 Watershed Delineation

The first task of the hydrologic evaluation included the delineation of the subwatershed areas included within the two pilot study areas. Subwatersheds were initially delineated utilizing two-foot topographic mapping obtained from the Richland County GIS database. Adjustments to the subwatershed delineations were then made based on observations recorded during a field visit conducted by Fuss & O'Neill personnel on December 15, 2011. Major topographical depressions, or areas where runoff could temporarily pond or store during storm events, were also identified and incorporated into the hydrologic model due to the potential effect that such areas can have on drainage patterns and peak runoff rates and volumes.

A summary of the significant features that influence runoff patterns in the two pilot areas follows:

- The topography in both pilot study areas generally slopes in a southerly direction with the majority of runoff being directed to the Amherst Avenue-Wheat Street Intersection (in the East Pilot Area) and the Maple Street-Duncan Street Intersection (in the West Pilot Area).

- A topographical depression exists in the East Pilot Area in the backyards of 3119 and 3123 Wheat Street. This depression collects and temporarily stores runoff during significant storm events prior to overtopping in a southerly direction and discharging to the Amherst Avenue- Wheat Street Intersection. The size and volume of storage provided by this depression was estimated based on aerial mapping and an assumption that this area only stores approximately 12 inches of flow prior to overtopping.

- Two topographical depressions exist in a utility easement that bisects the West Pilot Area. The first depression is located on the east side of Maple Street, which collects runoff generated by a portion of the West Pilot Area prior to overtopping in a westerly direction and discharging to Maple Street. The second depression is located on the west side of Maple Street. It collects runoff generated by a portion of the West Pilot Area prior to overtopping in an easterly direction and discharging to Maple Street. The size and volume of storage provided by both depressions were approximated based upon aerial mapping and an assumptions that both areas store approximately 12 inches of flow prior to overtopping.

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Figure 10 (below) shows East and West Pilot Area subwatershed delineations, labeled alphabetically, as well as two-foot topographical contours.

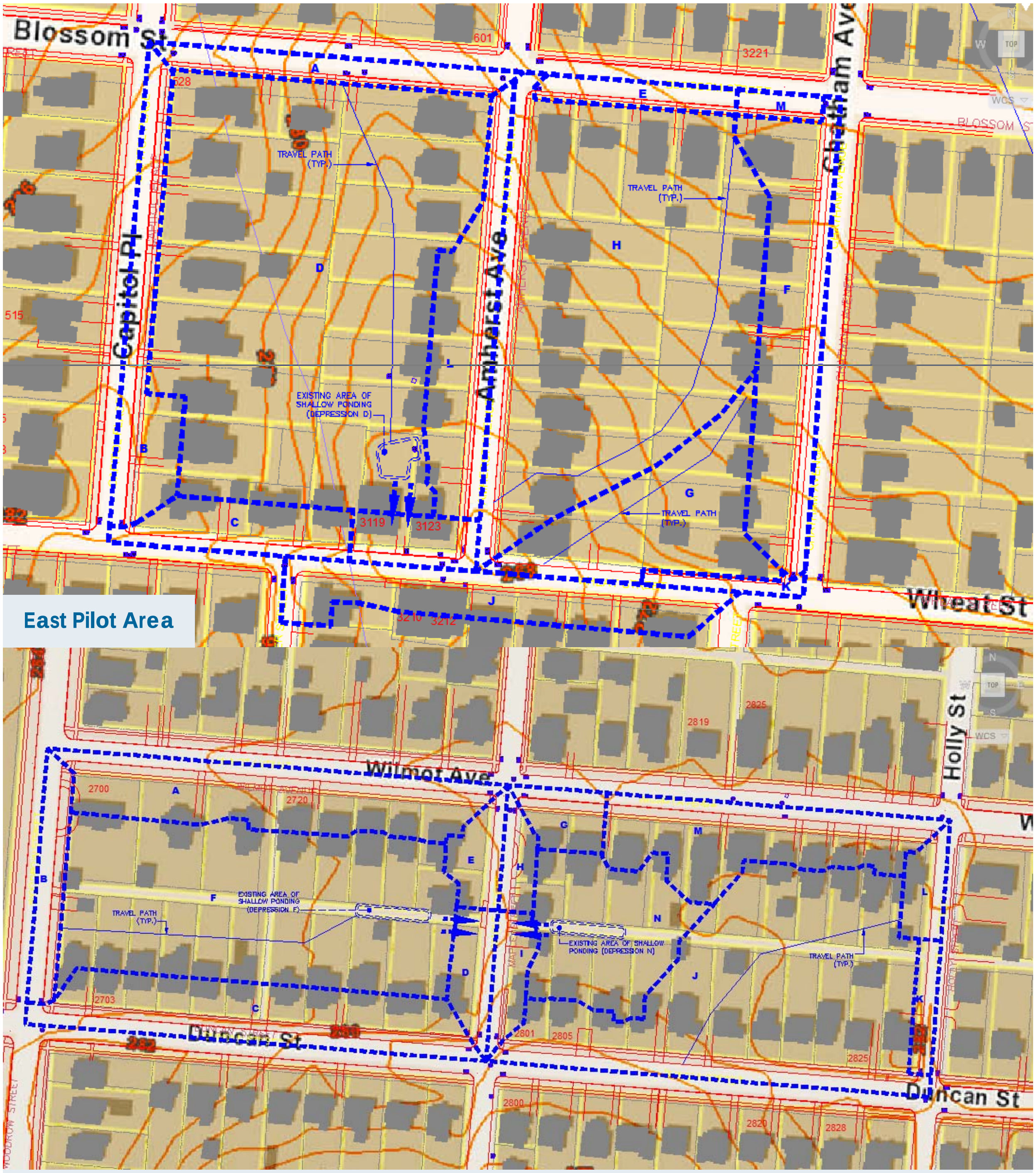


Figure 10— East and West Pilot Area Subwatershed Delineations

The East Pilot Area was divided into 13 subwatersheds (A through M); the West Pilot Area was divided into 14 subwatersheds (A through N). It should be noted that the crown of the roadway was generally assumed to be exterior limit of both pilot areas. The only exception to this occurred along the south side of Wheat Street in the East Pilot Area, where it was determined that subsurface system on the north side of the roadway could not accommodate all of the runoff from its contributing subwatershed and had to be hydrologically connected to the subsurface system across the street to provide additional storage.

A full-scale depiction of these subwatershed delineations has been provided as *Figure 10A* (at the end of this report).

5.2 Runoff Curve Number Development

The second task of our hydrologic analysis was to define the hydrologic parameters of each watershed and subwatershed. The soil types, topography, and hydrologic cover conditions within a subwatershed have a significant effect on the flow generated and are used to determine the "runoff curve number" of each subwatershed. The runoff curve number is an empirical parameter used in hydrology for predicting direct runoff and infiltration from rainfall within a given area. To estimate the runoff curve number of each contributing subwatershed, soil classifications, land use data (including percent imperviousness), and times of concentration for each subwatershed were obtained from the following sources:

- *Custom Soil Resource Report for Richland County, South Carolina* (2010).
- United States Department of Agriculture Web Soil Survey Website (2011).
- *Technical Release 55—Urban Hydrology for Small Watersheds* (NRCS, 1986).
- Aerial Mapping obtained from the Google Maps Website (2011).

5.2.1 Soil Classifications

As stated in *Section 3.3* of this report, both the East and West Pilot Areas are underlain entirely by type B soils. Soil group boundaries were imported from the South Carolina Geographic Information System (SCGIS) website, and are based on soil delineations provided within the USDA-NRCS Soil Survey of Richland County, South Carolina (2010).

The East Pilot Area is underlain by Fuquay-Urban land complex (FyB) and Orangeburg-Urban land complex (OgB) both of which are classified as hydrologic soil group (HSG) type B soils.

The West Pilot Area is underlain solely by OgB soils (type B).

5.2.2 Land Use Data

In order to estimate the runoff curve numbers of each subwatershed in both pilot study areas, aerial photography (in conjunction with *Technical Release 55—Urban Hydrology for Small*

Watersheds) was utilized to approximate the amount of impervious area within each subwatershed.

Based on our analysis, residential lots (excluding area within the roadway right-of-ways) within both pilot study areas had an average impervious percentage of approximately 45%. According to Technical Release 55, this correlates to a runoff curve number of approximately 78. This is based on an interpolation of runoff numbers provided for 1/8-acre or less residential lots (with an assumed 65% imperviousness) and 1/4-acre residential lots (with an assumed imperviousness of 38%).

Roadway areas (inclusive of concrete sidewalks and grassed strips within the roadway right-of-way) were assumed to have an impervious percentage of approximately 100% impervious and have a runoff curve number of 98 according to Technical Release 55. This is a conservative estimate for the purposes of this evaluation.

Composite[4] curve numbers for each subwatershed within the both pilot study areas were then calculated based upon weighted averages of area outside and within the right-of-way.

5.2.3 Time of Concentration (Lag Times)

The time of concentration, Tc, is another hydrologic parameter that effects flow rate and volume generated by a watershed. The time of concentration can be defined as the total time it takes for runoff to travel from the most hydrologically distant point of a watershed to the point of analysis (or interest). Several methods have been developed for estimating the time of concentration. The method used in this hydrologic analysis is the Segmental Time of Concentration Method. The Segmental Time of Concentration Method is the sum of the following three components of overland flow: (1) sheet flow (or flow over plane surfaces), (2) shallow concentrated flow (or concentrated flow), and (3) open channel flow (or flow through channels such as swales, streams, ditches, drain pipes, etc.).

In accordance with standard engineering practice and recommendations provided in Technical Release 55, sheet flow lengths were limited to 100 feet or less. The remainder of the travel path through the subwatershed was then assumed to consist of shallow-concentrated flow. Roadway gutter flow and flow through closed-conduit drainage systems were conservatively[5] neglected due to the relatively small size of the subwatersheds and minimal travel times that would be expected in these segments of the travel path. For subwatersheds that yielded times of

[4] Technical Release 55 provides a process for determining "composite" (also refered to as weighted) curve numbers.

[5] "Conservatively" in this context refers to an assumption(s) that add a factor of safty for purposes of sizing and designing BMPs. At the feasibility stage, it is generally more advantageous to intentionally oversize BMPs slightly than it is to inadvertently undersize them.

concentration of less than six minutes, a minimum time of concentration of six minutes was applied.

The travel paths used to calculate the times of concentration for the subwatersheds analyzed is illustrated both in *Figure 10* and *Figure 10A* of this report. Travel paths for subwatersheds that yielded times of concentration of six minutes or less were excluded for graphical purposes.

5.3 Summary of Watershed Hydrologic Characteristics

The following table summarizes the hydrologic characteristics (including the composite curve numbers and times of concentration) of each subwatershed area contributing storm flow to the East Pilot Area (*Subwatersheds East A through East M*) and the West Pilot Area (*Subwatersheds West A through West N*):

Table 2
Subwatershed Hydrologic Characteristic Summary Table

Subwatersheds	Area (Acres)	Approximate % of Impervious Area	Composite Curve Number	Time of Concentration (Minutes)
East A	0.30	100%	98	6.0
East B	0.57	60%	83	6.0
East C	0.37	70%	87	6.0
East D	4.08	49%	78	10.5
East E	0.17	100%	98	6.0
East F	1.03	63%	84	6.0
East G	0.88	50%	80	7.0
East H	3.29	50%	80	14.6
East I	0.22	73%	88	6.0
East J	0.71	64%	85	6.0
East K	0.09	100%	98	6.0
East L	0.69	73%	88	6.0
East M	0.07	100%	98	6.0
East Subtotal	**12.47 Acres**			
West A	1.29	66%	86	6.0
West B	0.34	100%	98	6.0

Subwatersheds	Area (Acres)	Approximate % of Impervious Area	Composite Curve Number	Time of Concentration (Minutes)
West C	1.26	70%	87	6.0
West D	0.27	70%	87	6.0
West E	0.25	66%	85	6.0
West F	3.10	45%	78	24.2
West G	0.25	67%	86	6.0
West H	0.18	71%	88	6.0
West I	0.24	69%	87	6.0
West J	3.05	53%	81	15.6
West K	0.15	88%	94	6.0
West L	0.21	69%	87	6.0
West M	1.10	63%	84	6.0
West N	1.08	45%	78	6.0
West Subtotal	**12.77 Acres**			

The total acreage for the combined East and West Pilot Areas is approximately 25.72 acres.

5.4 Peak Flow Rates and Volumes

The third task of our hydrologic evaluation was to calculate peak flow rates and volumes generated by each subwatershed within the East and West Pilot Areas. With the curve numbers and times of concentration calculated, Hydraflow Hydrographs (a program that utilizes the NRCS TR-20 Method[6] to generate hydrographs) was used to calculate peak flow rates and volumes generated by each subwatershed area.

Given the location of the project in Richland County, a Type II rainfall distribution was selected for analysis. Precipitation values of 5.3 inches for the 10-year, 24-hour storm, respectively, were used to compute peak flow rates and volumes generated by each subwatershed analyzed. The 10-year, 24-hour precipitation value is consistent with the value used in the May 2011 Report.

The following table summarizes peak runoff flow rates and volumes generated by each subwatershed area within the East and West Pilot Areas:

[6] TR-20 uses the same basic algorythms as Technical Release 55 making the methods compatible and the findings comparable.

Table 3
Peak Flow Rate and Volume Summary Table

Subwatershed	10-Year, 24-Hour Storm Peak Flow Rate (cfs)	10-Year, 24-Hour Storm Volume (cf)
East A	2.4	5,700
East B	3.5	7,400
East C	2.5	5,300
East D	18.5	44,700
East E	1.3	3,200
East F	6.5	13,700
East G	4.6	9,800
East H	14.0	37,700
East I	1.5	3,300
East J	4.6	9,700
East K	0.7	1,700
East L	4.8	10,200
East M	0.6	1,300
East Subtotal		**153,700**
West A	8.6	18,100
West B	2.7	6,400
West C	8.5	18,200
West D	1.8	3,900
West E	1.6	3,400
West F	9.4	33,400
West G	1.7	3,500
West H	1.2	2,700
West I	1.6	3,500
West J	12.7	36,500
West K	1.1	2,600
West L	1.4	3,000
West M	7.0	14,600
West N	5.9	12,000
West Subtotal		**161,800**

The total volume of runoff generated by all subwatersheds within the East and West Pilot Areas is approximately 315,500 cubic feet. The volume runoff generated by the East Pilot Area is approximately 153,700 cubic feet; the volume of runoff generated by the West Pilot Area is approximately 161,800 cubic feet.

6 Candidate Alternatives

For the purposes of this study, we focused on green infrastructure controls with the capacity abstract water from stormwater flows prior to enter the storm drain network. The commensurate reduction in drain line flow is intended to reduce drain line surcharge and backup onto watershed roadways. We also selected controls with limited maintenance needs and that would either remain out of sight (e.g., subsurface controls) or fit in readily with the residential context of the Shandon-Rosewood Neighborhood. This section of our report describes the types of controls we considered (*Section 6.1*) as well as the applications and advantages each of the candidate controls.

6.1 Types of Controls Considered

Sections 6.1.1 through *6.1.7* provide brief descriptions of each of the candidate alternatives. We also include a number of graphic representations of the candidate BMPs.

6.1.1 Porous Pavement

Porous pavement is designed to allow rain and snowmelt to flow through, into a gravel reservoir, and discharge into the ground or to a drainage network via subdrain.

Figure 11—Comparison of bituminous and porous paving during a rain event. Source: http://www.morrisbeacon.com/blog/?p=185

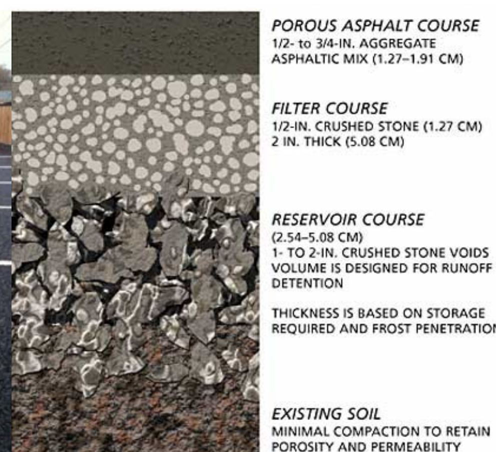


Figure 12—Cross section of porous pavement. Source: http://stormh2o.org/march-april-

6.1.2 Subsurface Infiltration

Subsurface infiltration structures are underground systems that infiltrate captured runoff into groundwater through natural soils.

Figure 13—Infiltration bed. Source: Cultec

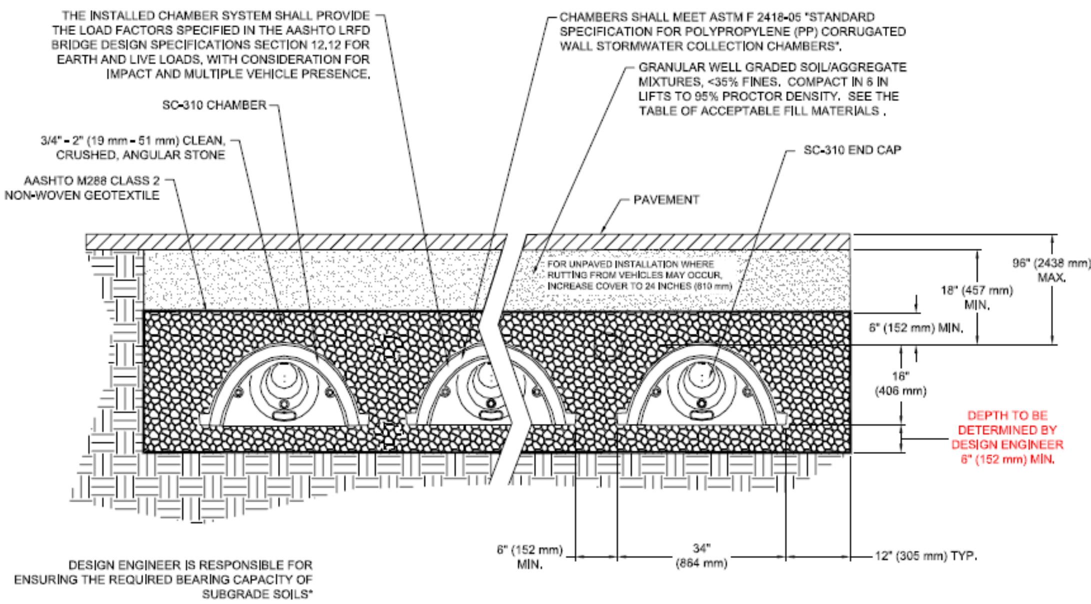


Figure 14—Cross section of infiltration chambers. Source: Stormtech.

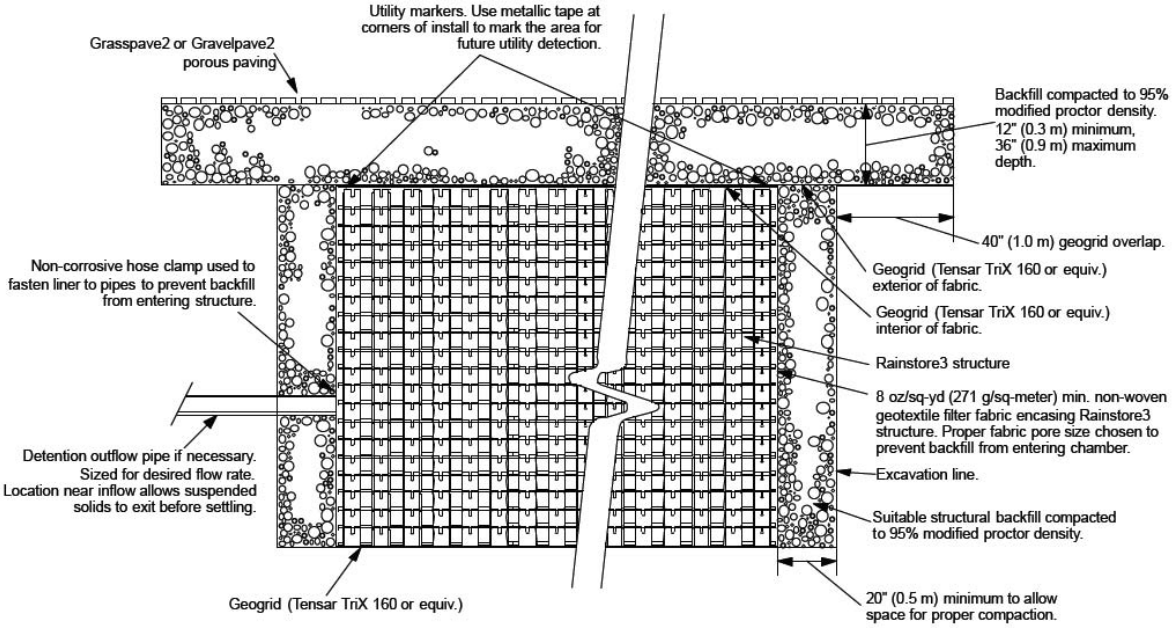


Figure 15—Cross section of modular storage system. Source: http://www.invisiblestructures.com/design_details/rainstore3_details/RS3porouspaveinflow10.pdf.

Subsurface infiltration BMPs are commonly constructed of crushed stone in combination with manufactured systems such as:

- Infiltration pits—Pre-cast concrete or plastic barrel with uniform perforations.
- Chambers—High-density polyethylene (HDPE) arched chambers with open or perforated bottoms over a stone bed.
- Modular storage units – Cellular block-like or "crate" systems which can be stacked below-grade to provide storage for runoff and to facilitate exfiltration.

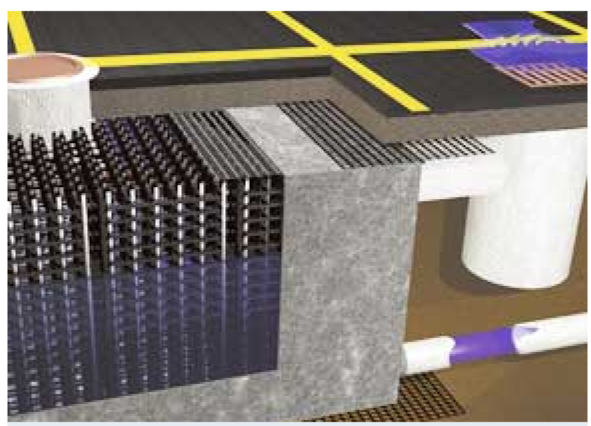


Figure 16—Infiltration bed. Source: http://www.invisiblestructures.com/rainstore3.html

- Perforated pipes—Typically, polyvinyl-chloride (PVC) or polyethylene (PE) pipes,with holes at 4 and 8 o'clock—placed in a leaching bed.
- Galleys—Perforated concrete rectangular vaults with open bottoms or modular systems placed under a parking lot.

6.1.3 Infiltrating Catch Basins

Infiltrating catch basins are a specialized from of subsurface infiltration. They are generally used in place of standard (i.e., nonleaching catch basins) to limit the amount of flow entering the remainder of the drainage system.

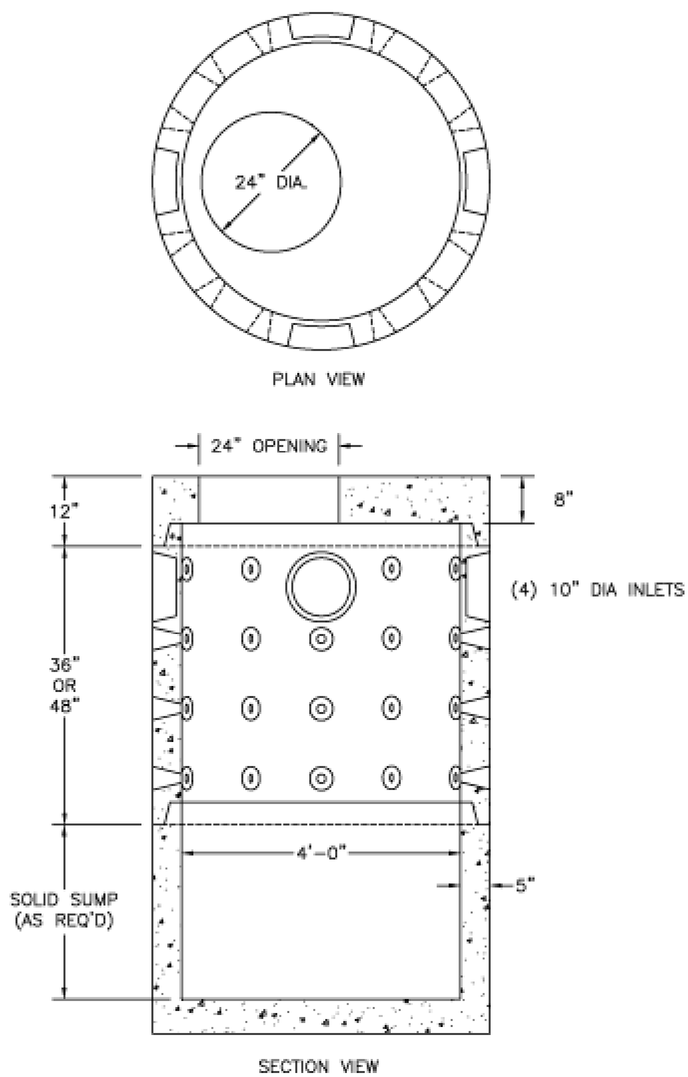


Figure 17—Section view of an infiltrating catch basin. Adapted from: http://phcjam.blogspot.com/2011/07/rainwater-drainage.html

6.1.4 Bioretention and Rain Gardens

Bioretention—also referred to as rain gardens when they are of small size—are shallow landscaped depressions designed to filter stormwater through engineered soils for treatment. Storm water flows into the bioretention area, ponds on the surface, and gradually infiltrates into the soil bed. Treated water is then allowed to infiltrate into the surrounding soils or is collected by an underdrain system and discharged to the storm drain system or receiving waters.

Some bioretention systems are designed to convey stormwater. These systems are known as bioswales or infiltrating swales.

Figure 18—Rain Garden in Cayce, SC. Source: Fuss &O'Neill

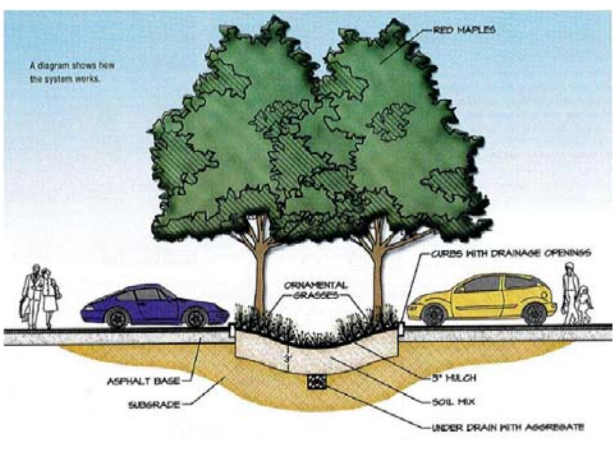


Figure 19—Bioswale in a parking area. Source: City of North Olmstead, OH.

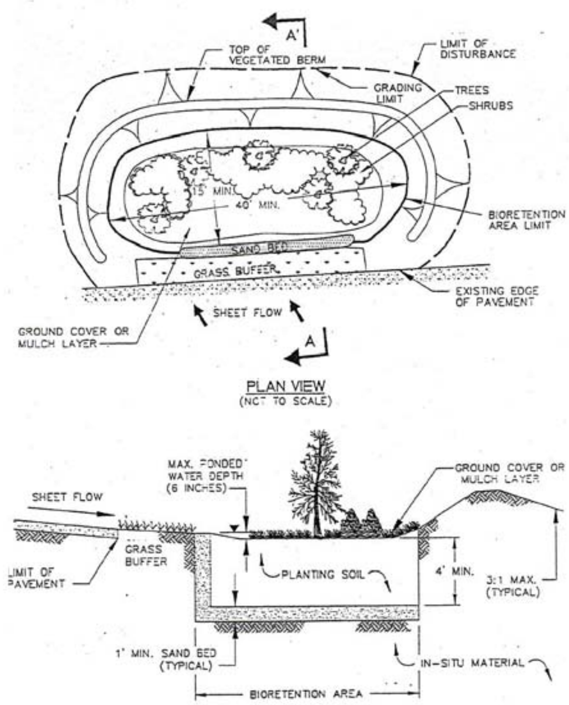


Figure 20—Components of Bioretention. Source: Prince George's County, Maryland.

6.1.5 Dry Wells

A dry well is a small, excavated pit, backfilled with stone aggregate. Dry wells function like infiltration systems to control roof runoff and are applicable for most types of buildings.

Figure 21--Installation of a dry well. Source: www.thisoldhouse.com.

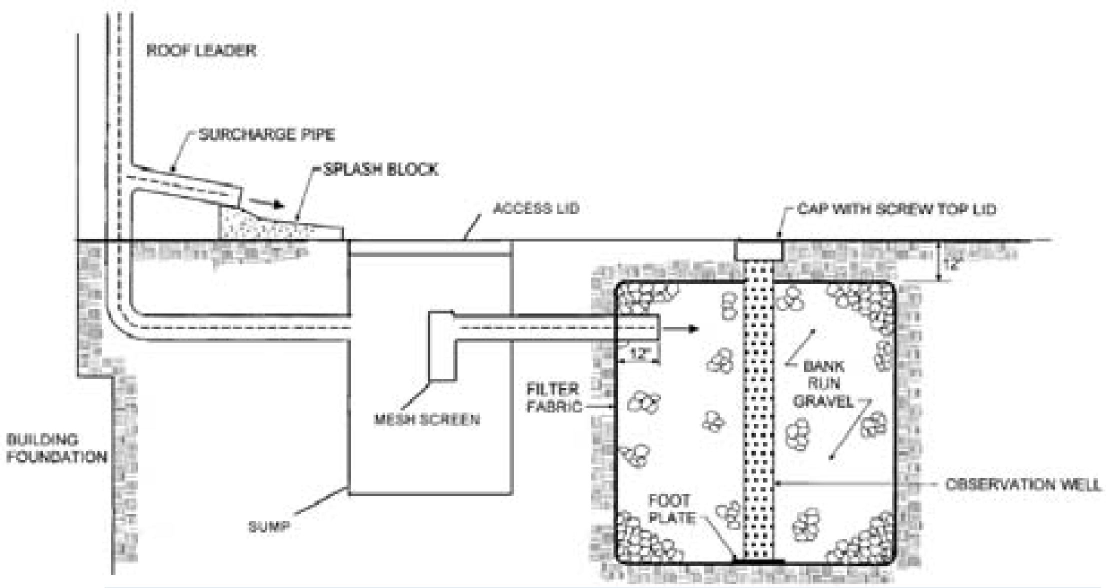


Figure 22—Schematic of a dry well. Source: Adapted from New York, 2001.

6.1.6 Drain Leader Disconnection

Drain leaders are pipes for roof gutters. Connected drain leaders collect stormwater, delivering it to combined drainage systems or storm sewers. Drain leaders connected to drainage systems in this manner increase the peak flow to these systems, often surpassing the capacity of the system, resulting in flooding. Drain leaders can also be disconnetd from traditional drainage system and reconnected to rain barrels, rainwater pillows, or drywells to provide storage and detention.

Figure 23—Disconnected drain leader directing flow away from a house. Source: http://www.inspectthebest.biz/services

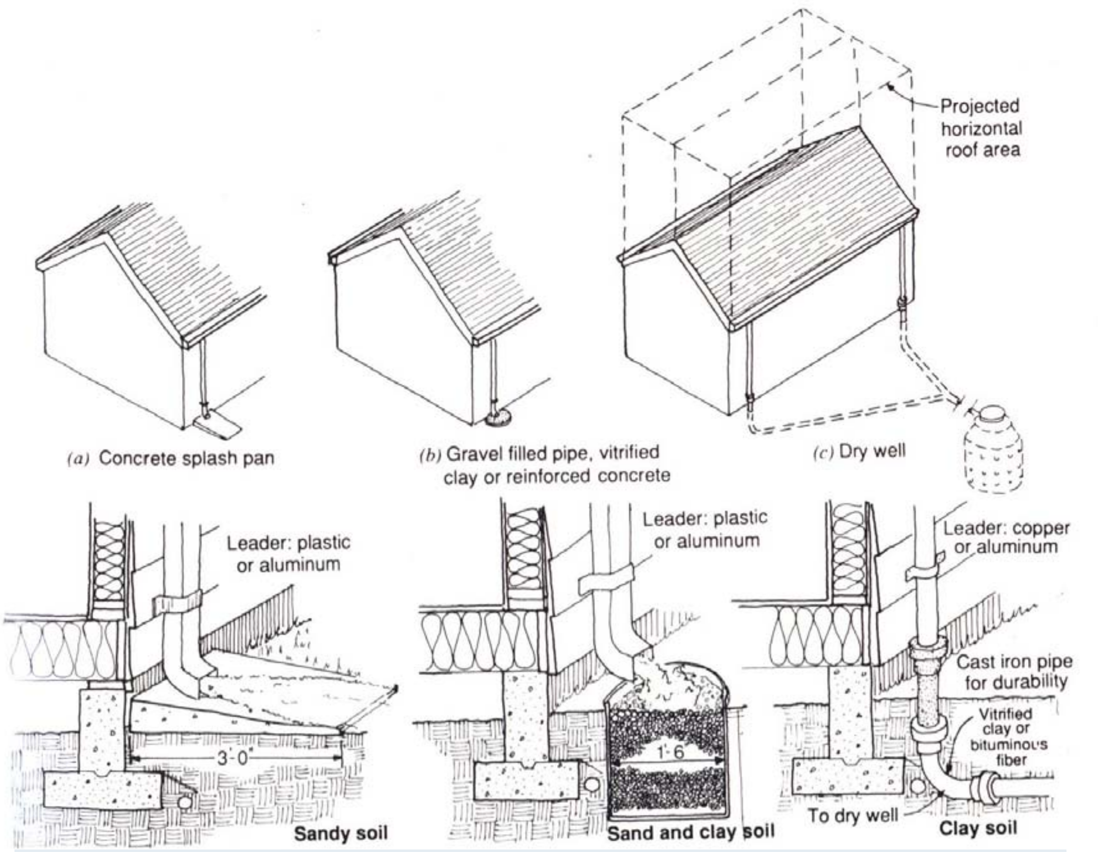


Figure 24—Schematics of drain leader disconnection using various approaches. Source: http://phcjam.blogspot.com/2011/07/rainwater-drainage.html

6.1.7 Rain Barrels and Pillows

Rain barrels are rainwater storage devices. They are generally low-cost and easy to maintain. They are appropriate for residential, commercial and industrial sites roof runoff management.

Rain pillows are flexible rainwater collection and storage devices designed to fit in unused horizontal areas such as crawlspaces

a

Figure 25—Photo of a rain pillow within the crawlspace of a residence. Source: www.rainwaterpillow.com.

Figure 26—Example of a rain barrel. Source: Connecticut Department of Environmental Protection.

6.2 Use and Advantages of Candidate Alternatives

Table 4 (next page) itemizes uses and advantages for each of the candidate alternatives analyzed in this report.

Table 4
Green Infrastructure BMP Uses and Advantages

BMP Type	Uses	Advantages
Porous Pavement	• Appropriate for low vehicle volume and speed areas such as parking lots, parking lanes, and some residential areas. • Ideal for dense urban areas where open space is limited and parking is essential. • Adaptable to cold weather climates as well as temperate weather.	• Capacity to manage significant stormwater flows from roadways. • Can be designed to promote groundwater recharge. • Hardscape that does not generate runoff. • Reduces peak discharge rates by redirecting stormwater from drainage systems and into the ground. • Increases effective developable area on a site by decreasing aboveground stormwater management systems. • Subsurface BMP, presents no apparent footprint.
Subsurface infiltration	• May be designed to infiltrate to groundwater; or to redirect stormwater to larger drainage systems. • Appropriate beneath parking lots, low-traffic roadways and grassed recreational areas. • Can be utilized in conjunction with both permeable and impermeable surfaces. • Applicable to all types of land use (residential/commercial/industrial).	• Capacity to manage significant stormwater flows from roadways. • Can be designed to promote groundwater recharge. • Can be designed to reduce need for end-of-pipe treatment. • Can be designed to reduce peak discharge rates by redirecting stormwater from drainage systems and into the ground. • Low cost per unit of runoff. • Subsurface BMP, presents no apparent footprint.
Infiltrating catch basin	• Appropriate in paved or grassed settings. • Applicable for both small and large drainage areas.	• Capacity to manage moderate stormwater flows from roadways. • Reduces peak discharge rates by redirecting stormwater from drainage systems and into the ground. • Low cost per unit of runoff. • Subsurface BMP, presents no apparent footprint.

BMP Type	Uses	Advantages
Bioretention and rain gardens	• May be designed to infiltrate and recharge groundwater; or lined and underdrained. • May be decentralized (e.g., as rain gardens on individual lots) or centralized in common areas to manage multiple properties. • Applicable for small to medium drainage areas. • Applicable to all types of land use (residential/commercial/industrial).	• Can be designed to reduce peak discharge rates by redirecting stormwater from drainage systems and into the ground. • Few site constraints and many design variations. • Can be sited in road shoulders to collect road runoff. • Can be landscaped to provide aesthetic appeal.
Dry wells	• Infiltration of rooftop runoff. • Applicable to all types of land use (residential/commercial/industrial).	• Can be sited to capture roof runoff. • Reduces peak discharge rates by redirecting stormwater from drainage systems and into the ground. • Low cost per capacity to infiltrate inches of runoff.
Drain leader disconnection	• Direct roof runoff and runoff from paved surfaces to stabilized vegetated areas such as buffers. • Applicable to all types of land use (residential/commercial/industrial).	• Captures roof runoff. • Reduces peak discharge rates by redirecting stormwater from drainage systems and into the ground. • Encourages sheet flow through vegetated areas. • Low cost per capacity to infiltrate inches of runoff.
Rain barrels and pillows	• May be used to temporarily store stormwater. • Applicable to all types of land use (residential/commercial/industrial).	• Captures roof runoff. • Reduces peak discharge rates. • Can provide reuse of water for landscape irrigation. • Can be incorporated into landscape design. • Low cost per capacity to store inches of runoff.

6.3 Selection of Alternatives Based on Design Criteria

We selected porous pavement, subsurface infiltration, and bioretention for modeling and feasibility analysis based the design criteria and on the following observations related to our review of available data, onsite investigation, and characteristics of candidate BMPs or green infrastructure improvements:

- By far, the largest fraction of stormwater runoff is generated by roadways. Roadways make up the greatest expance of impervious surface in the pilot areas.
- Most roofs are at least partially disconnected to the roadway drainage system as several roof leaders discharge to yard (lawn) areas prior to discharging to the roadway. Roofs that are connected (e.g. roof leaders that drain to driveways) could be disconnected from roadway runoff via the incorporation of porous pavement (with subsurface infiltration) at the end of such driveways or the edge of the roadway.
- Due to the limited space available within the roadway right-of-way to accommodate the size of above-grade green infrastructure improvements (e.g. bioretention basins) necessary to handle yard and roadway runoff generated during the 10-year storm, bioretention could not be used as the sole improvement. However, bioretention could be used in combination with other BMPs or green infrastructure improvements as a solution to the flooding problem.
- Subsurface storage BMPs, such as stone trenches/reservoir bases, infiltration chambers, and/or modular storage units, in combination with porous pavement appear to be the only green infrastructure improvements with large enough capacity to manage a significant fraction of the the flow generated during the 10-year storm given the constraints.

7 Conceptual Design of Controls in the Pilot Areas

The following sections summarize the specific types, sizes, and quantities of green infrastructure improvements proposed in each pilot area. Due to the limited space available within the roadway right-of-way to accommodate the size of above-grade green infrastructure improvements necessary tohandle runoff generated during the 10-year storm, porous pavement in conjunction with the following subsurface green infrastructure improvements were considered:

- Stone trench or reservoir base.
- Infiltration chamers encompassed by stone.
- Modular storage units encompassed by stone.

Runoff rates and volumes generated by each subwatershed as part of our hydrologic analysis were routed through the proposed subsurface systems in order to determine the sizes and configurations of each of these systems on a streetwide-basis. Hydraflow Hydrographs (2011) was utilized to perform this hydraulic analysis. A factor of safety of two was conservatively applied to the underlying soil's hydraulic conductivity (at each system location) as obtained from our soil investigation. Refer to *Figures 8 and 9* for a summary of test pit locations and hydraulic conductivity results.

7.1 Green Infrastructure Improvement Sizing

The following tables provide a summary of the specific types and sizes of stormwater green infrastructure improvments proposed within each subwatershed in the East and West Pilot Areas necessary to control flooding during the 10-year, 24-hour storm event. These systems include porous pavement underlain by either a stone reservoir base or trench(only), a chamber system, or a modular storage system. While bioretention systems are proposed, they were not included in the calculations in managing runoff from subwatershed areas as their capacity is limited compared to the porous pavement with subsurface infiltration alternatives. Bioretention systems are proposed primarily as bump outs to delineate porous pavement areas and provide some level of traffic calming.

Table 5
East Pilot Area Type and Size of Controls

Subwatershed	Control Type	Width of Porous Pavement [1] (ft.)	Width of System [2] (ft)	Depth of System [2] (ft)	Length of System [2] (ft)	Storage Volume of System [3] (cf)
East A	Porous pavement with stone trench	7.6	7.6	2.8	246	1,320
East B	Porous pavement with stone trench	6.5	6.5	2.3	462	1,770
East C	Porous pavement with stone trench	4.0	4.0	4.8	257	1,510
East D	Combines with runoff from East I; Refer to control for East I	---	---	---	---	---
East E	Porous pavement with stone trench	7.6	7.6	1.8	205	600
East F	Porous pavement with modular storage	6.7	6.7	3.0	472	4,315
East G	Porous pavement with modular storage	4.0	6.7	6.0	165	3,610
East H	Porous pavement with modular storage	5.4	6.7	7.3	510	14,270
East I	Porous pavement with modular storage	4.0	6.7	6.0	119	2,720
East J	Porous pavement with modular storage	5.3	16.7	5.3	327	19,650
East K	Porous pavement with stone trench	4.0	4.0	2.0	168	330
East L	Porous pavement with chamber	4.8	5.5	3.0	510	2,880

Subwatershed	Control Type	Width of Porous Pavement 1 (ft.)	Width of System 2 (ft)	Depth of System 2 (ft)	Length of System 2 (ft)	Storage Volume of System3 (cf)
	system					
East M	Porous pavement with stone trench	7.6	7.6	2.3	68	280
Total						**53,257**

Notes:
1. Value reflects the width of porous asphalt to be installed in the roadway shoulder area at ground level.
2. Refer *to Figures 10A and 10B* for details that define the width, depth, and length of each type of subsurface system.
3. The storage volume listed excludes the volume of storage that is exfiltrated.

Table 6
West Pilot Area Type and Size of Controls

Subwatershed	Control Type	Width of Porous Pavement 1 (ft.)	Width of System 2 (ft)	Depth of System 2 (ft)	Length of System 2 (ft)	Storage Volume of System3 (cf)
West A	Porous pavement with modular storage	3.8	6.7	4.3	497	7,576
West B	Porous pavement with stone trench	8.0	8.0	2.8	336	1,948
West C	Porous pavement with modular storage	7.8	7.8	8.0	542	18,864
West D	Porous pavement with modular storage	5.6	6.7	9.0	156	5,601
West E	Porous pavement with modular storage	5.6	6.7	3.3	124	1,349
West F	Combines with runoff from West D; Refer to control for West D	---	---	---	---	---
West G	Porous pavement with modular storage	5.0	6.7	5.0	85	1,507
West H	Porous pavement with modular storage	5.6	6.7	8.7	125	983
West I	Porous pavement with modular storage	5.6	6.7	8.7	157	5,407
West J	Porous pavement with modular storage	7.6	7.6	9.0	542	16,784
West K	Porous pavement with stone trench	6.7	6.7	2.8	166	818
West L	Porous pavement with modular storage	6.7	6.7	3.3	118	1,177
West M	Porous pavement with modular storage	5.0	6.7	4.7	369	6,227
West N	Combines with runoff from West I; Refer to control for West I	---	---	---	---	---
Total						**68,241**

Notes:
1. Value reflects the width of porous asphalt to be installed in the roadway shoulder area at ground level.
2. Refer to Figures 10A and 10B for details that define the width, depth, and length of each type of subsurface system.

3. The storage volume listed excludes the volume of storage that is exfiltrated.

Refer to *Appendix B* for hydrologic and hydraulic calculations which document and support the sizing of controls for the East and West Pilot Areas.

It is important to note that although pervious pavement is proposed in roadway shoulder areas only (i.e. those areas subjected to low traffic volume or light vehicle loading), the subsurface infiltration systems will extend further into the roadways (below-grade) in order to accommodate the volume of runoff discharged to the roadways by contributing subwatershed areas.

7.2 Planimetric concept drawings

Refer to *Figures 10A and 10B* for drawings that depict the layout, dimensions, cross-section details, and components of each green infrastructure stormwater management practice proposed in the East and West Pilot Areas. In general, bioretention bump-outs are proposed on each side of the roadway intersection with strips of porous pavement lining the roadway shoulder areas in between bump-outs. The width of the porous pavement shoulder areas was defined based on the assumptions that:

- Minimum travel widths of 20 feet are necessary to safely accommodate two-way traffic and emergency vehicle access on Amherst Avenue, Capitol Place, and Wheat Street in the East Pilot Area and Holly Street and Maple Street in the West Pilot Area; and
- Minimum travel widths of 24 feet are necessary to safely accommodate two-way traffic and emergency vehicle access on Blossom Street and Chatham Avenue in the East Pilot Area and Duncan Street, Wilmot Avenue, and Woodrow Street in the West Pilot Area.

7.2.1 Budgetary Costs for East and West Pilot Areas

A budgetary-scale opinion of cost was generated using Fuss & O'Neill's standard opinion of cost template tailored to this project. The term "budgetary" implies that some design information is available; however it is still early in the design process. A budgetary opinion of cost has an expected range of accuracy within +30% or -15%.

A 20% contingency has been allotted within the budgetary opinions of cost for each pilot area to account for such items excluded from the estimates including, but not limited to, erosion and sedimentation controls, utility protection and/or relocation (though the infrastructure improvements have been designed to avoid this potential), maintenance and protection of traffic, trench protection, and engineering/permitting fees.

Although green infrastructure controls have been sized according to the runoff generated by their corresponding subwatersheds, costs have been calculated on a street by street basis per pilot area. This method was selected to provide the City of Columbia with the option of implementing suggested controls incrementally, on a street-by-street basis as budget allows.

The following summarizes a list of items considered in preparing the budgetary opinions of cost for each pilot area:

- Full depth bituminous sawcut
- Pavement excavation and removal
- Curb removal and disposal
- Earth excavation
- Fine grading, compacting and finishing
- Rainstore system (including stone, system and other misc.)
- Cultec 100HD chambers
- Geotextile filter fabric
- Crushed stone encasement
- New pervious pavement
- New asphalt pavement binder course
- New asphalt surface course
- Pavement removal by cold planing
- Crushed stone choker course and base
- New concrete curb
- Imported soil mixture
- Seeding and topsoil

Unit prices for items listed in the budgetary opinions of cost were attained from a combination of RSMeans 2008 and some published DOT average unit prices. Unit prices were reduced by approximately 10% due to the geographic location of the project in Columbia, South Carolina. However, specialized items such as the subsurface infiltration chambers and modular storage systems were priced per recommendations provided by manufacturers of Cultec 100HD and the Rainstore[3] system respectively.

7.2.1.1 East Pilot Area

The East Pilot Area consists of five streets. A summary of the costs generated by implementing green infrastructure stormwater management controls in the East Pilot Area is provided in the following table:

Table 7
Opinion of Cost for Green Infrastructure Controls by Street in the East Pilot Area

Street	Subtotal	Contingency (20%)	Total Cost	Upper Cost Range Limit (+30%)	Lower Cost Range Limit (-15%)
Amherst Avenue	$237,000	$47,000	$284,000	$369,000	$241,000
Wheat Street	$391,000	$78,000	$469,000	$609,000	$399,000
Capitol Place	$44,000	$9,000	$53,000	$69,000	$45,000

Street	Subtotal	Contingency (20%)	Total Cost	Upper Cost Range Limit (+30%)	Lower Cost Range Limit (-15%)
Blossom Street	$70,000	$14,000	$84,000	$109,000	$71,000
Chatham Avenue	$76,000	$15,000	$91,000	$118,000	$77,000
East Pilot Area Total	$818,000	$163,000	$981,000	$1,275,000	$833,000

Engineering is not included in the opinion of cost for the East Pilot Area (Table 7, above). If a 15% engineering cost is added, the total project cost increases to $1,129,000 (range of $960,650 to $1,467,000). The costs without engineering are presented in the table above in order to directly compare with the costs presented in the May 2011 report which did not include engineering.

The opinions of cost listed in the table above, include stormwater management controls proposed on both sides of Amherst Avenue and Wheat Street and on one-side of Blossom Street, Capitol Place, and Chatham Avenue. Because the subsurface infiltration systems will extend further into the roadways (below-grade) on Amherst Avenue and Wheat Steet than the porous pavement (which is limited to shoulder areas), a significant amount of roadway patching would be visible following construction. Consequently, the cost of cold planing and resurfacing of Amherst Avenue and Wheat has been included in the total cost for green infrastructure implementation on these streets. Capitol Place, Blossom Street, and Chatham Avenue, however, only have subsurface stormwater management systems proposed on one side of the street. Due to the limited disturbance of the roadway surface at these locations, the cost of cold planing and resurfacing of these streets has not been included in the above opinion of cost.

Appendix C contains the complete budgetary opinion of cost which includes an itemized cost breakdown. The additional cost that would be anticipated if Capitol, Blossom and Chatham were to be cold-planed and resurfaced within the limits of the East Pilot Area is also included in *Appendix C.*

7.2.1.2 West Pilot Area

The West Pilot Area consists of five streets. A summary of the costs generated by implementing green infrastructure stormwater management controls in the West Pilot Area is provided in the following table:

Table 8
Opinion of Cost for Green Infrastructure Controls by Street in the West Pilot Area

Street	Subtotal	Contingency (20%)	Total Cost	Upper Cost Range Limit (+30%)	Lower Cost Range Limit (-15%)
Maple Street	$230,000	$46,000	$276,000	$359,000	$235,000
Duncan Street	$452,000	$90,000	$542,000	$705,000	$461,000

Street	Subtotal	Contingency (20%)	Total Cost	Upper Cost Range Limit (+30%)	Lower Cost Range Limit (-15%)
Woodrow Street	$44,000	$9,000	$53,000	$69,000	$45,000
Holly Street	$39,000	$8,000	$47,000	$61,000	$40,000
Wilmot Avenue	$227,000	$45,000	$272,000	$354,000	$231,000
West Pilot Area Total	$992,000	$198,000	$1,190,000	$1,547,000	$1,011,000

Engineering is not included in the opinion of cost for the West Pilot Area (Table 8, above). If a 15% engineering cost is added, the total project cost increases to $1,369,000 (range of $1,164,000 to $1,780,000). The costs without engineering are presented in the table above in order to directly compare with the costs presented in the May 2011 report which did not include engineering.

The opinions of cost (on a street by street basis) listed in the table above, include stormwater management controls proposed on both sides of Maple Street and on one-side of Duncan Street, Holly Street, Wilmot Avenue, and Woodrow Street. Because the subsurface infiltration systems will extend further into the roadway (below-grade) on Maple Steet than the porous pavement (which is limited to shoulder areas), a significant amount of roadway patchwork would be visible following construction. Consequently, the cost of cold planing and resurfacing of Maple Street has been included in the total cost for green infrastructure implementation on these streets. Duncan Street, Holly Street, Wilmot Avenue, and Woodrow Street, however, only have subsurface stormwater management systems proposed on one side of the street. Due to the limited disturbance of the roadway surface at these locations, the cost of cold planing and resurfacing of these streets has not been included in the above opinion of cost.

Appendix C contains the complete budgetary opinion of cost which includes an itemized cost breakdown. The additional cost that would be anticipated if Duncan Street, Holly Street, Wilmot Avenue, and Woodrow Street were to be cold-planed and resurfaced within the limits of the West Pilot Area is also included in *Appendix C*.

7.2.2 Benefits and Limitations

Porous asphalt can be used in place of traditional stormwater management measures given the proper conditions. The primary advantages to installing porous asphalt (in lieu of conventional asphalt) is that it allows storm water to percolate through the pavement and into the ground, thereby, reducing flow to convential stormwater management systems. This approach not only reduces stormwater runoff volumes, but also minimizes the pollutants introduced into the conventional stormwater management system. In the case of this project, porous pavement used in conjunction with stone trenches, subsurface infiltration chambers, and subsurface modular storage units will reduce the rate and volume of flow discharged to the Shandon-Rosewood drainage system:

- In the East Pilot Area: by approximately 154,000 cubic feet, respectively, during the 10-year, 24-hour storm event.
- In the West Pilot Area: by approximately 162,000 cubic feet, respectively, during the 10-year, 24-hour storm event.

Potential concerns regarding porous pavement include:

- Vacuum sweeping as required to ensure that void spaces do not become clogged with vegetative litter, sand and fine sediments;
- Quality control for material production and installation are essential;
- Future repair and/or replacement must be made with porous asphalt;
- The limit of porous pavement has been restricted to roadway shoulder areas since porous asphalt should not be used in high-traffic areas or where it will be subject to heavy axle loads.
- Yard waste pickup may need to be modified to avoid potential damage to pervious pavement and bioretention from particulate leaf matter clogging pervious pavement.

7.2.3 Operation and Maintenance Requirements

The following table provides a recommended list of operation and maintenance requirements for the porous pavement and subsurface systems proposed in the East and West Pilot Areas:

Table 9
Operation and Maintenance Requirements for Proposed BMPs

Operations & Maintenance Activity	Schedule
• Keep landscaped areas up-gradient well maintained • Prevent soil from being washed onto pavement • Do not allow high axial loads onto pavement • Check for standing water on the surface of pavement after a precipitation event; if standing water remains for 30 minutes after rainfall has ended, cleaning of porous pavement is recommended	On-going
• Vaccuum sweep surface (vac-assisted dry sweeper only) at end of spring and at end of fall	As needed, up to two times a year
• Vaccuum adjacent non-porous asphalt as well • Check for damage to porous pavement and debris build-up • Inspect performance of subsurface infiltration systems via inspection ports	
• Repairs may be needed from utility work; repairs can be made using standard asphalt as long as it does not exceed 10% of surface area • Posting ofsignage is recommended indicating presence of porous pavement and displaying limitation of design load (for passenger vehicles only)	As needed
• If routine cleaning does not restore infiltration rates, then reconstruction of part or all of the roadway's porous asphalt may be required	Once every 20 years

Operations & Maintenance Activity	Schedule
• Sub-surface layers may need cleaning and replacing	

It is anticipated that proper maintenance of the porous pavement will reduce the maintenance need for stone trench, infiltration chamber, or modular systems below the porous pavement and its choker course. However, inspection ports will be installed at select locations to inspect the operation of the chamber and modular storage systems. The following tables provide an estimate of the annual maintenance costs that are anticipated for the pervious pavement and subsurface infiltration systems on a street by street basis in the East and West Pilot Areas. It is recommended that vacuum sweeping be conducted using a regenerative air sweeper.

Table 10
Opinion of Cost for O&M (by Street) in the East Pilot Area

Street	Porous Pavement Area (Acres)	O&M Cost Per Acre/Year[1] ($)	Approximate Annual Cost/Street (Rounded to Nearest $100)
Amherst Avenue	0.15	$3,000	$500
Wheat Street	0.25	$3,000	$800
Capitol Place	0.08	$3,000	$300
Blossom Street	0.13	$3,000	$400
Chatham Avenue	0.09	$3,000	$300
East Pilot Area Annual Total	0.70		$2,300

Notes:
1. Cost assumes that the pavement will be swept two times per year and inspected two times per year over the life of the system.

Table 11
Opinion of Cost for O&M (by Street) in the West Pilot Area

Street	Porous Pavement Area (Acres)	O&M Cost Per Acre/Year[1] ($)	Approximate Annual Cost/ Street (Rounded to Nearest $100)
Maple Street	0.10	$3,000	$200
Duncan Street	0.22	$3,000	$700
Woodrow Street	0.06	$3,000	$200

Holly Street	0.05	$3,000	$200
Wilmot Avenue	0.18	$3,000	$500
West Pilot Area Annual Total	0.61		$1,800

Notes:
1. Cost assumes that the pavement will be swept two times per year and inspected two times per year over the life of the system.

7.2.4 Additional Alternative for Flood Management Using Green Infrastructure

During our hydrologic and hydraulic analysis of the West Pilot Area, two topographical depressions were observed within the utility right-of-way that bisects the pilot area with an approximate width of 15 feet. The right-of-way runs parallel to Wilmot Avenue and Duncan Street. Based on our review of two-foot Citywide contouring and field observations made on December 15, 2010, it appears that a significant amount of runoff generated by the West Pilot Area drains overland to these topographical depressions. Since these depressions currently provide only limited storage, the majority of runoff discharging to these depressions is allowed to overtop these areas and discharge to the Maple Street drainage system and ultimately to the the Maple- Duncan Street Intersection. As an alternative, more substantial bioretention basins can be installed within the utility right-of-way.

Designing green infrastructure improvements (i.e., bioretention basins) within the utility right-of-way located in the West Pilot Area was not completed. However, a separate Hydraflow Hydrographs report was generated to simulate the inclusion of the proposed bioretention basins and is located in *Appendix D*. The bioretention basins proposed were modeled having a depth of approximately 1.5 feet, a bottom width of six feet, and three (horizontal) to one (vertical) side slopes. These bioretention basins were designed to span the entire width of the right-of-way and have a total approximate length of 920 feet. Based upon preliminary results, the depths of modular storage systems on Duncan Street could be reduced by at least three feet and still maintain their ability to manage a 10-year, 24-hour storm if these bioretention basins were constructed in the utility right-of-way. This reduction in modular storage could reduce the total construction cost of the green infrastructure improvements in the West Pilot Area by approximately $290,000.

7.3 Perspective Drawings

Perspective drawings/renderings have been provided as *Figures 27-29,* both below at the end of the report, which depict the pre- and post-installation of green infrastructure improvements for Amherst Avenue, the Holly and Duncan Street intersection, and Chatham Street at the surface and subsurface levels.

Figure 27— Amherst Avenue Green Infrastructure Improvement Rendering

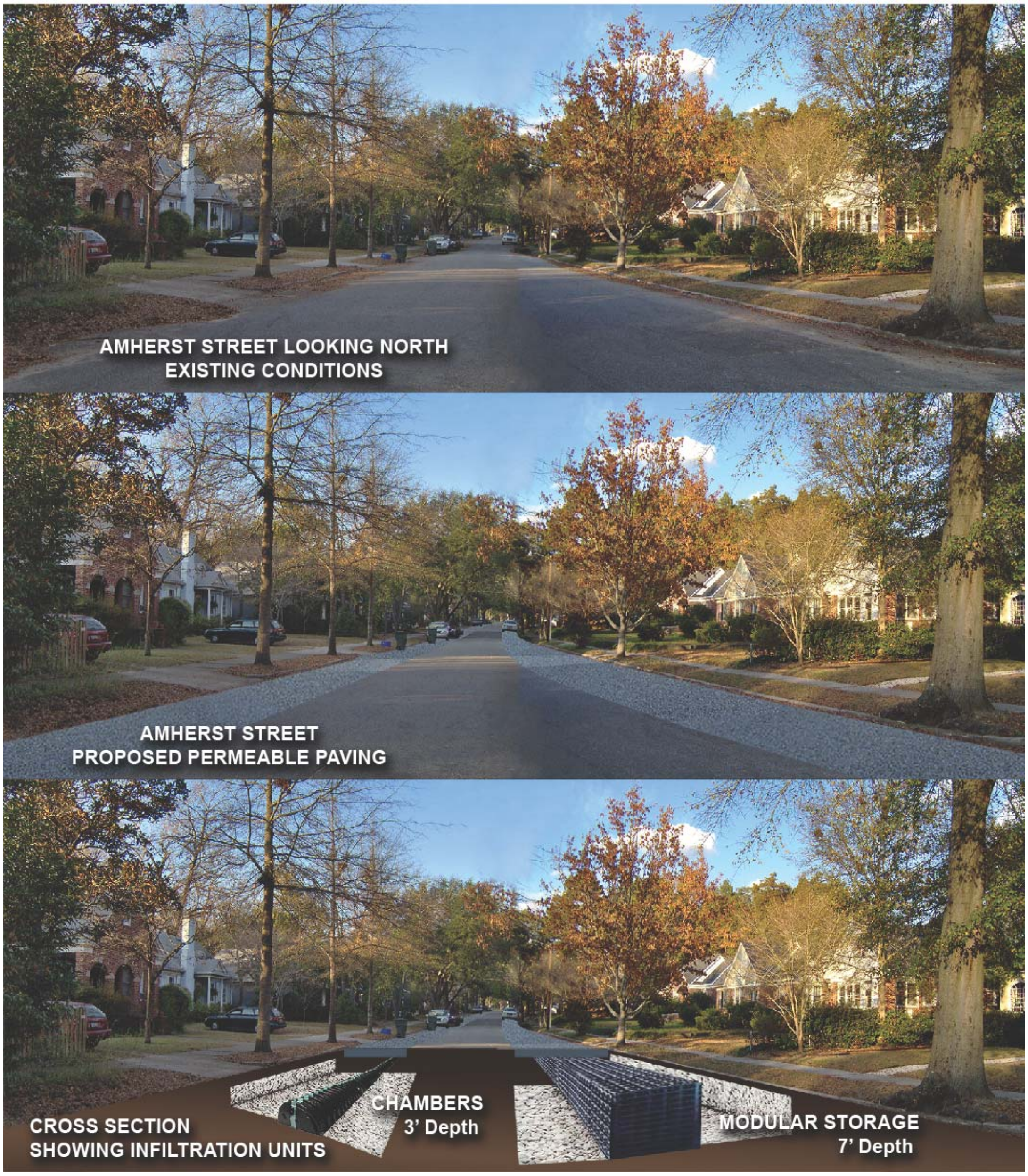


Figure 28— Duncan & Holly Street Intersection Green Infrastructure Improvement Rendering

Figure 29— chatham & Wheats Streets Intersection Existing Conditions

Additionally, recommended planting lists for shrubs, perennials, and grasses within the proposed bioretention basins have been provided within *Figures 30-31* which have been provided both below and at the end of this report.

Figure 30— Illustration of Recommended Plantings for Biroretention Basins

Figure 31— Lists of Recommended Plantings for Biroretention Basins

SHRUBS – for private gardens behind walks

Callicarpa americana	Beautyberry	6'	striking purple berries on new growth, yellow fall color
Hibiscus moscheutos	Rose Mallow	4'	shrubby with huge white to pink flowers, can grow near water
Ilex vomitoria nana	Dwarf Yaupon	5'	evergreen, long lasting translucent scarlet berries, many cultivars
Itea virginica	Sweet spire	4'	fragrant white tassel flowers, deep red or purple fall foliage
Rhus aromatica	Fragrant Sumac	3'	'gro-low' variety is good groundcover, orange to red fall color
Sabal minor	Dwarf Palmetto	5'	native palm that slowly spreads, black berries, drought tolerant

PERENNIALS & GRASSES – low plants within ROW

Aster novae angliae	New England Aster	dwarf varieties, deep violet flowers in fall, drought tolerant
Chasmanthum latifolium	River Oats	tolerates dry shade, dangling oats ornamental, copper in fall
Dennstaedtia punctilob	Hayscented Fern	spreads rapidly, fragrant foliage, light green turning yellow in fall
Eupatorium coelestinum	Blue Mist Flower	ageratum like blue flowers, spreads quickly, tolerates many soils
Heuchera americana	Coralbells	semi-evergreen groundcover with wine color in winter, airy flowers
Hemerocallis var.	Daylily	showy summer flowers, shade and soil tolerance
Liatris spicata	Gayfeather	purple flower spikes, tolerates heavier soils
Schizachyrium scoparium	Little Bluestem	drought tolerant, turn reddish gold in fall, good color all winter
Tradescantia virginiana	Spiderwort	long blooming with many colors, evergreen grass-like foliage

8 Watershedwide Benefits

8.1 Modeling Approach

XP-SWMM models were developed in the May 2011 study for the East Branch and West Branch subwatersheds to assess the benefit that conventional drainage retrofits would have on flooding. As part of Fuss & O'Neill's drainage pilot study, the XP-SWMM models were converted to EPA SWMM version 5.0.022. The EPA SWMM model is widely-accepted in the public and private sectors, the software is non-proprietary, and the code is open-source, ensuring that the results of the hydrologic and hyraulic model can be transferred easily, modified, or re-run if needed. EPA SWMM also allows LID controls to be directly modeled if desired.

The converted models were run with a 10-year, 24-hour design storm, consistent with the May 2011 report. The XP-SWMM models of the East Branch and West Branch existing conditions models in the May 2011 report were converted to EPA SWMM 5.0.022 using available converter tools (Dickinson, 2007) and manual revision of the input files. Although XP-SWMM is based on the EPA SWMM model, certain slight differences in methodology exist between the two models. The differences between the models are as follows:

- The infiltration method used in XP-SWMM is the SCS method (TR-55 Method), which is not available in EPA SWMM. The Curve Number Method is used in EPA SWMM, using the curve numbers from the XP-SWMM model.
- The routing method was changed from the Diffusive Wave Method in XP-SWMM to the Dynamic Wave Routing Method in EPA SWMM.

* The junction data in XP-SWMM includes both crown elevations and ground elevations. The crown elevation is considered equal to the ground elevation in EPA SWMM.
* The variable time step convergence criteria are different between the two models. The models also use different methods for the variable time step calculation.

Other model parameters and geometry are identical between the XP-SWMM and EPA SWMM models, including, but not limited to, evaporation rates, conduit and junction connectivity and geometry, depression storage, ponding area, and calculation time steps. The Manning's coefficients and depression storage for overland flow are based on literature values from the SWMM 5.0 User's Manual, 2010. Manning's coefficients for the pipes are identical to the XP-SWMM model.

It should be noted that the May 2011 XP-SWMM model used a subcatchment width of one foot for all subcatchments; the width is used in defining the length of flow to the subcatchment outlet. This is much less than the typical width of the subcatchments in the study area. Therefore, the characteristic subcatchment width was considered a calibration parameter, as recommended by the SWMM 5.0 User's Manual, 2010. In addition, subcatchment slopes entered appear to have been mistakenly entered in percent rather than unitless terms, which makes the slopes 100 times greater than they actually are. The slopes were corrected in the EPA SWMM model.

Existing conditions for both the East Branch and West Branch subwatersheds were first modeled to provide water elevation profiles and are included below in *Figures 32* and *35*, respectively. These existing condition profiles were used to confirm that the existing modeled conditions were consistent with the anecdotal observations of flooding at the problem intersection areas. We are not aware of any quantitative data of flows or depth of flooding from this watershed that can be used for model calibration.

8.2 Reduction in Flooding

Fuss & O'Neill's green infrastructure controls were modeled for the East and West Pilot Areas in the EPA SWMM model. Green infrastructure controls that were developed for these two pilot areas have been sized to manage all of the runoff generated within the pilot areas for a 10-year, 24-hour storm event. This alternative was modeled by subtracting the stormwater flow from specific subcatchments originally delineated in the May 2011 study from the subwatersheds which coincide with the pilot area boundaries, totaling 12.5 acres across 6 subcatchments in the East Branch subwatershed and 12.8 acres across 4 subcatchments in the West Branch subwatershed. Existing water elevation profiles and those generated by the removal of the East and West Pilot Areas in their entirety during a 10-year frequency storm are shown in *Figures 32, 33, 35,* and *36* below.

Modeling demonstartes that removal of the pilot areas alone will not be adequate to solve flooding problems at the intersections of concern. However, implementation of green infrastructure in other portions of the watershed would solve these flooding problems. The additional areas that need to be managed in each subwatershed is described in the following paragraphs:

East Branch Subwatershed

- 37.5 acres of the East Branch Subwatershed must be managed to eliminate flooding at all three problem intersections in the East Branch Subwatershed for the 10-year frequency storm. This is approximately 3.0 times the area of the East Pilot Area.

West Branch Subwatershed

- 35.3 acres of the subwatershed must be managed to eliminate the flooding at the two problem intersections in the West Branch Subwatershed. This is approximately 2.7 times the area of the West Pilot Area.

Table 12 provides the water surface elevations at interesections with known flooding problems for the existing conditions and the proposed alternatives. The "Proposed Conditions with Additional Controls" alternative includes green infrastructure controls in additional subwatershed areas to solve the flooding problems at all of the intersections with known flooding issues. This is also shown in the water surface profiles in *Figures 34 and 37*.

Table 12
Summary of Water Surface Elevations at Intersections with Flooding Problems

	Ground Surface Elevation (ft)	Existing Conditions Water Surface Elevation (ft)	Proposed Conditions with Only Pilot Area Water Surface Elevation (ft)	Proposed Conditions with Additional Controls Water Surface Elevation (ft)
East Watershed				
Intersection of Amherst Avenue & Wheat Street	268.24	269.17	268.24	268.24
At Monroe Street near Ravenel Street	248.90	249.83	249.59	248.90
At Hayward Street near Ravenel Street	245.34	245.61	245.48	245.35
West Watershed				
Intersection of Wilmot Avenue & Shandon Street	278.72	278.75	278.73	278.72
Intersection of Maple Street & Monroe Street	266.93	269.67	268.75	266.36

Figure 32—East Branch Subwatershed Existing Conditions (10-year storm)

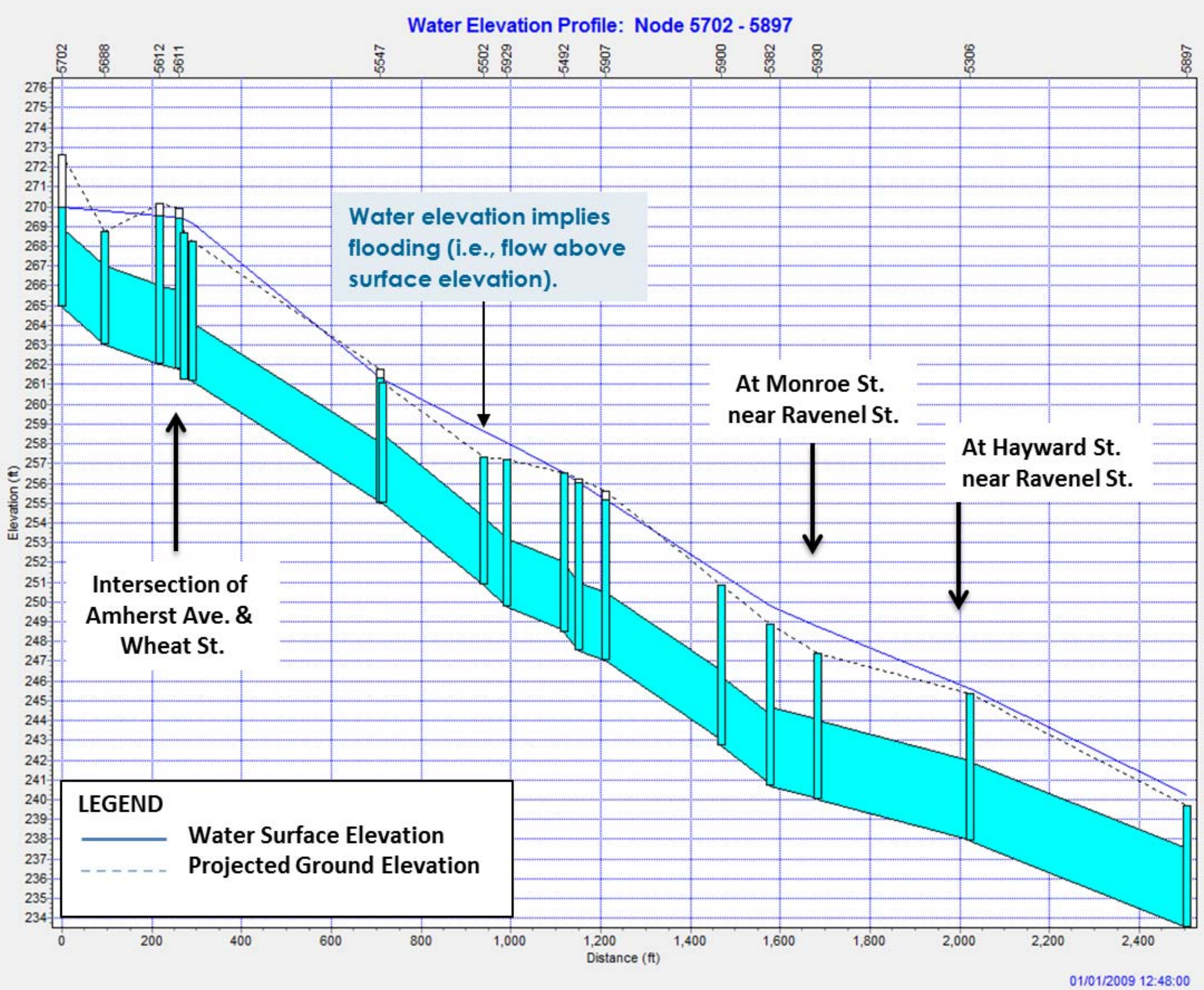


Figure 33—East Branch Subwatershed Green Infrastructure Alternative installed in East Pilot Area (10-year storm)

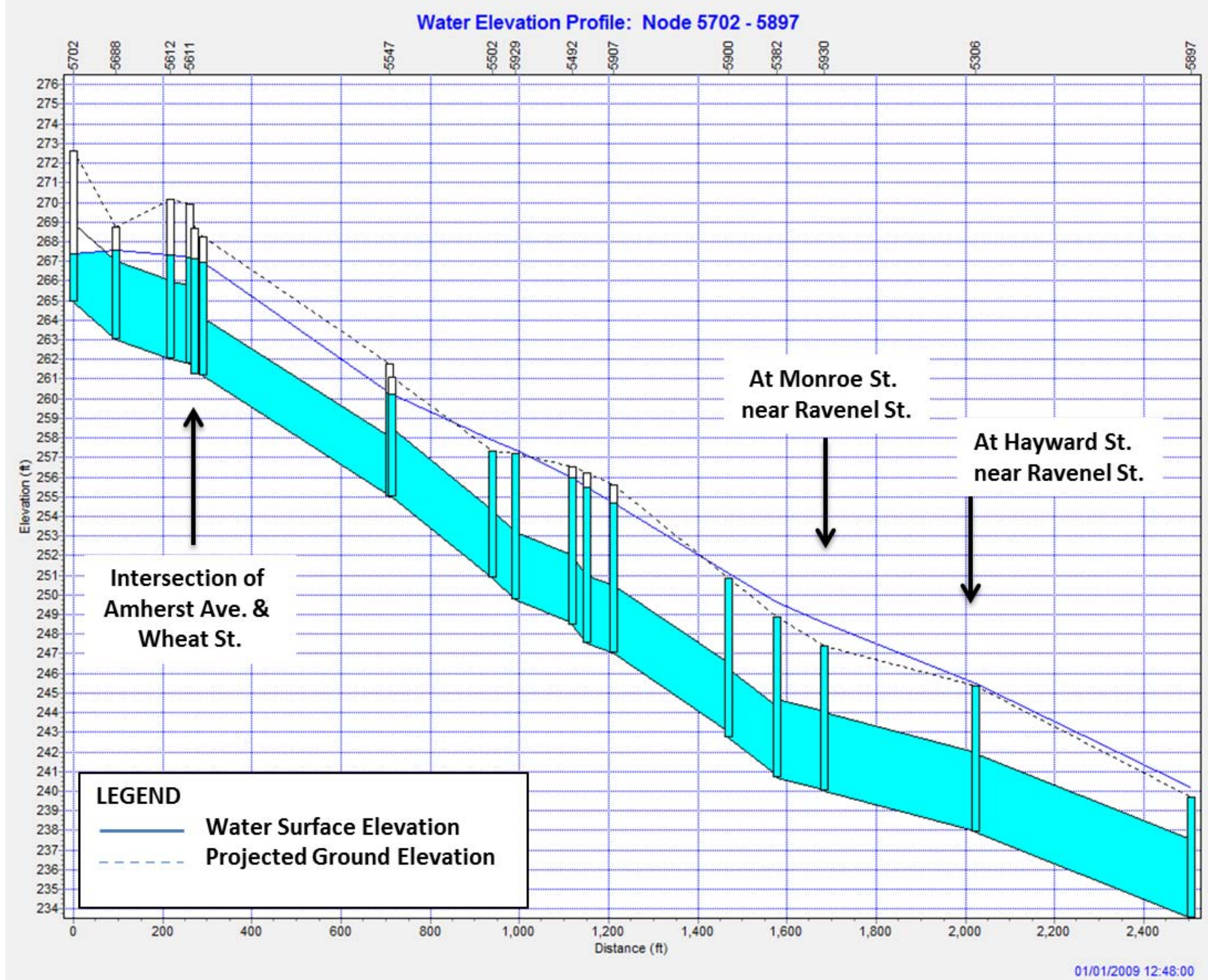


Figure 34—East Branch Subwatershed Green Infrastructure Alternative installed throughout Shandon-Rosewood Watershed

(10-year storm, discount East Pilot Area and subwatersheds 5382, 5342, & 5306)

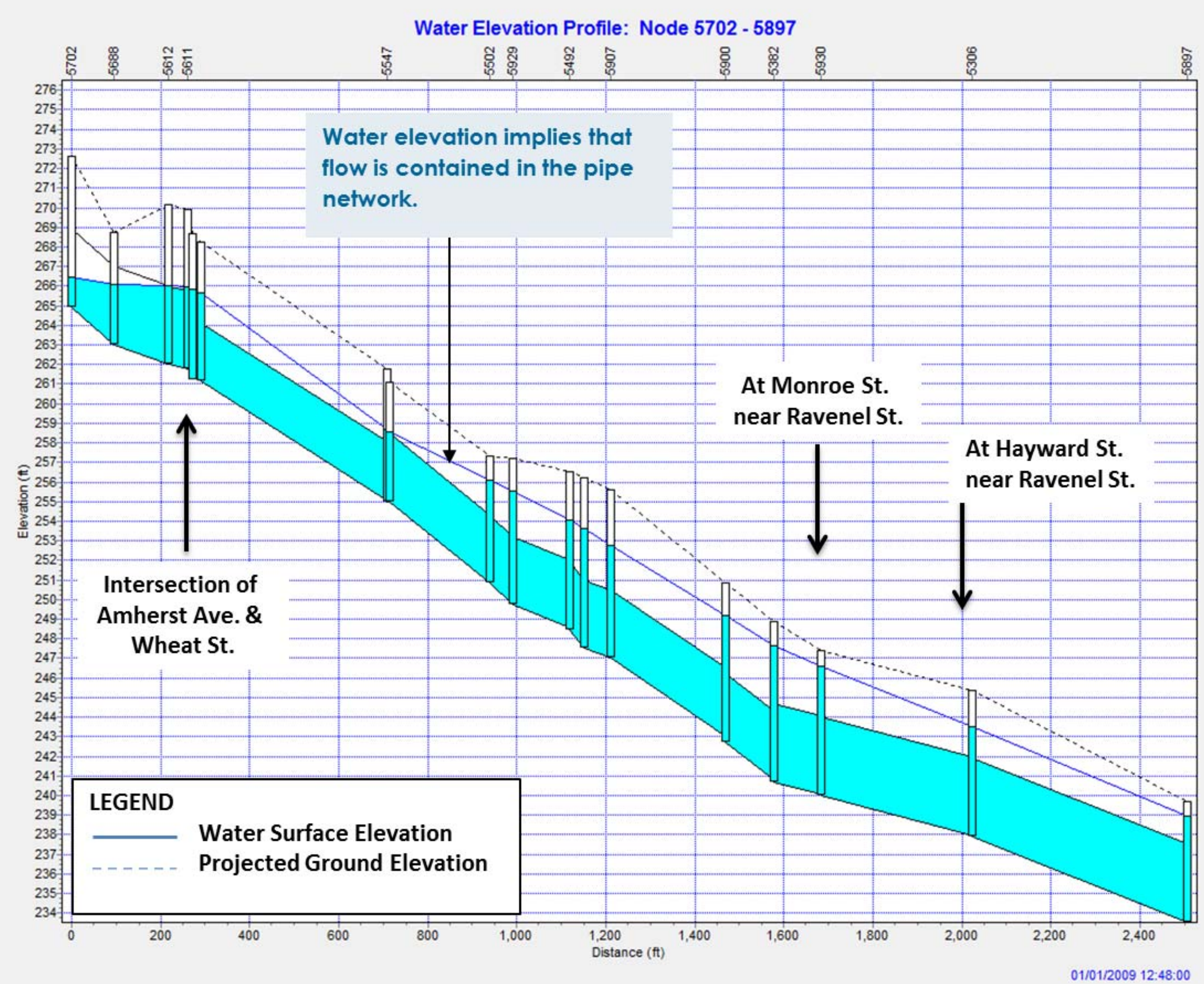


Figure 35—West Branch Subwatershed Existing Conditions (10-year storm)

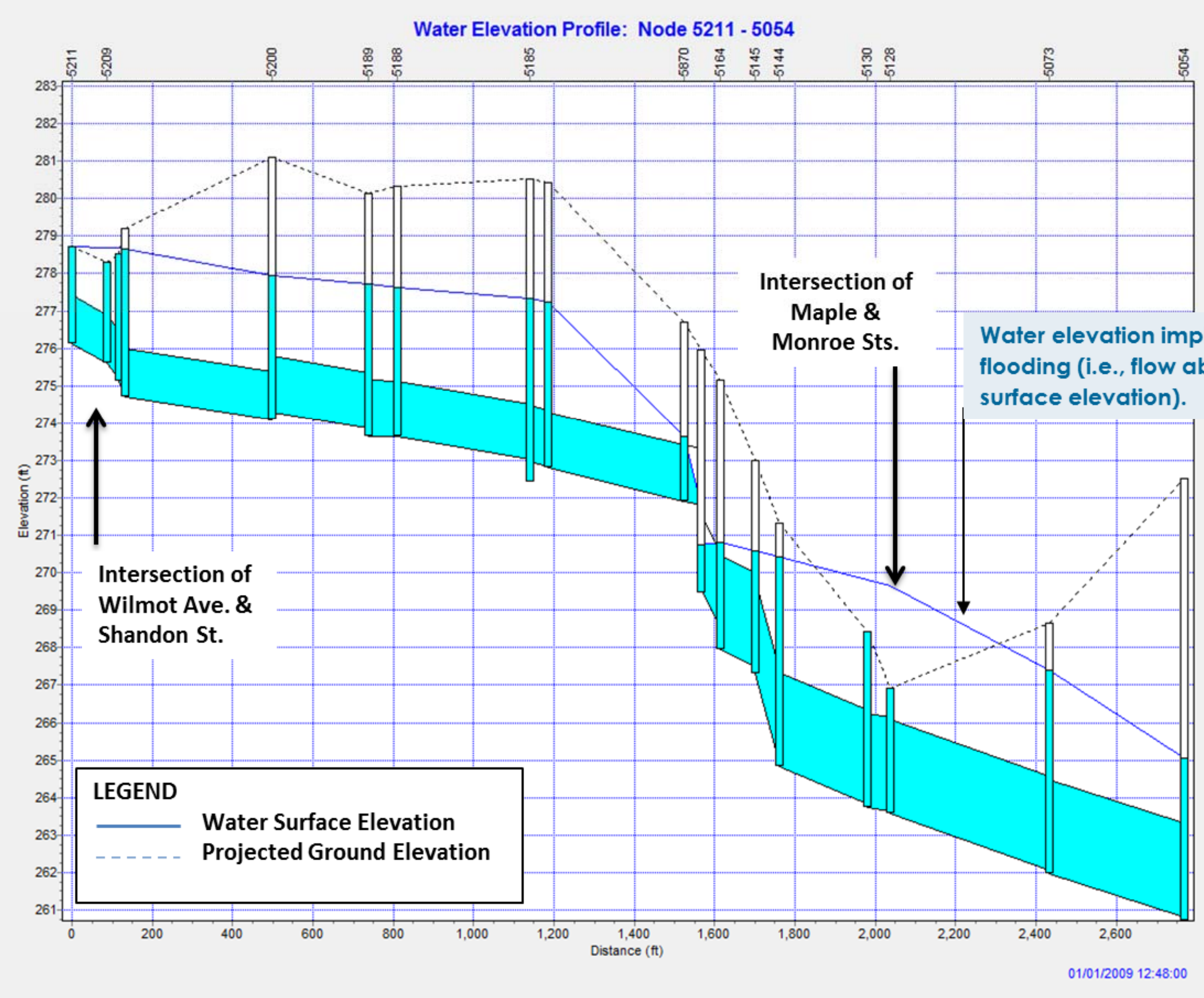


Figure 36—West Branch Subwatershed Green Infrastructure Alternative installed in West Pilot Area (10-year storm)

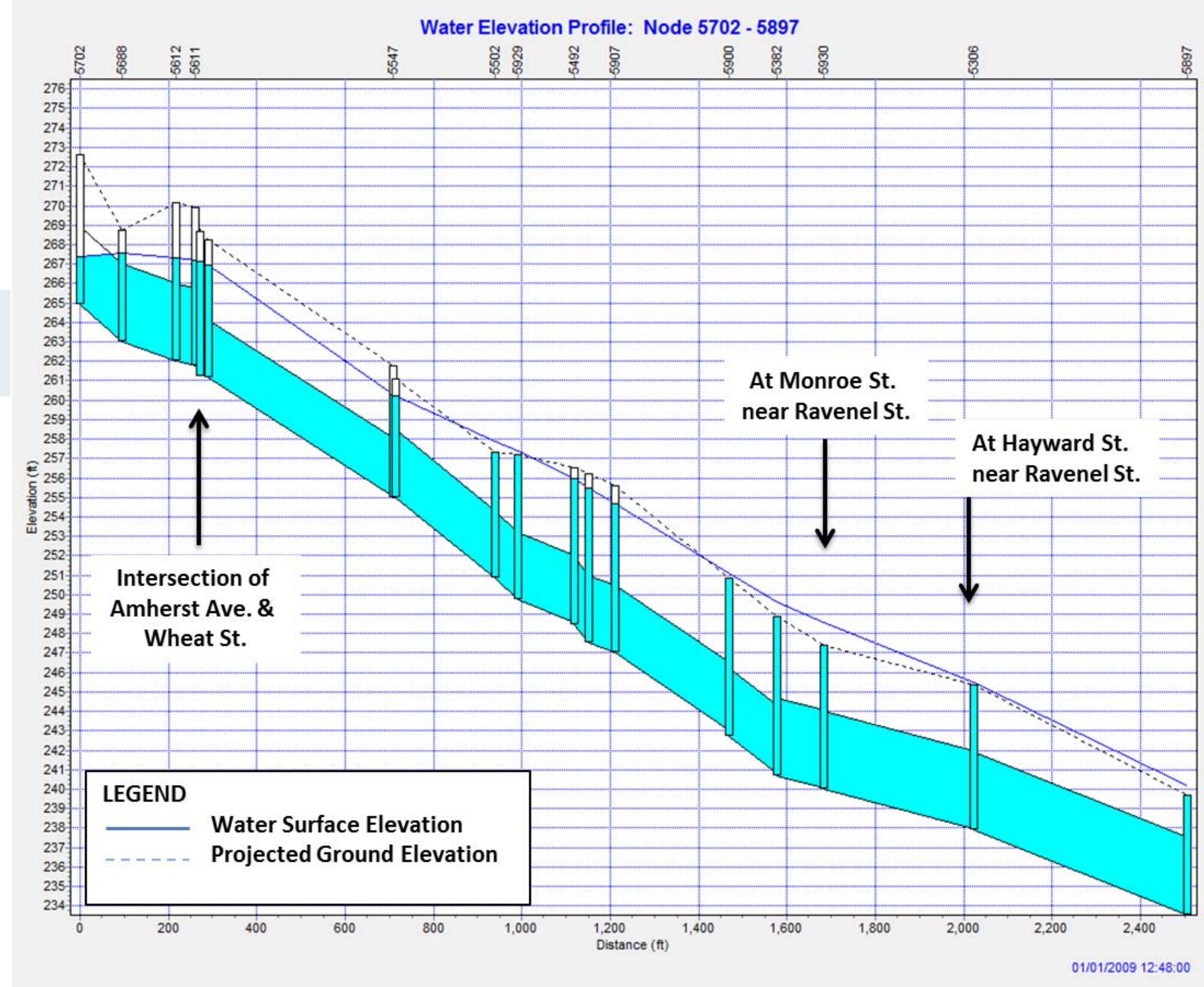
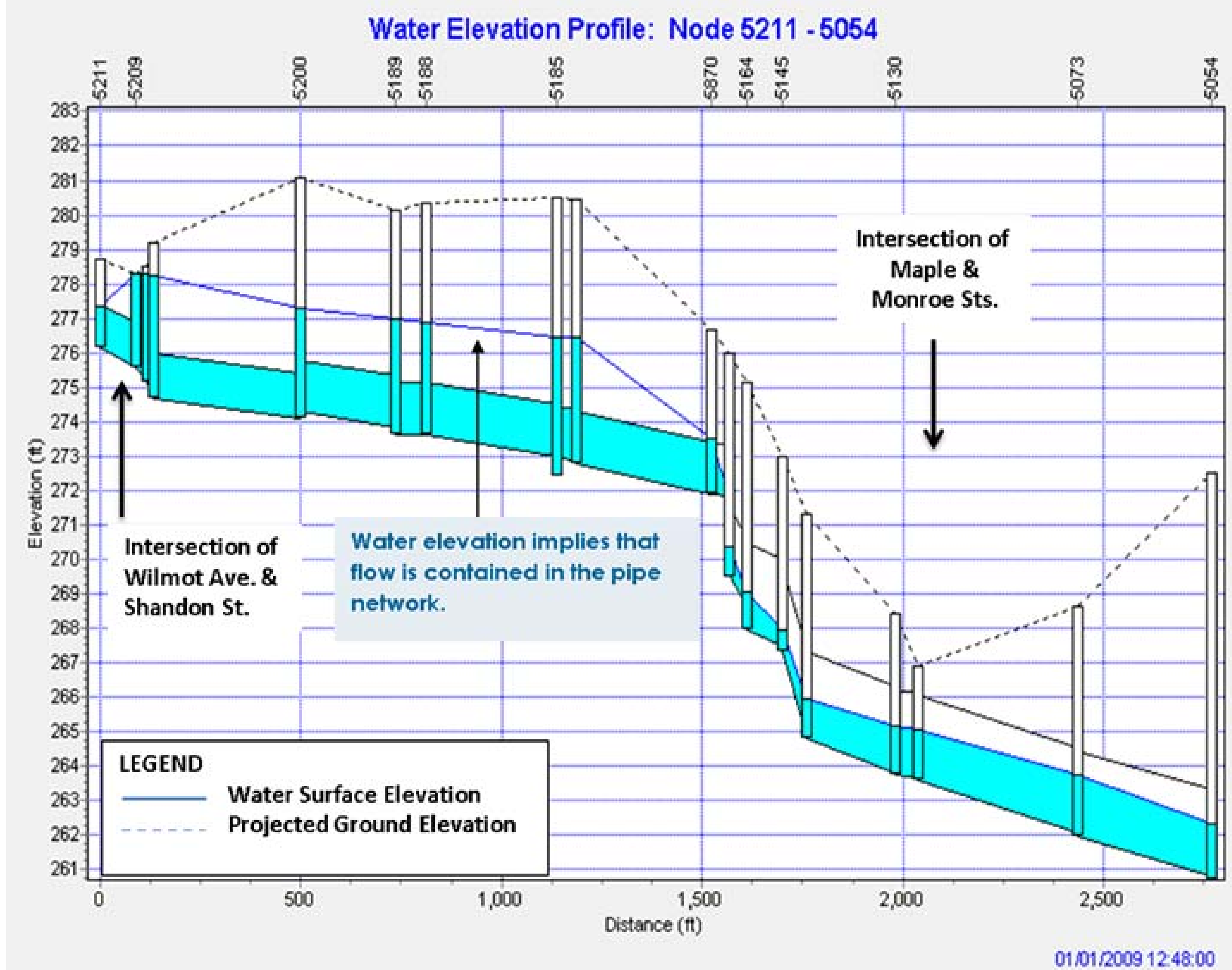


Figure 37—West Branch Subwatershed Green Infrastructure Alternative installed throughout Shandon-Rosewood Watershed

(10-year storm, discount West Pilot Area and subwatersheds 5219 entirely & 5209)



Note that the water levels shown on the above profiles may not appear to cotrrelate directly with *Table 12*. The reason is that *Table 12* represents highest water elevations at specic locations while the profiles represent a point in time that generally has the highest water elevations but not necessarily at all of the locations (flooding would peak at different locations at different times).

Table 13
Summary of SWMM Modeling Results

	East Branch alternative	West Branch alternative
Total modeled subwatershed size (ac)	406.8	355.8
Fuss & O'Neill Modeled Pilot Area Size (ac)	12.5	12.8
Fuss & O'Neill Modeled Pilot Area – Percent of total subwatershed	3.1%	3.6%
Total area removed to eliminate flooding at problem intersections (ac)	37.5	35.3
Number of Pilot-sized areas required to eliminate flooding at problem intersections	3.0	2.7

8.3 Order of Magnitude Costs

To develop order of magnitude costs for the East and West Branch Subwatersheds, we computed a straight-line extrapolation of cost of East and West Pilot Areas (respectively) based on ratio of the size of each pilot area to its subwatershed.

Based on Fuss & O'Neill's modeling in the East Branch Subwatershed, runoff generated by approximately 37.5 acres of this subwatershed must be managed to eliminate flooding at the three problem intersections. Since this is approximately 3.0 times the area of the East Pilot Area (which is approximately 12.5 acres), we estimate that the overall cost to eliminate flooding in the East Branch would be approximately $2,943,000 ($3,387,000 with engineering and other fees).

Based on Fuss & O'Neill's modeling in the West Branch of the Shandon-Rosewood Watershed, runoff generated by approximately 35.3 acres of this subwatershed must be managed to eliminate the flooding at the two problem intersections. Since this is approximately 2.7 times the area of the West Pilot Area (which is approximately 12.8 acres), we estimate that the overall coset to eliminate flooding in the West Branch would be approximately $3,213,000 ($3,695,000 with engineering and other fees).

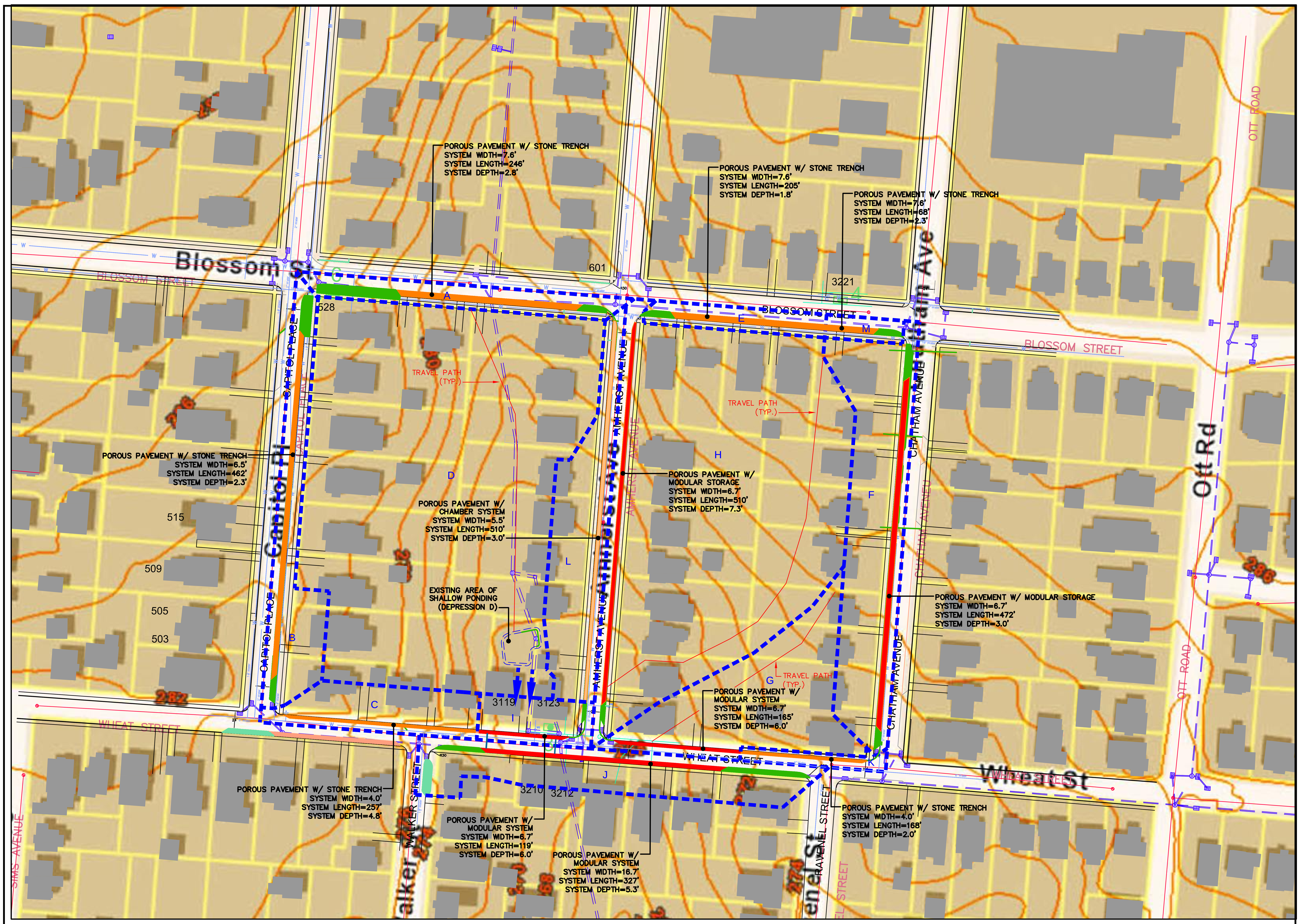
For comparison purposes, it is our opinion that it would cost the City approximately $6,156,000 in total (without engineering) to construct green infrastructure improvements to eliminate flooding at the five problem intersections in the Shandon-Rosewood Watershed during storm events up to, and including, the 10-year, 24 hour storm event. This is about 50% of the total cost approximated by the May 2011 report (approximately $11,800,000) to eliminate flooding at these intersections by conventional methods.

9 Implementation Plan

The following paragraphs summarize a recommended implmentation plan if the City decides to move forard with the improvements recommended herein to address the flooding problems in this watershed.

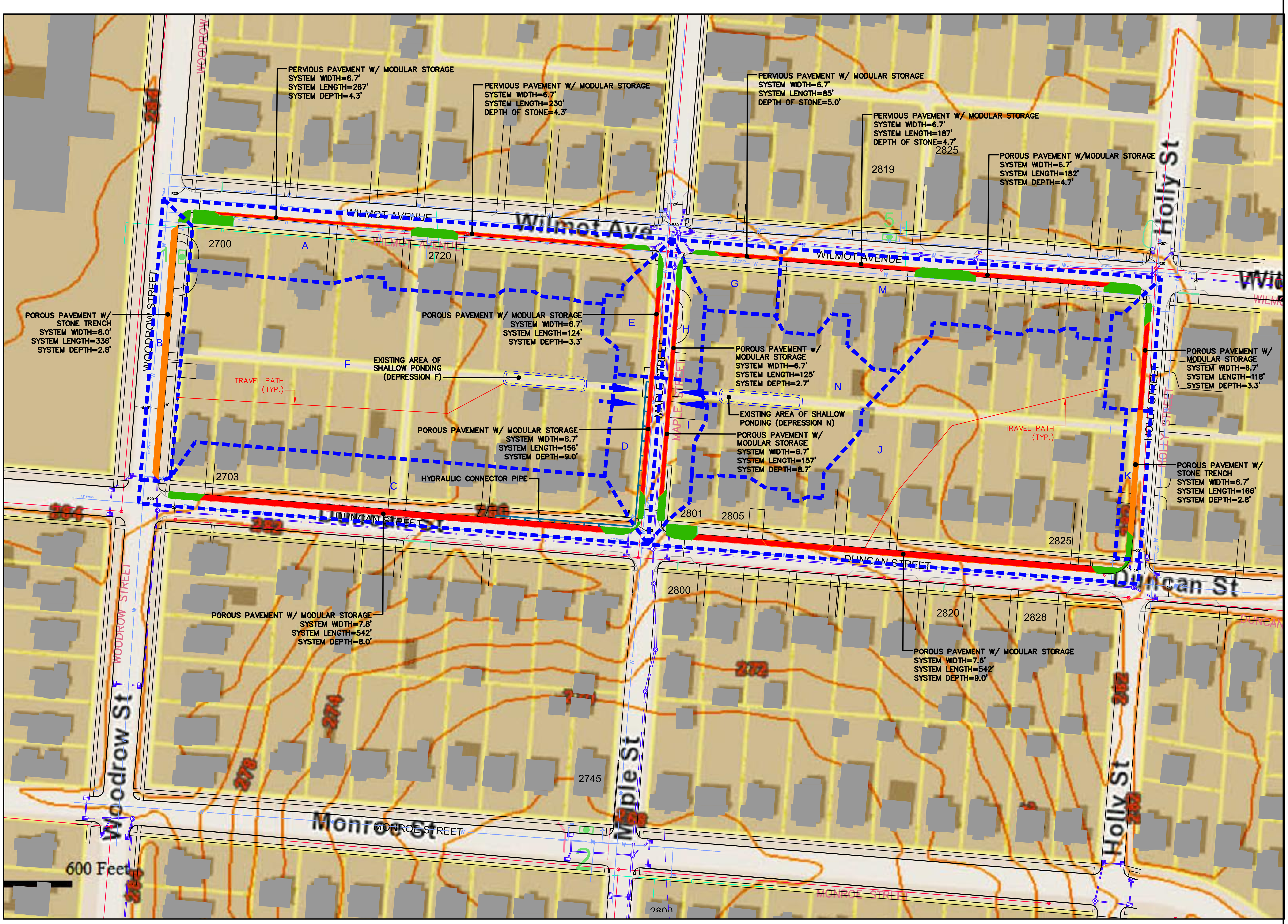
- Implement improvements one street at a time. This approach would allow the City to better gauge actual costs as well as their actual performance and maintenace needs. Lessons learned can then be applied to additional streets as those are developed.
    - In the East Subwatershed, the first street to develop would be Wheat Street which would manage most of the runoff from the East pilot area. The opinion of cost to design, permit and construct this street would be $539,000.
    - In the West Subwatershed, the first street to develop would be Duncan Street which would manage most of the runoff from the West pilot area. The opinion of cost to design, permit and construct this street would be $623,000.
- Complete design and permitting for these improvements. An Underground Injection Control permit will be required from DHEC for these improvements.
- Conduct field measurements of flooding during actual storm events in order to calibrate the SWMM model. The reliability of the existing model is not known at this time because the model has not been calibrated.
- Decide on whether bioretntion improvements should be included as part of these improvements. Bioretention improvements have been proposed as part of the controls to provide some delineation of porous pavement parking areas as well as provide some traffic calming value. However, these bioretantion improvements provide very little value for stormwater management with the exception of improving public awareness. The City will need to decide whether the investments for these bioretnetion improvements are worthwhile.
- Conduct public education which will be an important part of implementing this plan as these controls will be implemented in neighborhoods. If the City decides to move forward, we recommend neighborhood meetings so that people can better understand what is being proposed on the streets in front of their homes.
- Consider purchasing a vacuum sweeper to maintain porous pavements. This investment will be more important as more streets are converted to porous pavement. A vacuum sweeper can be an investment that is also made when the broom sweeeper service life ends.
- Review how yard waste is currently managed in the watershed. Currently yard waste is placed on the edge of pavement. From here, it can readily clog existing storm drains. It may also have the potential to clog porous pavements.

Figures



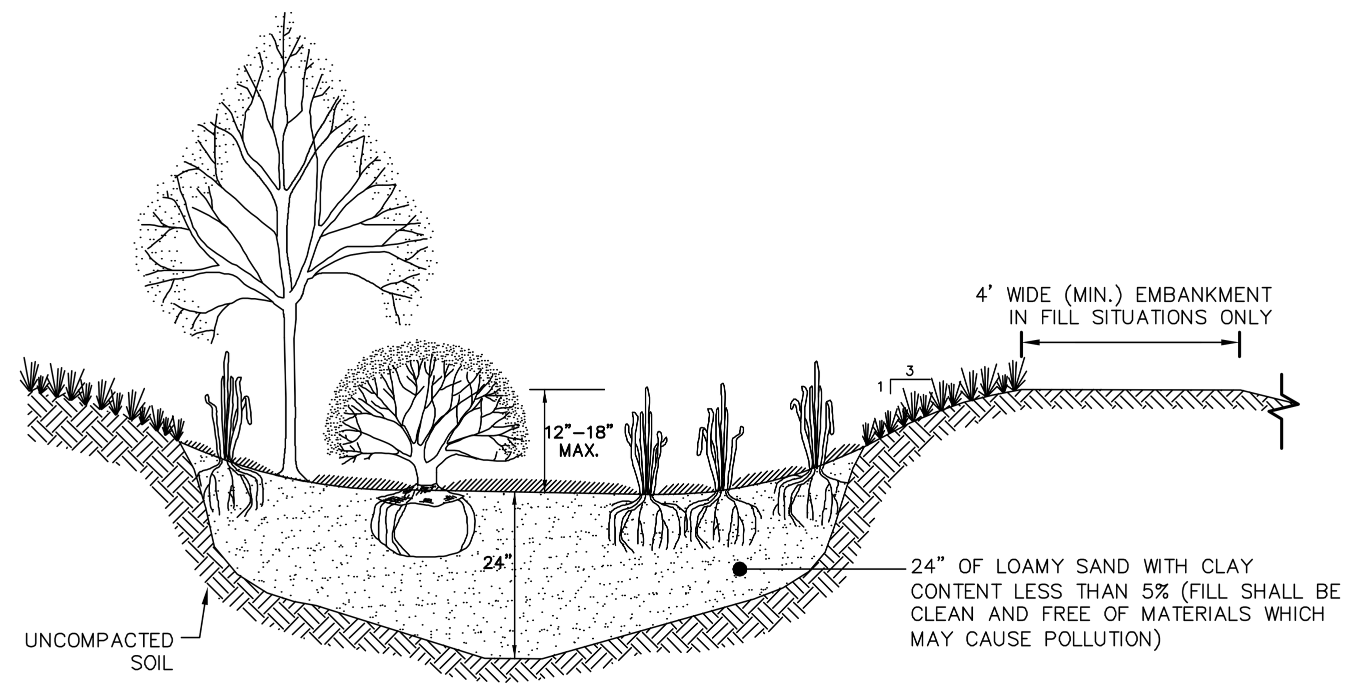
NOTES

1. WATERSHED DELINEATIONS WERE INITIALLY APPROXIMATED, BY FUSS & O'NEILL, FROM TWO-FOOT CONTOURING SHOWN ON THIS PLAN. ADJUSTMENTS TO THE DELINEATIONS WERE THEN MADE BASED UPON OBSERVATIONS RECORDED DURING A FIELD VISIT CONDUCTED BY FUSS & O'NEILL.
2. REFER TO THE DETAILS FOR VISUAL REPRESENTATIONS OF THE LOW-IMPACT DEVELOPMENT TECHNIQUES PROPOSED ON THIS PLAN.
3. BOTH STUDY AREAS ARE UNDERLAIN ENTIRELY BY TYPE B SOILS.



PROJ. No.: 20100678.A10 DATE: September 2011 Fig. 10A	CITY OF COLUMBIA SHANDON FLOOD STUDY LOW-IMPACT DEVELOPMENT STORM WATER MANAGEMENT LAYOUT PLAN COLUMBIA SOUTH CAROLINA	FUSS & O'NEILL 717 LADY ST, SUITE E COLUMBIA, SOUTH CAROLINA 29201 803.376.6034 www.fando.com	SCALE: HORZ.: 1" = 80' VERT.: DATUM: HORZ.: VERT.: 1200 600 0 1200 GRAPHIC SCALE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER
1.			SDA/AMB	DEA



NOTES:

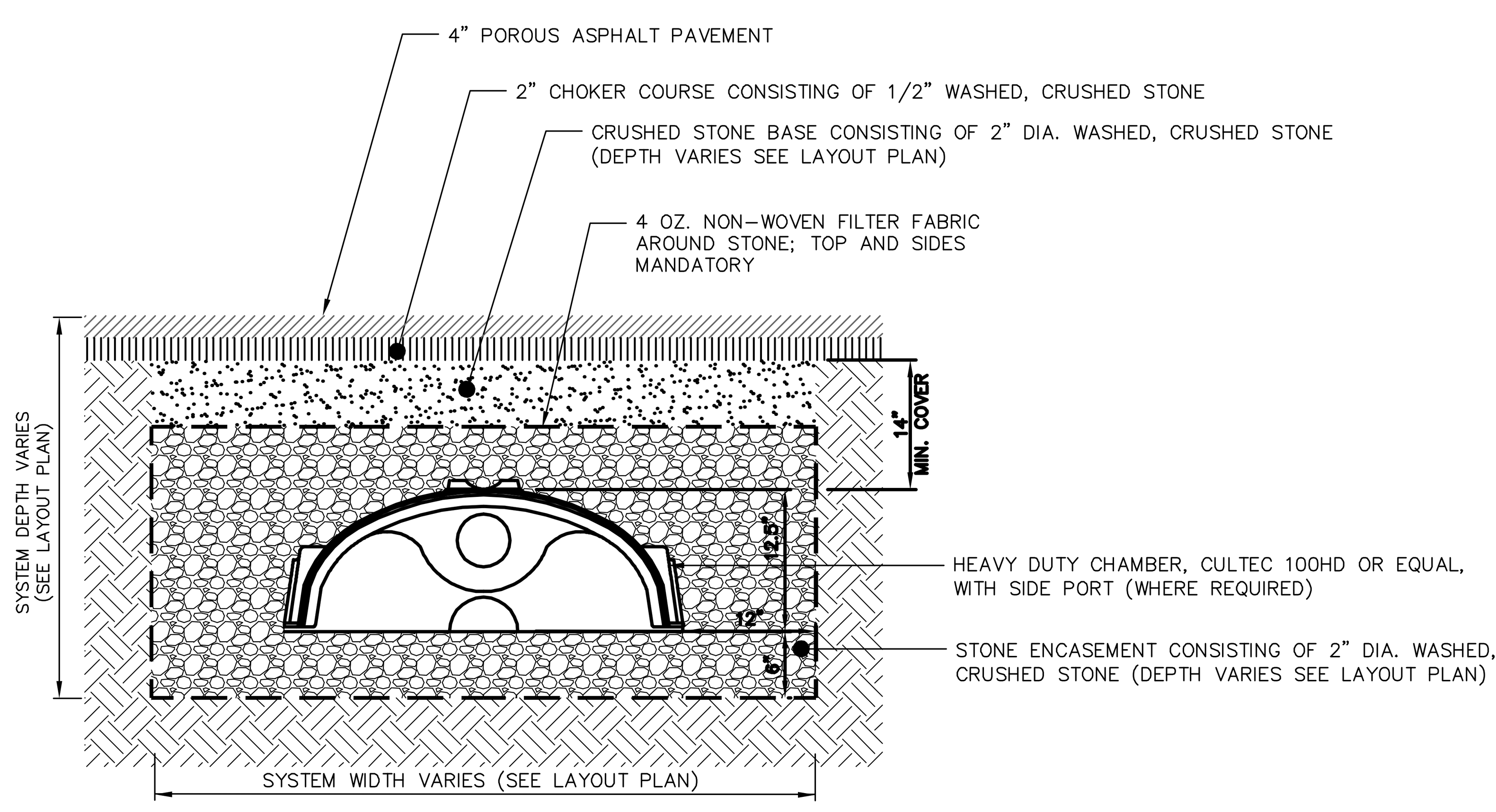
1. BIORETENTION AND RAIN GARDEN SOIL MIX SHALL HAVE A LOAMY SAND TEXTURE PER USDA TEXTURAL TRIANGLE. MAXIMUM CLAY CONTENT IS <5%; SOIL MIXTURE SHALL BE 50-60% SAND; 20-30% LEAF COMPOST*; AND 20-30% TOPSOIL. THE SOIL SHALL BE A UNIFORM MIX, FREE OF STONES, STUMPS, ROOTS, OR OTHER SIMILAR OBJECTS LARGER THAN TWO INCHES. NO OTHER MATERIALS OR SUBSTANCES SHALL BE MIXED OR DUMPED WITHIN THE BIORETENTION THAT MAY BE HARMFUL TO PLANT GROWTH, OR PROVE A HINDRANCE TO THE PLANTING OR MAINTENANCE OPERATIONS. THE PLANTING SOIL SHALL BE FREE OF BERMUDA GRASS, QUACKGRASS, JOHNSON GRASS, MUGWORT, NUTSEDGE, POISON IVY, CANADIAN THISTLE, TEARTHUB, OR OTHER NOXIOUS WEEDS.

* LEAF COMPOST IS ESSENTIALLY COMPOSED OF AGED LEAF MULCH AND PROVIDES ADDED ORGANIC MATTER TO IMPROVE THE HEALTH OF THE SOIL AND ENSURE ADEQUATE SOIL STRUCTURE.

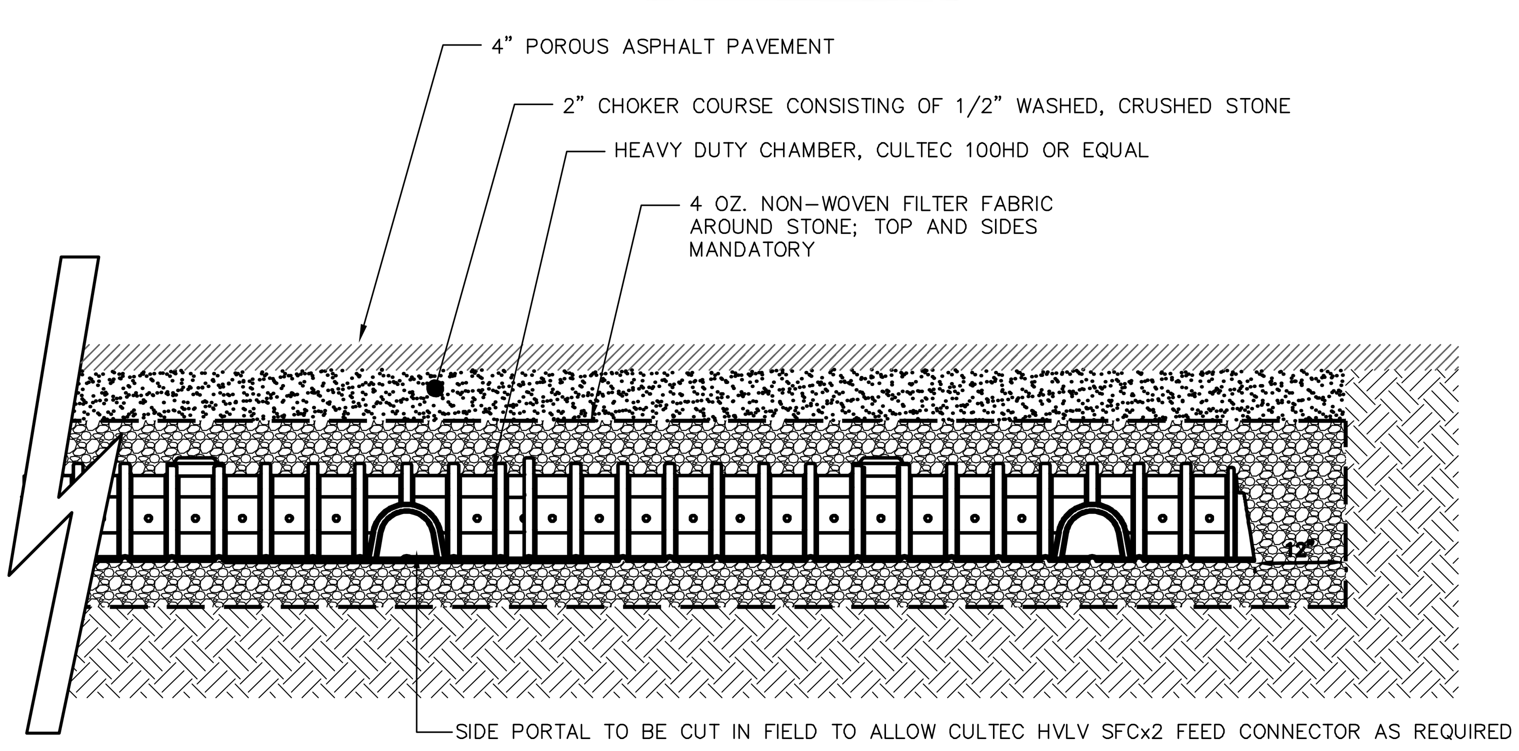
2. PLANTING SOIL FOR BIORETENTION AREAS MUST BE TESTED PRIOR TO INSTALLATION FOR PH AND ORGANIC MATTER. THE SOIL SHOULD MEET THE FOLLOWING CRITERIA (LANDSCAPE CONTRACTORS ASSOCIATION, 1986).
PH RANGE: 5.5 -6.5
ORGANIC MATTER: 1.5 -3.0%

TYPICAL BIORETENTION/RAIN GARDEN CROSS-SECTION AT ROADWAY BUMP-OUTS

NOT TO SCALE



TYPICAL CROSS SECTION



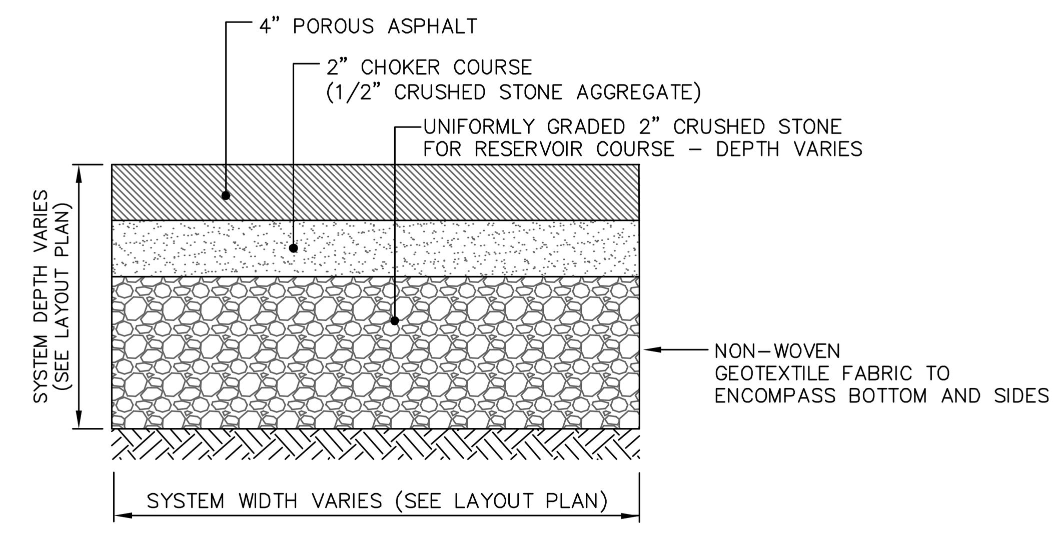
TYPICAL LONGITUDINAL SECTION

GENERAL NOTES

1. CONTACTOR 100HD HEAVY DUTY BY CULTEC, INC. OF BROOKFIELD, CT., OR APPROVED EQUAL.
2. THE UNIT SHALL PROVIDE APPROXIMATELY 3.84 CF/FT OF STORAGE PER DESIGN UNIT
3. CHAMBER DESIGN SHALL INCLUDE SIDE PORTS TO ALLOW FOR POTENTIAL HYDRAULIC CONNECTION TO SUBSURFACE SYSTEM ON OPPOSITE SIDE OF THE ROADWAY.
4. ALL STORAGE UNITS MUST BE INSTALLED IN ACCORDANCE WITH ALL APPLICABLE LOCAL, STATE AND FEDERAL REGULATIONS.

TYPICAL POROUS ASPHALT PAVEMENT WITH SUBSURFACE CHAMBER SYSTEM

NOT TO SCALE



NOTES:

1. POROUS ASPHALT MIX MATERIALS SHALL CONSIST OF MODIFIED PERFORMANCE GRADE ASPHALT BINDER (PGAB), COARSE AND FINE AGGREGATES, AND OPTIONAL ADDITIVES SUCH AS SILICONE, FIBERS, MINERAL FILLERS, FATTY AMINES, AND HYDRATED LIME. MATERIALS SHALL MEET THE REQUIREMENTS OF THE NAPA'S "DESIGN, CONSTRUCTION, AND MAINTENANCE OF OPEN-GRADED FRICTION COURSES, INFORMATION SERIES 115 (2002)," EXCEPT WHERE NOTED OTHERWISE BELOW OR APPROVED IN WRITING BY THE ENGINEER. THE FOLLOWING ASPHALT MIX DESIGN IS RECOMMENDED: PG 64-28 WITH 5 POUNDS OF FIBERS PER TON OF ASPHALT MIX FOR DRIVEWAYS AND OFF-STREET PARKING AREAS.
2. MATERIAL FOR THE CHOKER COURSE AND RESERVOIR COURSE SHALL HAVE THE AASHTO NO. 57 AND AASHTO NO. 3 GRADATIONS, RESPECTIVELY, AS SPECIFIED IN THE ADJACENT TABLE. IF THE AASHTO NO. 3 GRADATION CANNOT BE MET, AASHTO NO. 5 IS ACCEPTABLE WITH APPROVAL OF THE ENGINEER. AASHTO NO. 3 IS ALSO SUITABLE FOR THE CHOKER COURSE.
3. NON-WOVEN GEOTEXTILE FILTER FABRIC SHALL BE MIRAFI 160N, OR APPROVED EQUAL.

Table . Porous Asphalt Mix Design Criteria.

Sieve Size (inch/mm)	Percent Passing (%)
0.75/19	100
0.50/12.5	85-100
0.375/9.5	55-75
No.4/4.75	10-25
No.8/2.36	5-10
No.200/0.075 (#200)	2-4
Binder Content (AASHTO T164)	6 - 6.5%
Air Void Content (ASTM D6752)	18.0-22.0%
Draindown (ASTM D6390)*	≤0.3 %
Retained Tensile Strength (AASHTO 283)**	≥ 80 %
Cantabro abrasion test on unaged samples (ASTM D7064-04)	≤ 20%
Cantabro abrasion test on 7 day aged samples	≤ 30%

* Either method is acceptable
**Cellulose or mineral fibers may be used to reduce draindown.
***If the TSR (retained tensile strength) values fall below 80% when tested per NAPA IS 131 (with a single freeze thaw cycle rather than 5), then in Step 4, the contractor shall employ an antistrip additive, such as hydrated lime (ASTM C977) or a fatty amine, to raise the TSR value above 80%.

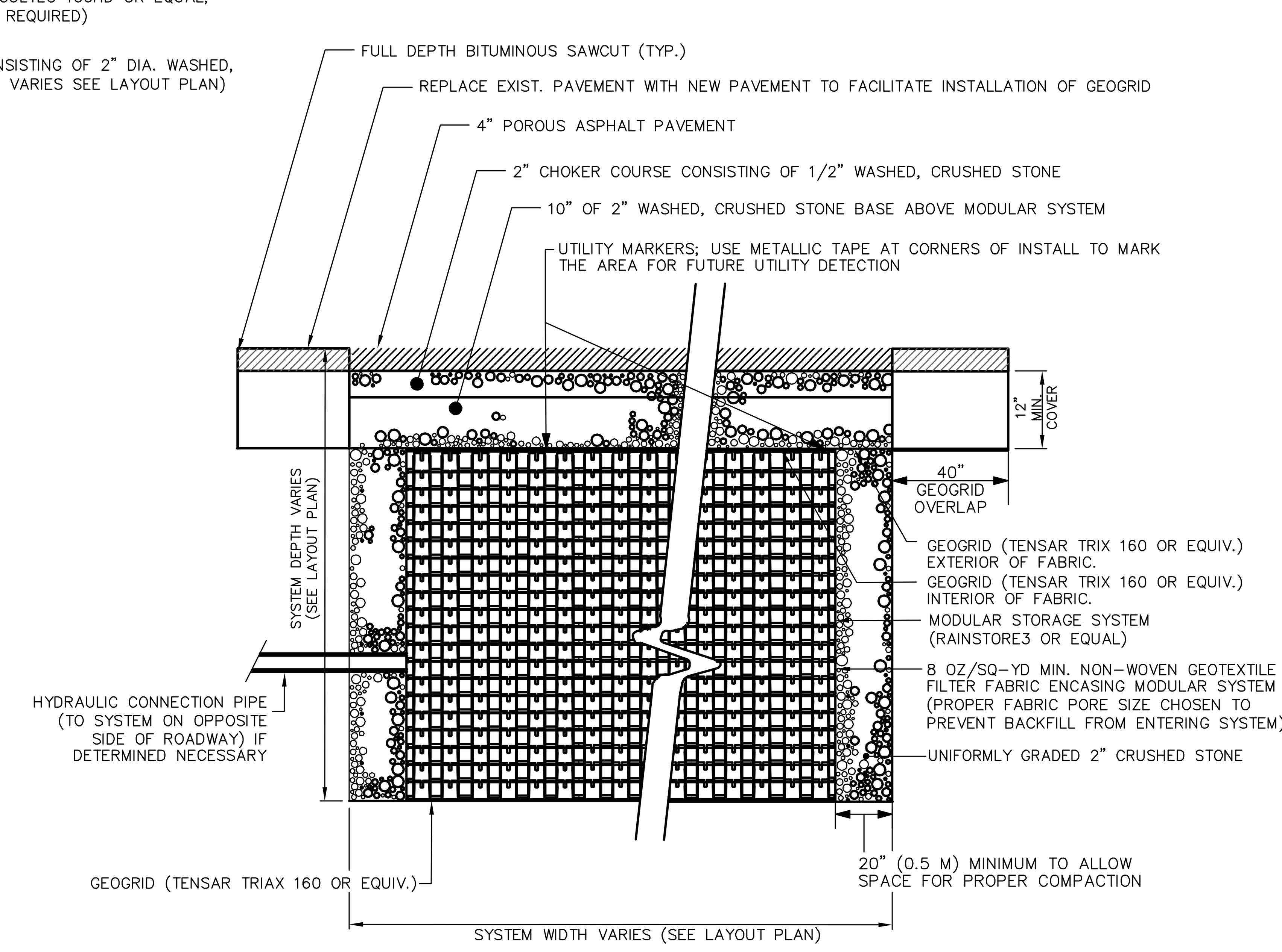
Table Gradations of choker, filter, and reservoir course materials.

US Standard Sieve Size Inches/mm	Percent Passing (%)			
	Choker Course (AASHTO No. 57)	Filter Course (*Modified* NHDOT 304.1)	Reservoir Course (AASHTO No. 3)	Reservoir Course Alternative* (AASHTO No. 5)
6/150	-	100	-	
2½/63	-		100	-
2 /50	-		90 – 100	-
1½/37.5	100		35 – 70	100
1/25	95 - 100		0 – 15	90 – 100
¾/19	-		-	20 - 55
½/12.5	25 - 60		0 - 5	0 - 10
3/8/9.5	-		-	0 - 5
#4/4.75	0 - 10	70-100	-	
#8/2.36	0 - 5		-	
#200/0.075		0 – 6**		

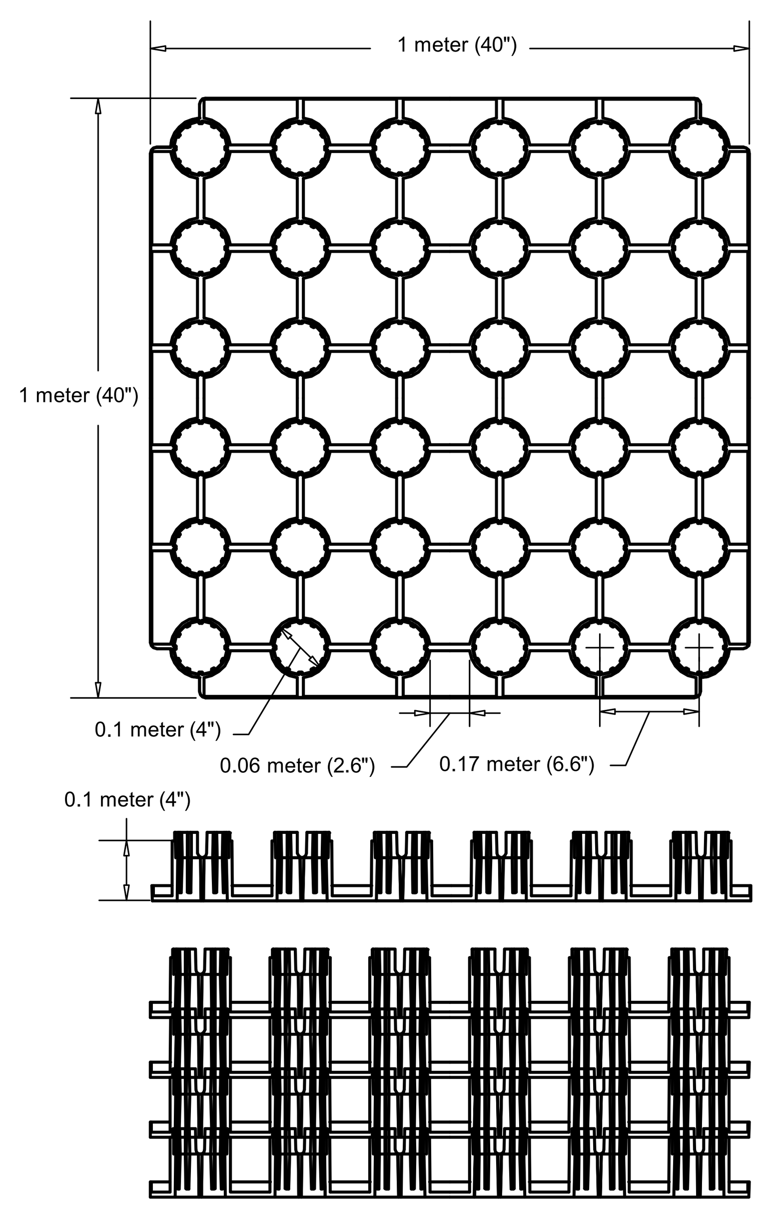
* Alternate gradations (e.g. AASHTO No. 5) may be accepted upon Engineer's approval.
** Preferably less than 4% fines

TYPICAL POROUS ASPHALT PAVEMENT CROSS-SECTION AT ROADWAY SHOULDERS

NOT TO SCALE



TYPICAL CROSS SECTION



SAMPLE MODULAR SYSTEM DIMENSIONS

TYPICAL POROUS ASPHALT PAVEMENT WITH SUBSURFACE MODULAR SYSTEM

NOT TO SCALE

PROJ. No.: 20100678.A10	
DATE: September 2011	
Fig. 10B	

CITY OF COLUMBIA

SHANDON FLOOD STUDY

LOW-IMPACT DEVELOPMENT STORM WATER MANAGEMENT TYPICAL DETAILS

COLUMBIA SOUTH CAROLINA

FUSS & O'NEILL
717 LADY ST, SUITE E
COLUMBIA, SOUTH CAROLINA 29201
803.376.6034
www.fando.com

SCALE:
HORZ.: N/A
VERT.:
DATUM:
HORZ.:
VERT.:
1200 600 0 1200
GRAPHIC SCALE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER
1.			XX/XX	XX

Appendix A

Soil Resource Report for Richland County, South Carolina

100%

United States Department of Agriculture

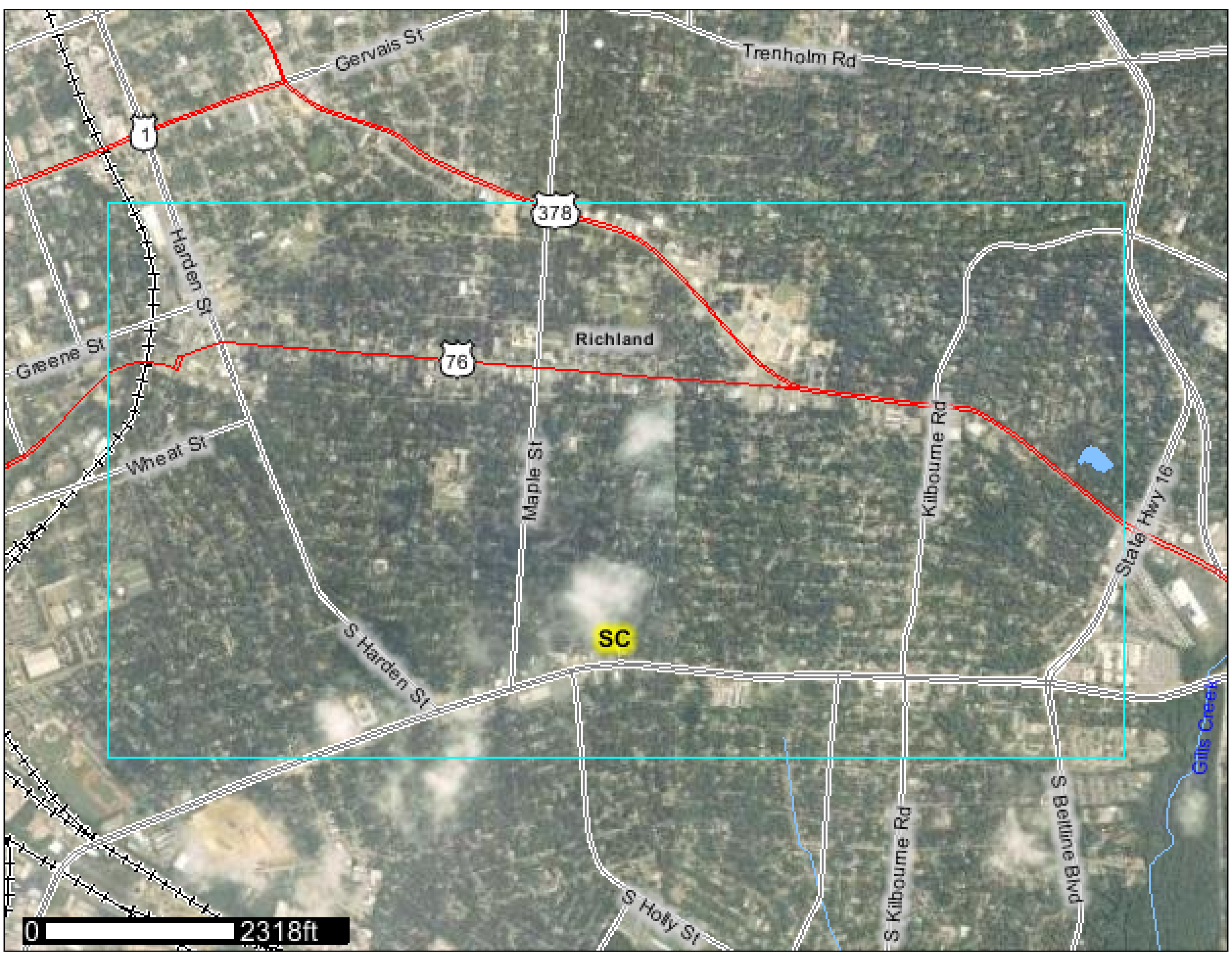
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Richland County, South Carolina



September 28, 2010

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://soils.usda.gov/sqi/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

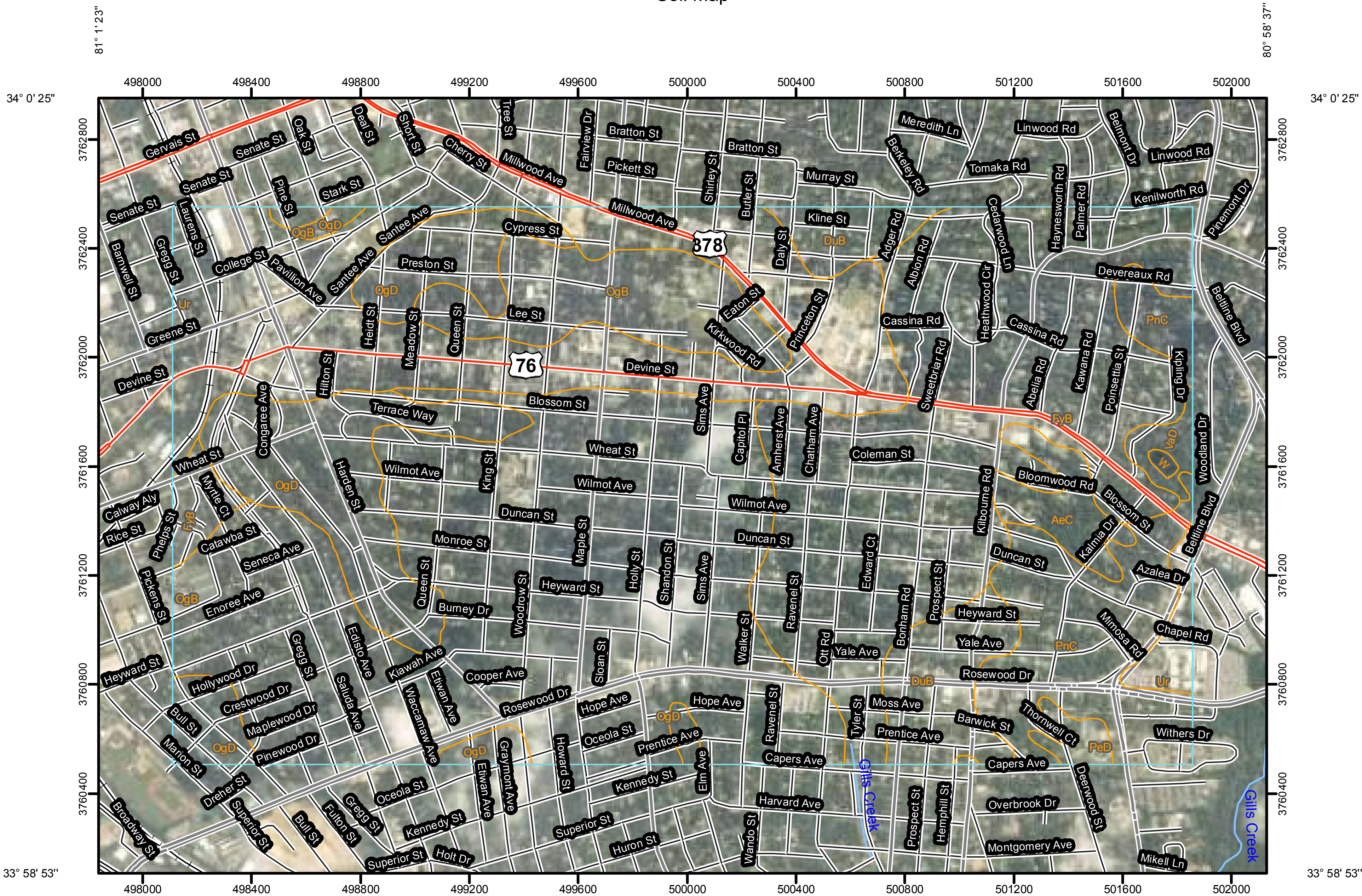
The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:20,400 if printed on A size (8.5" x 11") sheet.

N

Meters: 0, 250, 500, 1,000, 1,500

Feet: 0, 1,000, 2,000, 4,000, 6,000

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

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
- Gully
- Short Steep Slope
- Other

Political Features
- Cities

Water Features
- Oceans
- Streams and Canals

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

MAP INFORMATION

Map Scale: 1:20,400 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 17N NAD83

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

Soil Survey Area: Richland County, South Carolina
Survey Area Data: Version 13, Feb 9, 2010

Date(s) aerial images were photographed: 7/11/2006

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

Richland County, South Carolina (SC079)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AeC	Ailey loamy sand, 2 to 10 percent slopes	32.1	1.7%
DuB	Dothan-Urban land complex, 0 to 6 percent slopes	80.3	4.2%
FyB	Fuquay-Urban land complex, 0 to 6 percent slopes	432.8	22.8%
OgB	Orangeburg-Urban land complex, 2 to 6 percent slopes	680.0	35.9%
OgD	Orangeburg-Urban land complex, 6 to 15 percent slopes	191.9	10.1%
PeD	Pelion loamy sand, 6 to 15 percent slopes	10.2	0.5%
PnC	Pelion-Urban land complex, 2 to 10 percent slopes	140.4	7.4%
Ur	Urban land	315.6	16.6%
VaD	Vaucluse loamy sand, 10 to 15 percent slopes	11.5	0.6%
W	Water	1.7	0.1%
Totals for Area of Interest		**1,896.4**	**100.0%**

Map Unit Descriptions

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, 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 and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils 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. Other minor components, however, have properties and behavioral 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*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one 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.

Richland County, South Carolina

AeC—Ailey loamy sand, 2 to 10 percent slopes

Map Unit Setting

Elevation: 80 to 550 feet
Mean annual precipitation: 44 to 55 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 230 to 265 days

Map Unit Composition

Ailey and similar soils: 100 percent

Description of Ailey

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy and loamy marine deposits

Properties and qualities

Slope: 2 to 10 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.5 inches)

Interpretive groups

Land capability (nonirrigated): 4s

Typical profile

0 to 5 inches: Loamy sand
5 to 30 inches: Loamy sand
30 to 38 inches: Sandy clay loam
38 to 69 inches: Sandy clay loam
69 to 81 inches: Sandy clay loam

DuB—Dothan-Urban land complex, 0 to 6 percent slopes

Map Unit Setting

Elevation: 80 to 550 feet
Mean annual precipitation: 44 to 55 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 230 to 265 days

Map Unit Composition

Dothan and similar soils: 60 percent
Urban land: 40 percent

Description of Dothan

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Plinthic loamy marine deposits

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 6.4 inches)

Interpretive groups

Land capability (nonirrigated): 2e

Typical profile

0 to 7 inches: Loamy sand
7 to 17 inches: Loamy sand
17 to 37 inches: Sandy clay loam
37 to 78 inches: Sandy clay

Description of Urban Land

Setting

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Interpretive groups

Land capability (nonirrigated): 8s

FyB—Fuquay-Urban land complex, 0 to 6 percent slopes

Map Unit Setting

Elevation: 80 to 550 feet
Mean annual precipitation: 44 to 55 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 230 to 265 days

Map Unit Composition

Fuquay and similar soils: 60 percent
Urban land: 40 percent

Description of Fuquay

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Plinthic loamy marine deposits

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 48 to 72 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.0 inches)

Interpretive groups

Land capability (nonirrigated): 2s

Typical profile

0 to 8 inches: Sand
8 to 35 inches: Sand
35 to 48 inches: Sandy clay loam
48 to 75 inches: Sandy clay loam

Description of Urban Land

Setting

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Interpretive groups

Land capability (nonirrigated): 8s

OgB—Orangeburg-Urban land complex, 2 to 6 percent slopes

Map Unit Setting

Elevation: 80 to 550 feet
Mean annual precipitation: 44 to 55 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 230 to 265 days

Map Unit Composition

Orangeburg and similar soils: 60 percent
Urban land: 40 percent

Description of Orangeburg

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy marine deposits

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.1 inches)

Interpretive groups

Land capability (nonirrigated): 2e

Typical profile

0 to 5 inches: Loamy sand
5 to 12 inches: Loamy sand
12 to 18 inches: Sandy loam
18 to 90 inches: Sandy clay loam

Description of Urban Land

Setting

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy marine deposits

Interpretive groups

Land capability (nonirrigated): 8s

OgD—Orangeburg-Urban land complex, 6 to 15 percent slopes

Map Unit Setting

Elevation: 80 to 550 feet
Mean annual precipitation: 44 to 55 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 230 to 265 days

Map Unit Composition

Orangeburg and similar soils: 55 percent
Urban land: 45 percent

Description of Orangeburg

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Loamy marine deposits

Properties and qualities

Slope: 6 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.1 inches)

Interpretive groups

Land capability (nonirrigated): 4e

Typical profile

0 to 5 inches: Loamy sand
5 to 12 inches: Loamy sand
12 to 18 inches: Sandy loam
18 to 90 inches: Sandy clay loam

Description of Urban Land

Setting

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy marine deposits

Interpretive groups

Land capability (nonirrigated): 8s

PeD—Pelion loamy sand, 6 to 15 percent slopes

Map Unit Setting

Elevation: 80 to 550 feet
Mean annual precipitation: 44 to 55 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 230 to 265 days

Map Unit Composition

Pelion and similar soils: 100 percent

Description of Pelion

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Properties and qualities

Slope: 6 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.57 in/hr)
Depth to water table: About 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.7 inches)

Interpretive groups

Land capability (nonirrigated): 6e

Typical profile

0 to 5 inches: Loamy sand
5 to 7 inches: Loamy sand
7 to 26 inches: Sandy clay loam
26 to 57 inches: Sandy clay loam
57 to 58 inches: Sandy clay loam
58 to 75 inches: Loamy sand

PnC—Pelion-Urban land complex, 2 to 10 percent slopes

Map Unit Setting

Elevation: 80 to 550 feet
Mean annual precipitation: 44 to 55 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 230 to 265 days

Map Unit Composition

Pelion and similar soils: 60 percent
Urban land: 40 percent

Description of Pelion

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex

Across-slope shape: Convex
Parent material: Loamy marine deposits

Properties and qualities
Slope: 2 to 10 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.57 in/hr)
Depth to water table: About 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.7 inches)

Interpretive groups
Land capability (nonirrigated): 4e

Typical profile
0 to 5 inches: Loamy sand
5 to 7 inches: Loamy sand
7 to 26 inches: Sandy clay loam
26 to 57 inches: Sandy clay loam
57 to 58 inches: Sandy clay loam
58 to 75 inches: Loamy sand

Description of Urban Land

Setting
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy marine deposits

Interpretive groups
Land capability (nonirrigated): 8s

Ur—Urban land

Map Unit Setting
Elevation: 80 to 550 feet
Mean annual precipitation: 44 to 55 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 230 to 265 days

Map Unit Composition
Urban land: 100 percent

Description of Urban Land

Setting
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy marine deposits and clayey residuum

Interpretive groups

Land capability (nonirrigated): 8s

VaD—Vaucluse loamy sand, 10 to 15 percent slopes

Map Unit Setting

Elevation: 80 to 550 feet
Mean annual precipitation: 44 to 55 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 230 to 265 days

Map Unit Composition

Vaucluse and similar soils: 100 percent

Description of Vaucluse

Setting

Landform: Marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy marine deposits

Properties and qualities

Slope: 10 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.6 inches)

Interpretive groups

Land capability (nonirrigated): 4e

Typical profile

0 to 6 inches: Loamy sand
6 to 15 inches: Loamy sand
15 to 29 inches: Sandy clay loam
29 to 58 inches: Sandy clay loam
58 to 72 inches: Sandy loam

W—Water

Map Unit Setting

Elevation: 80 to 550 feet

Mean annual precipitation: 44 to 55 inches
Mean annual air temperature: 61 to 70 degrees F
Frost-free period: 230 to 265 days

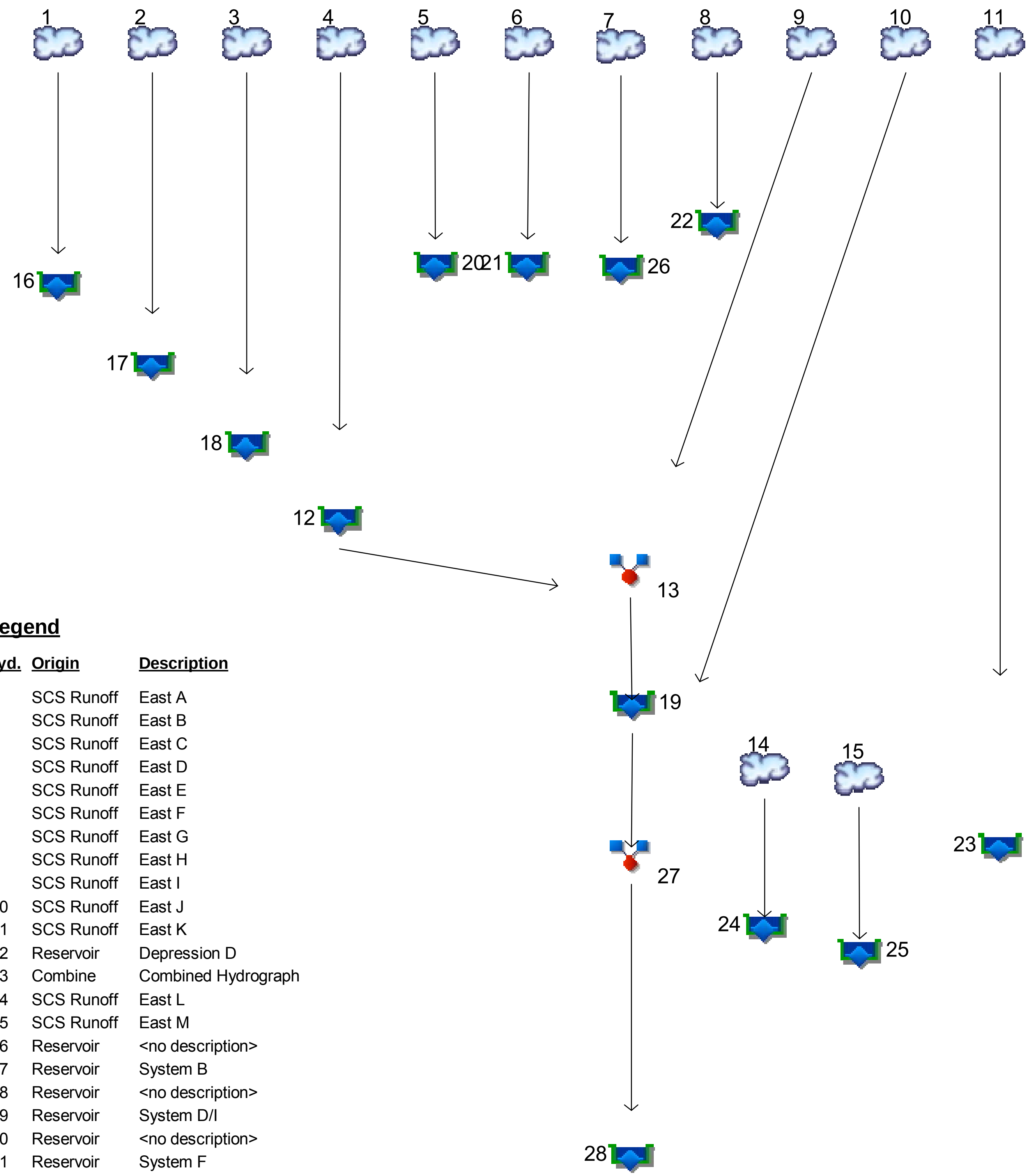
Map Unit Composition
Water: 100 percent

Appendix B

Hydrologic and Hydraulic Analyses of East and West Pilot Areas

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8



Legend

Hyd.	Origin	Description
1	SCS Runoff	East A
2	SCS Runoff	East B
3	SCS Runoff	East C
4	SCS Runoff	East D
5	SCS Runoff	East E
6	SCS Runoff	East F
7	SCS Runoff	East G
8	SCS Runoff	East H
9	SCS Runoff	East I
10	SCS Runoff	East J
11	SCS Runoff	East K
12	Reservoir	Depression D
13	Combine	Combined Hydrograph
14	SCS Runoff	East L
15	SCS Runoff	East M
16	Reservoir	<no description>
17	Reservoir	System B
18	Reservoir	<no description>
19	Reservoir	System D/I
20	Reservoir	<no description>
21	Reservoir	System F
22	Reservoir	System H
23	Reservoir	<no description>
24	Reservoir	System L
25	Reservoir	System M
26	Reservoir	East System G
27	Combine	Combined Hydrograph
28	Reservoir	System J

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	2.352	1	717	5,686	------	------	------	East A
2	SCS Runoff	3.536	1	717	7,355	------	------	------	East B
3	SCS Runoff	2.507	1	717	5,333	------	------	------	East C
4	SCS Runoff	18.46	1	720	44,745	------	------	------	East D
5	SCS Runoff	1.333	1	717	3,222	------	------	------	East E
6	SCS Runoff	6.541	1	717	13,672	------	------	------	East F
7	SCS Runoff	4.595	1	718	9,830	------	------	------	East G
8	SCS Runoff	13.97	1	722	37,693	------	------	------	East H
9	SCS Runoff	1.520	1	717	3,257	------	------	------	East I
10	SCS Runoff	4.612	1	717	9,691	------	------	------	East J
11	SCS Runoff	0.706	1	717	1,706	------	------	------	East K
12	Reservoir	17.83	1	721	25,127	4	270.42	2,868	Depression D
13	Combine	18.93	1	721	28,374	9, 12	------	------	Combined Hydrograph
14	SCS Runoff	4.768	1	717	10,215	------	------	------	East L
15	SCS Runoff	0.549	1	717	1,327	------	------	------	East M
16	Reservoir	0.000	1	670	0	1	2.02	1,320	<no description>
17	Reservoir	0.000	1	696	0	2	1.68	1,769	System B
18	Reservoir	0.000	1	814	0	3	4.21	1,513	<no description>
19	Reservoir	18.46	1	721	21,649	13	5.47	2,723	System D/I
20	Reservoir	0.000	1	658	0	5	1.10	597	<no description>
21	Reservoir	0.000	1	696	0	6	2.37	4,315	System F
22	Reservoir	0.000	1	689	0	8	6.42	14,271	System H
23	Reservoir	0.000	1	698	0	11	1.41	332	<no description>
24	Reservoir	0.000	1	n/a	0	14	2.08	2,877	System L
25	Reservoir	0.000	1	699	0	15	1.56	282	System M
26	Reservoir	0.000	1	673	0	7	5.04	3,609	East System G
27	Combine	22.21	1	718	31,340	10, 19,	------	------	Combined Hydrograph
28	Reservoir	0.000	1	1001	0	27	4.36	19,649	System J

SDA_TR20_East_20111213.gpw	Return Period: 10 Year	Friday, Jan 20, 2012

Hydrograph Report

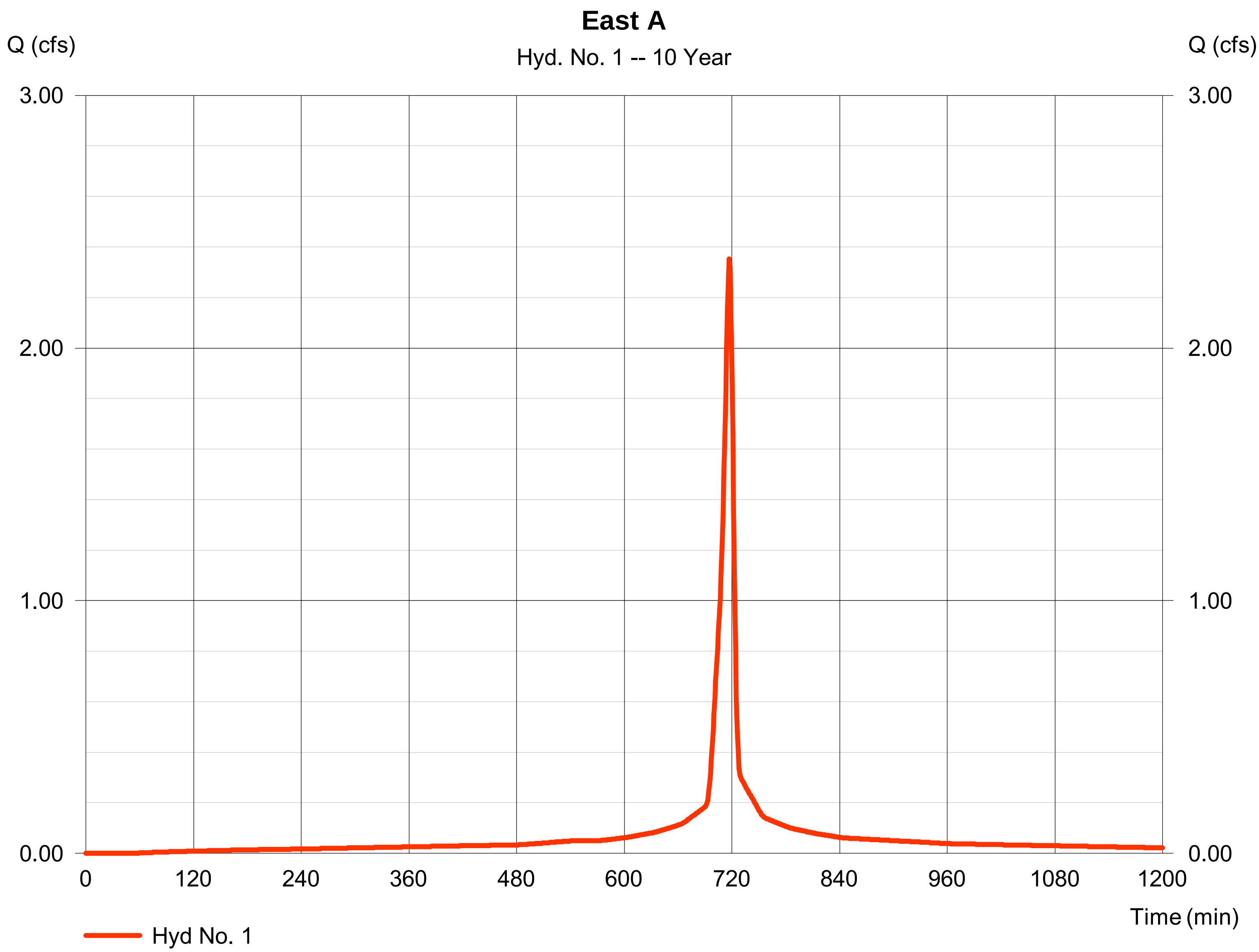
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 1

East A

Hydrograph type	= SCS Runoff	Peak discharge	= 2.352 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 5,686 cuft
Drainage area	= 0.300 ac	Curve number	= 98*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(5.000 x 78) + (2.000 x 98)] / 0.300



Hydrograph Report

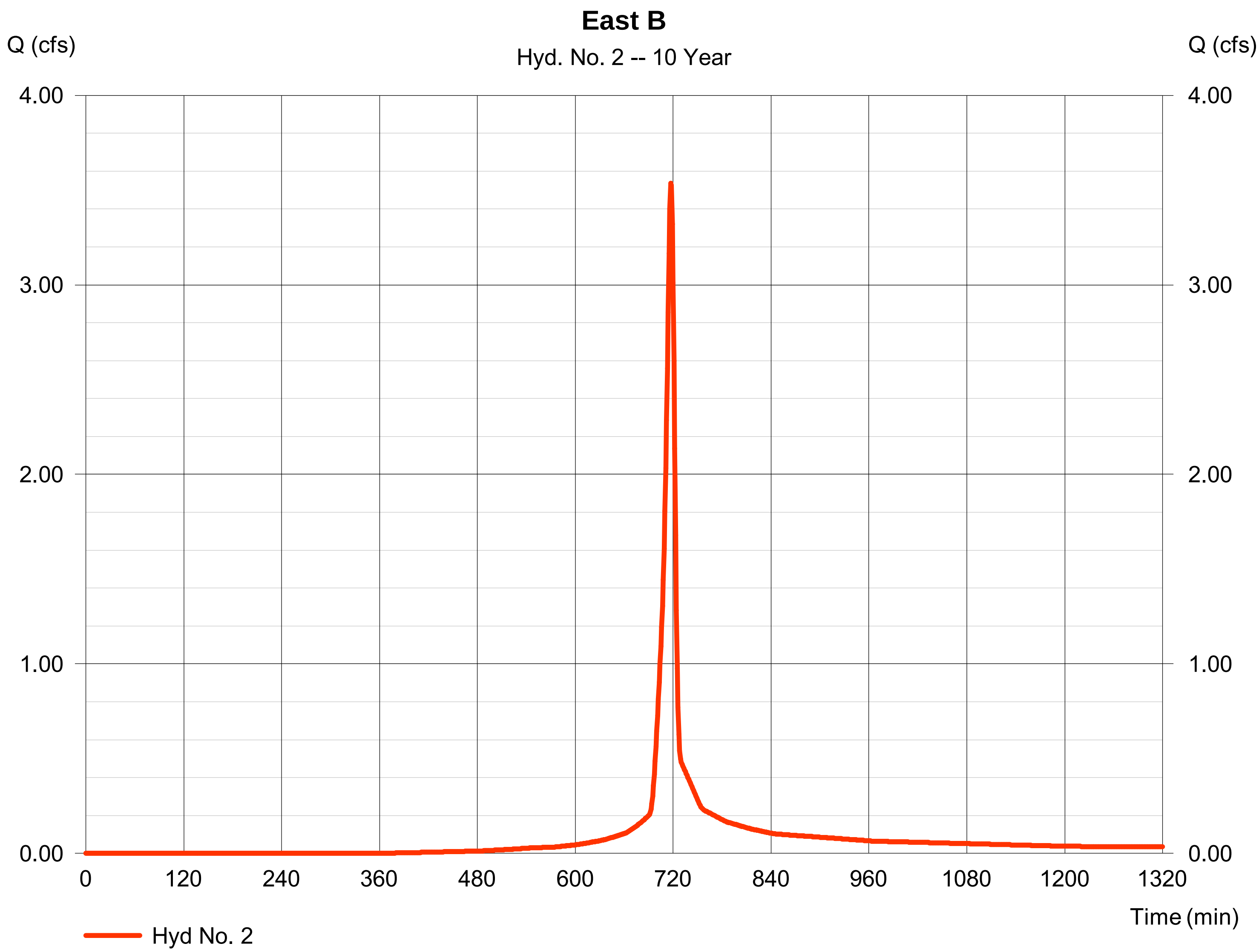
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 2

East B

Hydrograph type	= SCS Runoff	Peak discharge	= 3.536 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 7,355 cuft
Drainage area	= 0.570 ac	Curve number	= 83*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.149 x 98) + (0.416 x 78)] / 0.570



Hydrograph Report

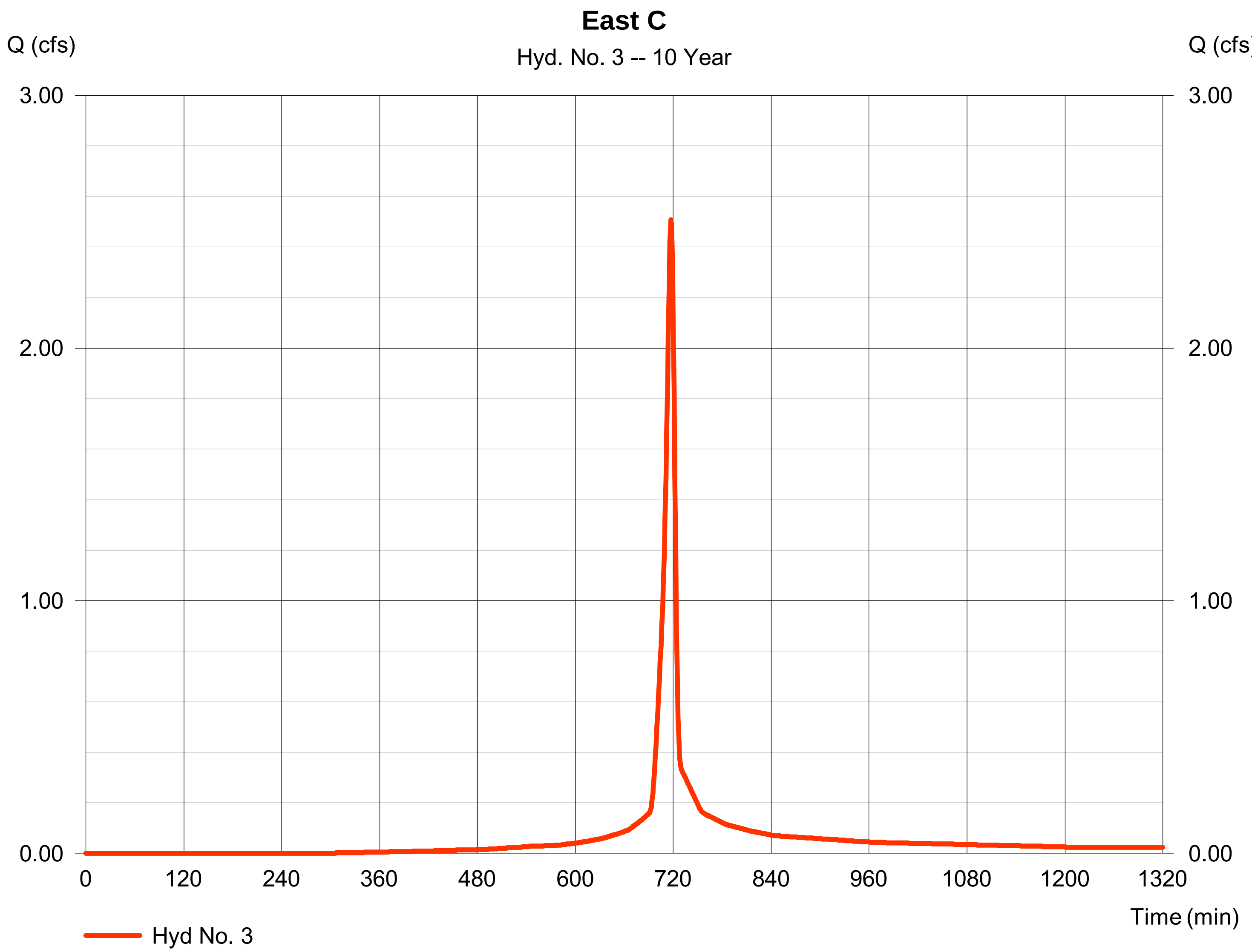
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 3

East C

Hydrograph type	= SCS Runoff	Peak discharge	= 2.507 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 5,333 cuft
Drainage area	= 0.370 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.167 x 98) + (0.202 x 78)] / 0.370



Hydrograph Report

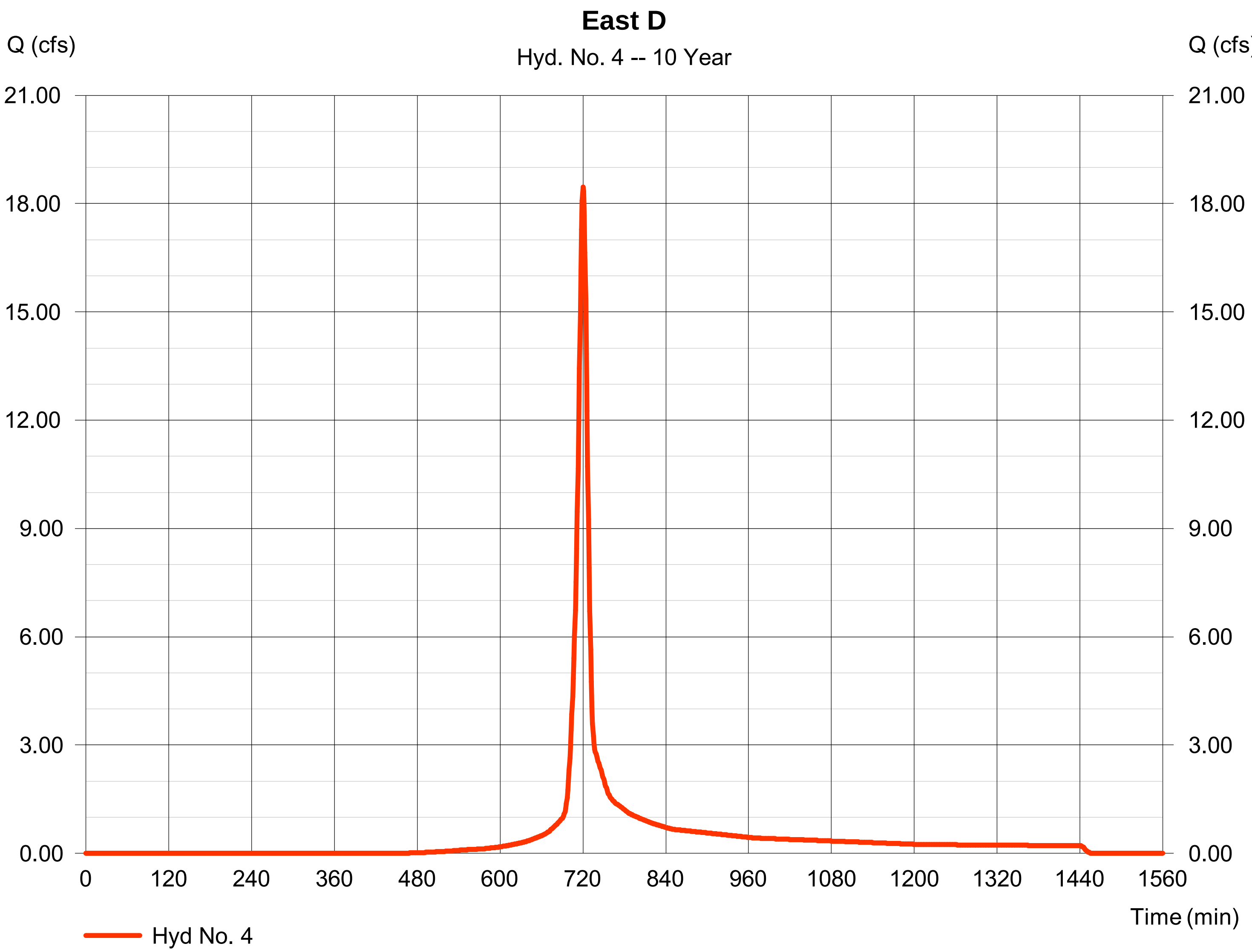
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 4

East D

Hydrograph type	= SCS Runoff	Peak discharge	= 18.46 cfs
Storm frequency	= 10 yrs	Time to peak	= 720 min
Time interval	= 1 min	Hyd. volume	= 44,745 cuft
Drainage area	= 4.080 ac	Curve number	= 78*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 10.50 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.315 x 98) + (4.604 x 78)] / 4.080



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No. 4

East D

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	65.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.60		0.00		0.00		
Land slope (%)	=	1.50		0.00		0.00		
Travel Time (min)	**=**	**7.34**	**+**	**0.00**	**+**	**0.00**	**=**	**7.34**
Shallow Concentrated Flow								
Flow length (ft)	=	381.00		0.00		0.00		
Watercourse slope (%)	=	1.60		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	2.04		0.00		0.00		
Travel Time (min)	**=**	**3.11**	**+**	**0.00**	**+**	**0.00**	**=**	**3.11**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	0.00		0.00		0.00		
Flow length (ft)		({0})0.0		0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 10.50 min

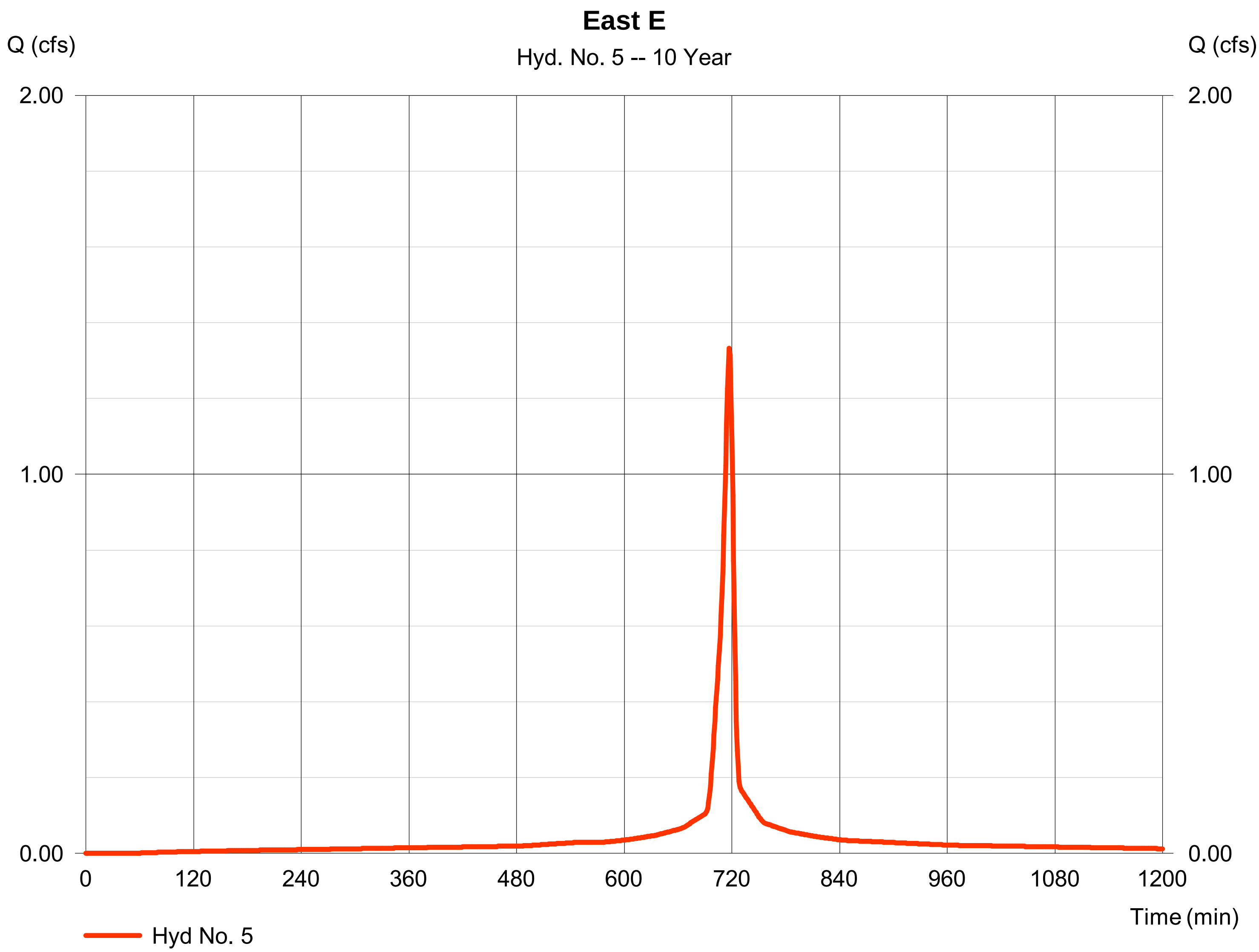
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 5

East E

Hydrograph type	= SCS Runoff	Peak discharge	= 1.333 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 3,222 cuft
Drainage area	= 0.170 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

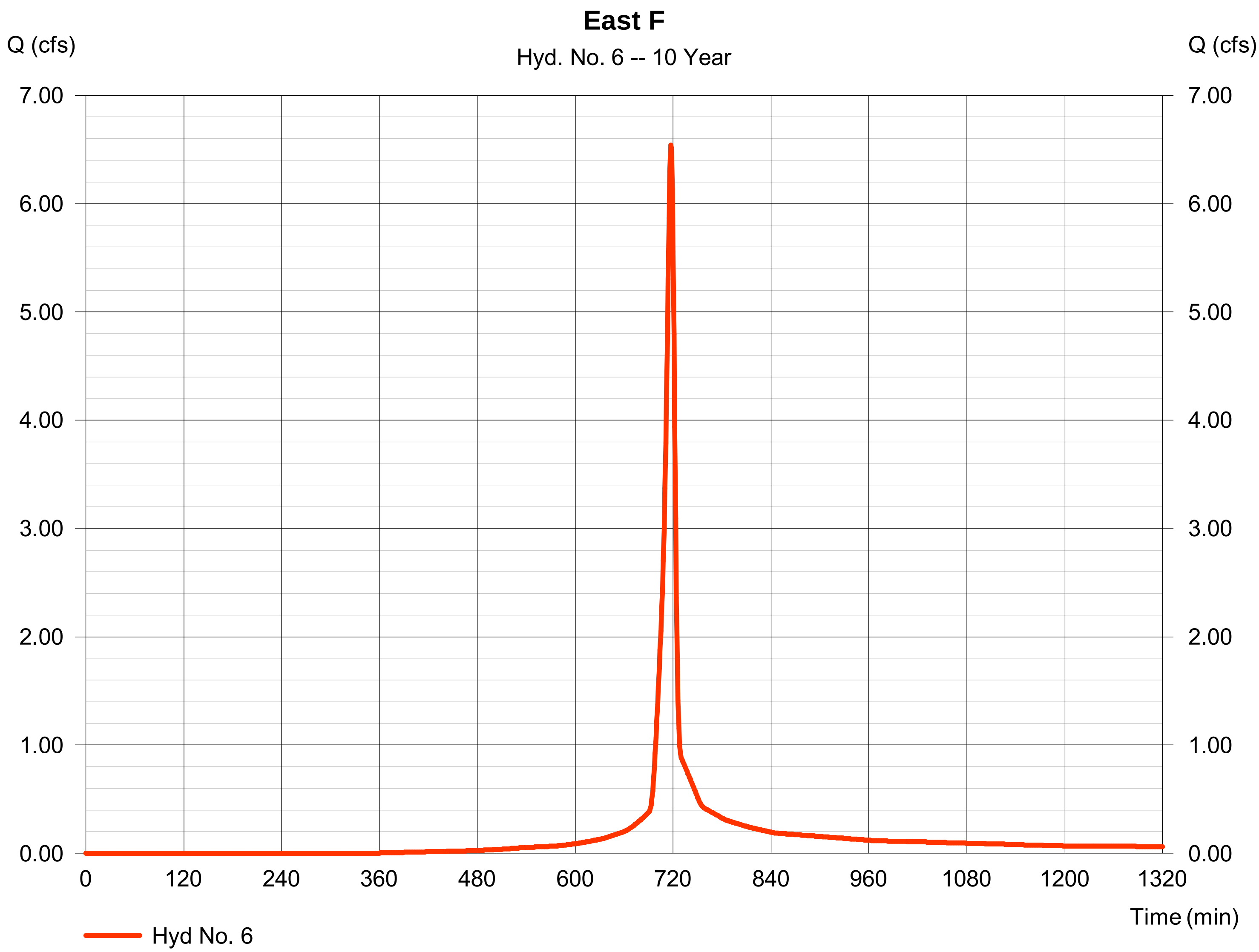
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 6

East F

Hydrograph type	= SCS Runoff	Peak discharge	= 6.541 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 13,672 cuft
Drainage area	= 1.030 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.327 x 98) + (0.699 x 78)] / 1.030



Hydrograph Report

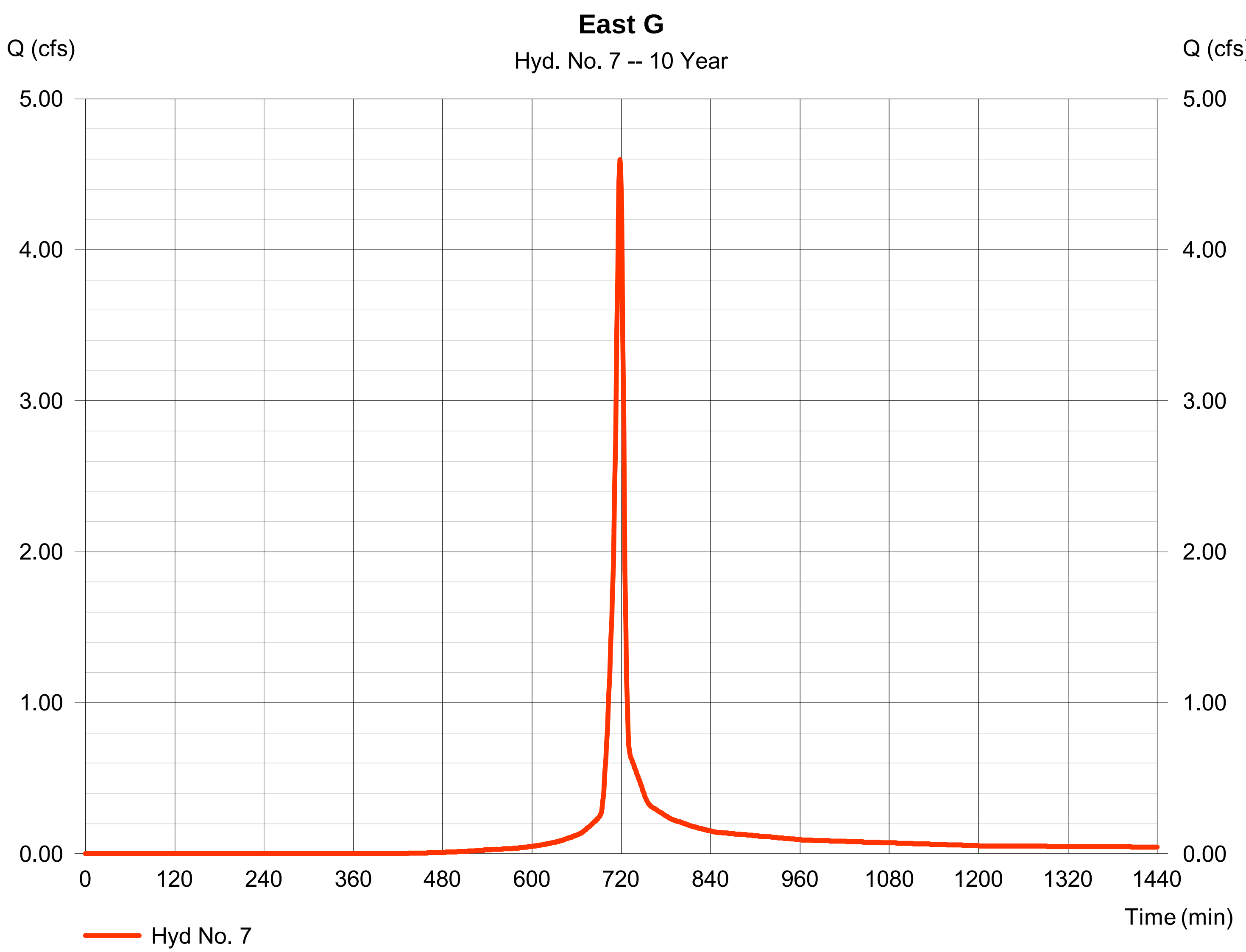
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 7

East G

Hydrograph type	= SCS Runoff	Peak discharge	= 4.595 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 9,830 cuft
Drainage area	= 0.880 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.077 x 98) + (0.800 x 78)] / 0.880



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No. 7

East G

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	60.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.60		0.00		0.00		
Land slope (%)	=	2.50		0.00		0.00		
Travel Time (min)	**=**	**5.61**	**+**	**0.00**	**+**	**0.00**	**=**	**5.61**
Shallow Concentrated Flow								
Flow length (ft)	=	263.00		0.00		0.00		
Watercourse slope (%)	=	3.80		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=3.15			0.00		0.00		
Travel Time (min)	**=**	**1.39**	**+**	**0.00**	**+**	**0.00**	**=**	**1.39**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=0.00							
				0.00				
						0.00		
Flow length (ft)	({0})0.0			0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... **7.00 min**

Hydrograph Report

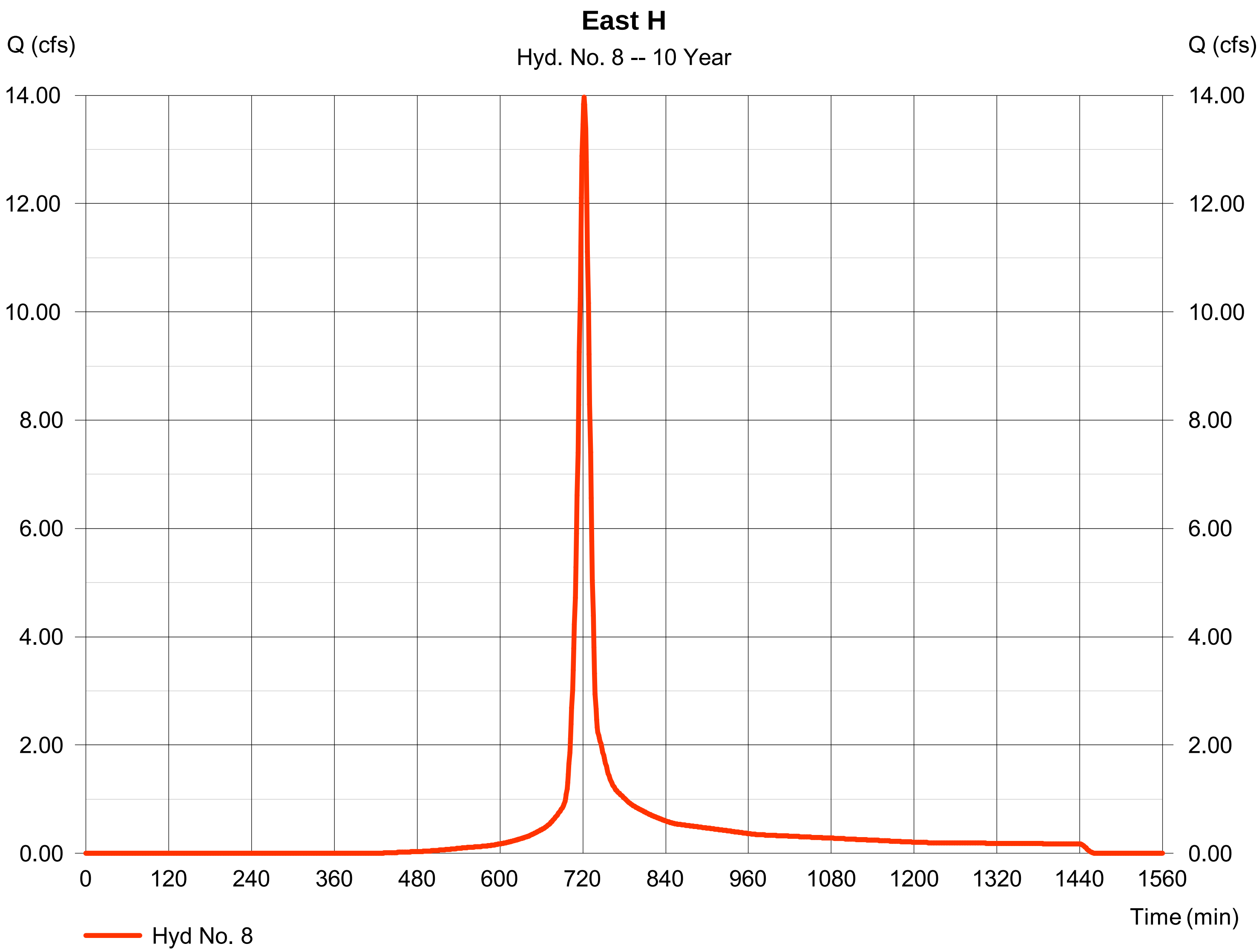
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 8

East H

Hydrograph type	= SCS Runoff	Peak discharge	= 13.97 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 37,693 cuft
Drainage area	= 3.290 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 14.60 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.310 x 98) + (2.980 x 78)] / 3.290



TR55 Tc Worksheet

Hyd. No. 8

East H

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.60		0.00		0.00		
Land slope (%)	=	1.10		0.00		0.00		
Travel Time (min)	**=**	**11.73**	**+**	**0.00**	**+**	**0.00**	**=**	**11.73**
Shallow Concentrated Flow								
Flow length (ft)	=	502.00		0.00		0.00		
Watercourse slope (%)	=	3.20		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.89			0.00		0.00		
Travel Time (min)	**=**	**2.90**	**+**	**0.00**	**+**	**0.00**	**=**	**2.90**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=0.00							
				0.00				
						0.00		
Flow length (ft)	({0})0.0			0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Total Travel Time, Tc								**14.60 min**

Hydrograph Report

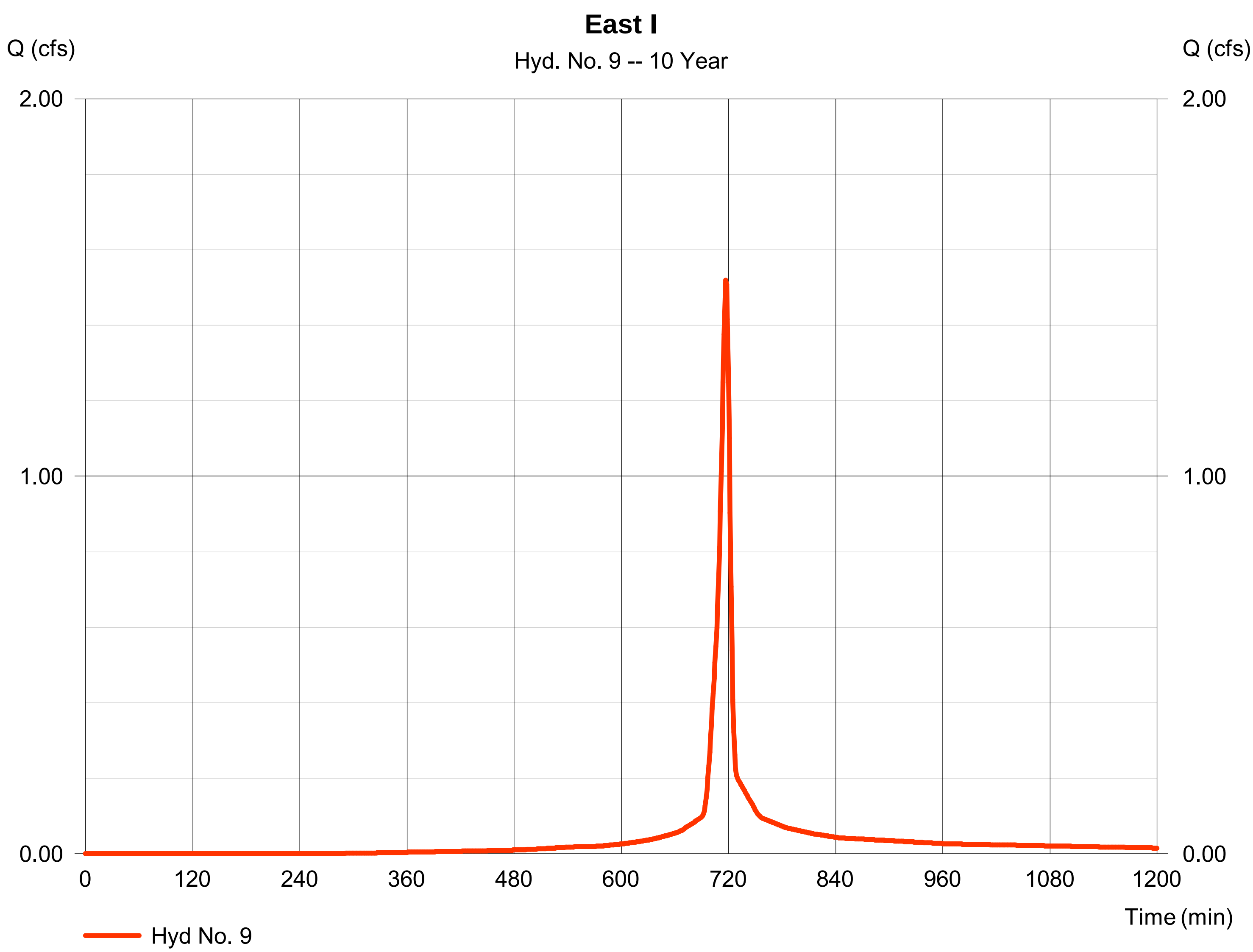
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 9

East I

Hydrograph type	= SCS Runoff	Peak discharge	= 1.520 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 3,257 cuft
Drainage area	= 0.220 ac	Curve number	= 88*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.111 x 98) + (0.109 x 78)] / 0.220



Hydrograph Report

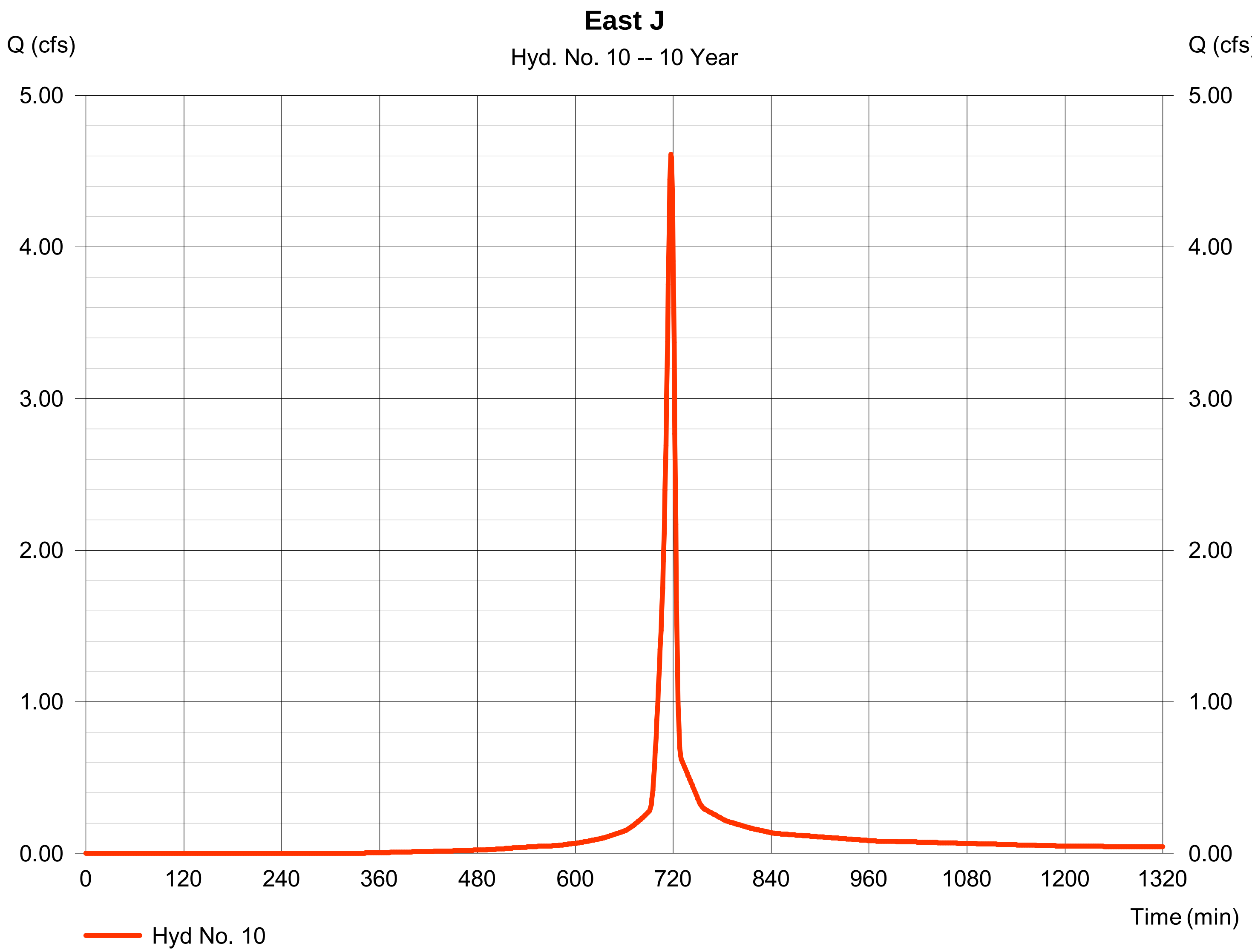
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 | Friday, Jan 20, 2012

Hyd. No. 10

East J

Hydrograph type	= SCS Runoff	Peak discharge	= 4.612 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 9,691 cuft
Drainage area	= 0.710 ac	Curve number	= 85*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.240 x 98) + (0.470 x 78)] / 0.710



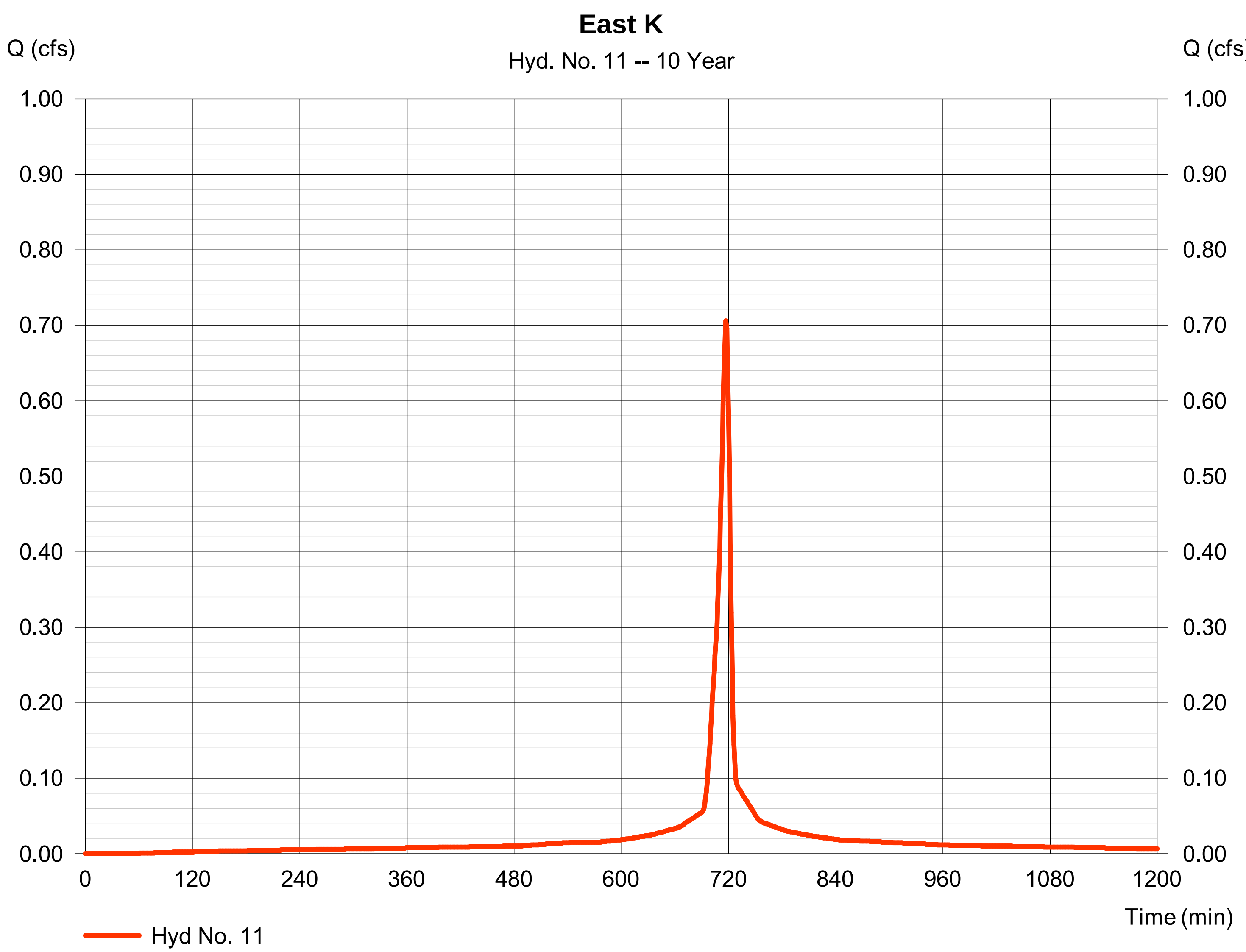
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 11

East K

Hydrograph type	= SCS Runoff	Peak discharge	= 0.706 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 1,706 cuft
Drainage area	= 0.090 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

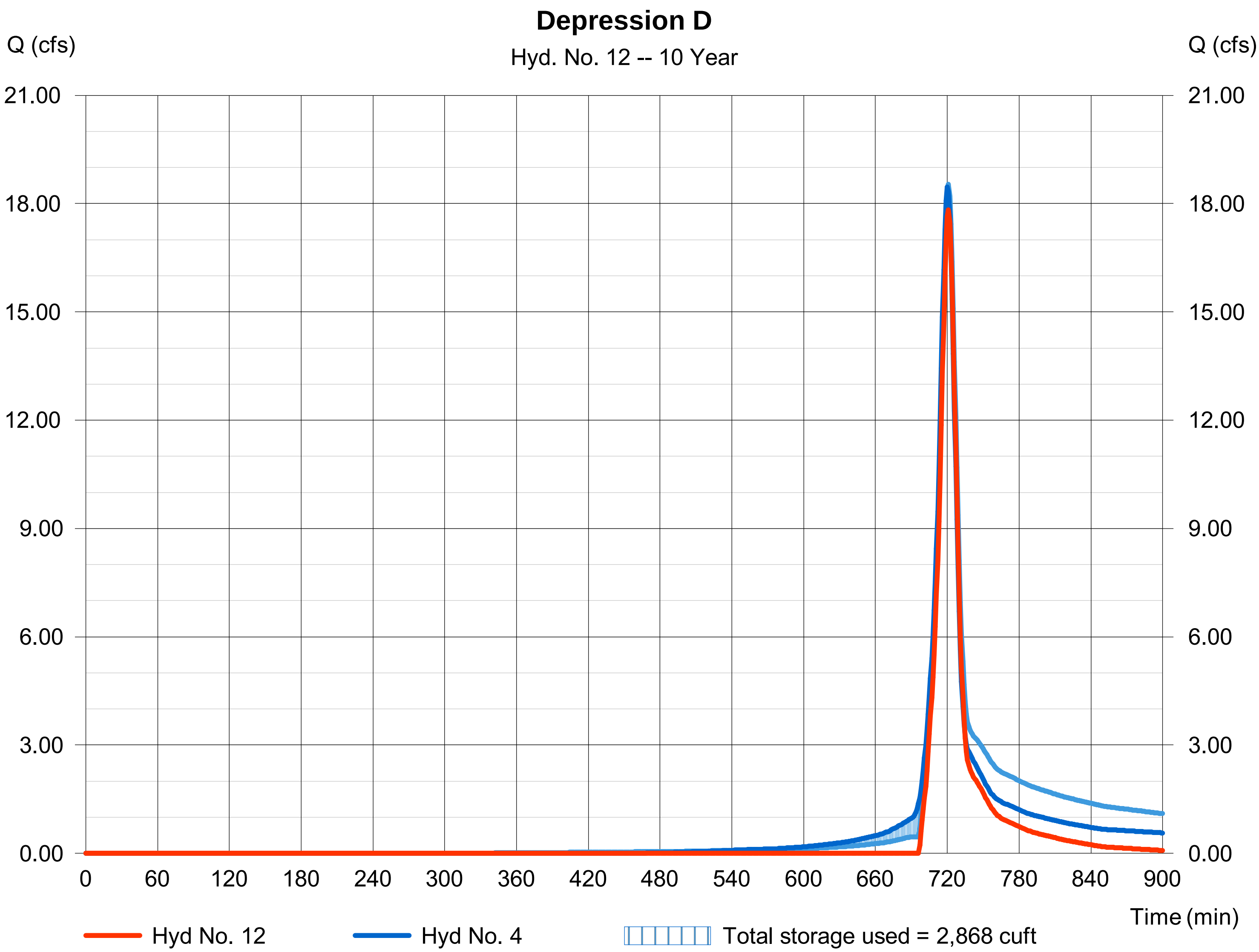
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 12

Depression D

Hydrograph type	= Reservoir	Peak discharge	= 17.83 cfs
Storm frequency	= 10 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 25,127 cuft
Inflow hyd. No.	= 4 - East D	Max. Elevation	= 270.42 ft
Reservoir name	= Depression D	Max. Storage	= 2,868 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 9 - Depression D

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 269.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	269.00	1,610	0	0
1.00	270.00	2,119	1,858	1,858
2.00	271.00	2,686	2,397	4,255

Culvert / Orifice Structures

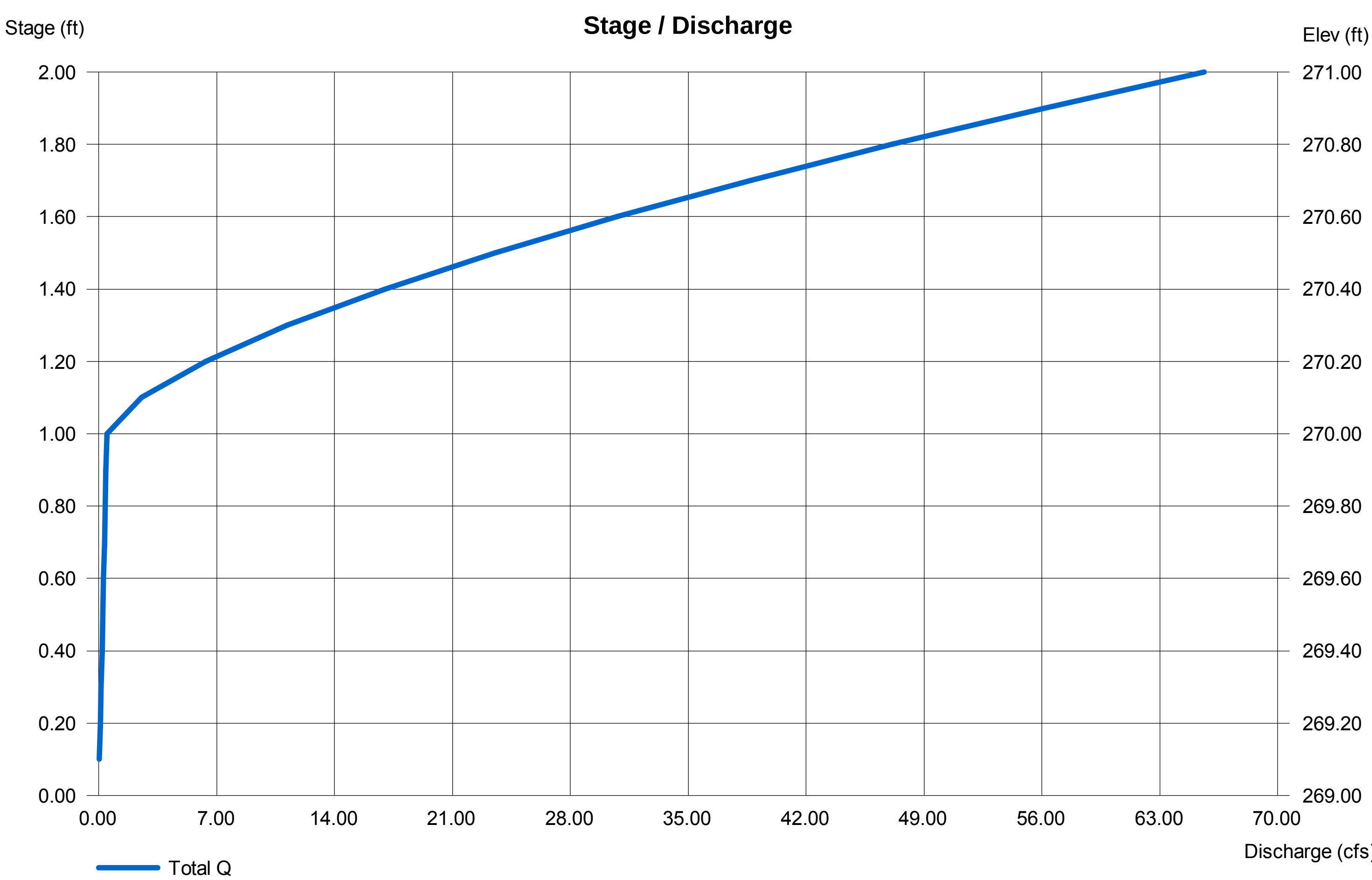
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 25.00	0.00	0.00	0.00
Crest El. (ft)	= 270.00	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 10.000 (by Contour)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



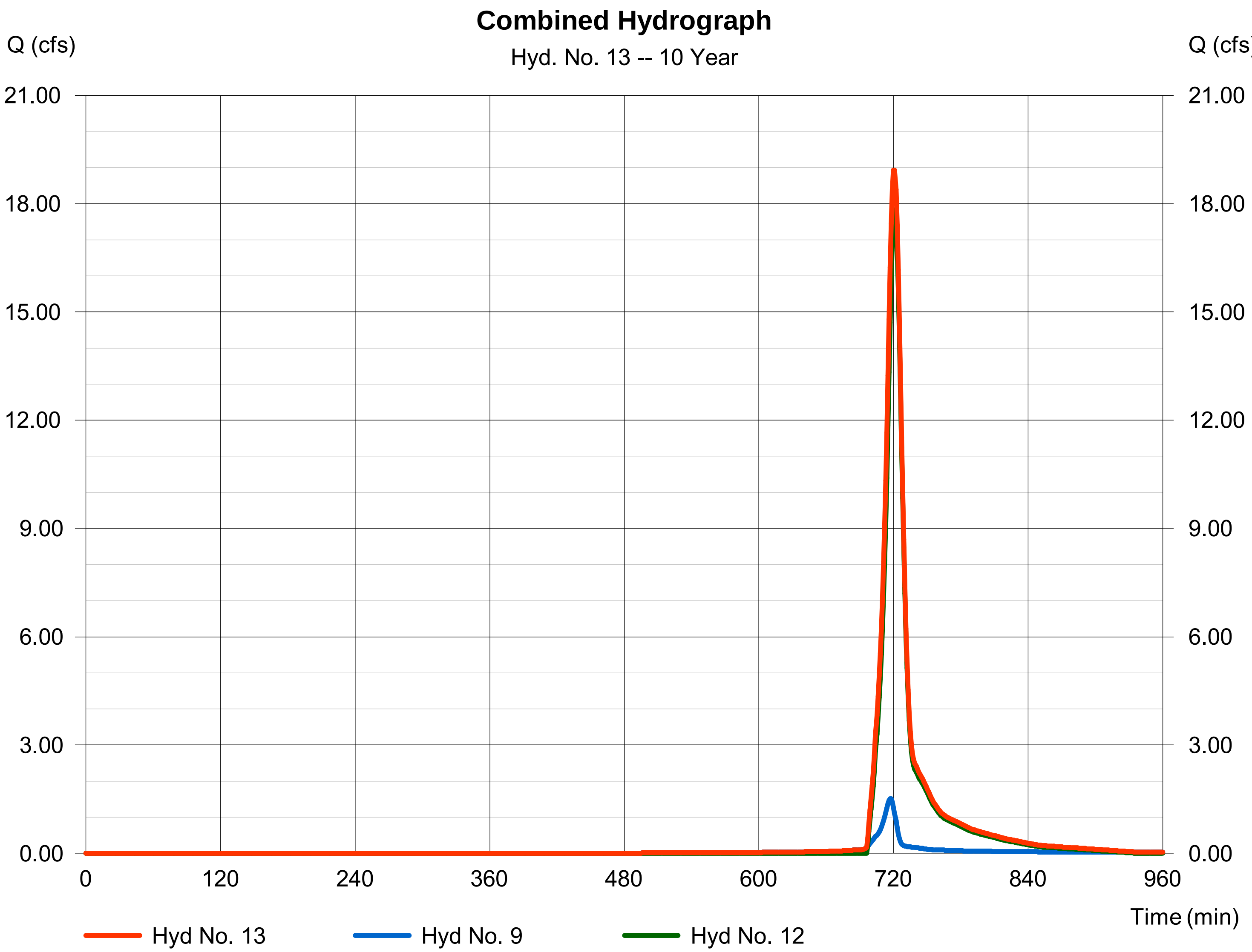
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 13

Combined Hydrograph

Hydrograph type	= Combine	Peak discharge	= 18.93 cfs
Storm frequency	= 10 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 28,374 cuft
Inflow hyds.	= 9, 12	Contrib. drain. area	= 0.220 ac



Hydrograph Report

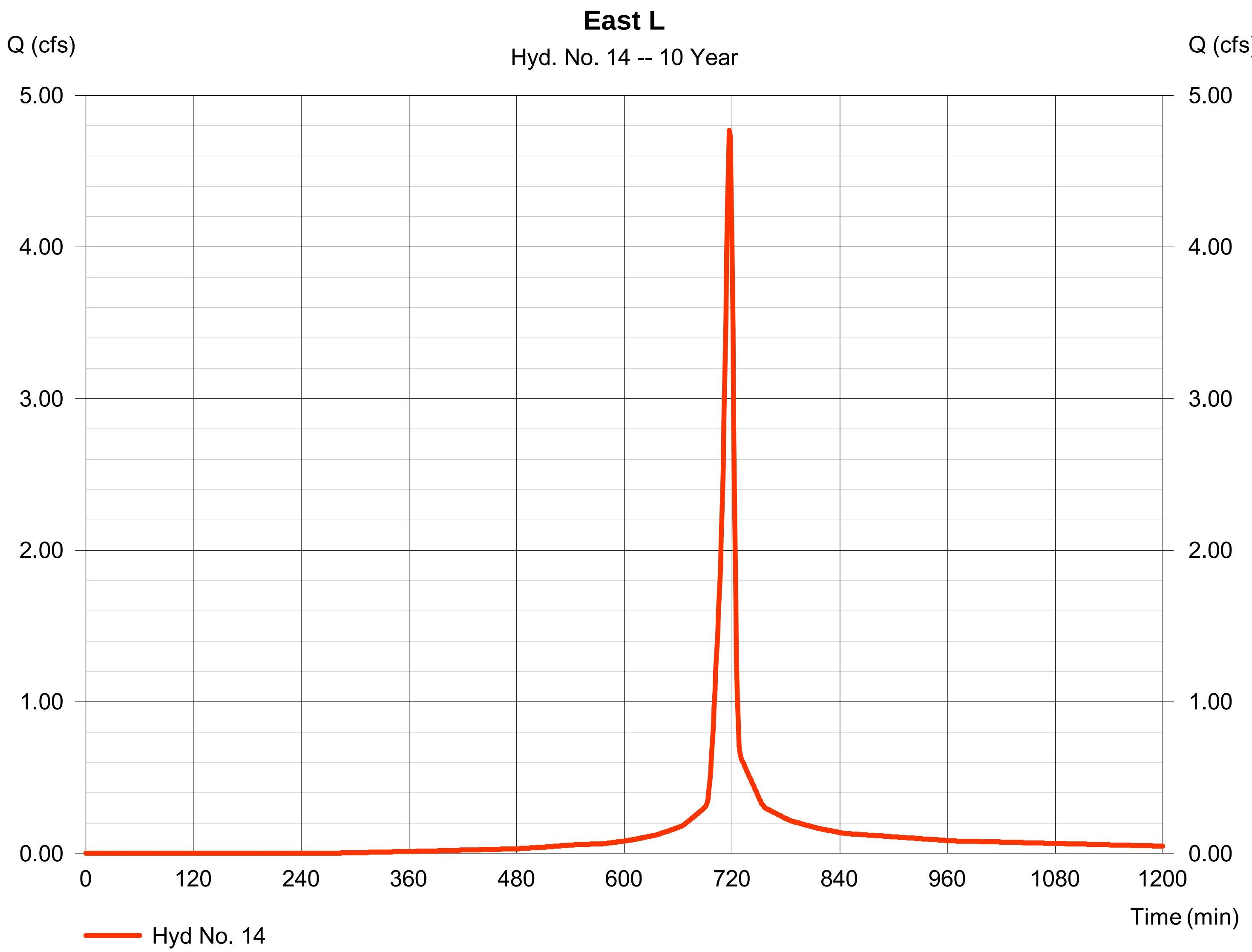
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 14

East L

Hydrograph type	= SCS Runoff	Peak discharge	= 4.768 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 10,215 cuft
Drainage area	= 0.690 ac	Curve number	= 88*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.329 x 98) + (0.361 x 78)] / 0.690



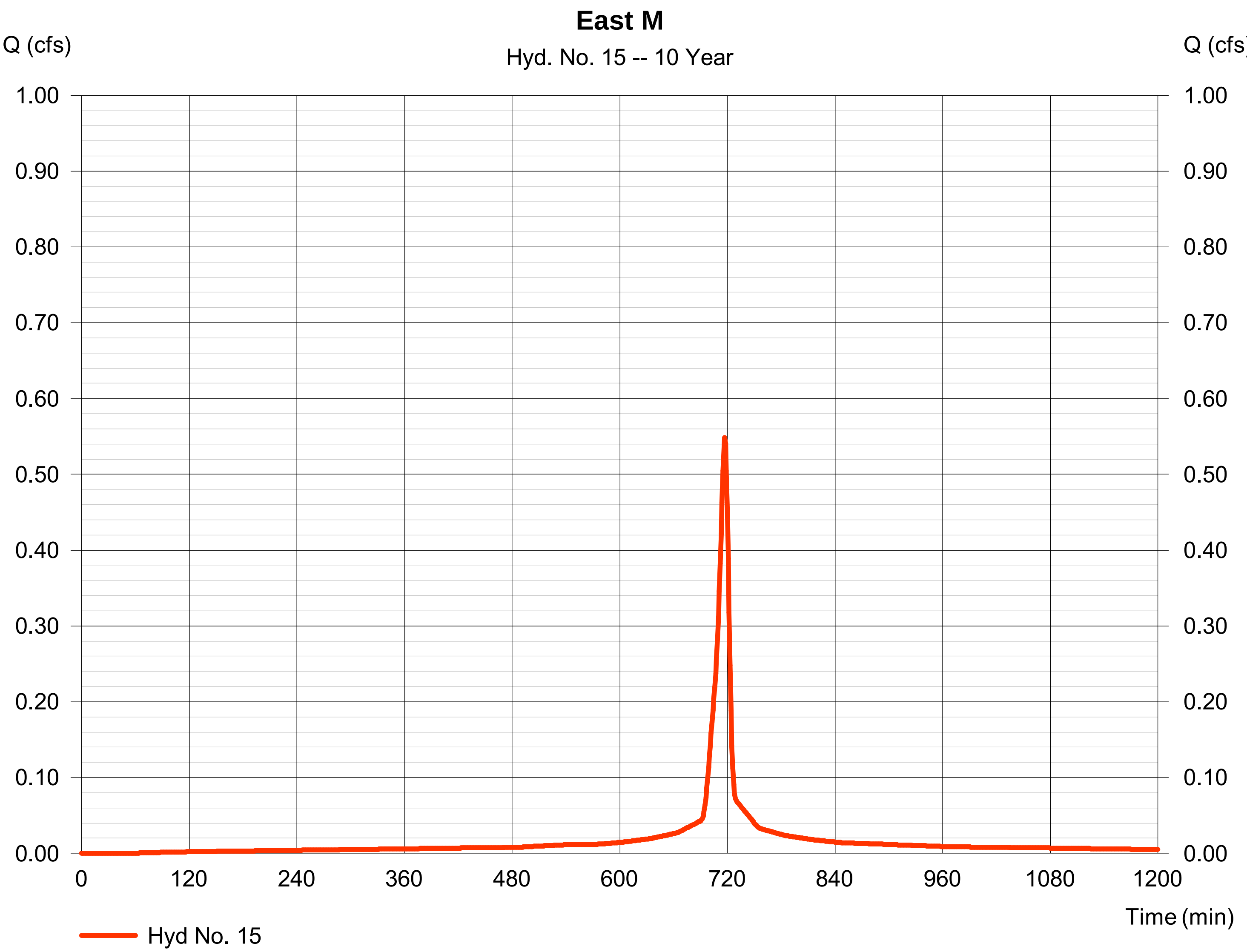
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 15

East M

Hydrograph type	= SCS Runoff	Peak discharge	= 0.549 cfs
Storm frequency	= 10 yrs	Time to peak	= 717 min
Time interval	= 1 min	Hyd. volume	= 1,327 cuft
Drainage area	= 0.070 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

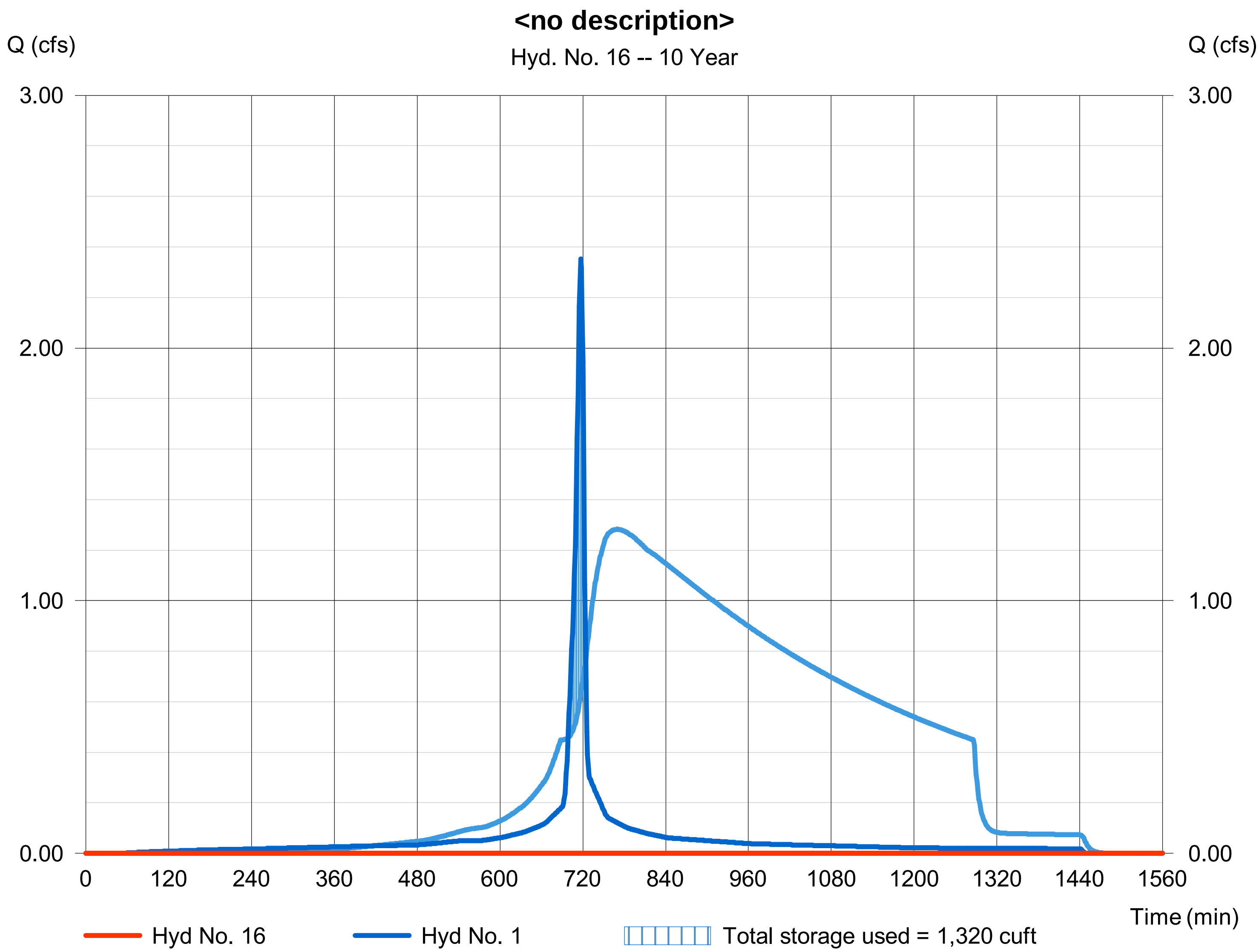
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 16

<no description>

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 670 min
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - East A	Max. Elevation	= 2.02 ft
Reservoir name	= Pervious Pavement East A	Max. Storage	= 1,320 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 3 - Pervious Pavement East A

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 0.01 x 0.01 ft , Barrel Len = 246.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 7.60 ft, Height = 2.25 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.22	0.22	n/a	147	147
0.45	0.45	n/a	147	295
0.68	0.68	n/a	147	442
0.90	0.90	n/a	147	589
1.13	1.13	n/a	147	736
1.35	1.35	n/a	147	884
1.58	1.58	n/a	147	1,031
1.80	1.80	n/a	147	1,178
2.03	2.03	n/a	147	1,325
2.25	2.25	n/a	147	1,473

Culvert / Orifice Structures

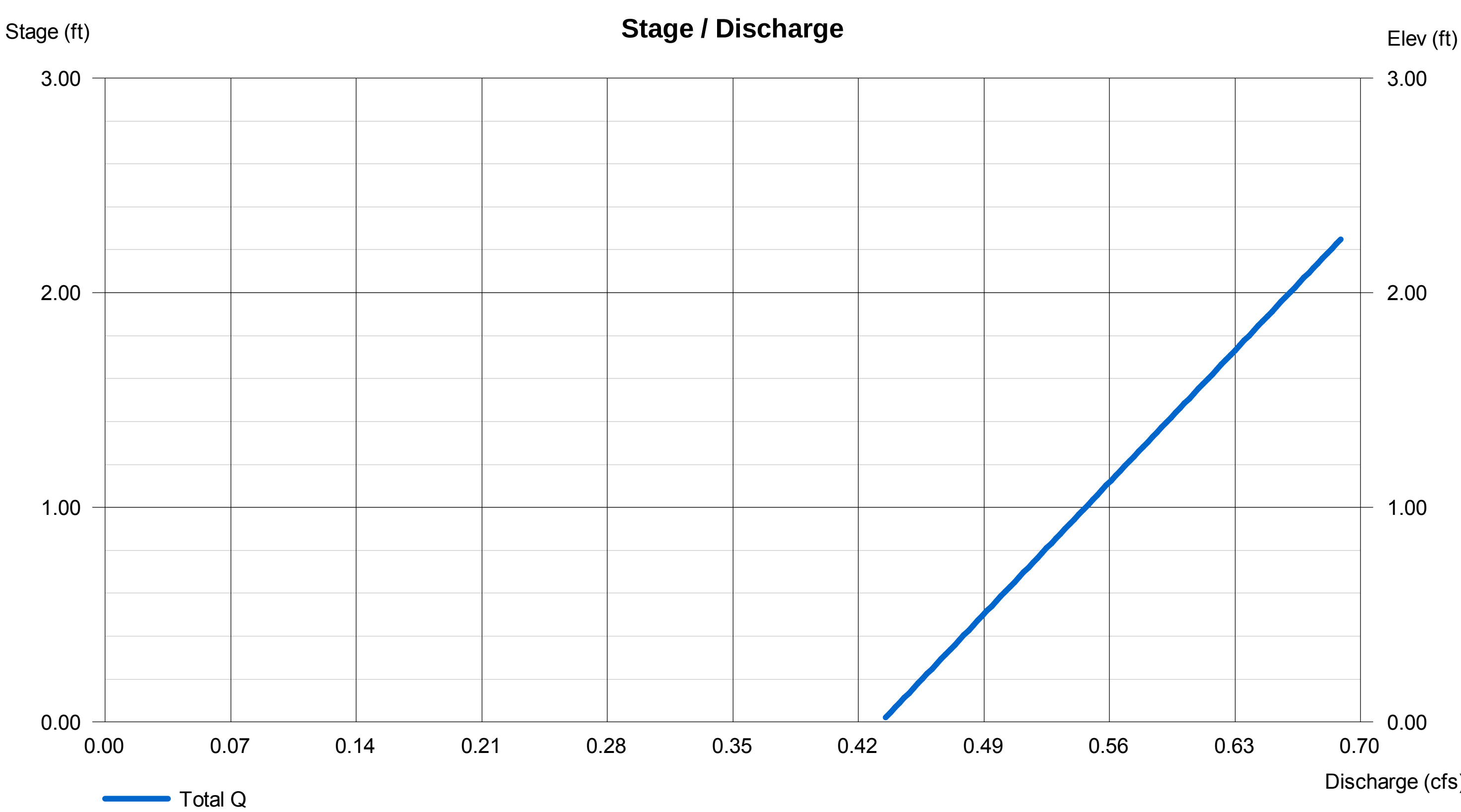
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 10.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

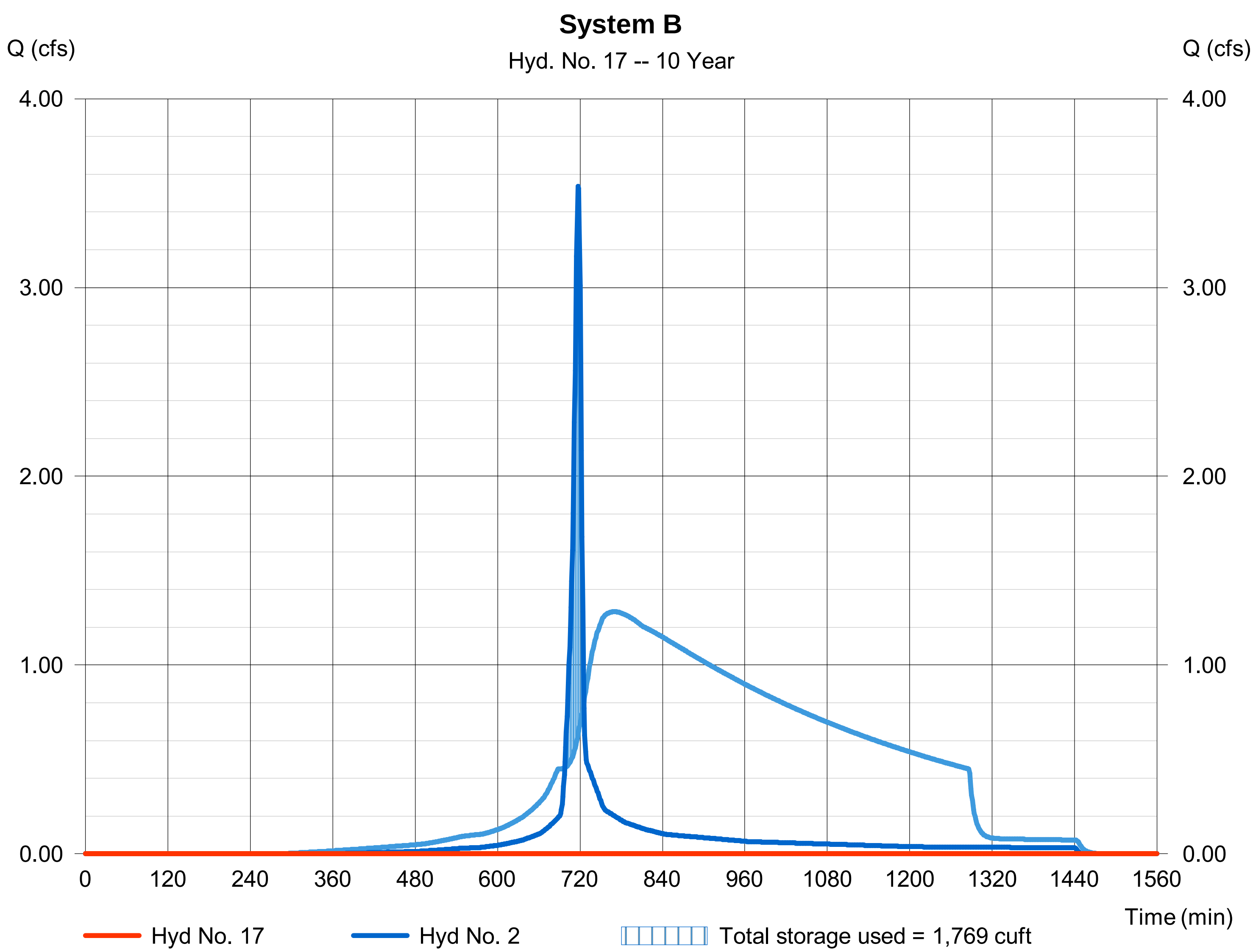
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 17

System B

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 696 min
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 2 - East B	Max. Elevation	= 1.68 ft
Reservoir name	= Porous Pavement East B	Max. Storage	= 1,769 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Pond No. 4 - Porous Pavement East B

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 0.01 x 0.01 ft , Barrel Len = 462.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.50 ft, Height = 1.75 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.17	0.17	n/a	184	184
0.35	0.35	n/a	184	368
0.52	0.52	n/a	184	552
0.70	0.70	n/a	184	736
0.88	0.88	n/a	184	920
1.05	1.05	n/a	184	1,104
1.23	1.23	n/a	184	1,288
1.40	1.40	n/a	184	1,472
1.58	1.58	n/a	184	1,656
1.75	1.75	n/a	184	1,840

Culvert / Orifice Structures

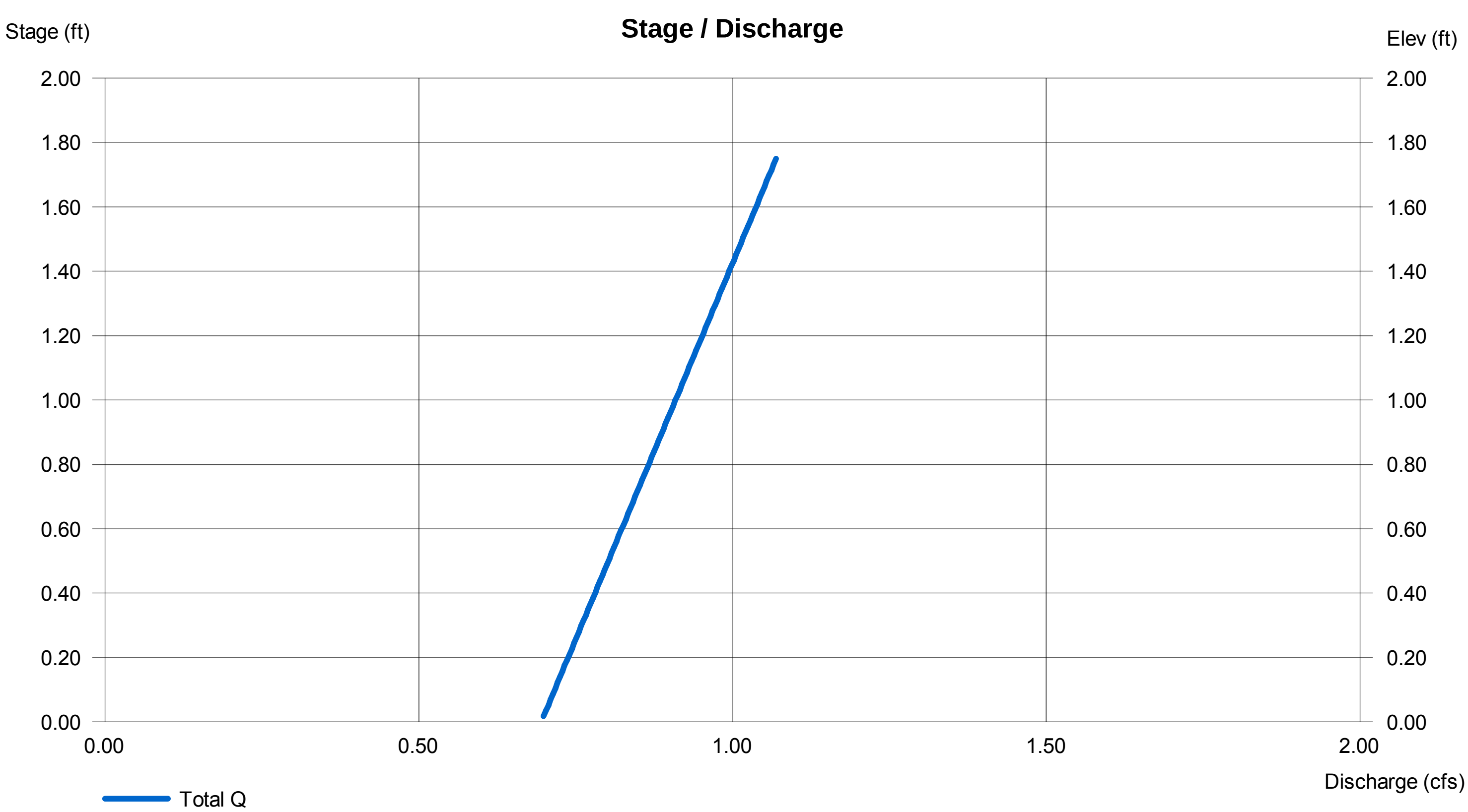
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 10.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

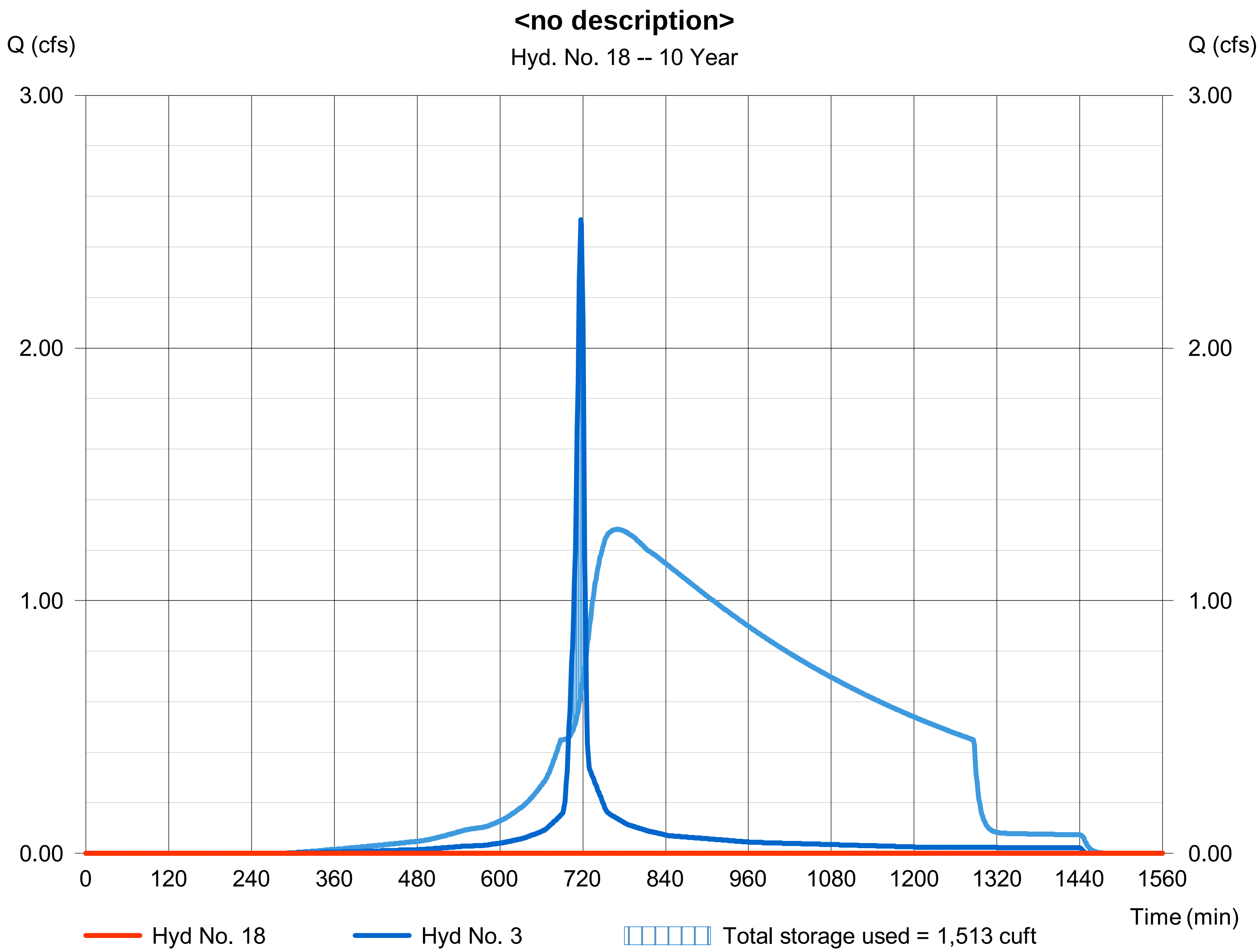
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 18

<no description>

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 814 min
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 3 - East C	Max. Elevation	= 4.21 ft
Reservoir name	= Porous Pavement East C	Max. Storage	= 1,513 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 5 - Porous Pavement East C

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 0.01 x 0.01 ft , Barrel Len = 257.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 4.00 ft, Height = 4.25 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.43	0.43	n/a	153	153
0.85	0.85	n/a	153	306
1.27	1.27	n/a	153	459
1.70	1.70	n/a	153	612
2.13	2.13	n/a	153	765
2.55	2.55	n/a	153	918
2.97	2.97	n/a	153	1,071
3.40	3.40	n/a	153	1,224
3.83	3.83	n/a	153	1,377
4.25	4.25	n/a	153	1,529

Culvert / Orifice Structures

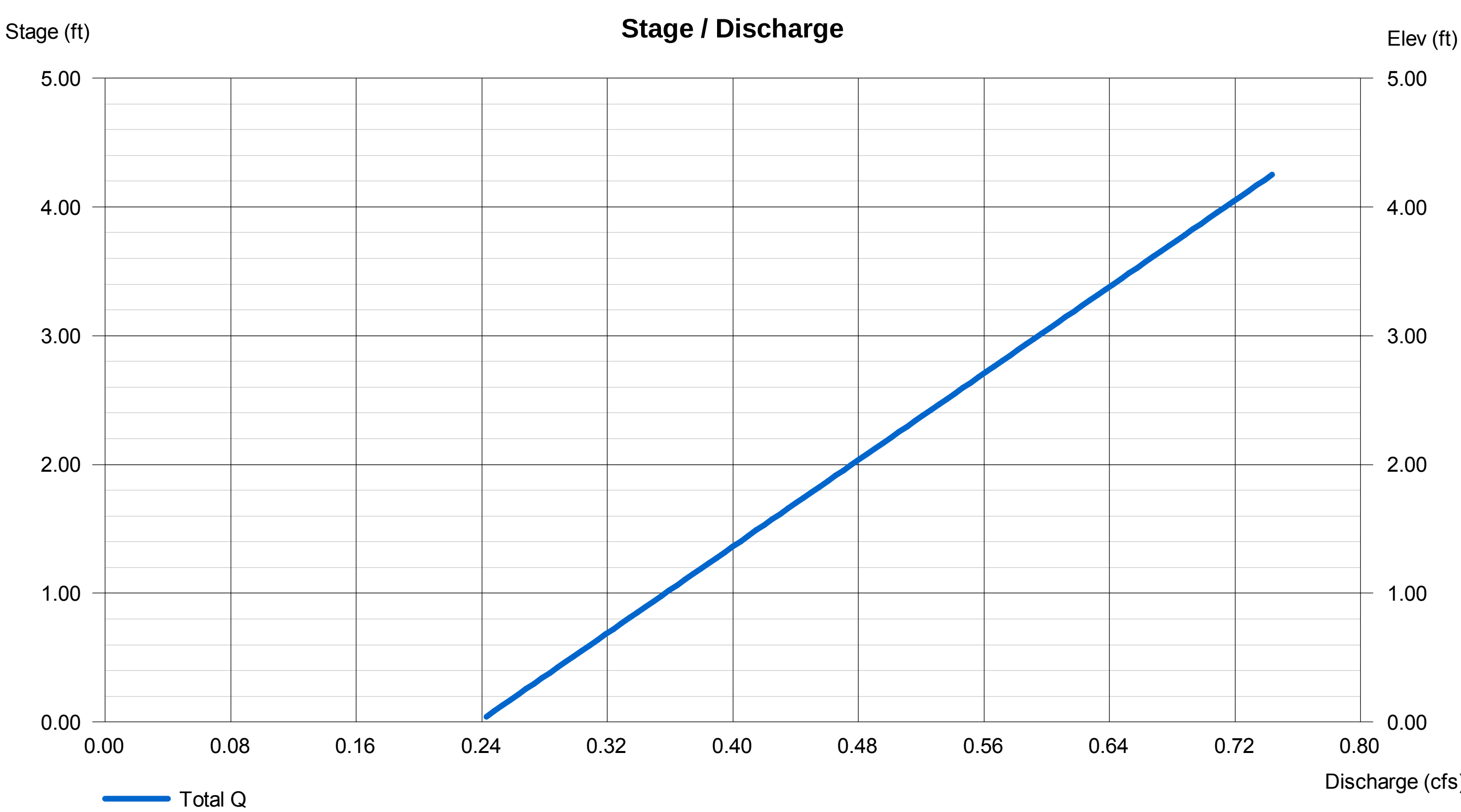
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 10.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

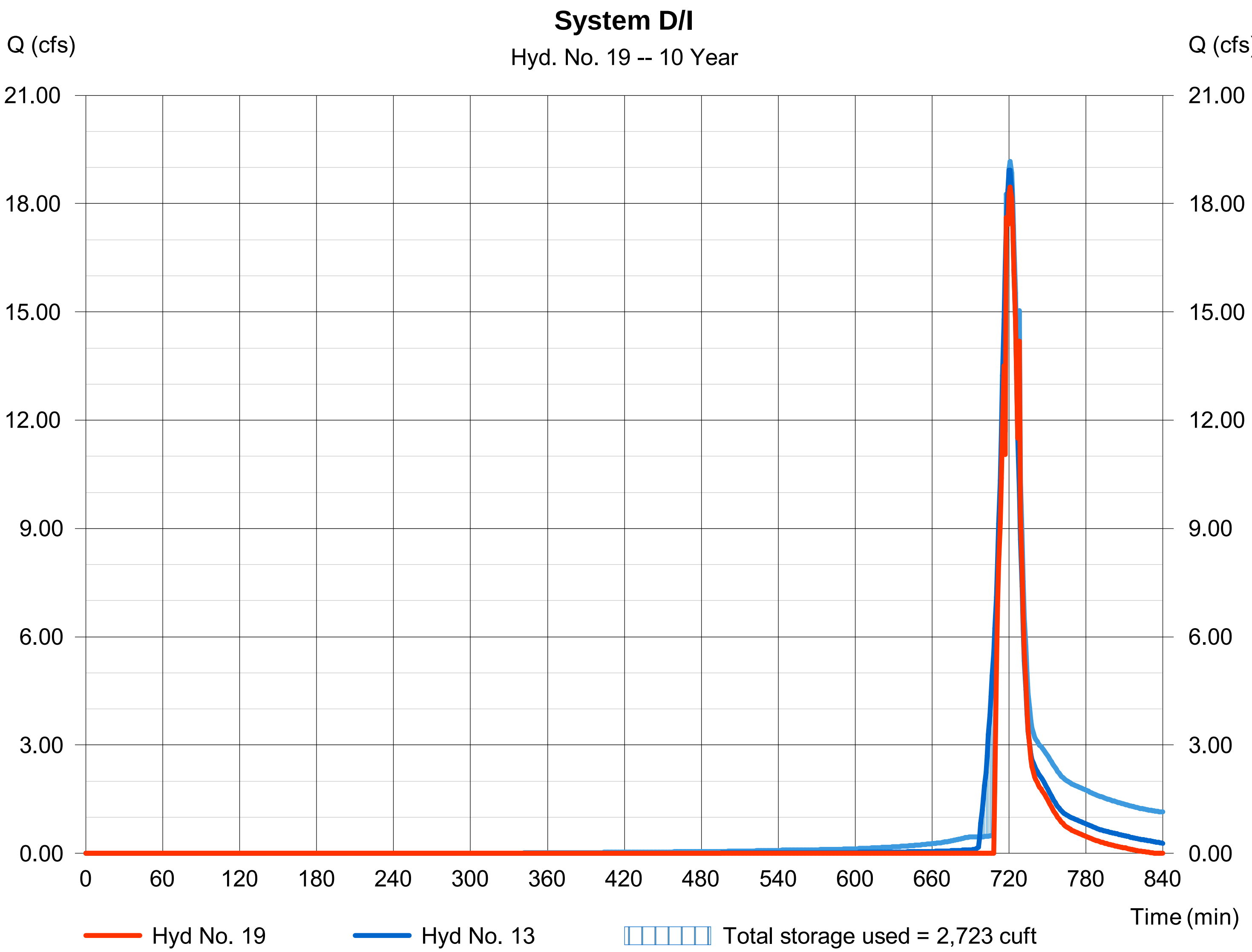
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 19

System D/I

Hydrograph type	= Reservoir	Peak discharge	= 18.46 cfs
Storm frequency	= 10 yrs	Time to peak	= 721 min
Time interval	= 1 min	Hyd. volume	= 21,649 cuft
Inflow hyd. No.	= 13 - Combined Hydrograph	Max. Elevation	= 5.47 ft
Reservoir name	= Porous Pavement I/D	Max. Storage	= 2,723 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 6 - Porous Pavement I/D

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 4.67 x 3.33 ft , Barrel Len = 119.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 5.50 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.55	0.55	n/a	292	292
1.10	1.10	n/a	295	586
1.65	1.65	n/a	295	881
2.20	2.20	n/a	295	1,175
2.75	2.75	n/a	295	1,470
3.30	3.30	n/a	295	1,765
3.85	3.85	n/a	295	2,059
4.40	4.40	n/a	295	2,354
4.95	4.95	n/a	225	2,579
5.50	5.50	n/a	153	2,731

Culvert / Orifice Structures

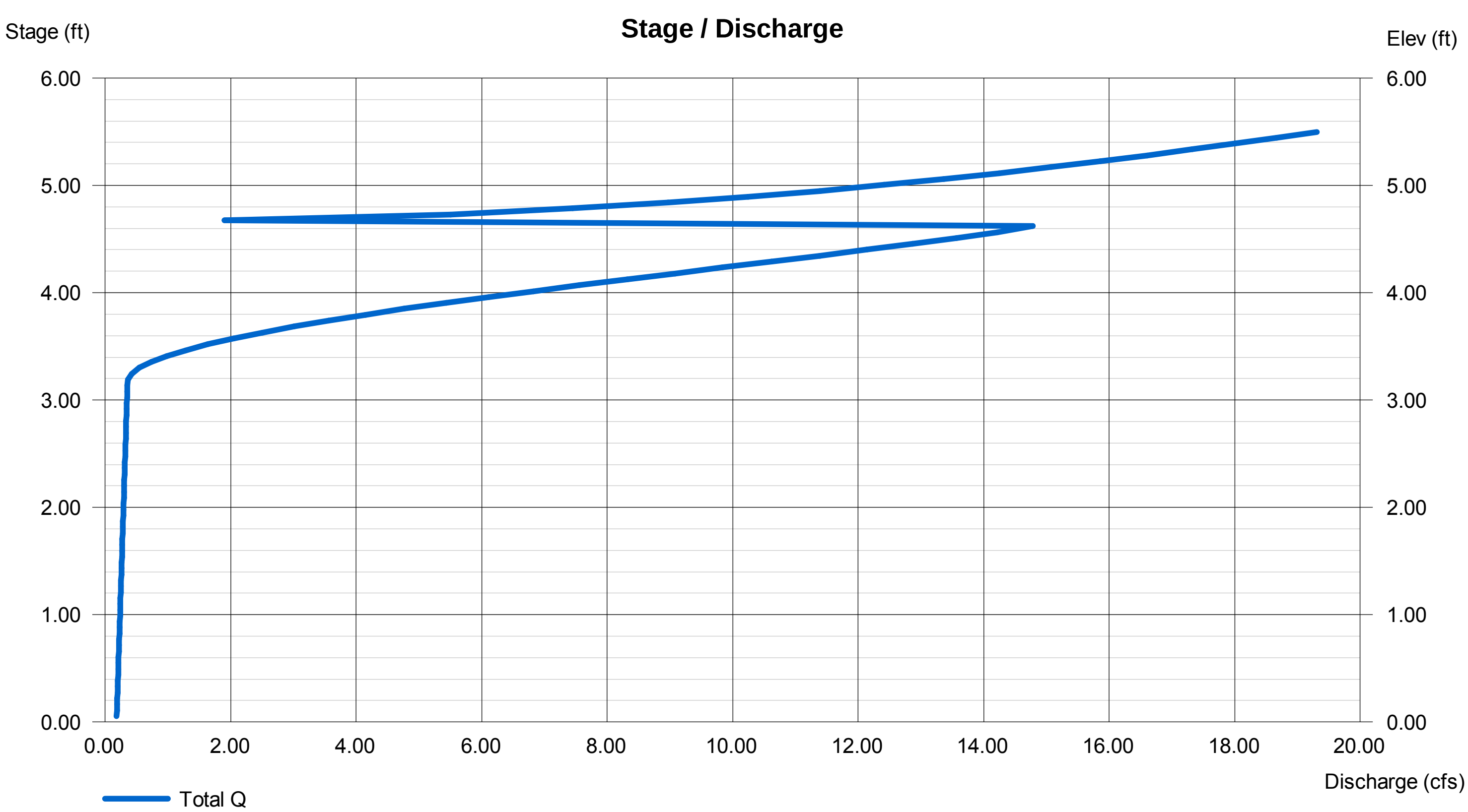
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	0.00	0.00	0.00
Span (in)	= 18.00	0.00	0.00	0.00
No. Barrels	= 2	0	0	0
Invert El. (ft)	= 3.17	0.00	0.00	0.00
Length (ft)	= 25.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 10.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

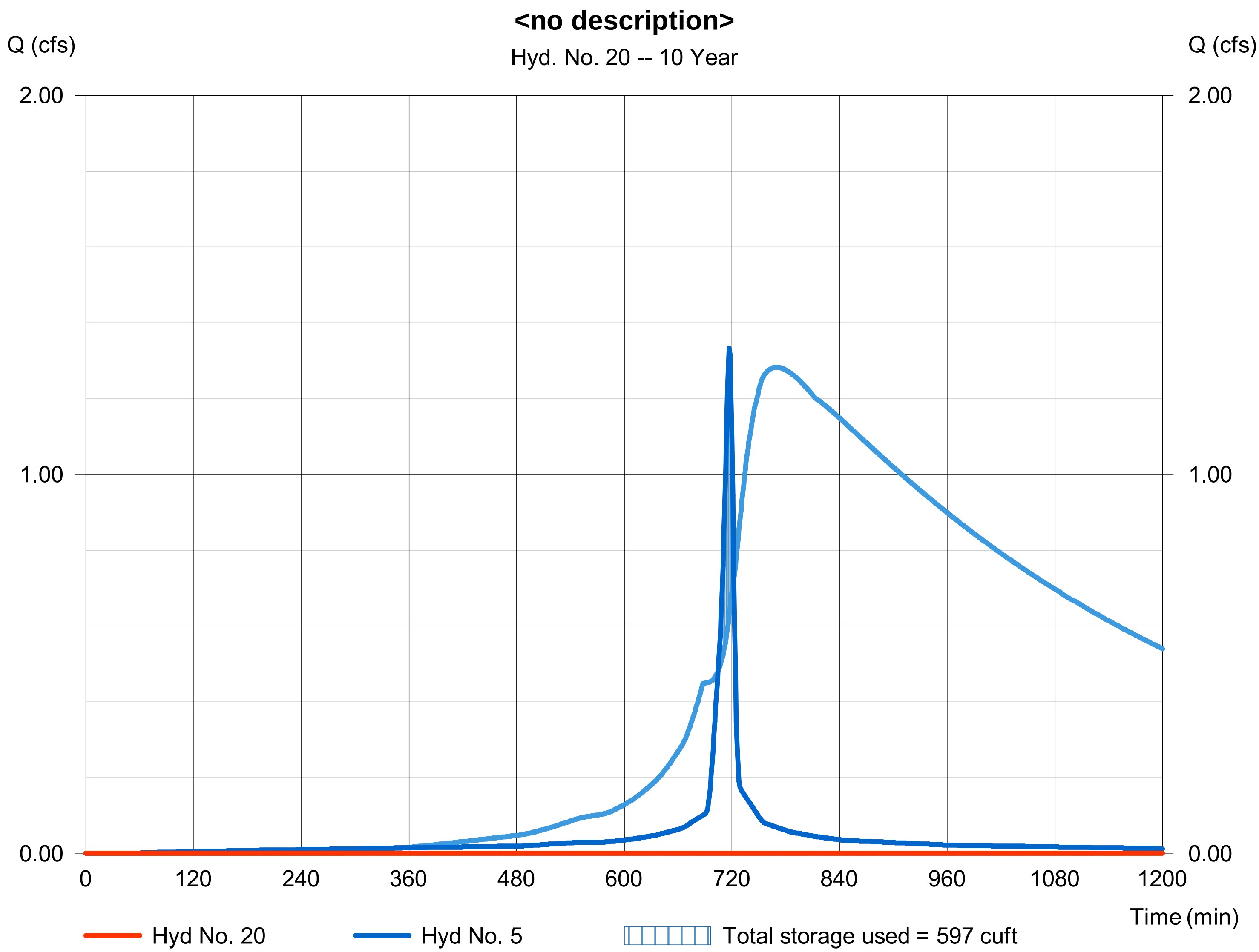
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 | Friday, Jan 20, 2012

Hyd. No. 20

<no description>

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 658 min
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 5 - East E	Max. Elevation	= 1.10 ft
Reservoir name	= Porous Pavement East E	Max. Storage	= 597 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Pond No. 7 - Porous Pavement East E

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 0.01 x 0.01 ft , Barrel Len = 205.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 7.60 ft, Height = 1.25 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.13	0.13	n/a	68	68
0.25	0.25	n/a	68	136
0.38	0.38	n/a	68	205
0.50	0.50	n/a	68	273
0.63	0.63	n/a	68	341
0.75	0.75	n/a	68	409
0.88	0.88	n/a	68	477
1.00	1.00	n/a	68	545
1.13	1.13	n/a	68	614
1.25	1.25	n/a	68	682

Culvert / Orifice Structures

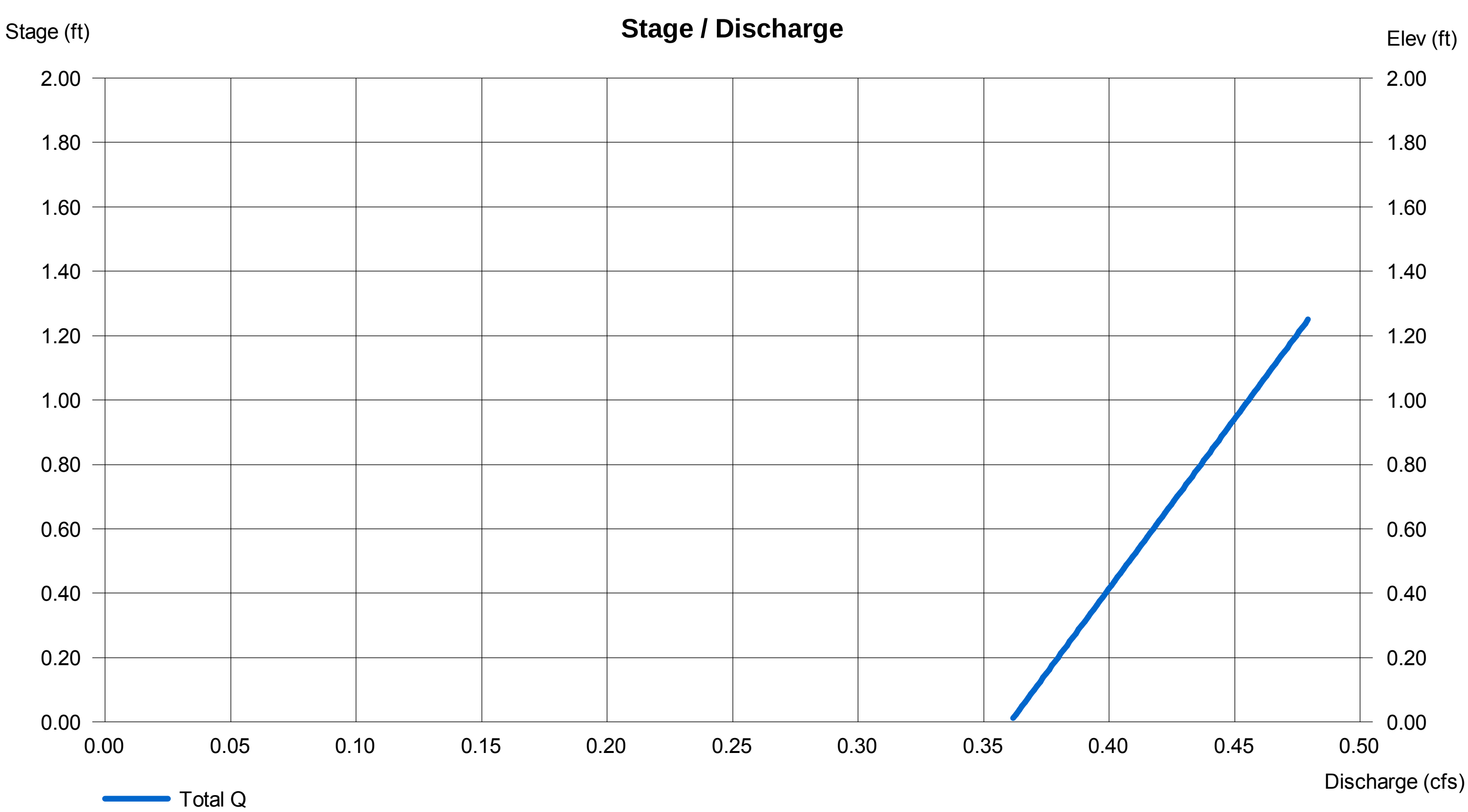
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 10.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

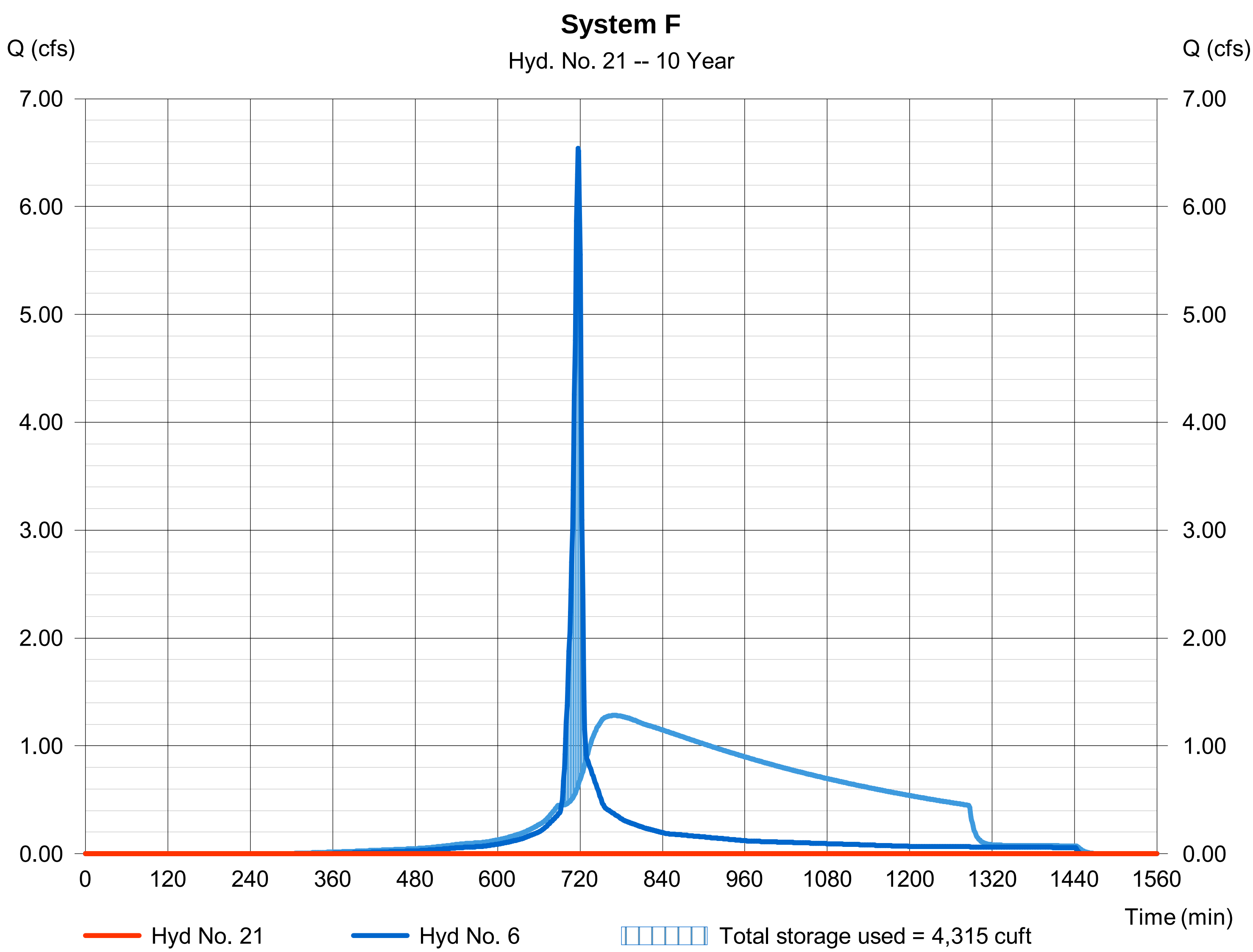
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 21

System F

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 696 min
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 6 - East F	Max. Elevation	= 2.37 ft
Reservoir name	= Porous Pavement F	Max. Storage	= 4,315 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 8 - Porous Pavement F

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 1.67 x 3.33 ft , Barrel Len = 472.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 2.50 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.25	0.25	n/a	521	521
0.50	0.50	n/a	531	1,052
0.75	0.75	n/a	531	1,583
1.00	1.00	n/a	531	2,114
1.25	1.25	n/a	531	2,645
1.50	1.50	n/a	531	3,176
1.75	1.75	n/a	459	3,635
2.00	2.00	n/a	276	3,911
2.25	2.25	n/a	276	4,186
2.50	2.50	n/a	276	4,462

Culvert / Orifice Structures

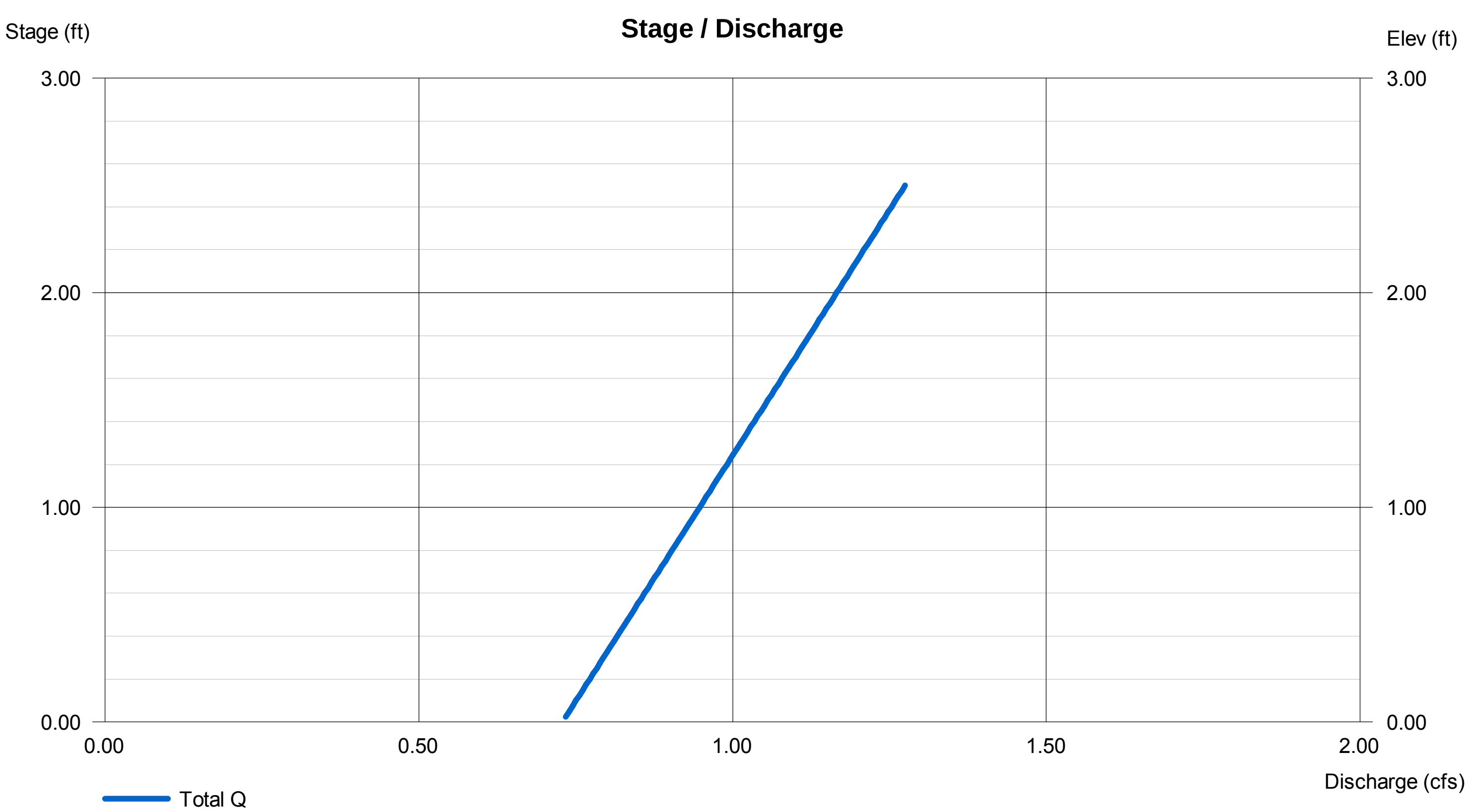
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 10.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

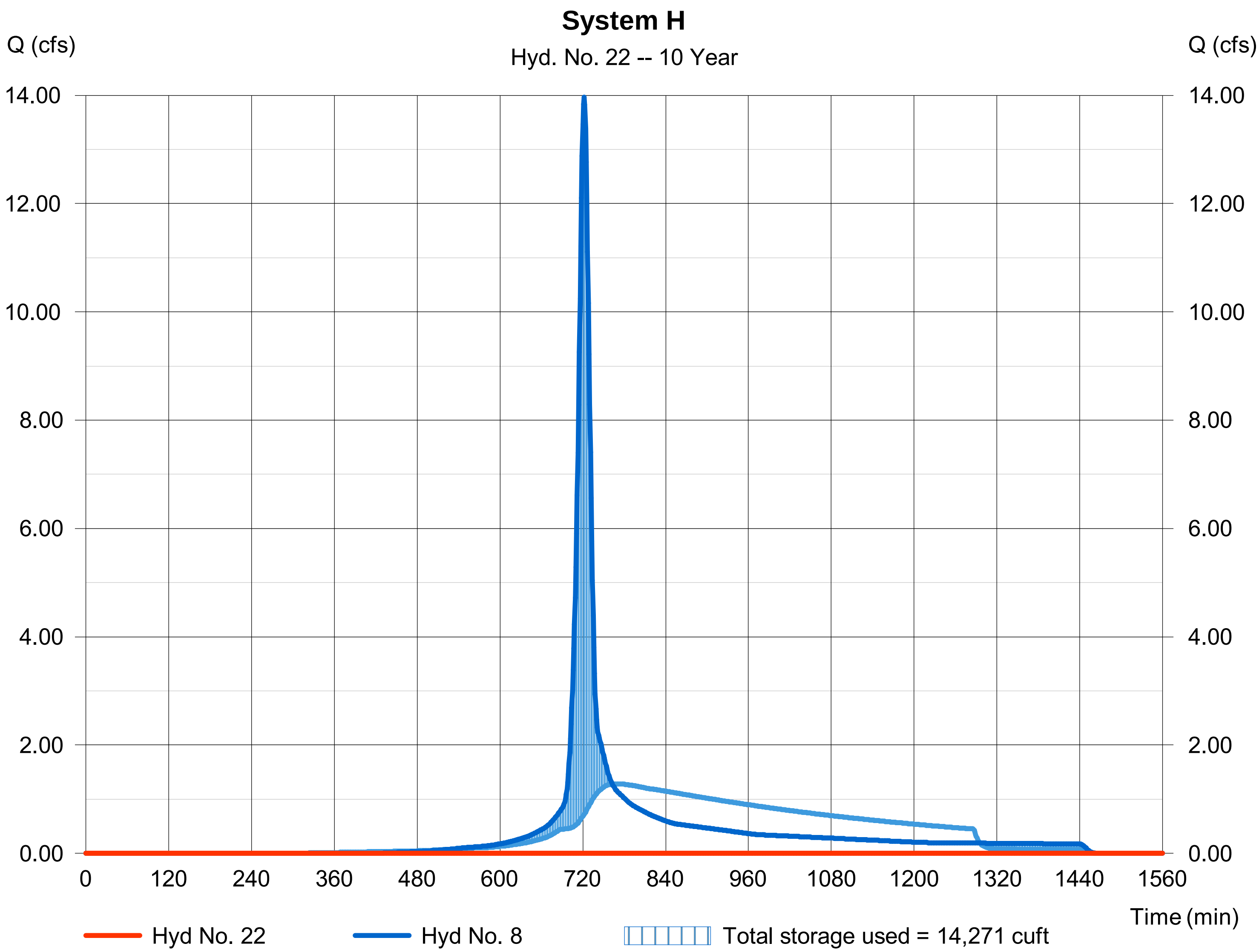
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 22

System H

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 689 min
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 8 - East H	Max. Elevation	= 6.42 ft
Reservoir name	= Porous Pavement East H	Max. Storage	= 14,271 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 10 - Porous Pavement East H

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 6.00 x 3.33 ft , Barrel Len = 510.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 6.83 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.68	0.68	n/a	1,556	1,556
1.37	1.37	n/a	1,567	3,124
2.05	2.05	n/a	1,567	4,691
2.73	2.73	n/a	1,567	6,259
3.41	3.41	n/a	1,567	7,826
4.10	4.10	n/a	1,567	9,394
4.78	4.78	n/a	1,567	10,961
5.46	5.46	n/a	1,567	12,529
6.15	6.15	n/a	1,416	13,945
6.83	6.83	n/a	813	14,758

Culvert / Orifice Structures

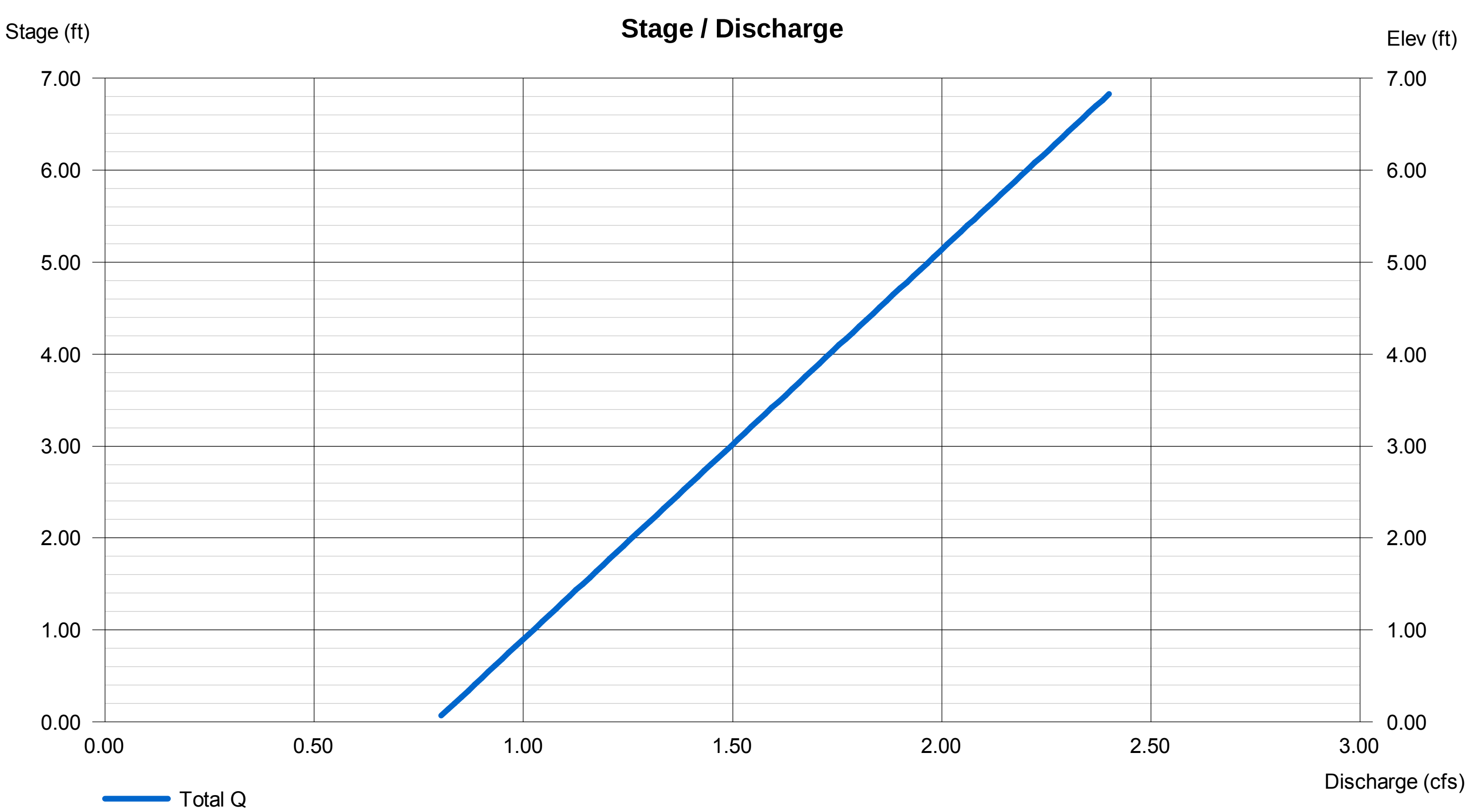
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 10.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

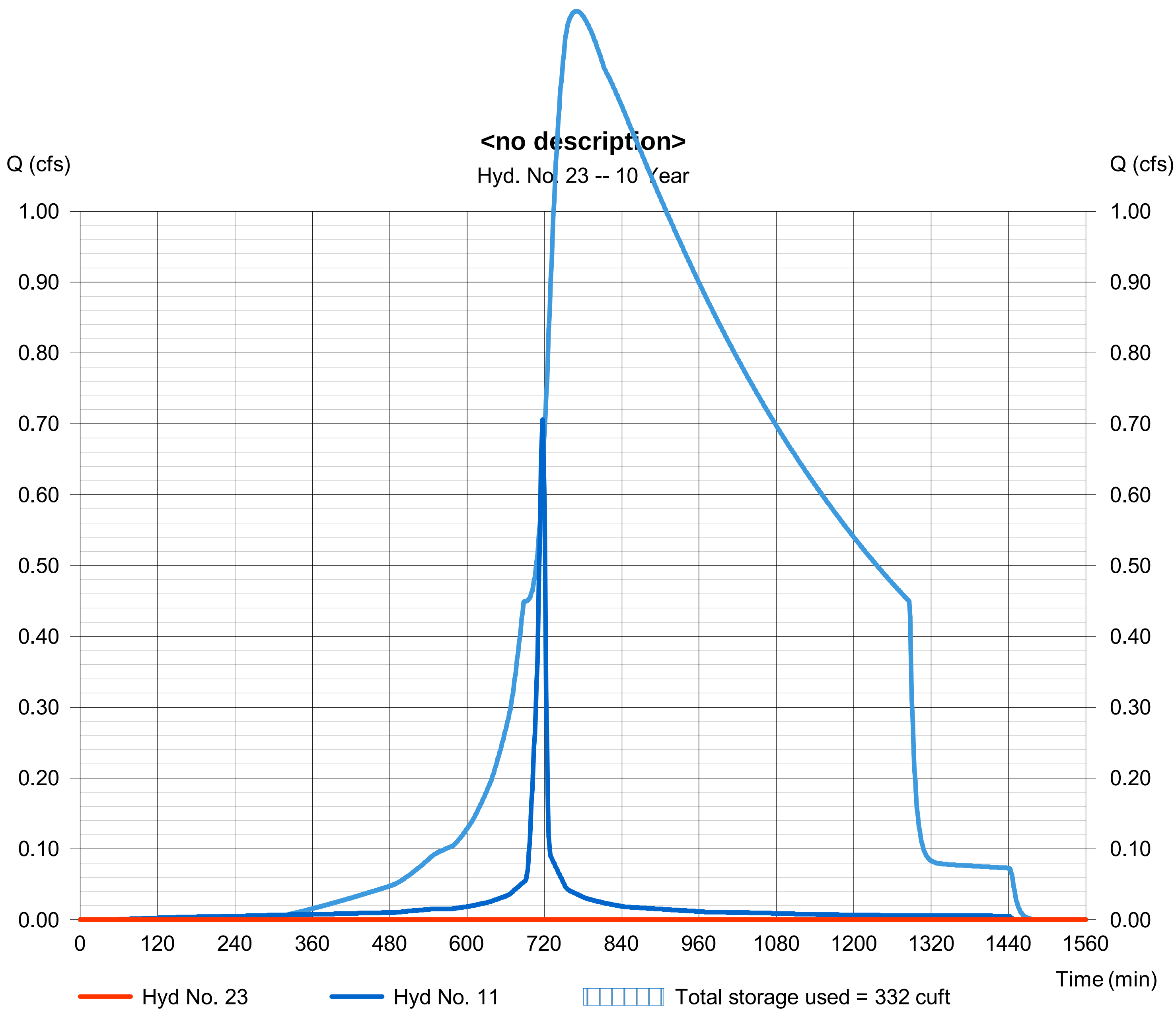
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 23

<no description>

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 698 min
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 11 - East K	Max. Elevation	= 1.41 ft
Reservoir name	= Porous Pavement East K	Max. Storage	= 332 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Pond No. 11 - Porous Pavement East K

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 0.01 x 0.01 ft , Barrel Len = 168.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 4.00 ft, Height = 1.50 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.15	0.15	n/a	35	35
0.30	0.30	n/a	35	71
0.45	0.45	n/a	35	106
0.60	0.60	n/a	35	141
0.75	0.75	n/a	35	176
0.90	0.90	n/a	35	212
1.05	1.05	n/a	35	247
1.20	1.20	n/a	35	282
1.35	1.35	n/a	35	318
1.50	1.50	n/a	35	353

Culvert / Orifice Structures

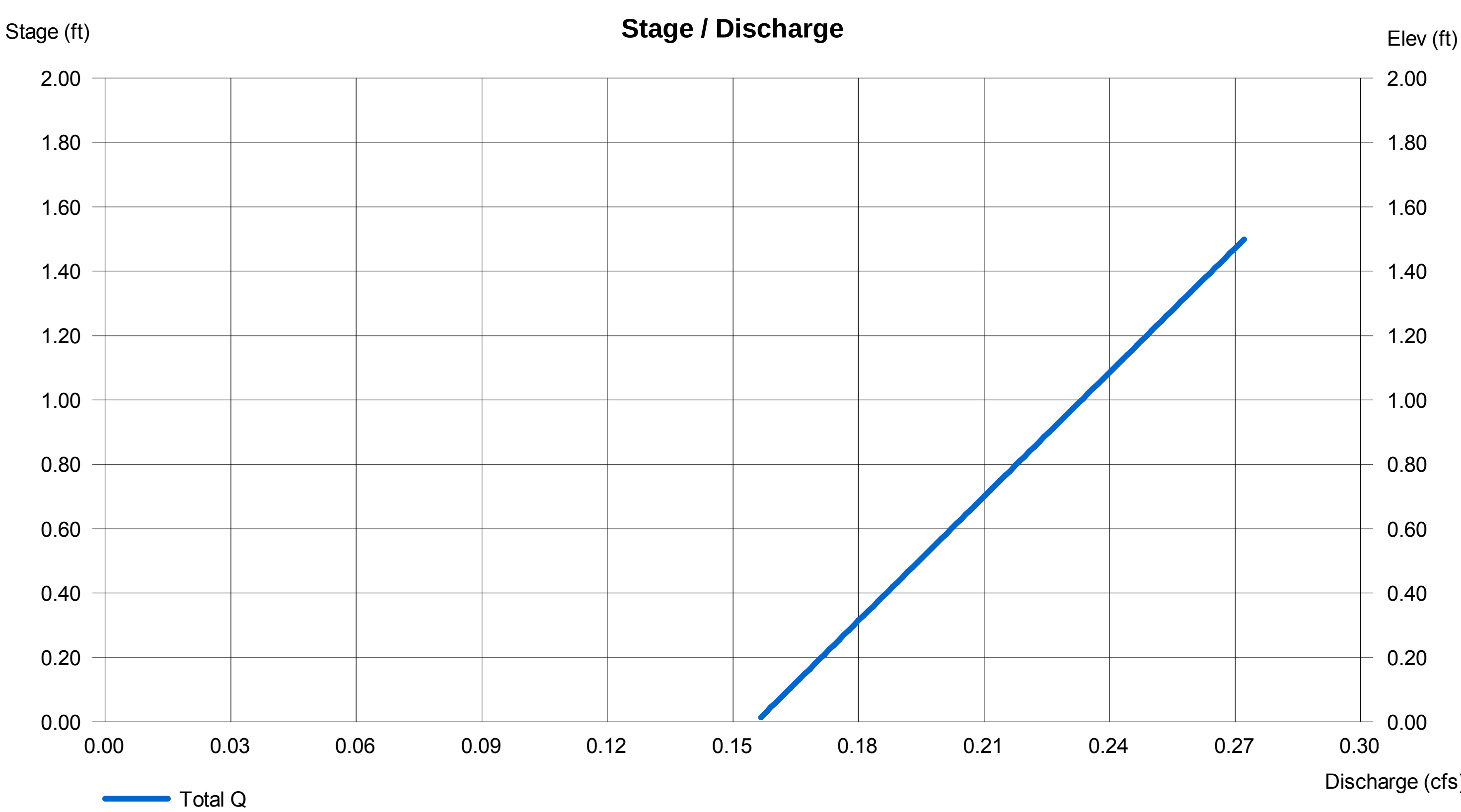
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 10.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

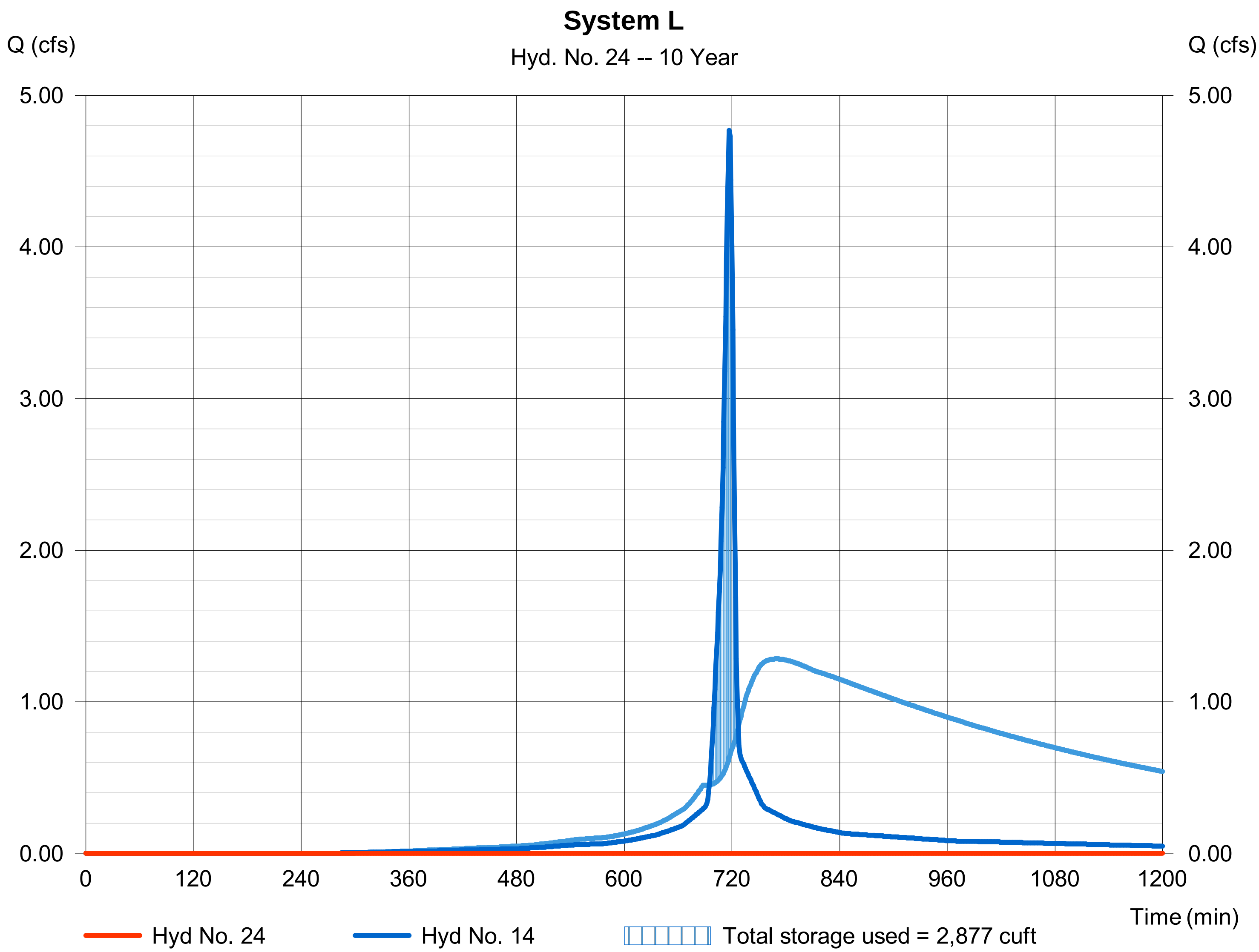
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 24

System L

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 14 - East L	Max. Elevation	= 2.08 ft
Reservoir name	= Porous Pavement East L	Max. Storage	= 2,877 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Pond No. 12 - Porous Pavement East L

Pond Data

UG Chambers - Invert elev. = 0.50 ft , Rise x Span = 1.04 x 3.00 ft , Barrel Len = 515.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 5.50 ft, Height = 2.50 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.25	0.25	n/a	248	248
0.50	0.50	n/a	248	496
0.75	0.75	n/a	497	992
1.00	1.00	n/a	481	1,474
1.25	1.25	n/a	447	1,921
1.50	1.50	n/a	379	2,300
1.75	1.75	n/a	255	2,556
2.00	2.00	n/a	248	2,804
2.25	2.25	n/a	248	3,051
2.50	2.50	n/a	248	3,299

Culvert / Orifice Structures

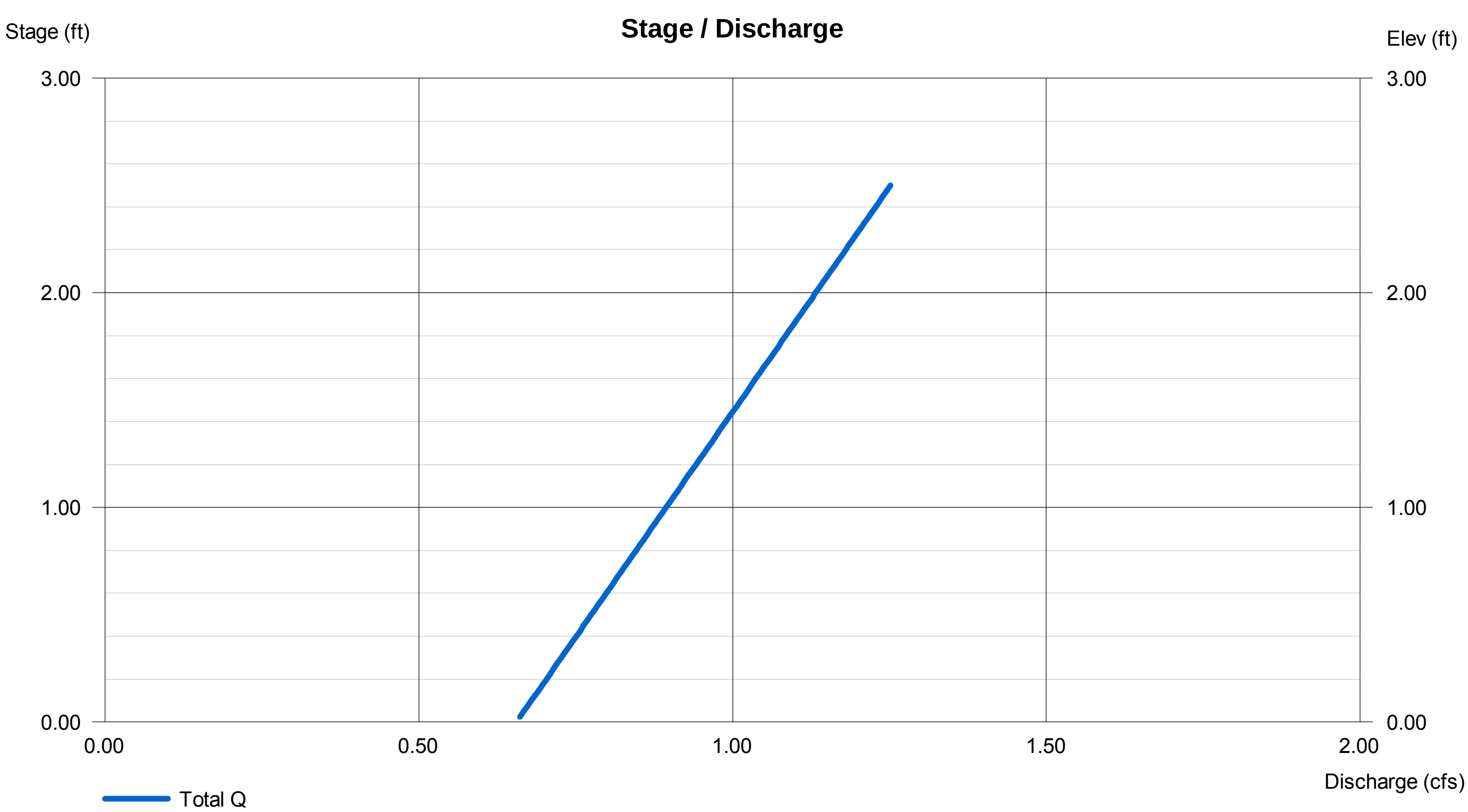
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 10.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

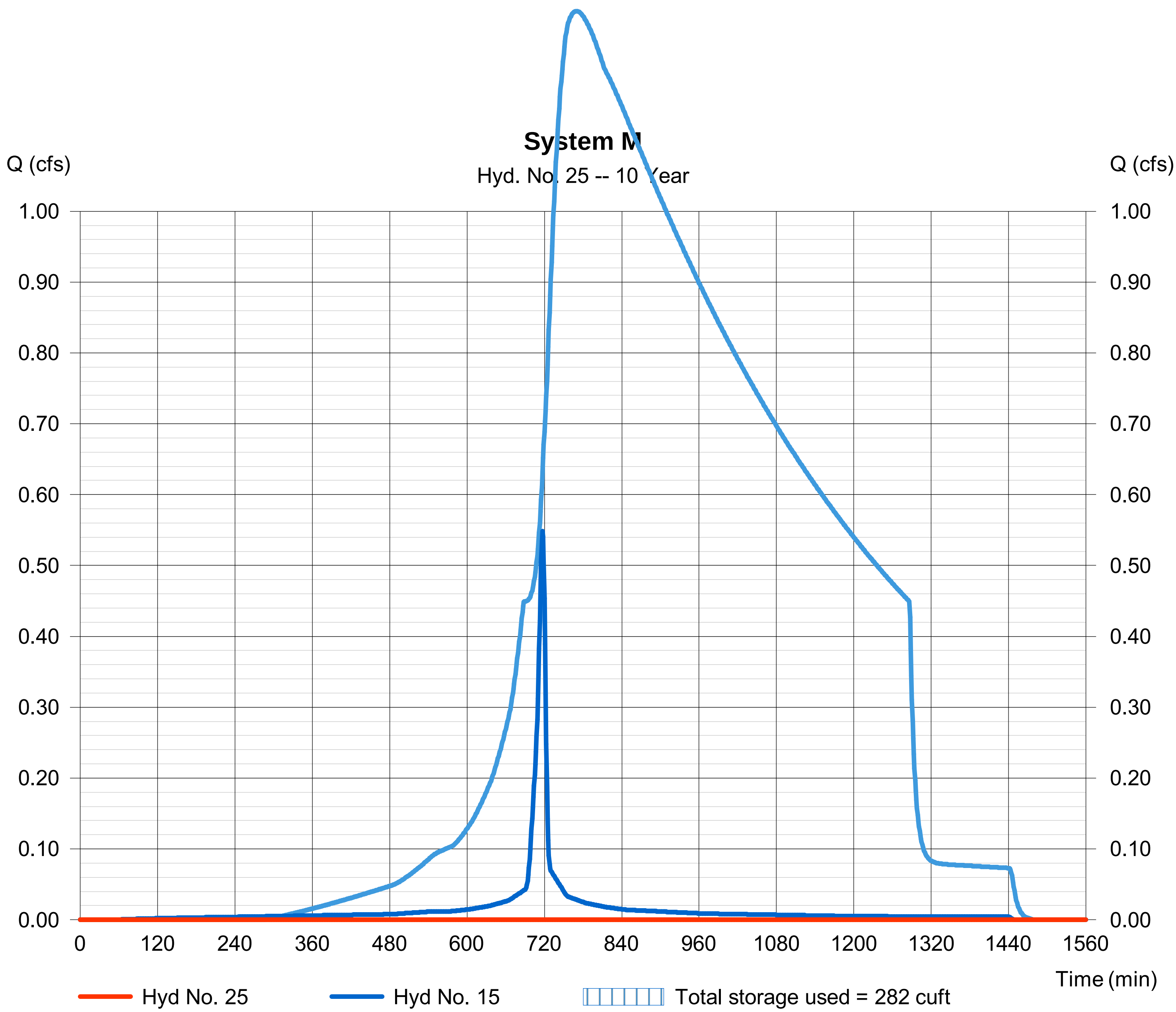
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 25

System M

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 699 min
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 15 - East M	Max. Elevation	= 1.56 ft
Reservoir name	= Porous Pavement East M	Max. Storage	= 282 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 | Friday, Jan 20, 2012

Pond No. 13 - Porous Pavement East M

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 0.01 x 0.01 ft , Barrel Len = 68.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 7.60 ft, Height = 1.75 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.17	0.17	n/a	32	32
0.35	0.35	n/a	32	63
0.52	0.52	n/a	32	95
0.70	0.70	n/a	32	127
0.88	0.88	n/a	32	158
1.05	1.05	n/a	32	190
1.23	1.23	n/a	32	222
1.40	1.40	n/a	32	253
1.58	1.58	n/a	32	285
1.75	1.75	n/a	32	317

Culvert / Orifice Structures

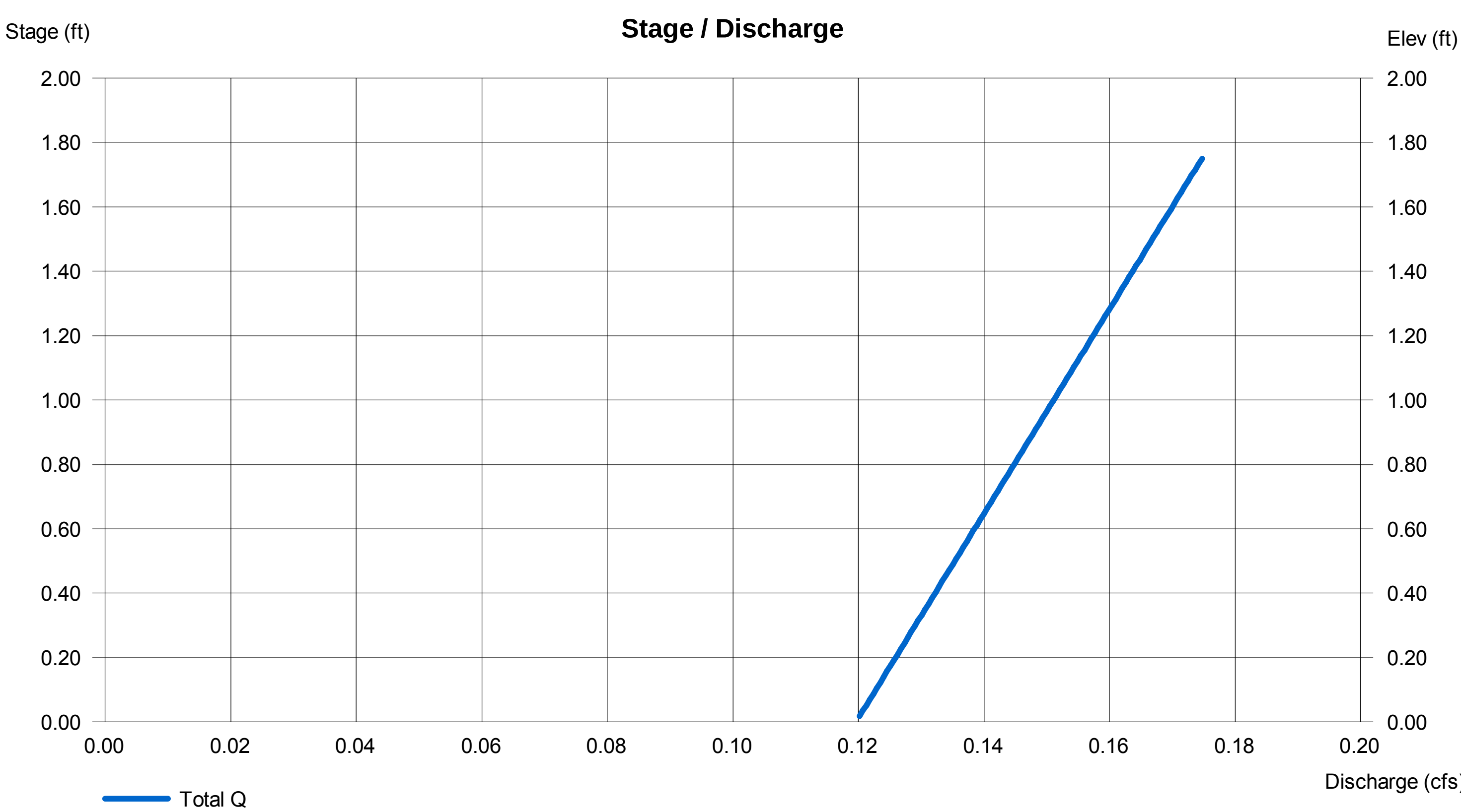
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 10.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

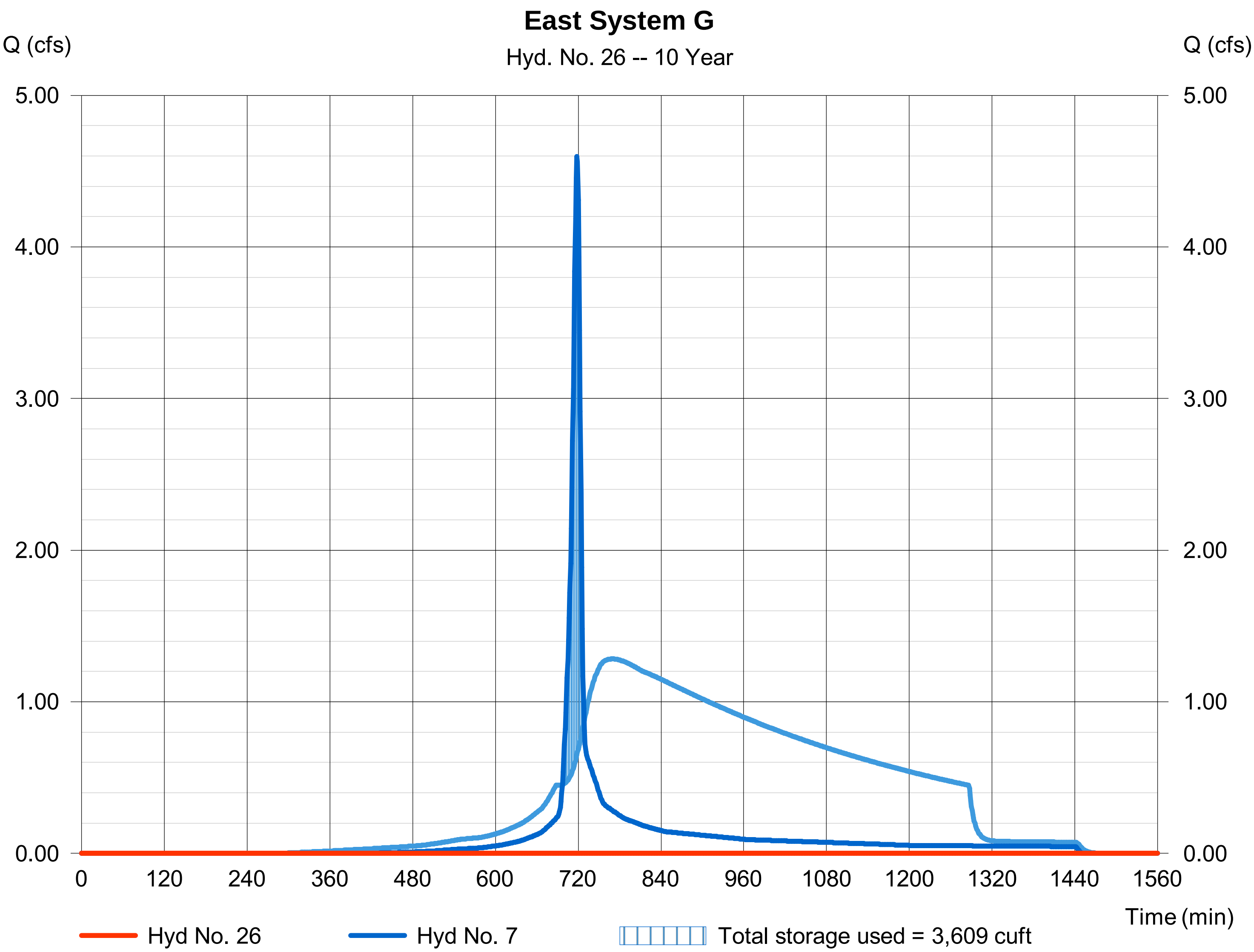
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 26

East System G

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 673 min
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 7 - East G	Max. Elevation	= 5.04 ft
Reservoir name	= Porous Pavement G	Max. Storage	= 3,609 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 14 - Porous Pavement G

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 4.67 x 3.33 ft , Barrel Len = 165.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 5.50 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.55	0.55	n/a	405	405
1.10	1.10	n/a	408	813
1.65	1.65	n/a	408	1,222
2.20	2.20	n/a	408	1,630
2.75	2.75	n/a	408	2,038
3.30	3.30	n/a	408	2,447
3.85	3.85	n/a	408	2,855
4.40	4.40	n/a	408	3,263
4.95	4.95	n/a	312	3,575
5.50	5.50	n/a	212	3,787

Culvert / Orifice Structures

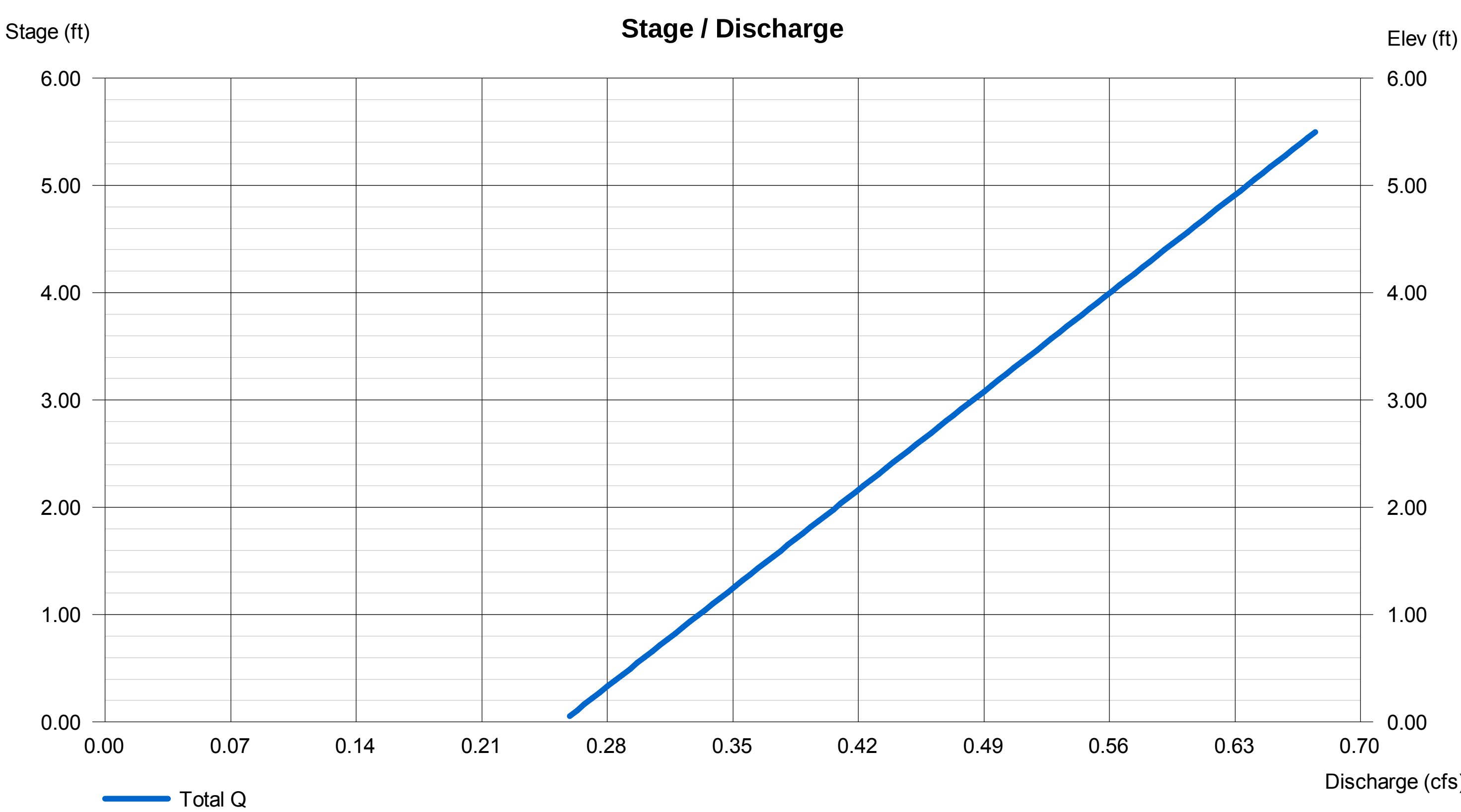
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 10.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



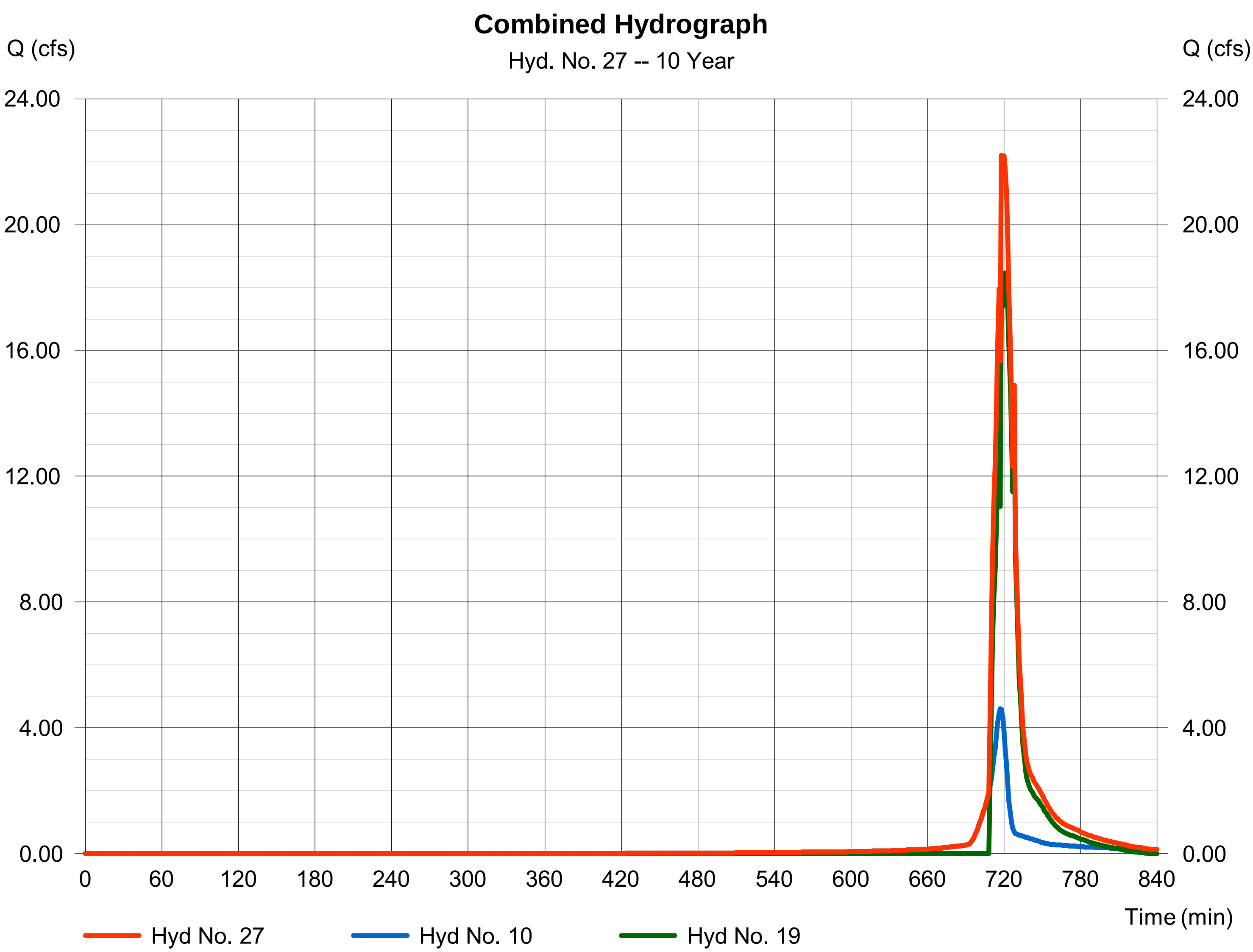
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 27

Combined Hydrograph

Hydrograph type	= Combine	Peak discharge	= 22.21 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 1 min	Hyd. volume	= 31,340 cuft
Inflow hyds.	= 10, 19	Contrib. drain. area	= 0.710 ac



Hydrograph Report

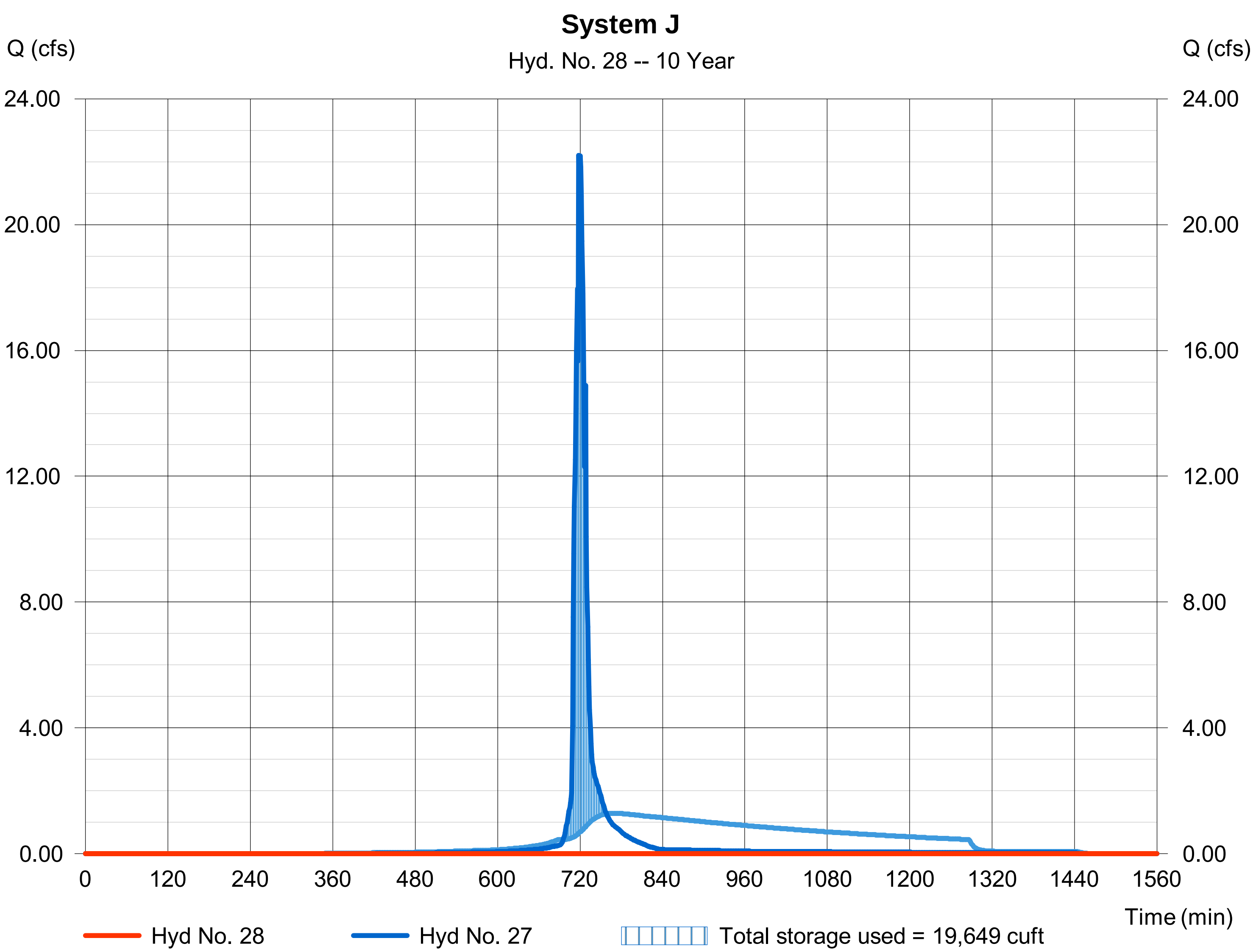
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 28

System J

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 1001 min
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 27 - Combined Hydrograph	Max. Elevation	= 4.36 ft
Reservoir name	= Porous Pavement J	Max. Storage	= 19,649 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 15 - Porous Pavement J

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 4.00 x 13.33 ft , Barrel Len = 327.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 16.67 ft, Height = 4.83 ft , Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.48	0.48	n/a	2,262	2,262
0.97	0.97	n/a	2,290	4,553
1.45	1.45	n/a	2,290	6,843
1.93	1.93	n/a	2,290	9,133
2.41	2.41	n/a	2,290	11,424
2.90	2.90	n/a	2,290	13,714
3.38	3.38	n/a	2,290	16,005
3.86	3.86	n/a	2,290	18,295
4.35	4.35	n/a	1,335	19,631
4.83	4.83	n/a	922	20,552

Culvert / Orifice Structures

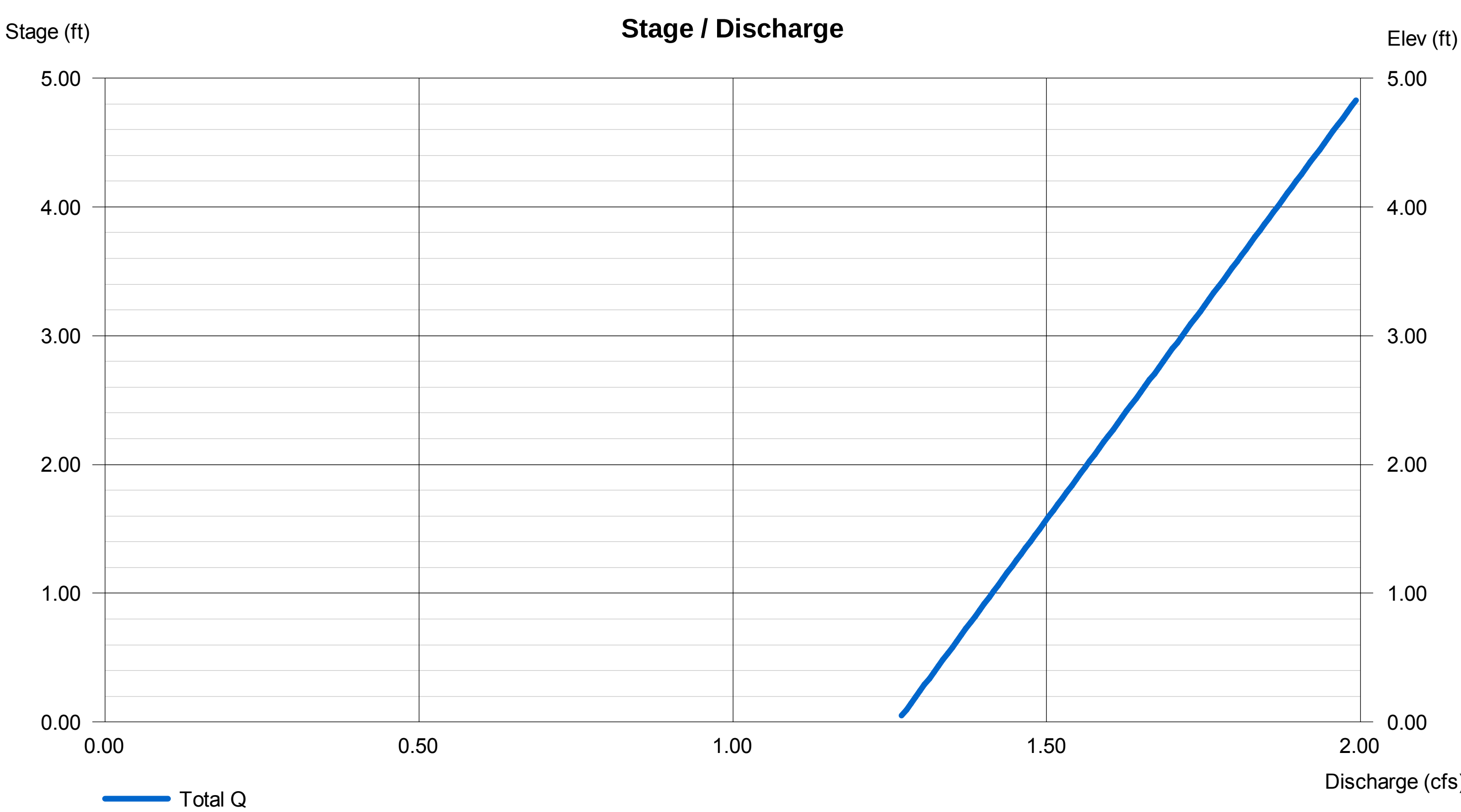
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

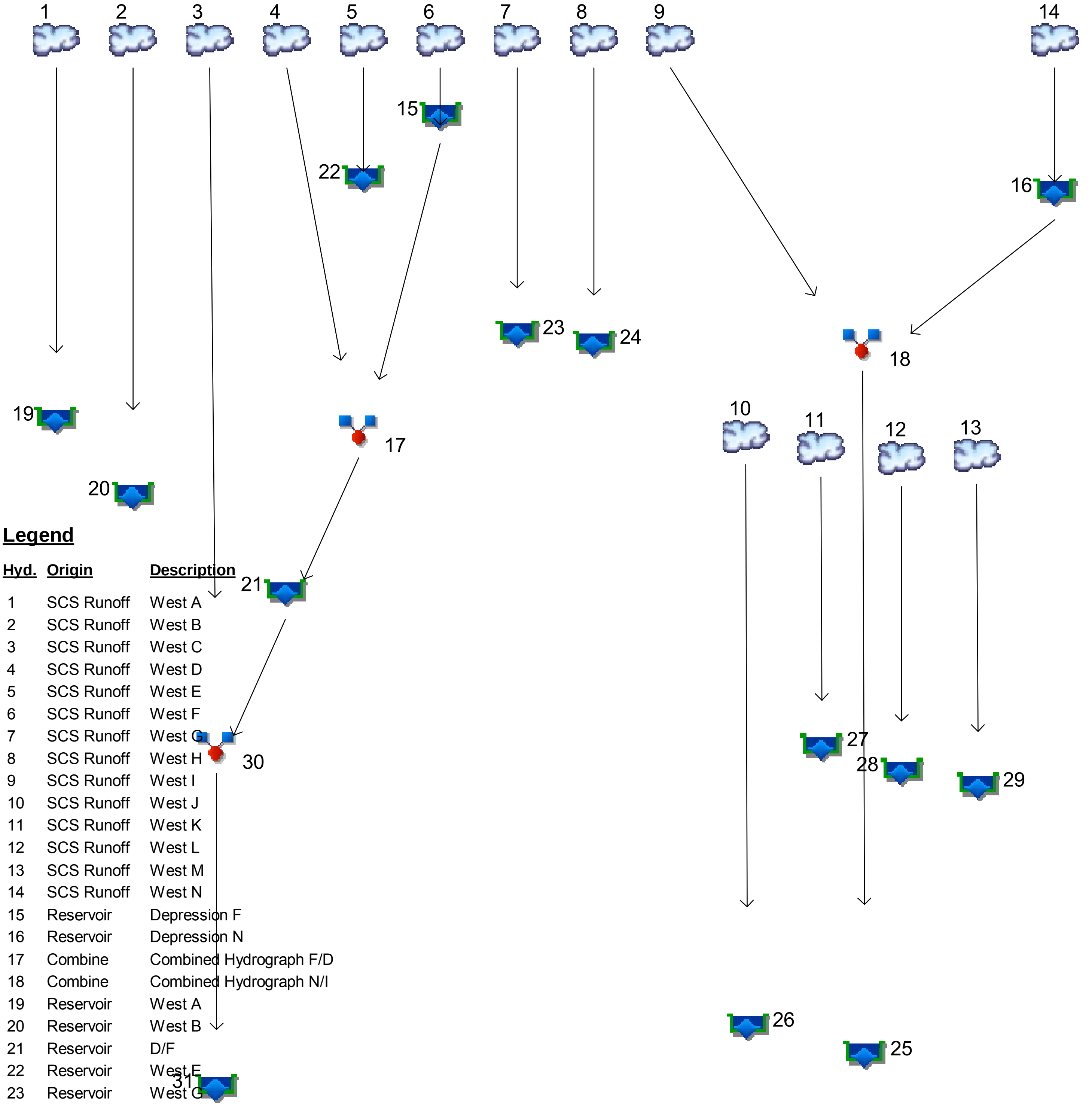
Exfil.(in/hr) = 10.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8



Legend

Hyd.	Origin	Description
1	SCS Runoff	West A
2	SCS Runoff	West B
3	SCS Runoff	West C
4	SCS Runoff	West D
5	SCS Runoff	West E
6	SCS Runoff	West F
7	SCS Runoff	West G
8	SCS Runoff	West H
9	SCS Runoff	West I
10	SCS Runoff	West J
11	SCS Runoff	West K
12	SCS Runoff	West L
13	SCS Runoff	West M
14	SCS Runoff	West N
15	Reservoir	Depression F
16	Reservoir	Depression N
17	Combine	Combined Hydrograph F/D
18	Combine	Combined Hydrograph N/I
19	Reservoir	West A
20	Reservoir	West B
21	Reservoir	D/F
22	Reservoir	West E
23	Reservoir	West G
24	Reservoir	West H
25	Reservoir	I/N
26	Reservoir	West J
27	Reservoir	West K
28	Reservoir	West L
29	Reservoir	West M
30	Combine	<no description>
31	Reservoir	West C

Project: SDA_TR20_West_20111214.gpw

Friday, Jan 20, 2012

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	8.563	1	717	18,099	------	------	------	West A
2	SCS Runoff	2.665	1	717	6,444	------	------	------	West B
3	SCS Runoff	8.538	1	717	18,162	------	------	------	West C
4	SCS Runoff	1.830	1	717	3,892	------	------	------	West D
5	SCS Runoff	1.624	1	717	3,412	------	------	------	West E
6	SCS Runoff	9.390	1	728	33,401	------	------	------	West F
7	SCS Runoff	1.659	1	717	3,508	------	------	------	West G
8	SCS Runoff	1.244	1	717	2,665	------	------	------	West H
9	SCS Runoff	1.626	1	717	3,460	------	------	------	West I
10	SCS Runoff	12.73	1	723	36,453	------	------	------	West J
11	SCS Runoff	1.137	1	717	2,585	------	------	------	West K
12	SCS Runoff	1.423	1	717	3,027	------	------	------	West L
13	SCS Runoff	6.986	1	717	14,602	------	------	------	West M
14	SCS Runoff	5.882	1	718	12,000	------	------	------	West N
15	Reservoir	9.134	1	729	21,638	6	281.17	2,181	Depression F
16	Reservoir	5.488	1	718	4,816	14	280.19	2,243	Depression N
17	Combine	9.393	1	728	25,530	4, 15,	------	------	Combined Hydrograph F/D
18	Combine	7.104	1	718	8,275	9, 16,	------	------	Combined Hydrograph N/I
19	Reservoir	0.000	1	n/a	0	1	3.75	7,576	West A
20	Reservoir	0.000	1	320	0	2	2.07	1,948	West B
21	Reservoir	8.996	1	729	14,332	17	8.27	5,601	D/F
22	Reservoir	0.000	1	674	0	5	2.80	1,349	West E
23	Reservoir	0.000	1	624	0	7	4.19	1,507	West G
24	Reservoir	0.000	1	n/a	0	8	2.14	983	West H
25	Reservoir	0.000	1	689	0	18	7.95	5,407	I/N
26	Reservoir	0.000	1	651	0	10	6.42	16,784	West J
27	Reservoir	0.000	1	n/a	0	11	2.11	818	West K
28	Reservoir	0.000	1	604	0	12	2.42	1,177	West L
29	Reservoir	0.000	1	466	0	13	4.14	6,227	West M
30	Combine	10.77	1	723	32,495	3, 21,	------	------	<no description>
31	Reservoir	0.000	1	1287	0	30	7.46	18,864	West C

SDA_TR20_West_20111214.gpw	Return Period: 10 Year	Friday, Jan 20, 2012

Hydrograph Report

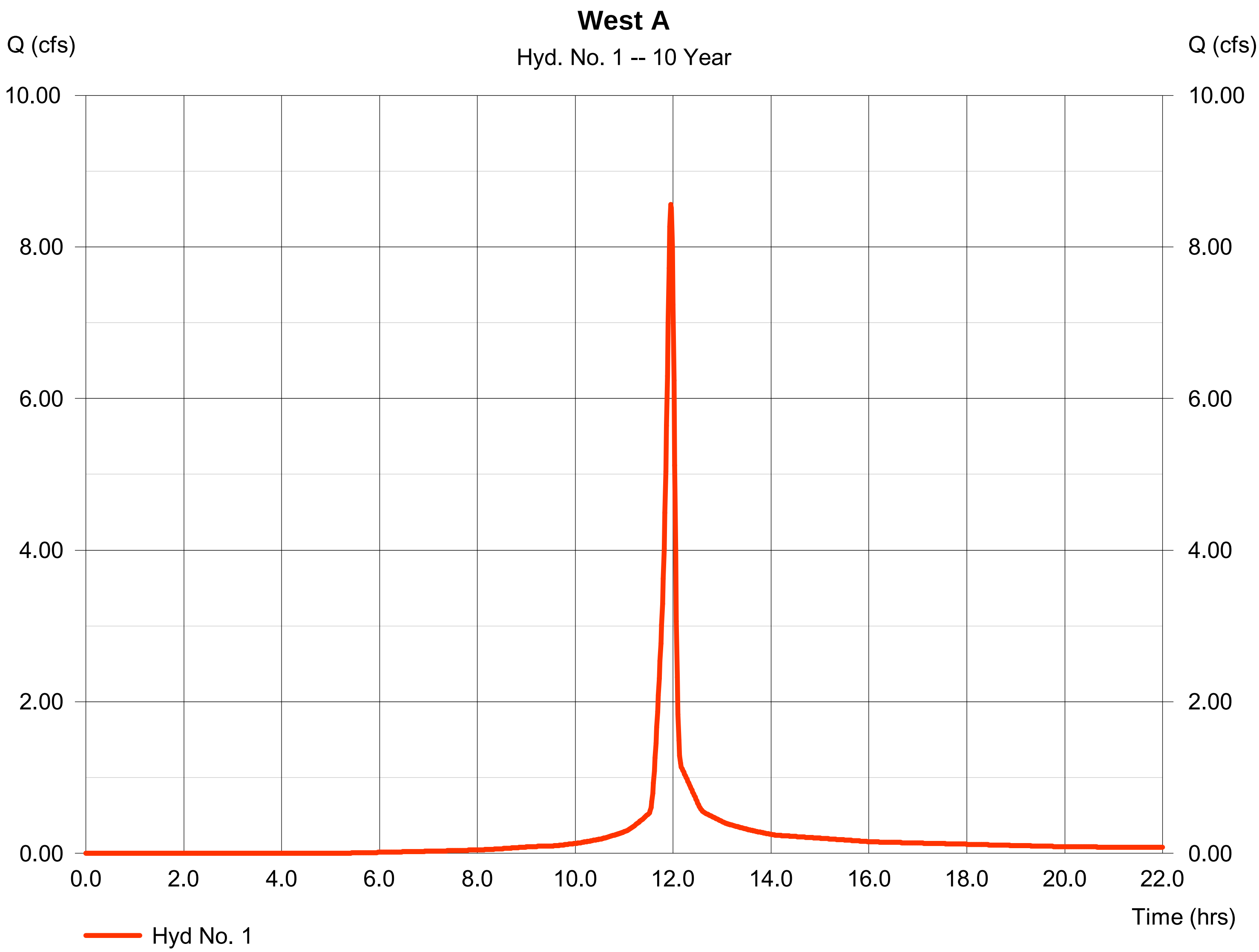
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 | Friday, Jan 20, 2012

Hyd. No. 1

West A

Hydrograph type	= SCS Runoff	Peak discharge	= 8.563 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 18,099 cuft
Drainage area	= 1.290 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.490 x 98) + (0.800 x 78)] / 1.290



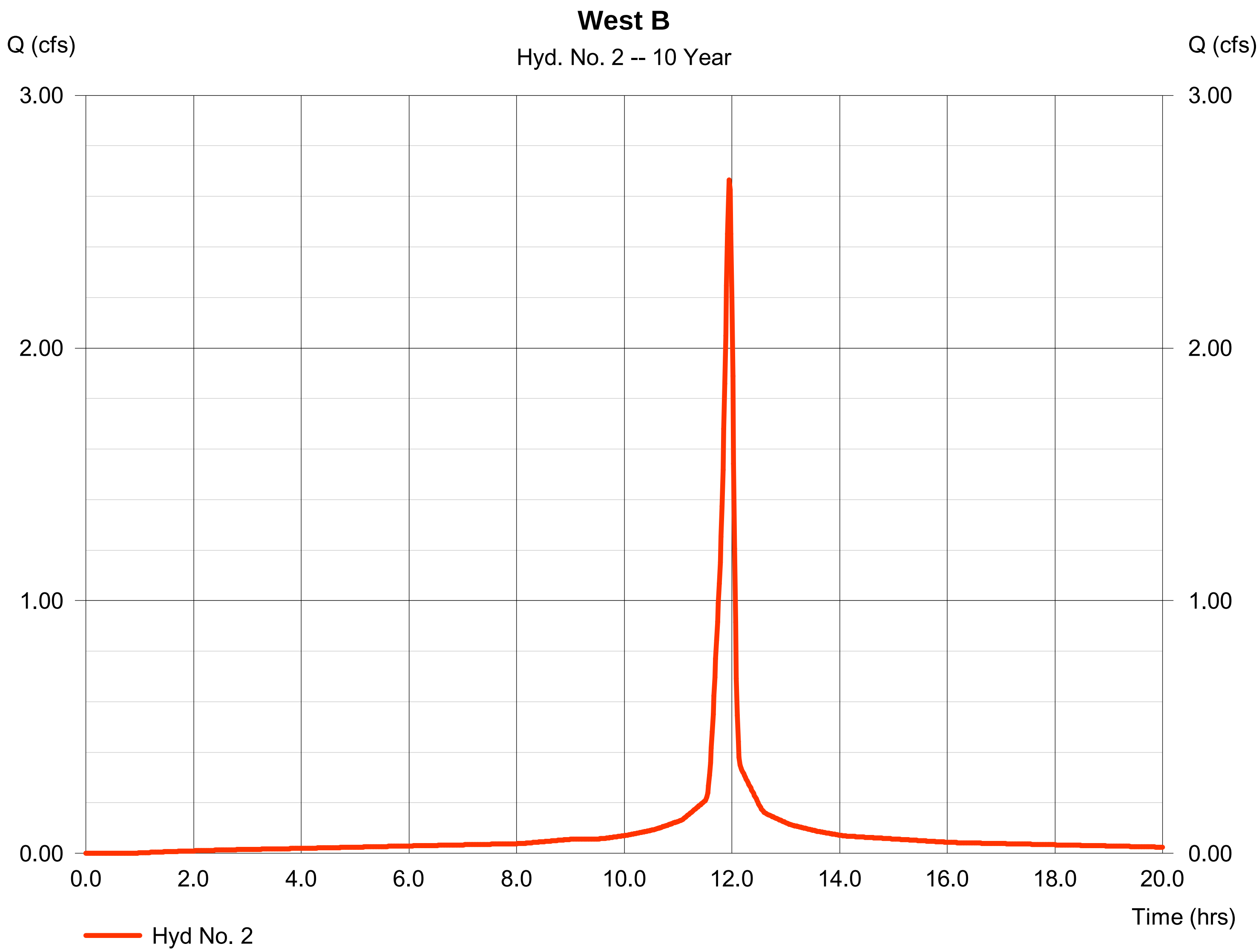
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 2

West B

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.665 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.95 hrs
Time interval	=	1 min	Hyd. volume	=	6,444 cuft
Drainage area	=	0.340 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	6.00 min
Total precip.	=	5.30 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

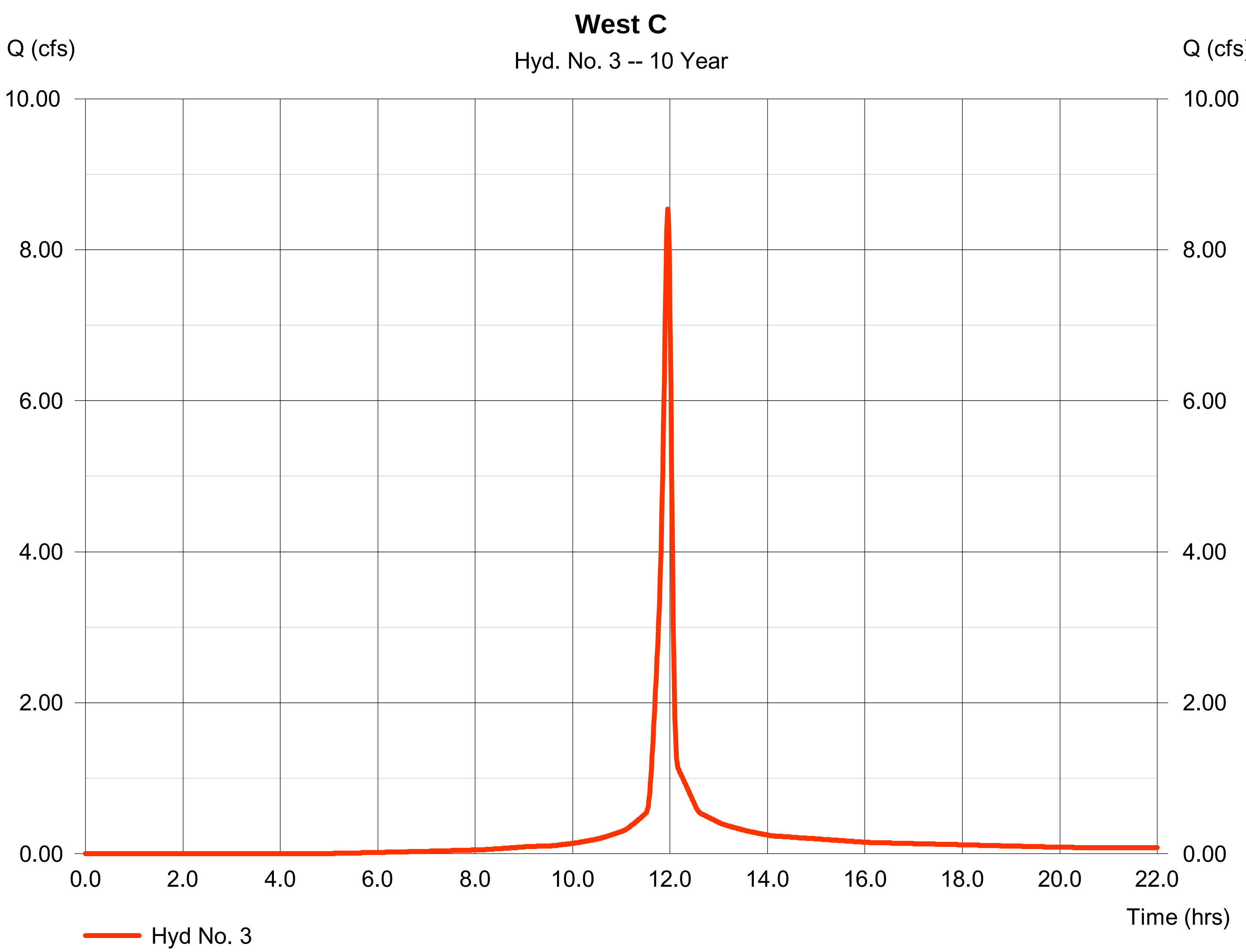
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 3

West C

Hydrograph type	= SCS Runoff	Peak discharge	= 8.538 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 18,162 cuft
Drainage area	= 1.260 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.593 x 98) + (0.696 x 78)] / 1.260



Hydrograph Report

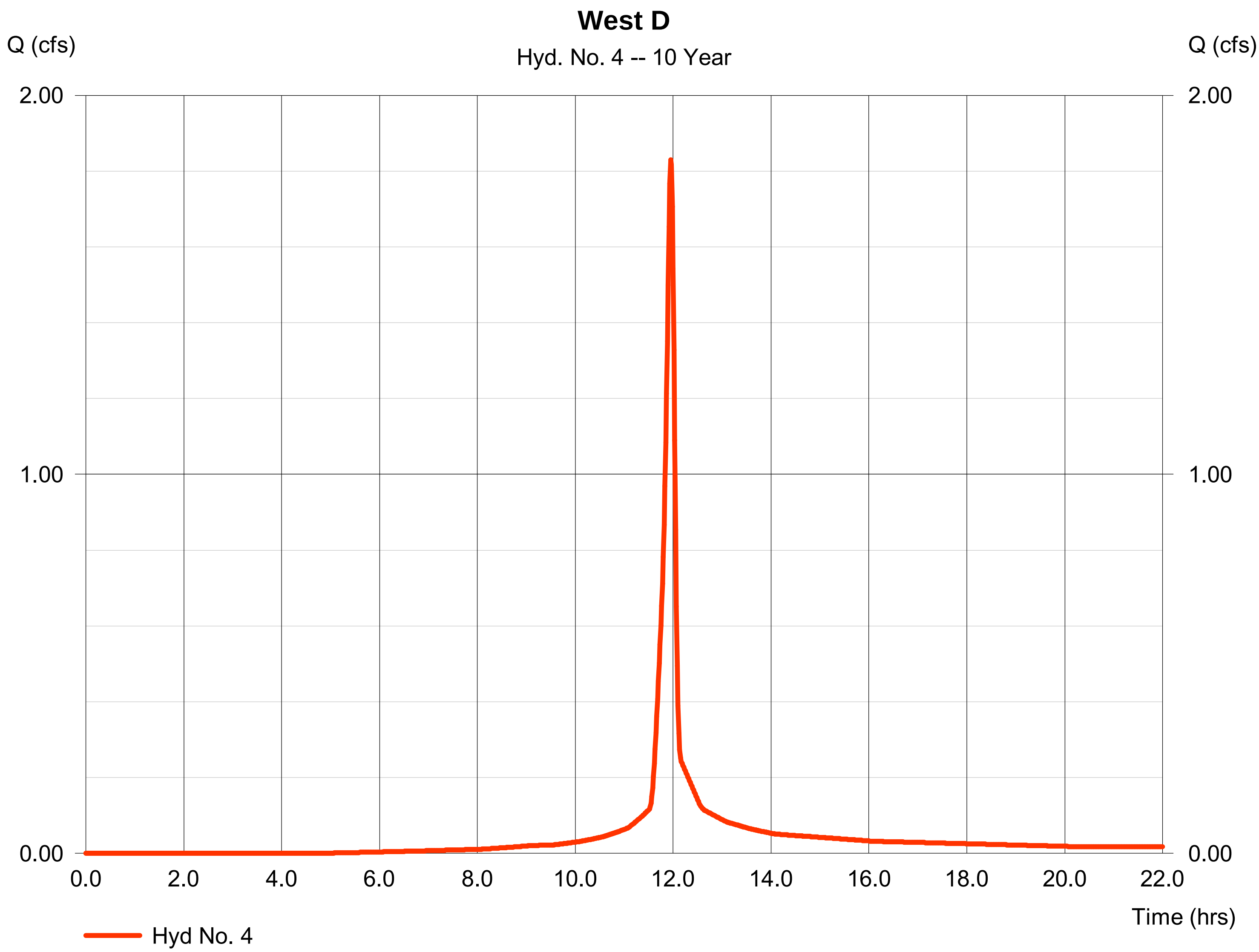
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 4

West D

Hydrograph type	= SCS Runoff	Peak discharge	= 1.830 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 3,892 cuft
Drainage area	= 0.270 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.127 x 98) + (0.144 x 78)] / 0.270



Hydrograph Report

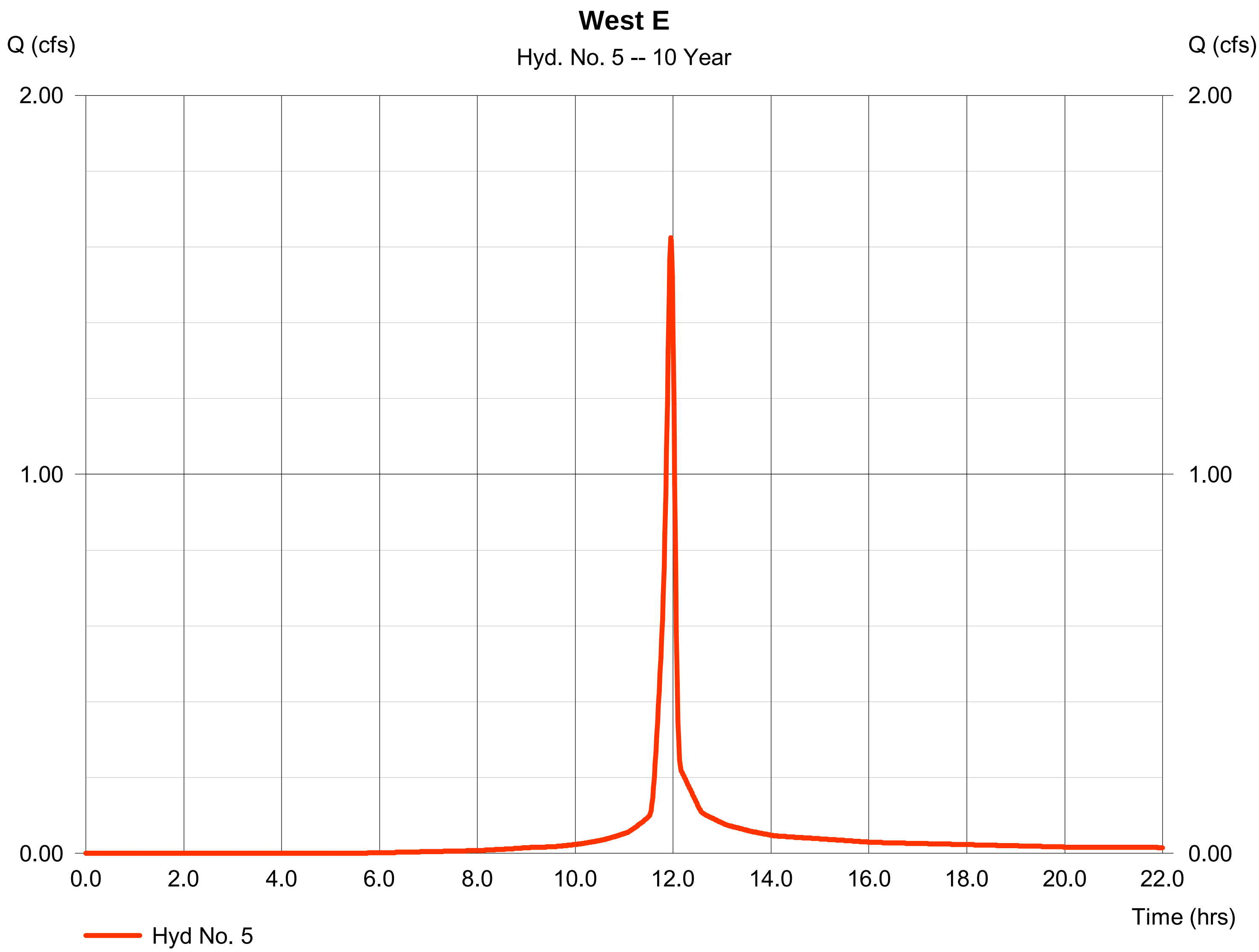
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 | Friday, Jan 20, 2012

Hyd. No. 5

West E

Hydrograph type	= SCS Runoff	Peak discharge	= 1.624 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 3,412 cuft
Drainage area	= 0.250 ac	Curve number	= 85*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.094 x 98) + (0.157 x 78)] / 0.250



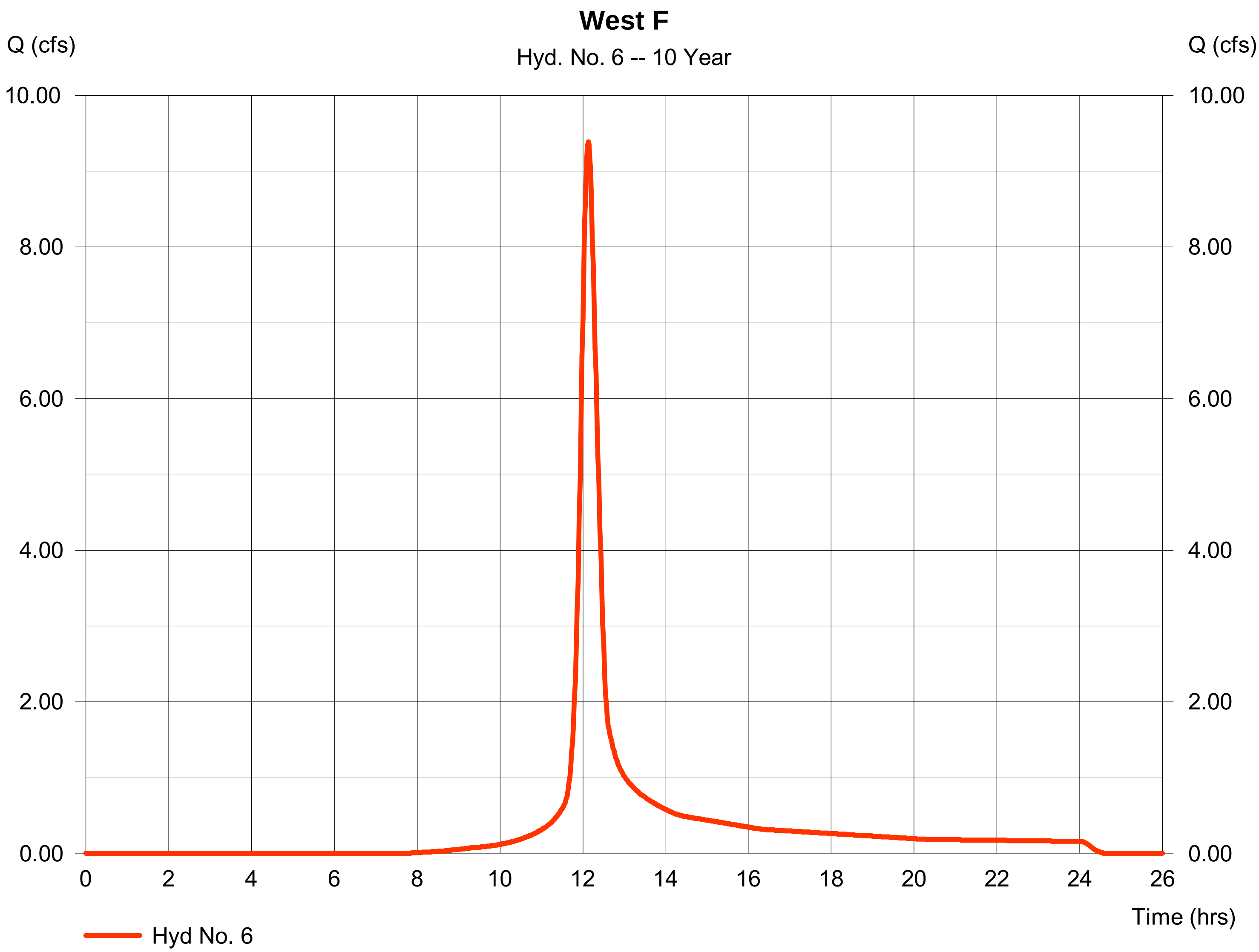
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 6

West F

Hydrograph type	= SCS Runoff	Peak discharge	= 9.390 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.13 hrs
Time interval	= 1 min	Hyd. volume	= 33,401 cuft
Drainage area	= 3.100 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 24.20 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 6

West F

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.60		0.00		0.00		
Land slope (%)	=	0.50		0.00		0.00		
Travel Time (min)	**=**	**16.08**	**+**	**0.00**	**+**	**0.00**	**=**	**16.08**
Shallow Concentrated Flow								
Flow length (ft)	=	554.00		0.00		0.00		
Watercourse slope (%)	=	0.50		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=1.14			0.00		0.00		
Travel Time (min)	**=**	**8.09**	**+**	**0.00**	**+**	**0.00**	**=**	**8.09**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=0.00							
				0.00				
						0.00		
Flow length (ft)	({0})0.0			0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... **24.20 min**

Hydrograph Report

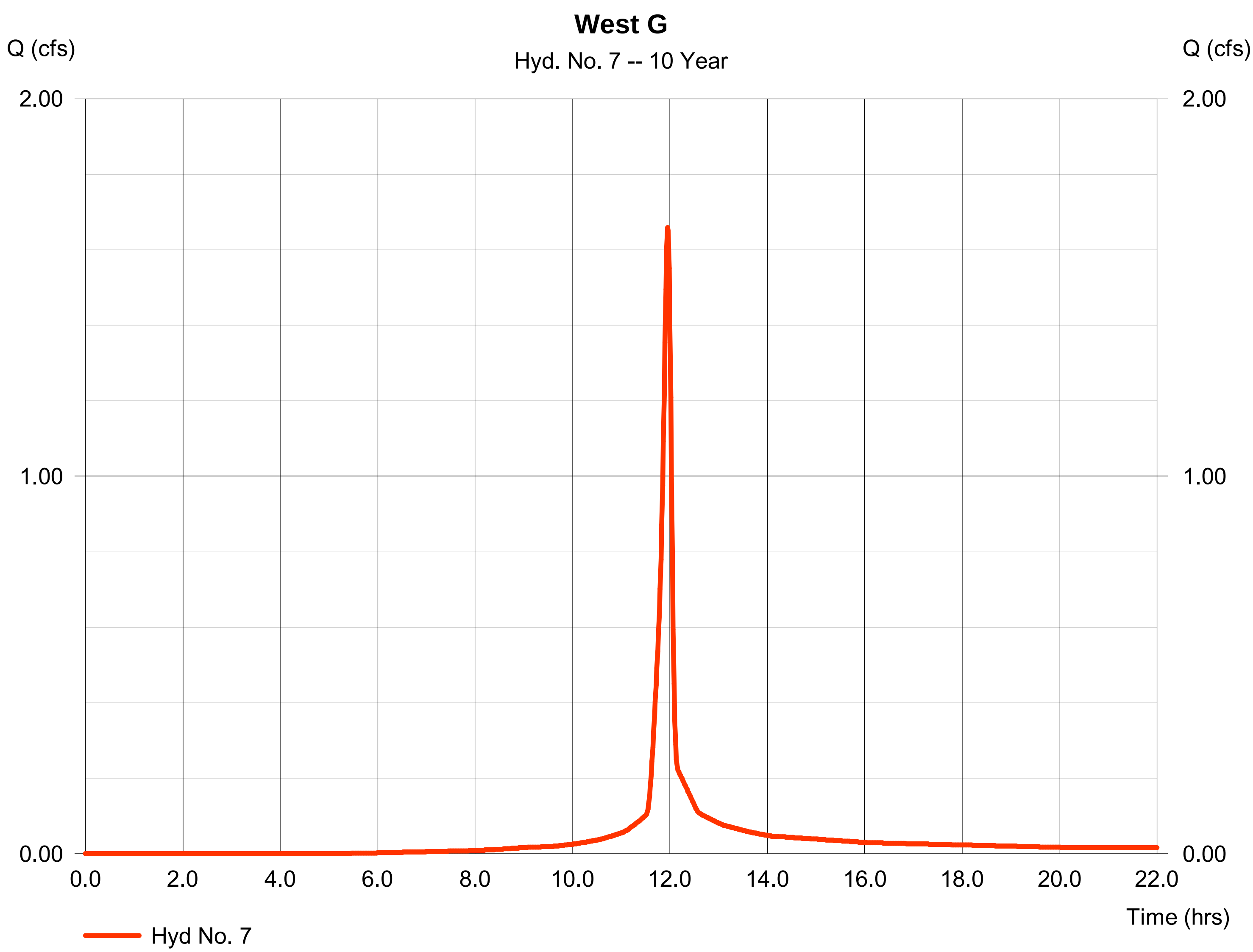
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 | Friday, Jan 20, 2012

Hyd. No. 7

West G

Hydrograph type	= SCS Runoff	Peak discharge	= 1.659 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 3,508 cuft
Drainage area	= 0.250 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 98) + (0.150 x 78)] / 0.250



Hydrograph Report

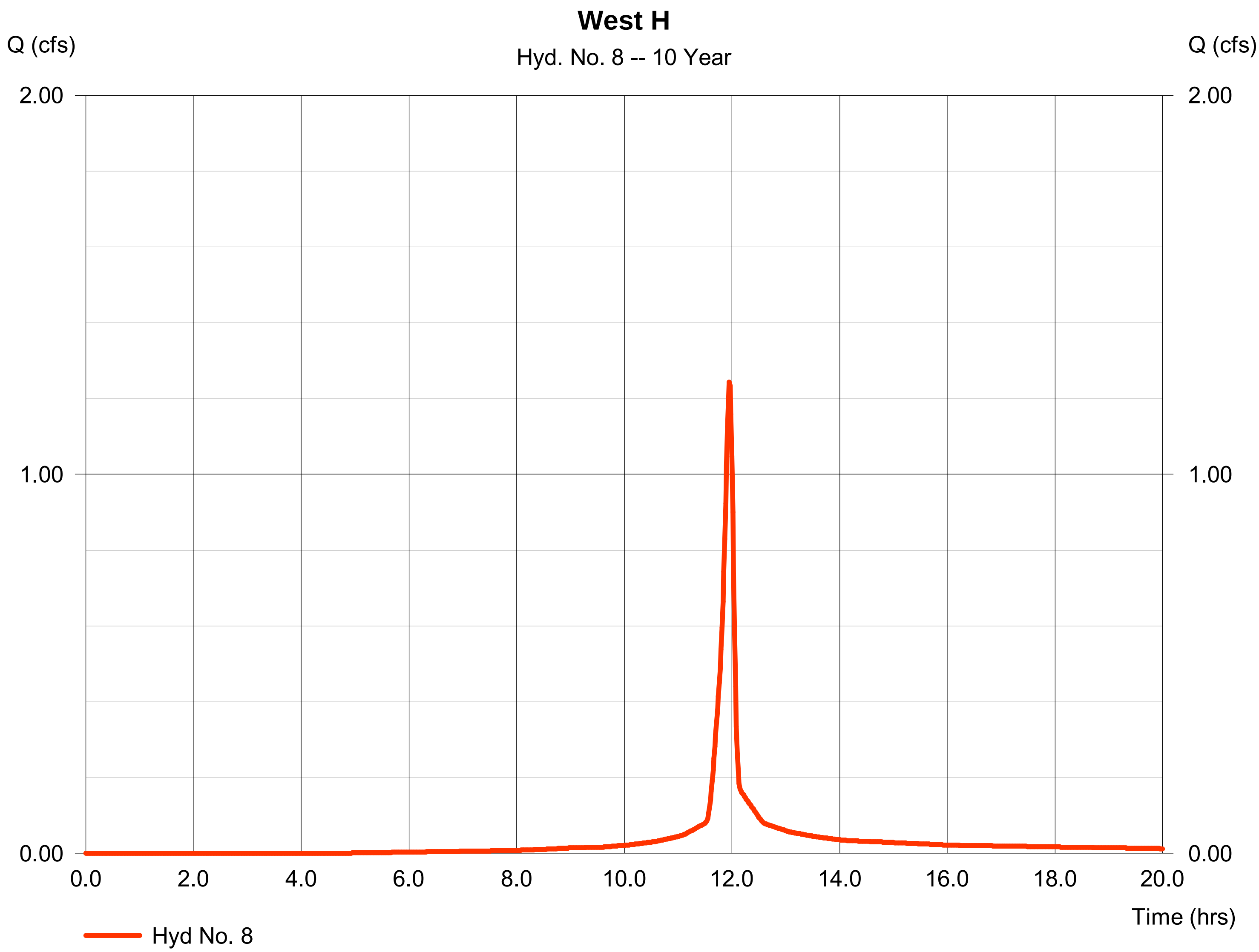
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 | Friday, Jan 20, 2012

Hyd. No. 8

West H

Hydrograph type	= SCS Runoff	Peak discharge	= 1.244 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 2,665 cuft
Drainage area	= 0.180 ac	Curve number	= 88*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.084 x 98) + (0.092 x 78)] / 0.180



Hydrograph Report

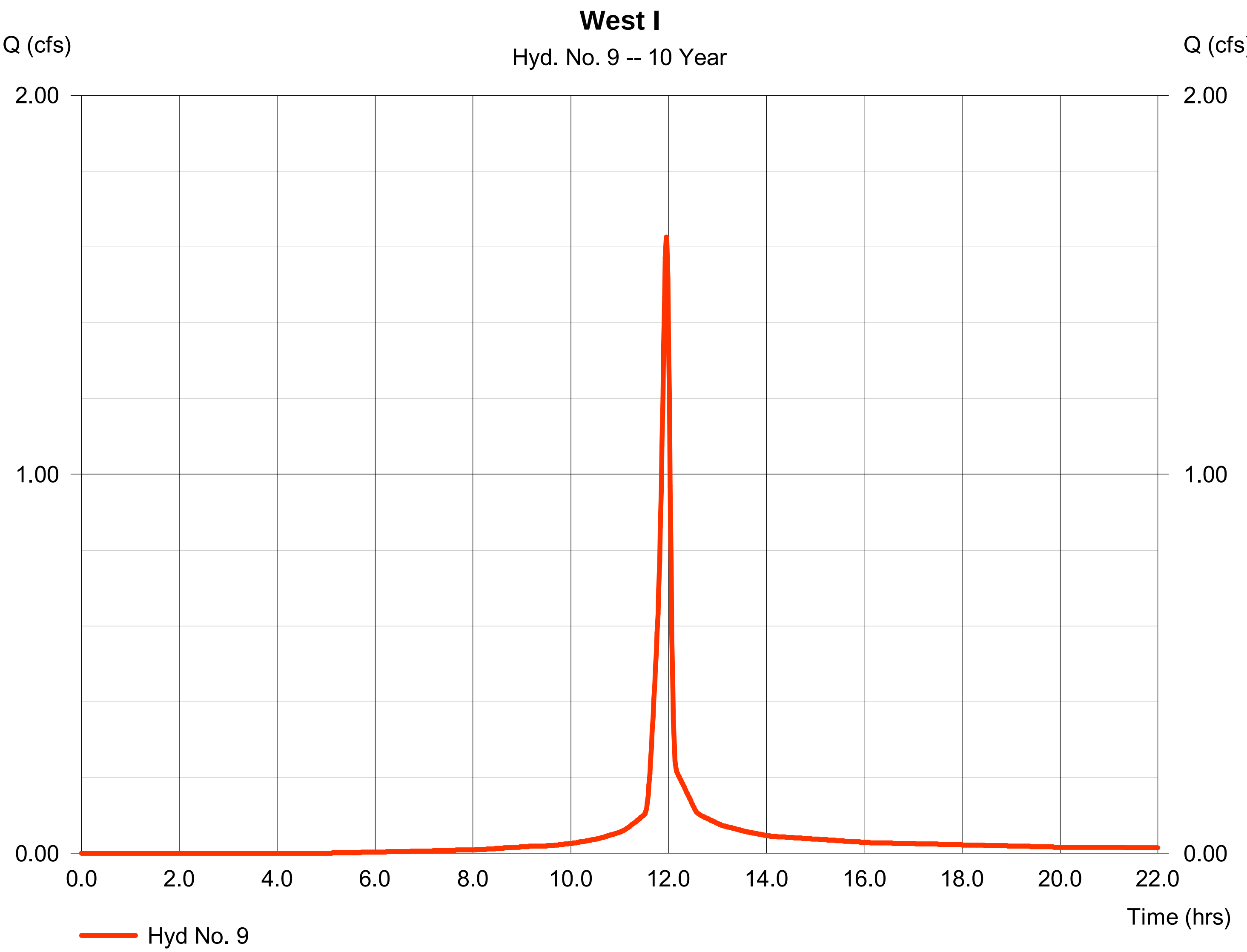
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 9

West I

Hydrograph type	= SCS Runoff	Peak discharge	= 1.626 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 3,460 cuft
Drainage area	= 0.240 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.105 x 98) + (0.136 x 78)] / 0.240



Hydrograph Report

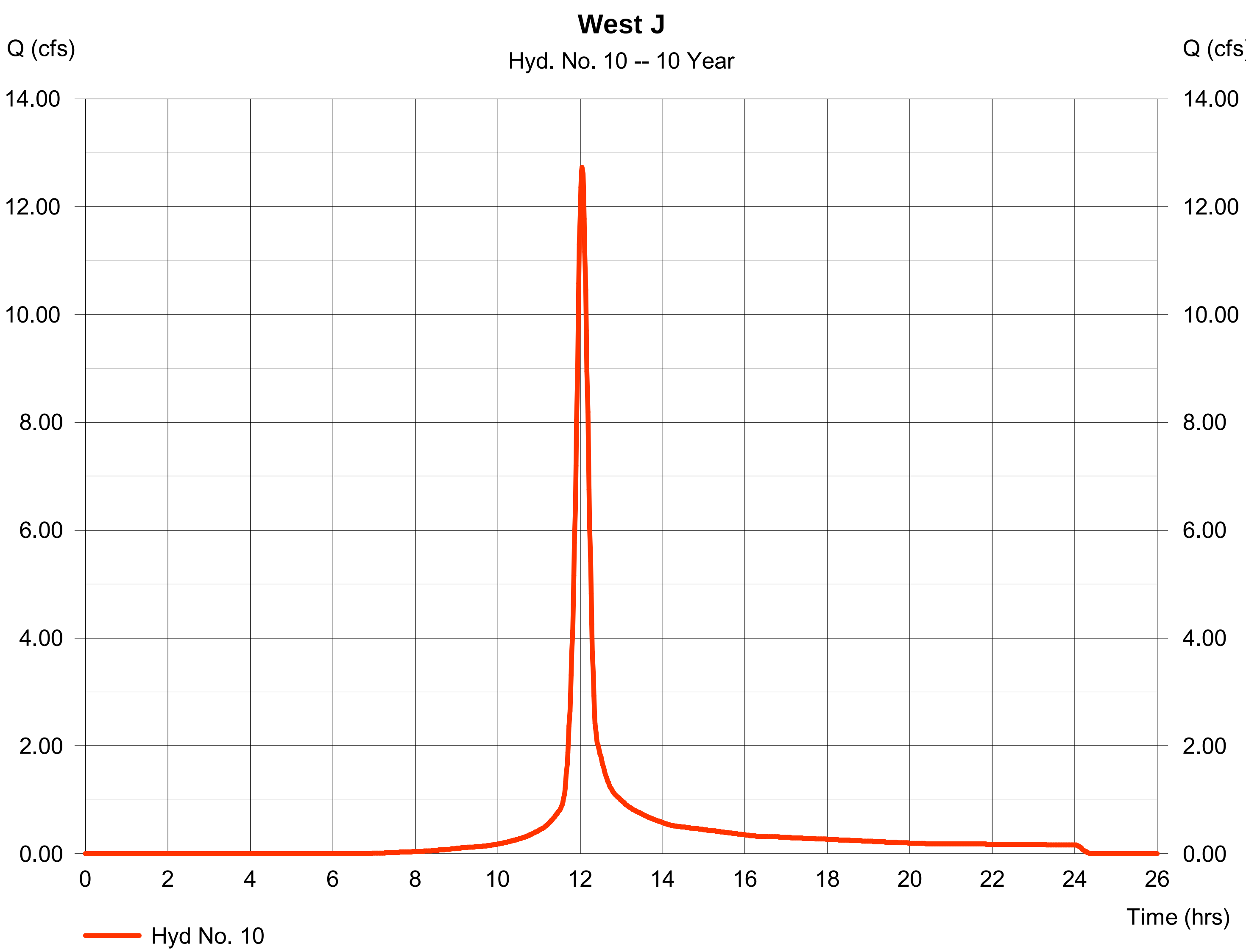
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 10

West J

Hydrograph type	= SCS Runoff	Peak discharge	= 12.73 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.05 hrs
Time interval	= 1 min	Hyd. volume	= 36,453 cuft
Drainage area	= 3.050 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.60 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.460 x 98) + (2.590 x 78)] / 3.050



TR55 Tc Worksheet

Hyd. No. 10

West J

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.60		0.00		0.00		
Land slope (%)	=	0.90		0.00		0.00		
Travel Time (min)	**=**	**12.71**	**+**	**0.00**	**+**	**0.00**	**=**	**12.71**
Shallow Concentrated Flow								
Flow length (ft)	=	315.00		0.00		0.00		
Watercourse slope (%)	=	1.30		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=1.84			0.00		0.00		
Travel Time (min)	**=**	**2.85**	**+**	**0.00**	**+**	**0.00**	**=**	**2.85**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=0.00							
				0.00				
						0.00		
Flow length (ft)	({0})0.0			0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... **15.60 min**

Hydrograph Report

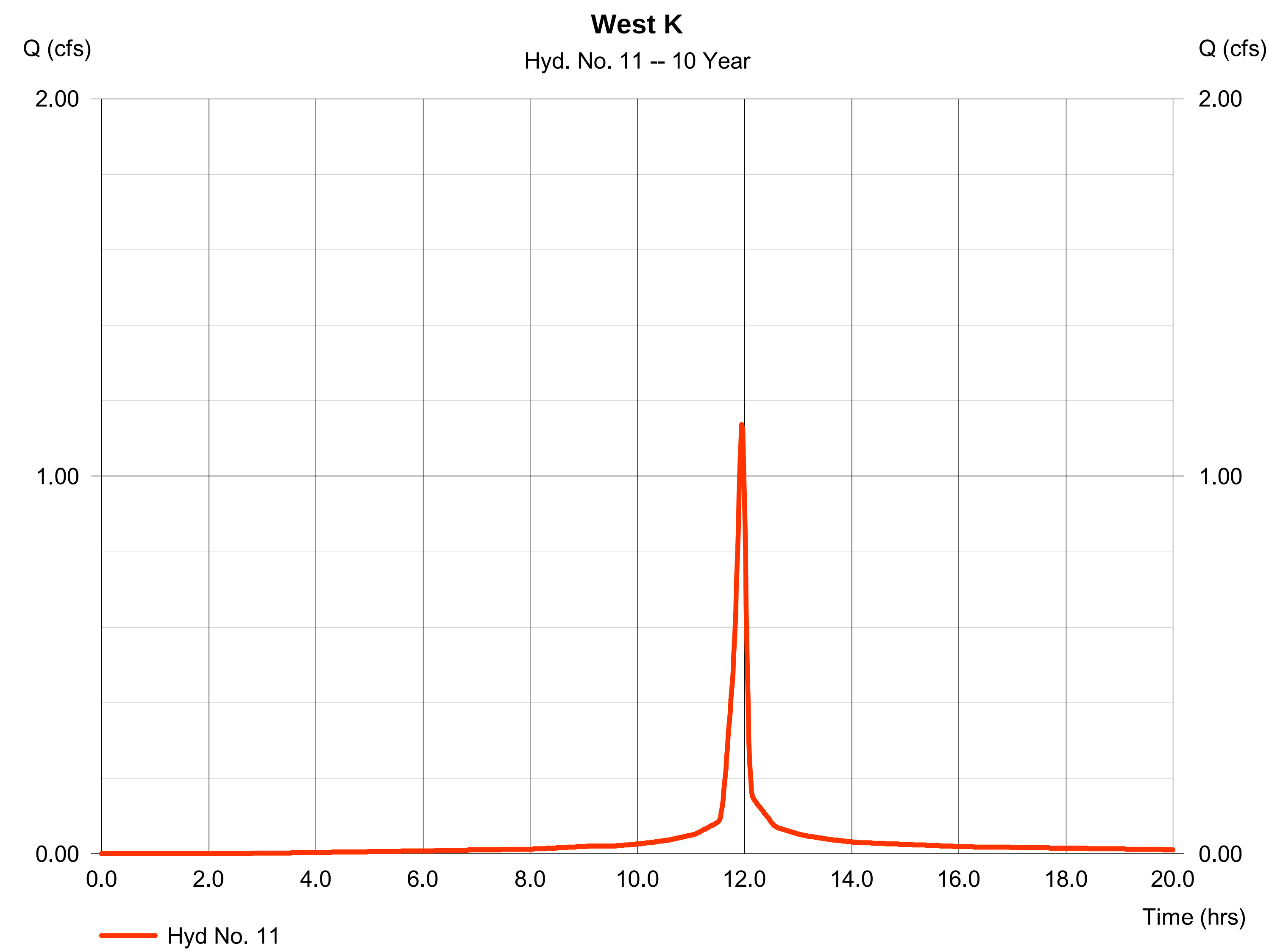
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 11

West K

Hydrograph type	= SCS Runoff	Peak discharge	= 1.137 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 2,585 cuft
Drainage area	= 0.150 ac	Curve number	= 94*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.120 x 98) + (0.034 x 78)] / 0.150



Hydrograph Report

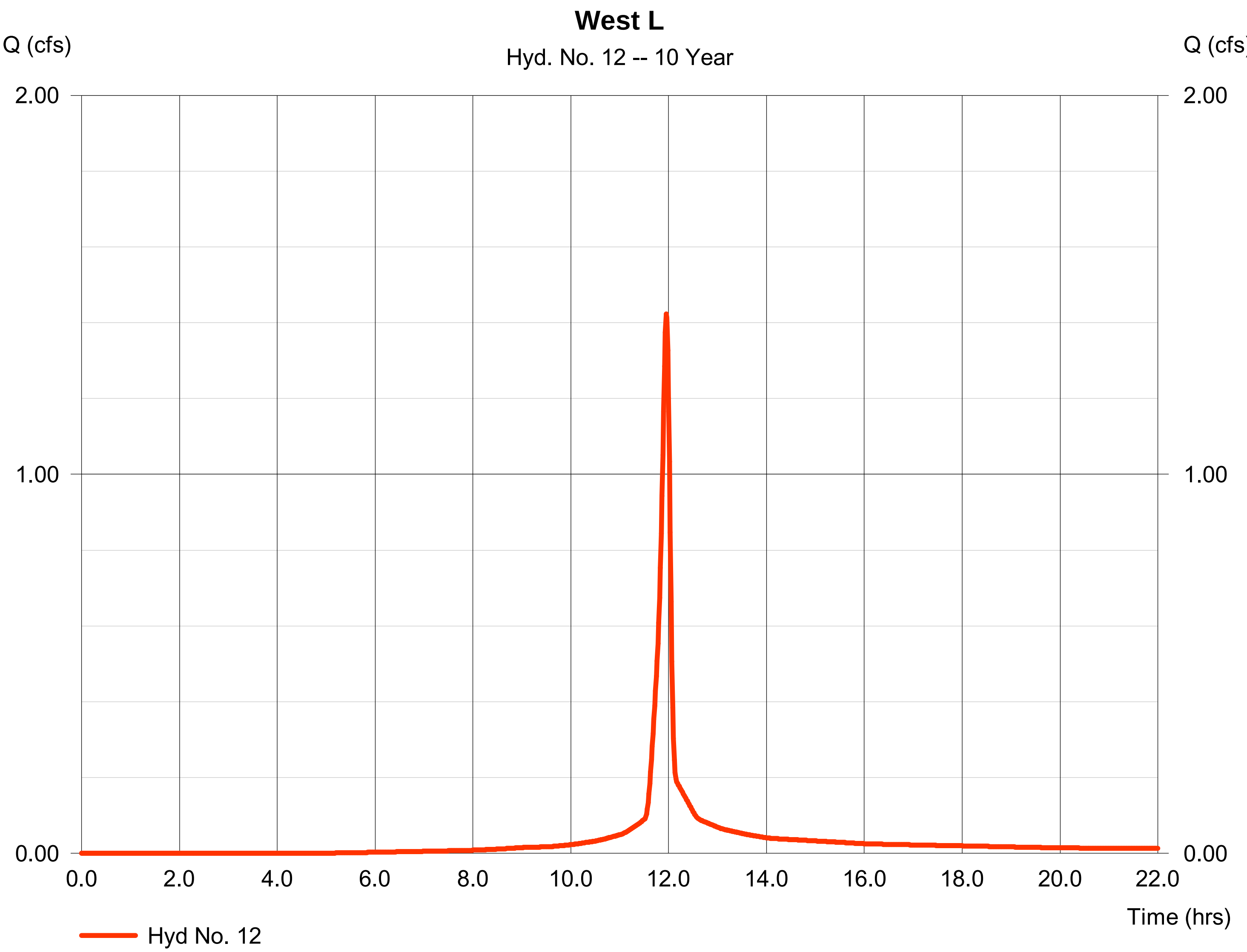
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 12

West L

Hydrograph type	= SCS Runoff	Peak discharge	= 1.423 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 3,027 cuft
Drainage area	= 0.210 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.094 x 98) + (0.118 x 78)] / 0.210



Hydrograph Report

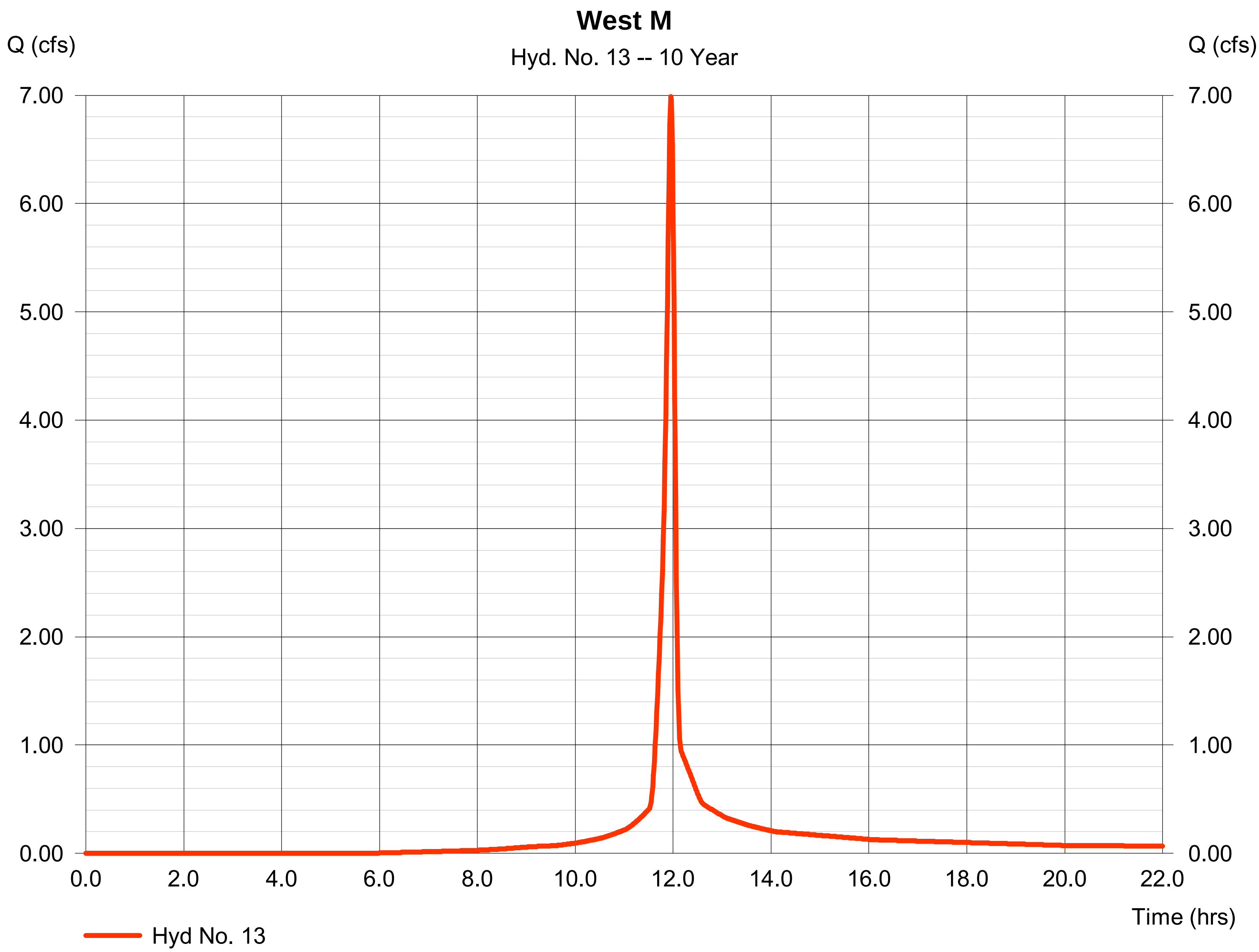
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 13

West M

Hydrograph type	= SCS Runoff	Peak discharge	= 6.986 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 14,602 cuft
Drainage area	= 1.100 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.350 x 98) + (0.750 x 78)] / 1.100



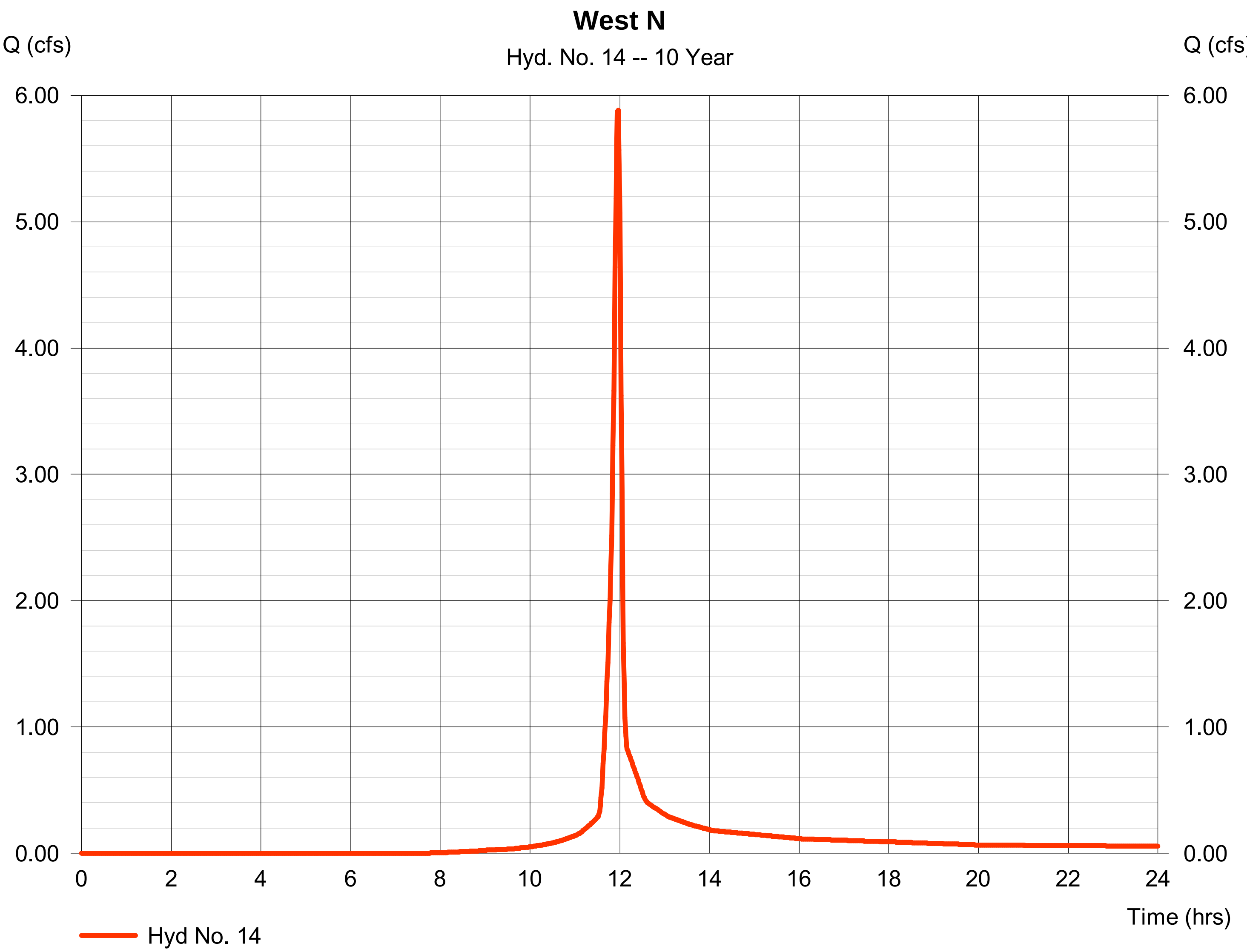
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 14

West N

Hydrograph type	= SCS Runoff	Peak discharge	= 5.882 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.97 hrs
Time interval	= 1 min	Hyd. volume	= 12,000 cuft
Drainage area	= 1.080 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

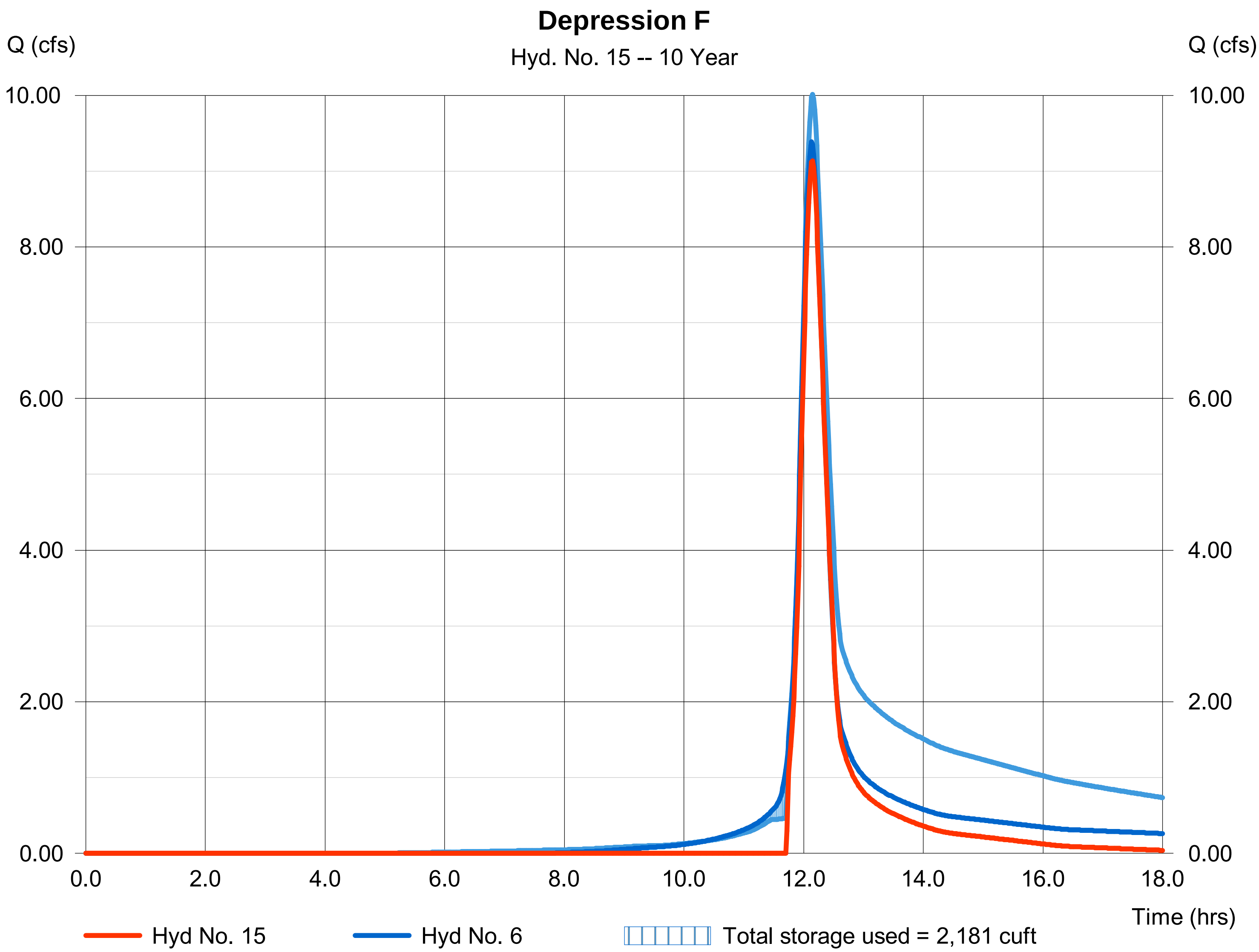
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 15

Depression F

Hydrograph type	= Reservoir	Peak discharge	= 9.134 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.15 hrs
Time interval	= 1 min	Hyd. volume	= 21,638 cuft
Inflow hyd. No.	= 6 - West F	Max. Elevation	= 281.17 ft
Reservoir name	= Depression F	Max. Storage	= 2,181 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 2 - Depression F

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 280.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	280.00	1,409	0	0
1.00	281.00	2,138	1,761	1,761
2.00	282.00	2,925	2,521	4,282

Culvert / Orifice Structures

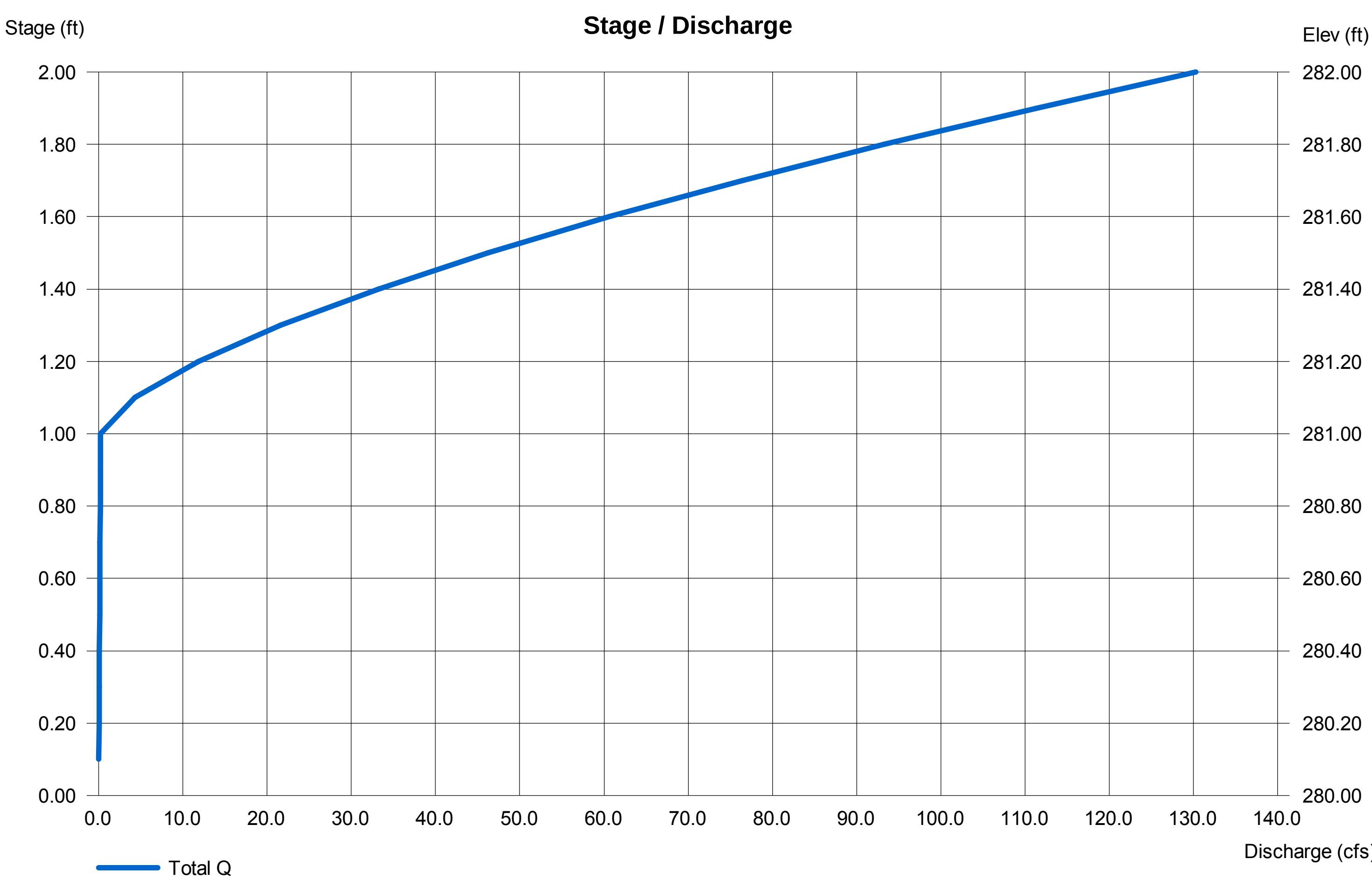
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 50.00	0.00	0.00	0.00
Crest El. (ft)	= 281.00	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Contour)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

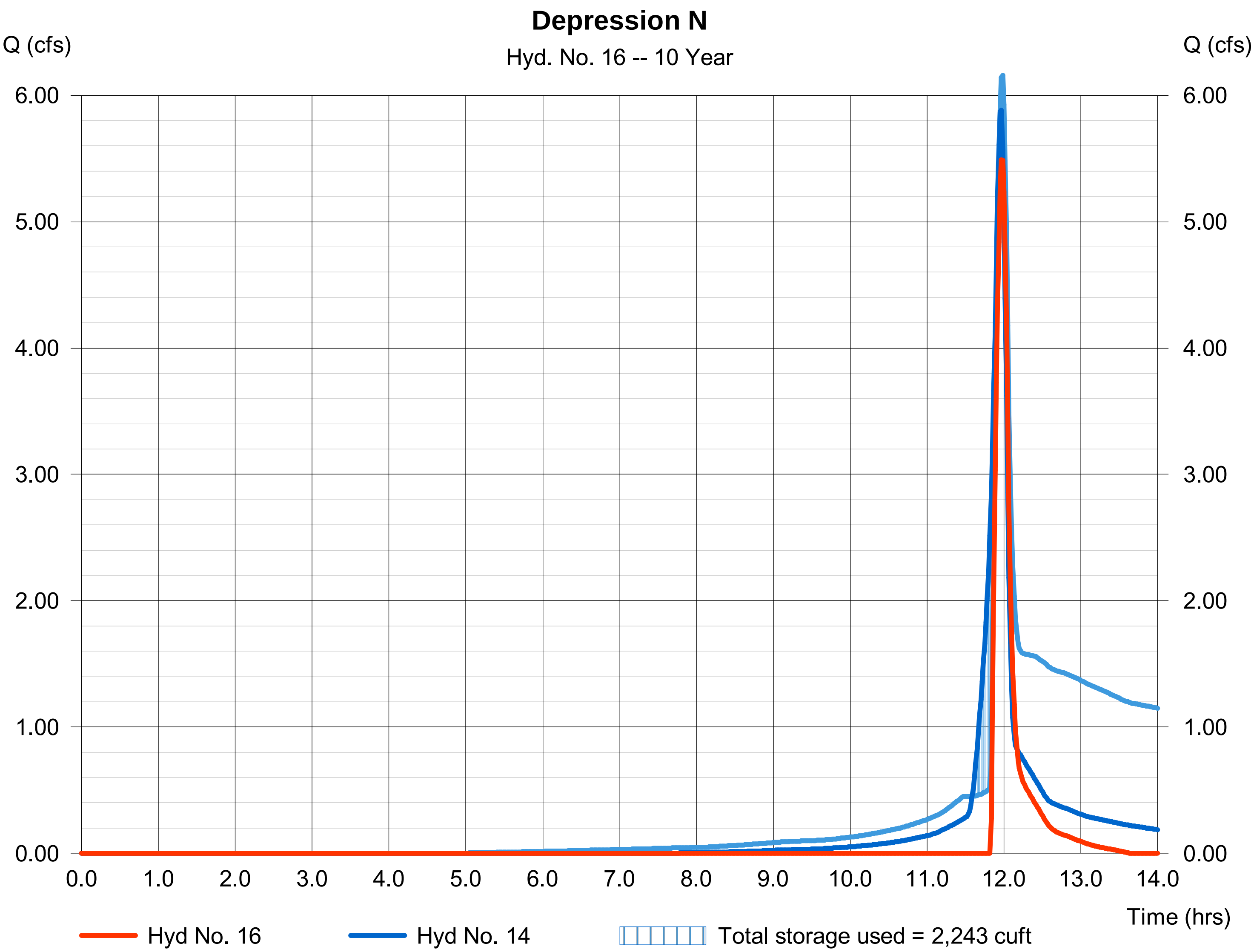
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 16

Depression N

Hydrograph type	= Reservoir	Peak discharge	= 5.488 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.97 hrs
Time interval	= 1 min	Hyd. volume	= 4,816 cuft
Inflow hyd. No.	= 14 - West N	Max. Elevation	= 280.19 ft
Reservoir name	= Depression N	Max. Storage	= 2,243 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Pond No. 3 - Depression N

Pond Data

Contours - User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 279.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	279.00	1,409	0	0
1.00	280.00	2,138	1,761	1,761
2.00	281.00	2,925	2,521	4,282

Culvert / Orifice Structures

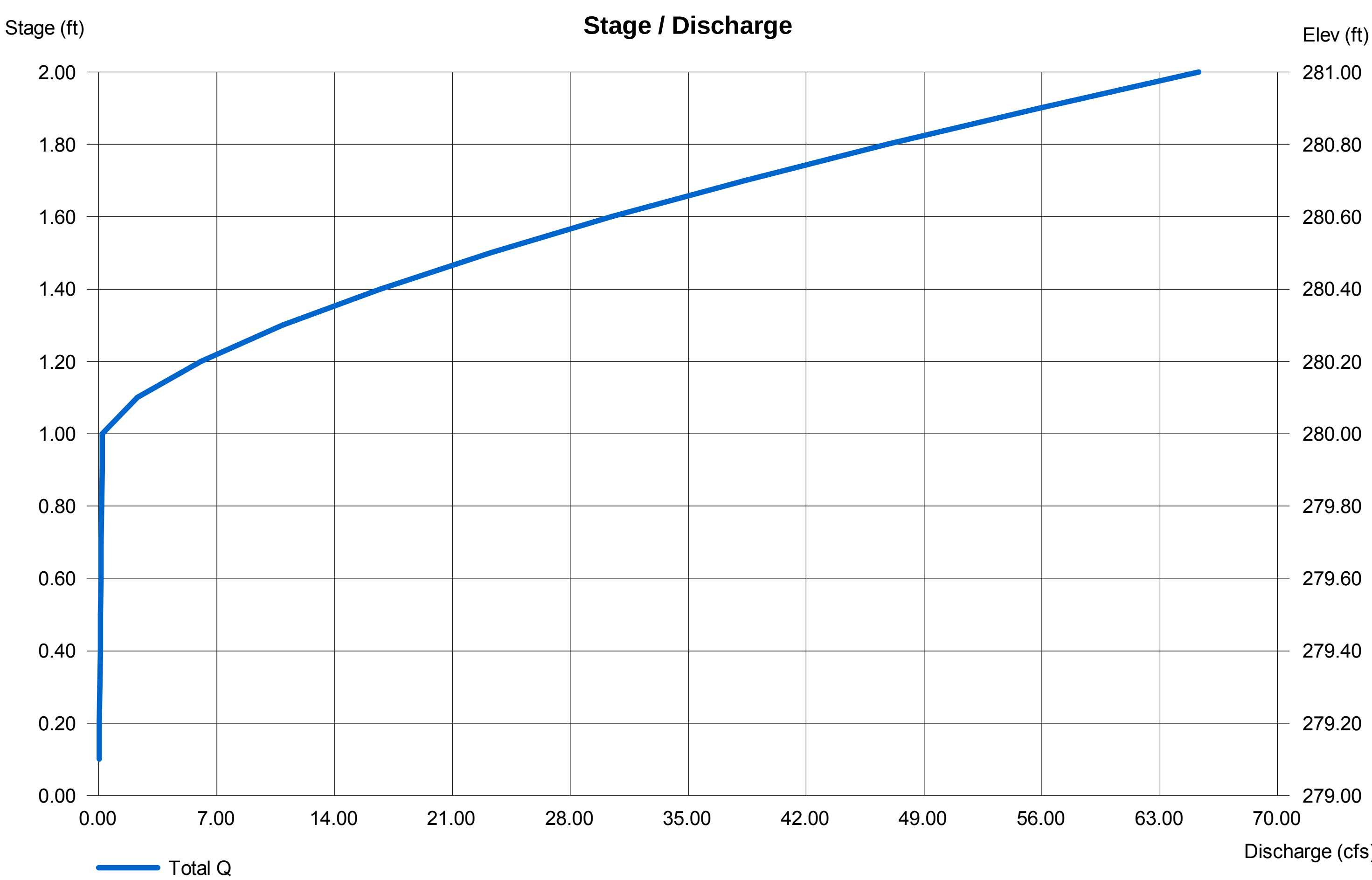
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 25.00	0.00	0.00	0.00
Crest El. (ft)	= 280.00	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Contour)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



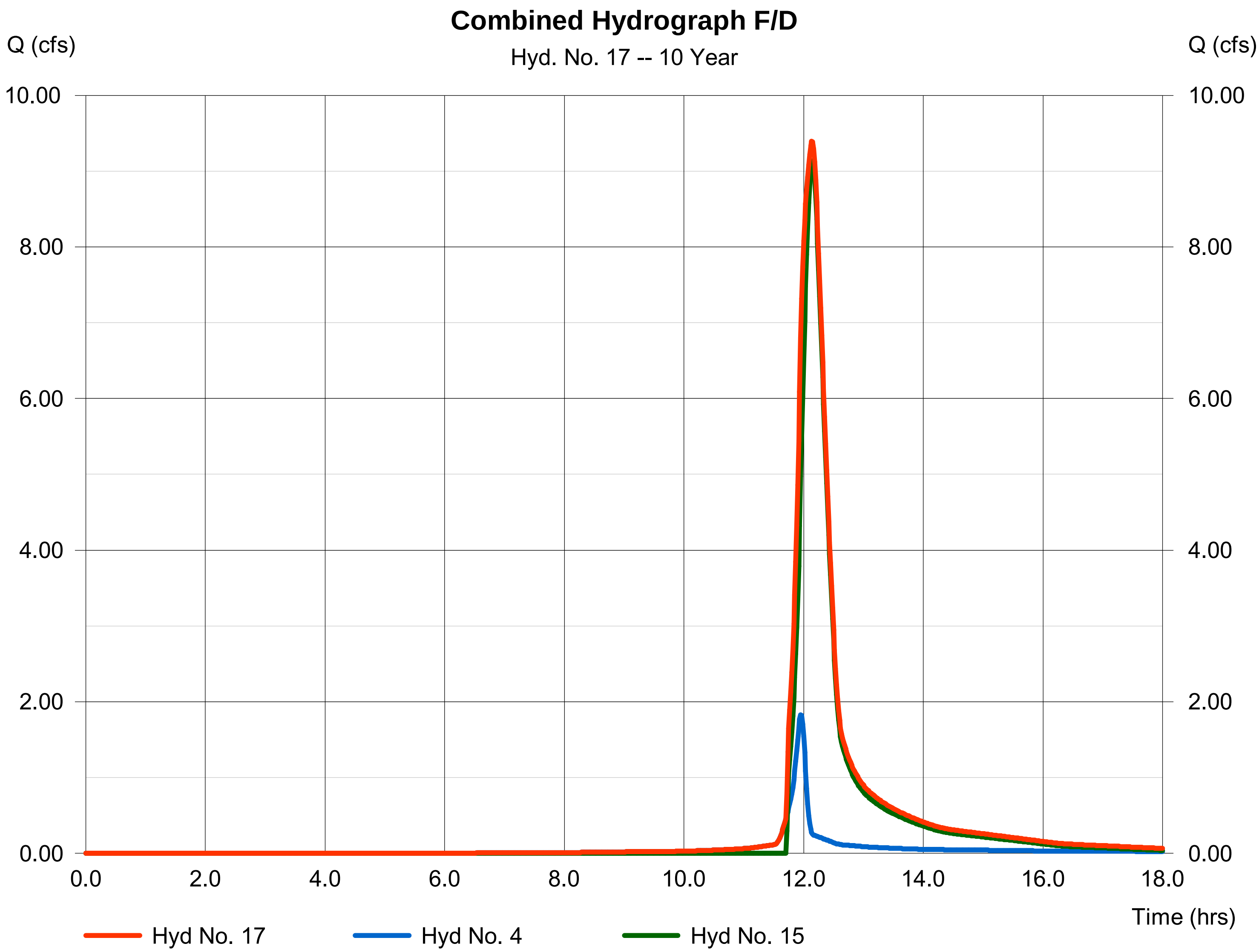
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 17

Combined Hydrograph F/D

Hydrograph type	= Combine	Peak discharge	= 9.393 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.13 hrs
Time interval	= 1 min	Hyd. volume	= 25,530 cuft
Inflow hyds.	= 4, 15	Contrib. drain. area	= 0.270 ac



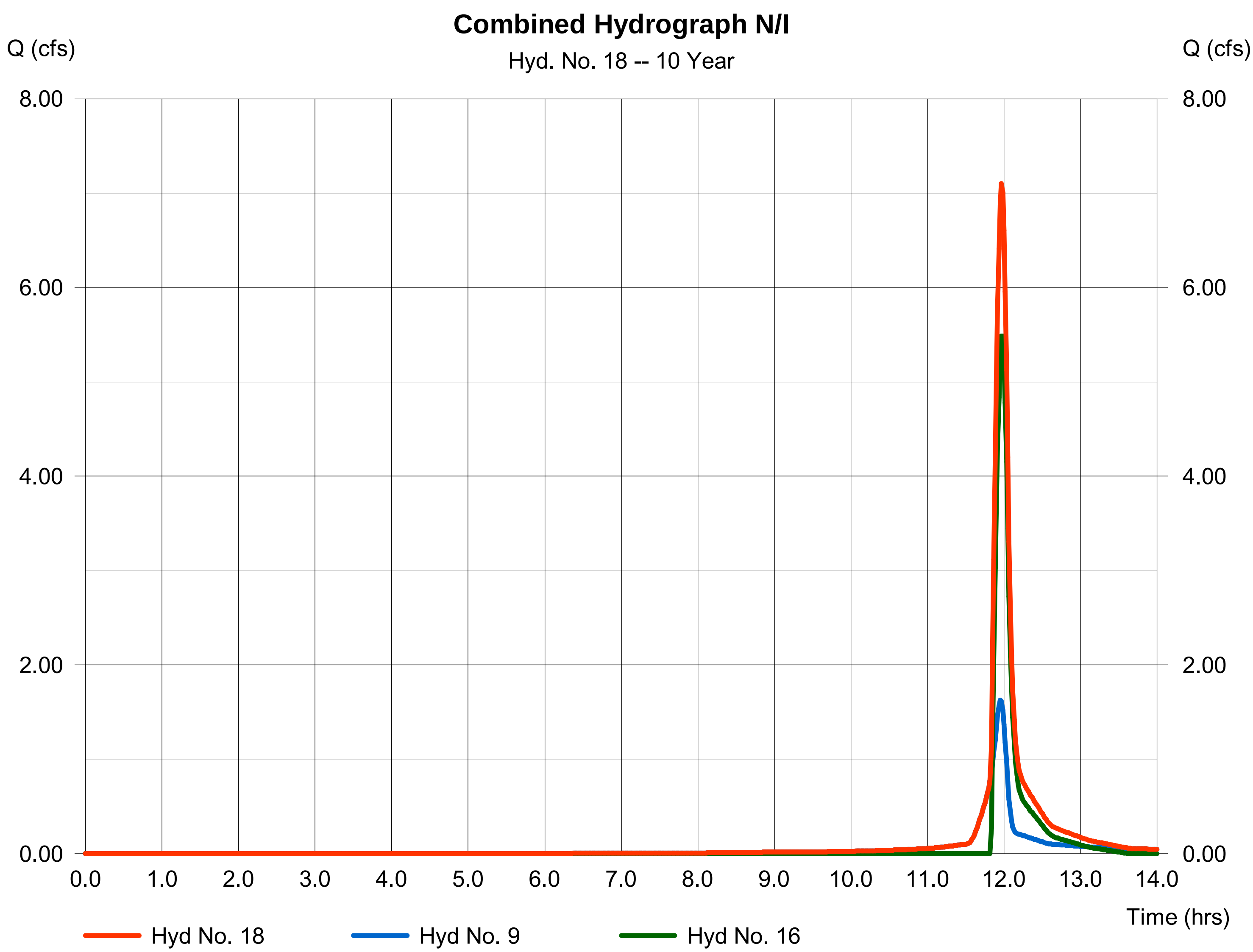
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 18

Combined Hydrograph N/I

Hydrograph type	= Combine	Peak discharge	= 7.104 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.97 hrs
Time interval	= 1 min	Hyd. volume	= 8,275 cuft
Inflow hyds.	= 9, 16	Contrib. drain. area	= 0.240 ac



Hydrograph Report

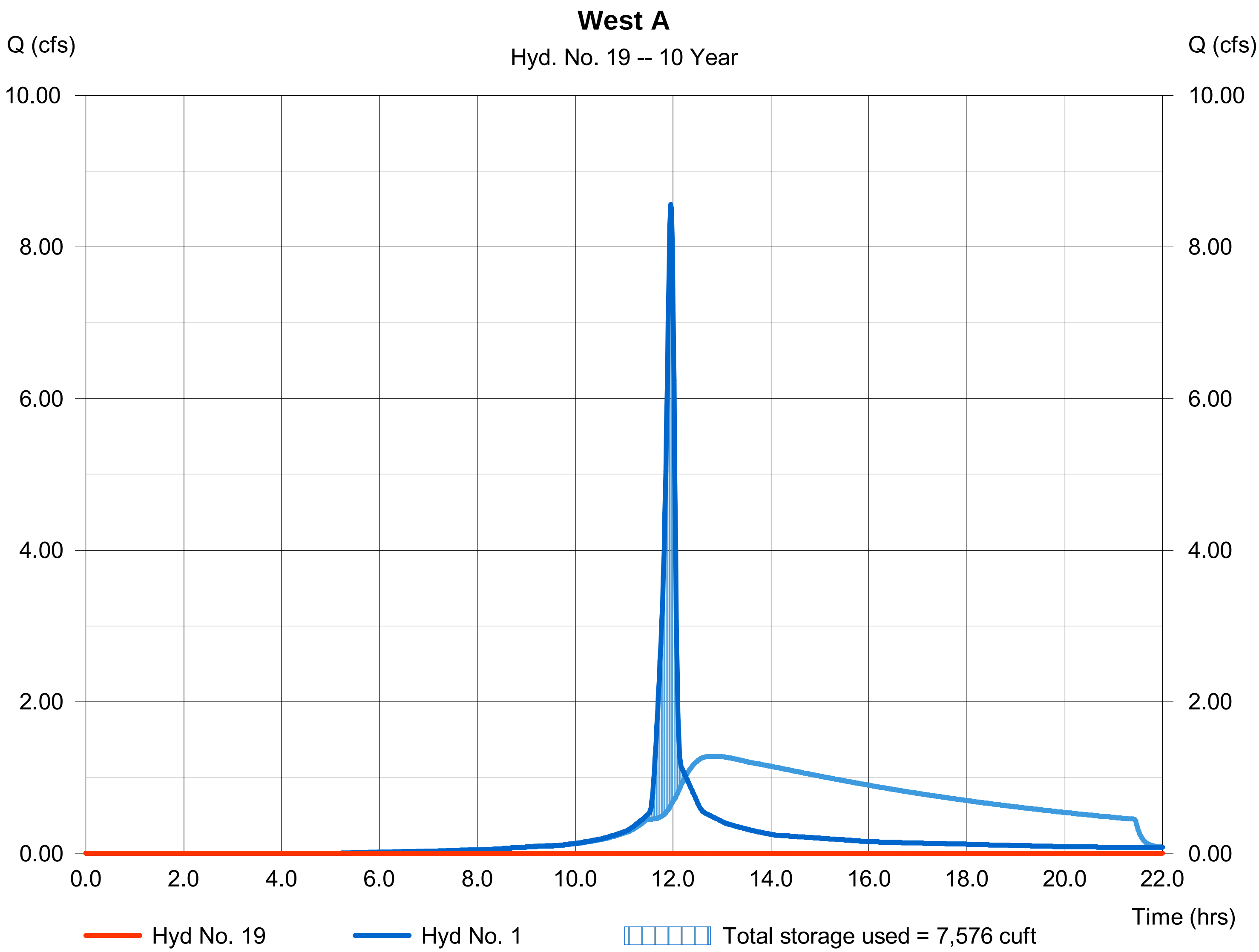
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 19

West A

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - West A	Max. Elevation	= 3.75 ft
Reservoir name	= Porous Pavement West A	Max. Storage	= 7,576 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 1 - Porous Pavement West A

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 3.00 x 3.33 ft , Barrel Len = 497.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 3.83 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.38	0.38	n/a	846	846
0.77	0.77	n/a	857	1,702
1.15	1.15	n/a	857	2,559
1.53	1.53	n/a	857	3,415
1.91	1.91	n/a	857	4,272
2.30	2.30	n/a	857	5,129
2.68	2.68	n/a	857	5,985
3.06	3.06	n/a	798	6,784
3.45	3.45	n/a	444	7,228
3.83	3.83	n/a	444	7,673

Culvert / Orifice Structures

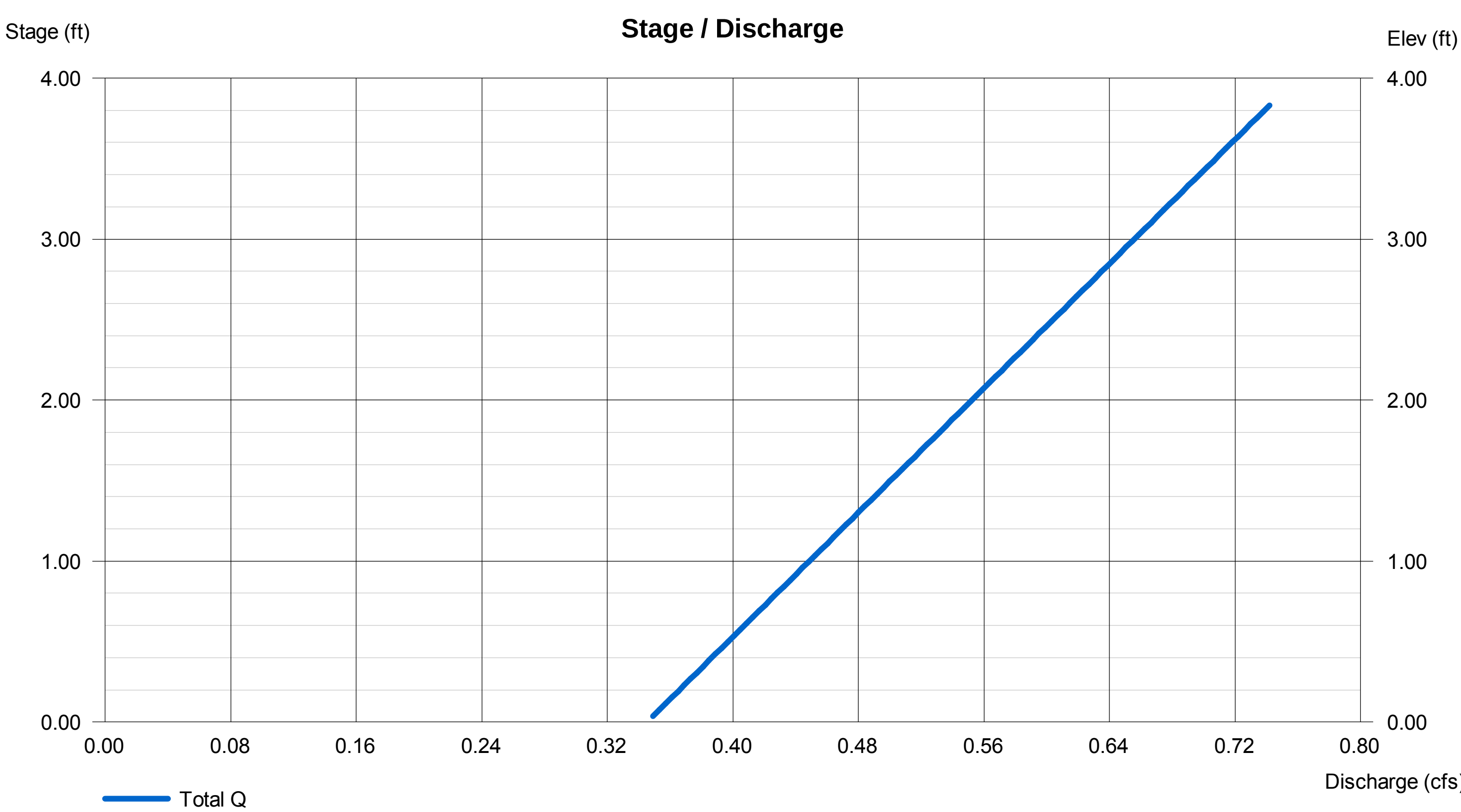
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

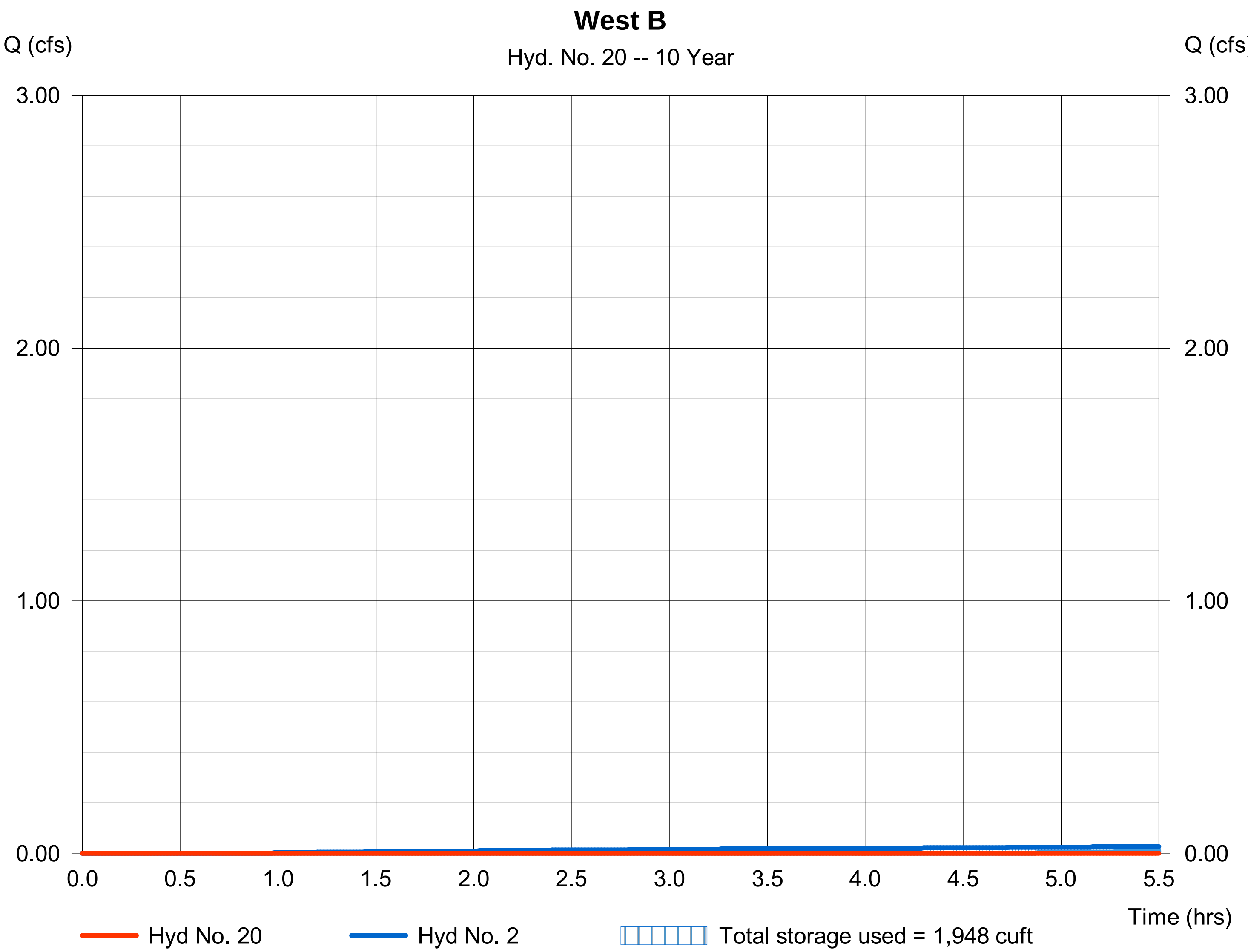
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 20

West B

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 5.33 hrs
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 2 - West B	Max. Elevation	= 2.07 ft
Reservoir name	= Porous Pavement West B	Max. Storage	= 1,948 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 4 - Porous Pavement West B

Pond Data

UG Chambers - Invert elev. = 0.50 ft , Rise x Span = 0.01 x 0.01 ft , Barrel Len = 336.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 8.00 ft, Height = 2.25 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.22	0.22	n/a	212	212
0.45	0.45	n/a	212	423
0.68	0.68	n/a	212	635
0.90	0.90	n/a	212	847
1.13	1.13	n/a	212	1,059
1.35	1.35	n/a	212	1,270
1.58	1.58	n/a	212	1,482
1.80	1.80	n/a	212	1,694
2.03	2.03	n/a	212	1,906
2.25	2.25	n/a	212	2,117

Culvert / Orifice Structures

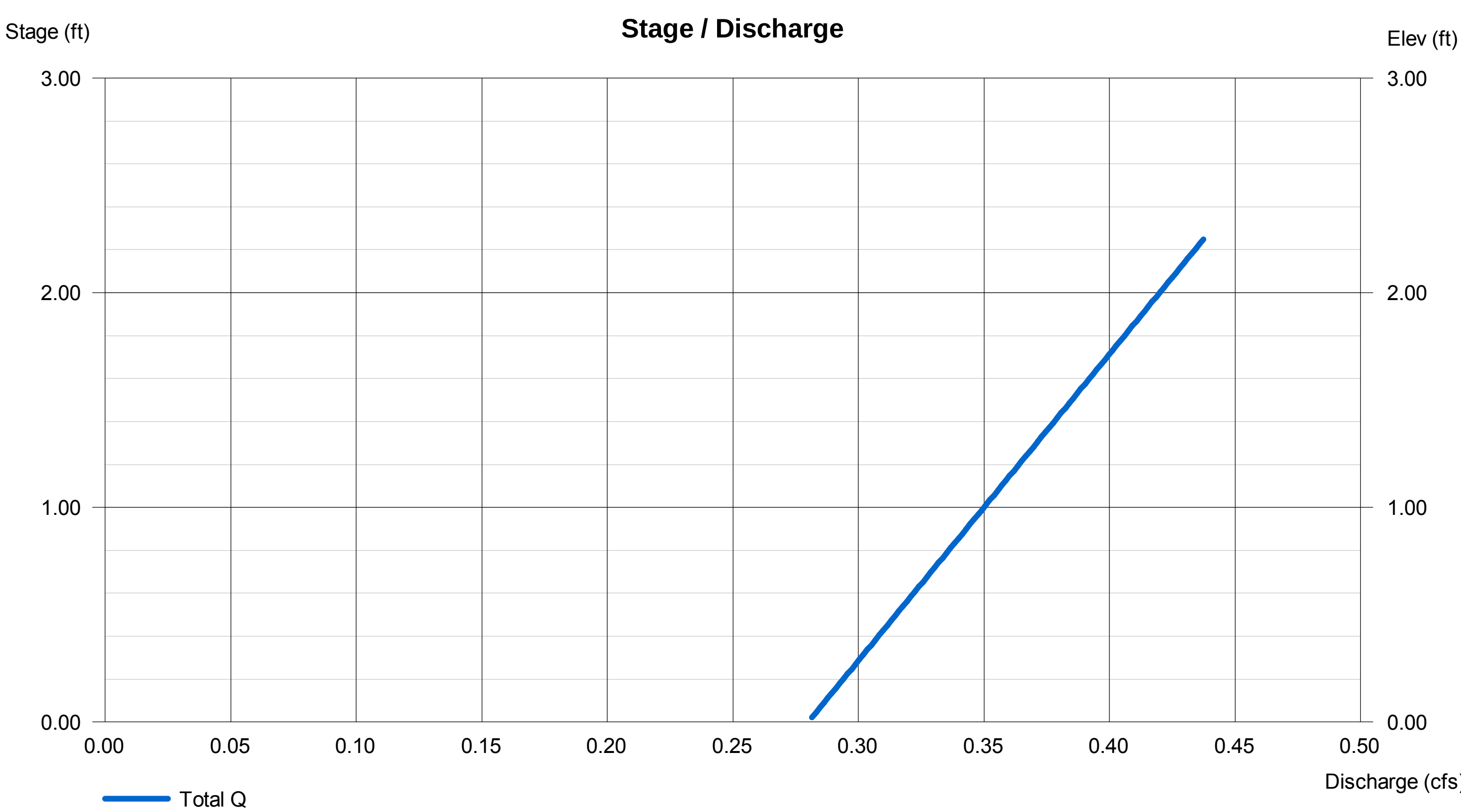
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

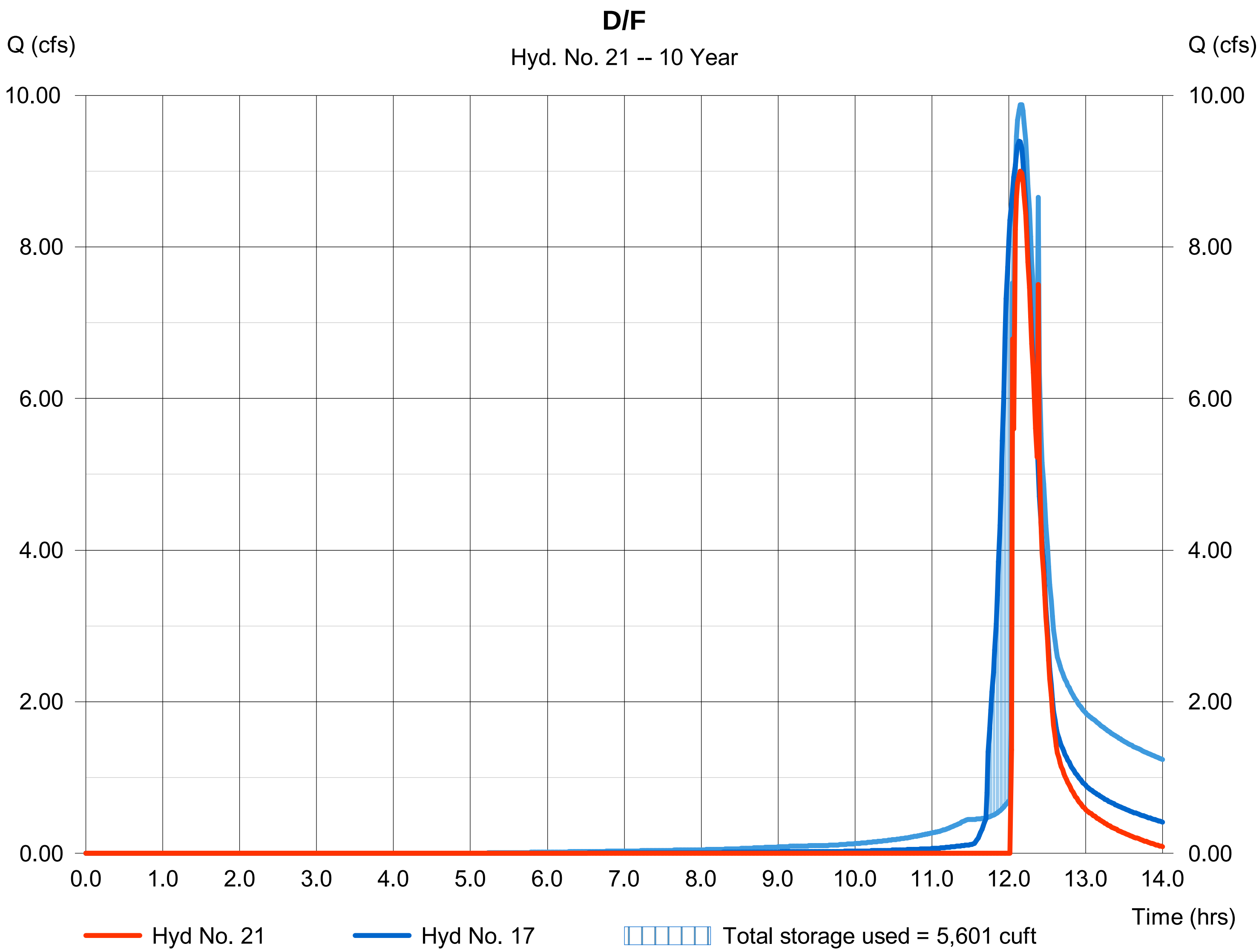
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 21

D/F

Hydrograph type	= Reservoir	Peak discharge	= 8.996 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.15 hrs
Time interval	= 1 min	Hyd. volume	= 14,332 cuft
Inflow hyd. No.	= 17 - Combined Hydrograph F/D	Max. Elevation	= 8.27 ft
Reservoir name	= Porous Pavement West D/F	Max. Storage	= 5,601 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Pond No. 6 - Porous Pavement West D/F

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 7.67 x 3.33 ft , Barrel Len = 156.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft , Height = 8.50 ft , Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.85	0.85	n/a	593	593
1.70	1.70	n/a	597	1,190
2.55	2.55	n/a	597	1,787
3.40	3.40	n/a	597	2,383
4.25	4.25	n/a	597	2,980
5.10	5.10	n/a	597	3,577
5.95	5.95	n/a	597	4,173
6.80	6.80	n/a	597	4,770
7.65	7.65	n/a	597	5,367
8.50	8.50	n/a	320	5,687

Culvert / Orifice Structures

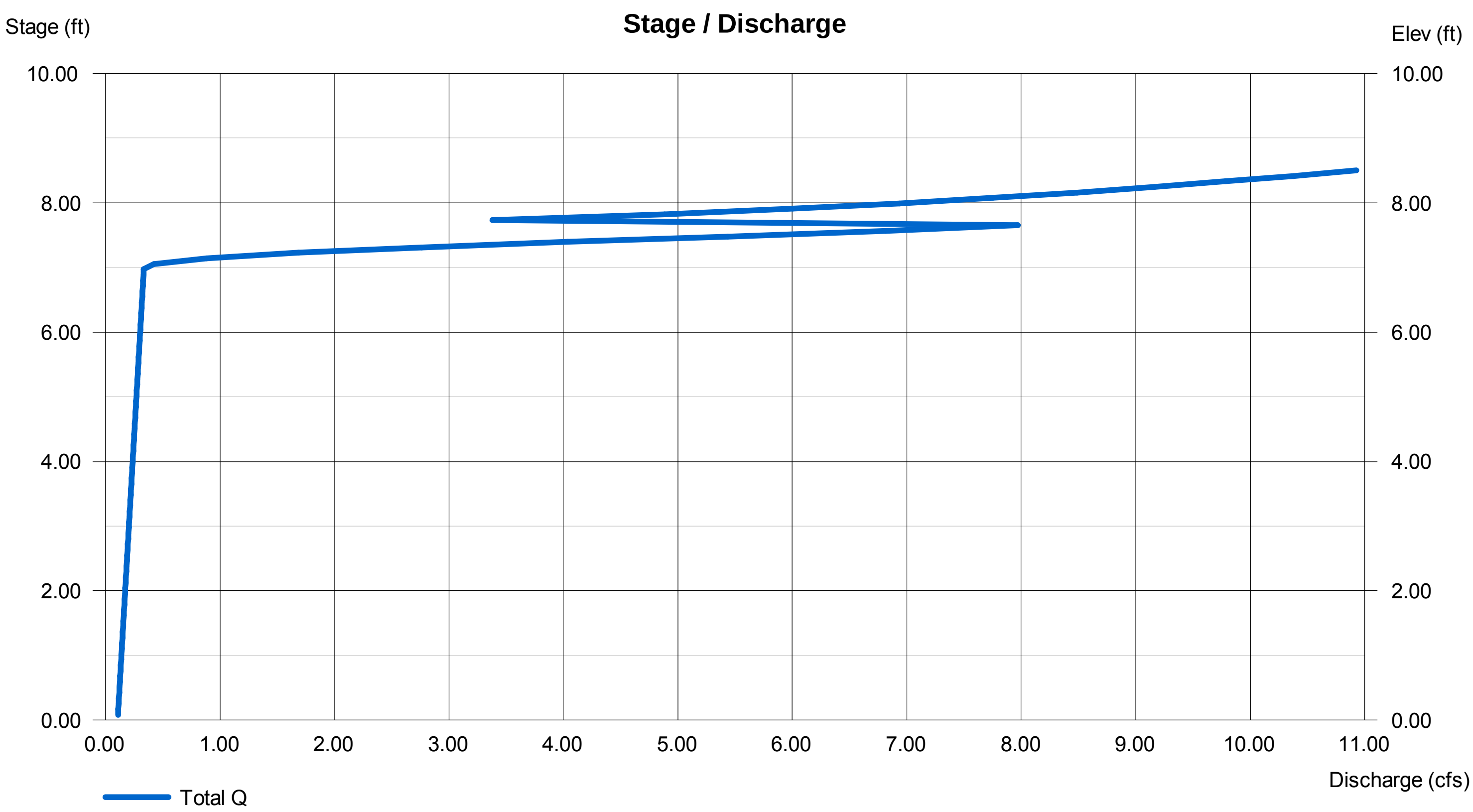
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 8.00	0.00	0.00	0.00
Span (in)	= 8.00	0.00	0.00	0.00
No. Barrels	= 8	0	0	0
Invert El. (ft)	= 7.00	0.00	0.00	0.00
Length (ft)	= 50.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

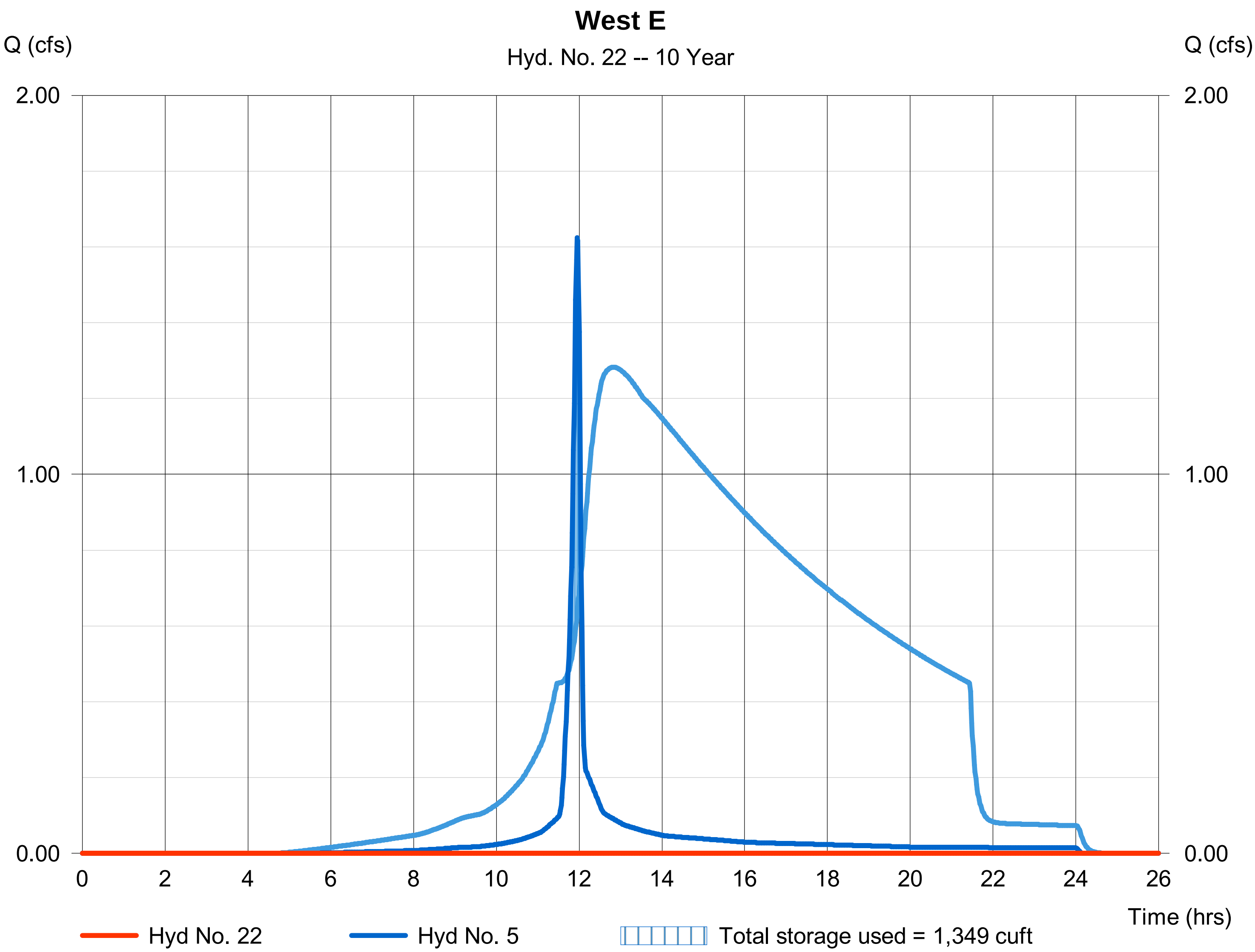
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 22

West E

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.23 hrs
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 5 - West E	Max. Elevation	= 2.80 ft
Reservoir name	= Porous Pavement West E	Max. Storage	= 1,349 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond No. 7 - Porous Pavement West E

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 2.00 x 3.33 ft , Barrel Len = 124.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 2.83 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.28	0.28	n/a	155	155
0.57	0.57	n/a	158	313
0.85	0.85	n/a	158	471
1.13	1.13	n/a	158	629
1.41	1.41	n/a	158	787
1.70	1.70	n/a	158	945
1.98	1.98	n/a	158	1,103
2.26	2.26	n/a	90	1,192
2.55	2.55	n/a	82	1,274
2.83	2.83	n/a	82	1,356

Culvert / Orifice Structures

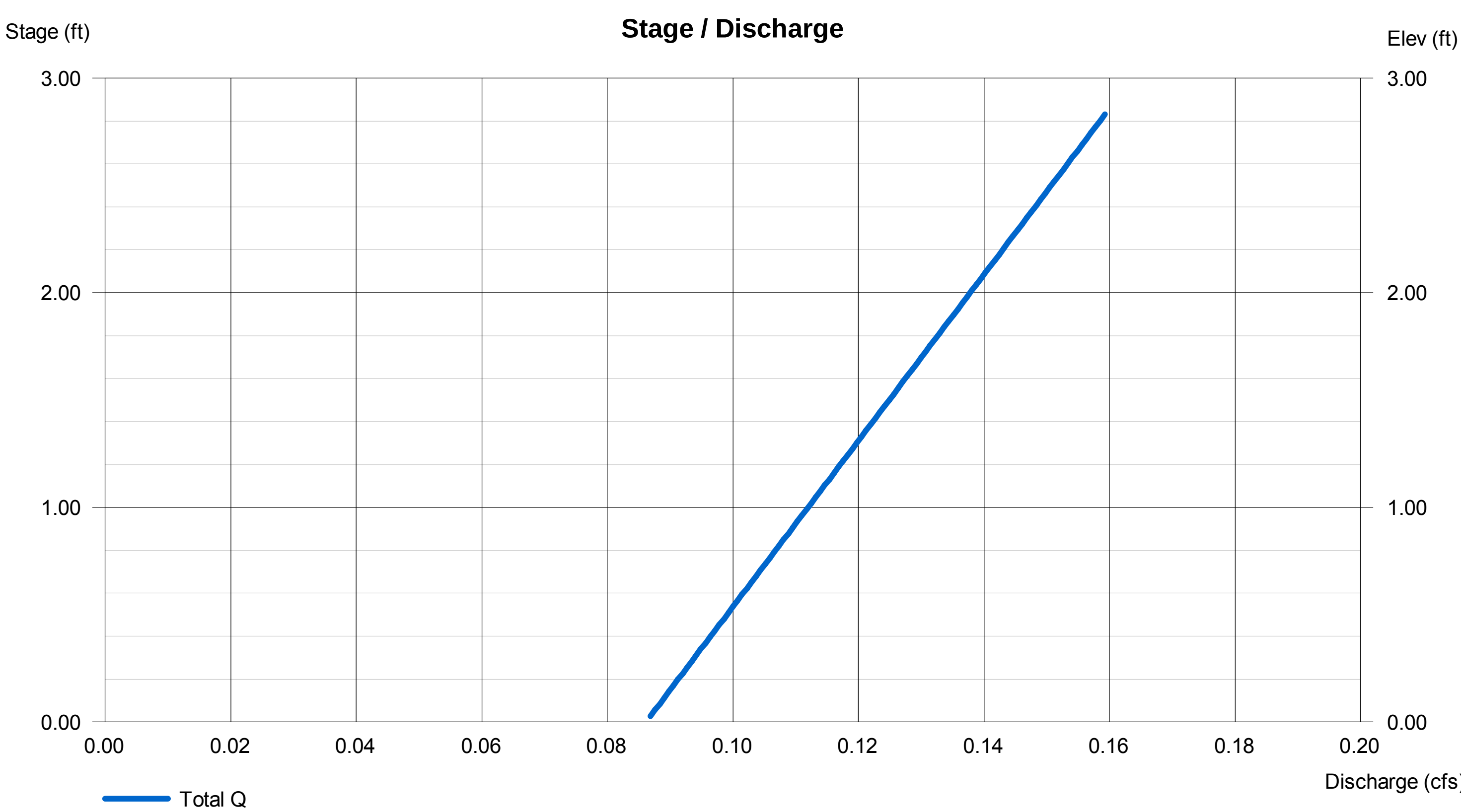
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

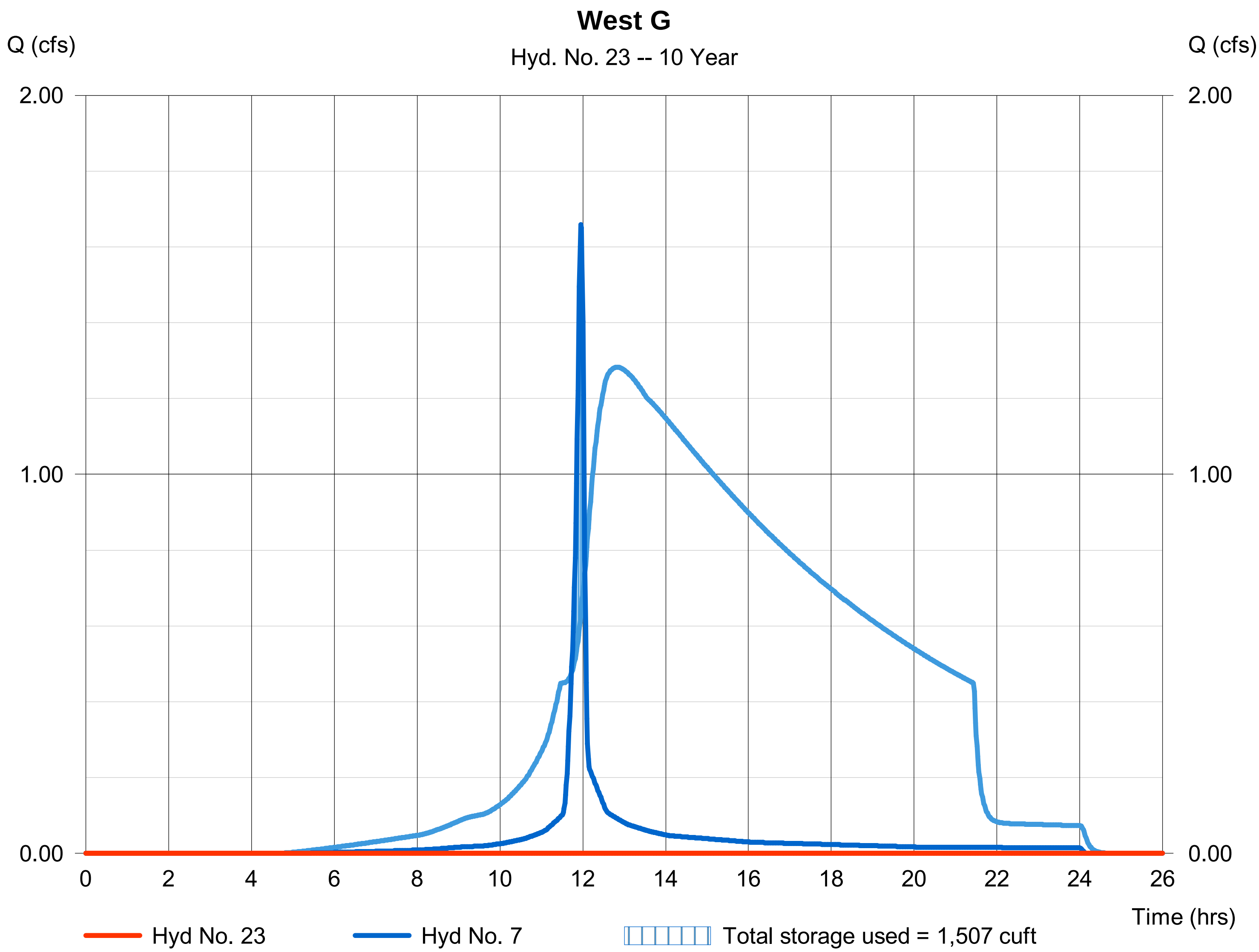
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 23

West G

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 10.40 hrs
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 7 - West G	Max. Elevation	= 4.19 ft
Reservoir name	= Porous Pavement West G	Max. Storage	= 1,507 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Pond No. 8 - Porous Pavement West G

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 3.67 x 3.33 ft , Barrel Len = 85.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 4.50 ft , Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.45	0.45	n/a	170	170
0.90	0.90	n/a	172	342
1.35	1.35	n/a	172	515
1.80	1.80	n/a	172	687
2.25	2.25	n/a	172	859
2.70	2.70	n/a	172	1,031
3.15	3.15	n/a	172	1,203
3.60	3.60	n/a	172	1,375
4.05	4.05	n/a	104	1,479
4.50	4.50	n/a	89	1,568

Culvert / Orifice Structures

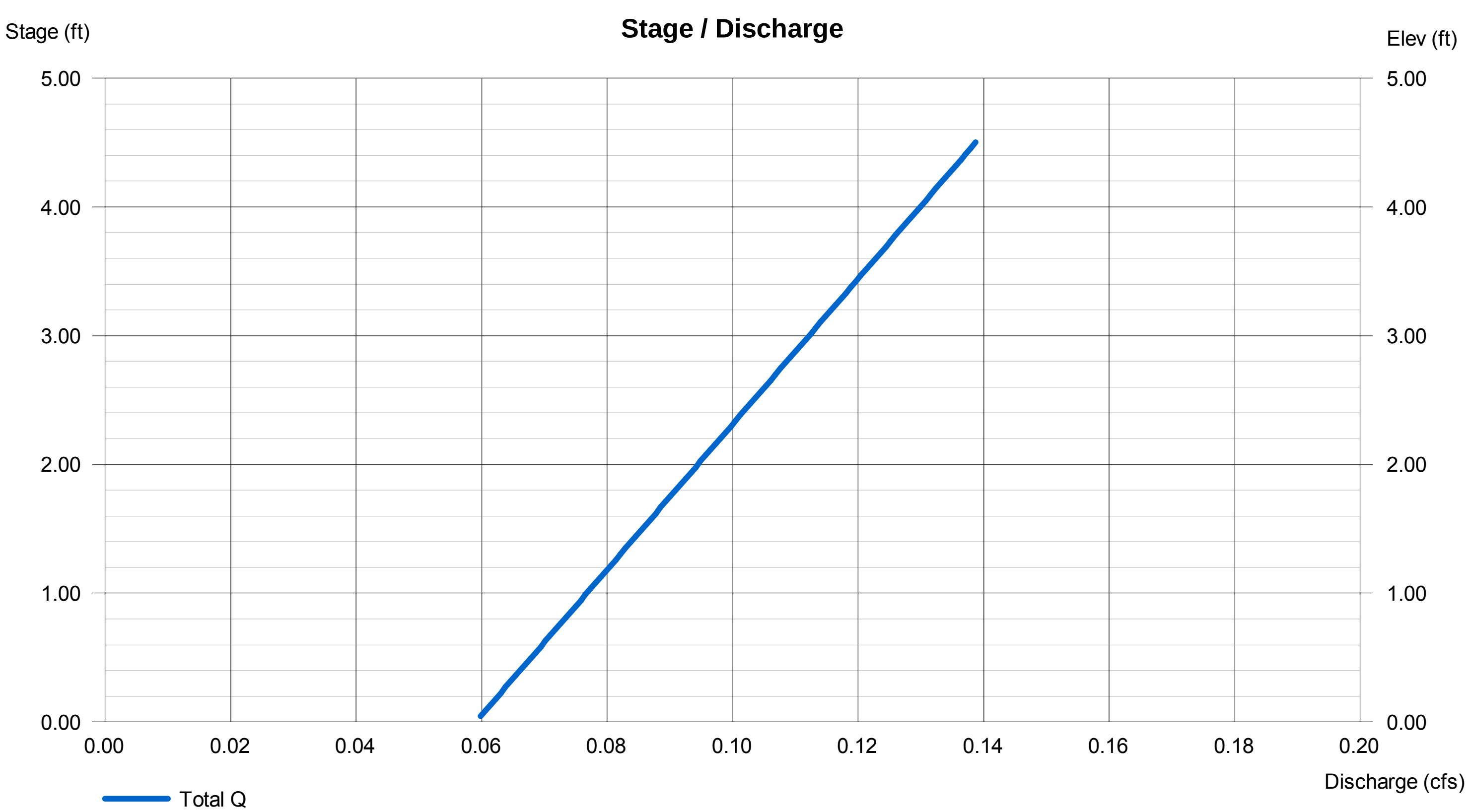
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

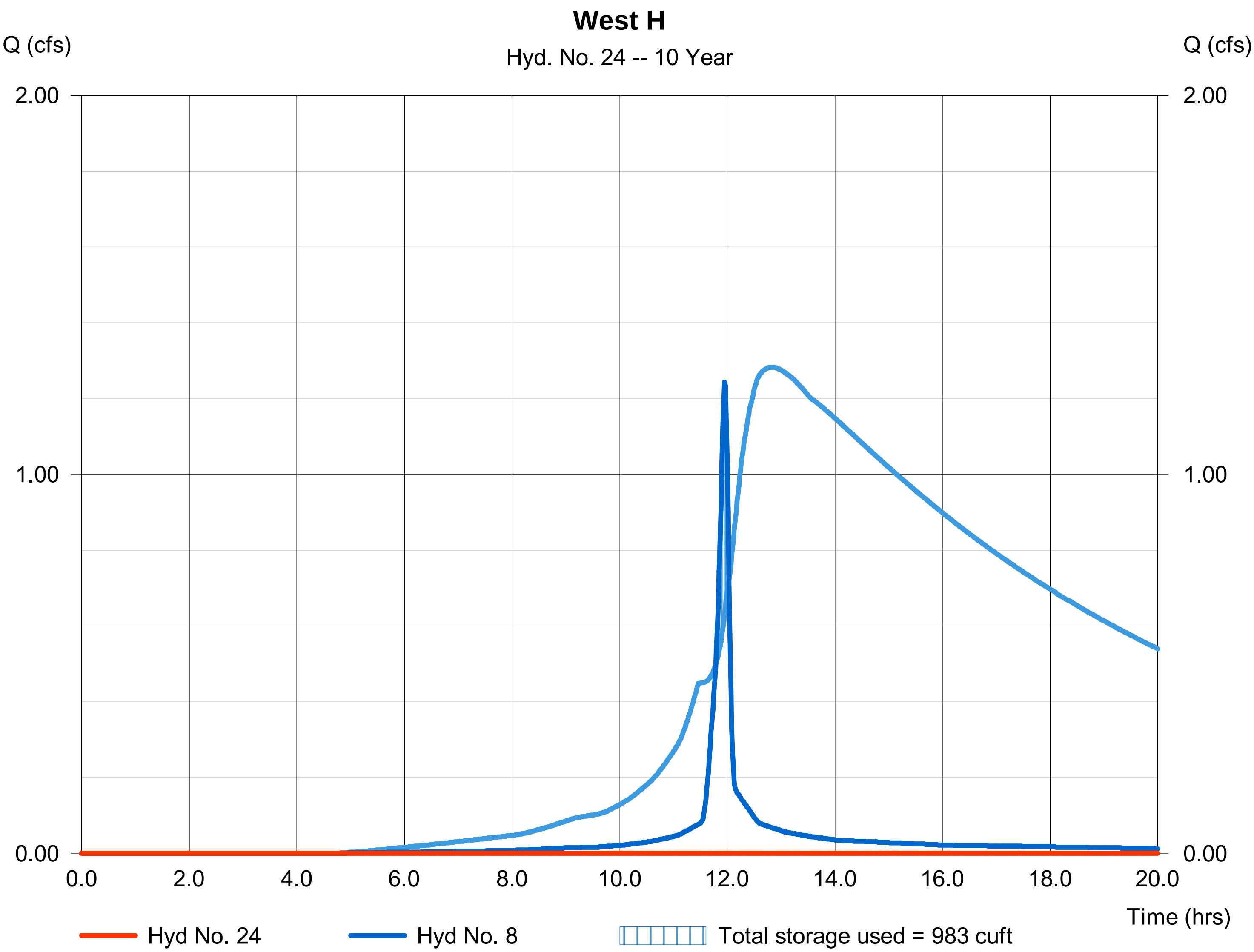
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 24

West H

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 8 - West H	Max. Elevation	= 2.14 ft
Reservoir name	= Porous Pavement West H	Max. Storage	= 983 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond No. 9 - Porous Pavement West H

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 1.33 x 3.33 ft , Barrel Len = 125.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 2.17 ft , Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.22	0.22	n/a	119	119
0.43	0.43	n/a	122	241
0.65	0.65	n/a	122	363
0.87	0.87	n/a	122	486
1.09	1.09	n/a	122	608
1.30	1.30	n/a	122	730
1.52	1.52	n/a	74	803
1.74	1.74	n/a	63	867
1.95	1.95	n/a	63	930
2.17	2.17	n/a	63	993

Culvert / Orifice Structures

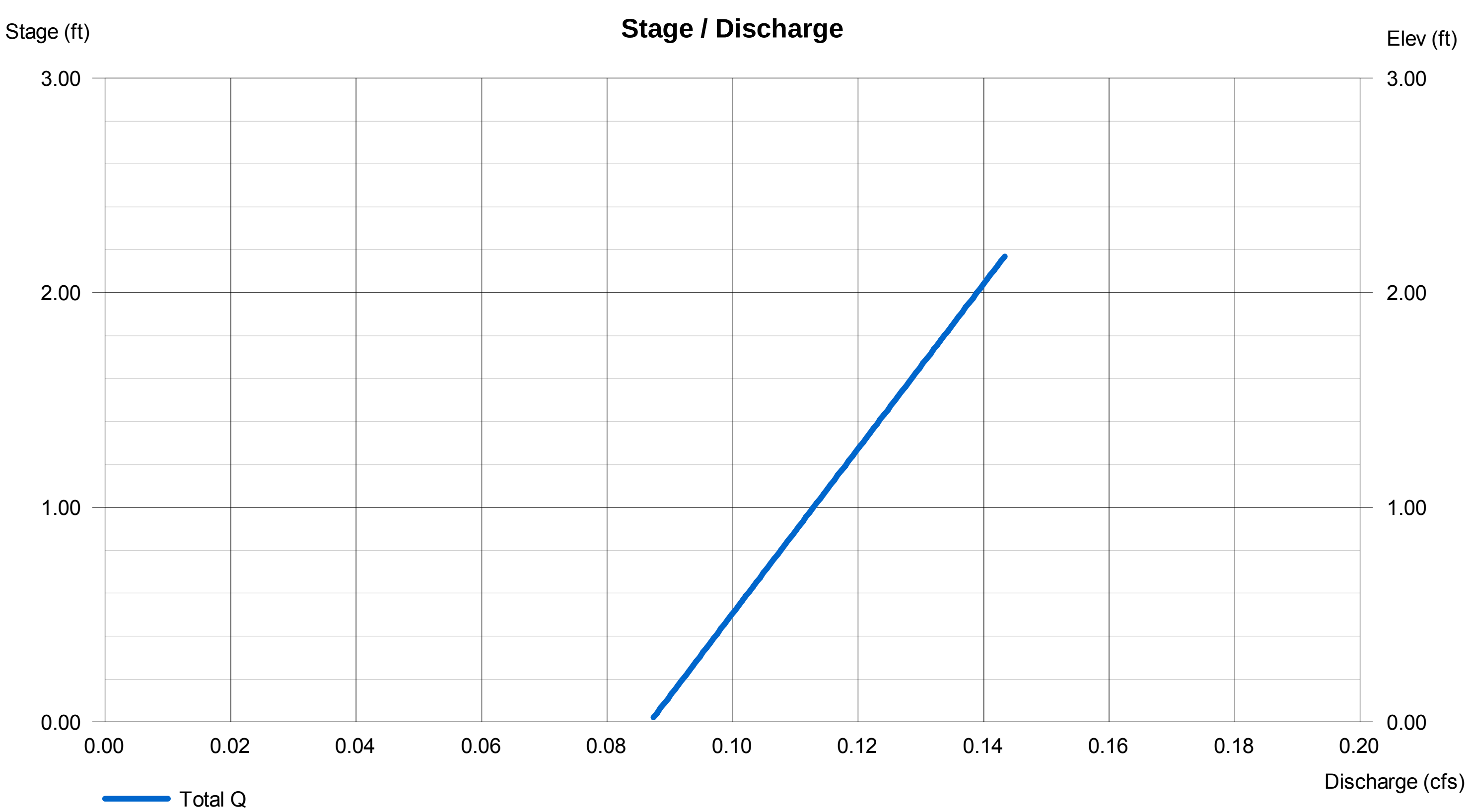
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

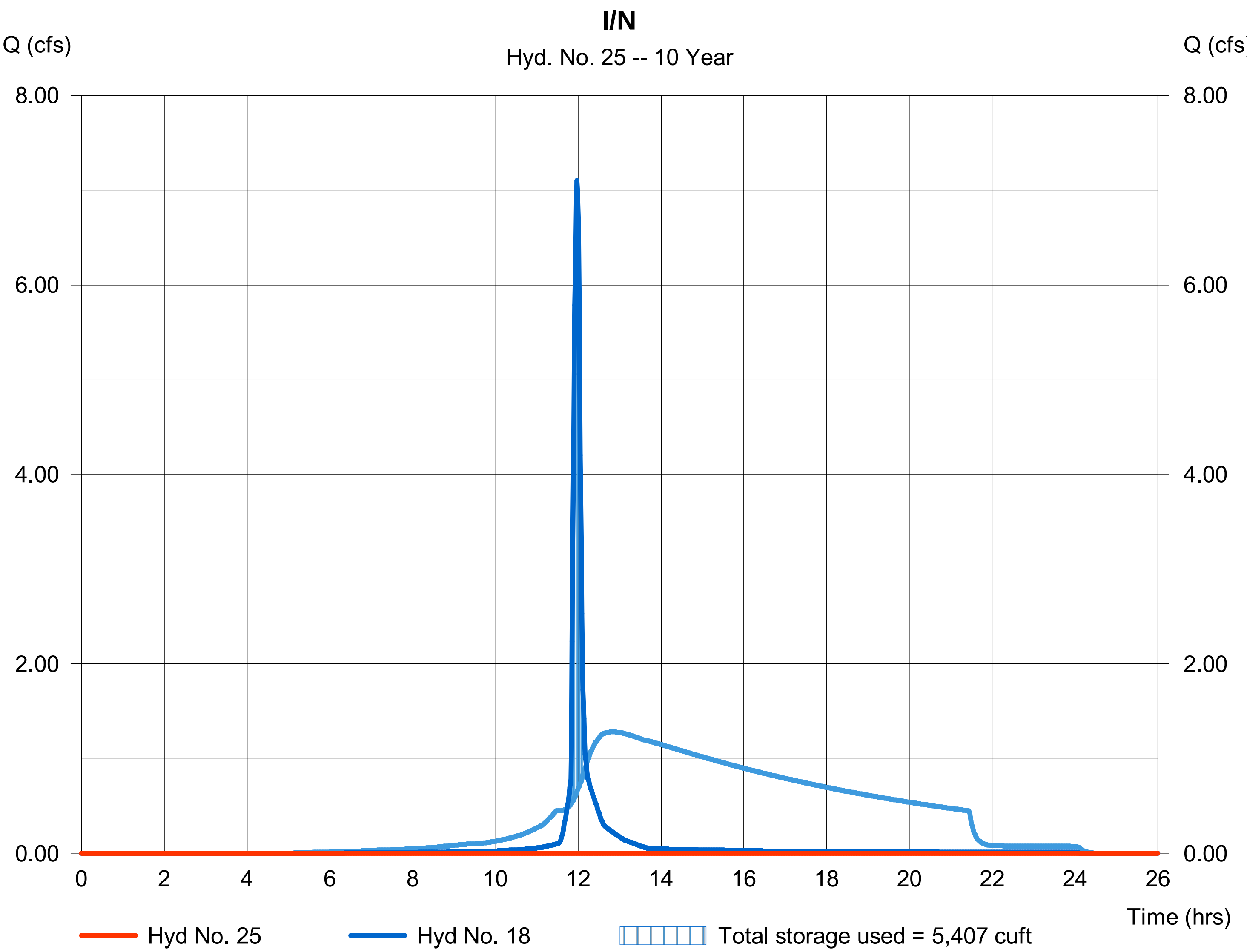
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 25

I/N

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.48 hrs
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 18 - Combined Hydrograph N/I	Max. Elevation	= 7.95 ft
Reservoir name	= Porous Pavement Wets I/N	Max. Storage	= 5,407 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 10 - Porous Pavement Wets I/N

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 7.33 x 3.33 ft , Barrel Len = 157.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 8.17 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.82	0.82	n/a	574	574
1.63	1.63	n/a	577	1,151
2.45	2.45	n/a	577	1,728
3.27	3.27	n/a	577	2,305
4.09	4.09	n/a	577	2,883
4.90	4.90	n/a	577	3,460
5.72	5.72	n/a	577	4,037
6.54	6.54	n/a	577	4,614
7.35	7.35	n/a	573	5,187
8.17	8.17	n/a	300	5,486

Culvert / Orifice Structures

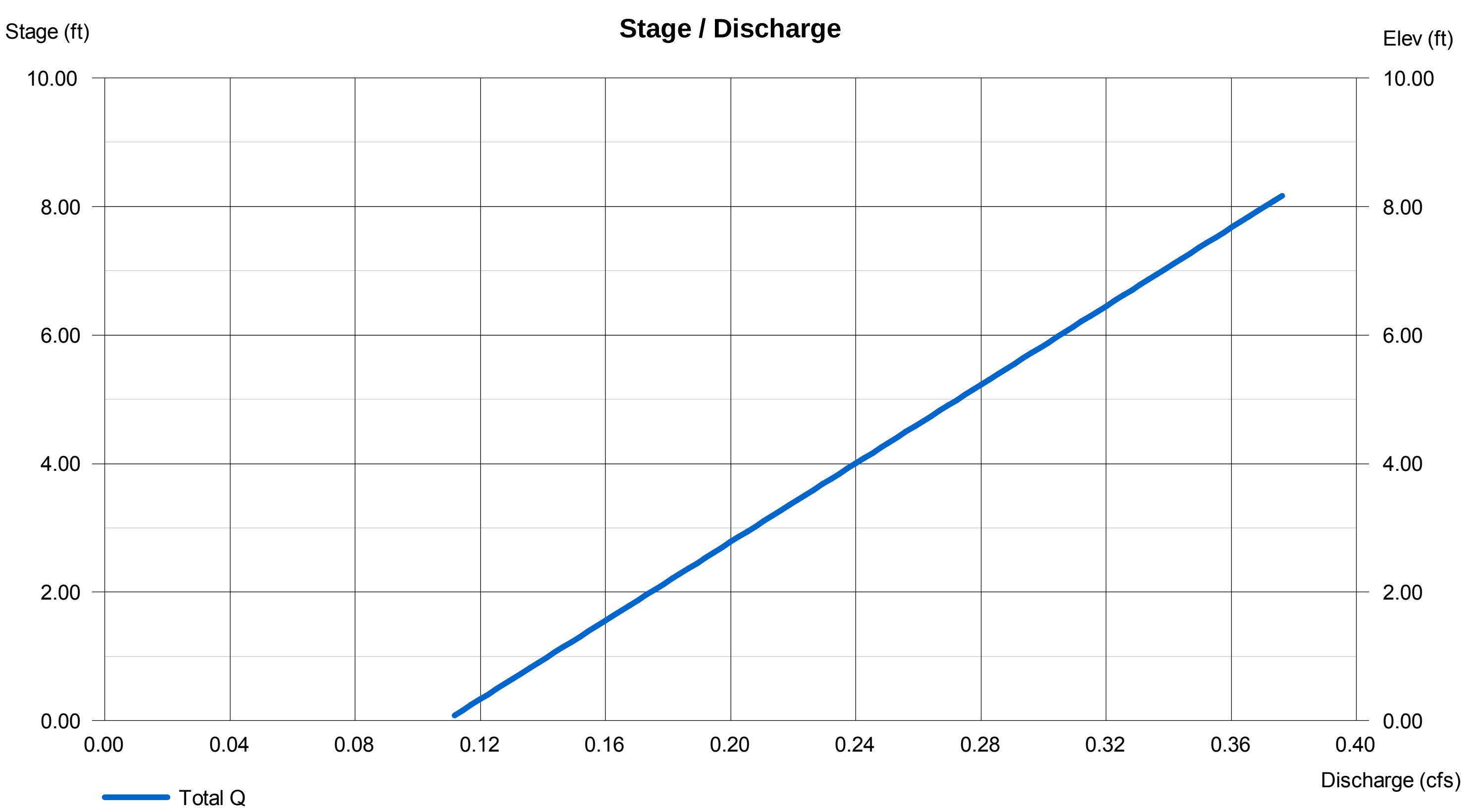
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

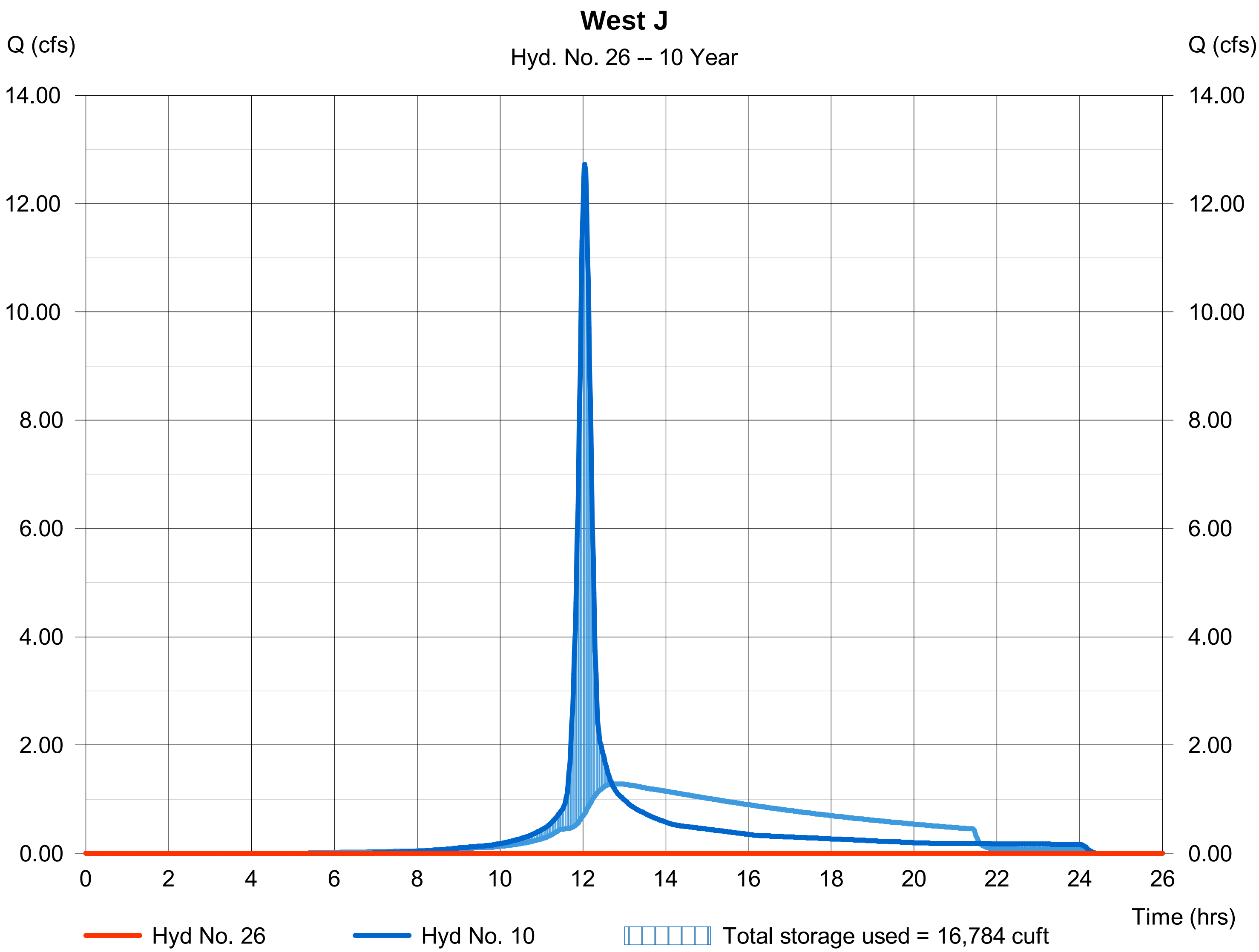
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 26

West J

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 10.85 hrs
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 10 - West J	Max. Elevation	= 6.42 ft
Reservoir name	= Porous Pavement West J	Max. Storage	= 16,784 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Pond No. 11 - Porous Pavement West J

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 7.67 x 3.33 ft , Barrel Len = 542.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 7.60 ft , Height = 8.50 ft , Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.85	0.85	n/a	2,211	2,211
1.70	1.70	n/a	2,223	4,434
2.55	2.55	n/a	2,223	6,658
3.40	3.40	n/a	2,223	8,881
4.25	4.25	n/a	2,223	11,104
5.10	5.10	n/a	2,223	13,327
5.95	5.95	n/a	2,223	15,550
6.80	6.80	n/a	2,223	17,773
7.65	7.65	n/a	2,223	19,996
8.50	8.50	n/a	1,261	21,257

Culvert / Orifice Structures

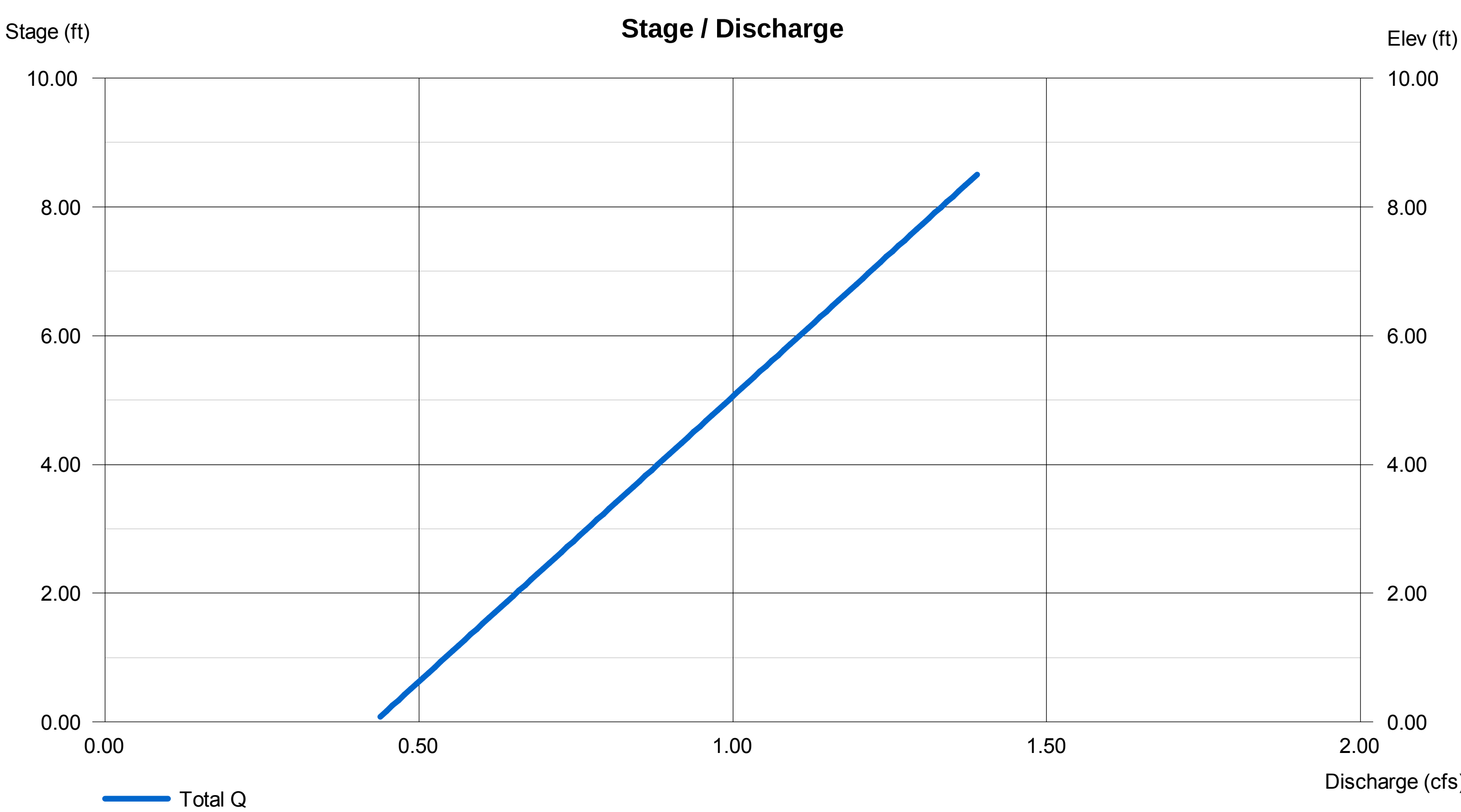
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

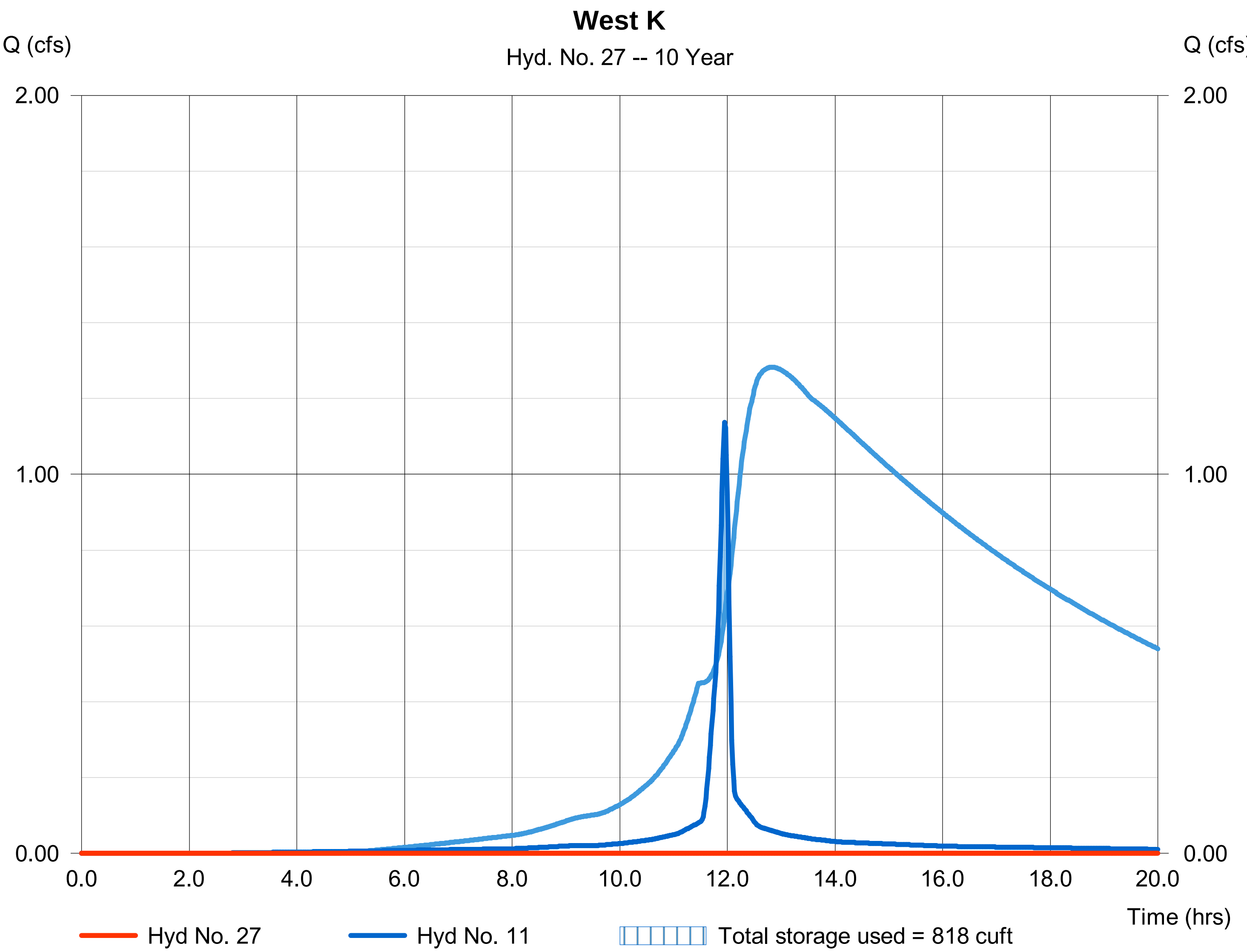
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 27

West K

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 11 - West K	Max. Elevation	= 2.11 ft
Reservoir name	= Porous Pavement West K	Max. Storage	= 818 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 12 - Porous Pavement West K

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 0.01 x 0.01 ft , Barrel Len = 166.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 2.25 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.22	0.22	n/a	87	87
0.45	0.45	n/a	87	174
0.68	0.68	n/a	87	262
0.90	0.90	n/a	87	349
1.13	1.13	n/a	87	436
1.35	1.35	n/a	87	523
1.58	1.58	n/a	87	610
1.80	1.80	n/a	87	698
2.03	2.03	n/a	87	785
2.25	2.25	n/a	87	872

Culvert / Orifice Structures

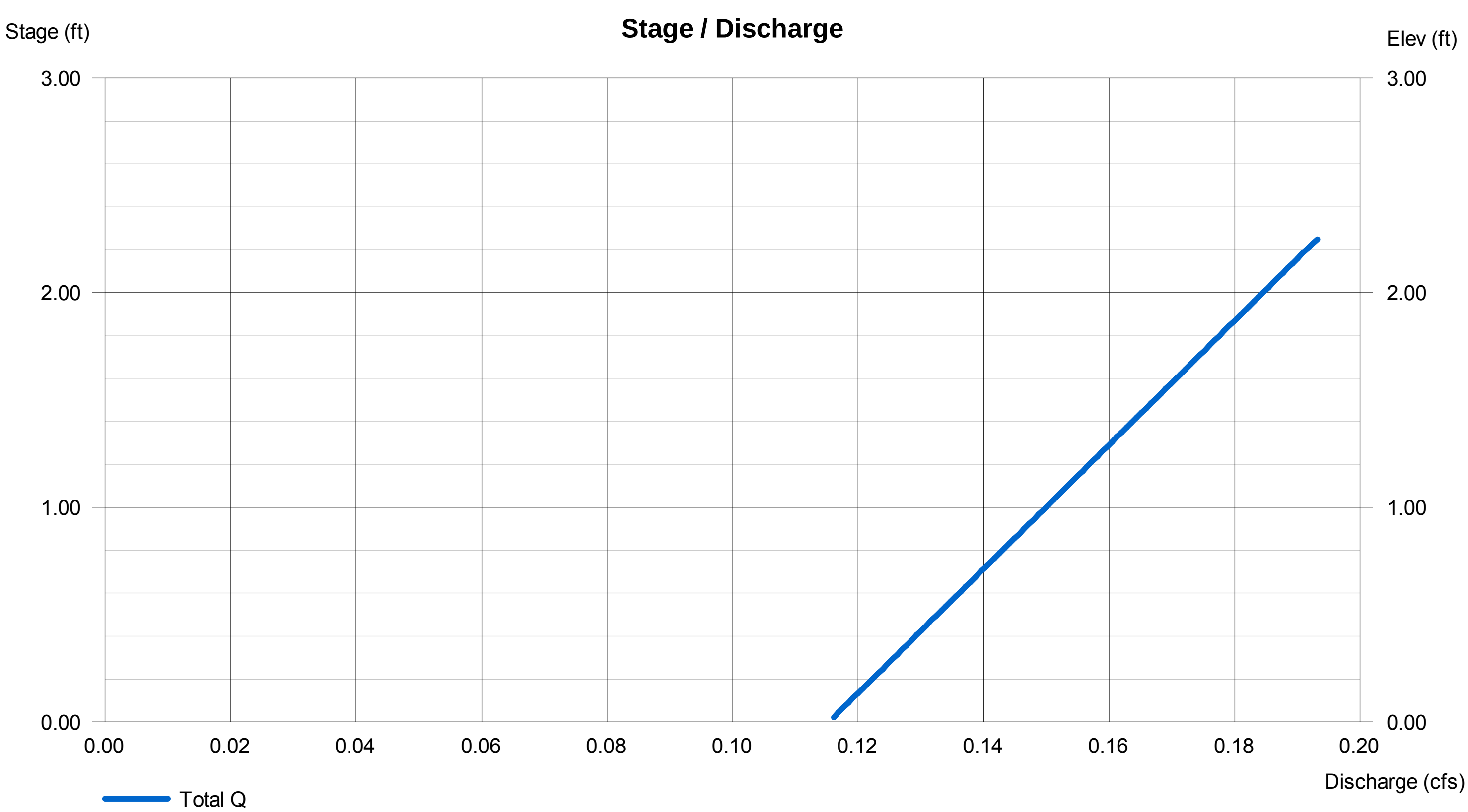
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

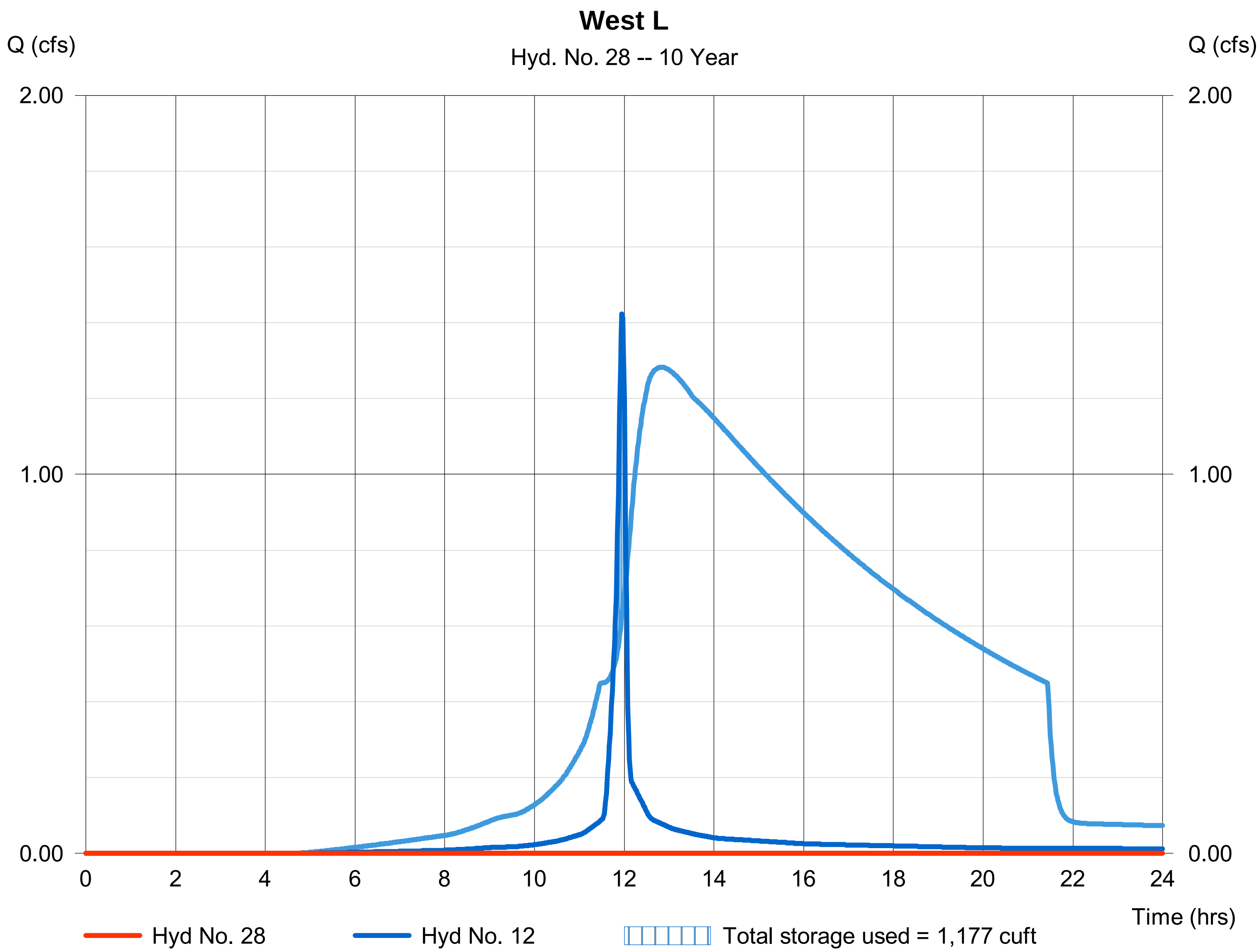
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 | Friday, Jan 20, 2012

Hyd. No. 28

West L

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 10.07 hrs
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 12 - West L	Max. Elevation	= 2.42 ft
Reservoir name	= Porous Pavement West L	Max. Storage	= 1,177 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 13 - Porous Pavement West L

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 2.00 x 3.33 ft , Barrel Len = 118.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 2.83 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.28	0.28	n/a	148	148
0.57	0.57	n/a	150	298
0.85	0.85	n/a	150	448
1.13	1.13	n/a	150	599
1.41	1.41	n/a	150	749
1.70	1.70	n/a	150	899
1.98	1.98	n/a	150	1,049
2.26	2.26	n/a	85	1,135
2.55	2.55	n/a	78	1,213
2.83	2.83	n/a	78	1,291

Culvert / Orifice Structures

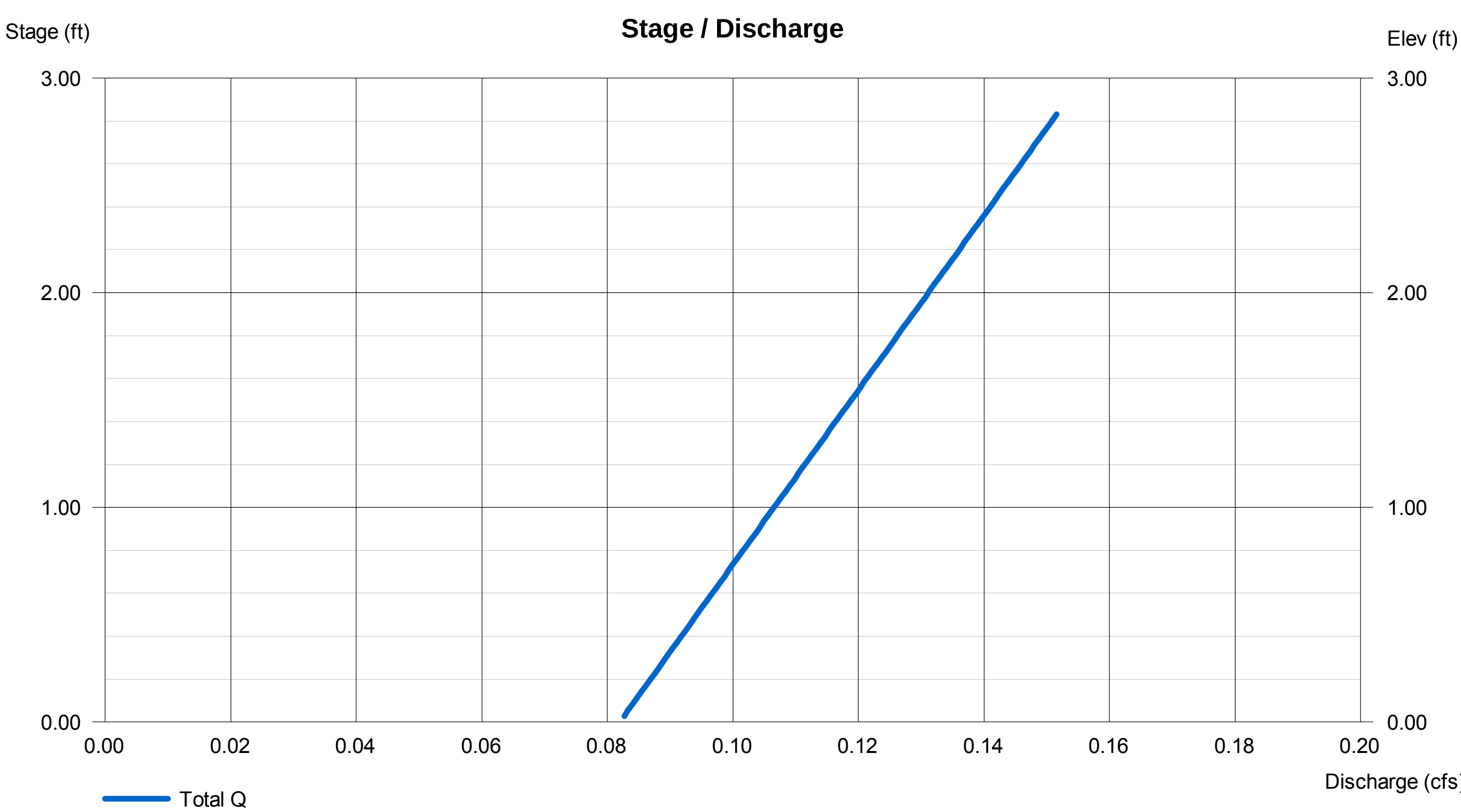
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

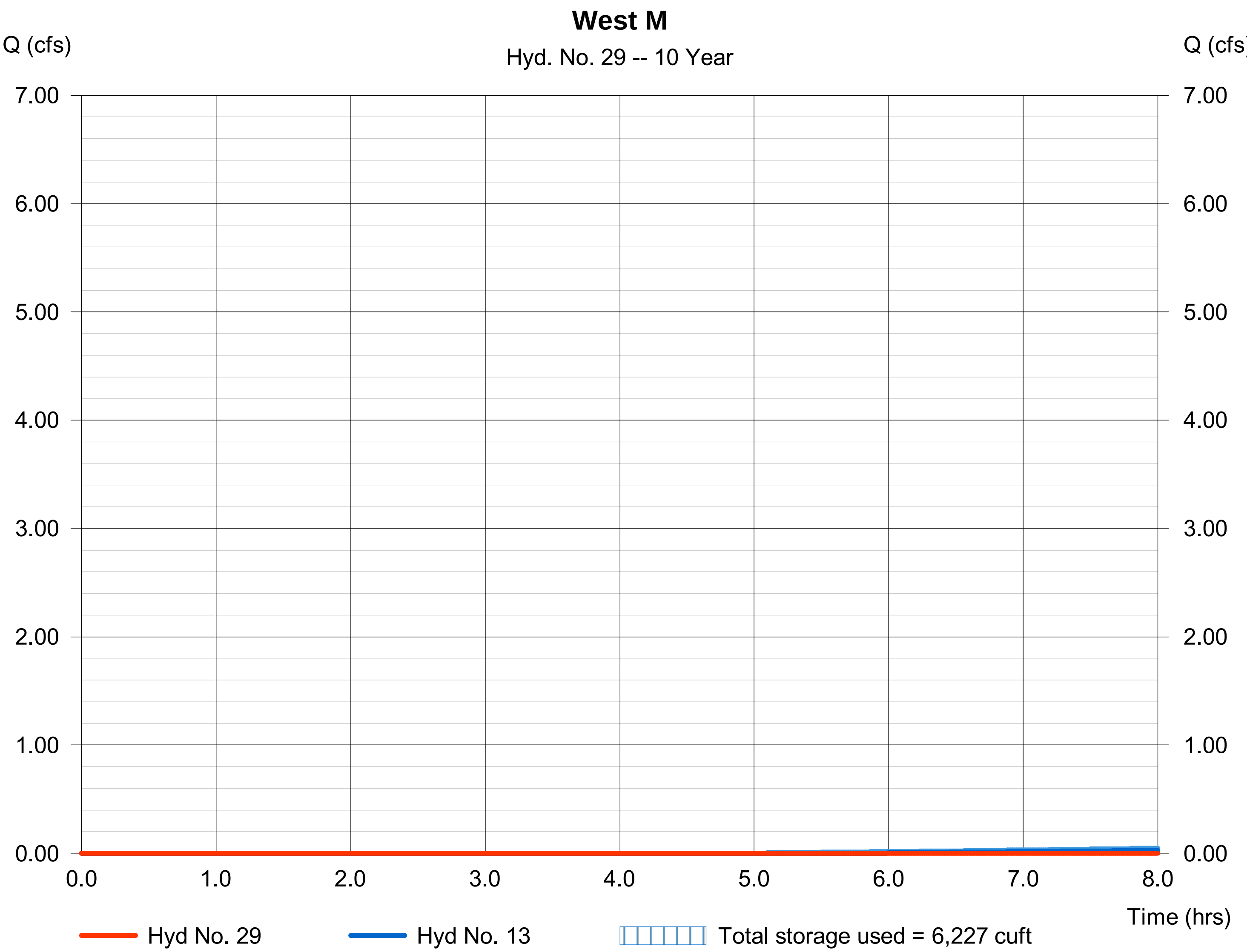
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 29

West M

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 7.77 hrs
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 13 - West M	Max. Elevation	= 4.14 ft
Reservoir name	= Porous Pavement West M	Max. Storage	= 6,227 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 14 - Porous Pavement West M

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 3.33 x 3.33 ft , Barrel Len = 369.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 4.17 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.42	0.42	n/a	684	684
0.83	0.83	n/a	692	1,377
1.25	1.25	n/a	692	2,069
1.67	1.67	n/a	692	2,762
2.09	2.09	n/a	692	3,454
2.50	2.50	n/a	692	4,146
2.92	2.92	n/a	692	4,839
3.34	3.34	n/a	692	5,531
3.75	3.75	n/a	362	5,894
4.17	4.17	n/a	359	6,253

Culvert / Orifice Structures

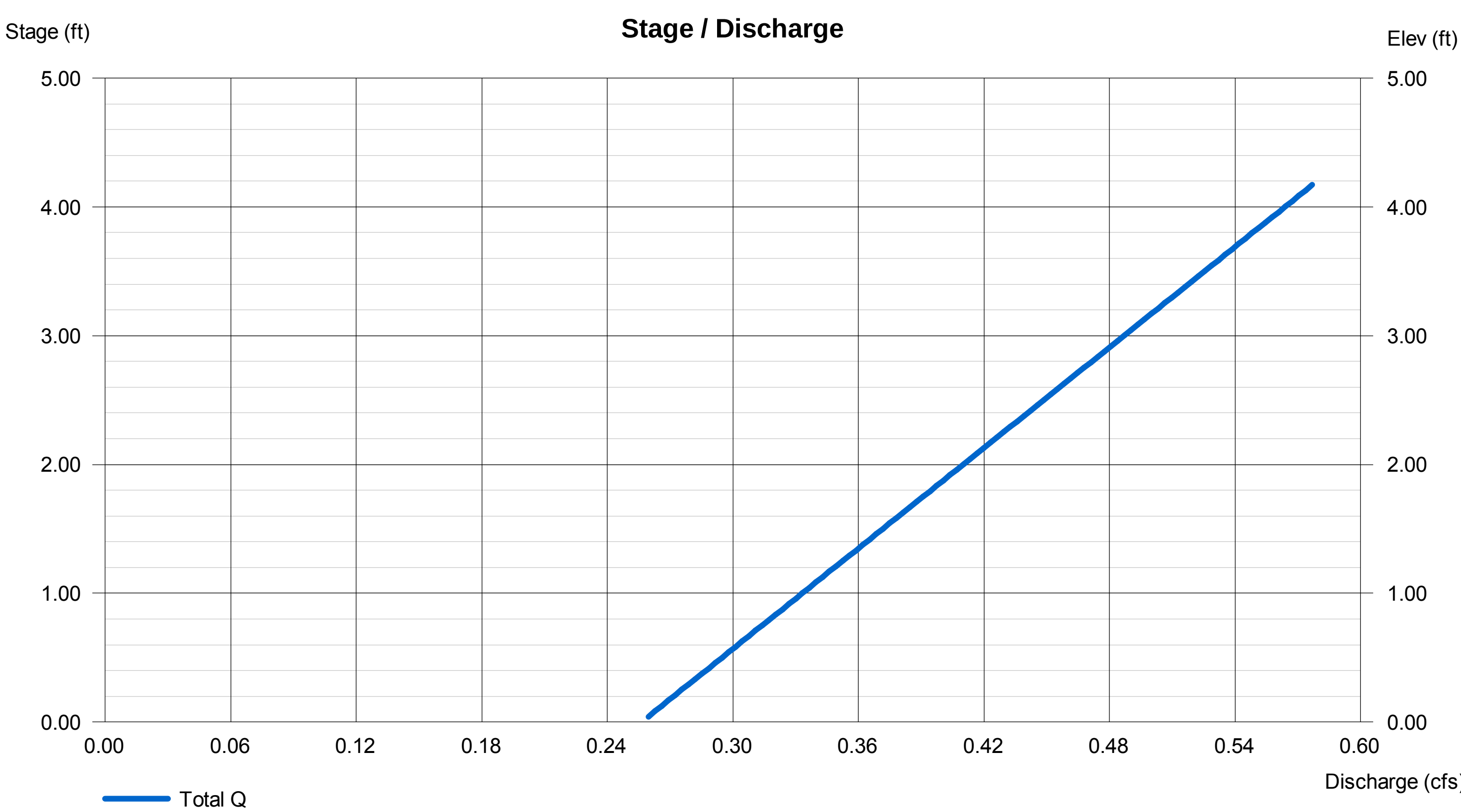
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



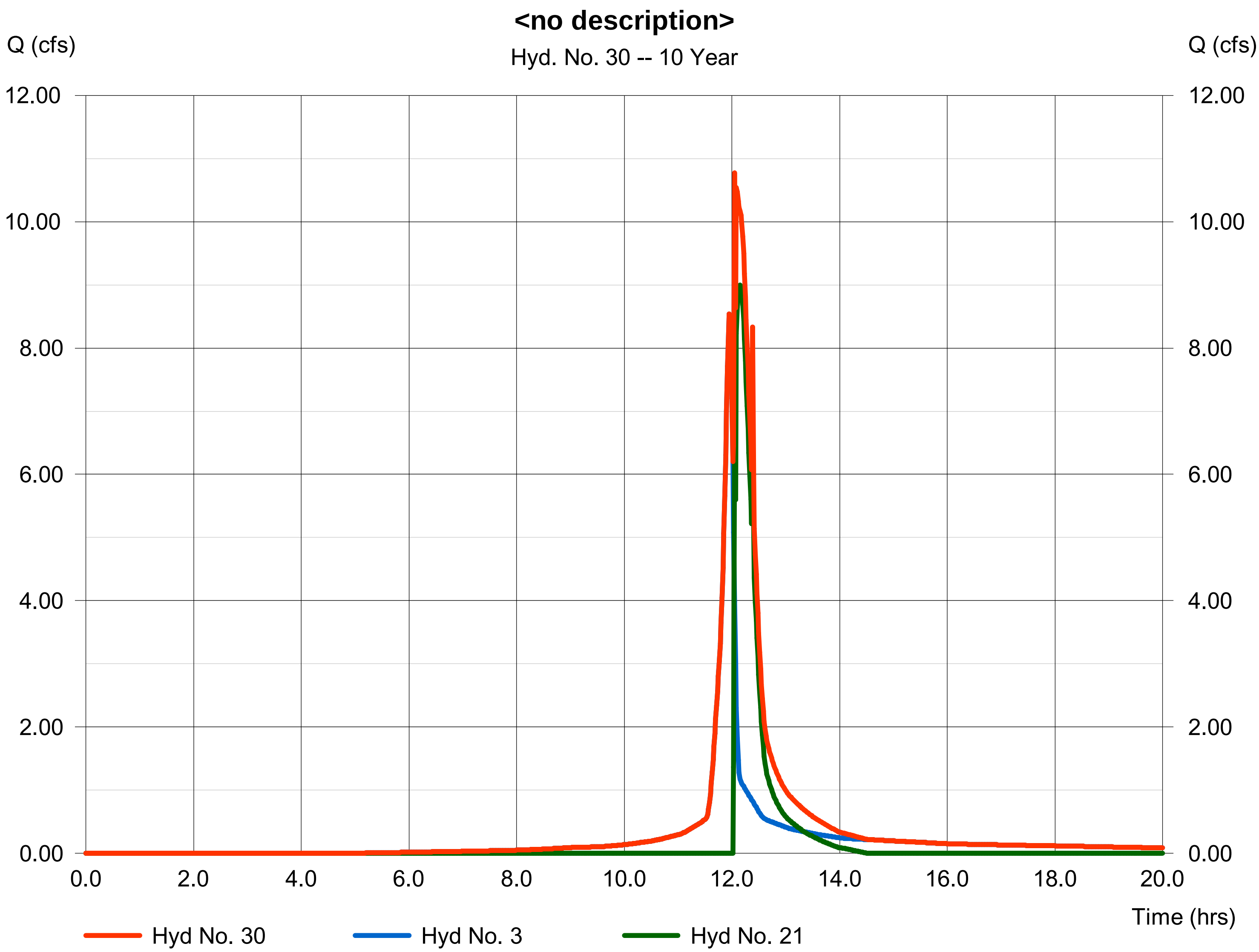
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 30

<no description>

Hydrograph type	= Combine	Peak discharge	= 10.77 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.05 hrs
Time interval	= 1 min	Hyd. volume	= 32,495 cuft
Inflow hyds.	= 3, 21	Contrib. drain. area	= 1.260 ac



Hydrograph Report

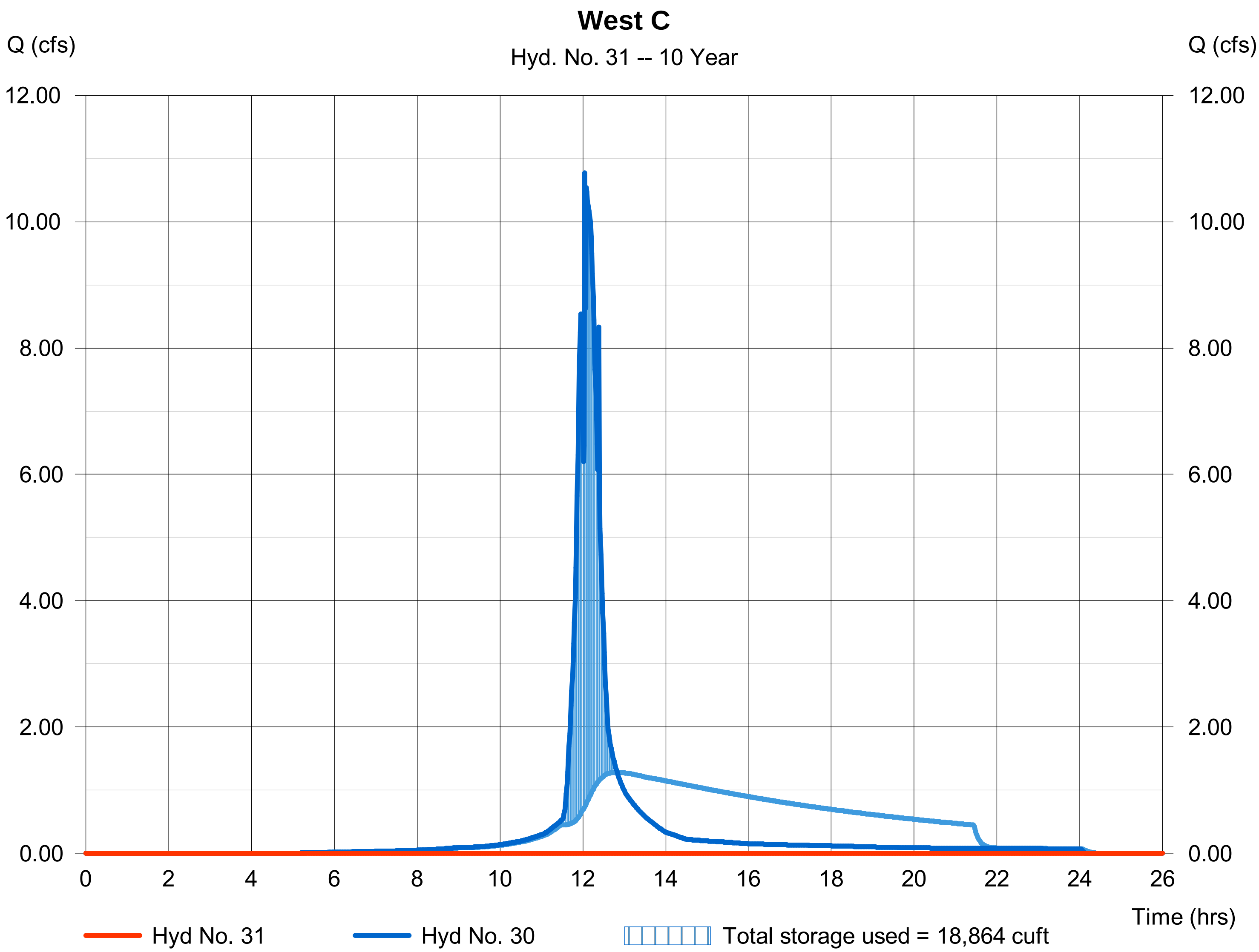
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 31

West C

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 21.45 hrs
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 30 - <no description>	Max. Elevation	= 7.46 ft
Reservoir name	= Porous Pavement West C	Max. Storage	= 18,864 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 5 - Porous Pavement West C

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 6.67 x 3.33 ft , Barrel Len = 542.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 7.80 ft, Height = 7.50 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.75	0.75	n/a	1,978	1,978
1.50	1.50	n/a	1,990	3,968
2.25	2.25	n/a	1,990	5,958
3.00	3.00	n/a	1,990	7,948
3.75	3.75	n/a	1,990	9,938
4.50	4.50	n/a	1,990	11,928
5.25	5.25	n/a	1,990	13,918
6.00	6.00	n/a	1,990	15,908
6.75	6.75	n/a	1,908	17,816
7.50	7.50	n/a	1,110	18,926

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

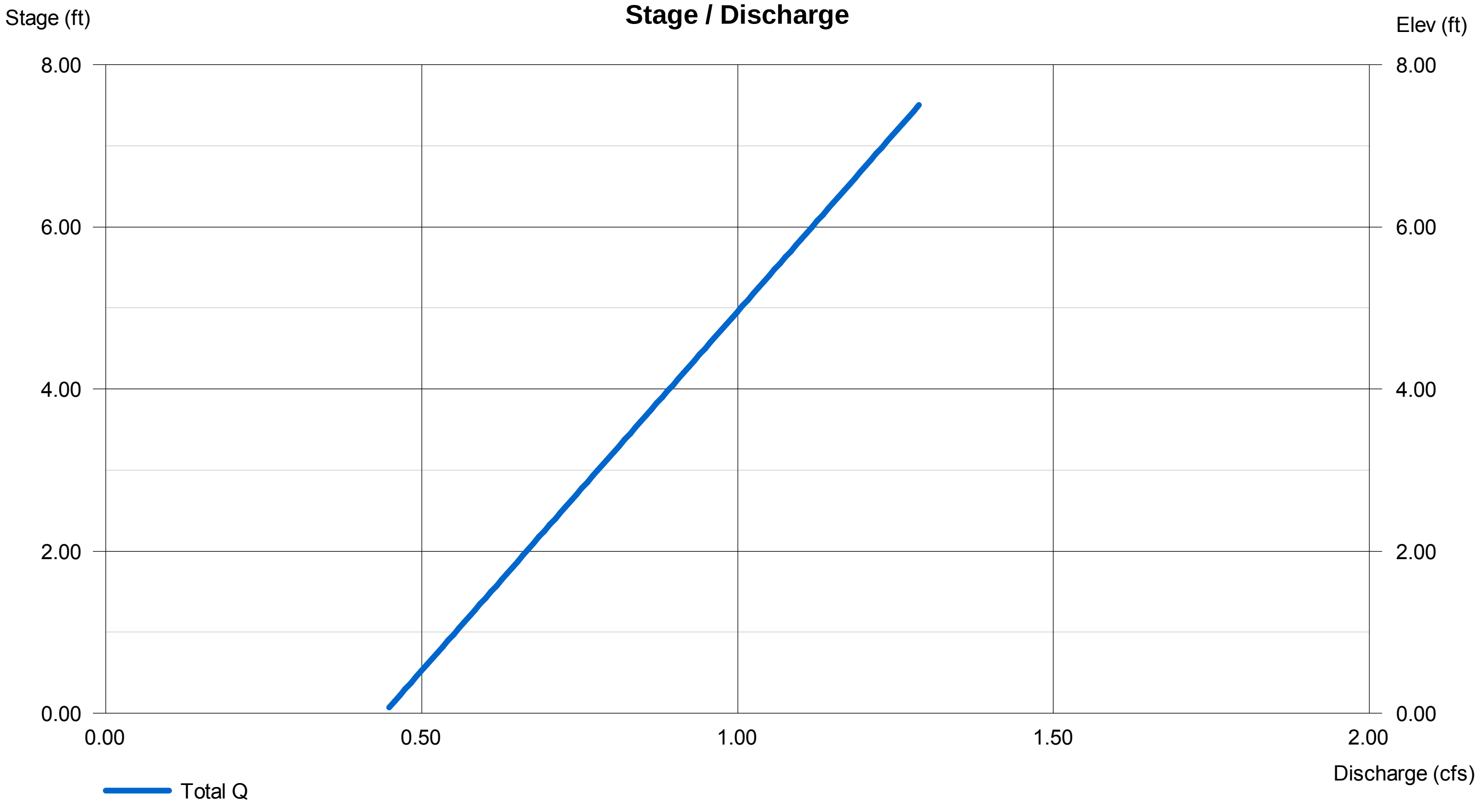
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Discharge



FUSS & O'NEILL

Appendix C

Opinions of Cost for Green Infrastructure Improvements

100%

FUSS & O'NEILL

FUSS & O'NEILL

317 Iron Horse Way, Ste 204
Providence, RI 02908

BUDGETARY OPINION OF COST	DATE PREPARED : 01/10/12	SHEET 1	of 1
PROJECT : Shandon Drainage Study	BASIS : 2010-2011 Mass Highway and RIDOT Weighted Average Unit Prices in addition to RSMeans2008.		
LOCATION : Columbia, South Carolina			
DESCRIPTION **Budgetary Opinion of Cost for LID Alternatives**			
DRAWING NO. 20061078.A10	ESTIMATOR : AMB	CHECKED BY : SDA	

Since Fuss & O'Neill has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor(s)' methods of determining prices, or over competitive bidding or market conditions, Fuss & O'Neill's opinion of probable Total Project Costs and Construction Cost are made on the basis of Fuss & O'Neill's experience and qualifications and represent Fuss & O'Neill's best judgment as an experienced and qualified professional engineer, familiar with the construction industry; but Fuss & O'Neill cannot and does not guarantee that proposals, bids or actual Total Project or Construction Costs will not vary from opinions of probable cost prepared by Fuss & O'Neill. If prior to the bidding or negotiating Phase the Owner wishes greater assurance as to Total Project or Construction Costs, the Owner shall employ an independent cost estimator.

ITEM NO.	ITEM DESCRIPTION	UNIT MEAS.	NO. UNITS	PER UNIT	COST
1	**AMHERST AVENUE**				
	Full Depth Bituminous Sawcut	LF	1,094	$1.00	$1,100
	Pavement Excavation and Removal	SY	735	$7.50	$5,500
	Curb Remove and Dispose	LF	1,085	$4.50	$4,900
	Earth Excavation	CY	1,231	$15.00	$18,500
	Fine Grading, Compacting, and Finishing	SY	735	$3.00	$2,200
	Rainstore (including Stone, System, Geotextile, and Misc.)	CF	10,140	$12.00	$121,700
	Cultec Chambers (100HD)	EA	68	$100.00	$6,800
	Geotextile Filter Fabric for Separation	SY	855	$3.50	$3,000
	Crushed Stone Encasement	CY	169	$40.00	$6,800
	New Pervious Pavement (4-inches Total Depth)	TON	135	$85.00	$11,500
	New Asphalt Pavement Binder Course (2.5-Inches)	TON	20	$85.00	$1,700
	New Asphalt Surface Course (1.5-Inches)	TON	119	$85.00	$10,100
	Pavement Removal by Cold Planing	SY	1,248	$2.50	$3,100
	Crushed Stone Choker Course and Base	CY	242	$40.00	$9,700
	Concrete Curb	LF	1,085	$25.00	$27,100
	Imported Soil Mixture (Loamy Sand or Sandy Loam)	CY	17	$40.00	$700
	Seeding	SY	505	$2.00	$1,000
	Topsoil (4"Depth)	CY	55	$35.00	$1,900
	SUBTOTAL				$237,000
	CONTINGENCY (20%)				$47,000
	TOTAL COST (ROUNDED TO NEAREST $1,000)				$284,000
	UPPER COST RANGE LIMIT (+30%)				$308,000
	LOWER COST RANGE LIMIT (-15%)				$201,000
2	**WHEAT STREET**				
	Full Depth Bituminous Sawcut	LF	1,268	$1.00	$1,300
	Pavement Excavation and Removal	SY	1,104	$7.50	$8,300
	Curb Remove and Dispose	LF	1,235	$4.50	$5,600
	Earth Excavation	CY	1,172	$15.00	$17,600
	Fine Grading, Compacting, and Finishing	SY	1,104	$3.00	$3,300
	Rainstore (including Stone, System, and Misc.)	CF	21,708	$12.00	$260,500
	Crushed Stone Trench	CY	199	$40.00	$8,000
	Geotextile Filter Fabric for Separation	SY	779	$3.50	$2,700
	New Pervious Pavement (4-inches)	TON	117	$85.00	$9,900
	New Asphalt Pavement Binder Course (2.5-Inches)	TON	72	$85.00	$6,100
	New Asphalt Surface Course (1.5-Inches)	TON	179	$85.00	$15,200
	Pavement Removal by Cold Planing	SY	1,592	$2.50	$4,000
	Crushed Stone Choker Course and Base	CY	283	$40.00	$11,300
	Concrete Curb	LF	1,235	$25.00	$30,900
	Imported Soil Mixture (Loamy Sand or Sandy Loam)	CY	68	$40.00	$2,700
	Seeding	SY	653	$2.00	$1,300
	Topsoil (4"Depth)	CY	61	$35.00	$2,100
	SUBTOTAL				$391,000
	CONTINGENCY (20%)				$78,000
	TOTAL COST (ROUNDED TO NEAREST $1,000)				$469,000
	UPPER COST RANGE LIMIT (+30%)				$508,000
	LOWER COST RANGE LIMIT (-15%)				$332,000

ITEM NO.	ITEM DESCRIPTION	UNIT MEAS.	NO. UNITS	PER UNIT	COST
3	**CAPITOL PLACE**				
	Full Depth Bituminous Sawcut	LF	557	$1.00	$600
	Pavement Excavation and Removal	SY	391	$7.50	$2,900
	Curb Remove and Dispose	LF	550	$4.50	$2,500
	Earth Excavation	CY	306	$15.00	$4,600
	Fine Grading, Compacting, and Finishing	SY	438	$3.00	$1,300
	Crushed Stone Trench	CY	108	$40.00	$4,300
	Geotextile Filter Fabric for Separation	SY	767	$3.50	$2,700
	New Pervious Pavement (4-inches)	TON	77	$85.00	$6,500
	Crushed Stone Choker Course and Base	CY	19	$40.00	$800
	Concrete Curb	LF	550	$25.00	$13,800
	Imported Soil Mixture (Loamy Sand or Sandy Loam)	CY	69	$40.00	$2,800
	Seeding	SY	348	$2.00	$700
	Topsoil (4"Depth)	CY	27	$35.00	$900
	Optional Single Lane of Pavement Removal by Cold Planing	SY	720	$2.50	$1,800
	Optional Single Lane of New Asphalt Surface Course (1.5-Inch	TON	62	$85.00	$5,300
	SUBTOTAL				$44,000
	CONTINGENCY (20%)				$9,000
	TOTAL COST (ROUNDED TO NEAREST $1,000)				$53,000
	UPPER COST RANGE LIMIT (+30%)				$57,000
	LOWER COST RANGE LIMIT (-15%)				$37,000
4	**BLOSSOM STREET**				
	Full Depth Bituminous Sawcut	LF	761	$1.00	$800
	Pavement Excavation and Removal	SY	615	$7.50	$4,600
	Curb Remove and Dispose	LF	744	$4.50	$3,300
	Earth Excavation	CY	569	$15.00	$8,500
	Fine Grading, Compacting, and Finishing	SY	677	$3.00	$2,000
	Crushed Stone Trench	CY	261	$40.00	$10,400
	Geotextile Filter Fabric for Separation	SY	1,082	$3.50	$3,800
	New Pervious Pavement (4-inches)	TON	101	$85.00	$8,600
	Crushed Stone Choker Course and Base	CY	24	$40.00	$1,000
	Concrete Curb	LF	744	$25.00	$18,600
	Imported Soil Mixture (Loamy Sand or Sandy Loam)	CY	159	$40.00	$6,400
	Seeding	SY	569	$2.00	$1,100
	Topsoil (4"Depth)	CY	37	$35.00	$1,300
	Optional Single Lane of Pavement Removal by Cold Planing	SY	1,202	$2.50	$3,000
	Optional Single Lane of New Asphalt Surface Course (1.5-Inch	TON	104	$85.00	$8,800
	SUBTOTAL				$70,000
	CONTINGENCY (20%)				$14,000
	TOTAL COST (ROUNDED TO NEAREST $1,000)				$84,000
	UPPER COST RANGE LIMIT (+30%)				$91,000
	LOWER COST RANGE LIMIT (-15%)				$60,000
5	**CHATHAM AVENUE**				
	Full Depth Bituminous Sawcut	LF	556	$1.00	$600
	Pavement Excavation and Removal	SY	444	$7.50	$3,300
	Curb Remove and Dispose	LF	547	$4.50	$2,500
	Earth Excavation	CY	411	$15.00	$6,200
	Fine Grading, Compacting, and Finishing	SY	444	$3.00	$1,300
	Rainstore (including Stone, System, and Misc.)	CF	2,704	$12.00	$32,400
	New Pervious Pavement (4-inches)	TON	89	$85.00	$7,500
	Crushed Stone Choker Course and Base	CY	129	$40.00	$5,200
	Concrete Curb	LF	547	$25.00	$13,700
	Imported Soil Mixture (Loamy Sand or Sandy Loam)	CY	39	$40.00	$1,500
	Seeding	SY	305	$2.00	$600
	Topsoil (4"Depth)	CY	27	$35.00	$900
	Optional Single Lane of Pavement Removal by Cold Planing	SY	746	$2.50	$1,900
	Optional Single Lane of New Asphalt Surface Course (1.5-Inch	TON	64	$85.00	$5,500
	SUBTOTAL				$76,000
	CONTINGENCY (20%)				$15,000
	TOTAL COST (ROUNDED TO NEAREST $1,000)				$91,000
	UPPER COST RANGE LIMIT (+30%)				$99,000
	LOWER COST RANGE LIMIT (-15%)				$65,000
	EAST PILOT STUDY AREA				
	SUBTOTAL				$981,000
	UPPER COST RANGE LIMIT (+30%)				$1,275,000
	LOWER COST RANGE LIMIT (-15%)				$834,000

ITEM NO.	ITEM DESCRIPTION	UNIT MEAS.	NO. UNITS	PER UNIT	COST
6	**MAPLE STREET**				
	Full Depth Bituminous Sawcut	LF	724	$1.00	$700
	Pavement Excavation and Removal	SY	505	$7.50	$3,800
	Curb Remove and Dispose	LF	712	$4.50	$3,200
	Earth Excavation	CY	943	$15.00	$14,100
	Fine Grading, Compacting, and Finishing	SY	518	$3.00	$1,600
	Rainstore (including Stone, System, and Misc.)	CF	9,220	$12.00	$110,600
	New Pervious Pavement (4-inches)	TON	96	$85.00	$8,200
	New Asphalt Pavement Binder Course (2.5-Inches)	TON	8	$85.00	$700
	New Asphalt Surface Course (1.5-Inches)	TON	668	$85.00	$56,700
	Pavement Removal by Cold Planing	SY	872	$2.50	$2,200
	Crushed Stone Choker Course and Base	CY	140	$40.00	$5,600
	Concrete Curb	LF	712	$25.00	$17,800
	Imported Soil Mixture (Loamy Sand or Sandy Loam)	CY	67	$40.00	$2,700
	Seeding	SY	405	$2.00	$800
	Topsoil (4"Depth)	CY	34	$35.00	$1,200
	SUBTOTAL				$230,000
	CONTINGENCY (20%)				$46,000
	TOTAL COST (ROUNDED TO NEAREST $1,000)				$276,000
	UPPER COST RANGE LIMIT (+30%)				$299,000
	LOWER COST RANGE LIMIT (-15%)				$196,000
7	**DUNCAN STREET**				
	Full Depth Bituminous Sawcut	LF	1,304	$1.00	$1,300
	Pavement Excavation and Removal	SY	1,060	$7.50	$8,000
	Curb Remove and Dispose	LF	1,266	$4.50	$5,700
	Earth Excavation	CY	2,734	$15.00	$41,000
	Fine Grading, Compacting, and Finishing	SY	1,108	$3.00	$3,300
	Rainstore (including Stone, System, and Misc.)	CF	25,881	$12.00	$310,600
	New Pervious Pavement (4-inches)	TON	213	$85.00	$18,100
	Crushed Stone Choker Course and Base	CY	598	$40.00	$23,900
	Concrete Curb	LF	1,266	$25.00	$31,700
	Imported Soil Mixture (Loamy Sand or Sandy Loam)	CY	121	$40.00	$4,800
	Seeding	SY	662	$2.00	$1,300
	Topsoil (4"Depth)	CY	54	$35.00	$1,900
	Optional Single Lane of Pavement Removal by Cold Planing	SY	1,560	$2.50	$3,900
	Optional Single Lane of New Asphalt Surface Course (1.5-Inch	TON	135	$85.00	$11,500
	SUBTOTAL				$452,000
	CONTINGENCY (20%)				$90,000
	TOTAL COST (ROUNDED TO NEAREST $1,000)				$542,000
	UPPER COST RANGE LIMIT (+30%)				$588,000
	LOWER COST RANGE LIMIT (-15%)				$384,000
8	**WOODROW STREET**				
	Full Depth Bituminous Sawcut	LF	351	$1.00	$400
	Pavement Excavation and Removal	SY	299	$7.50	$2,200
	Curb Remove and Dispose	LF	344	$4.50	$1,500
	Earth Excavation	CY	246	$15.00	$3,700
	Fine Grading, Compacting, and Finishing	SY	299	$3.00	$900
	Crushed Stone Trench	CY	146	$40.00	$5,800
	Geotextile Filter Fabric for Separation	SY	707	$3.50	$2,500
	New Pervious Pavement (4-inches)	TON	69	$85.00	$5,800
	Crushed Stone Choker Course and Base	CY	299	$40.00	$12,000
	Concrete Curb	LF	344	$25.00	$8,600
	Seeding	SY	149	$2.00	$300
	Topsoil (4"Depth)	CY	17	$35.00	$600
	Optional Single Lane of Pavement Removal by Cold Planing	SY	608	$2.50	$1,500
	Optional Single Lane of New Asphalt Surface Course (1.5-Inch	TON	53	$85.00	$4,500
	SUBTOTAL				$44,000
	CONTINGENCY (20%)				$9,000
	TOTAL COST (ROUNDED TO NEAREST $1,000)				$53,000
	UPPER COST RANGE LIMIT (+30%)				$57,000
	LOWER COST RANGE LIMIT (-15%)				$37,000

ITEM NO.	ITEM DESCRIPTION	UNIT MEAS.	NO. UNITS	PER UNIT	COST
9	**HOLLY STREET**				
	Full Depth Bituminous Sawcut	LF	357	$1.00	$400
	Pavement Excavation and Removal	SY	259	$7.50	$1,900
	Curb Remove and Dispose	LF	345	$4.50	$1,600
	Earth Excavation	CY	243	$15.00	$3,600
	Fine Grading, Compacting, and Finishing	SY	259	$3.00	$800
	Rainstore (including Stone, System, and Misc.)	CF	774	$12.00	$9,300
	Crushed Stone Trench	CY	61	$40.00	$2,400
	Geotextile Filter Fabric for Separation	SY	301	$3.50	$1,100
	New Pervious Pavement (4-inches)	TON	49	$85.00	$4,200
	Crushed Stone Choker Course and Base	CY	70	$40.00	$2,800
	Concrete Curb	LF	345	$25.00	$8,600
	Imported Soil Mixture (Loamy Sand or Sandy Loam)	CY	31	$40.00	$1,200
	Seeding	SY	206	$2.00	$400
	Topsoil (4"Depth)	CY	18	$35.00	$600
	Optional Single Lane of Pavement Removal by Cold Planing	SY	361	$2.50	$900
	Optional Single Lane of New Asphalt Surface Course (1.5-Inch	TON	31	$85.00	$2,600
	SUBTOTAL				$39,000
	CONTINGENCY (20%)				$8,000
	TOTAL COST (ROUNDED TO NEAREST $1,000)				$47,000
	UPPER COST RANGE LIMIT (+30%)				$51,000
	LOWER COST RANGE LIMIT (-15%)				$33,000
10	**WILMOT AVE**				
	Full Depth Bituminous Sawcut	LF	1,256	$1.00	$1,300
	Pavement Excavation and Removal	SY	850	$7.50	$6,400
	Curb Remove and Dispose	LF	1,248	$4.50	$5,600
	Earth Excavation	CY	1,407	$15.00	$21,100
	Fine Grading, Compacting, and Finishing	SY	1,082	$3.00	$3,200
	Rainstore (including Stone, System, and Misc.)	CF	10,093	$12.00	$121,100
	New Pervious Pavement (4-inches)	TON	163	$85.00	$13,900
	Crushed Stone Choker Course and Base	CY	236	$40.00	$9,400
	Concrete Curb	LF	1,248	$25.00	$31,200
	Imported Soil Mixture (Loamy Sand or Sandy Loam)	CY	249	$40.00	$10,000
	Seeding	SY	932	$2.00	$1,900
	Topsoil (4"Depth)	CY	62	$35.00	$2,200
	Optional Single Lane of Pavement Removal by Cold Planing	SY	2,079	$2.50	$5,200
	Optional Single Lane of New Asphalt Surface Course (1.5-Inch	TON	179	$85.00	$15,200
	SUBTOTAL				$227,000
	CONTINGENCY (20%)				$45,000
	TOTAL COST (ROUNDED TO NEAREST $1,000)				$272,000
	UPPER COST RANGE LIMIT (+30%)				$295,000
	LOWER COST RANGE LIMIT (-15%)				$193,000
	WEST PILOT STUDY AREA				
	SUBTOTAL				$1,190,000
	UPPER COST RANGE LIMIT (+30%)				$1,550,000
	LOWER COST RANGE LIMIT (-15%)				$1,010,000

Costs Associated with Cold-Planing of Capitol, Blossom and Chatham in East Pilot Area

Capitol Place	$7,100	$7,000
Blossom Street	$11,800	$12,000
Chatham Avenue	$7,400	$7,000
East Pilot Area Total	$26,300	$26,000

Costs Associated with Cold-Planing of Capitol, Blossom and Chatham in West Pilot Area

Duncan Street	$15,400	$15,000
Woodrow Street	$6,000	$6,000
Holly Street	$3,500	$4,000
Wilmot Avenue	$20,400	$20,000
West Pilot Area Total	$45,300	$45,000
Total Cost for East and West Pilot Areas	$71,600	$71,000

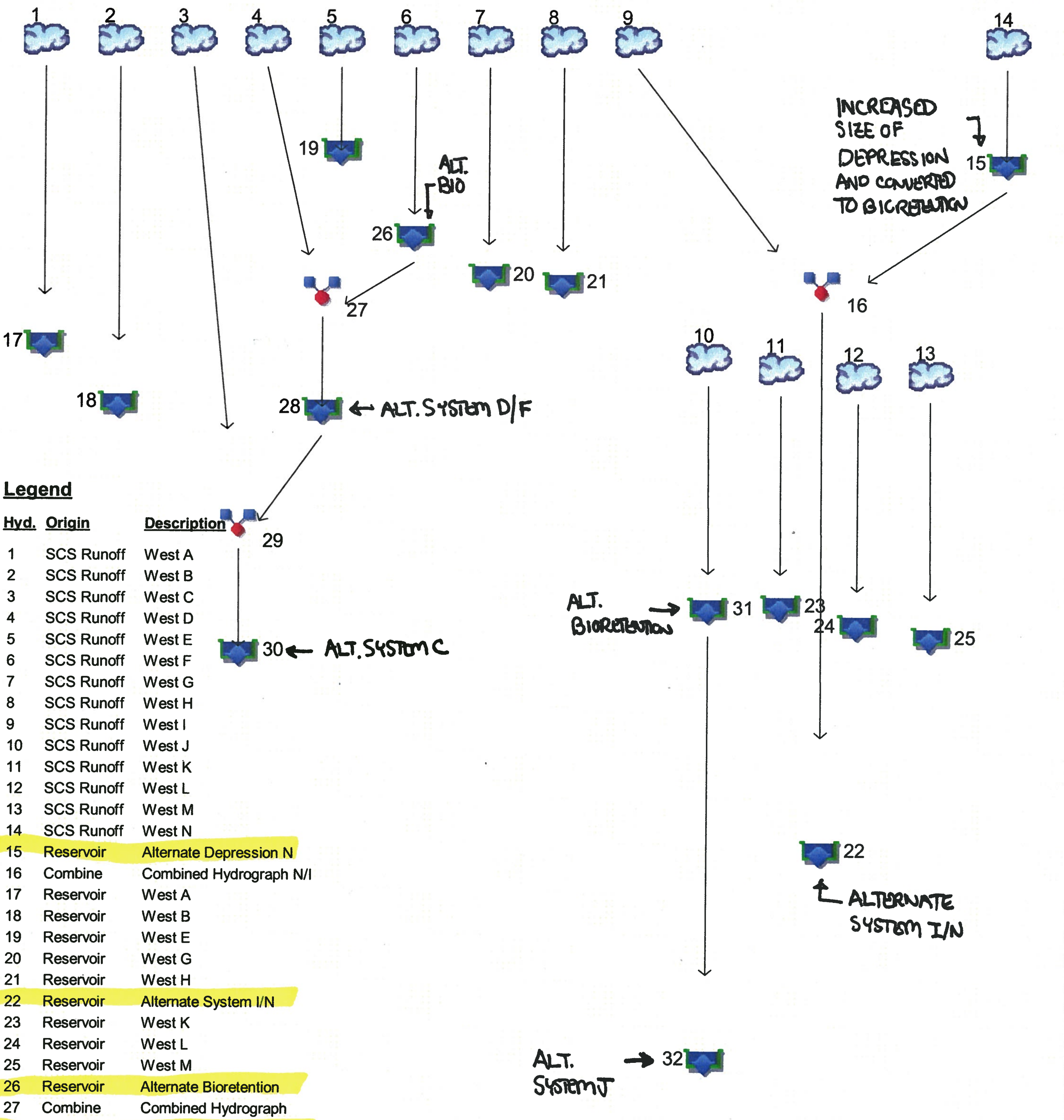
Appendix D

Hydrologic and Hydraulic Analysis of
Alternative Improvement in West Pilot Area

Hydraflow Table of Contents

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8



Legend

Hyd.	Origin	Description
1	SCS Runoff	West A
2	SCS Runoff	West B
3	SCS Runoff	West C
4	SCS Runoff	West D
5	SCS Runoff	West E
6	SCS Runoff	West F
7	SCS Runoff	West G
8	SCS Runoff	West H
9	SCS Runoff	West I
10	SCS Runoff	West J
11	SCS Runoff	West K
12	SCS Runoff	West L
13	SCS Runoff	West M
14	SCS Runoff	West N
15	Reservoir	Alternate Depression N
16	Combine	Combined Hydrograph N/I
17	Reservoir	West A
18	Reservoir	West B
19	Reservoir	West E
20	Reservoir	West G
21	Reservoir	West H
22	Reservoir	Alternate System I/N
23	Reservoir	West K
24	Reservoir	West L
25	Reservoir	West M
26	Reservoir	Alternate Bioretention
27	Combine	Combined Hydrograph
28	Reservoir	Alternate System D/F
29	Combine	Combined Hydrograph
30	Reservoir	Alternate System C
31	Reservoir	Bioretention System J
32	Reservoir	System J

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Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	8.563	1	717	18,099	------	------	------	West A
2	SCS Runoff	2.665	1	717	6,444	------	------	------	West B
3	SCS Runoff	8.538	1	717	18,162	------	------	------	West C
4	SCS Runoff	1.830	1	717	3,892	------	------	------	West D
5	SCS Runoff	1.624	1	717	3,412	------	------	------	West E
6	SCS Runoff	9.390	1	728	33,401	------	------	------	West F
7	SCS Runoff	1.659	1	717	3,508	------	------	------	West G
8	SCS Runoff	1.244	1	717	2,665	------	------	------	West H
9	SCS Runoff	1.626	1	717	3,460	------	------	------	West I
10	SCS Runoff	12.73	1	723	36,453	------	------	------	West J
11	SCS Runoff	1.137	1	717	2,585	------	------	------	West K
12	SCS Runoff	1.423	1	717	3,027	------	------	------	West L
13	SCS Runoff	6.986	1	717	14,602	------	------	------	West M
14	SCS Runoff	5.882	1	718	12,000	------	------	------	West N
15	Reservoir	3.773	1	721	2,169	14	280.15	3,920	Alternate Depression N
16	Combine	4.954	1	721	5,628	9, 15	------	------	Combined Hydrograph N/I
17	Reservoir	0.000	1	n/a	0	1	3.75	7,576	West A
18	Reservoir	0.000	1	320	0	2	2.07	1,948	West B
19	Reservoir	0.000	1	674	0	5	2.80	1,349	West E
20	Reservoir	0.000	1	624	0	7	4.19	1,507	West G
21	Reservoir	0.000	1	n/a	0	8	2.14	983	West H
22	Reservoir	0.000	1	n/a	0	16	4.81	3,235	≈3.4' REDUCTION Alternate System I/N
23	Reservoir	0.000	1	n/a	0	11	2.11	818	West K
24	Reservoir	0.000	1	604	0	12	2.42	1,177	West L
25	Reservoir	0.000	1	466	0	13	4.14	6,227	West M
26	Reservoir	5.814	1	738	6,249	6	281.13	10,400	Alternate Bioretention
27	Combine	6.016	1	738	10,141	4, 26	------	------	Combined Hydrograph
28	Reservoir	5.476	1	740	4,585	27	4.51	3,158	≈ 3.8' REDUCTION Alternate System D/F
29	Combine	8.538	1	717	22,747	3, 28	------	------	Combined Hydrograph
30	Reservoir	0.000	1	645	0	29	4.27	11,320	≈ 3.2' REDUCTION Alternate System C
31	Reservoir	11.93	1	724	14,089	10	282.20	6,842	Bioretention System J
32	Reservoir	0.000	1	n/a	0	31	5.30	10,873	System J

SDA_TR20_West_Alternative_20111229.gpw Return Period: 10 Year | Friday, Jan 20, 2012

Hydrograph Report

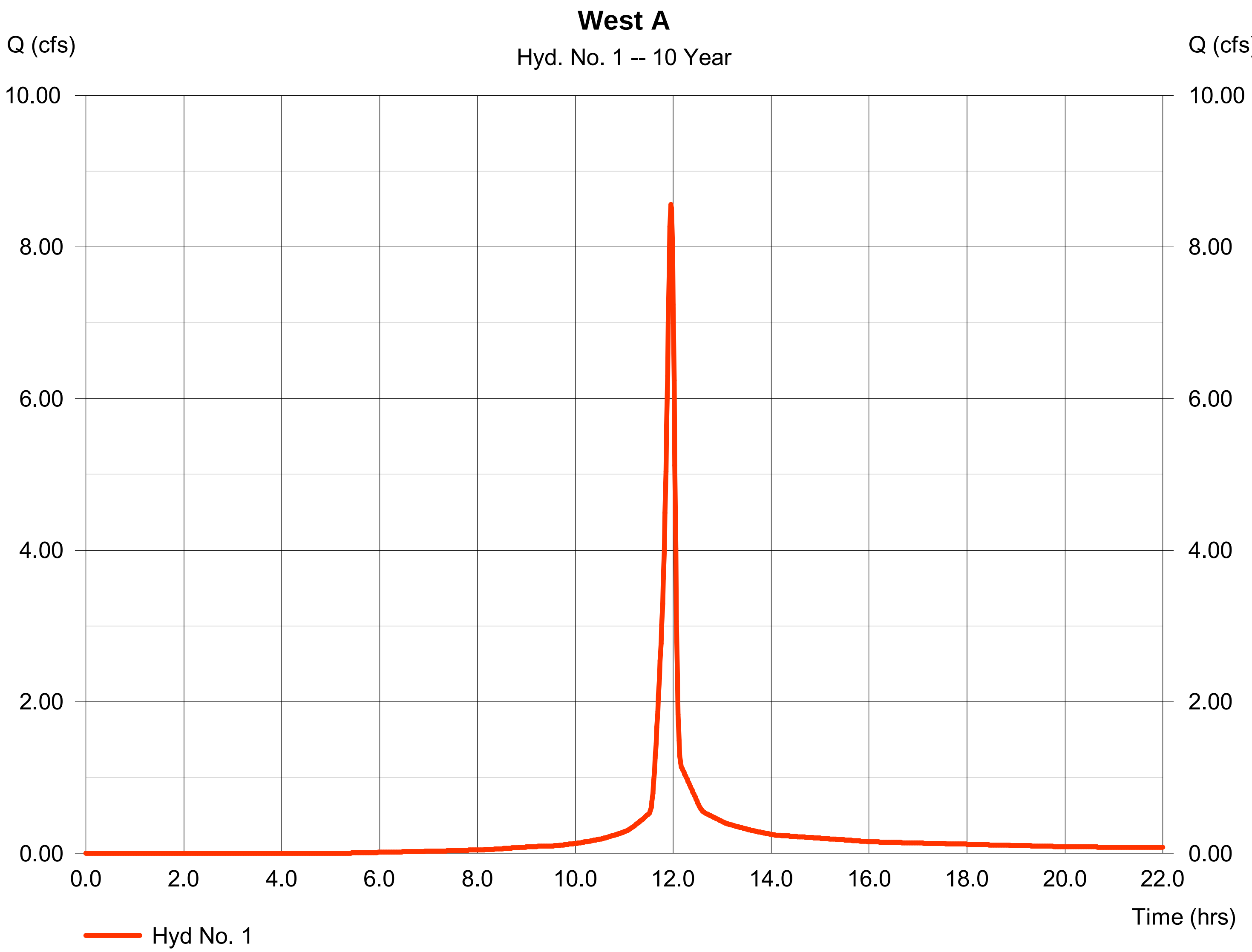
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 1

West A

Hydrograph type	= SCS Runoff	Peak discharge	= 8.563 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 18,099 cuft
Drainage area	= 1.290 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.490 x 98) + (0.800 x 78)] / 1.290



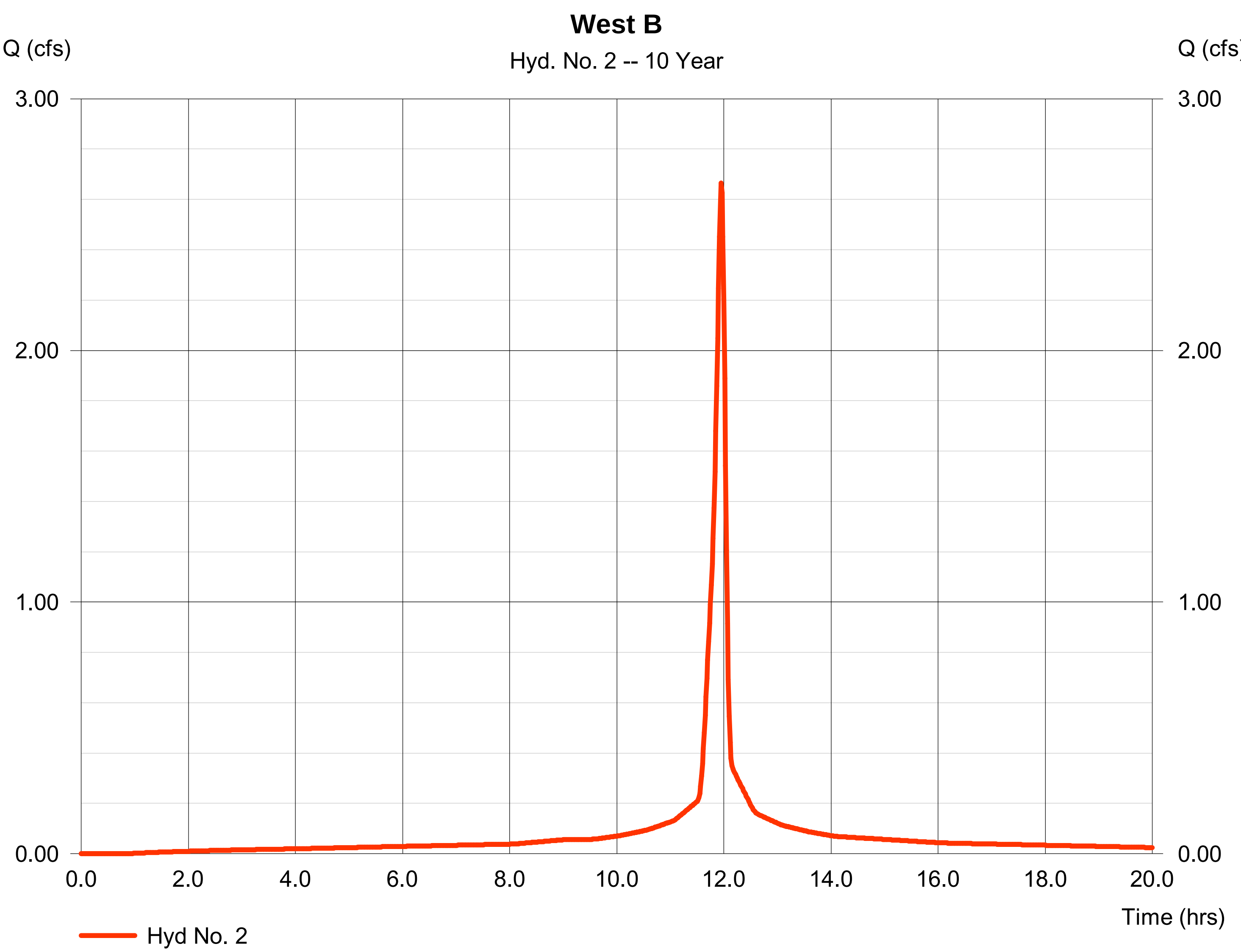
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 2

West B

Hydrograph type	= SCS Runoff	Peak discharge	= 2.665 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 6,444 cuft
Drainage area	= 0.340 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

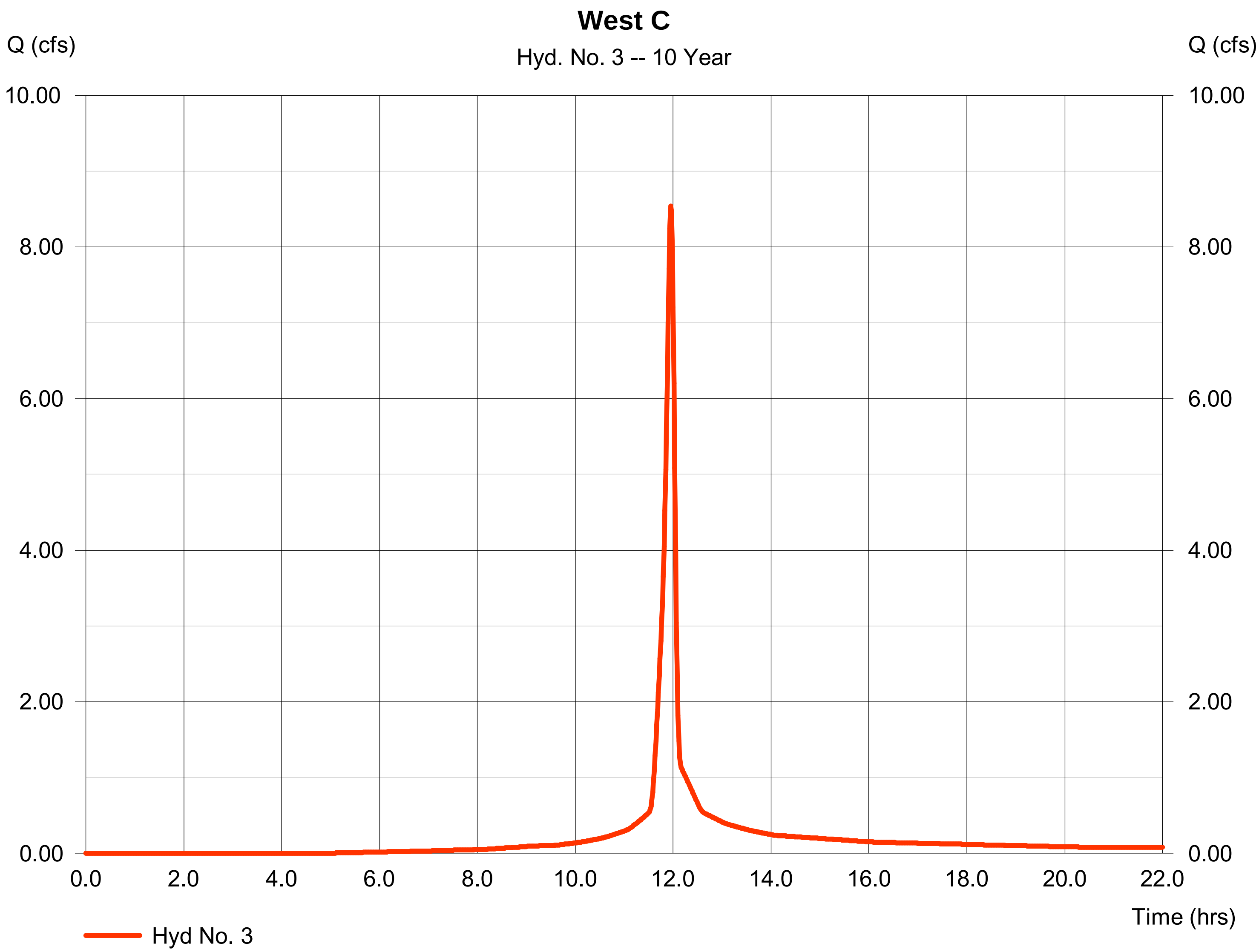
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 3

West C

Hydrograph type	= SCS Runoff	Peak discharge	= 8.538 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 18,162 cuft
Drainage area	= 1.260 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.593 x 98) + (0.696 x 78)] / 1.260



Hydrograph Report

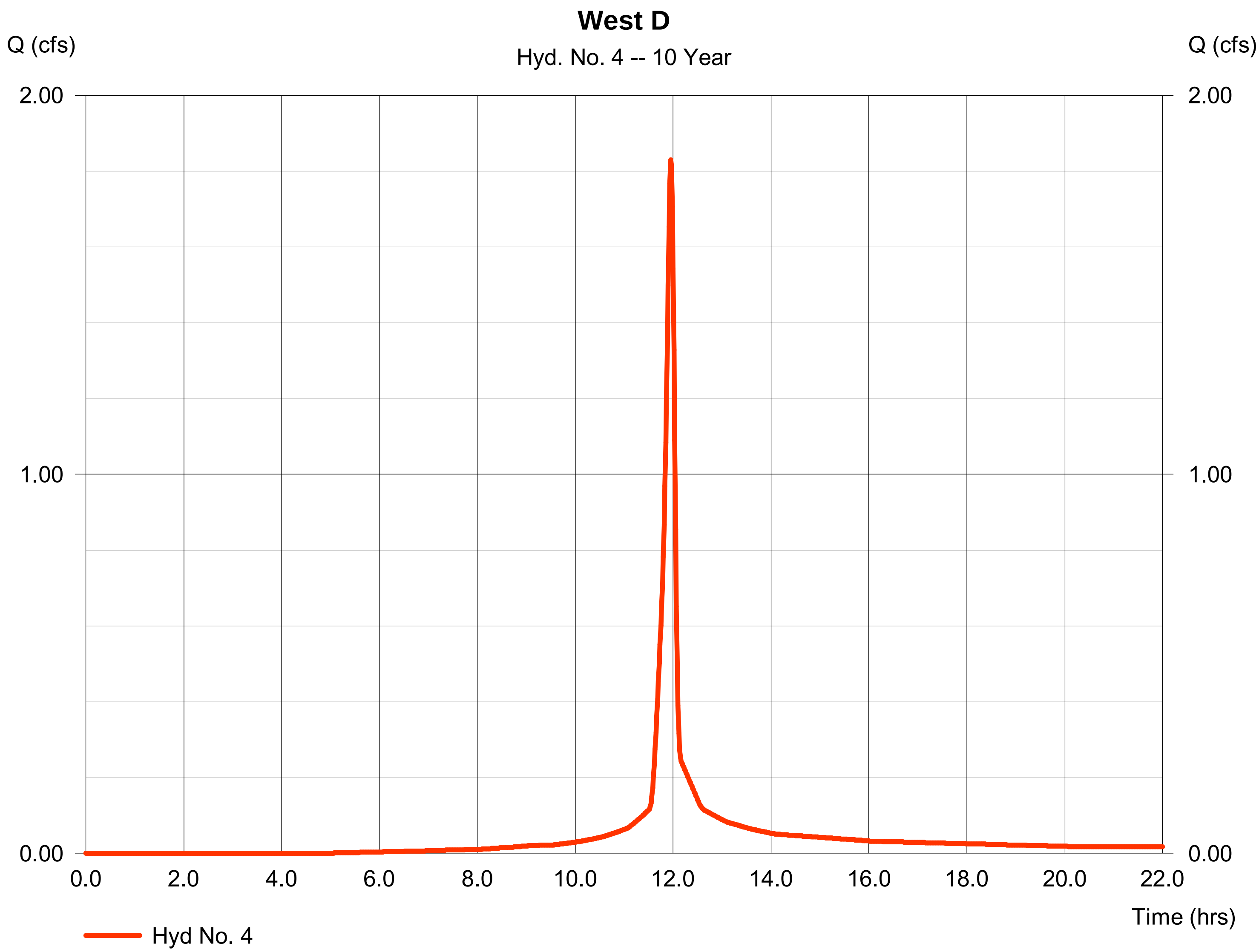
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 4

West D

Hydrograph type	= SCS Runoff	Peak discharge	= 1.830 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 3,892 cuft
Drainage area	= 0.270 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.127 x 98) + (0.144 x 78)] / 0.270



Hydrograph Report

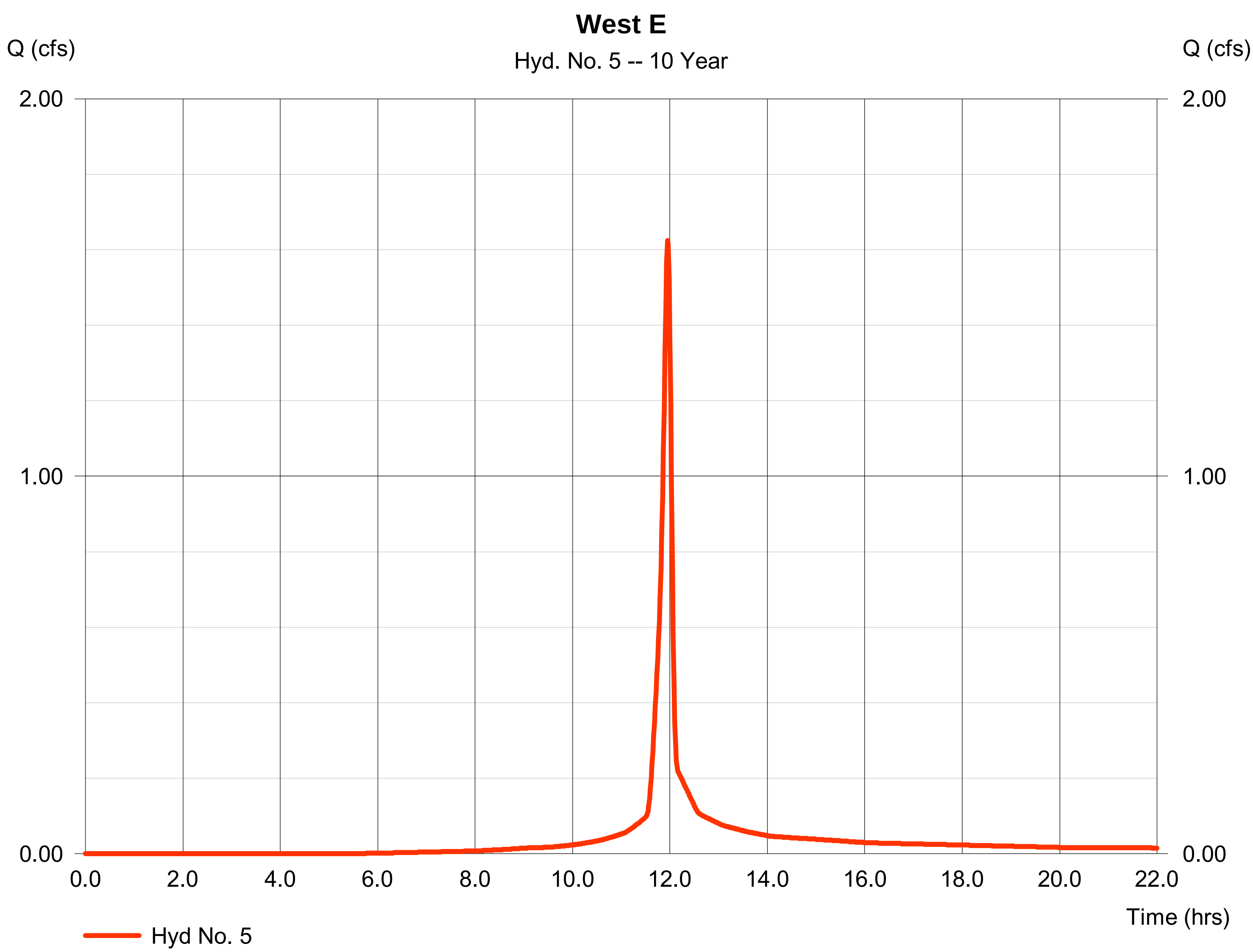
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 5

West E

Hydrograph type	= SCS Runoff	Peak discharge	= 1.624 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 3,412 cuft
Drainage area	= 0.250 ac	Curve number	= 85*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.094 x 98) + (0.157 x 78)] / 0.250



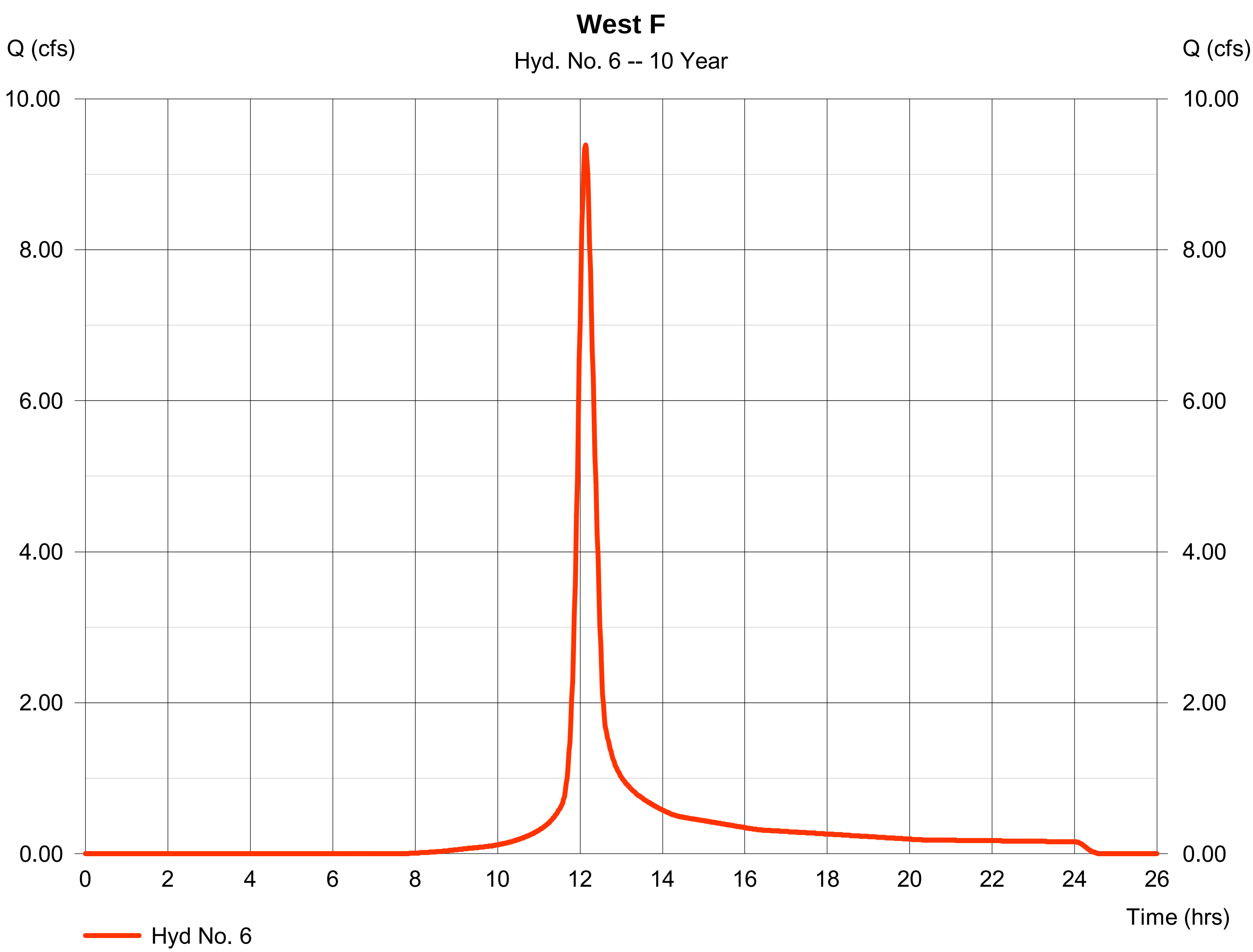
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 6

West F

Hydrograph type	= SCS Runoff	Peak discharge	= 9.390 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.13 hrs
Time interval	= 1 min	Hyd. volume	= 33,401 cuft
Drainage area	= 3.100 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 24.20 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 6

West F

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.60		0.00		0.00		
Land slope (%)	=	0.50		0.00		0.00		
Travel Time (min)	**=**	**16.08**	**+**	**0.00**	**+**	**0.00**	**=**	**16.08**
Shallow Concentrated Flow								
Flow length (ft)	=	554.00		0.00		0.00		
Watercourse slope (%)	=	0.50		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=1.14			0.00		0.00		
Travel Time (min)	**=**	**8.09**	**+**	**0.00**	**+**	**0.00**	**=**	**8.09**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=0.00							
				0.00				
						0.00		
Flow length (ft)	({0})0.0			0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... **24.20 min**

Hydrograph Report

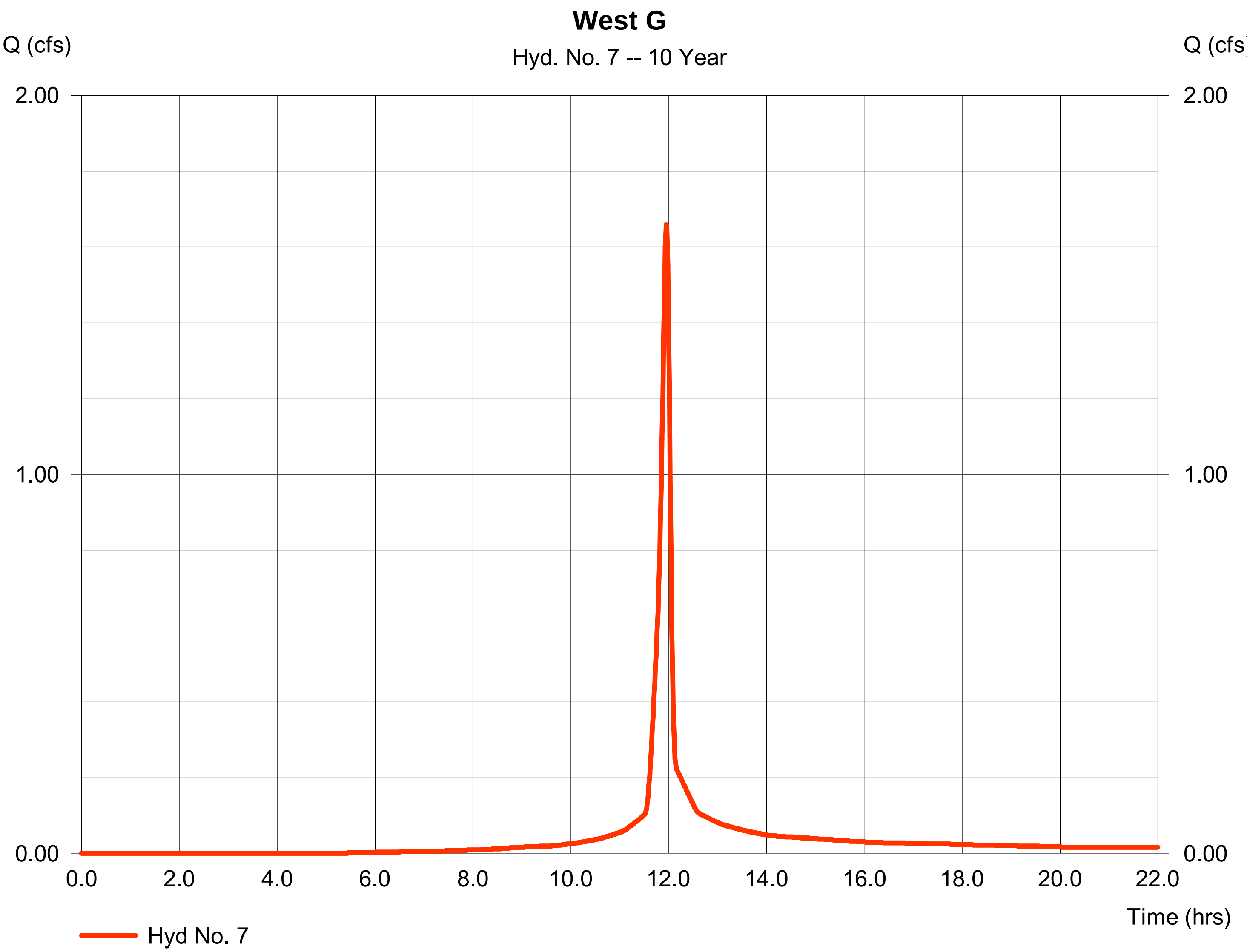
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 7

West G

Hydrograph type	= SCS Runoff	Peak discharge	= 1.659 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 3,508 cuft
Drainage area	= 0.250 ac	Curve number	= 86*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 98) + (0.150 x 78)] / 0.250



Hydrograph Report

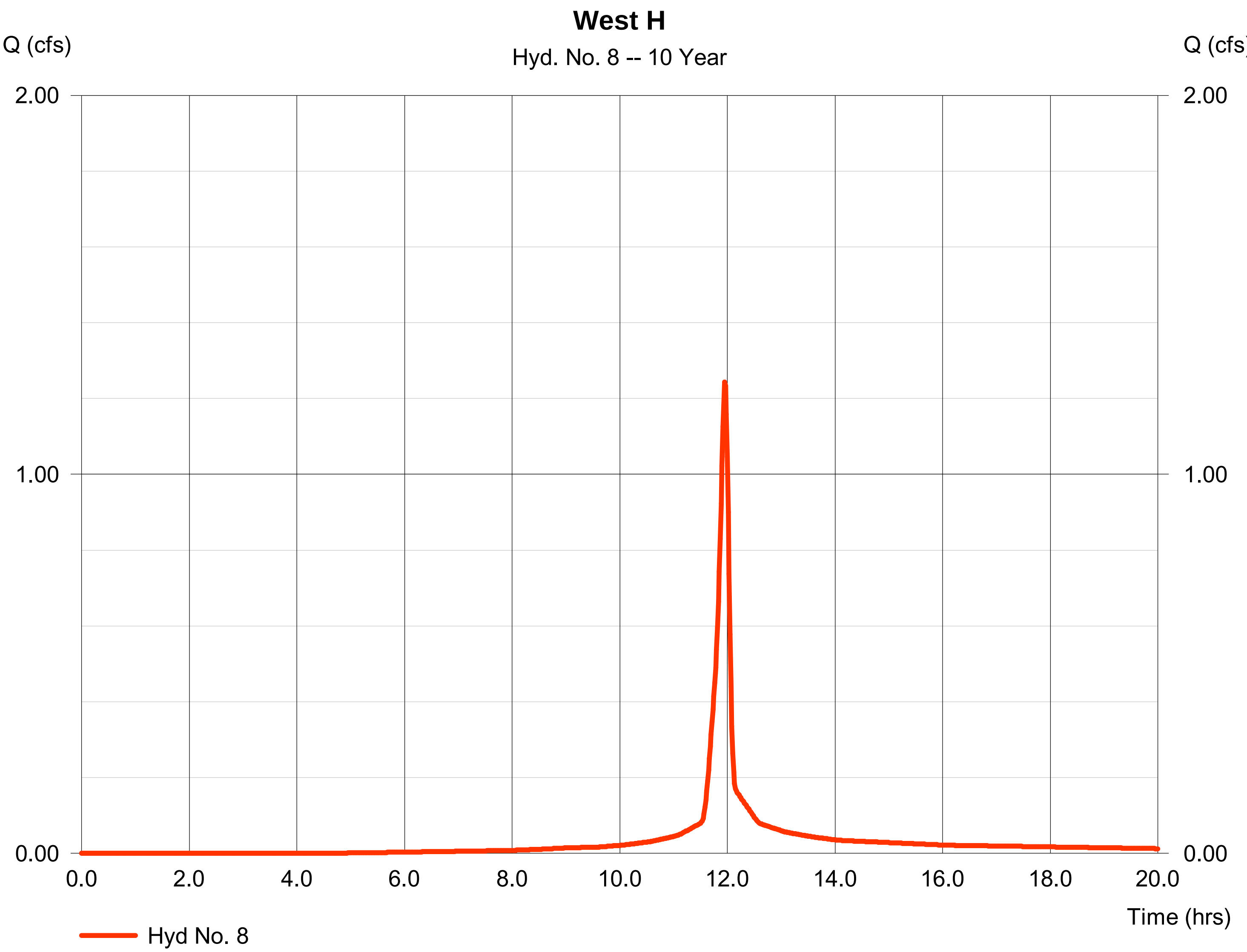
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 8

West H

Hydrograph type	= SCS Runoff	Peak discharge	= 1.244 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 2,665 cuft
Drainage area	= 0.180 ac	Curve number	= 88*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.084 x 98) + (0.092 x 78)] / 0.180



Hydrograph Report

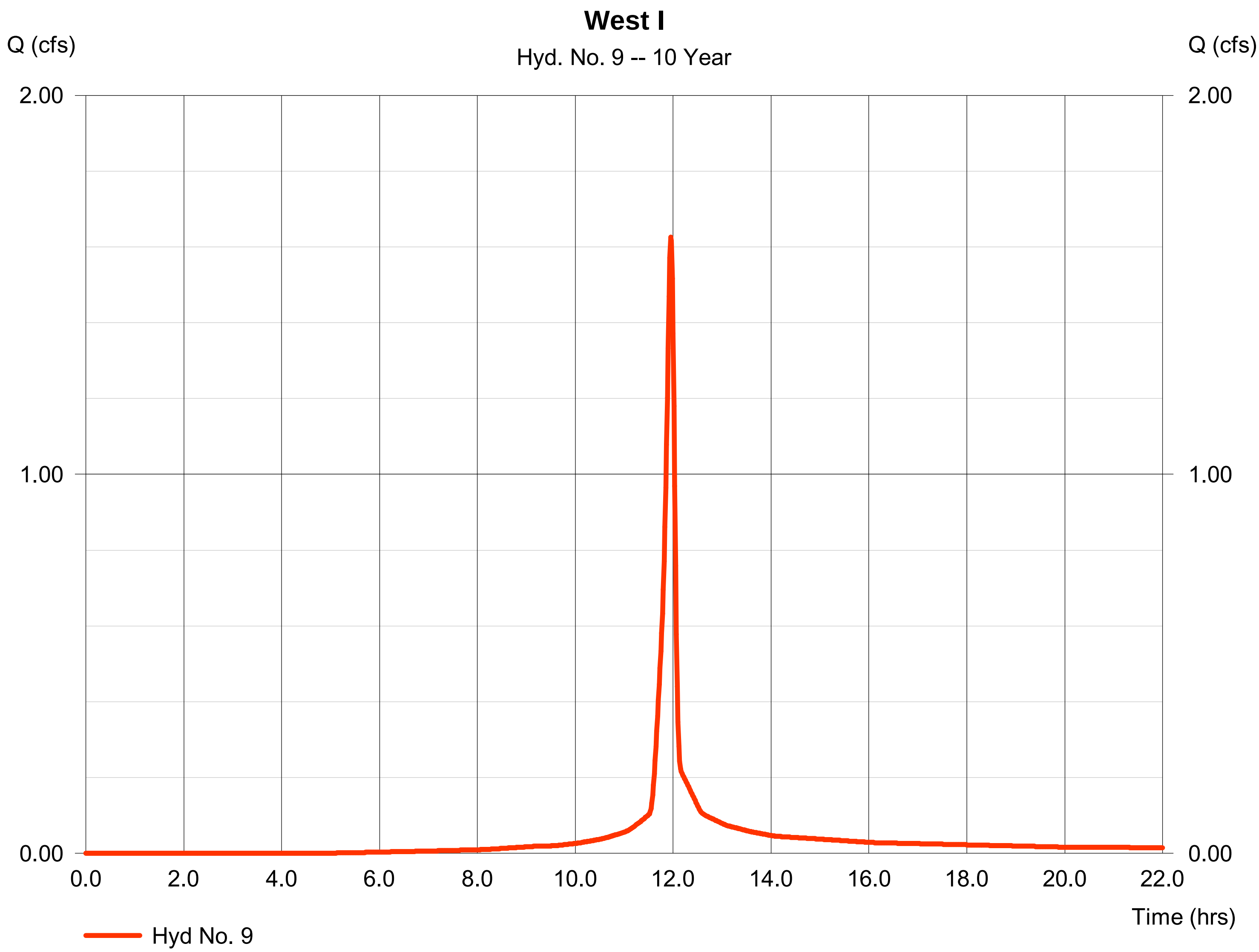
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 9

West I

Hydrograph type	= SCS Runoff	Peak discharge	= 1.626 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 3,460 cuft
Drainage area	= 0.240 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.105 x 98) + (0.136 x 78)] / 0.240



Hydrograph Report

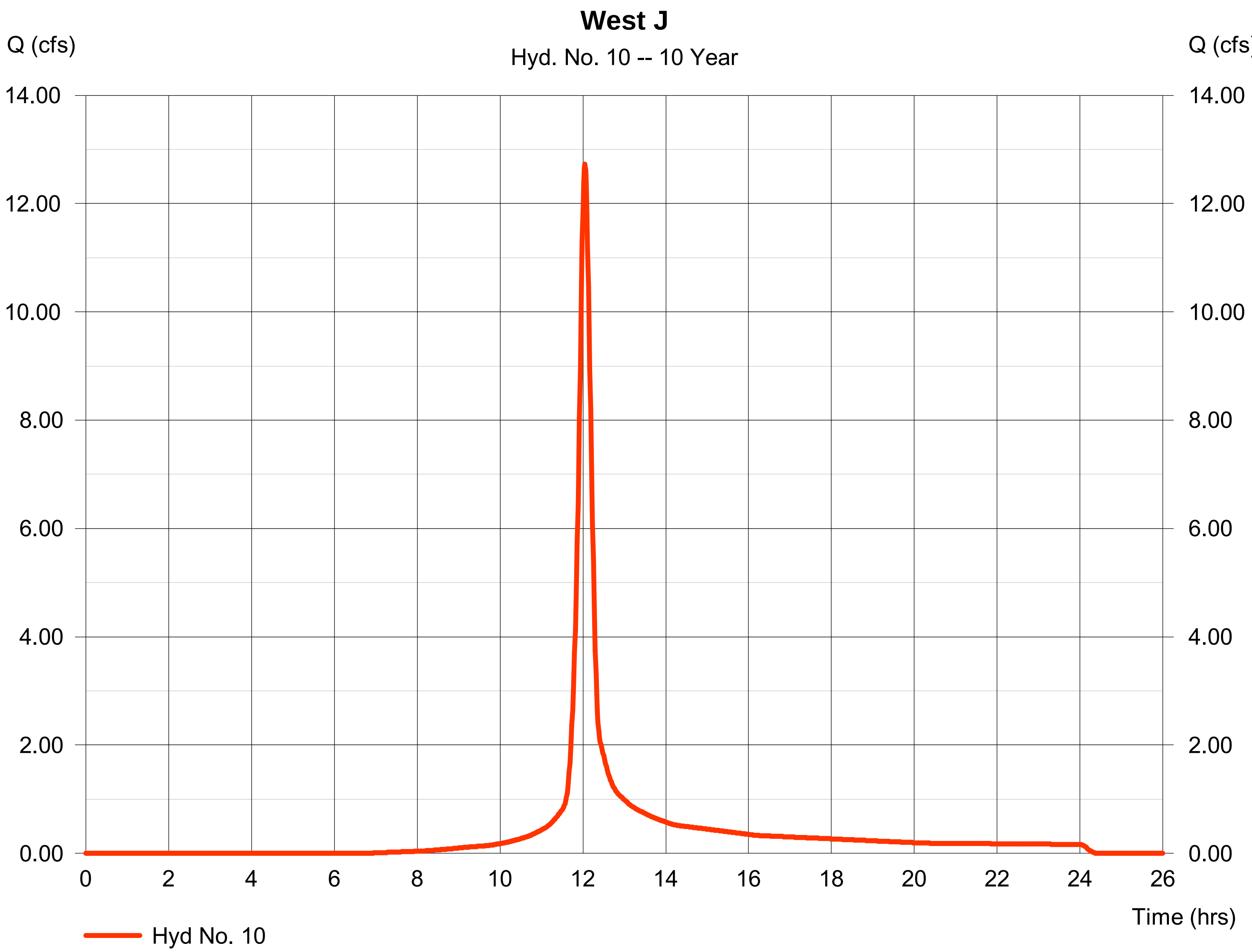
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 10

West J

Hydrograph type	= SCS Runoff	Peak discharge	= 12.73 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.05 hrs
Time interval	= 1 min	Hyd. volume	= 36,453 cuft
Drainage area	= 3.050 ac	Curve number	= 81*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.60 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.460 x 98) + (2.590 x 78)] / 3.050



TR55 Tc Worksheet

Hyd. No. 10

West J

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	100.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.60		0.00		0.00		
Land slope (%)	=	0.90		0.00		0.00		
Travel Time (min)	**=**	**12.71**	**+**	**0.00**	**+**	**0.00**	**=**	**12.71**
Shallow Concentrated Flow								
Flow length (ft)	=	315.00		0.00		0.00		
Watercourse slope (%)	=	1.30		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=1.84			0.00		0.00		
Travel Time (min)	**=**	**2.85**	**+**	**0.00**	**+**	**0.00**	**=**	**2.85**
Channel Flow								
X sectional flow area (sqft)	=	0.00		0.00		0.00		
Wetted perimeter (ft)	=	0.00		0.00		0.00		
Channel slope (%)	=	0.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=0.00							
				0.00				
						0.00		
Flow length (ft)	({0})0.0			0.0		0.0		
Travel Time (min)	**=**	**0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc .... 15.60 min

Hydrograph Report

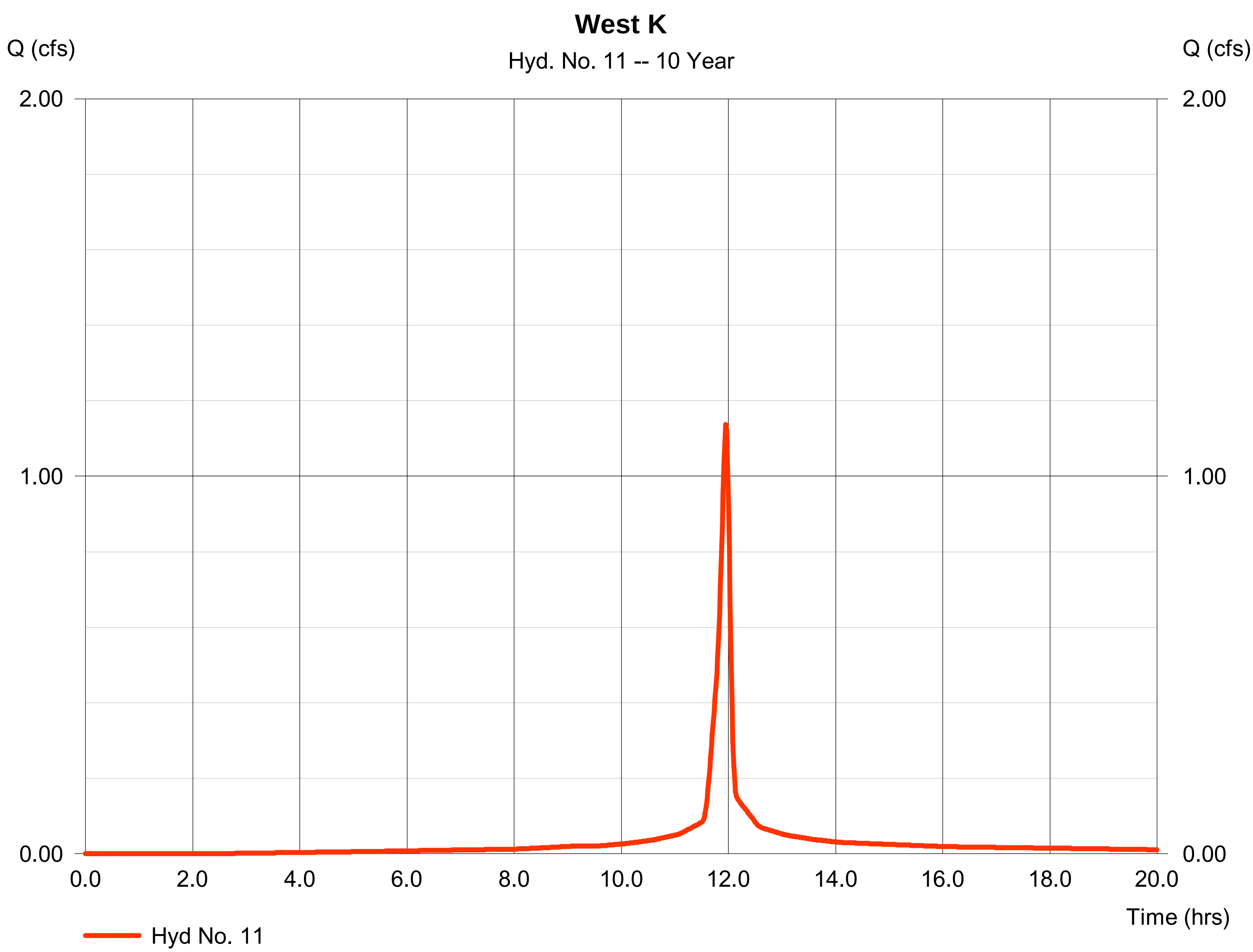
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 11

West K

Hydrograph type	= SCS Runoff	Peak discharge	= 1.137 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 2,585 cuft
Drainage area	= 0.150 ac	Curve number	= 94*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.120 x 98) + (0.034 x 78)] / 0.150



Hydrograph Report

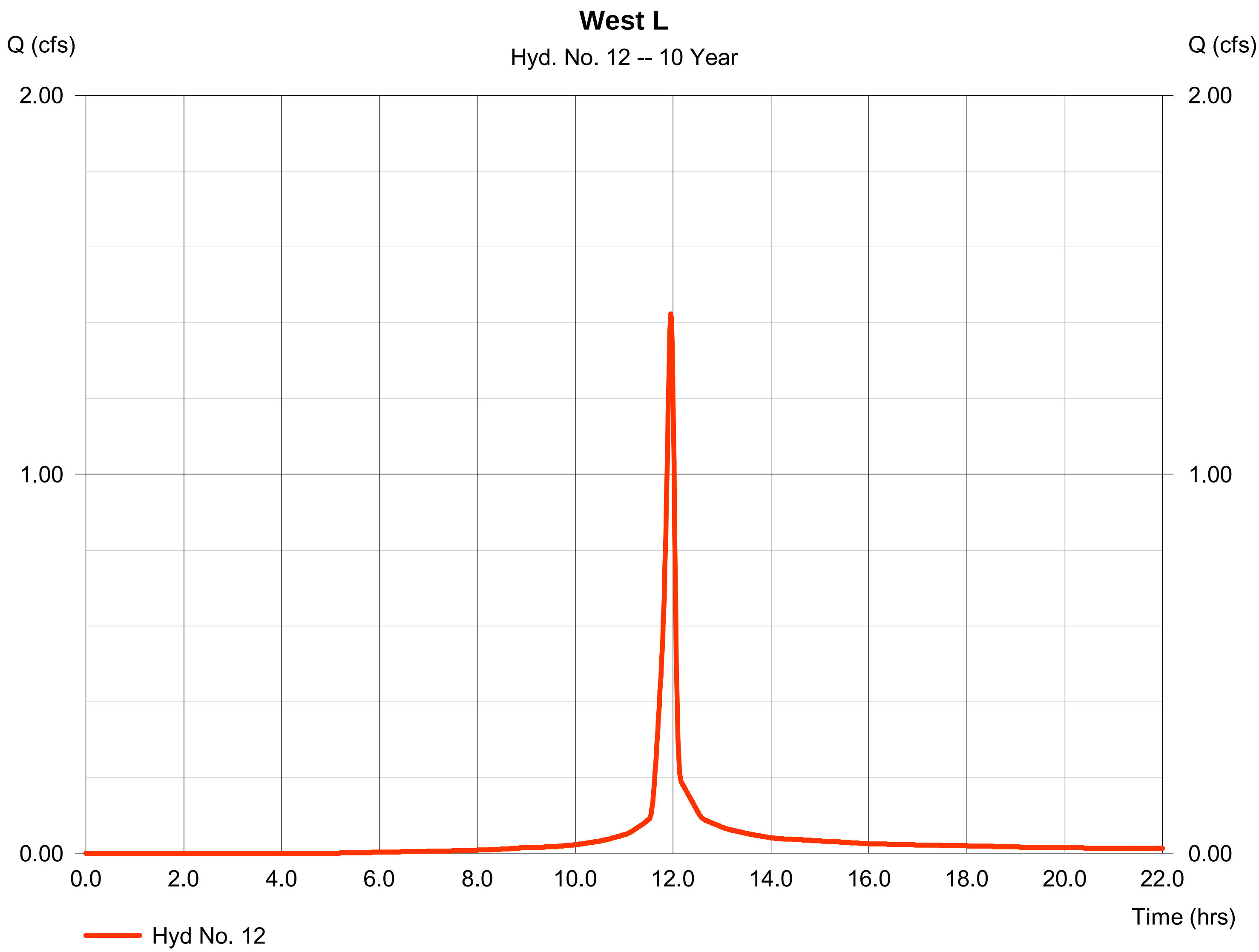
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 12

West L

Hydrograph type	= SCS Runoff	Peak discharge	= 1.423 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 3,027 cuft
Drainage area	= 0.210 ac	Curve number	= 87*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.094 x 98) + (0.118 x 78)] / 0.210



Hydrograph Report

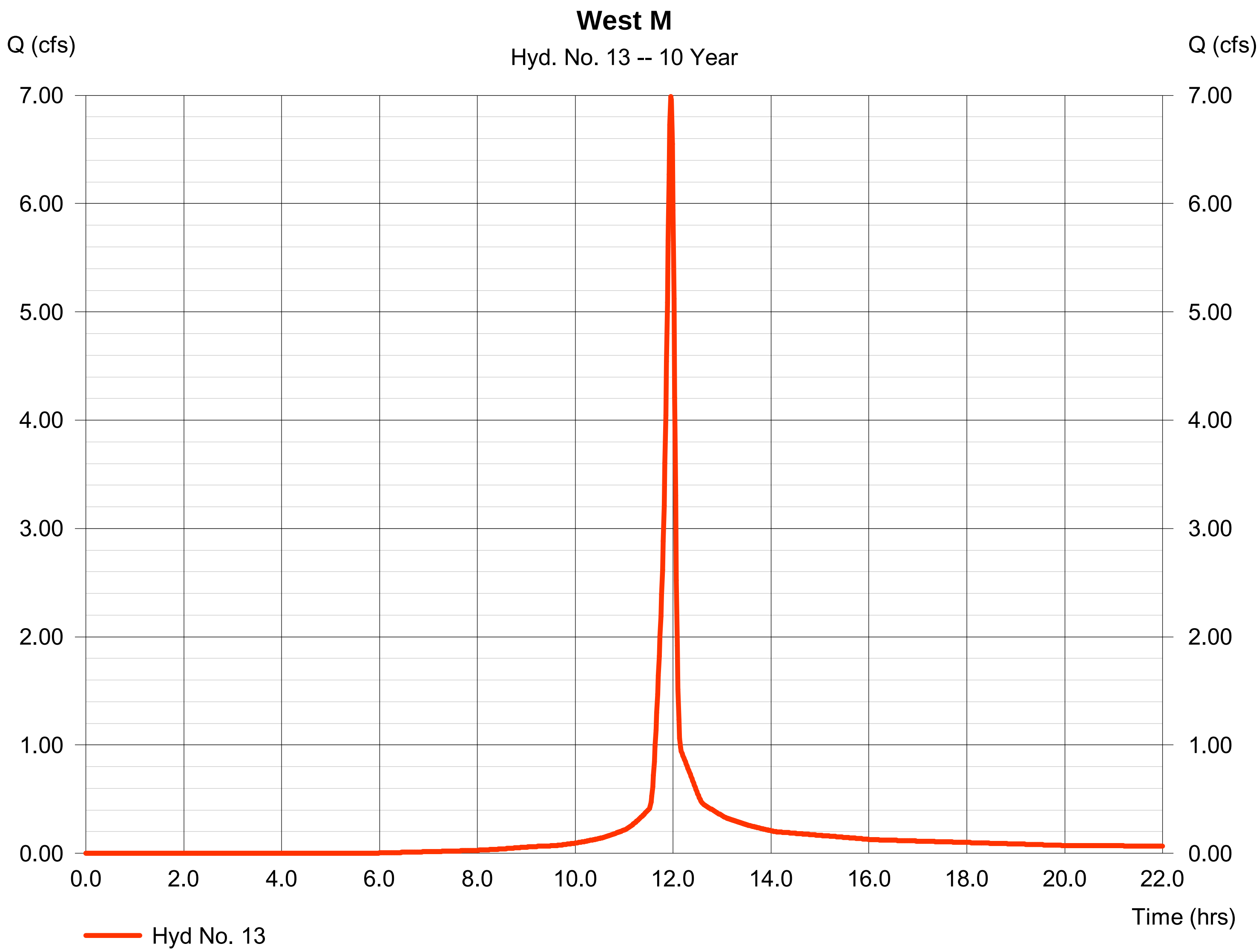
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 13

West M

Hydrograph type	= SCS Runoff	Peak discharge	= 6.986 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 14,602 cuft
Drainage area	= 1.100 ac	Curve number	= 84*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.350 x 98) + (0.750 x 78)] / 1.100



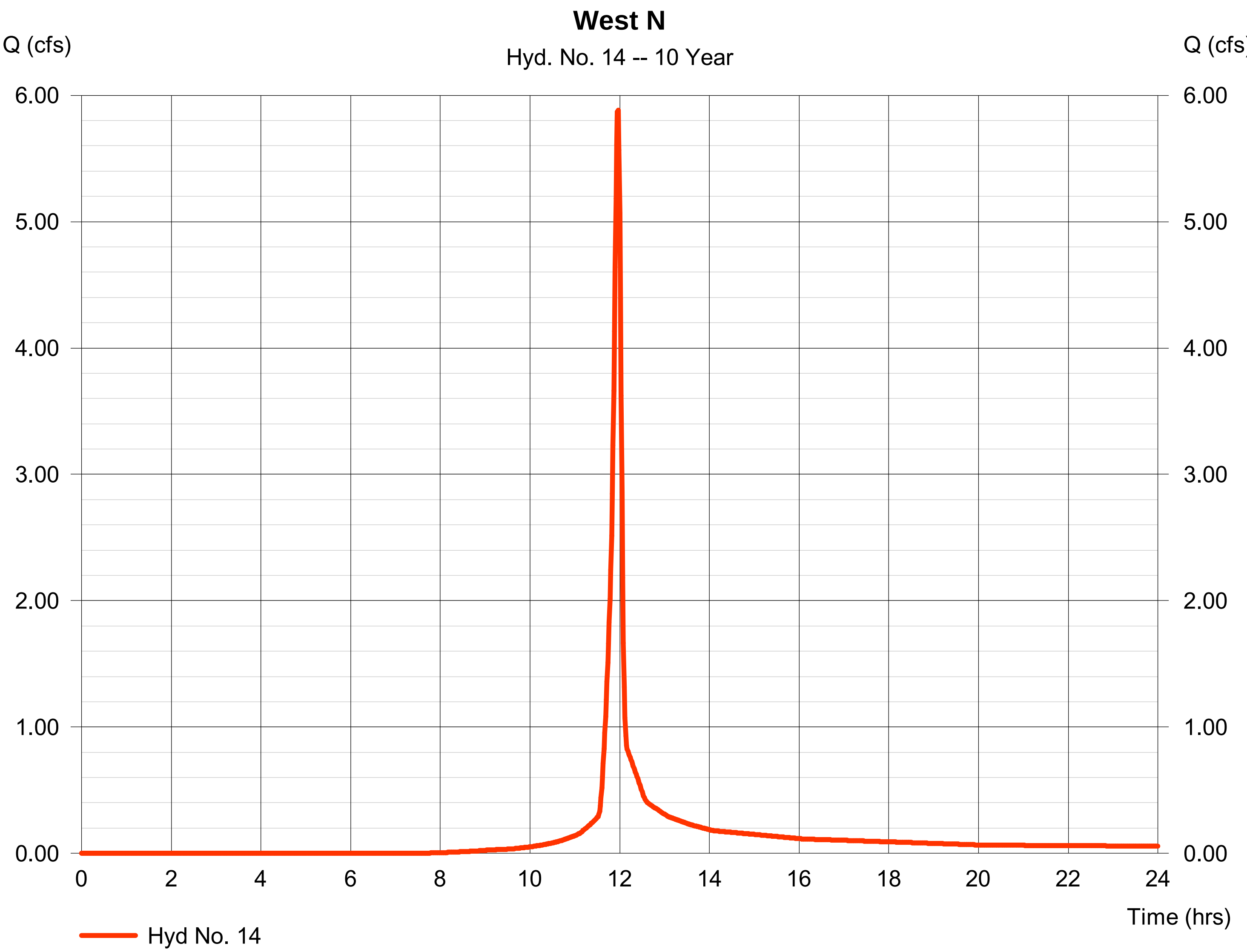
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 14

West N

Hydrograph type	= SCS Runoff	Peak discharge	= 5.882 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.97 hrs
Time interval	= 1 min	Hyd. volume	= 12,000 cuft
Drainage area	= 1.080 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 5.30 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

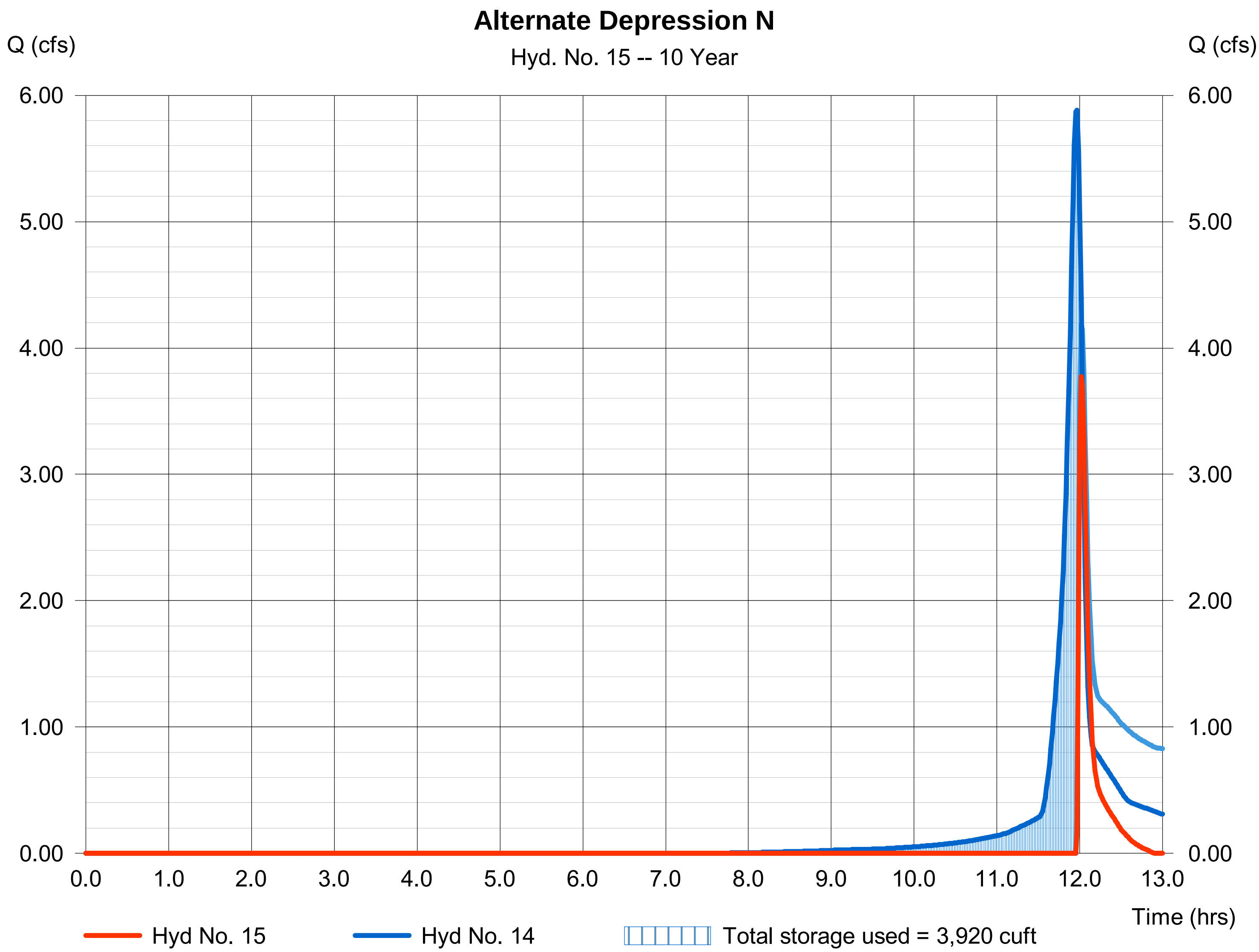
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 15

Alternate Depression N

Hydrograph type	= Reservoir	Peak discharge	= 3.773 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.02 hrs
Time interval	= 1 min	Hyd. volume	= 2,169 cuft
Inflow hyd. No.	= 14 - West N	Max. Elevation	= 280.15 ft
Reservoir name	= Depression N	Max. Storage	= 3,920 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 3 - Depression N

Pond Data

Trapezoid -Bottom L x W = 211.0 x 6.0 ft , Side slope = 3.00:1 , Bottom elev. = 278.50 ft , Depth = 2.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	278.50	1,266	0	0
0.20	278.70	1,528	279	279
0.40	278.90	1,793	332	611
0.60	279.10	2,060	385	997
0.80	279.30	2,331	439	1,436
1.00	279.50	2,604	493	1,929
1.20	279.70	2,880	548	2,477
1.40	279.90	3,159	604	3,081
1.60	280.10	3,441	660	3,741
1.80	280.30	3,726	717	4,458
2.00	280.50	4,014	774	5,232

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

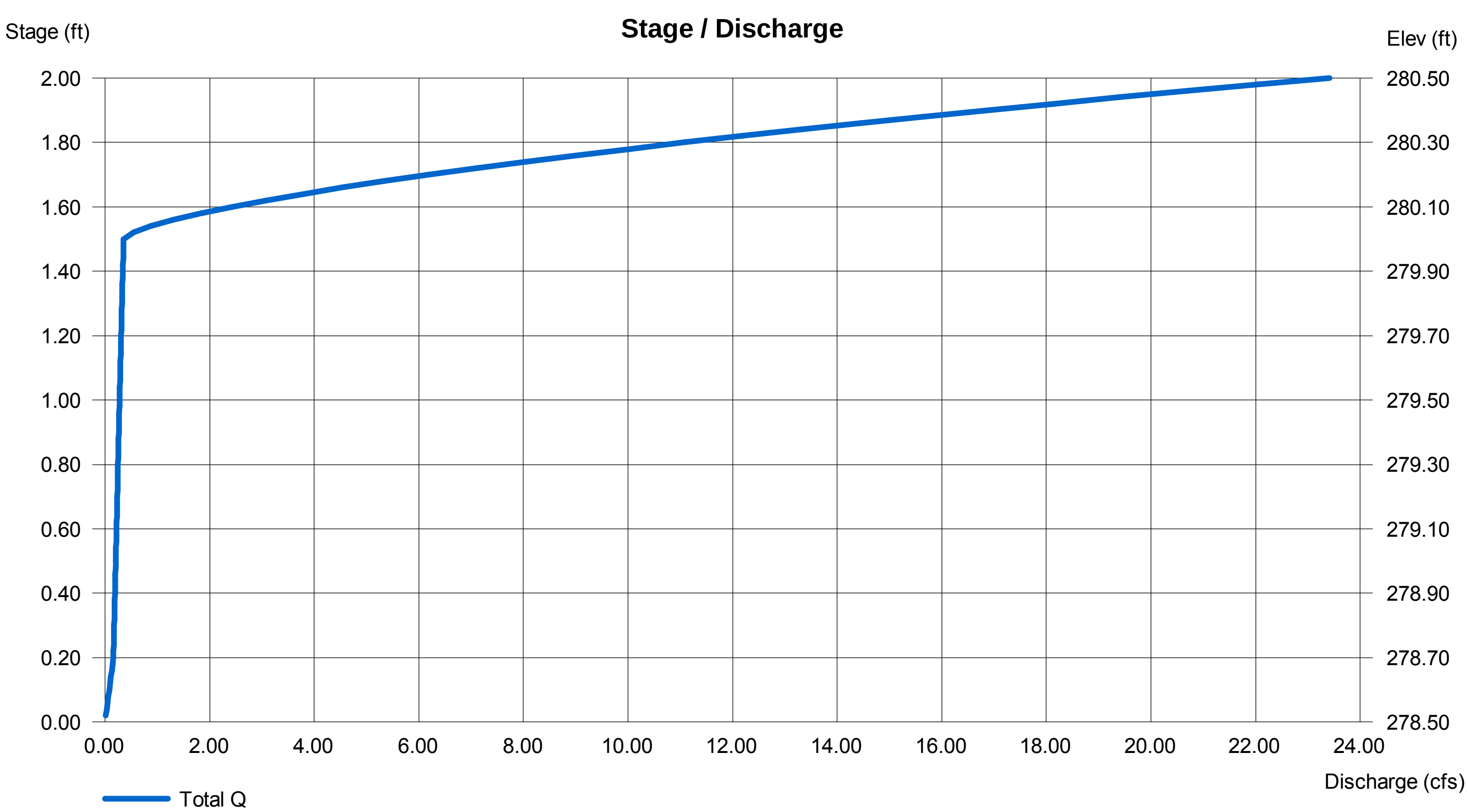
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 25.00	0.00	0.00	0.00
Crest El. (ft)	= 280.00	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



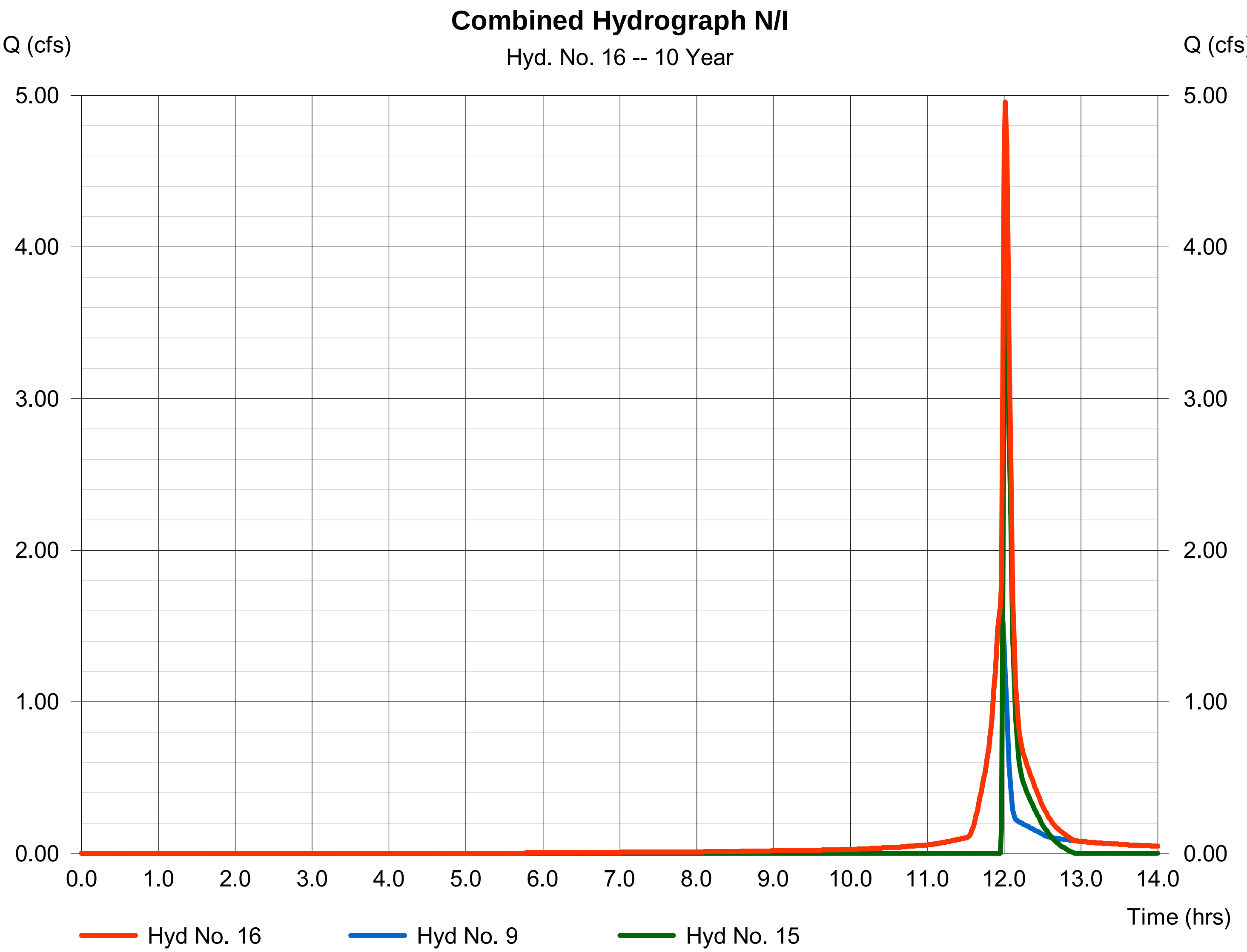
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 16

Combined Hydrograph N/I

Hydrograph type	= Combine	Peak discharge	= 4.954 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.02 hrs
Time interval	= 1 min	Hyd. volume	= 5,628 cuft
Inflow hyds.	= 9, 15	Contrib. drain. area	= 0.240 ac



Hydrograph Report

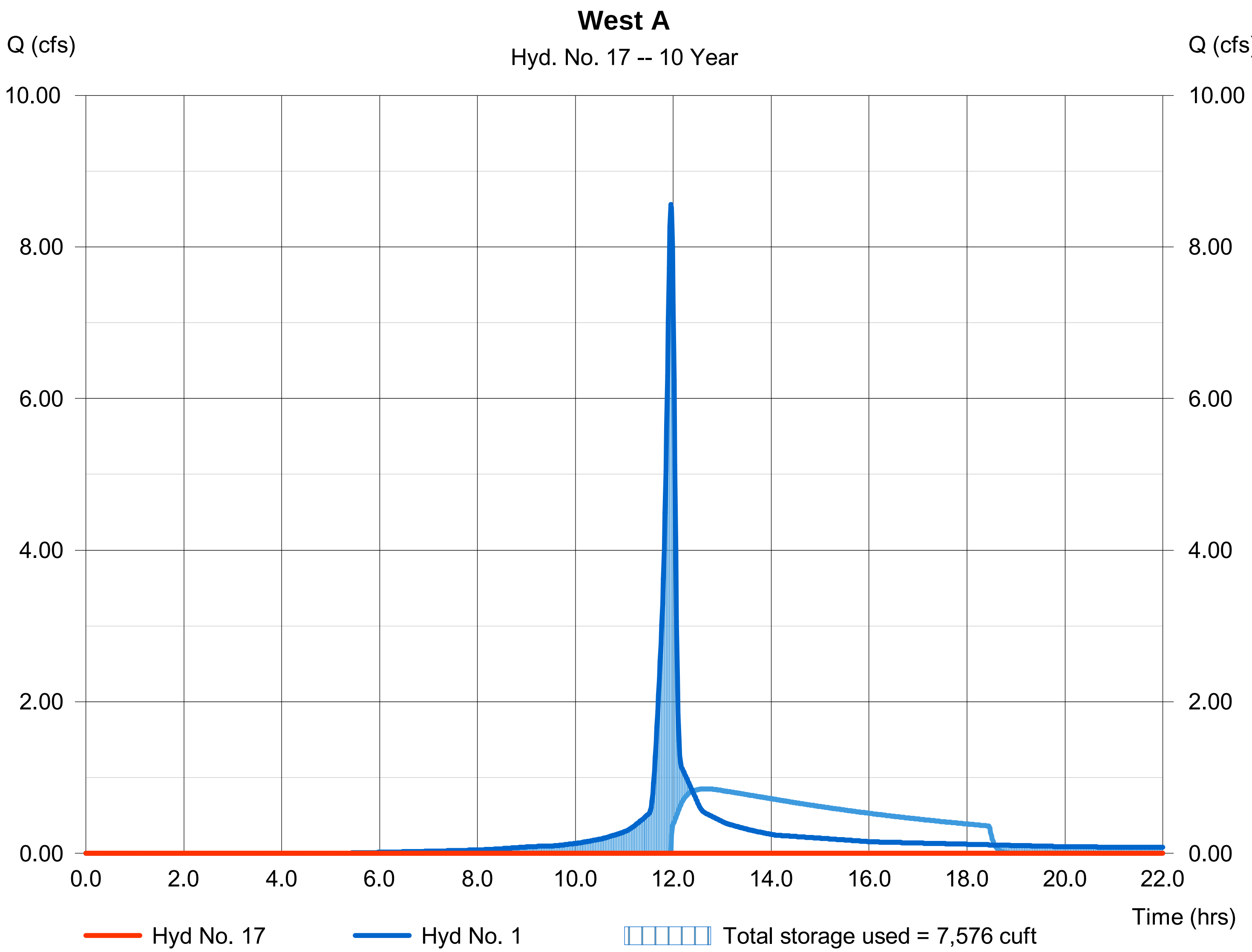
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 17

West A

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - West A	Max. Elevation	= 3.75 ft
Reservoir name	= Porous Pavement West A	Max. Storage	= 7,576 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 1 - Porous Pavement West A

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 3.00 x 3.33 ft , Barrel Len = 497.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft , Height = 3.83 ft , Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.38	0.38	n/a	846	846
0.77	0.77	n/a	857	1,702
1.15	1.15	n/a	857	2,559
1.53	1.53	n/a	857	3,415
1.91	1.91	n/a	857	4,272
2.30	2.30	n/a	857	5,129
2.68	2.68	n/a	857	5,985
3.06	3.06	n/a	798	6,784
3.45	3.45	n/a	444	7,228
3.83	3.83	n/a	444	7,673

Culvert / Orifice Structures

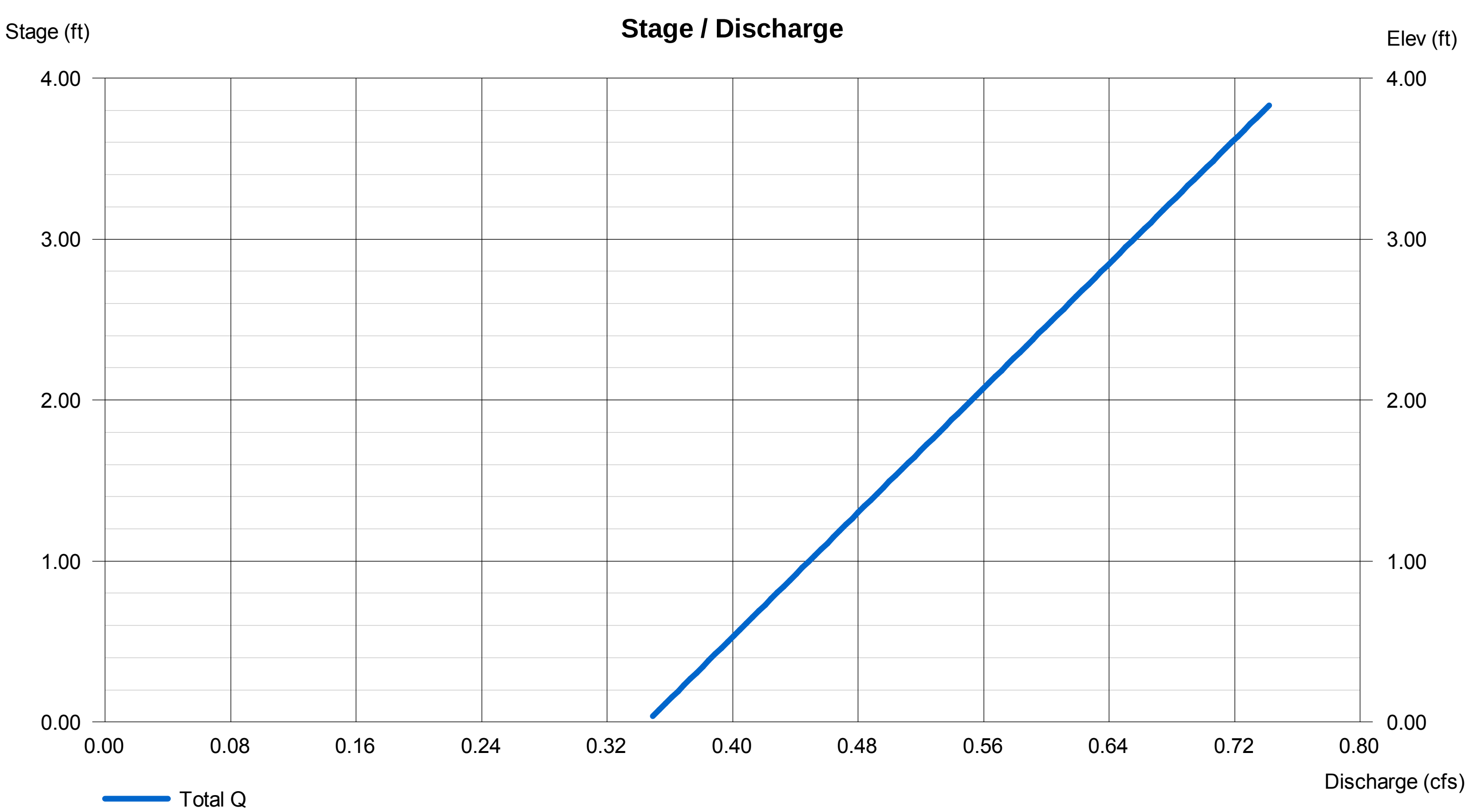
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

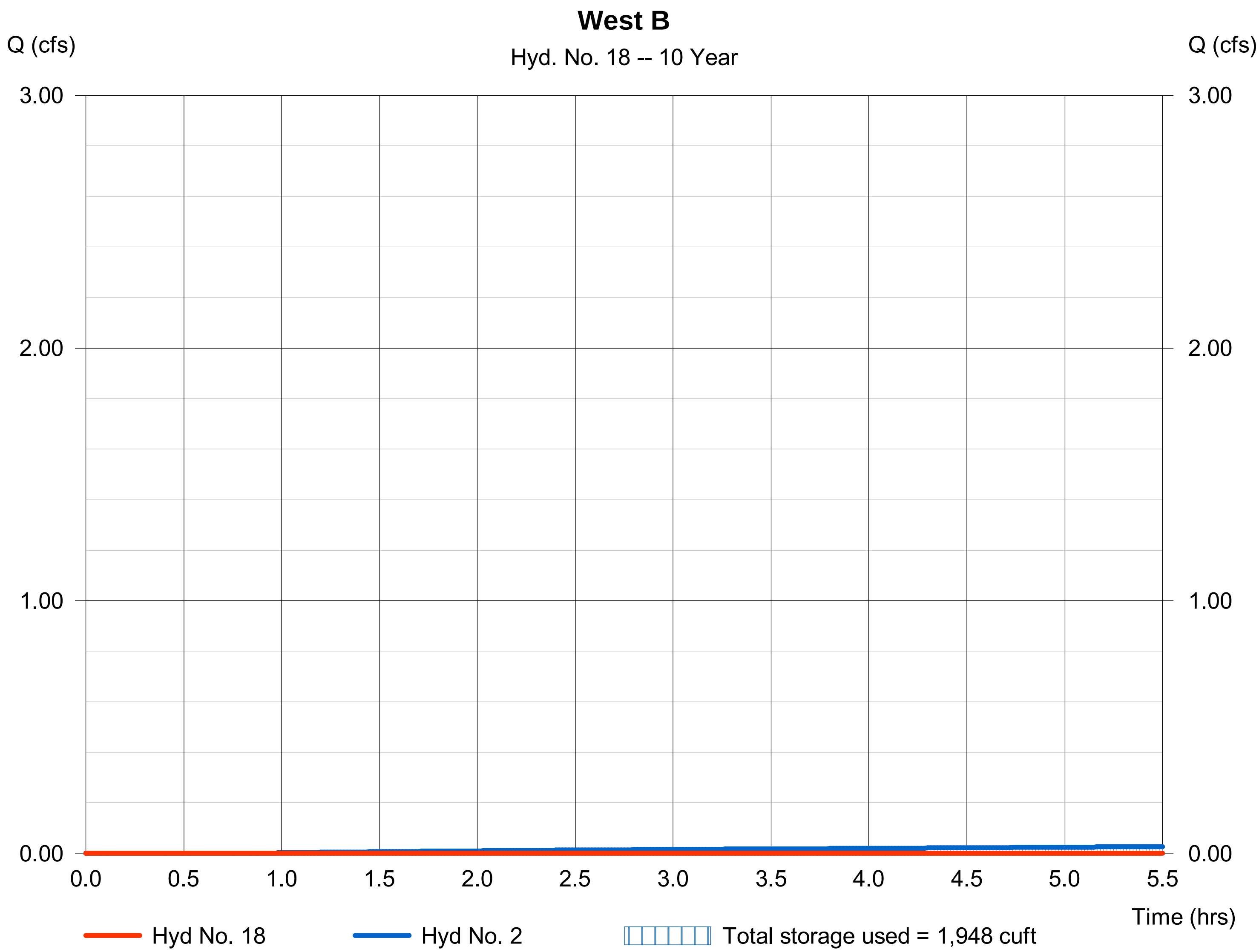
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 18

West B

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	10 yrs	Time to peak	=	5.33 hrs
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	2 - West B	Max. Elevation	=	2.07 ft
Reservoir name	=	Porous Pavement West B	Max. Storage	=	1,948 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Pond No. 4 - Porous Pavement West B

Pond Data

UG Chambers - Invert elev. = 0.50 ft , Rise x Span = 0.01 x 0.01 ft , Barrel Len = 336.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 8.00 ft, Height = 2.25 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.22	0.22	n/a	212	212
0.45	0.45	n/a	212	423
0.68	0.68	n/a	212	635
0.90	0.90	n/a	212	847
1.13	1.13	n/a	212	1,059
1.35	1.35	n/a	212	1,270
1.58	1.58	n/a	212	1,482
1.80	1.80	n/a	212	1,694
2.03	2.03	n/a	212	1,906
2.25	2.25	n/a	212	2,117

Culvert / Orifice Structures

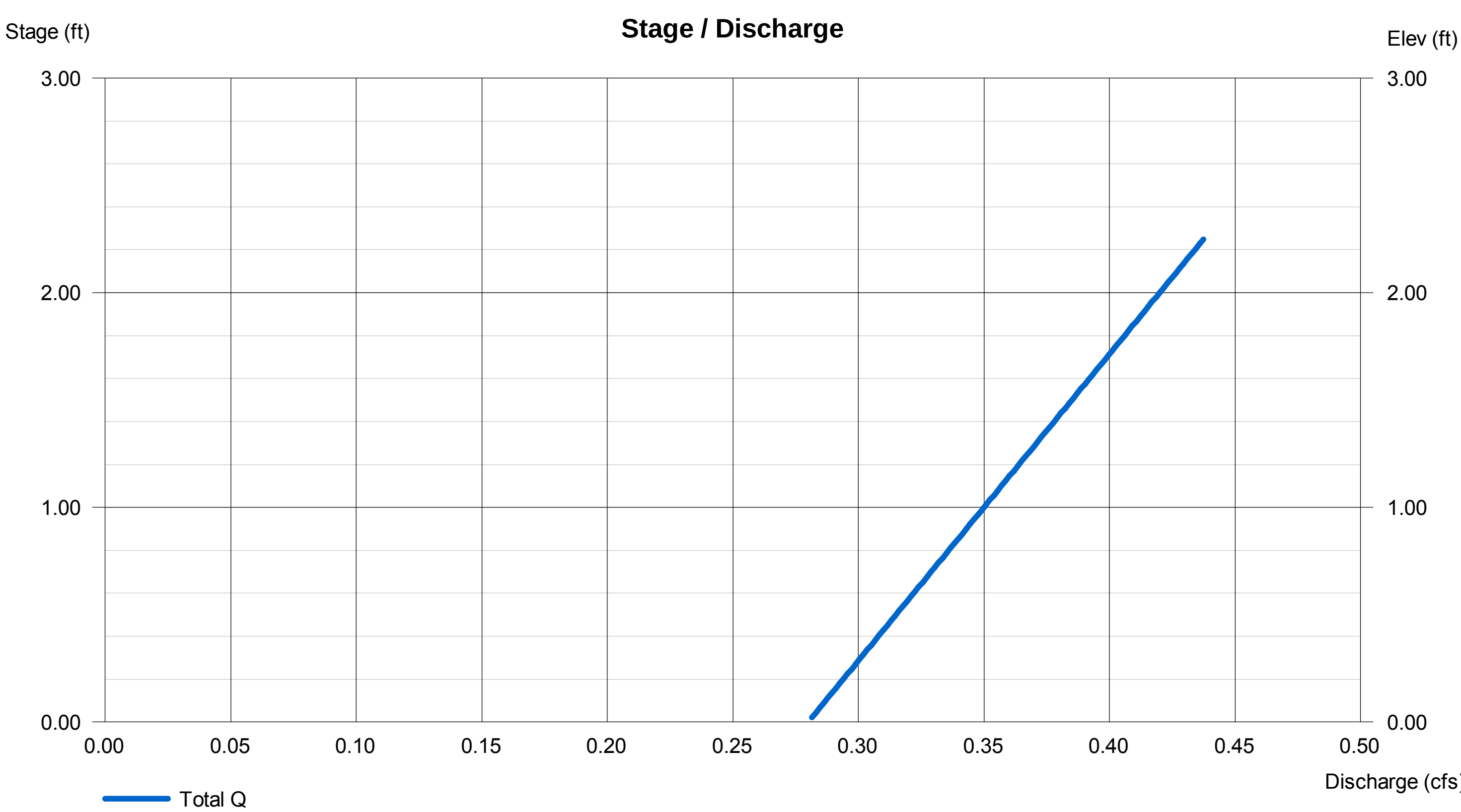
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

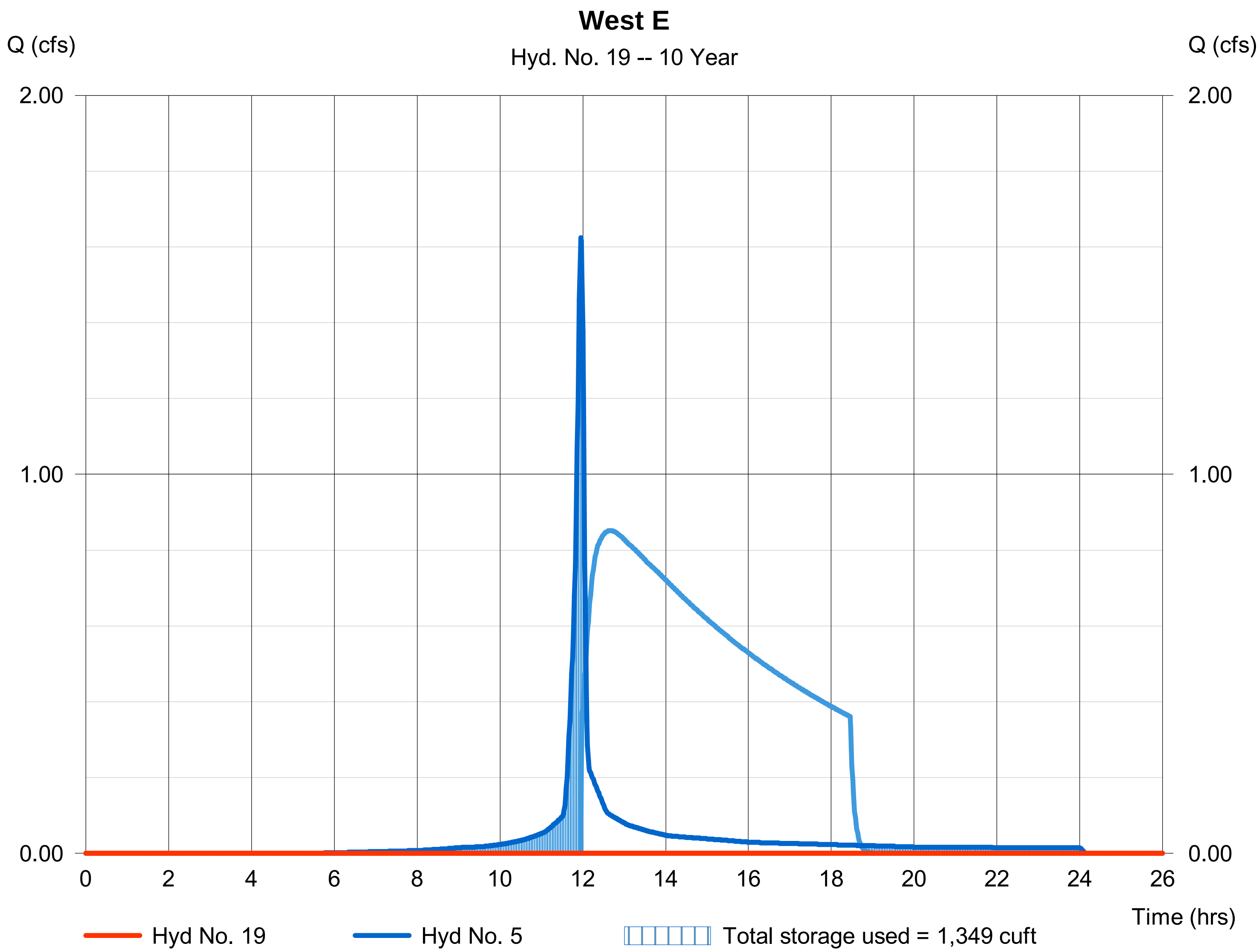
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 19

West E

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.23 hrs
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 5 - West E	Max. Elevation	= 2.80 ft
Reservoir name	= Porous Pavement West E	Max. Storage	= 1,349 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 7 - Porous Pavement West E

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 2.00 x 3.33 ft , Barrel Len = 124.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 2.83 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.28	0.28	n/a	155	155
0.57	0.57	n/a	158	313
0.85	0.85	n/a	158	471
1.13	1.13	n/a	158	629
1.41	1.41	n/a	158	787
1.70	1.70	n/a	158	945
1.98	1.98	n/a	158	1,103
2.26	2.26	n/a	90	1,192
2.55	2.55	n/a	82	1,274
2.83	2.83	n/a	82	1,356

Culvert / Orifice Structures

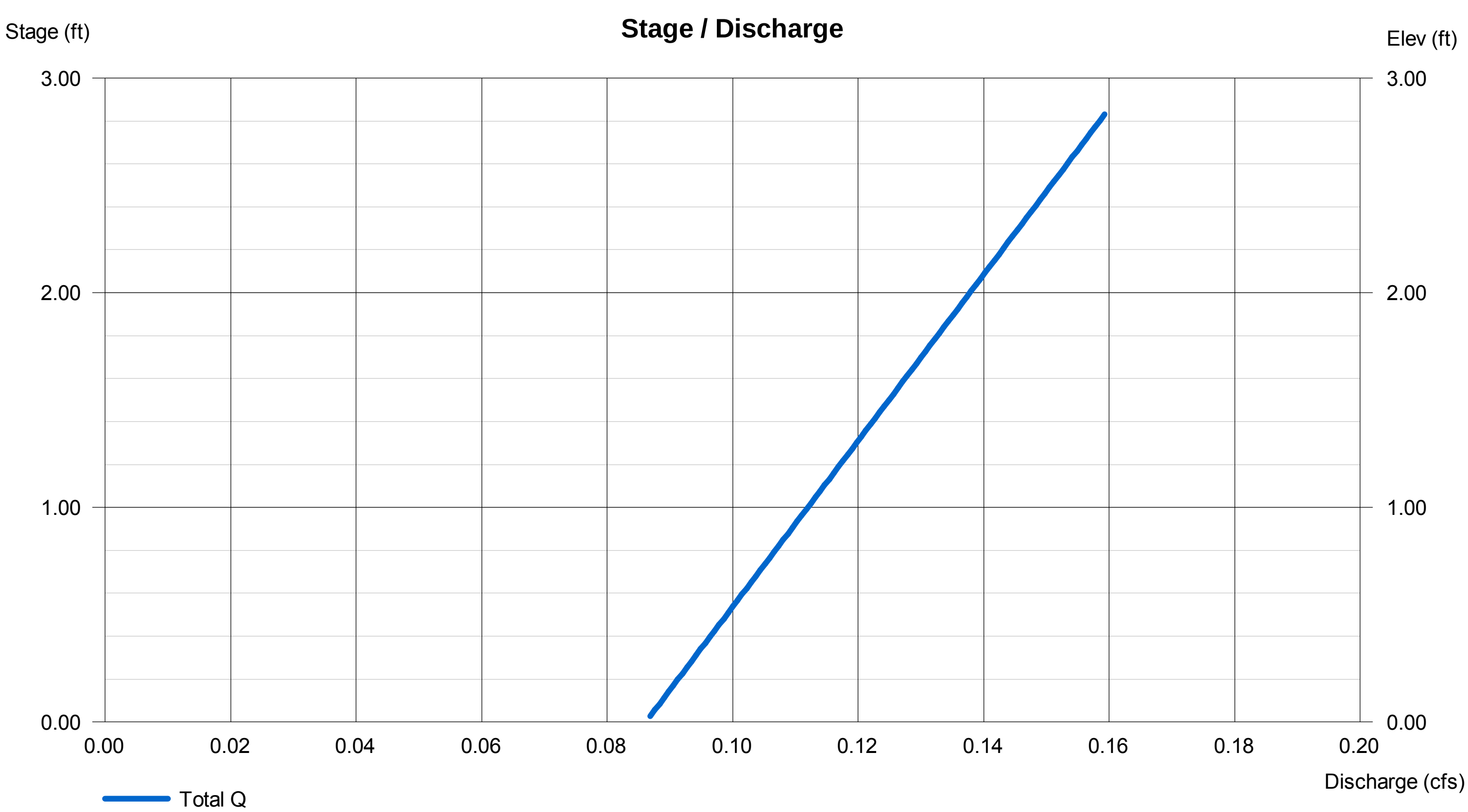
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

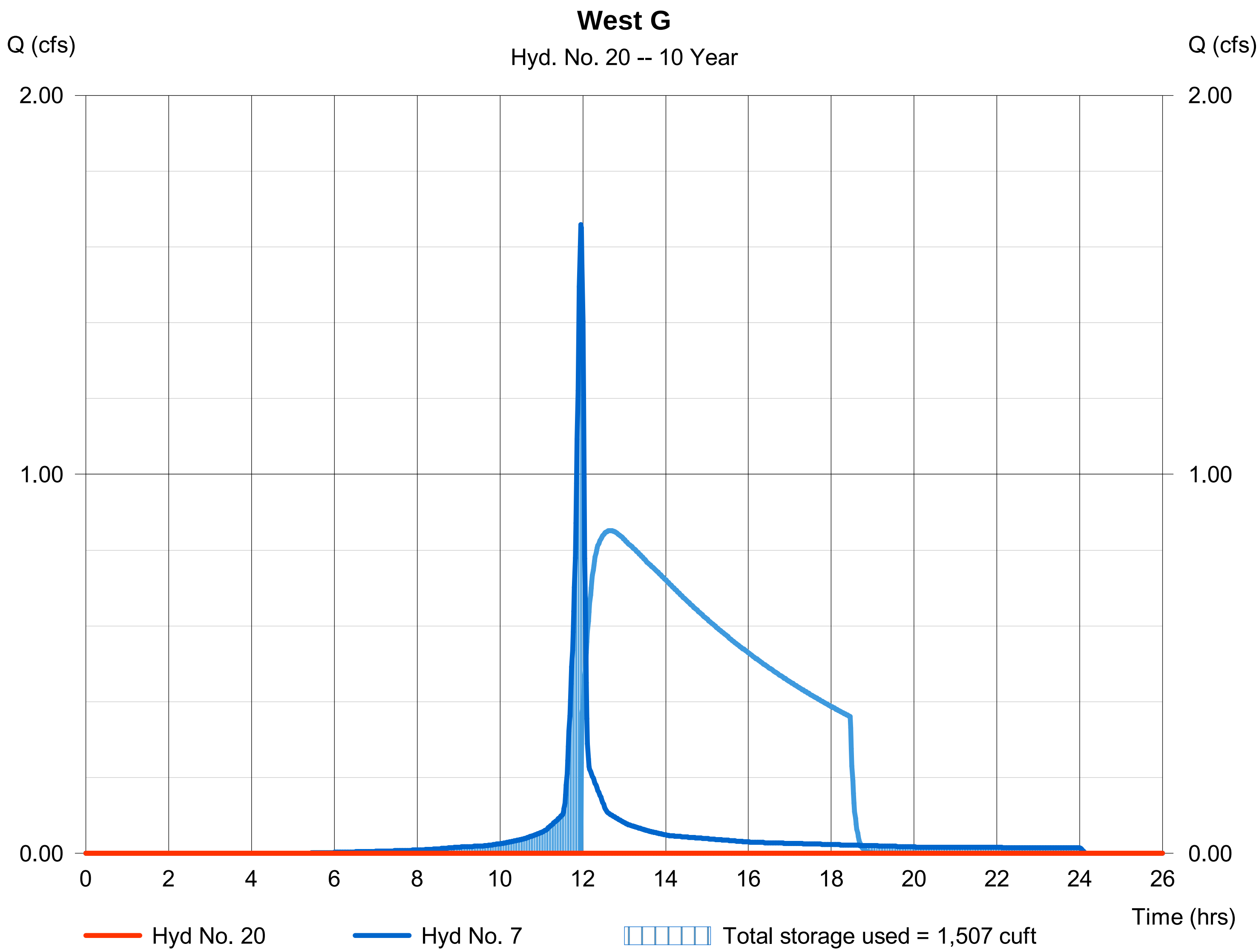
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 20

West G

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 10.40 hrs
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 7 - West G	Max. Elevation	= 4.19 ft
Reservoir name	= Porous Pavement West G	Max. Storage	= 1,507 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 8 - Porous Pavement West G

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 3.67 x 3.33 ft , Barrel Len = 85.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 4.50 ft , Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.45	0.45	n/a	170	170
0.90	0.90	n/a	172	342
1.35	1.35	n/a	172	515
1.80	1.80	n/a	172	687
2.25	2.25	n/a	172	859
2.70	2.70	n/a	172	1,031
3.15	3.15	n/a	172	1,203
3.60	3.60	n/a	172	1,375
4.05	4.05	n/a	104	1,479
4.50	4.50	n/a	89	1,568

Culvert / Orifice Structures

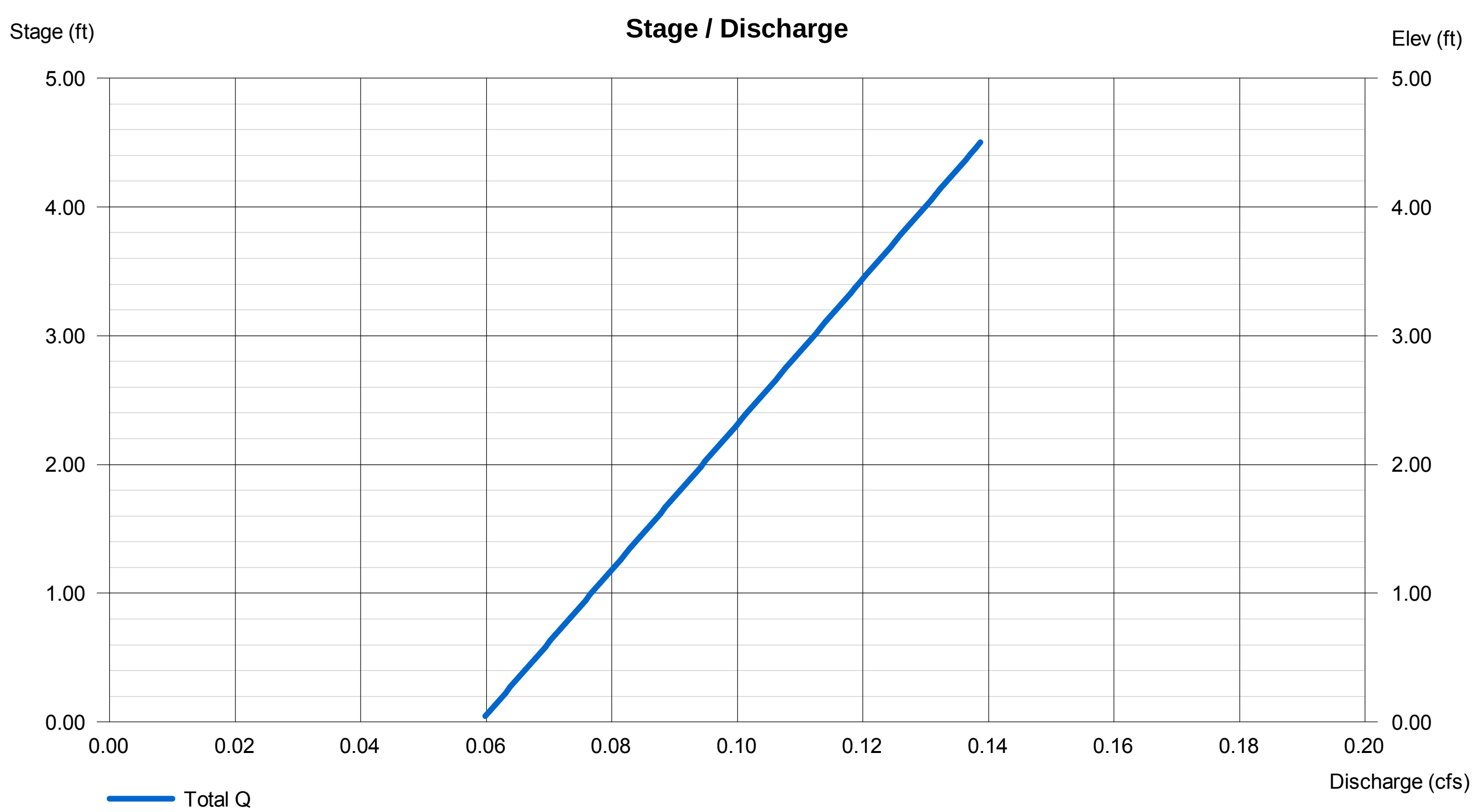
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

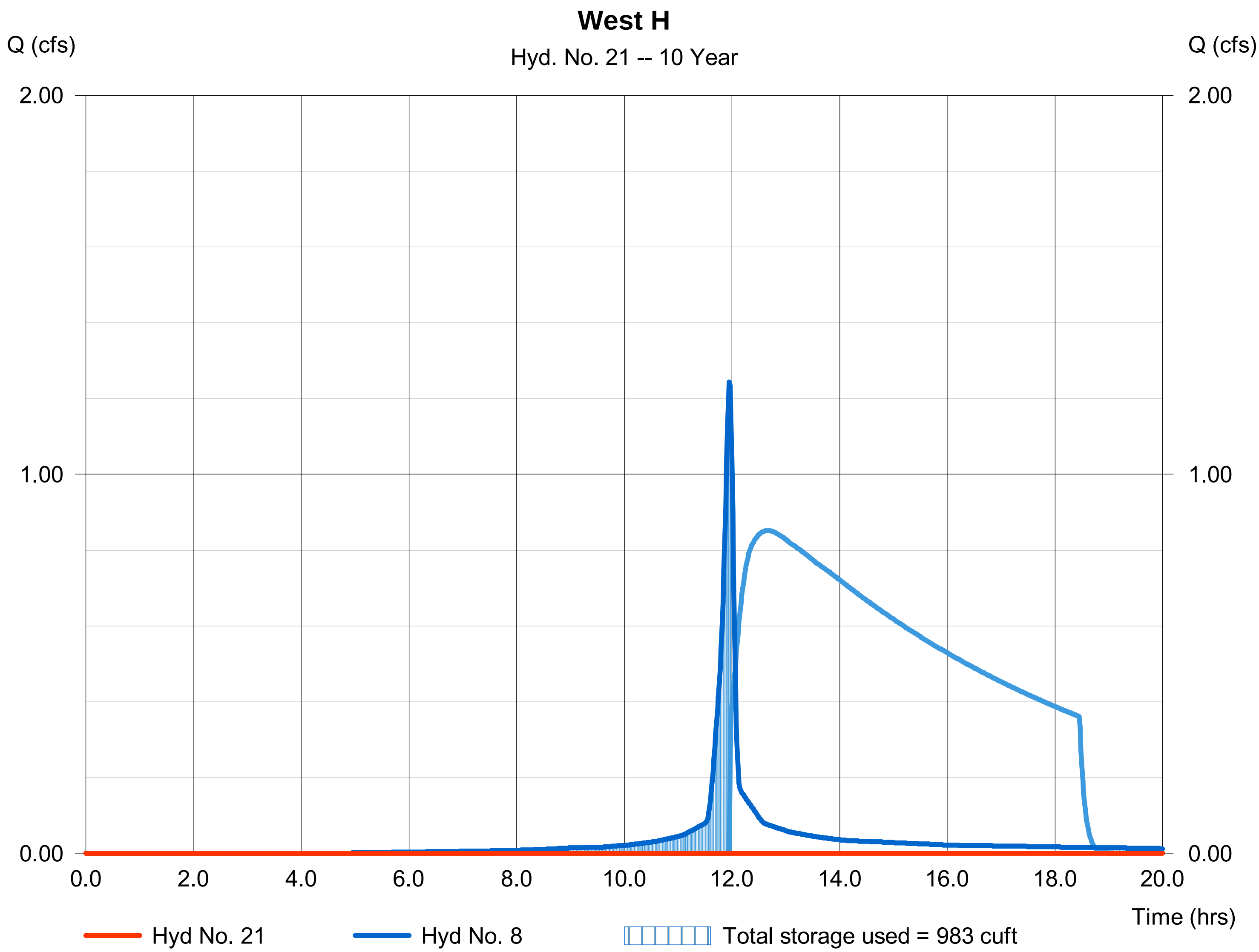
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 21

West H

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 8 - West H	Max. Elevation	= 2.14 ft
Reservoir name	= Porous Pavement West H	Max. Storage	= 983 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 9 - Porous Pavement West H

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 1.33 x 3.33 ft , Barrel Len = 125.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 2.17 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.22	0.22	n/a	119	119
0.43	0.43	n/a	122	241
0.65	0.65	n/a	122	363
0.87	0.87	n/a	122	486
1.09	1.09	n/a	122	608
1.30	1.30	n/a	122	730
1.52	1.52	n/a	74	803
1.74	1.74	n/a	63	867
1.95	1.95	n/a	63	930
2.17	2.17	n/a	63	993

Culvert / Orifice Structures

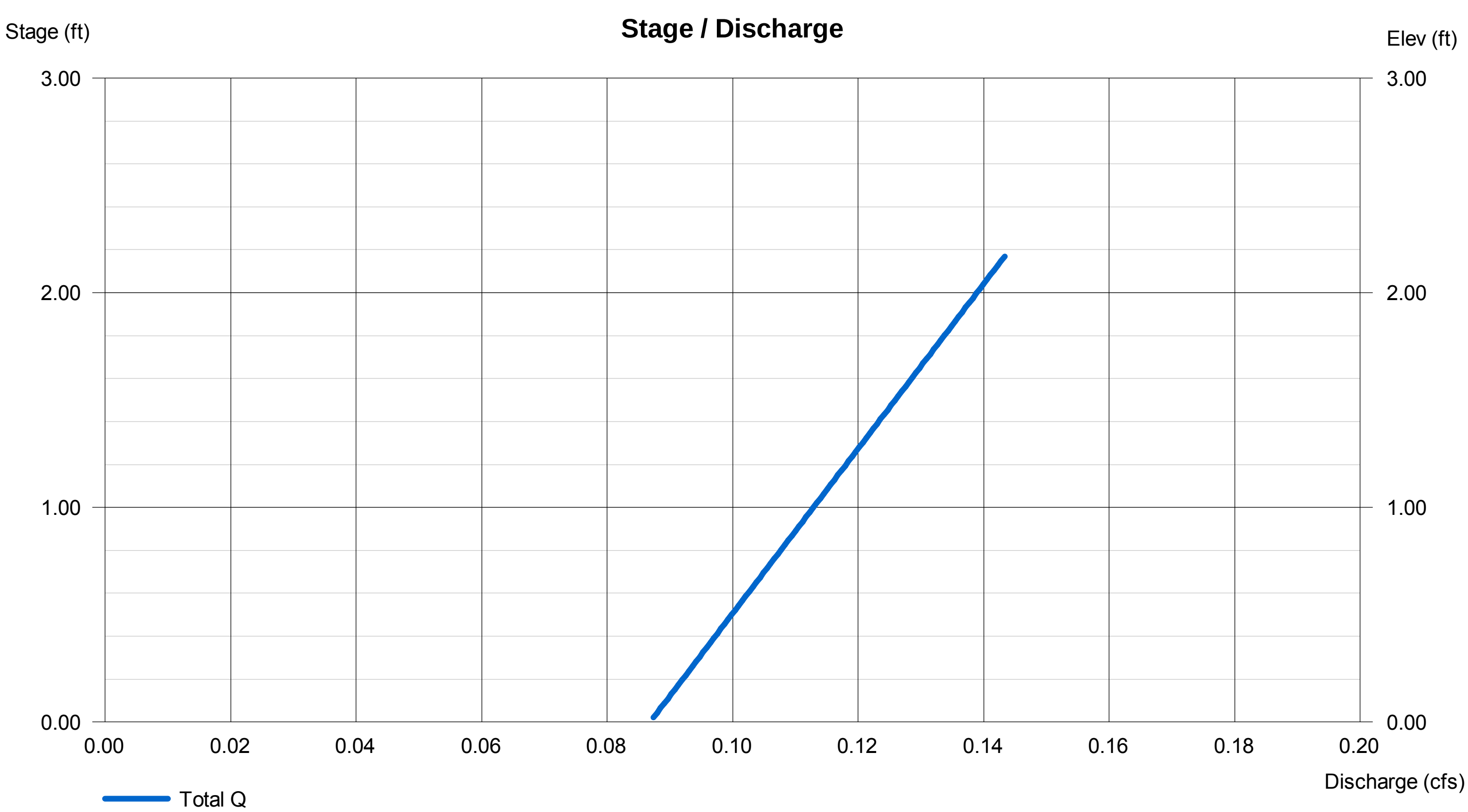
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

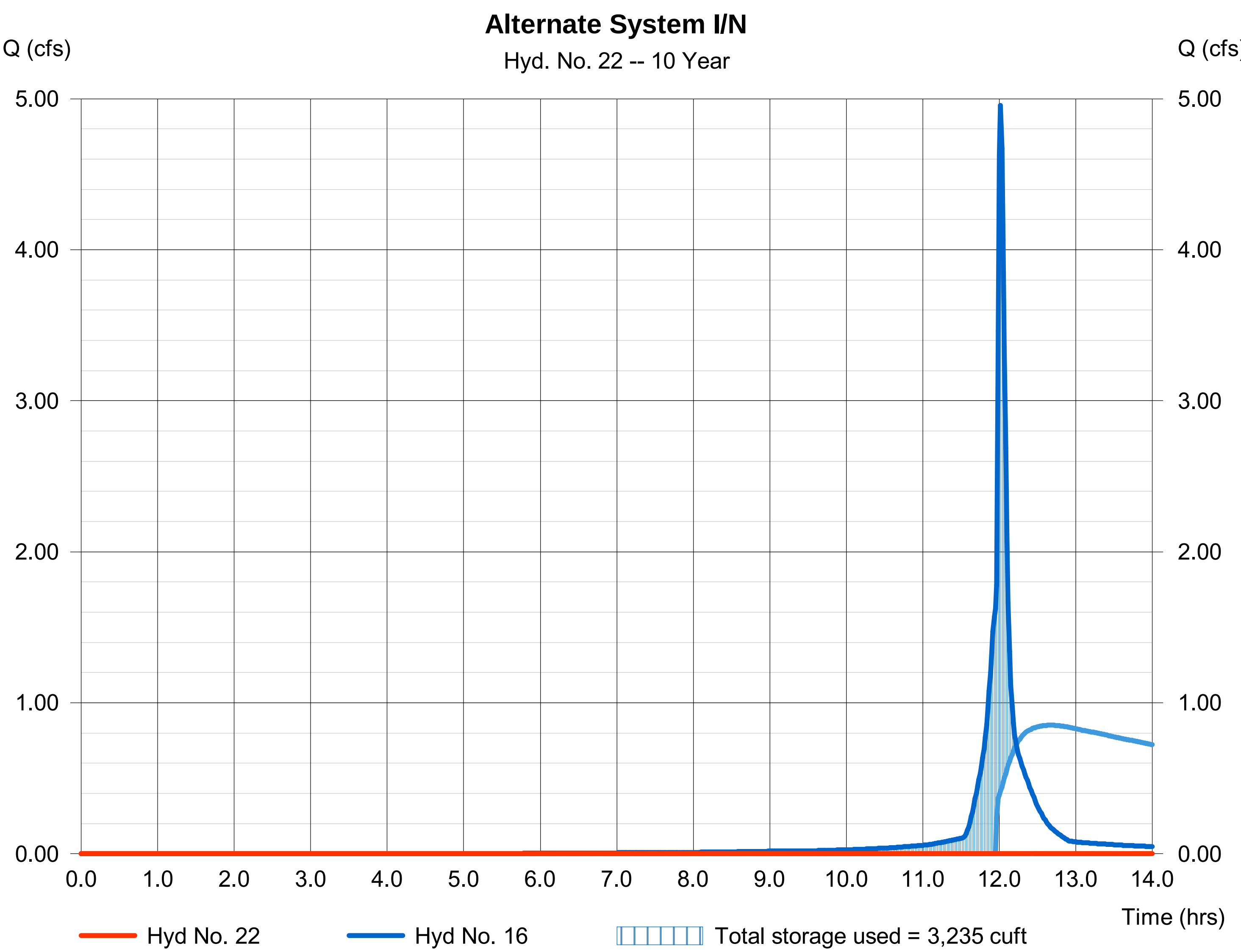
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 | Friday, Jan 20, 2012

Hyd. No. 22

Alternate System I/N

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 16 - Combined Hydrograph N/I	Max. Elevation	= 4.81 ft
Reservoir name	= Porous Pavement Wets I/N	Max. Storage	= 3,235 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond No. 10 - Porous Pavement Wets I/N

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 4.33 x 3.33 ft , Barrel Len = 157.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 5.17 ft , Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.52	0.52	n/a	362	362
1.03	1.03	n/a	365	727
1.55	1.55	n/a	365	1,092
2.07	2.07	n/a	365	1,458
2.59	2.59	n/a	365	1,823
3.10	3.10	n/a	365	2,188
3.62	3.62	n/a	365	2,553
4.14	4.14	n/a	365	2,919
4.65	4.65	n/a	259	3,177
5.17	5.17	n/a	190	3,367

Culvert / Orifice Structures

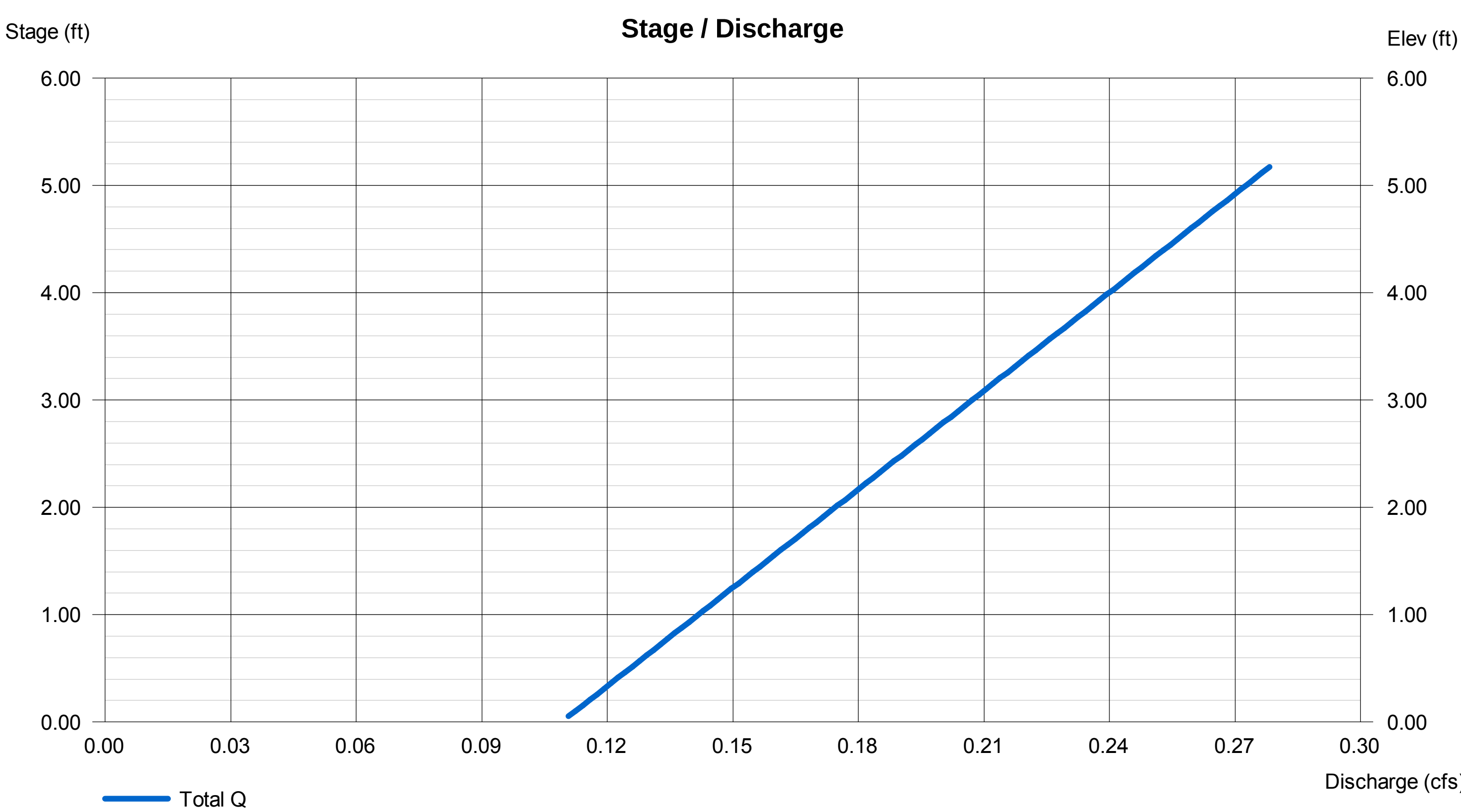
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

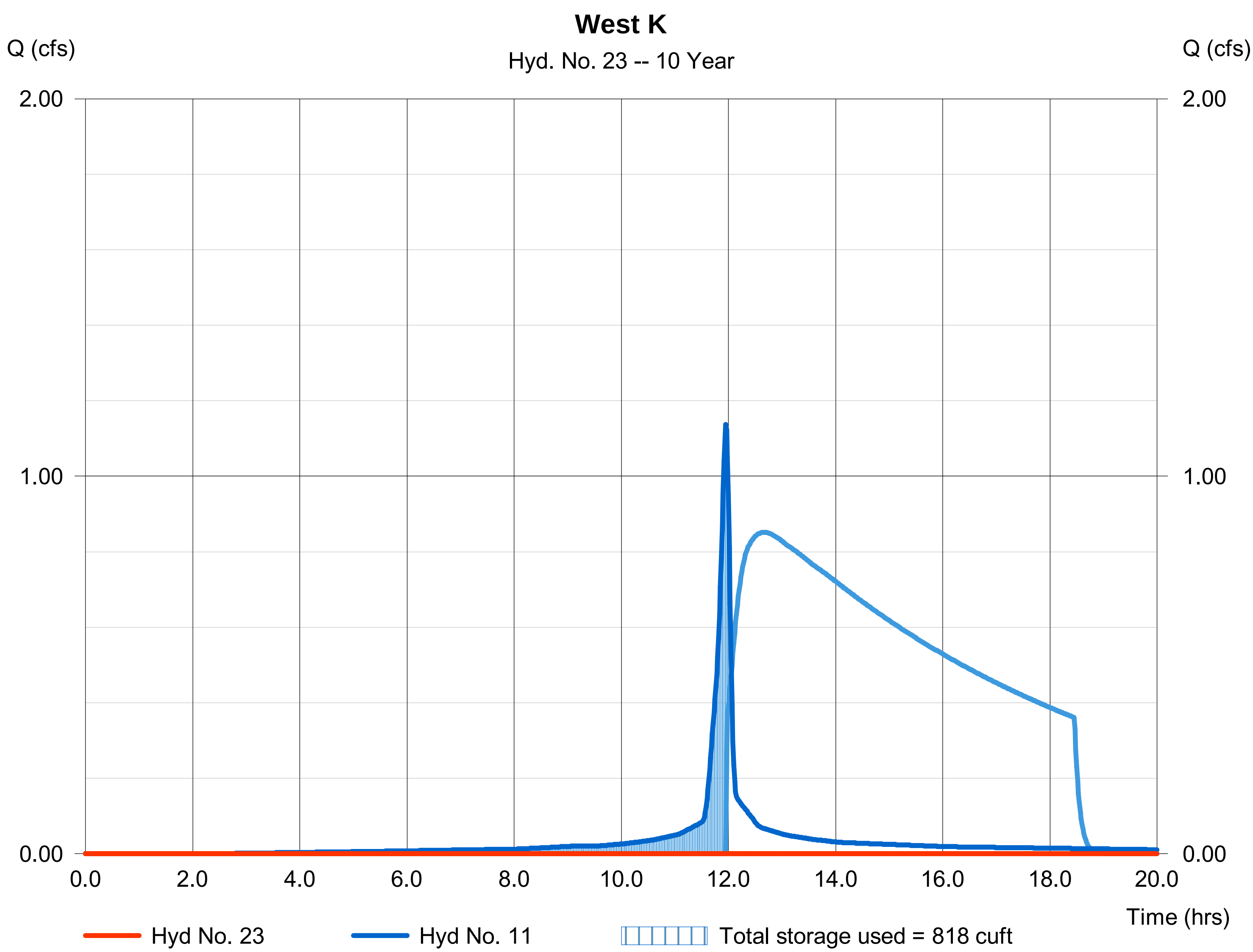
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 23

West K

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 11 - West K	Max. Elevation	= 2.11 ft
Reservoir name	= Porous Pavement West K	Max. Storage	= 818 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 12 - Porous Pavement West K

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 0.01 x 0.01 ft , Barrel Len = 166.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft , Height = 2.25 ft , Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.22	0.22	n/a	87	87
0.45	0.45	n/a	87	174
0.68	0.68	n/a	87	262
0.90	0.90	n/a	87	349
1.13	1.13	n/a	87	436
1.35	1.35	n/a	87	523
1.58	1.58	n/a	87	610
1.80	1.80	n/a	87	698
2.03	2.03	n/a	87	785
2.25	2.25	n/a	87	872

Culvert / Orifice Structures

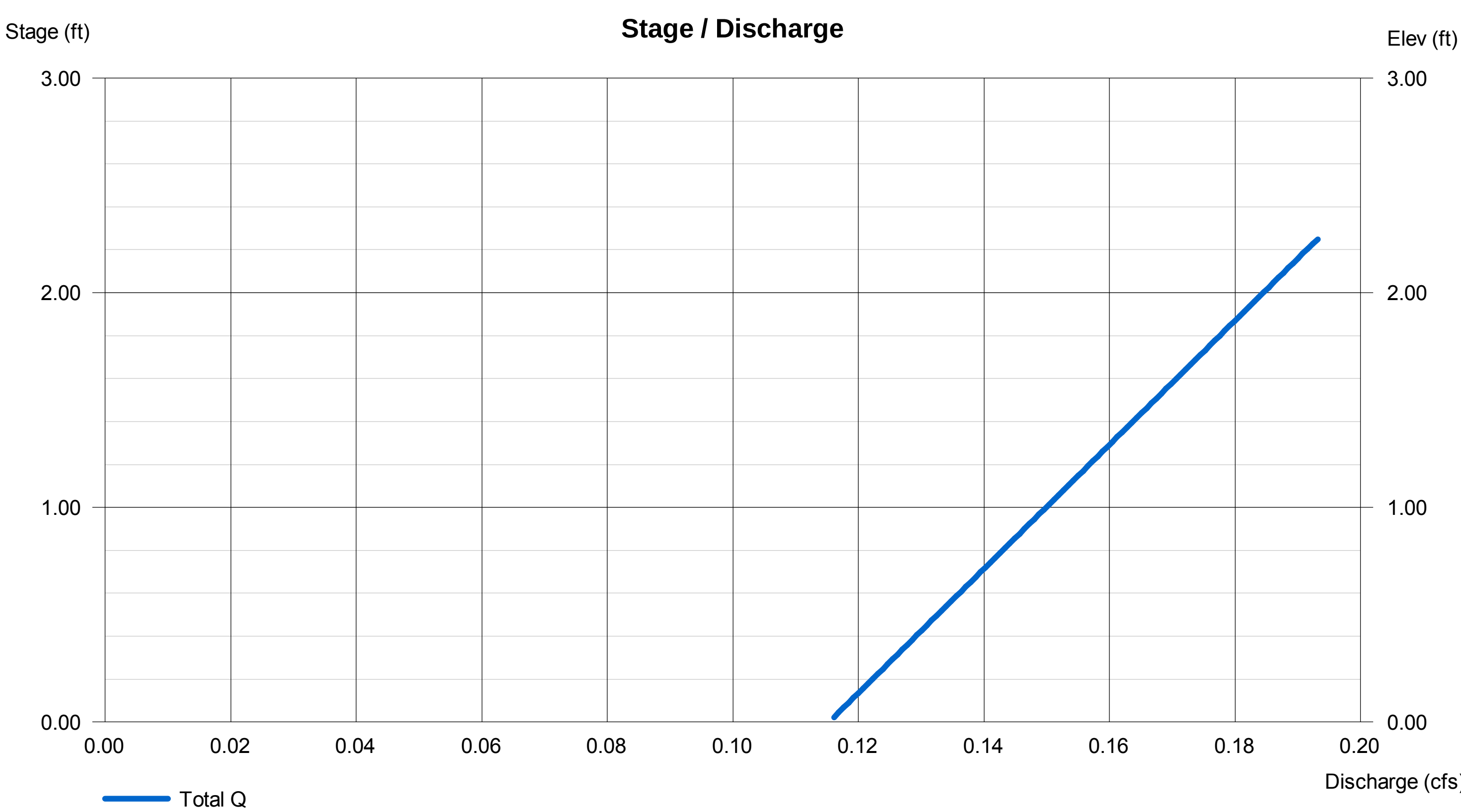
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

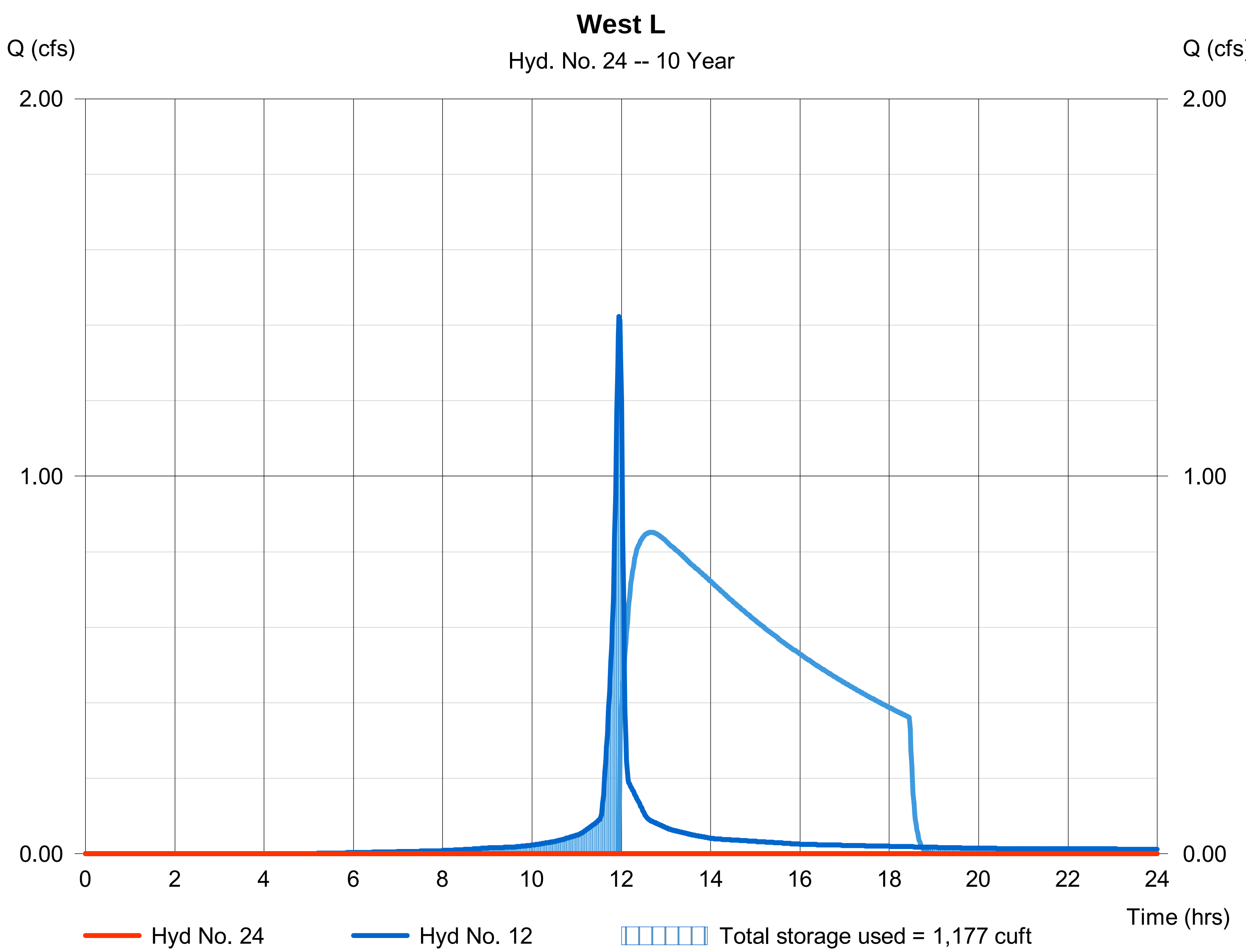
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 24

West L

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 10.07 hrs
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 12 - West L	Max. Elevation	= 2.42 ft
Reservoir name	= Porous Pavement West L	Max. Storage	= 1,177 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Pond No. 13 - Porous Pavement West L

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 2.00 x 3.33 ft , Barrel Len = 118.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 2.83 ft , Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.28	0.28	n/a	148	148
0.57	0.57	n/a	150	298
0.85	0.85	n/a	150	448
1.13	1.13	n/a	150	599
1.41	1.41	n/a	150	749
1.70	1.70	n/a	150	899
1.98	1.98	n/a	150	1,049
2.26	2.26	n/a	85	1,135
2.55	2.55	n/a	78	1,213
2.83	2.83	n/a	78	1,291

Culvert / Orifice Structures

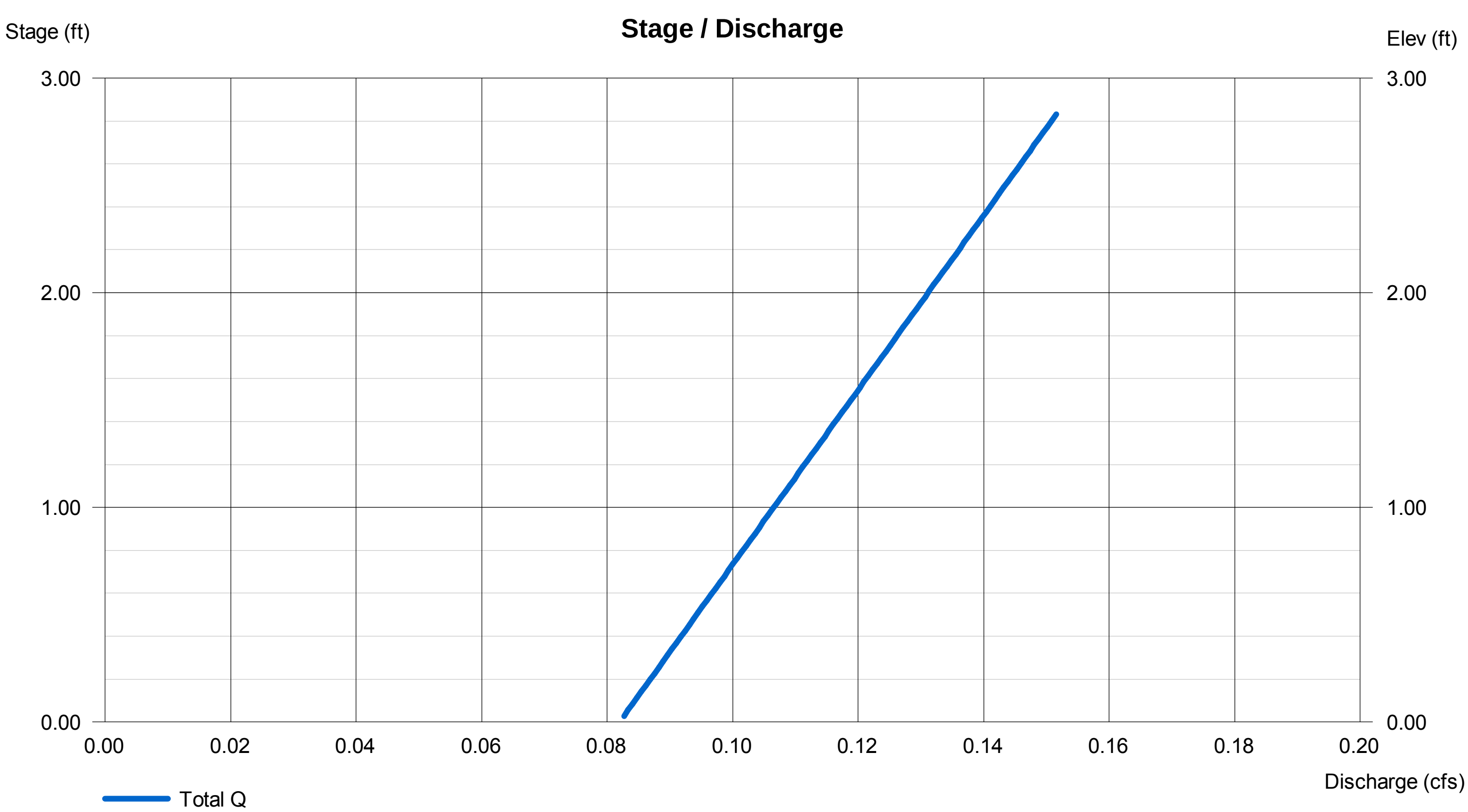
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

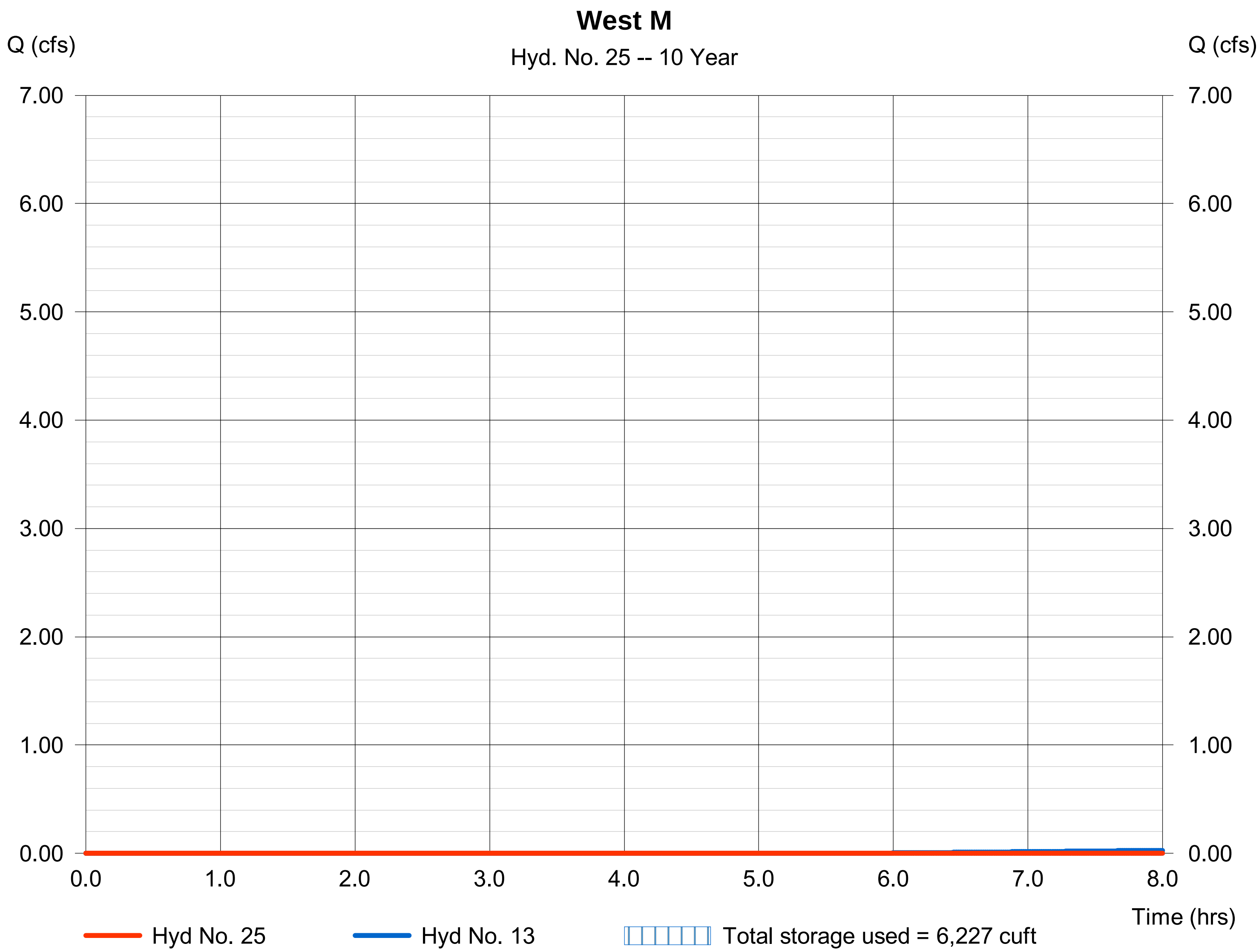
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 25

West M

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 7.77 hrs
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 13 - West M	Max. Elevation	= 4.14 ft
Reservoir name	= Porous Pavement West M	Max. Storage	= 6,227 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 14 - Porous Pavement West M

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 3.33 x 3.33 ft , Barrel Len = 369.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft , Height = 4.17 ft , Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.42	0.42	n/a	684	684
0.83	0.83	n/a	692	1,377
1.25	1.25	n/a	692	2,069
1.67	1.67	n/a	692	2,762
2.09	2.09	n/a	692	3,454
2.50	2.50	n/a	692	4,146
2.92	2.92	n/a	692	4,839
3.34	3.34	n/a	692	5,531
3.75	3.75	n/a	362	5,894
4.17	4.17	n/a	359	6,253

Culvert / Orifice Structures

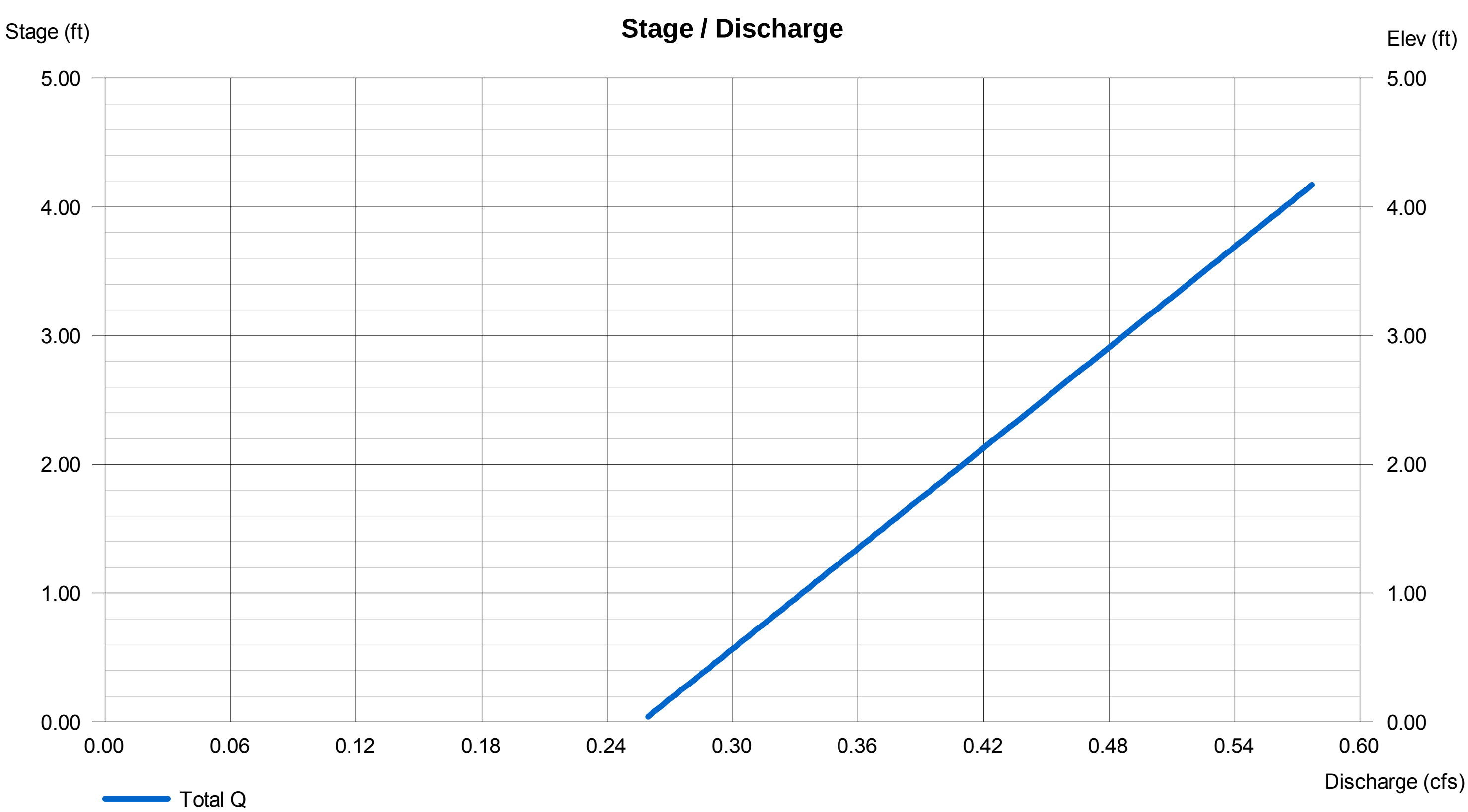
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

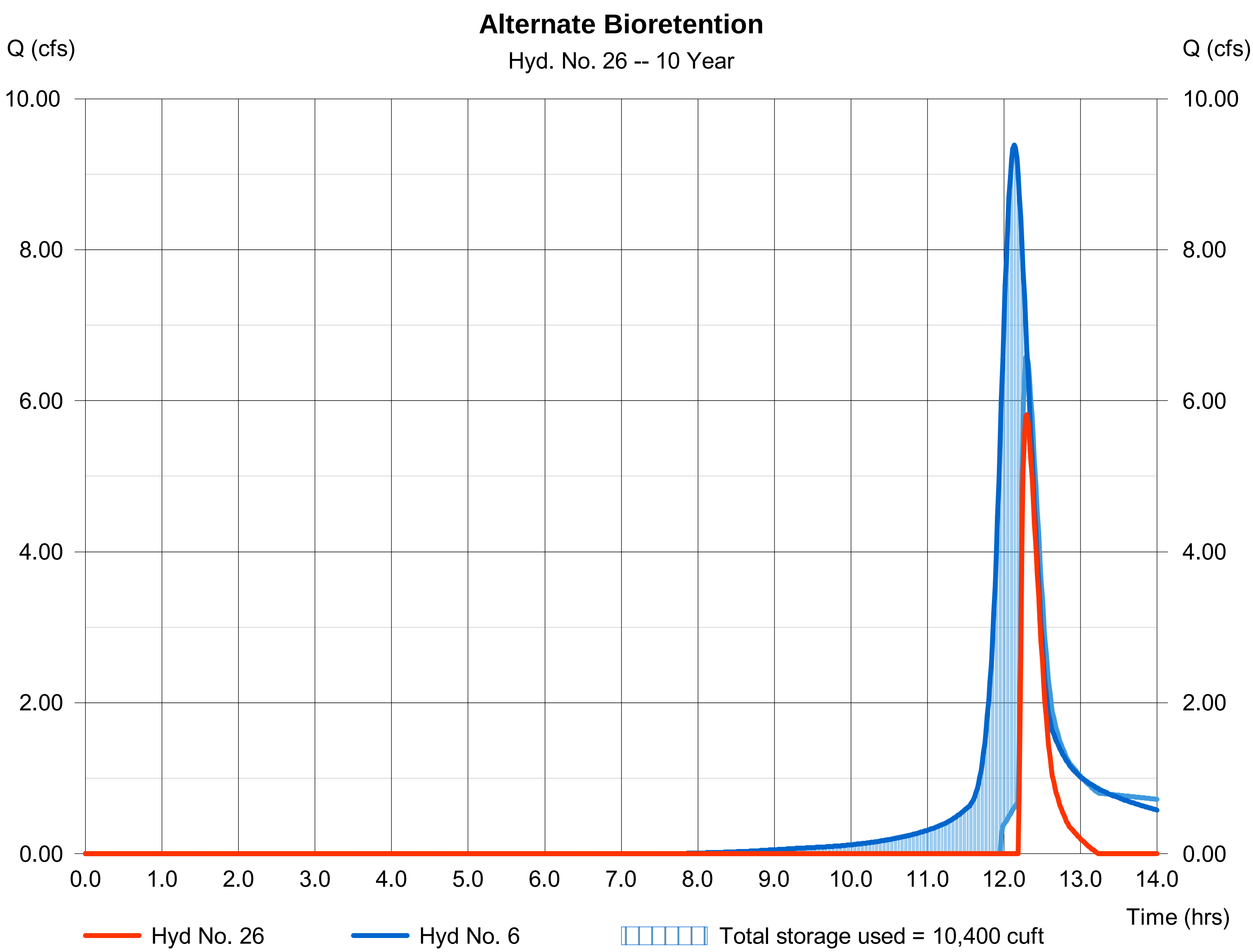
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 26

Alternate Bioretention

Hydrograph type	= Reservoir	Peak discharge	= 5.814 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.30 hrs
Time interval	= 1 min	Hyd. volume	= 6,249 cuft
Inflow hyd. No.	= 6 - West F	Max. Elevation	= 281.13 ft
Reservoir name	= Bioretention F	Max. Storage	= 10,400 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 2 - Bioretention F

Pond Data

Trapezoid -Bottom L x W = 582.0 x 6.0 ft , Side slope = 3.00:1 , Bottom elev. = 279.50 ft , Depth = 2.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	279.50	3,492	0	0
0.20	279.70	4,199	769	769
0.40	279.90	4,909	911	1,680
0.60	280.10	5,622	1,053	2,733
0.80	280.30	6,337	1,196	3,929
1.00	280.50	7,056	1,339	5,268
1.20	280.70	7,777	1,483	6,751
1.40	280.90	8,502	1,628	8,379
1.60	281.10	9,229	1,773	10,152
1.80	281.30	9,959	1,919	12,071
2.00	281.50	10,692	2,065	14,136

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

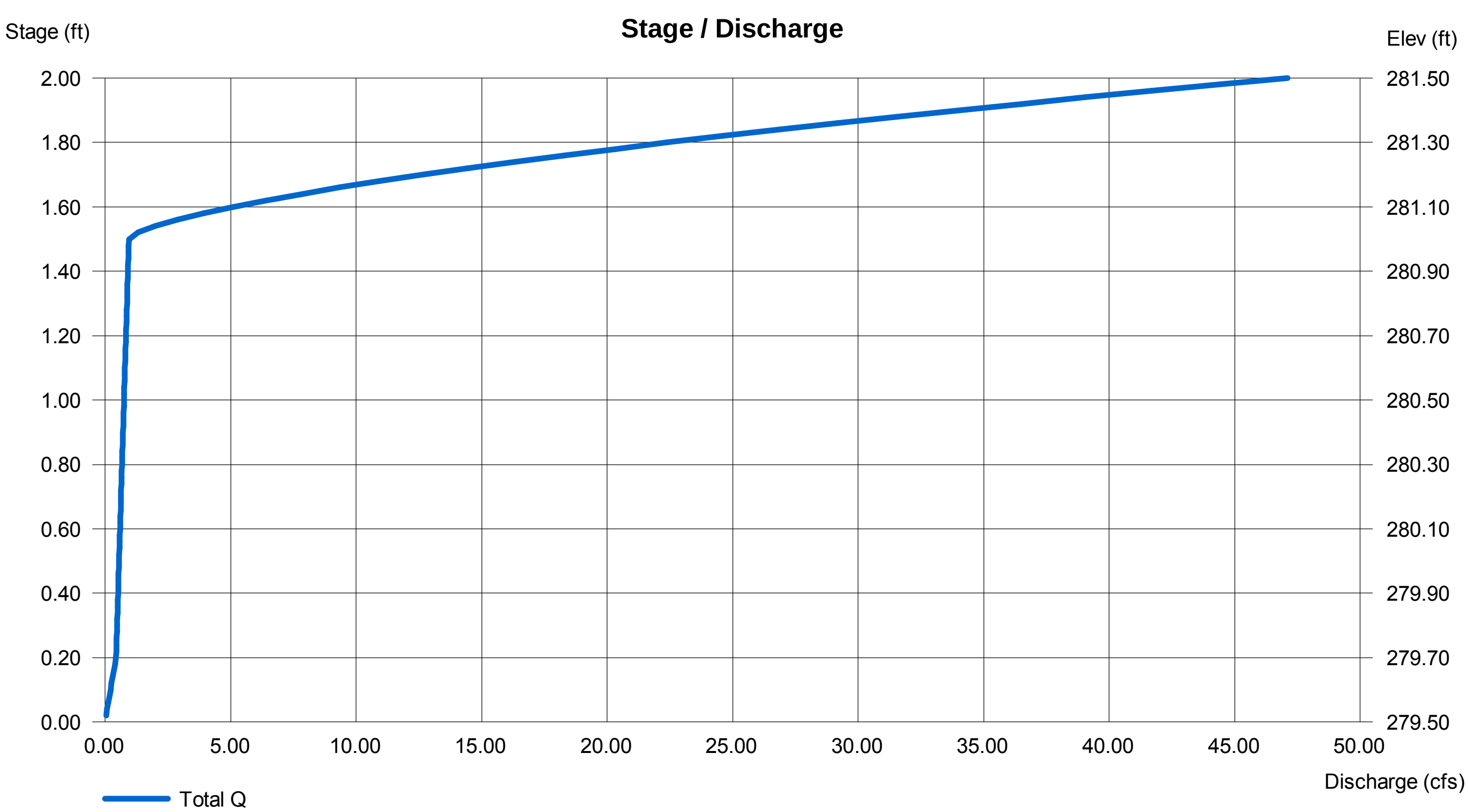
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 50.00	0.00	0.00	0.00
Crest El. (ft)	= 281.00	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



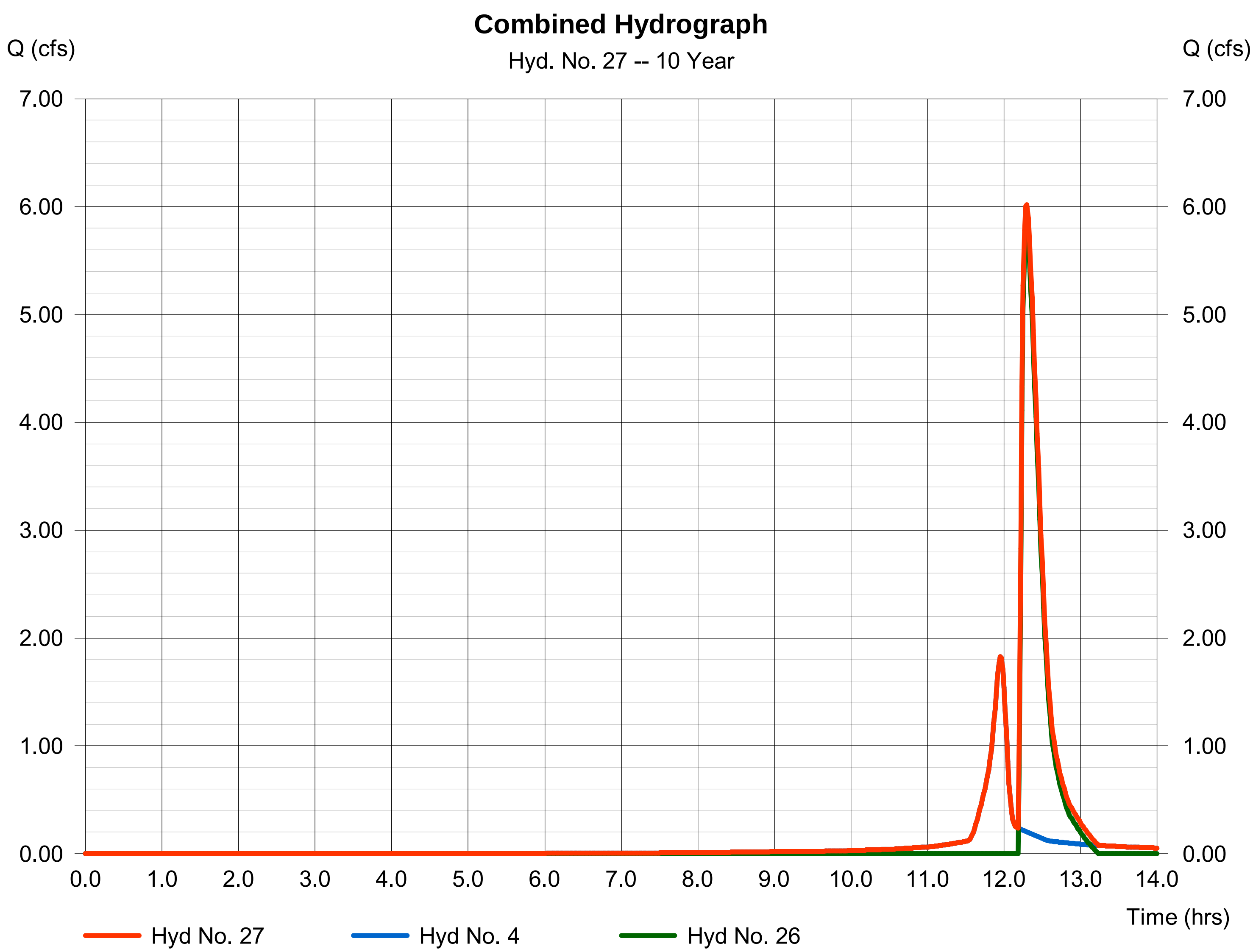
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 | Friday, Jan 20, 2012

Hyd. No. 27

Combined Hydrograph

Hydrograph type	= Combine	Peak discharge	= 6.016 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.30 hrs
Time interval	= 1 min	Hyd. volume	= 10,141 cuft
Inflow hyds.	= 4, 26	Contrib. drain. area	= 0.270 ac



Hydrograph Report

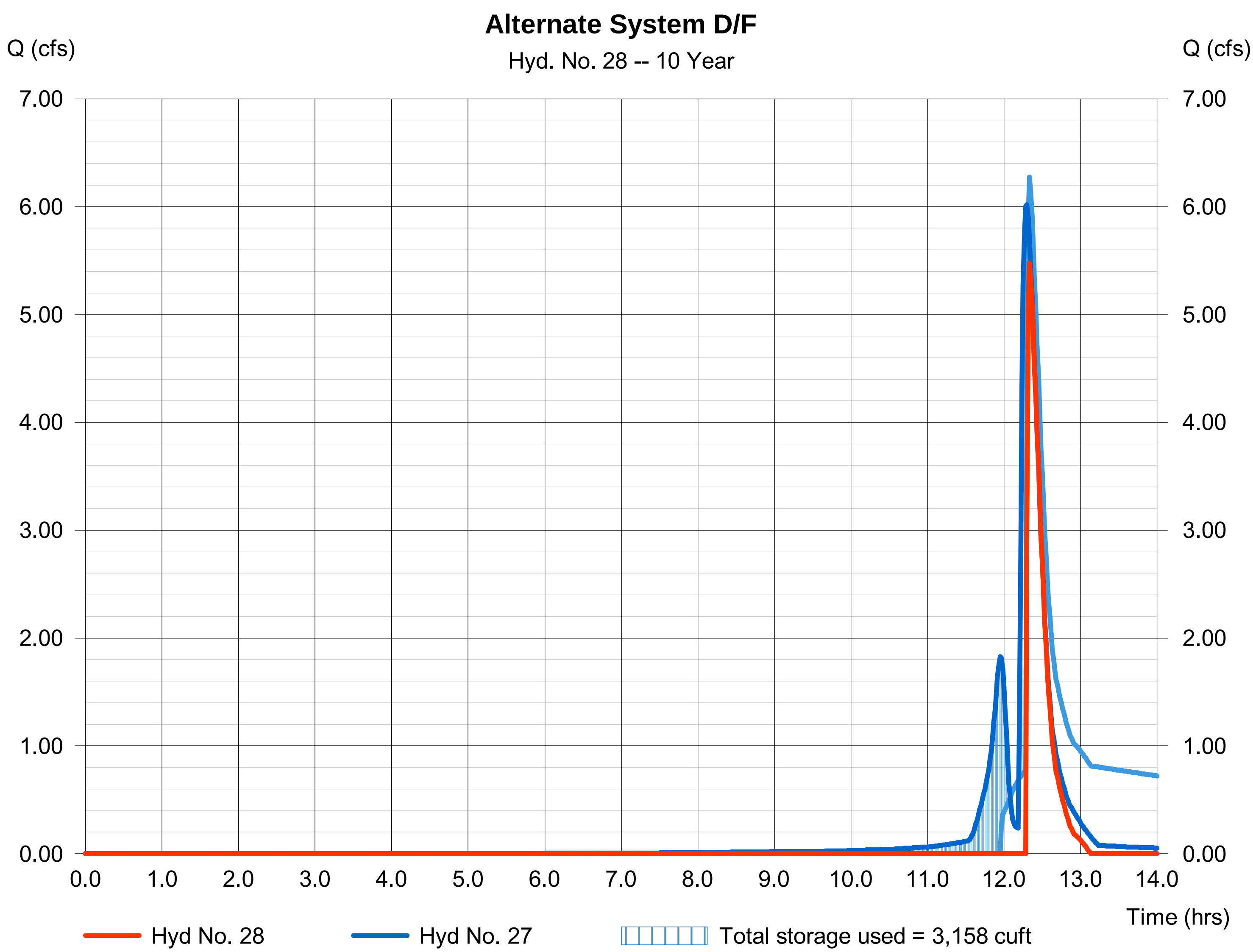
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 28

Alternate System D/F

Hydrograph type	= Reservoir	Peak discharge	= 5.476 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.33 hrs
Time interval	= 1 min	Hyd. volume	= 4,585 cuft
Inflow hyd. No.	= 27 - Combined Hydrograph	Max. Elevation	= 4.51 ft
Reservoir name	= Porous Pavement West D/F	Max. Storage	= 3,158 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 6 - Porous Pavement West D/F

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 7.67 x 3.33 ft , Barrel Len = 156.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 6.67 ft, Height = 8.50 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.85	0.85	n/a	593	593
1.70	1.70	n/a	597	1,190
2.55	2.55	n/a	597	1,787
3.40	3.40	n/a	597	2,383
4.25	4.25	n/a	597	2,980
5.10	5.10	n/a	597	3,577
5.95	5.95	n/a	597	4,173
6.80	6.80	n/a	597	4,770
7.65	7.65	n/a	597	5,367
8.50	8.50	n/a	320	5,687

Culvert / Orifice Structures

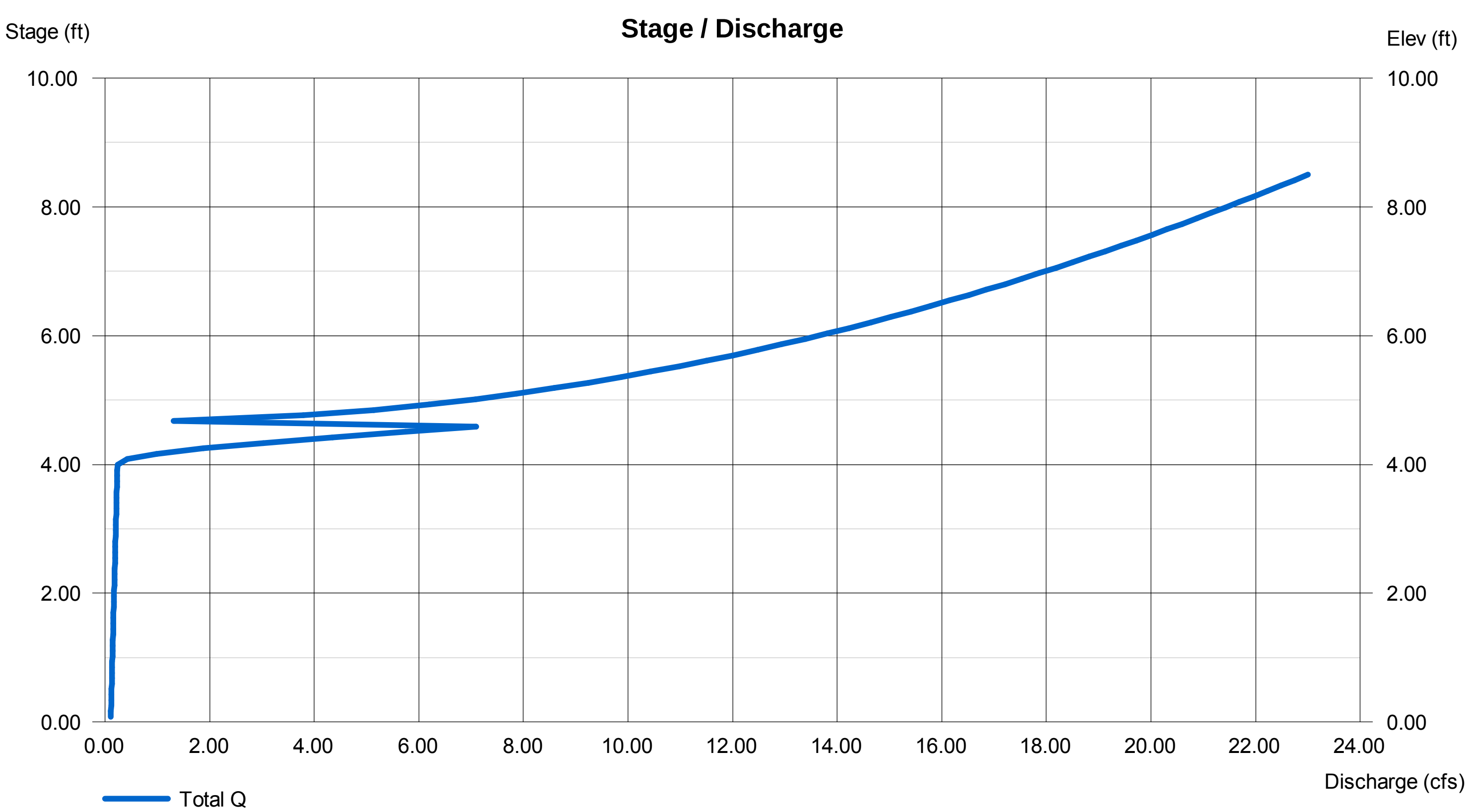
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 8.00	0.00	0.00	0.00
Span (in)	= 8.00	0.00	0.00	0.00
No. Barrels	= 8	0	0	0
Invert El. (ft)	= 4.00	0.00	0.00	0.00
Length (ft)	= 50.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



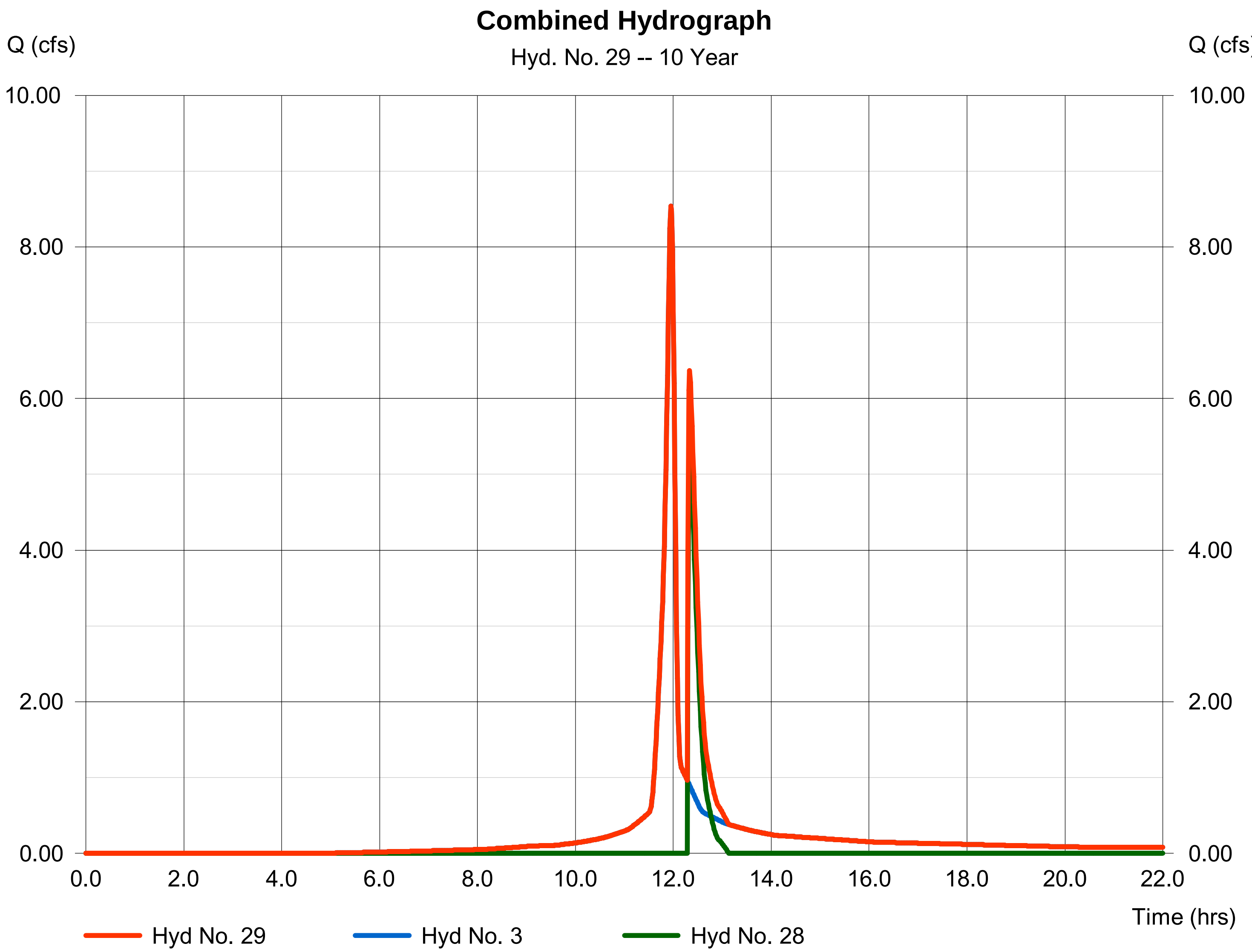
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 29

Combined Hydrograph

Hydrograph type	= Combine	Peak discharge	= 8.538 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 22,747 cuft
Inflow hyds.	= 3, 28	Contrib. drain. area	= 1.260 ac



Hydrograph Report

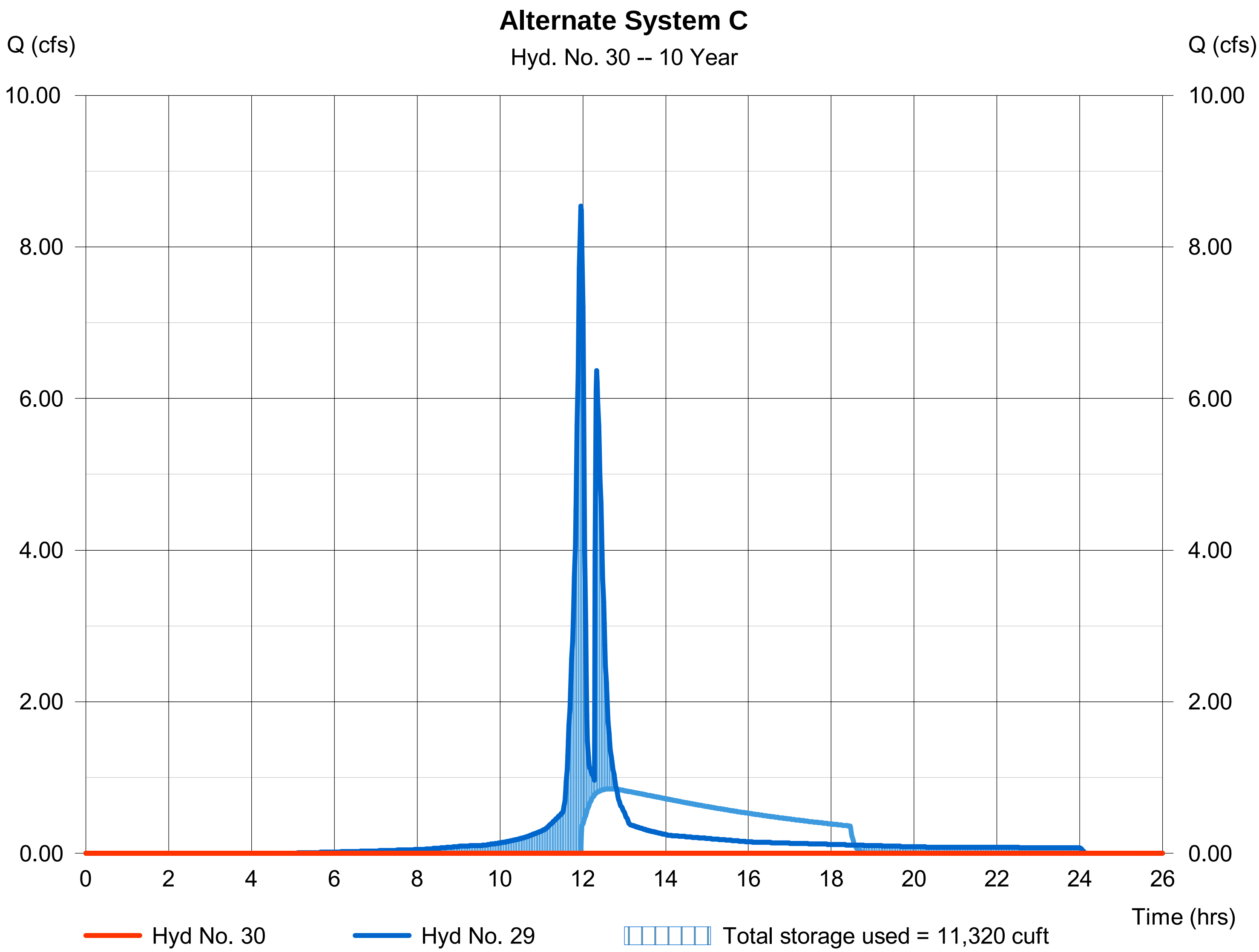
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 30

Alternate System C

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= 10.75 hrs
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 29 - Combined Hydrograph	Max. Elevation	= 4.27 ft
Reservoir name	= Porous Pavement West C	Max. Storage	= 11,320 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Pond No. 5 - Porous Pavement West C

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 6.67 x 3.33 ft , Barrel Len = 542.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 7.80 ft, Height = 7.50 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.75	0.75	n/a	1,978	1,978
1.50	1.50	n/a	1,990	3,968
2.25	2.25	n/a	1,990	5,958
3.00	3.00	n/a	1,990	7,948
3.75	3.75	n/a	1,990	9,938
4.50	4.50	n/a	1,990	11,928
5.25	5.25	n/a	1,990	13,918
6.00	6.00	n/a	1,990	15,908
6.75	6.75	n/a	1,908	17,816
7.50	7.50	n/a	1,110	18,926

Culvert / Orifice Structures

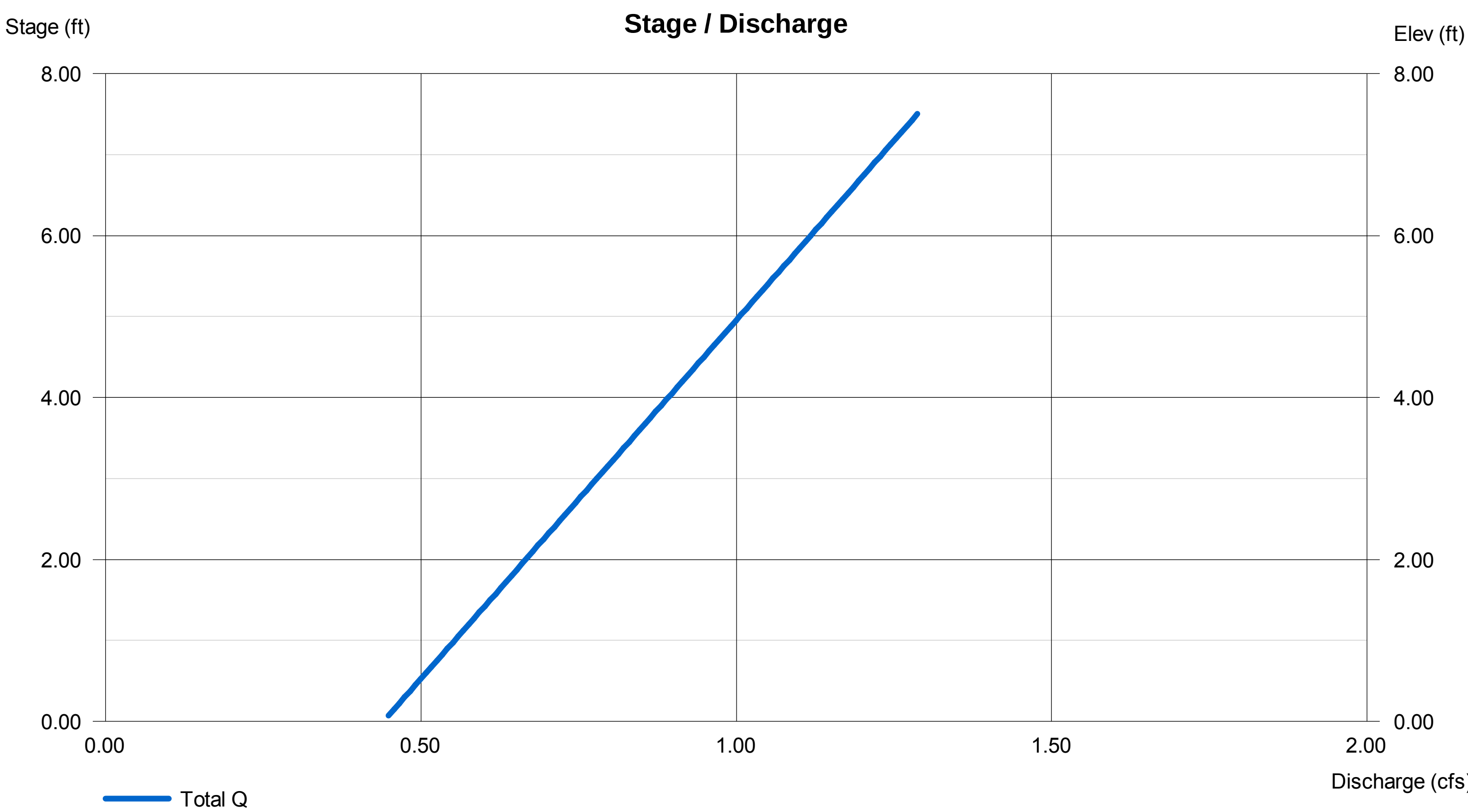
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

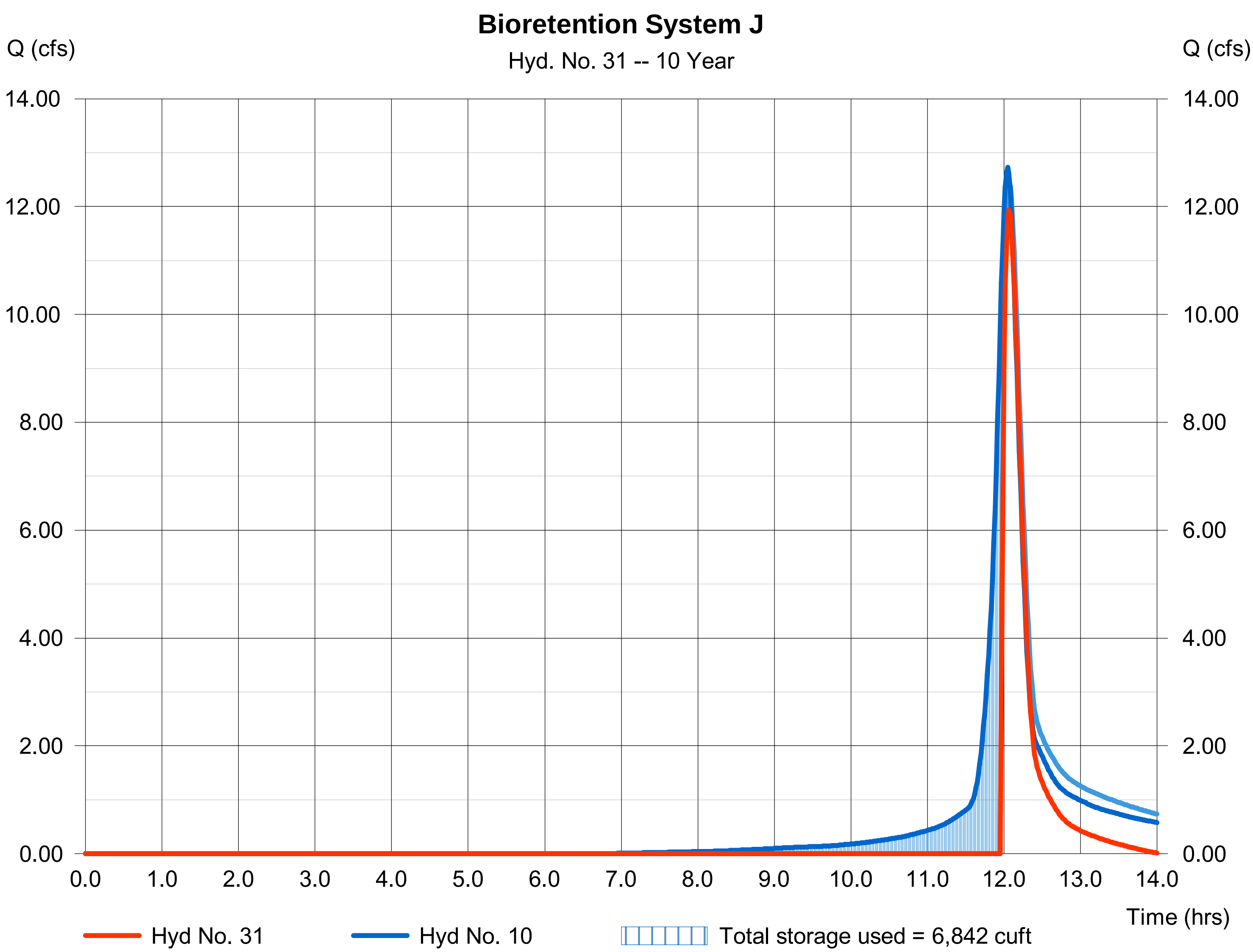
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Hyd. No. 31

Bioretention System J

Hydrograph type	= Reservoir	Peak discharge	= 11.93 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 1 min	Hyd. volume	= 14,089 cuft
Inflow hyd. No.	= 10 - West J	Max. Elevation	= 282.20 ft
Reservoir name	= Bioretention J	Max. Storage	= 6,842 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Pond No. 17 - Bioretention J

Pond Data

Trapezoid -Bottom L x W = 355.0 x 6.0 ft , Side slope = 3.00:1 , Bottom elev. = 280.50 ft , Depth = 2.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	280.50	2,130	0	0
0.20	280.70	2,565	469	469
0.40	280.90	3,002	557	1,026
0.60	281.10	3,443	644	1,670
0.80	281.30	3,886	733	2,403
1.00	281.50	4,332	822	3,225
1.20	281.70	4,781	911	4,136
1.40	281.90	5,233	1,001	5,138
1.60	282.10	5,688	1,092	6,230
1.80	282.30	6,145	1,183	7,413
2.00	282.50	6,606	1,275	8,688

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

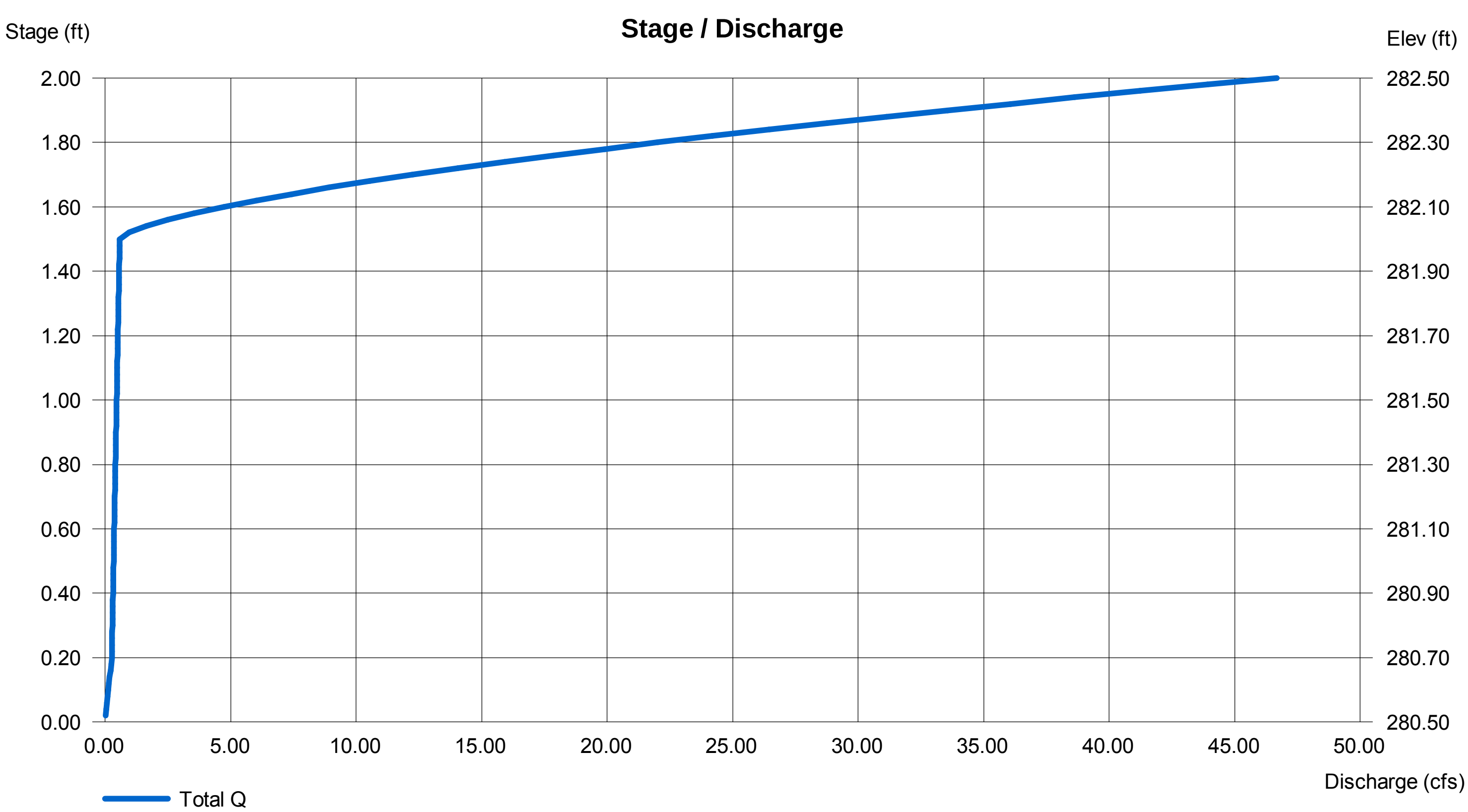
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 50.00	0.00	0.00	0.00
Crest El. (ft)	= 282.00	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

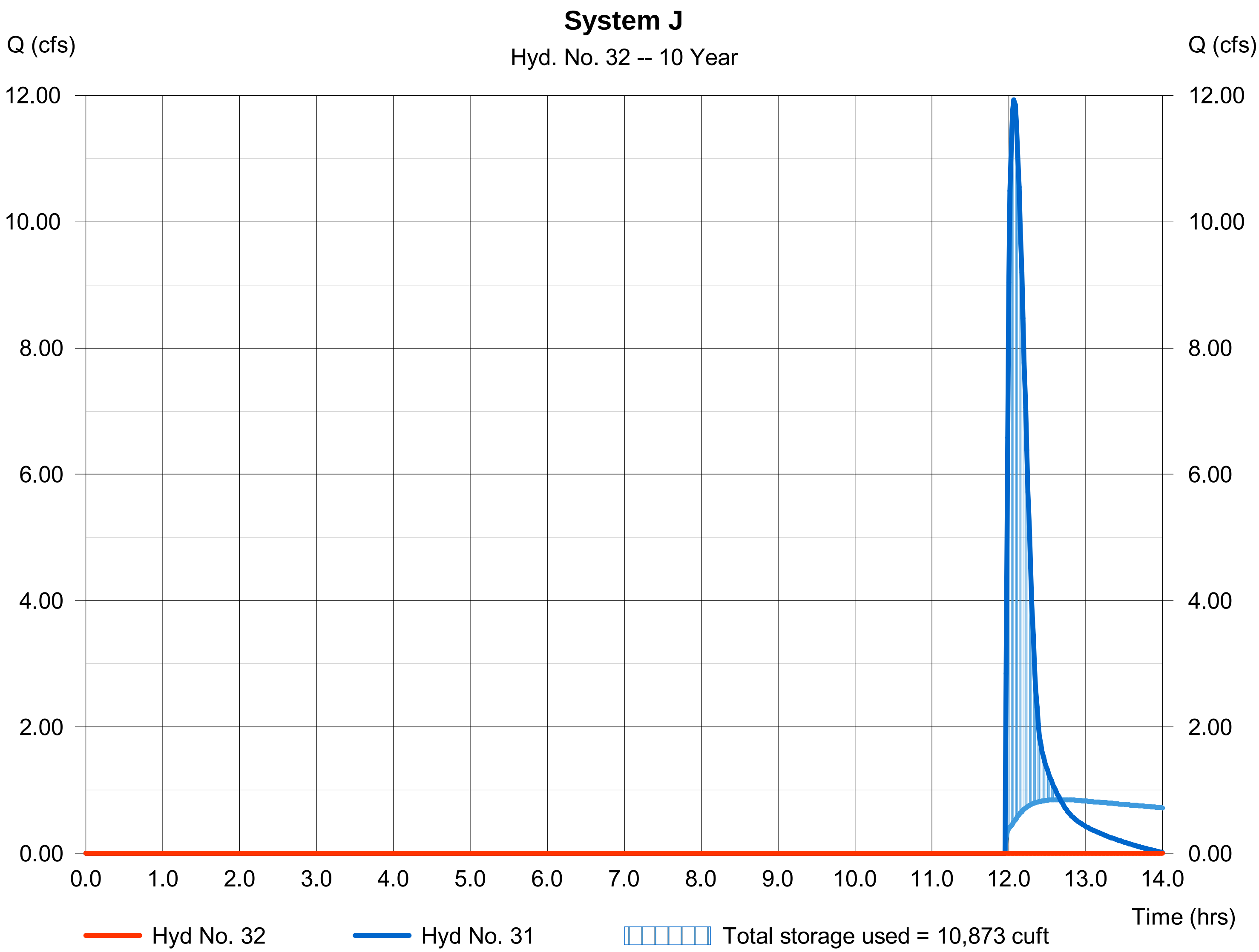
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Friday, Jan 20, 2012

Hyd. No. 32

System J

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 31 - Bioretention System J	Max. Elevation	= 5.30 ft
Reservoir name	= Porous Pavement West J	Max. Storage	= 10,873 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Friday, Jan 20, 2012

Pond No. 11 - Porous Pavement West J

Pond Data

UG Chambers - Invert elev. = 0.01 ft , Rise x Span = 4.67 x 3.33 ft , Barrel Len = 449.00 ft , No. Barrels = 1 , Slope = 0.00% , Headers = No
Encasement - Invert elev. = 0.00 ft , Width = 7.60 ft, Height = 5.50 ft, Voids = 35.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	0.00	n/a	0	0
0.55	0.55	n/a	1,182	1,182
1.10	1.10	n/a	1,192	2,374
1.65	1.65	n/a	1,192	3,565
2.20	2.20	n/a	1,192	4,757
2.75	2.75	n/a	1,192	5,949
3.30	3.30	n/a	1,192	7,140
3.85	3.85	n/a	1,192	8,332
4.40	4.40	n/a	1,192	9,523
4.95	4.95	n/a	929	10,453
5.50	5.50	n/a	657	11,110

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .012	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 4.500 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).