PIONEER DESIGN GROUP

Preliminary Storm Drainage Report

Riverside at Cedar Creek

Washington County, Oregon

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Sherwood Casefile No:

REGISTERED PROFESSIONAL ENGINEER
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OREGON
JAN. 09, 2007
GEOFF A. MIHALKO

VALID THROUGH 12–31–20

Date: February 8, 2020
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Reviewed by: Geoff A. Mihalko, PE
PDG Job No. 131-025

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TECHNICAL APPENDIX

1.0 INTRODUCTION

This report represents the preliminary storm drainage and storm water analysis for the Riverside at Cedar Creek project. The basis of this report is to comply with City of Sherwood, Clean Water Services (CWS), and the State of Oregon's regulations and engineering standards as well as the latest edition of the Oregon Plumbing Specialty Code (OPSC). Compiled in this report are the design criteria for the site, the hydrologic methodology, and the preliminary drainage analysis.

2.0 SITE DESCRIPTION AND LOCATION

The proposed project is a 28-Lot Single-Family Detached Residential Subdivision located on the north side of SW Brookman Road and approximately 50 feet east of its intersection with SW Oberst Rd in the City of Sherwood. The subject site is approximately 10.47 acres and is specifically identified as Tax Lot 104 of Tax Map 3S1 06. The property is zoned Medium Density Residential Low (MDRL).

3.0 EXISTING CONDITIONS

The site currently contains a single-family detached home, plus associated residential accessory structures and outbuildings. The north end of the site is used primarily as pasture for livestock, storage for landscaping materials and a small horse corral. The southern end of the site is forested with a riparian forested community along Cedar Creek and a short tributary flowing north from SW Brookman Road to a confluence with Cedar Creek in the middle of the site. The plan for the site includes removal of all existing structures to facilitate construction of the development.

3.1 Site Topography

The site topography slopes from the north and south ends to the middle of site along the Cedar Creek riparian corridor. The forested slopes from Cedar Creek and the small tributary in south end range from 20 percent to 42 percent. The topography at the north end is generally flat within the pasture areas with a small depression in the northwest corner. The site currently drains to Cedar Creek running through the center of the project which conveys storm water easterly and then north eventually releasing into the Tualatin River.

3.2 Soil Type

The predominant soils mapped on site with a corresponding hydrologic soil group (HSG) designation are listed below and shown on the attached Natural Resources Conservation Service (NRCS) soil survey for Washington County.

Table 3.2 – NRCS SOIL GROUPS		
Map Unit Name	**Map Unit Symbol**	**HSG Rating**
Aloha Silt Loam	1	C/D
Wapato Silty Clay Loam	43	C/D
Willamette Silt Loam, 3 to 7 percent slopes	44B	B
Woodburn Silt Loam, 3 to 7 percent slopes	45B	C
Verboort Silt Loam, 0 to 3 percent slopes	2027A	D

3.3 Runoff Curve Numbers

Based on the various soil and cover types existing throughout the site, a composite Predeveloped runoff curve number (RCN) of 70 will be used for pervious areas. While Table 3.2 above shows all of the soils on-site, we are only proposing to develop a portion of the site due to the riparian corridor, therefore only those soils located in our developed area have been used in our analysis. Those two soils are Map Unit 1 – Aloha Silt Loam with a hydrologic soil group rating of 'C', and Map Unit 45B - Woodburn Silt Loam at 3 to 7 percent slopes, also with a hydrologic soil group rating of 'C'.

Developed pervious areas represent a runoff curve number (RCN) of 79 for "Open Space" cover type in fair hydrologic condition, relative to HSG 'C'. A runoff curve number of 98 will be used for all predeveloped and developed impervious areas (refer to the *Runoff Curve Numbers (TR-55)* and *NRCS Soil Survey*).

Table 3.3 – RUNOFF CURVE NUMBERS		
Land Description	**Existing RCN**	**Proposed RCN**
Open Space, Good Hydrologic Condition	-	79
Meadows & Woods, Good Hydrologic Condition	70	-
Impervious	98	98

4.0 PROPOSED IMPROVEMENTS

Impervious surfaces will be created as a result of public and private streets and sidewalks along with the eventual homes and driveways. The proposed development will create approximately 114,406 square feet (2.63 acres) of impervious area, which comprise 47.9% of the proposed developed area. Public utilities will be extended throughout the site for use by the proposed lots.

Flows generated by the site will be conveyed to a storm water facility which will outfall to Cedar Creek. All proposed improvements are to be elevated out of the existing 100-year flood plain.

4.1 Hydrology/Hydraulic Methodology

Using the Santa Barbara Urban Hydrograph (SBUH) runoff method based on a Type 1A rainfall distribution, the site has been analyzed to determine the proposed peak runoff rates for the water quality storm, 2, 10, and 25-year 24-hour storm events. The SBUH method uses runoff curve numbers in conjunction with the property's hydrologic soil group to model the site's permeability.

A pre-developed time of concentration of 23.51 minutes and a developed time of concentration of 11.6 minutes were calculated using the methodology outlined in the TR-55 technical manual *(refer to the Time of Concentration Calculations and Exhibits)*.

Rainfall depths for all storm events used in the calculations and design of the proposed storm drainage system are found in latest edition of Clean Water Services (CWS) Design and Construction Standards and as shown below.

Table 4.1 – 24-Hour Rainfall Depths (CWS)

Recurrence Interval, Years	2	5	10	25	100
24-Hour Depths, Inches	2.50	3.10	3.45	3.90	4.50

4.2 Water Quality

As required by Clean Water Services, we will treat runoff from any new impervious surface created as a result of the proposed development. All water quality structures shall be designed to treat storm water generated by 0.36 inches of precipitation falling in 4 hours with an average storm return period of 96 hours. The water quality facilities, in conjunction with the sumped catch basins and a water quality manhole will remove a minimum of 65% of the Total Phosphorous (TP) from the storm water runoff.

Based on the CWS R&O 19-22 Section 4.08.1.d.1, the code requires treating all new impervious surface plus three times the modified impervious surface up to the total existing impervious surface. In this case we will be removing and replacing all of the existing impervious area on site, therefore we will be treating all of our new impervious surface as well as the total existing removed and replaced impervious surface on site.

Stormwater runoff from Riverside at Cedar Creek will convey stormwater to a proposed water quality pond designed to accommodate water quality treatment for the proposed subdivision per the water quality pond design below:

Table 4.2 - WATER QUALITY POND
• *Minimum Pond Volume =3,437 ft^3*
• *Water Quality Depth = 0.45 ft.*
• *Depth = 3.0 ft. max.*
• *Side Slopes = 3:1*
• *Design Inflow = 0.24 ft/s*

4.3 Detention

Per CWS R&O 19-22 Section 4.08.6.c, we are proposing to meet the hydromodification approach by matching (or releasing less than) the developed to ½ the 2-year pre-developed runoff rate, and then matching (or releasing less than) the consecutive 5 and 10-year storm events. The following table summarizes the developed, pre-developed, and released discharges and pond stage storage elevations:

Table 4.3 – APRIL CREST SUBDIVISION – COMBINED HYDROGRAPH (R&O 19-22)

Storm Event (yr)	Developed Discharge (cfs)	Pre-Developed Discharge (cfs)	Actual Released Discharge (cfs)	Water Surface Elevation in Pond (ft.)
2	1.67	0.085 (1/2–2YR)	0.08	188.77
5	2.39	0.41	0.41	188.91
10	2.83	0.61	0.53	188.93

See *Appendix 'A' – Stormwater Detention Facility Report* for complete analysis.

4.4 Conveyance

The conveyance system for the site consists of an underground pipe system with sumped and flow through catch basins. Stormwater will be conveyed through the site via a series of pipes and routed through the stormwater facility before being discharged into Cedar Creek.

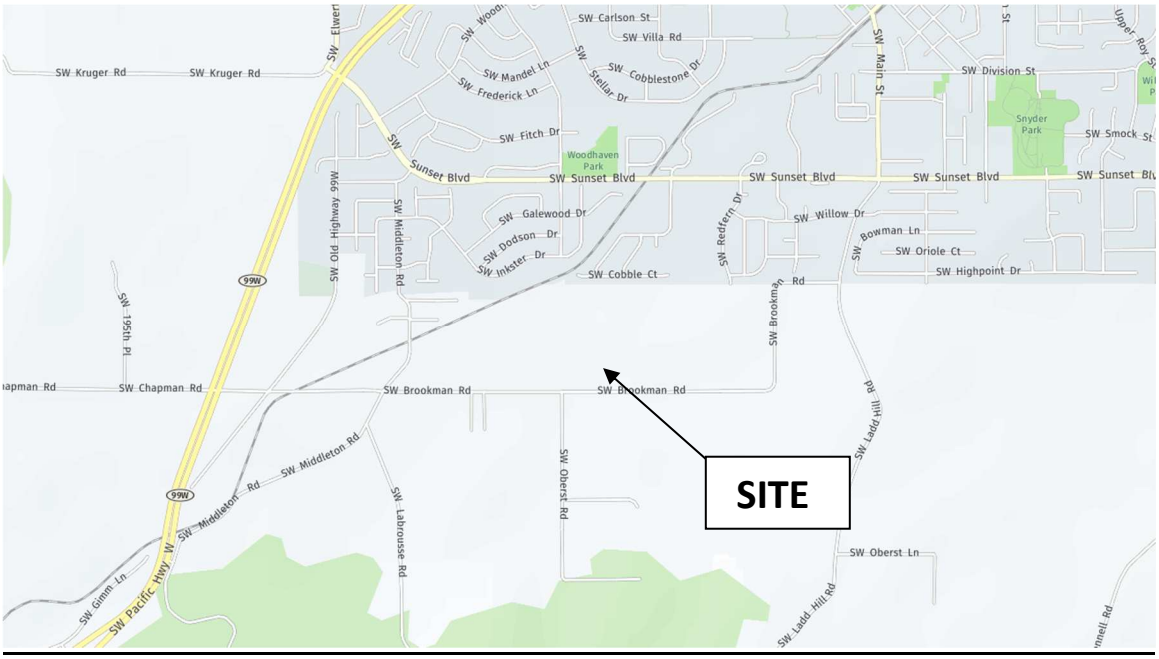
A water quality manhole has been installed upstream of the facility to provide the required stormwater pretreatment. As per the requirements of Clean Water Services, the drainage system has been designed to convey the 25-year storm event.

Using a Manning's 'n' value of 0.013, the minimum slope required to convey the 25-year storm event for the site in n 18" PVC pipe is 0.0050 ft./ft. (refer to the *Stormwater Conveyance Calculations).*

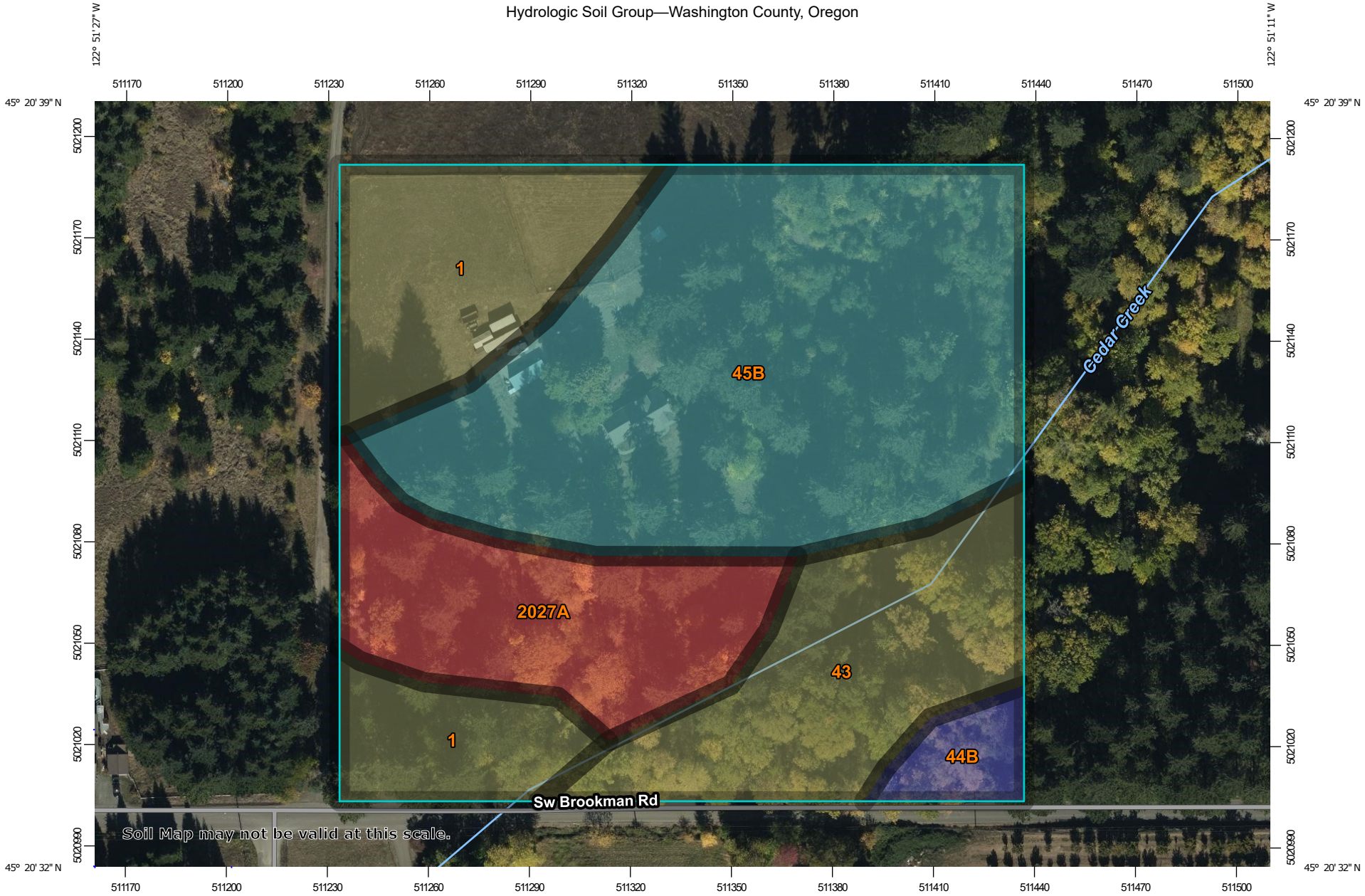
5.0 CONCLUSION

Based on the supporting stormwater calculations and attached analysis, it is the opinion of Pioneer Design Group that the development of the Riverside at Cedar Creek Subdivision project will not adversely affect the existing downstream drainage system or adjacent property owners. Water quality treatment for all new impervious areas created by the development will be treated by an onsite water quality pond and water quantity control is proposed meeting CWS's hydromodification approach. Therefore, all the requirements associated with the City of Sherwood, Clean Water Services' design and construction standards and Washington County have been met for this project.

7.0 VICINITY MAP



ENGINEERING CALCULATONS AND SPREADSHEETS



Map Scale: 1:1,600 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Washington County, Oregon
Survey Area Data: Version 17, Sep 10, 2019

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

Date(s) aerial images were photographed: Sep 19, 2018—Oct 20, 2018

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Aloha silt loam	C/D	1.8	19.3%
43	Wapato silty clay loam	C/D	1.6	17.1%
44B	Willamette silt loam, 3 to 7 percent slopes	B	0.3	2.8%
45B	Woodburn silt loam, 3 to 7 percent slopes	C	4.3	44.9%
2027A	Verboort silty clay loam, 0 to 3 percent slopes	D	1.5	15.9%
Totals for Area of Interest			**9.5**	**100.0%**

Description

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

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

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

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

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

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

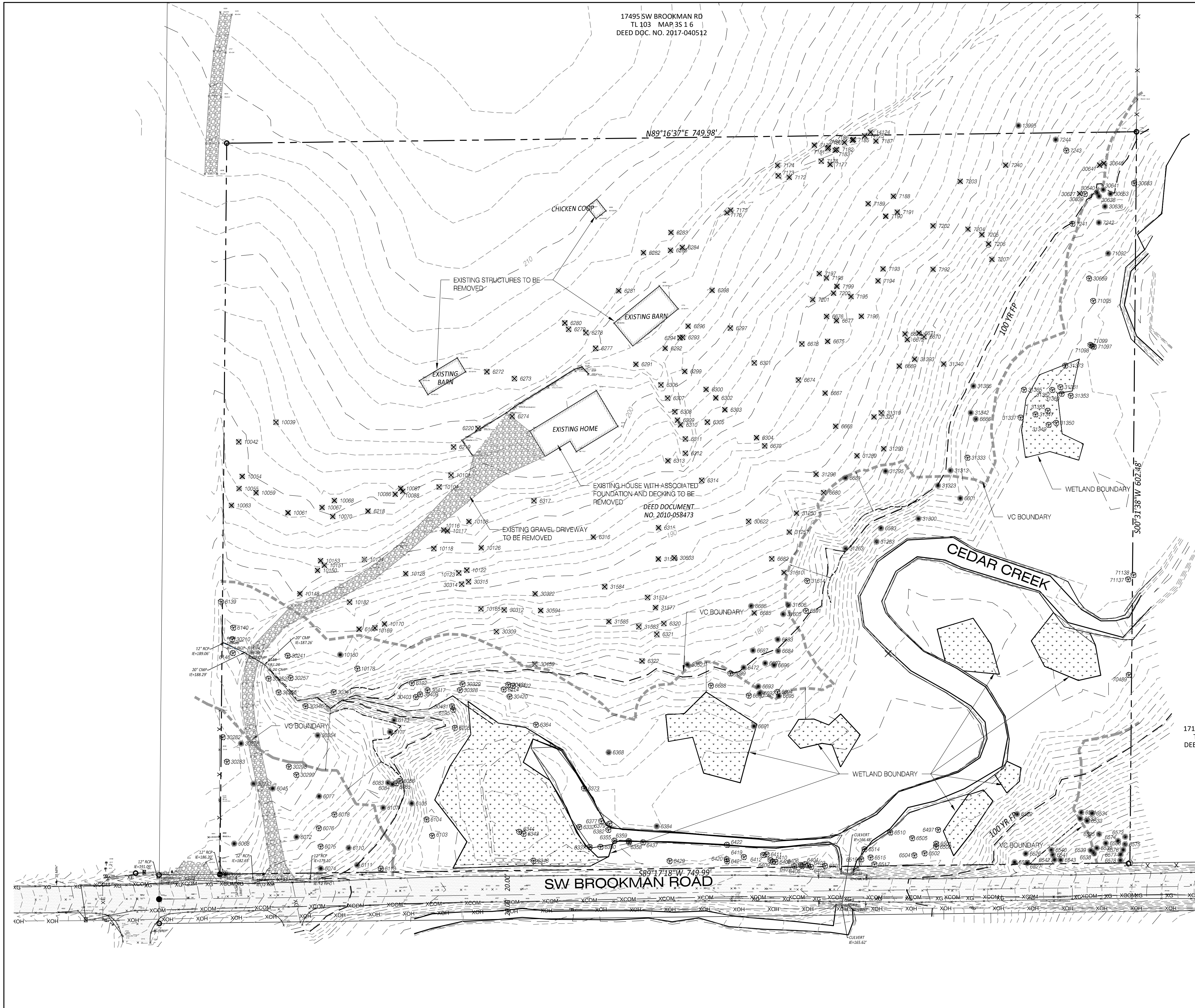
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



LEGEND

- RIGHT-OF-WAY LINE
- BOUNDARY LINE
- EXISTING LOT LINE
- CENTER LINE
- STORM DRAINAGE LINE
- SANITARY SEWER LINE
- WATER LINE
- GAS LINE
- COMMUNICATION LINE
- UNDERGROUND POWER LINE
- OVERHEAD WIRE
- WOOD FENCE (AS NOTED)
- EXISTING 1' CONTOUR
- EXISTING 5' CONTOUR
- CONIFEROUS TREE (DBH)
- DECIDUOUS TREE (DBH)
- CATCH BASIN/DRAIN INLET
- STORM DITCH INLET
- STORM MANHOLE
- SANITARY MANHOLE
- WATER VALVE
- FIRE HYDRANT ASSEMBLY
- WATER METER
- GAS VALVE
- GAS METER
- STREET SIGN
- MAILBOX
- ELECTRIC PEDESTAL
- LIGHT POLE
- POWER POLE
- COMMUNICATION VAULT
- TELECOMMUNICATION PEDESTAL
- UTILITY EXTENSION
- FOUND SURVEY MONUMENT AS NOTED
- EXISTING CONCRETE
- EXISTING ASPHALT PAVEMENT
- EXISTING GRAVEL SURFACE
- EXISTING BUILDING FOOTPRINT
- EXISTING TREE TO BE REMOVED
- -1.0% EXISTING SLOPE DIRECTION

SCALE
40 0 20 40
1 INCH = 40 FEET

PIONEER DESIGN GROUP
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EXISTING CONDITIONS AND DEMOLITION PLAN

SW BROOKMAN RD
CITY OF SHERWOOD, OREGON

Designed by	MLS	Date	2/2020
Drawn by	BDH	Date	2/2020
Reviewed by	MLS	Date	2/2020
Project No.	131-025	REF.	
Horiz. Scale:			
Vert. Scale:			

No.	Date	Revision	By

Project
RIVERSIDE AT CEDAR CREEK
No.
131-025
Type
PLANNING
Sheet
P2

SHERWOOD CASEFILE # ______

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MIDDLEBROOK SUBDIVISION
(BY OTHERS)

SW TRILLIUM LANE

MIDDLEBROOK SUBDIVISION
(BY OTHERS)

12"SD

1 5645 SF
2 5089 SF
3 5127 SF
4 5165 SF
5 5203 SF
6 5240 SF
7 5278 SF
8 5289 SF
9 4835 SF
10 4873 SF
11 5286 SF

TRACT A
OPEN SPACE
3725 SF

TRACT B
OPEN SPACE

TRACT C
PVT
779 SF

8"SS

12"SD

8"W

12 7943 SF
20 7201 SF
19 6550 SF
18 5622 SF
17 5133 SF
16 5040 SF
15 5040 SF
14 5038 SF
13 4831 SF

28

27 4722 SF

26 4889 SF

100 YR FP

TR. COMMUNITY TRAIL

18"SD

SW WAPATO LAKE DR.

TRACT D
PVT
300 SF

25 7953 SF

WETLAND BOUNDARY

VC BOUNDARY

21 5766 SF
22 6486 SF
23 8135 SF
24 7933 SF

TRACT E
STORM FACILITY
13270 SF

CEDAR CREEK

18"SD

COMMUNITY TRAIL

COMMUNITY TRAIL

VC BOUNDARY

TRACT B
OPEN SPACE
202312 SF

WETLAND BOUNDARY

TRACT F
VISUAL CORRIDOR
1926 SF

TRACT G
VIS. CORR.
594 SF

100 YR FP

VC BOUNDARY

SW BROOKMAN ROAD

LEGEND

- PROPOSED EASEMENT LINE
- PROPOSED CENTERLINE
- PROPOSED RIGHT-OF-WAY
- PROPOSED LOT LINE
- BOUNDARY LINE
- PROPOSED CONCRETE SIDEWALK
- PROPOSED PAVEMENT
- PROPOSED STANDARD CURB
- PROPOSED STORM LINE & MANHOLE
- PROPOSED SANITARY LINE & MANHOLE
- PROPOSED 1" WATER SERVICE & METER
- PRELIMINARY STREET LIGHT LOCATIONS

SCALE
40 0 20 40
1 INCH = 40 FEET

SHERWOOD CASEFILE # ____

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PRELIMINARY COMPOSITE UTILITY PLAN

SW BROOKMAN RD
CITY OF SHERWOOD, OREGON

Designed by	MLS	Date	2/2020
Drawn by	BDH	Date	2/2020
Reviewed by	MLS	Date	2/2020
Project No.	131-025	REF.	
Horiz. Scale:			
Vert. Scale:			

No.	Date	Revision	By

Project
RIVERSIDE AT CEDAR CREEK
No.
131-025
Type
PLANNING
Sheet
P10

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SOIL FEATURES FOR WASHINGTON COUNTY

Soil name and map symbol	Hydro-logic group	Flooding		
		Frequency	Duration	Months
Aloha:				
1	C	NONE	NONE	NONE
Amity:				
2	C	NONE	NONE	NONE
Astoria:				
3E, 3F	B	NONE	NONE	NONE
Briedwell:				
4B, 5B, 5C, 5D	B	NONE	NONE	NONE
Carlton:				
6B, 6C	B	NONE	NONE	NONE
Cascade:				
7B, 7C, 7D, 7E, 7F	C	NONE	NONE	NONE
Chehalem:				
8C	C	NONE	NONE	NONE
Chehalis:				
9, 10	B	COMMON	BRIEF	NOV-MAR
Cornelius:				
11B, 11C, 11D, 11E, 11F:				
Cornelius part	C	NONE	NONE	NONE
Kinton part	C	NONE	NONE	NONE
Cornelius Varient:				
12A, 12B, 12C	C	NONE	NONE	NONE
Cove:				
13, 14	D	COMMON	BRIEF	DEC-APR
Dayton:				
15	D	NONE	NONE	NONE
Delena:				
16C	D	NONE	NONE	NONE
Goble:				
17B, 17C, 17D, 17E, 18E, 18F	C	NONE	NONE	NONE
Helvetia:				
19B, 19C, 19D, 19E	C	NONE	NONE	NONE
Hembre:				
20E, 20F, 20G	B	NONE	NONE	NONE
Hillsboro:				
21A, 21B, 21C, 21D	B	NONE	NONE	NONE
Hubberly:				
22	D	NONE	NONE	NONE
Jory:				
23B, 23C, 23D, 23E, 23F	C	NONE	NONE	NONE
Kilchis:				
24G				
Kilchis part	C	NONE	NONE	NONE
Klickitat part	B	NONE	NONE	NONE

SOIL FEATURES FOR WASHINGTON COUNTY

Soil name and map symbol	Hydro-logic group	Flooding		
		Frequency	Duration	Months
Klickitat:				
25E, 25F, 25G	B	NONE	NONE	NONE
Knappa:				
26	B	NONE	NONE	NONE
Lablish:				
27	D	FREQUENT	VERY LONG	DEC - APR
Laurelwood:				
28B, 28C, 28D, 28E, 29E, 29F	B	NONE	NONE	NONE
McBee:				
30	B	FREQUENT	BRIEF	NOV - MAY
Melborne:				
31B, 31C, 31D, 31E, 31F	B	NONE	NONE	NONE
Melby:				
32C, 32D, 32E, 33E, 33F, 33G	C	NONE	NONE	NONE
Olyic:				
34C, 34D, 34E, 35E, 35F, 35G	B	NONE	NONE	NONE
Pervina:				
36C, 36D, 36E, 36F	C	NONE	NONE	NONE
Quatama:				
37A, 37B, 37C, 37D	C	NONE	NONE	NONE
Saum:				
38B, 38C, 38D, 38E, 38F	C	NONE	NONE	NONE
Tolke:				
39E, 39F	B	NONE	NONE	NONE
Udifluvents:				
40	B	FREQUENT	VERY LONG	NOV - APR
Verboot:				
42	D	FREQUENT	BRIEF	DEC - APR
Wapato:				
43	D	FREQUENT	BRIEF	DEC - APR
Willamette:				
44A, 44B, 44C, 44D	B	NONE	NONE	NONE
Woodburn:				
45A, 45B, 45C, 45D	C	NONE	NONE	NONE
Xerchrepts:				
46F				
Xerochrepts part	B	NONE	NONE	NONE
Haploxerolls part	C	NONE	NONE	NONE
47D				
Xerochrepts part	D	NONE	NONE	NONE
Rock outcrop part				

RUNOFF CURVE NUMBERS (TR55)

Table 2-2a: Runoff curve numbers for urban areas [1]

Cover description		CN for hydrologic soil group				
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D	
Fully developed urban areas (vegetation established)						
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:						
Poor condition (grass cover <50%)		68	79	86	89	
Fair condition (grass cover 50% to 75%)		49	69	79	84	POST
Good condition (grass cover >75%)		39	61	74	80	
Impervious areas:						
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98	
Streets and roads:						
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98	
Paved; open ditches (including right-of-way)		83	89	92	93	
Gravel (including right-of-way)		76	85	89	91	
Dirt (including right-of-way)		72	82	87	89	
Western desert urban areas:						
Natural desert landscaping (pervious areas only) [4]		63	77	85	88	
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96	
Urban districts:						
Commercial and business	85	89	92	94	95	
Industrial	72	81	88	91	93	
Residential districts by average lot size:						
1/8 acre or less (town houses)	65	77	85	90	92	
1/4 acre	38	61	75	83	87	
1/3 acre	30	57	72	81	86	
1/2 acre	25	54	70	80	85	
1 acre	20	51	68	79	84	
2 acres	12	46	65	77	82	
Developing urban areas						
Newly graded areas (pervious areas only, no vegetation) [5]	77	86	91	94		
Idle lands (CNs are determined using cover types similar to those in table 2-2c)						

1: Average runoff condition, and $I_a = 0.2S$.

2: The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas hava a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3: CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4: Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5: Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

RUNOFF CURVE NUMBERS (TR55)

Table 2-2c: Runoff curve numbers for other agricultural lands [1]

Cover description		Curve numbers for hydrologic soil group				
Cover type	Hydrologic condition	A	B	C	D	
Pasture, grassland, or range -- continuous forage for grazing						
<50% ground cover or heavily grazed with no mulch.	Poor	68	79	86	89	
50% to 75% ground cover and not heavily grazed.	Fair	49	69	79	84	
>75% ground cover and lightly or only occasionally grazed.	Good	39	61	74	80	
Meadow -- continuous grass, protected from grazing and generally mowed for hay	--	30	58	71	78	PRE
Brush – weed-grass mixture with brush as the major element						
<50% ground cover	Poor	48	67	77	83	
50% to 75% ground cover	Fair	35	56	70	77	
>75% ground cover	Good	30 [2]	48	65	73	
Woods – grass combination (orchard or tree farm) [3]	Poor	57	73	82	86	
	Fair	43	65	76	82	
	Good	32	58	72	79	
Woods						
Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.	Poor	45	66	77	83	
Woods are grazed but not burned, and some forest litter covers the soil.	Fair	36	60	73	79	
Woods are protected from grazing, and litter and brush adequately cover the soil.	Good	30 [2]	55	70	77	PRE
Farmsteads -- buildings, lanes, driveways, and surrounding lots	--	59	74	82	86	

1: Average runoff condition, and $I_a = 0.2S$.

2: Actual curve number is less than 30; use CN = 30 for runoff computations.

3: CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

PIONEER DESIGN GROUP

EXISTING CONDITIONS - PERVIOUS COMPOSITE CURVE NUMBERS

JOB NUMBER: 131-025
PROJECT: Riverside at Cedar Creek
FILE: 131-025_Preliminary Hydro.xls

TOTAL AREA= 238,944 SF

EXISTING CONDITIONS

COVER TYPE	SOIL TYPE	AREA (SF)	SOIL GRADE	CURVE NUMBER
MEADOWS	1 Aloha silt loam	87,176	C/D	71
WOODS "GOOD CONDITION"	45B Woodburn silt loam	151,768	C	70

EXISTING COMPOSITE CN (PERVIOUS) = $\frac{(109{,}447 \times 71) + (130569 \times 84)}{238{,}944}$ = **70**

MANNING'S "n" VALUES

SHEET FLOW EQUATION MANNING'S VALUES	n_s
Smooth Surfaces (concrete, asphault, gravel, or bare hand packed soil)	0.011
Fallow Fields or loose soil surface (no residue)	0.05
Cultivated soil with residue cover (≤ 20%)	0.06
Cultivated soil with residue cover (> 20%)	0.17
Short prairie grass and lawns	0.15
Dense grasses	0.24
Bermuda grasses	0.41
Range (natural)	0.13
Woods or forrest with light underbrush	0.40
Woods or forrest with dense underbrush	0.80

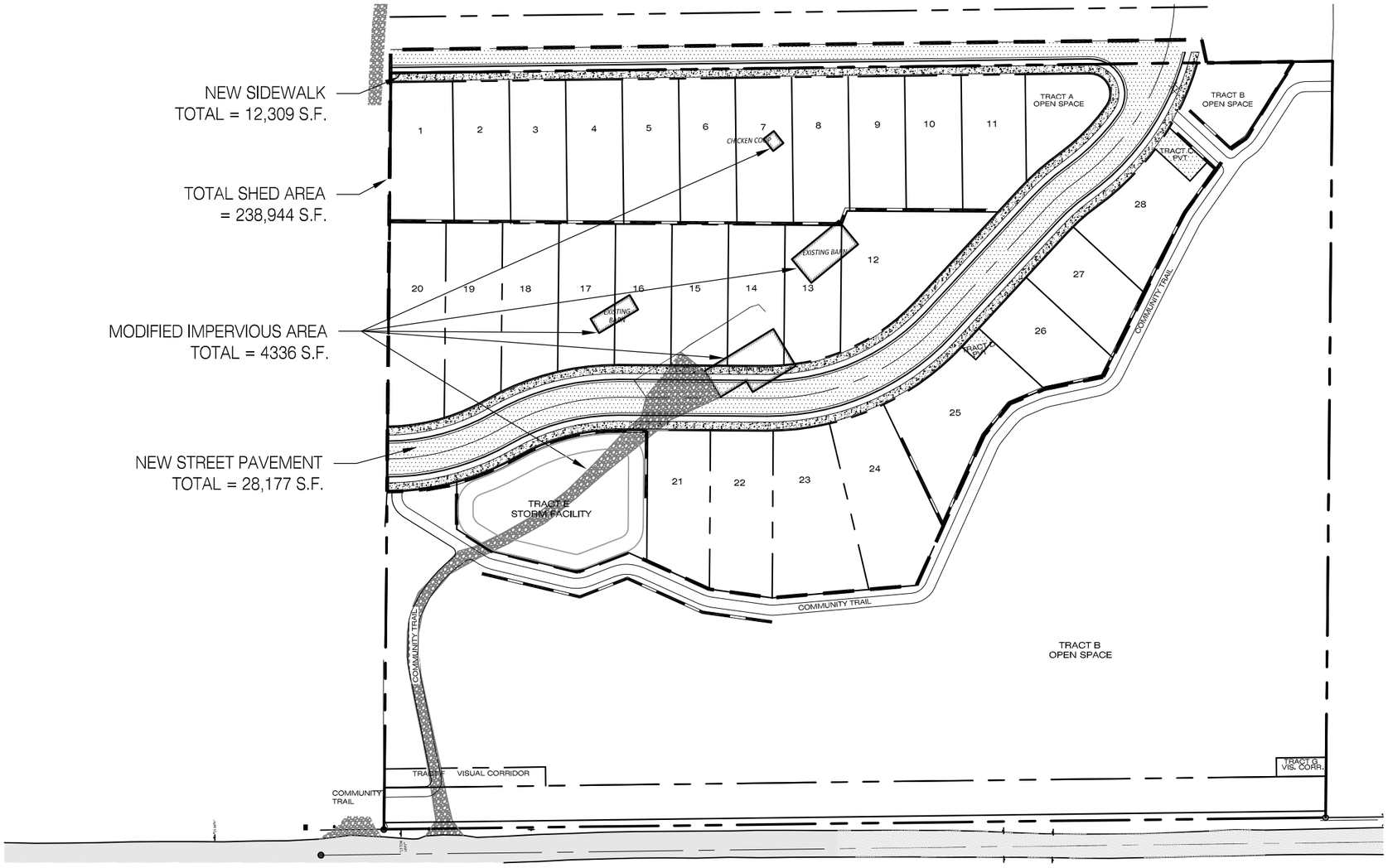
SHALLOW CONCENTRATED FLOW (after initial 300 ft of sheet flow, R = 0.1)	k_s
Forest with heavy ground litter and meadows (n = 0.010)	3
Brushy ground with some trees (n = 0.060)	5
Fallow or minimum tillage cultivation (n = 0.040)	8
High grass (n = 0.035)	9
Short grass, pasture and lawns (n = 0.030)	11
Nearly bare ground (n = 0.25)	13
Paved and gravel areas (n = 0.012)	27

CHANNEL FLOW (Intermittent) (At the beginning of all visible channels, R = 0.2)	k_c
Forested swale with heavy ground cover (n = 0.10)	5
Forested drainage course/ravine with defined channel bed (n = 0.050)	10
Rock-lined waterway (n = 0.035)	15
Grassed waterway (n = 0.030)	17
Earth-lined waterway (n = 0.025)	20
CMP pipe (n = 0.024)	21
Concrete pipe (n = 0.012)	42
Other waterways and pipe 0.508/n	

CHANNEL FLOW (continuous stream, R = 0.4)	k_c
Meandering stream (n = 0.040)	20
Rock-lined stream (n = 0.035)	23
Grass-lined stream (n = 0.030)	27
Other streams, man-made channels and pipe (n = 0.807/n)	

IMPERVIOUS AREA

RIVERSIDE AT CEDAR CREEK



PROPOSED IMPERVIOUS AREA

NEW SIDEWALK PAVEMENT:	12,309 S.F.
NEW STREET PAVEMENT:	28,177 S.F.
PRIVATE LOTS:	73,920 S.F.
TOTAL IMPERVIOUS:	114,406 S.F.

MODIFIED IMPERVIOUS AREA

MODIFIED AREA:	4,336 S.F.

TOTAL AREA

TOTAL SHED AREA:	238,944 S.F.
TOTAL SITE AREA:	451,690 S.F.

SCALE
100 0 50 100
1 INCH = 100 FEET

PIONEER DESIGN GROUP
CIVIL ENGINEERING • LAND USE PLANNING • LAND SURVEYING • LANDSCAPE ARCHITECTURE
PORTLAND, OREGON | HONOLULU, HAWAII
PH: 503.643.8286 PH: 808.753.2376
WWW.PD-GRP.COM

Designed by	GAM	Date	3/2020
Drawn by	CFS	Date	3/2020
Reviewed by	GAM	Date	3/2020
Project No.	131-025	REF.	
Horiz. Scale:			
Vert. Scale:			

Project
RIVERSIDE AT CEDAR CRK
No.
131-025
Type
PLANNING
Sheet
1 of 1

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PIONEER DESIGN GROUP

IMPERVIOUS AREA CALCULATIONS

JOB NUMBER: 131-025
PROJECT: Riverside at Cedar Creek
FILE: 131-025_Preliminary Hydro.xls

PROPOSED IMPERVIOUS AREA

28 LOTS AT 2,640-SF IMPERVIOUS AREA / LOT	73,920.00 ft^2	
SIDEWALKS	12,309.00 ft^2	
STREET PAVEMENT	28,177.00 ft^2	
	114,406.00 ft^2	**2.63 ac**

MODIFIED IMPERVIOUS AREA

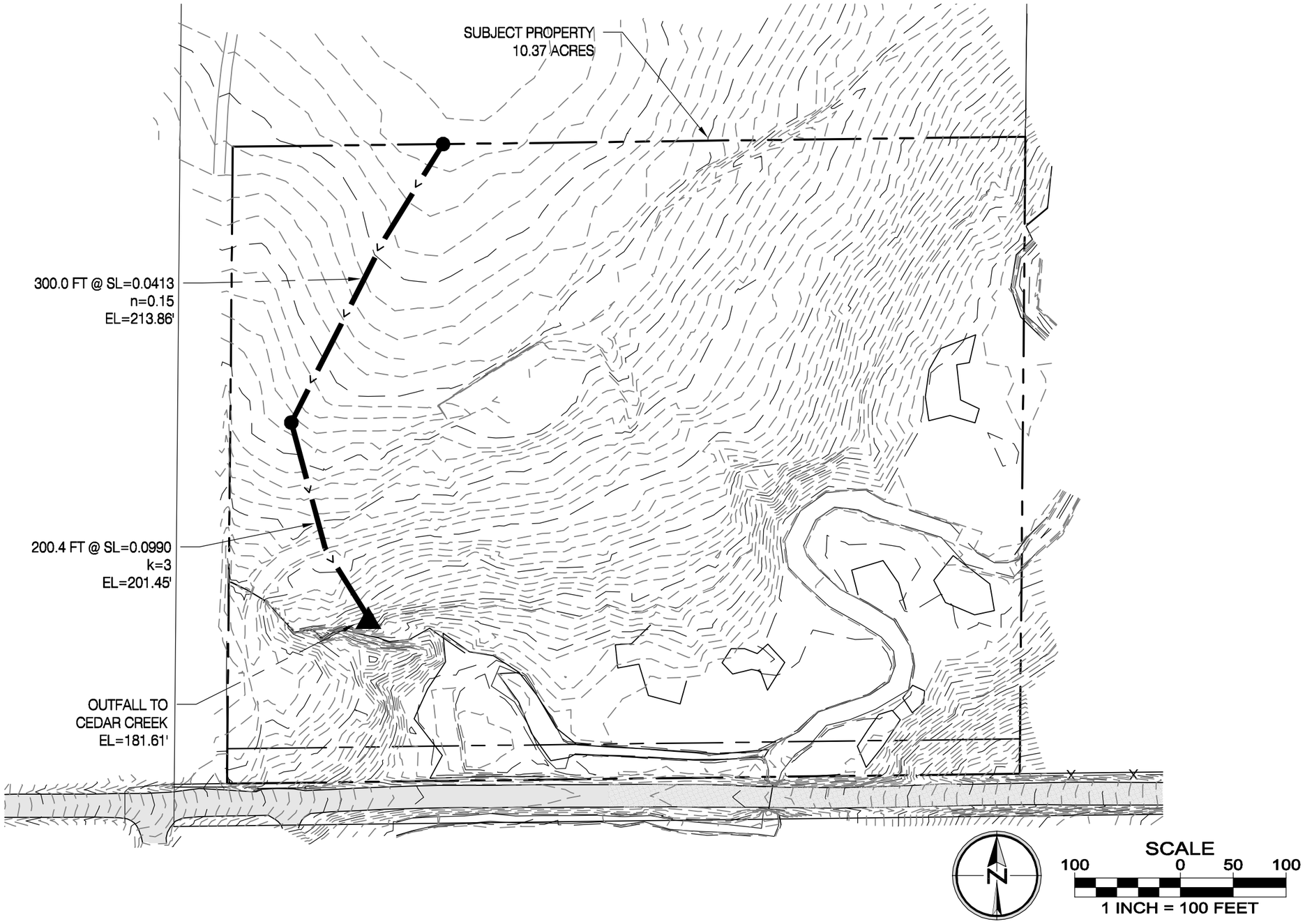
BUILDINGS	488.00 ft^2	
SIDEWALKS	0.00 ft^2	
GRAVEL AT 60% IMPERVIOUS	3,848.00 ft^2	
STREET PAVEMENT	0.00 ft^2	
	4,336.00 ft^2	**0.10 ac**

NEW IMPERVIOUS AREA	**110,070.00 ft^2**	**2.53 ac**

Total Shed Area	**238,944.00 ft^2**	**5.49 ac**
Existing Impervious Area	**4,336.00 ft^2**	**0.10 ac**
% Impervious		**1.8 %**
Proposed Impervious Area	**114,406.00 ft^2**	**2.63 ac**
% Impervious		**47.9 %**

PREDEVELOPED TIME OF CONCENTRATION

RIVERSIDE AT CEDAR CREEK



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PIONEER DESIGN GROUP
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PORTLAND, OREGON | HONOLULU, HAWAII
PH: 503.643.8286 PH: 808.753.2376
WWW.PD-GRP.COM

Designed by	GAM	Date	2/2020
Drawn by	CFS	Date	2/2020
Reviewed by	GAM	Date	2/2020
Project No.	131-025	REF.	
Horiz. Scale:			
Vert. Scale:			

Project
BROOKMAN

No.
131-025

Type
PLANNING

Sheet
1 of 1

PIONEER DESIGN GROUP

PREDEVELOPED TIME OF CONCENTRATION

JOB NUMBER: 131-025
PROJECT: Riverside at Cedar Creek
FILE: 131-025_Preliminary Hydro.xls

				Accum. Tc
LAG ONE: SHEET FLOW (FIRST 300 FEET)				
Tt = Travel time				
Manning's "n " =	0.15			
Flow Length, L =	300	ft	(300 ft. max.)	
P = 2-year, 24hr storm =	2.5	in		
Slope, S_0 =	0.041	ft/ft		
$T_T = \frac{(0.42)(n * L)^{0.8}}{(P)^{0.5}(S_0)^{0.4}}$	19.97	min.		19.97 min.
LAG TWO: SHALLOW CONCENTRATED FLOW (NEXT 200.4 FEET)				
Tc Velocity factor, k=	3			
Slope, S_0 =	0.099	ft/ft		
$V = k\sqrt{S_o}$	0.94	ft/s		
Flow Length, L =	200.4	ft		
$T = \frac{L}{(60)(V)}$	3.54	min.		23.51 min.

TOTAL PREDEVELOPED TIME OF CONCENTRATION (Tc) = 23.51 min.

PIONEER DESIGN GROUP

DEVELOPED TIME OF CONCENTRATION

JOB NUMBER: 131-025
PROJECT: Riverside at Cedar Creek
FILE: 131-025_Preliminary Hydro.xls

Catchment Time	5	min.
Longest Run of Pipe	1187	ft
Velocity of Flow	3	ft/s
Time in Pipe = (1187 ft)/(3.00 ft/s) =	396	s
TOTAL DEVELOPED Tc =	**11.6**	**min.**

PIONEER DESIGN GROUP

WATER QUALITY POND CALCULATIONS

JOB NUMBER: 131-025
PROJECT: Riverside at Cedar Creek
FILE: 131-025_Preliminary Hydro.xls

REFERENCES:
1. Clean Water Services R&O 07-20.
2. Discussions with Clean Water Services.

REQUIRED WATER QUALITY TREATMENT: 65% Phosphorus Removal.

PROPOSED TREATMENT METHODS:

1. Sumped Catch Basins		15%
2. Water quality Pond		50%
	total	65%

DESIGN STORM

Precipitation:	0.36	inches
Storm Duration:	4	hours
Storm Return Period:	96	hours
Storm Window:	2	weeks

IMPERVIOUS AREA:

Watershed Area:	5.49	acres
Percent imp:	47.88	%
Impervious Area:	2.63	acres

Design Inflow = (2.63 ac)*(43560 ft^2/ac)*(0.36 in / 4.0 hrs) = **0.24 cfs**

VOLUME CALCULATION:

POND VOLUME = (2.63 acres)(43560 sqft/acre)(0.36 inch)/(12 in/ft) = **3,437 ft^3**

POND PARAMETERS:

Storage Volume (Sd)=	3,437	ft^3
Storage Depth (Hd)=	3	ft (3' maximum)
Side Slopes =	3	:1

SOLVE FOR BOTTOM AREA:

Bottom Area (Ab) = 558 ft^2

STAGE VS STORAGE CALCULATIONS:

Stage, H* ft	Storage, S(H) ft^3	Water Surface Area S.F.
0.0	0.0	558.3
0.5	316.9	709.1
1.0	718.1	877.9
1.5	1217.3	1064.7
2.0	1827.8	1269.4
2.5	2563.2	1492.2
3.0	3437.0	1733.0
3.5	4462.7	1991.8
4.0	5653.8	2268.5
4.5	7023.7	2563.3
5.0	8586.1	2876.1

POND OUTLET ORIFICE CALCULATIONS:

Q = (3,437 ft3)/(48 hrs)/(60 min/hrs)/(60 s/min)= 0.02 cfs

h = average hydraulic head = 48 inches below high flow

A = 0.00 ft^2

$A = \pi r^2$

r = 0.03 ft. radius

d = 2r

d = 0.61 in. diameter, use **6/8 " orifice**

PIONEER DESIGN GROUP

WATER QUALITY MANHOLE
(SUMP CALCULATION)

JOB NUMBER: 131-025
PROJECT: Riverside at Cedar Creek
FILE: 131-025_Preliminary Hydro.

Q_{25}	=	**3.39 cfs**	
V_{REQ}	=	$^{20\ CF}/_{1\ CFS}$	
V_{REQ}	=	67.8	cf
WQ MH Radius	=	2.5	ft

Volume for a 60" Manhole
36" min. to 60" max. sump depth

$$V = H \times \pi r^2$$

(depth of sump)	H	=	4.0	ft
(radius of manhole)	r	=	2.5	ft
	V	=	78.5	ft^3

Is 78.5 cf > 67.8 cf ✓

PIONEER DESIGN GROUP

STORMWATER CONVEYANCE CALCULATIONS

JOB NUMBER: 131-025
PROJECT: Riverside at Cedar Creek
FILE: 131-025_Preliminary Hydro.xls

Design Storm: 25 YR
Storm Duration: 24 HRS
Precipitation: 3.9 IN
Manning's "n" 0.013

LINE	INC. AREA (AC)	AREA TOTAL (AC)	% IMP.	AREA PERV. (AC)	CN PER.	AREA IMP. (AC)	CN IMP.	TIME (MIN)	Q (CFS)	PIPE SIZE (IN)	SLOPE (FT/FT)	Qf (CFS)	Q/Qf (%)	Vf (FPS)	V/Vf (%)	ACTUAL V (FPS)
ENTIRE SHED	5.49	5.49	47.88	2.86	79	2.63	98	5.00	4.02	18	0.0050	7.45	53.94%	4.21	1.03	4.32

APPENDIX 'A' – STORMWATER DETENTION FACILITY REPORT

Table of Contents

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SBUH Runoff	0.17	5	540	9,073	----	------	------	Pre Developed
2	SBUH Runoff	1.67	5	480	27,531	----	------	------	Developed
3	Reservoir	0.08	5	1455	21,271	2	188.77	24,812	Pond

Hydrograph Plot

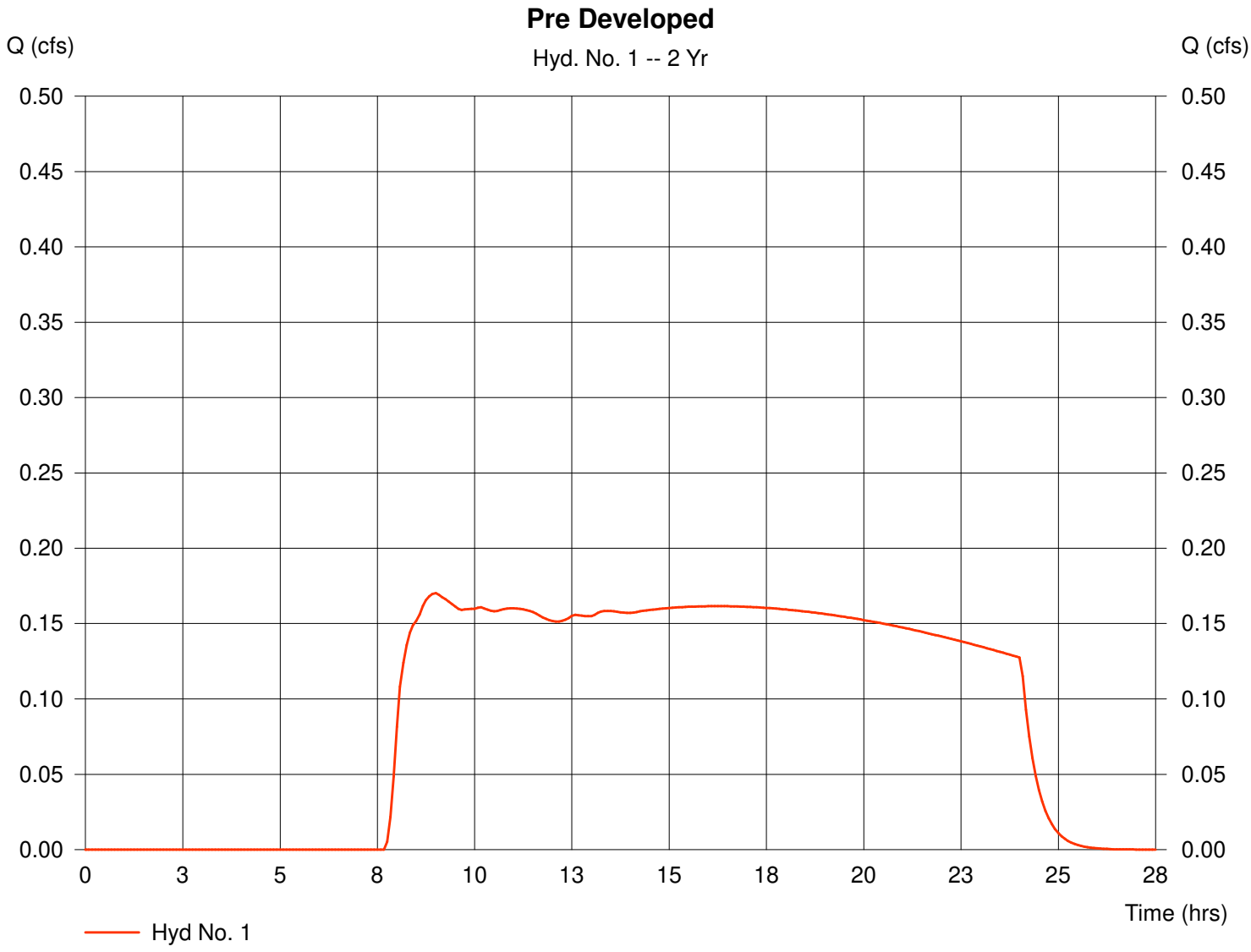
Hydraflow Hydrographs by Intelisolve | Friday, Feb 7 2020, 2:3 PM

Hyd. No. 1

Pre Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.17 cfs
Storm frequency	= 2 yrs	Time interval	= 5 min
Drainage area	= 5.490 ac	Curve number	= 70
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 23.51 min
Total precip.	= 2.50 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= N/A

Hydrograph Volume = 9,073 cuft



Hydrograph Plot

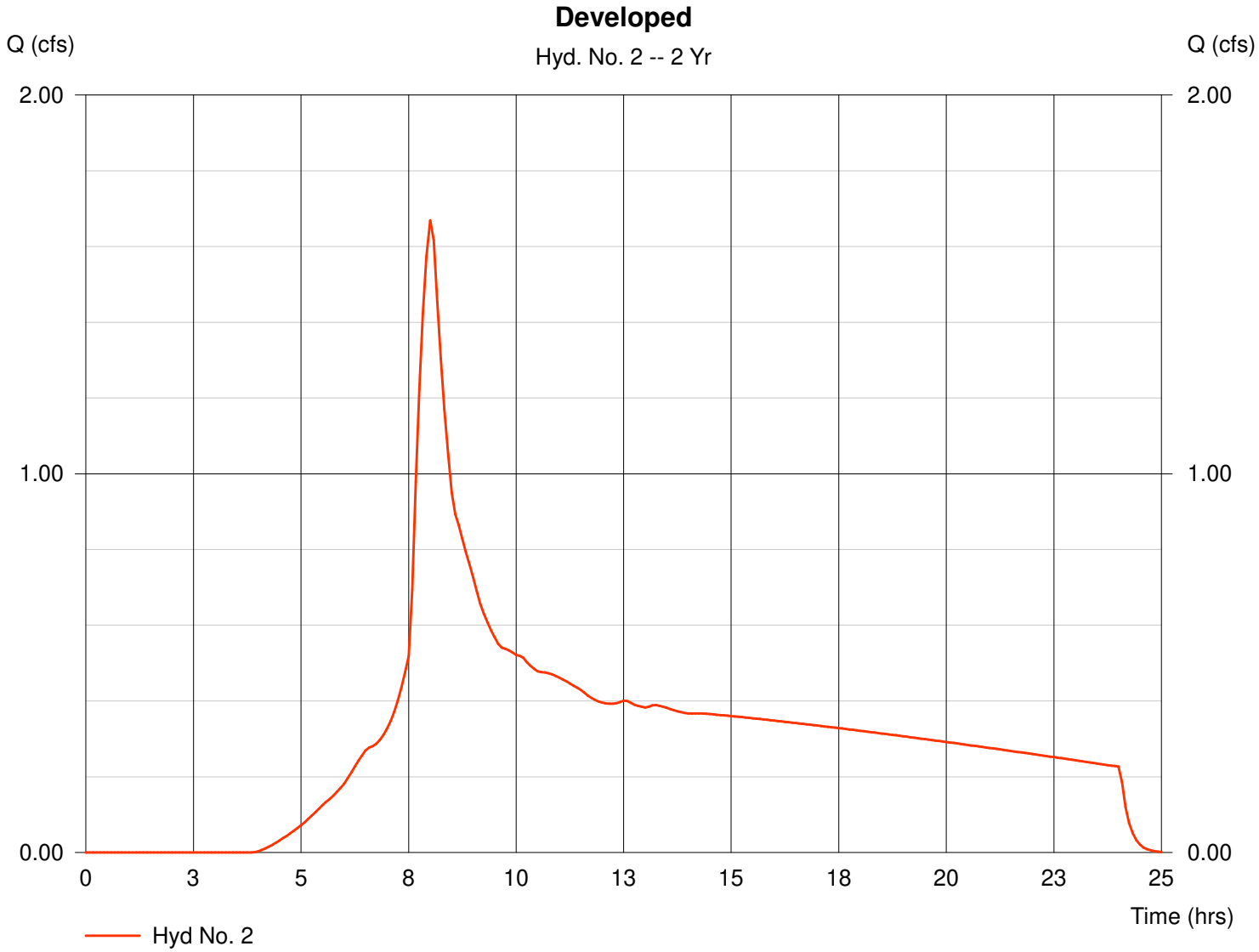
Hydraflow Hydrographs by Intelisolve | Friday, Feb 7 2020, 2:3 PM

Hyd. No. 2

Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 1.67 cfs
Storm frequency	= 2 yrs	Time interval	= 5 min
Drainage area	= 5.490 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 11.60 min
Total precip.	= 2.50 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= N/A

Hydrograph Volume = 27,531 cuft



Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow Hyd(s)	Peak Outflow (cfs)								Hydrograph description
			1-Yr	2-Yr	3-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	
1	SBUH Runoff	-------	-------	0.17	-------	0.41	0.61	0.90	-------	-------	Pre Developed
2	SBUH Runoff	-------	-------	1.67	-------	2.39	2.83	3.39	-------	-------	Developed
3	Reservoir	2	-------	0.08	-------	0.41	0.53	0.68	-------	-------	Pond

Hydrograph Plot

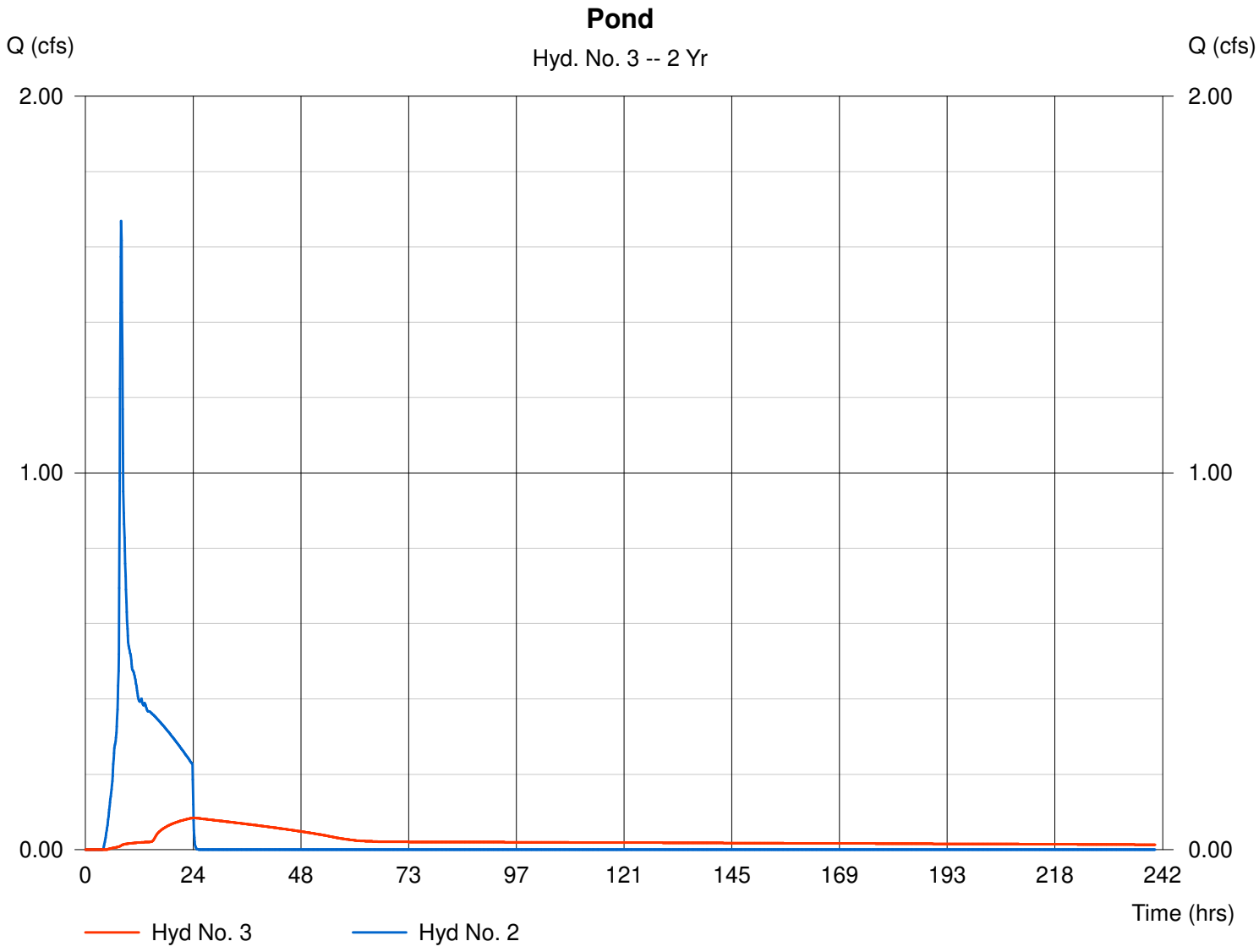
Hydraflow Hydrographs by Intelisolve | Friday, Feb 7 2020, 2:3 PM

Hyd. No. 3

Pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.08 cfs
Storm frequency	=	2 yrs	Time interval	=	5 min
Inflow hyd. No.	=	2	Max. Elevation	=	188.77 ft
Reservoir name	=	Pond	Max. Storage	=	24,812 cuft

Storage Indication method used. | Hydrograph Volume = 21,271 cuft



Pond Report

Pond No. 1 - Pond

Pond Data

Bottom LxW = 121.3 x 60.7 ft Side slope = 3.0:1 Bottom elev. = 186.00 ft Depth = 8.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	186.00	7,357	0	0
0.40	186.40	7,799	3,031	3,031
0.80	186.80	8,253	3,210	6,241
1.20	187.20	8,719	3,394	9,635
1.60	187.60	9,196	3,583	13,217
2.00	188.00	9,684	3,776	16,993
2.40	188.40	10,184	3,973	20,966
2.80	188.80	10,696	4,176	25,142
3.20	189.20	11,219	4,383	29,525
3.60	189.60	11,754	4,594	34,119
4.00	190.00	12,300	4,810	38,929
4.40	190.40	12,857	5,031	43,960
4.80	190.80	13,426	5,256	49,216
5.20	191.20	14,007	5,486	54,703
5.60	191.60	14,599	5,721	60,424
6.00	192.00	15,203	5,960	66,384
6.40	192.40	15,818	6,204	72,587
6.80	192.80	16,445	6,452	79,040
7.20	193.20	17,083	6,705	85,745
7.60	193.60	17,733	6,963	92,708
8.00	194.00	18,394	7,225	99,933

Culvert / Orifice Structures

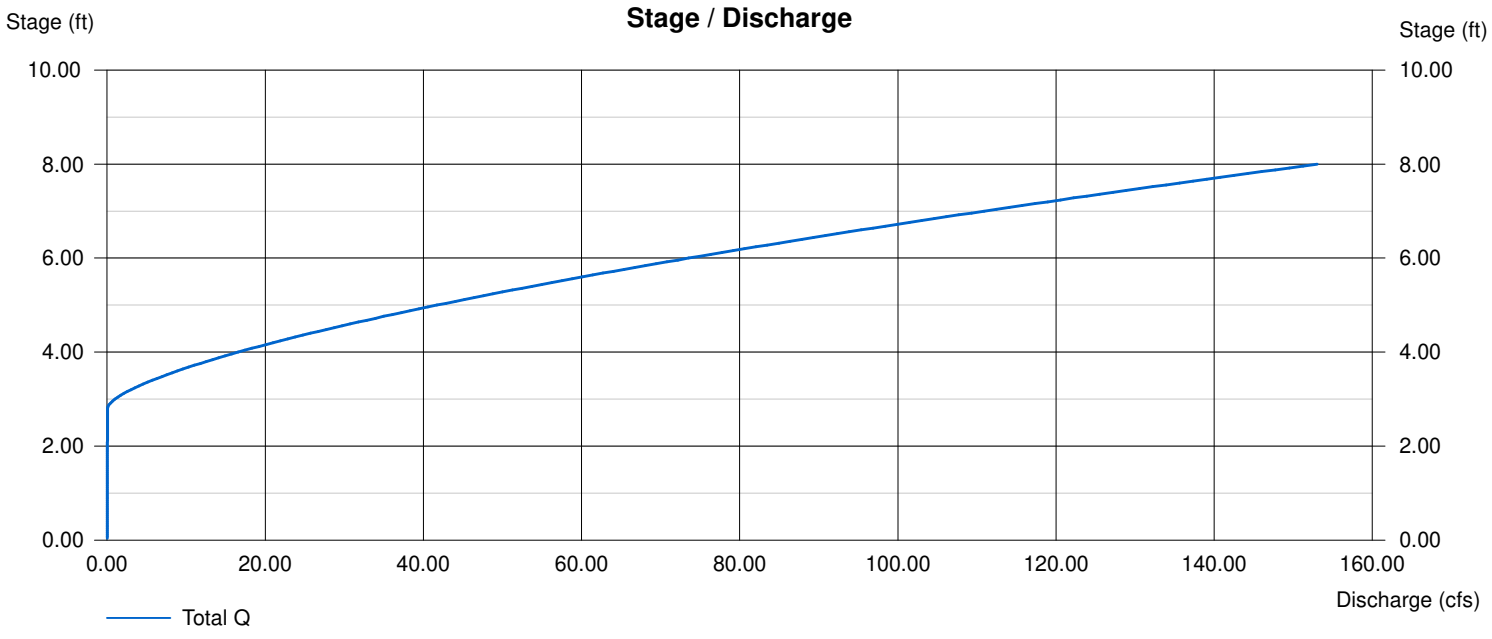
	[A]	[B]	[C]	[D]
Rise (in)	= 18.00	0.75	1.65	0.00
Span (in)	= 18.00	0.75	1.65	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 181.25	179.25	188.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	0.00
N-Value	= .013	.013	.013	.013
Orif. Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 5.00	0.00	0.00	0.00
Crest El. (ft)	= 188.83	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	0.00	0.00
Weir Type	= Rect	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration = 0.000 in/hr (Wet area) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.



Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SBUH Runoff	0.41	5	495	15,356	----	------	------	Pre Developed
2	SBUH Runoff	2.39	5	480	38,011	----	------	------	Developed
3	Reservoir	0.41	5	1100	31,601	2	188.91	26,397	Pond

Hydrograph Plot

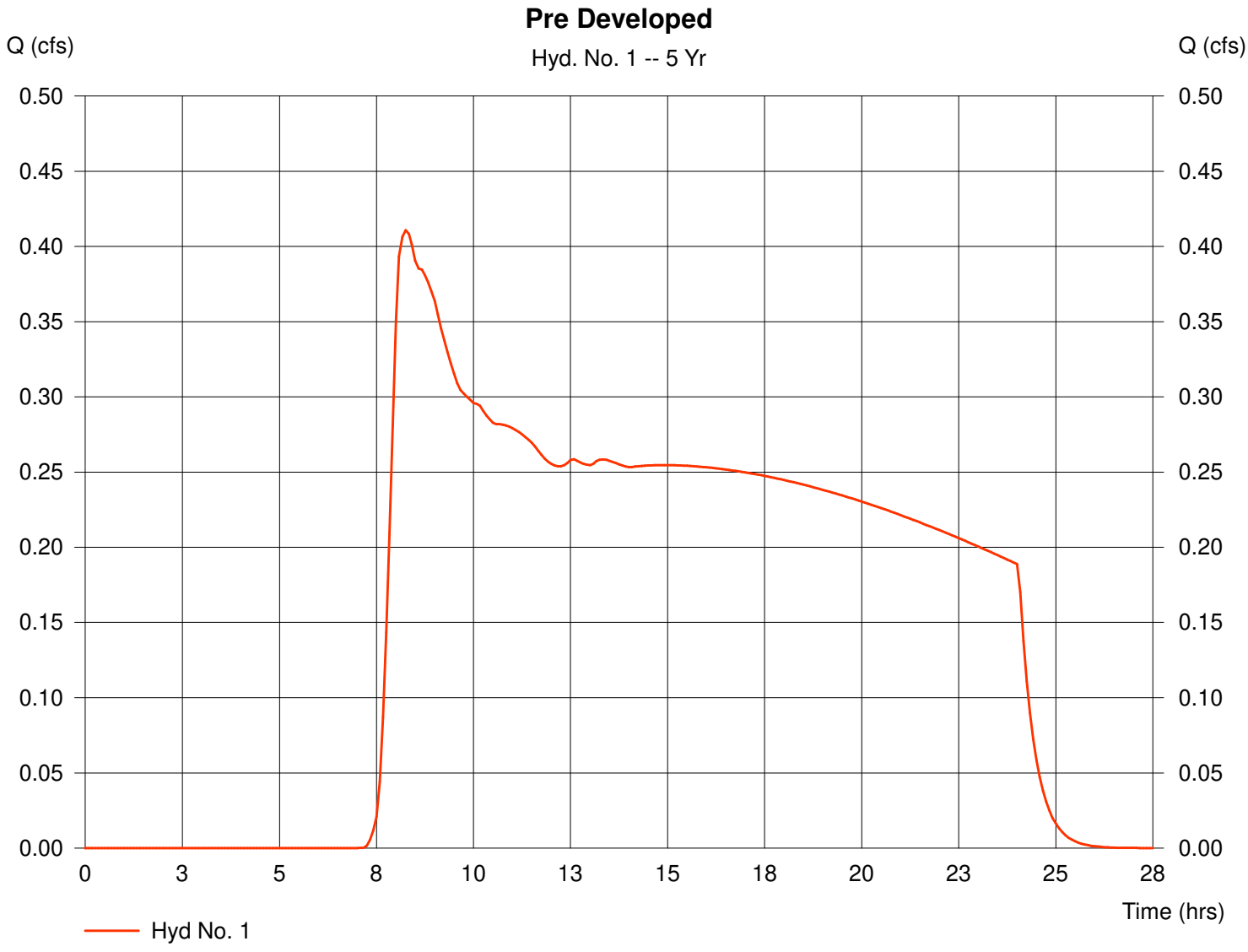
Hydraflow Hydrographs by Intelisolve | Friday, Feb 7 2020, 2:3 PM

Hyd. No. 1

Pre Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.41 cfs
Storm frequency	= 5 yrs	Time interval	= 5 min
Drainage area	= 5.490 ac	Curve number	= 70
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 23.51 min
Total precip.	= 3.10 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= N/A

Hydrograph Volume = 15,356 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

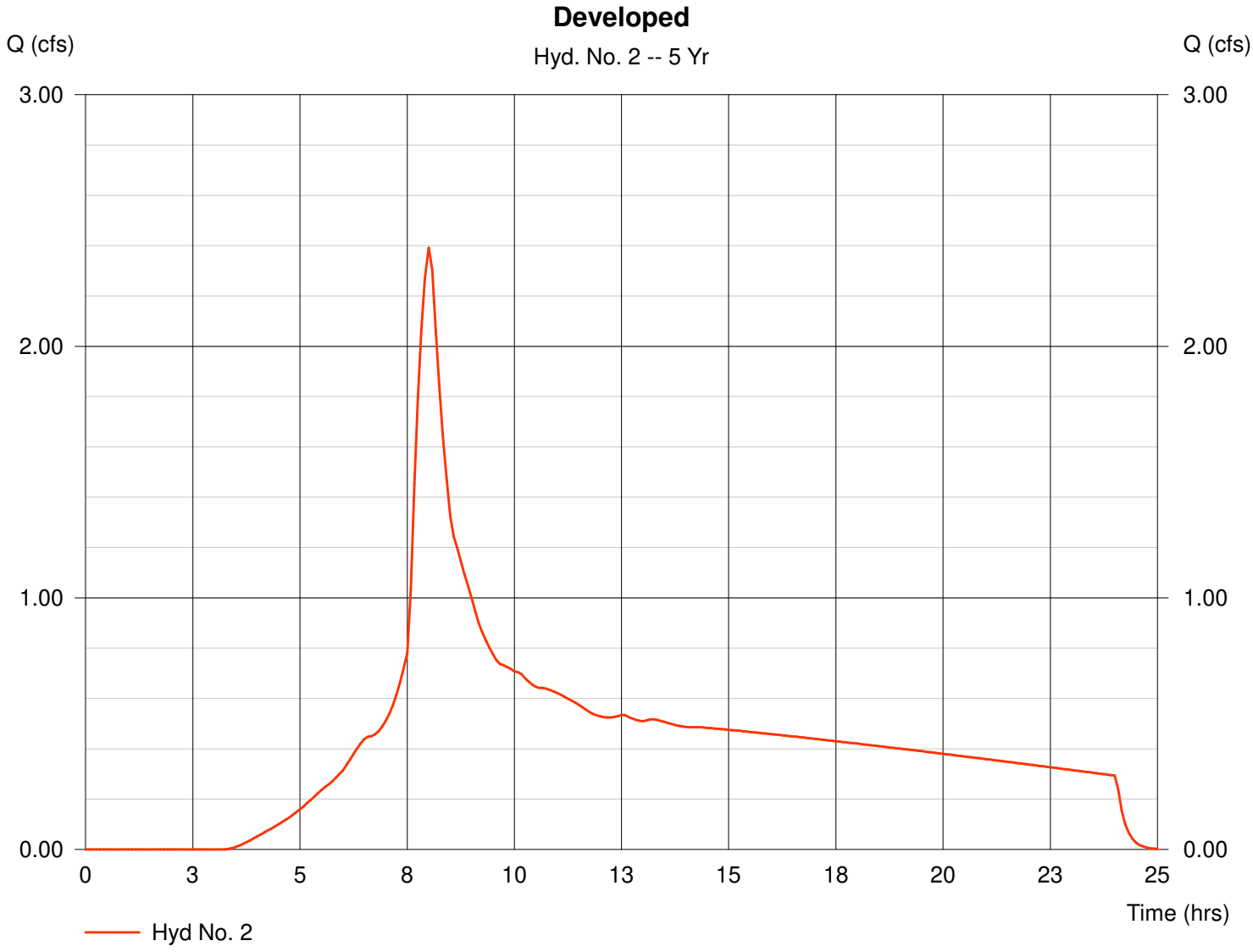
Friday, Feb 7 2020, 2:3 PM

Hyd. No. 2

Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 2.39 cfs
Storm frequency	= 5 yrs	Time interval	= 5 min
Drainage area	= 5.490 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 11.60 min
Total precip.	= 3.10 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= N/A

Hydrograph Volume = 38,011 cuft



Hydrograph Plot

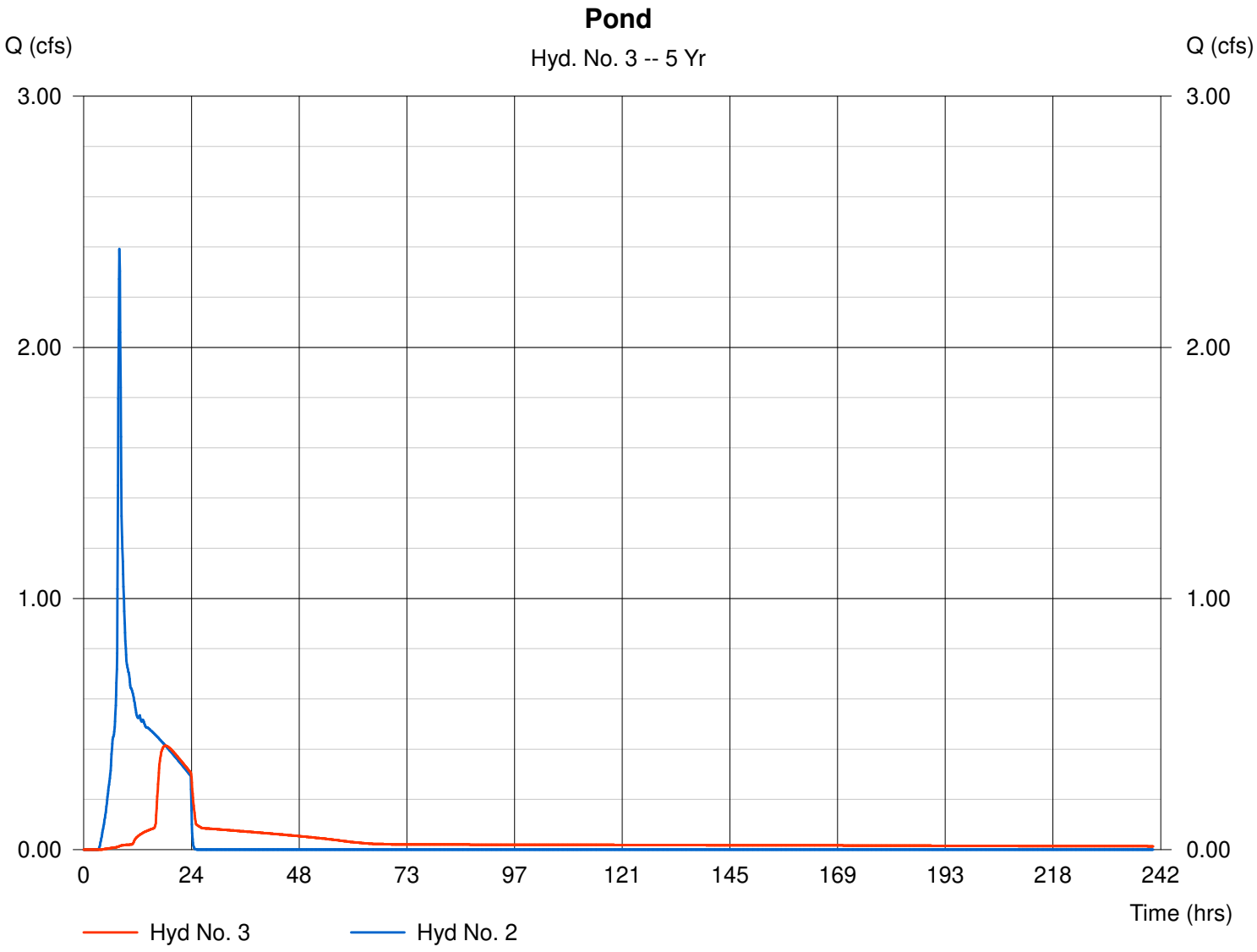
Hydraflow Hydrographs by Intelisolve | Friday, Feb 7 2020, 2:3 PM

Hyd. No. 3

Pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.41 cfs
Storm frequency	=	5 yrs	Time interval	=	5 min
Inflow hyd. No.	=	2	Max. Elevation	=	188.91 ft
Reservoir name	=	Pond	Max. Storage	=	26,397 cuft

Storage Indication method used. | Hydrograph Volume = 31,601 cuft



Pond Report

Pond No. 1 - Pond

Pond Data

Bottom LxW = 121.3 x 60.7 ft Side slope = 3.0:1 Bottom elev. = 186.00 ft Depth = 8.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	186.00	7,357	0	0
0.40	186.40	7,799	3,031	3,031
0.80	186.80	8,253	3,210	6,241
1.20	187.20	8,719	3,394	9,635
1.60	187.60	9,196	3,583	13,217
2.00	188.00	9,684	3,776	16,993
2.40	188.40	10,184	3,973	20,966
2.80	188.80	10,696	4,176	25,142
3.20	189.20	11,219	4,383	29,525
3.60	189.60	11,754	4,594	34,119
4.00	190.00	12,300	4,810	38,929
4.40	190.40	12,857	5,031	43,960
4.80	190.80	13,426	5,256	49,216
5.20	191.20	14,007	5,486	54,703
5.60	191.60	14,599	5,721	60,424
6.00	192.00	15,203	5,960	66,384
6.40	192.40	15,818	6,204	72,587
6.80	192.80	16,445	6,452	79,040
7.20	193.20	17,083	6,705	85,745
7.60	193.60	17,733	6,963	92,708
8.00	194.00	18,394	7,225	99,933

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise (in)	= 18.00	0.75	1.65	0.00
Span (in)	= 18.00	0.75	1.65	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 181.25	179.25	188.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	0.00
N-Value	= .013	.013	.013	.013
Orif. Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

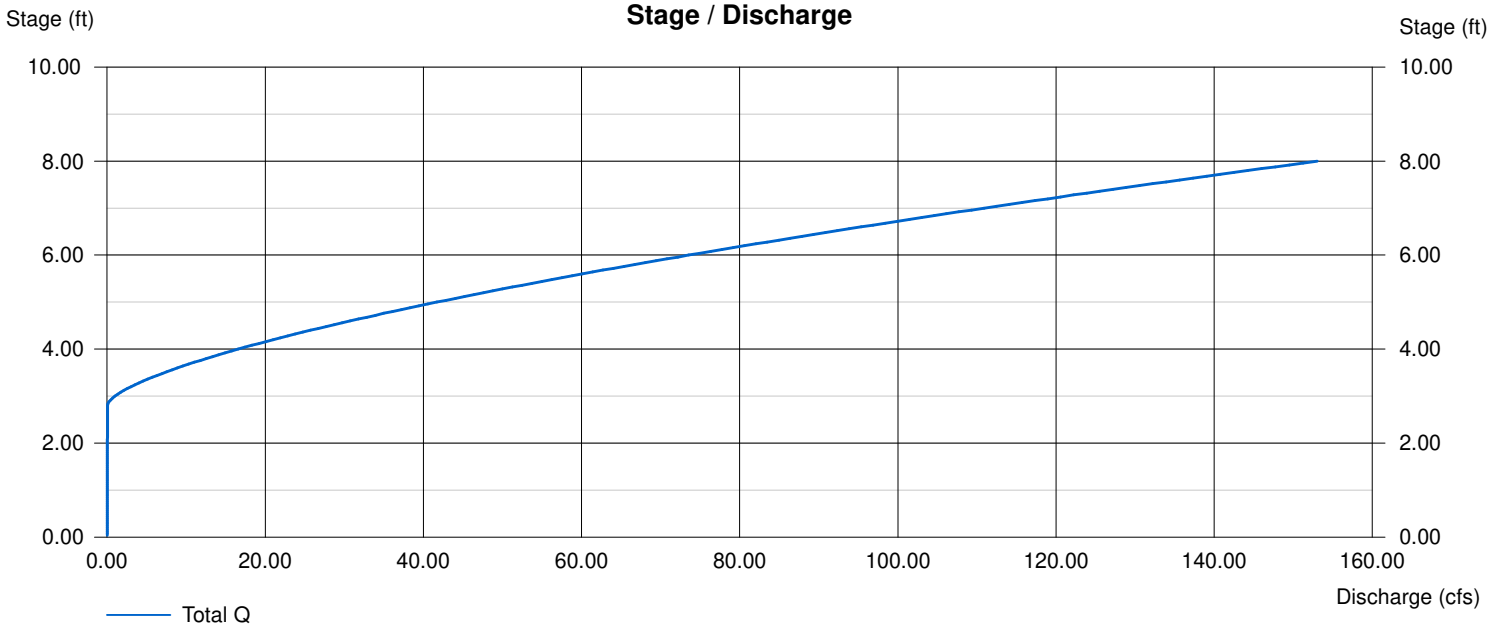
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 5.00	0.00	0.00	0.00
Crest El. (ft)	= 188.83	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	0.00	0.00
Weir Type	= Rect	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration = 0.000 in/hr (Wet area) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.

Stage / Discharge



Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SBUH Runoff	0.61	5	490	19,478	----	------	------	Pre Developed
2	SBUH Runoff	2.83	5	480	44,304	----	------	------	Developed
3	Reservoir	0.53	5	935	37,891	2	188.93	26,606	Pond

Hydrograph Plot

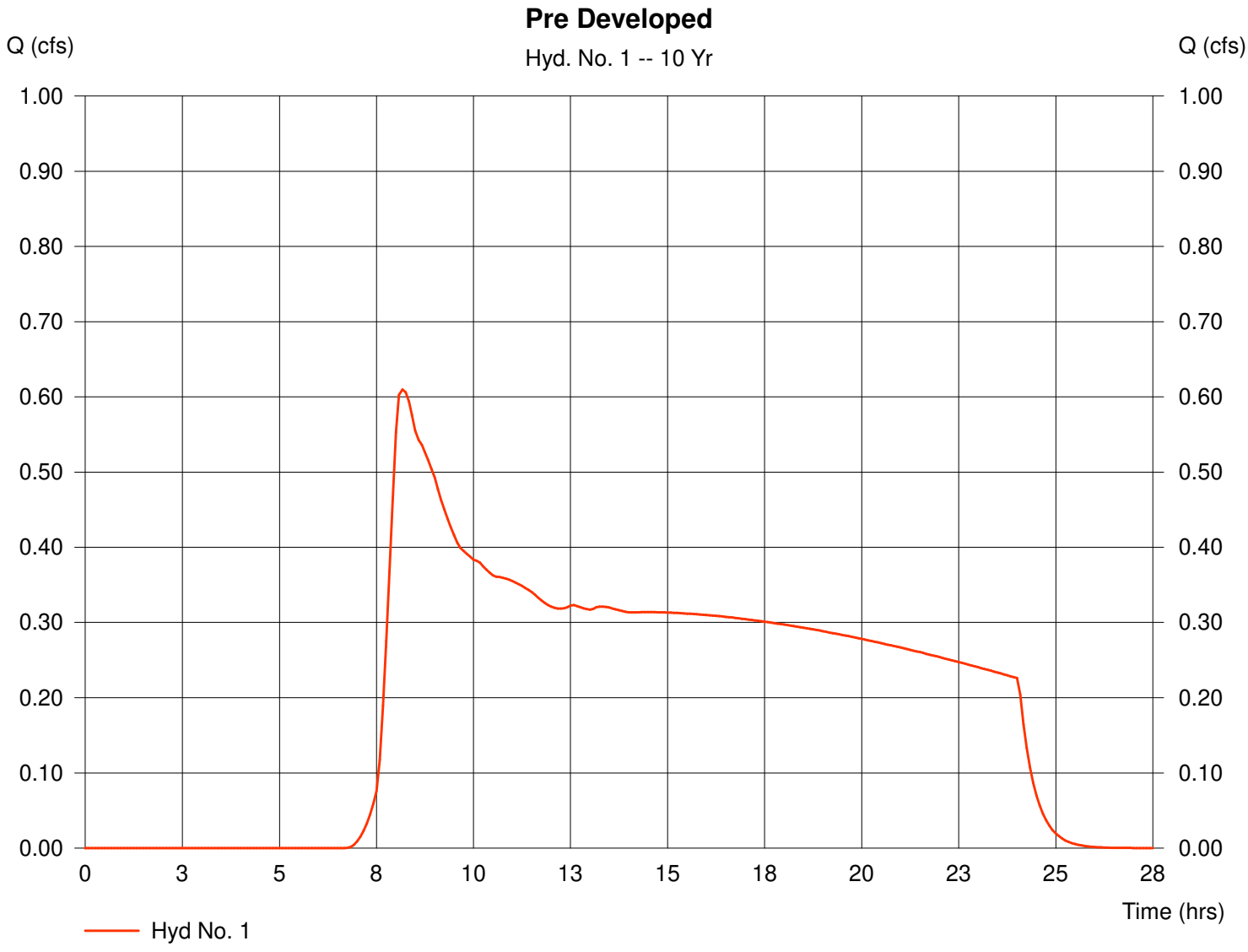
Hydraflow Hydrographs by Intelisolve | Friday, Feb 7 2020, 2:3 PM

Hyd. No. 1

Pre Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.61 cfs
Storm frequency	= 10 yrs	Time interval	= 5 min
Drainage area	= 5.490 ac	Curve number	= 70
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 23.51 min
Total precip.	= 3.45 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= N/A

Hydrograph Volume = 19,478 cuft



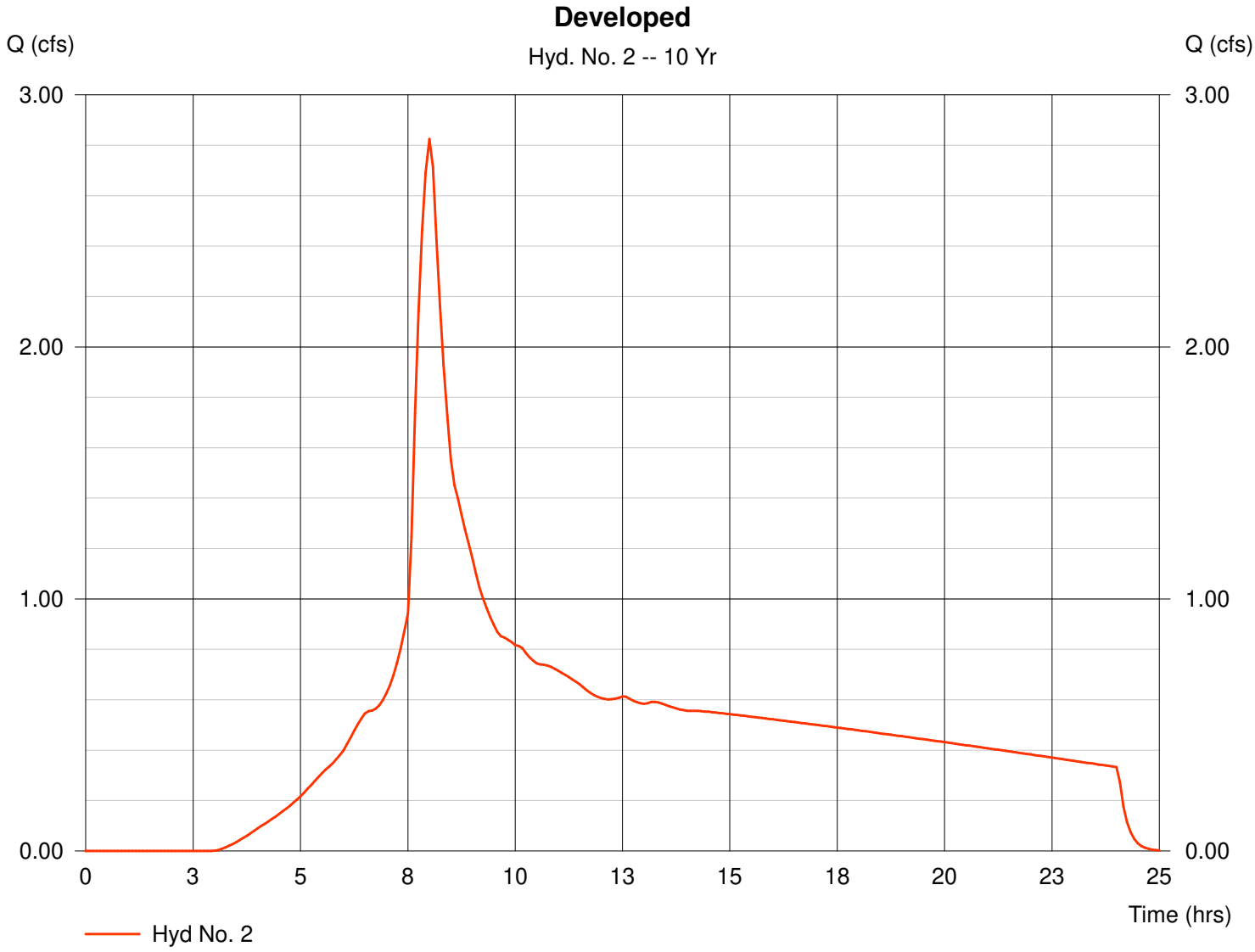
Hydrograph Plot

Hyd. No. 2

Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 2.83 cfs
Storm frequency	= 10 yrs	Time interval	= 5 min
Drainage area	= 5.490 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 11.60 min
Total precip.	= 3.45 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= N/A

Hydrograph Volume = 44,304 cuft



Hydrograph Plot

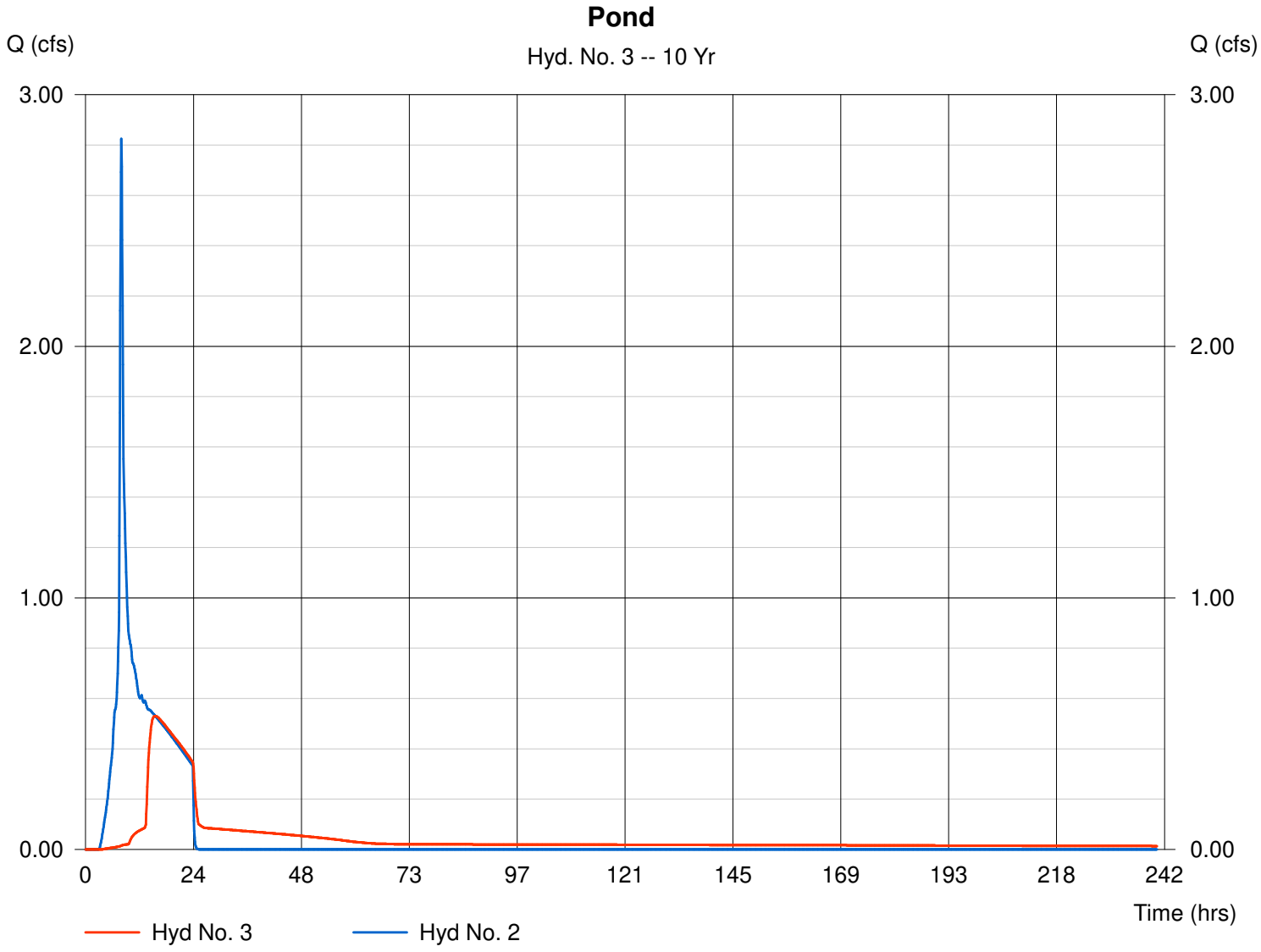
Hydraflow Hydrographs by Intelisolve | Friday, Feb 7 2020, 2:3 PM

Hyd. No. 3

Pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.53 cfs
Storm frequency	=	10 yrs	Time interval	=	5 min
Inflow hyd. No.	=	2	Max. Elevation	=	188.93 ft
Reservoir name	=	Pond	Max. Storage	=	26,606 cuft

Storage Indication method used. | Hydrograph Volume = 37,891 cuft



Pond Report

Pond No. 1 - Pond

Pond Data

Bottom LxW = 121.3 x 60.7 ft Side slope = 3.0:1 Bottom elev. = 186.00 ft Depth = 8.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	186.00	7,357	0	0
0.40	186.40	7,799	3,031	3,031
0.80	186.80	8,253	3,210	6,241
1.20	187.20	8,719	3,394	9,635
1.60	187.60	9,196	3,583	13,217
2.00	188.00	9,684	3,776	16,993
2.40	188.40	10,184	3,973	20,966
2.80	188.80	10,696	4,176	25,142
3.20	189.20	11,219	4,383	29,525
3.60	189.60	11,754	4,594	34,119
4.00	190.00	12,300	4,810	38,929
4.40	190.40	12,857	5,031	43,960
4.80	190.80	13,426	5,256	49,216
5.20	191.20	14,007	5,486	54,703
5.60	191.60	14,599	5,721	60,424
6.00	192.00	15,203	5,960	66,384
6.40	192.40	15,818	6,204	72,587
6.80	192.80	16,445	6,452	79,040
7.20	193.20	17,083	6,705	85,745
7.60	193.60	17,733	6,963	92,708
8.00	194.00	18,394	7,225	99,933

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise (in)	= 18.00	0.75	1.65	0.00
Span (in)	= 18.00	0.75	1.65	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 181.25	179.25	188.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	0.00
N-Value	= .013	.013	.013	.013
Orif. Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

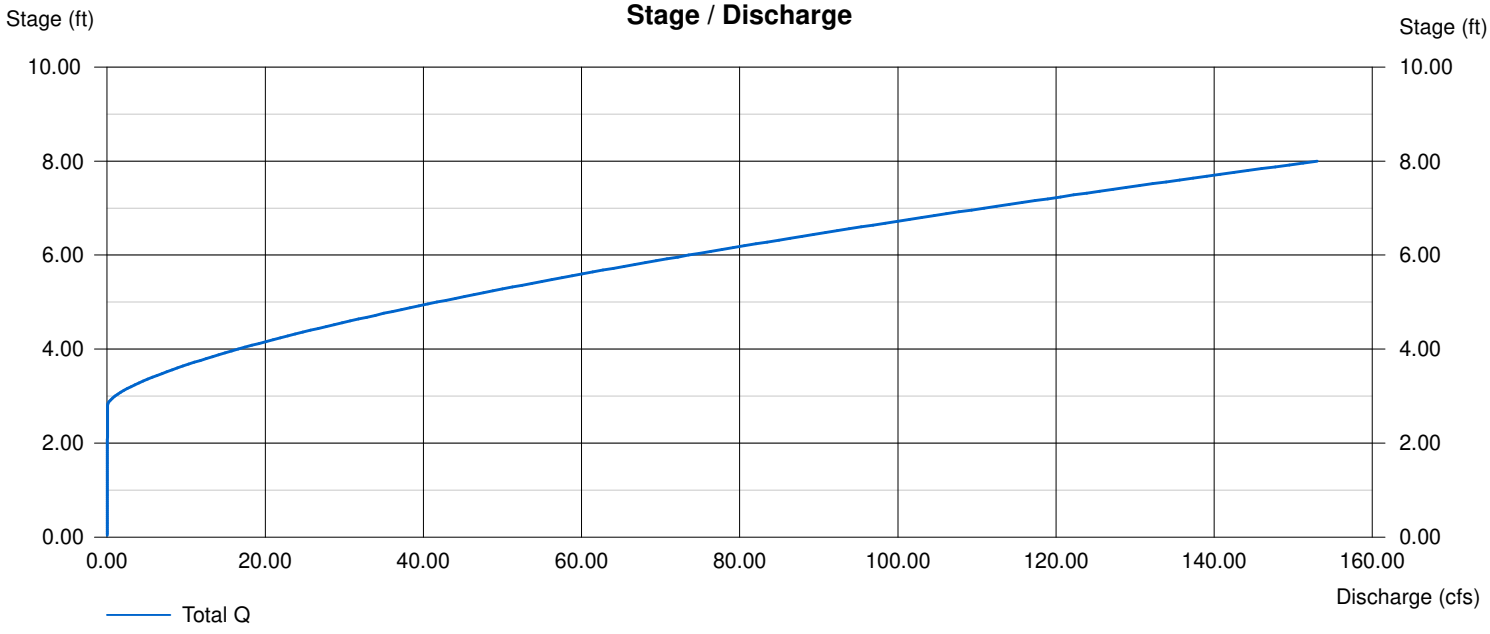
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 5.00	0.00	0.00	0.00
Crest El. (ft)	= 188.83	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	0.00	0.00
Weir Type	= Rect	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration = 0.000 in/hr (Wet area) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.

Stage / Discharge



Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SBUH Runoff	0.90	5	485	25,178	----	------	------	Pre Developed
2	SBUH Runoff	3.39	5	480	52,536	----	------	------	Developed
3	Reservoir	0.68	5	800	46,119	2	188.96	26,863	Pond

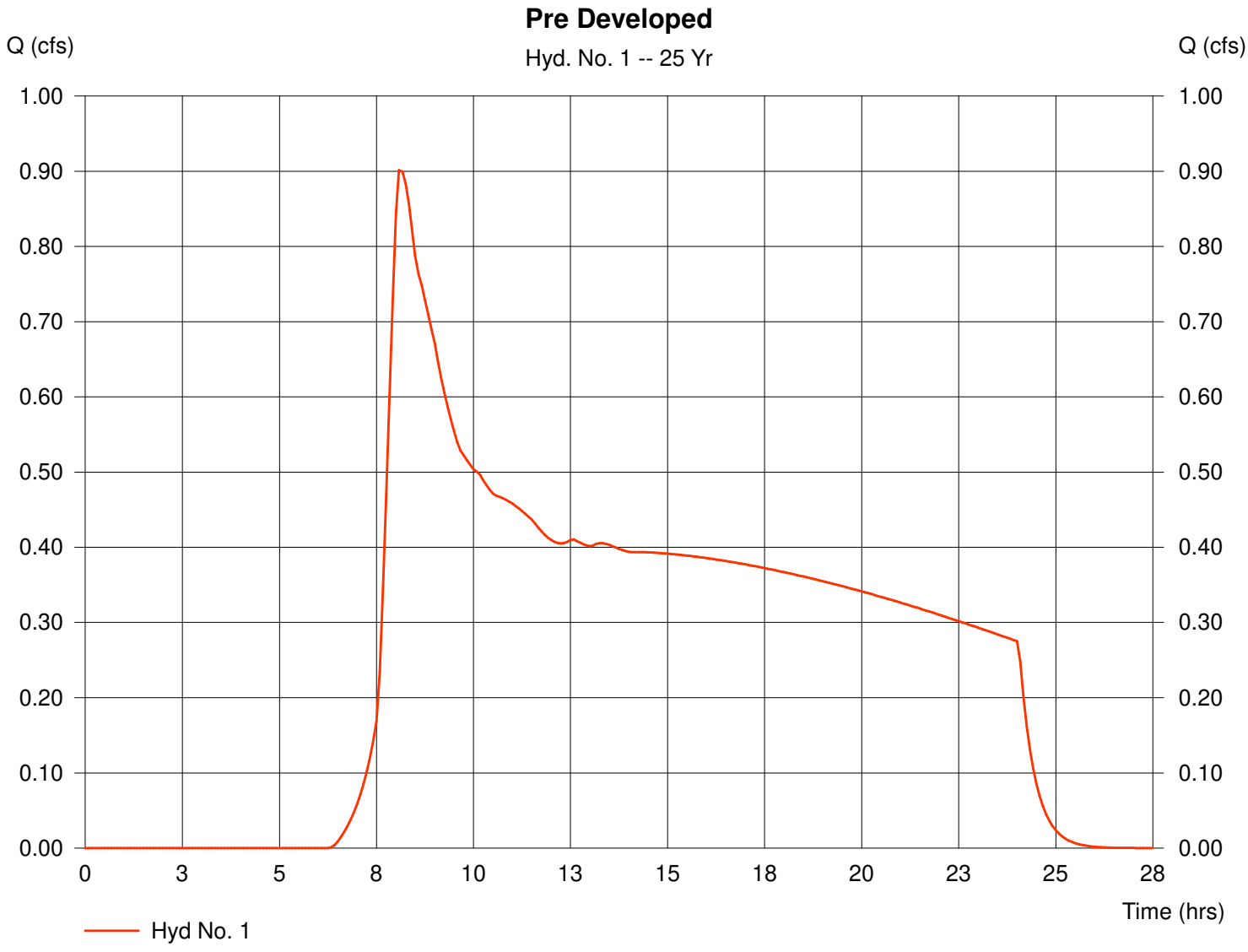
Hydrograph Plot

Hyd. No. 1

Pre Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.90 cfs
Storm frequency	= 25 yrs	Time interval	= 5 min
Drainage area	= 5.490 ac	Curve number	= 70
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 23.51 min
Total precip.	= 3.90 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= N/A

Hydrograph Volume = 25,178 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

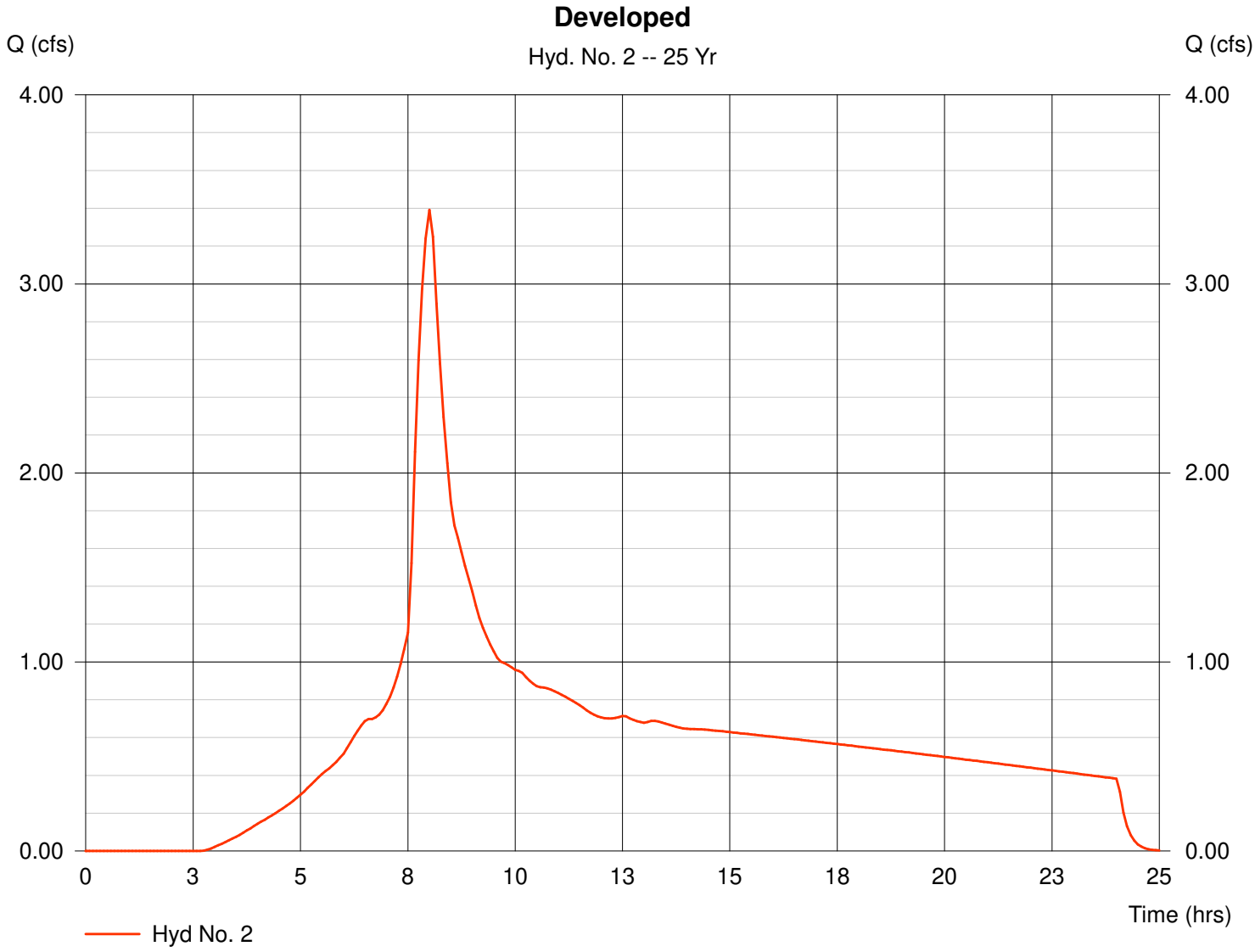
Friday, Feb 7 2020, 2:3 PM

Hyd. No. 2

Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 3.39 cfs
Storm frequency	= 25 yrs	Time interval	= 5 min
Drainage area	= 5.490 ac	Curve number	= 88
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= USER	Time of conc. (Tc)	= 11.60 min
Total precip.	= 3.90 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= N/A

Hydrograph Volume = 52,536 cuft



Hydrograph Plot

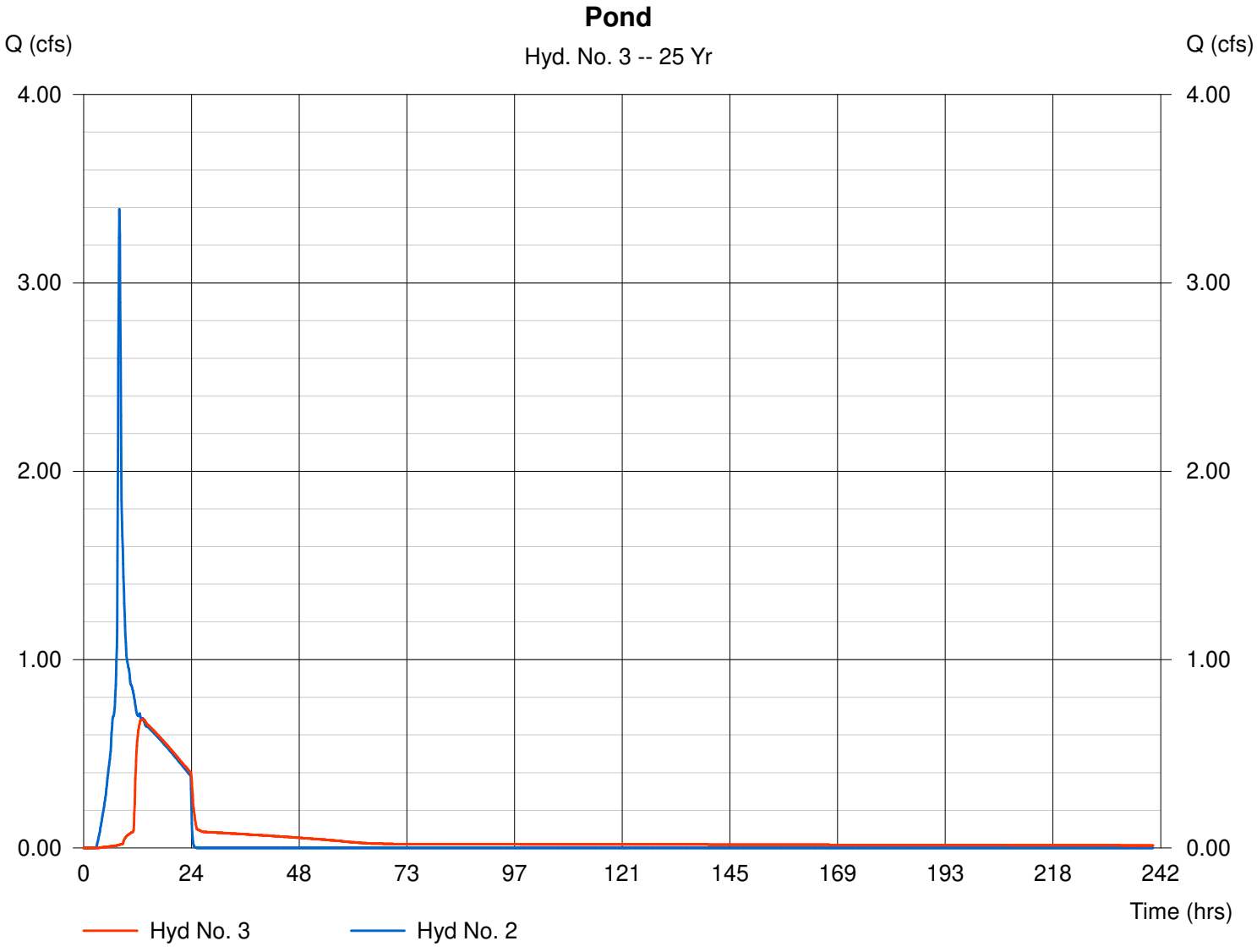
Hydraflow Hydrographs by Intelisolve | Friday, Feb 7 2020, 2:3 PM

Hyd. No. 3

Pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.68 cfs
Storm frequency	=	25 yrs	Time interval	=	5 min
Inflow hyd. No.	=	2	Max. Elevation	=	188.96 ft
Reservoir name	=	Pond	Max. Storage	=	26,863 cuft

Storage Indication method used. | Hydrograph Volume = 46,119 cuft



Pond Report

Pond No. 1 - Pond

Pond Data

Bottom LxW = 121.3 x 60.7 ft Side slope = 3.0:1 Bottom elev. = 186.00 ft Depth = 8.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	186.00	7,357	0	0
0.40	186.40	7,799	3,031	3,031
0.80	186.80	8,253	3,210	6,241
1.20	187.20	8,719	3,394	9,635
1.60	187.60	9,196	3,583	13,217
2.00	188.00	9,684	3,776	16,993
2.40	188.40	10,184	3,973	20,966
2.80	188.80	10,696	4,176	25,142
3.20	189.20	11,219	4,383	29,525
3.60	189.60	11,754	4,594	34,119
4.00	190.00	12,300	4,810	38,929
4.40	190.40	12,857	5,031	43,960
4.80	190.80	13,426	5,256	49,216
5.20	191.20	14,007	5,486	54,703
5.60	191.60	14,599	5,721	60,424
6.00	192.00	15,203	5,960	66,384
6.40	192.40	15,818	6,204	72,587
6.80	192.80	16,445	6,452	79,040
7.20	193.20	17,083	6,705	85,745
7.60	193.60	17,733	6,963	92,708
8.00	194.00	18,394	7,225	99,933

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise (in)	= 18.00	0.75	1.65	0.00
Span (in)	= 18.00	0.75	1.65	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 181.25	179.25	188.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	0.00
N-Value	= .013	.013	.013	.013
Orif. Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 5.00	0.00	0.00	0.00
Crest El. (ft)	= 188.83	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	0.00	0.00
Weir Type	= Rect	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration = 0.000 in/hr (Wet area) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.