EXHIBIT F

STORMWATER REPORT
Preliminary

MIXED USE SITE DEVELOPMENT
38015 HYW 26
Sandy, OR 97055
FDG # E21-043

September 12, 2022

Prepared By:

FIRWOOD DESIGN GROUP
Reliable Engineering Solutions

359 E. Historic Columbia River Highway
Sandy, OR 97060
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TABLE OF CONTENTS

STORM DRAINAGE CALCULATIONS

I. OBJECTIVE

The objective is to provide stormwater treatment and detention for the new impervious parking, sidewalk, and building areas.

Stormwater discharge from the above referenced impervious areas will be discharged into a 60" detention system and routed into a water quality manhole and into the public stormwater system in Meeker Street north of the site improvements.

II. METHODOLOGY

As per the City of Sandy code, the 2016 City of Portland stormwater manual (performance method for all facilities) was applied in developing the proposed stormwater management for the impervious surface areas. Water quality and quantity is managed via underground detention facilities and a water quality manhole. The City of Portland Hierarchy for the new impervious area categories 1-3 (See Section V) are not feasible due to site constraints including soil types and fill condition of the site development. HydroCAD is used to apply the Santa Barbara unit hydrograph for the respective storm intensities for the 2yr, 5yr, 10yr, and 25yr 24hour design storms.

III. REFERENCES:

USGS Soil Maps for Clackamas County, Oregon
City of Portland, Stormwater Management Manual

IV. SITE DESCRIPTION:

The site is a parcel located in the City of Sandy at 38015 HYW 26 and is approximately 2.0 acres in size with a topography that has slopes ranging from 0 to 12%. The site slopes from South to North towards Meeker Street. The site is currently an empty field area just north of Highway 26. The proposed on-site improvements include 41,740 sf of new asphalt drivelane and parking area, 5,490 sf new concrete / sidewalk area, and 11,320 sf of new building roof area.

The Soils per the USDA Soils maps are predominately classified as Cazadero silty clay loam, with 0 to 12 percent slopes. The Soils have a hydrologic soil group - Hydrologic Group C. 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.

V. STORMWATER MANAGEMENT:

Stormwater Hierarchy

The following management hierarchy is the order of preferred management approaches per the City of Portland manual:

Category 1. Requires total on-site infiltration in vegetation infiltration facilities.

Category 2. Requires total on-site infiltration in vegetation infiltration facilities that overflow to subsurface infiltration facilities or standalone subsurface infiltration facilities.

Category 3. Requires onsite detention with vegetated facilities that overflow to drainageway, stream, river, or storm pipe only.

Categories 1 and 2 are not feasible due to the low infiltration rate of the soils (0.5 inches per hour), see USDA NRCS soils report included in this report. Stormwater Hierarchy Categories 1-3 are not feasible due to site constraints such as site fill and the lack of adequate room for vegetated areas.

The design storms and detention requirements, as required by the City of Sandy design and construction standards, are as follows:

Recurrence Interval` (years)	Total Precipitation Depth (In)
WQ	0.20 intensity per rational method
2	3.5
5	4.5
10	4.8
25	5.5

1. The post construction 24-hour 2-year recurrence interval storm event runoff will not exceed the 2-year predevelopment 2-year 24-hour runoff

2. The post construction 24-hour 5-year recurrence interval storm event runoff will not exceed the 5-year predevelopment 5-year 24-hour runoff

3. The post construction 24-hour 10-year recurrence interval storm event runoff will not exceed the 10-year predevelopment 10-year 24-hour runoff

4. The post construction 24-hour 25-year recurrence interval storm event runoff will not exceed the predevelopment 25-year runoff.

Water Quantity Analysis for Impervious Areas

Stormwater detention is achieved by directing stormwater into the proposed underground detention pipes located at the northerly side of the parking area. The Santa Barbara Urban Hydrograph (HydroCAD) was used to create the basin hydrographs (see appendix for data and calculations) and to estimate the peak flows for the design storms. A curve number (CN) value of 98 was assigned to the impervious surfaces. The time of concentration for impervious area is 6 minutes as a minimum value.

A 250 lf 60" underground stormwater detention system for the impervious area will be required to detain stormwater per the City of Sandy standards. The City of Sandy standards for detention are used as outlined above for the calculations.

Stormwater Flows

Design Storm	Pre-Development (Existing) Peak Flow (cfs)	Post-Construction Peak Flow (cfs)	Allowed Post Construction Runoff	Actual Post Construction Runoff
2 year	0.46	1.09	0.46	0.45
5 year	0.74	1.41	0.74	0.74
10 year	0.83	1.51	0.83	0.83
25 year	1.05	1.73	1.05	0.99

Stage and Storage

Post construction event	Peak Stage Elevation (ft)	Peak Storage (cf)
2 year	2.33	1,927
5 year	2.90	2,644
10 year	3.05	2,829
25 year	3.43	3,293

Water Quality Analysis for Impervious Area

The water quality flow as required by the City of Sandy is the 0.20 inches / hour storm; Applying the rational method, CIA = (0.90) (0.20) (1.34) = 0.24 cfs is the water quality flow rate for all of the impervious area for the Mixed Use Site Development Improvements. Storm water treatment is proposed to be achieved by utilizing the CDS Hydrodynamic Separator Model PMSU20_15_4 water quality manhole; The treatment capacity of the PMSU20_15_4 water quality manhole is 0.70 cfs.

Treatment specification for the PMSU20_15_4 Stormwater Treatment Device (SWTD) meets the follows standards:

1. The SWTD is capable of achieving an 80 percent average annual reduction for a particle distribution having a mean particle size (d50) of 125 microns

2. The SWTD is capable of capturing and retaining 100 percent of pollutants greater than or equal to 3/16 of an inch regardless of the pollutant's specific gravity (i.e.: floatable and neutrally buoyant materials) for flows up to the device's rated-treatment capacity. The SWTD is designed to retain all previously captured pollutants addressed by this subsection under all flow conditions.

3. The SWTD is capable of capturing and retaining total petroleum hydrocarbons. The SWTD is capable of achieving a removal efficiency of 92 and 78 percent when the device is operating at 25 and 50 percent of its rated-treatment capacity. These removal efficiencies is based on independent third-party research for influent oil concentrations representative of storm water runoff (20 ± 5 mg/L). The SWTD is

greater than 99 percent effective in controlling dry-weather accidental oil spills.

Conclusion

Post development stormwater runoff will be detained, treated, and discharged into the existing City of Sandy Storm system located in Meeker Street at pre-existing flow rates for the design storms in conformance with the City of Sandy municipal code standards via a underground piped detention system and a water quality treatment CDS manhole.

PROPOSED 15.00' WIDE
STORM SEWER EASEMENT
TO BENEFIT TAX LOTS 1000 AND 902

N87°38'49"W
15.00'

OWNER: PAOLA
TAX LOT: 1000
DOC. NO.
2019-061145

TAX LOT: 1200
DOC. NO. 2016-050991

HERON

0 20 40
SCALE IN FEET

OWNER: OREGON TRAIL
SCHOOL DISTRICT #46
TAX LOT: 1202

OWNER: OREGON TRAIL
SCHOOL DISTRICT #46
TAX LOT: 500

OWNER: OREGON TRAIL
SCHOOL DISTRICT #46
TAX LOT: 600

TAX LOT: 902

230 LF TIME OF CONCENTRATION PATHWAY
SEE CALCULATIONS IN HYDROCAD CALCULATIONS

ARB. VIT. HEDGE

REGISTERED PROFESSIONAL ENGINEER
67149PE
PRELIMINARY
OREGON
Nov. 14, 2003
KELLI A. GROVER

EXPIRES: 06/30/23
SIGNATURE DATE: _____

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DATE:	NO.	REVISION

DRAWN: | DESIGNED: | CHECKED:
SCALE: AS SHOWN | DATE: DECEMBER 2021
PROJECT NO. E21-043

FIRWOOD DESIGN GROUP
Reliable Engineering Solutions

359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
(503) 668-3737

STATE STREET HOMES
1233 NW NORTHRUP ST. #125
PORTLAND, OR 97209

TIME OF CONCENTRATION PATHWAY
MIXED USE SITE DEVELOPMENT
38015 HWY 26, SANDY, OR 97055

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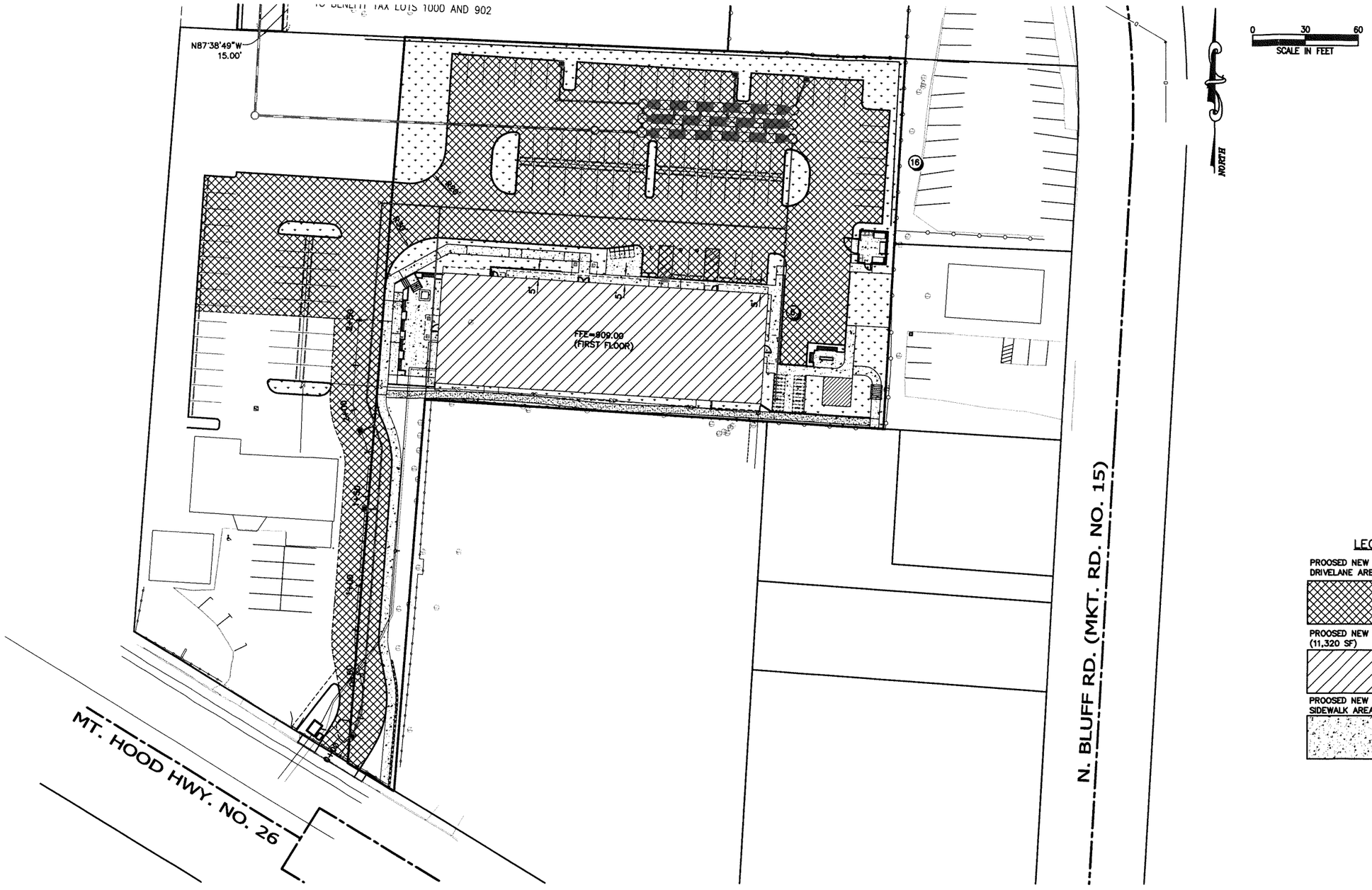

LEGEND

PROOSED NEW ASPHALT PARKING AND DRIVELANE AREA (41,740 SF)

PROOSED NEW BUILDING AREA (11,320 SF)

PROOSED NEW CONCRETE / SIDEWALK AREA (5,490 SF)

REGISTERED PROFESSIONAL ENGINEER
67149PE
PRELIMINARY
OREGON
APR. 14, 2003
KELLI A. GROVER

EXPIRES: 06/30/23
SIGNATURE DATE: _____

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DATE:	NO.	REVISION

DRAWN: | DESIGNED: | CHECKED:
SCALE: AS SHOWN | DATE: DECEMBER 2021
PROJECT NO. E21-043

FIRWOOD DESIGN GROUP
Reliable Engineering Solutions
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
(503) 668-3737

STATE STREET HOMES
1233 NW NORTHRUP ST. #125
PORTLAND, OR 97209

STORM BASIN AREA EXHIBIT
MIXED USE SITE DEVELOPMENT
38015 HWY 26, SANDY, OR 97055

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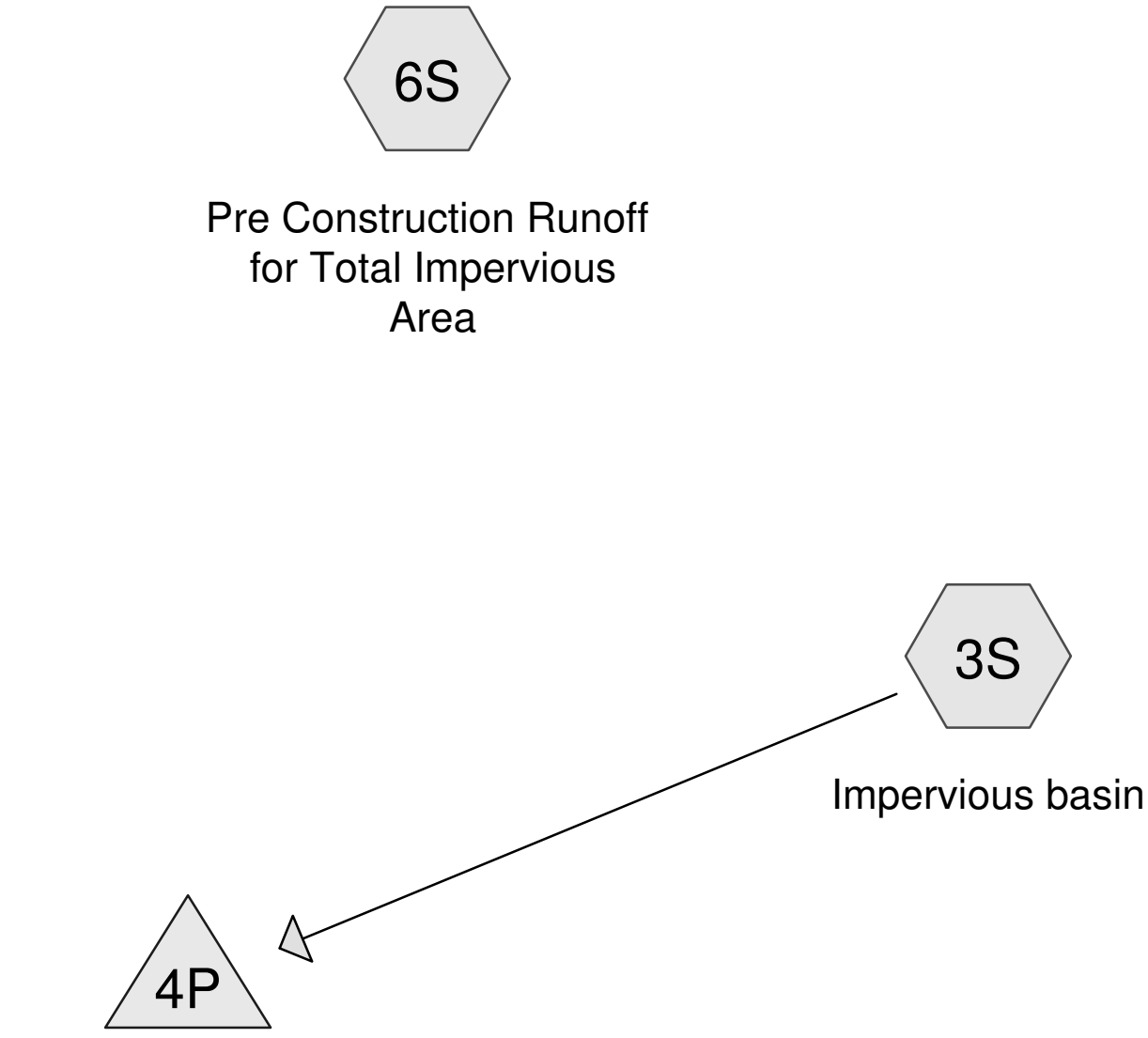


Subcat Reach Pond Link

Routing Diagram for REVISED PRELIMINARY E21-043 Storm
Prepared by Firwood Design Storm, Printed 9/15/2022

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2yr	Type IA 24-hr		Default	24.00	1	3.50	2
2	5yr	Type IA 24-hr		Default	24.00	1	4.50	2
3	10yr	Type IA 24-hr		Default	24.00	1	4.80	2
4	25yr	Type IA 24-hr		Default	24.00	1	5.50	2

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
41,740	98	Asphalt (3S)
11,320	98	Roof Area (3S)
5,490	98	Sidewalk (3S)
58,550	79	Woods/grass comb., Poor, HSG C (6S)
117,100	**89**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
58,550	HSG C	6S
0	HSG D	
58,550	Other	3S
117,100		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Su Nu
0	0	0	0	41,740	41,740	Asphalt	
0	0	0	0	11,320	11,320	Roof Area	
0	0	0	0	5,490	5,490	Sidewalk	
0	0	58,550	0	0	58,550	Woods/grass comb., Poor	
0	**0**	**58,550**	**0**	**58,550**	**117,100**	**TOTAL AREA**	

Time span=0.00-60.00 hrs, dt=0.05 hrs, 1201 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 3S: Impervious basin Runoff Area=58,550 sf 100.00% Impervious Runoff Depth=3.27"
Tc=6.0 min CN=0/98 Runoff=1.09 cfs 15,938 cf

Subcatchment 6S: Pre Construction Runoff Runoff Area=58,550 sf 0.00% Impervious Runoff Depth=1.57"
Flow Length=230' Tc=7.4 min CN=79/0 Runoff=0.46 cfs 7,641 cf

Pond 4P: 48" Detention Basin Peak Elev=2.33' Storage=1,927 cf Inflow=1.09 cfs 15,938 cf
Outflow=0.45 cfs 15,938 cf

Total Runoff Area = 117,100 sf Runoff Volume = 23,578 cf Average Runoff Depth = 2.42"
50.00% Pervious = 58,550 sf 50.00% Impervious = 58,550 sf

Summary for Subcatchment 3S: Impervious basin

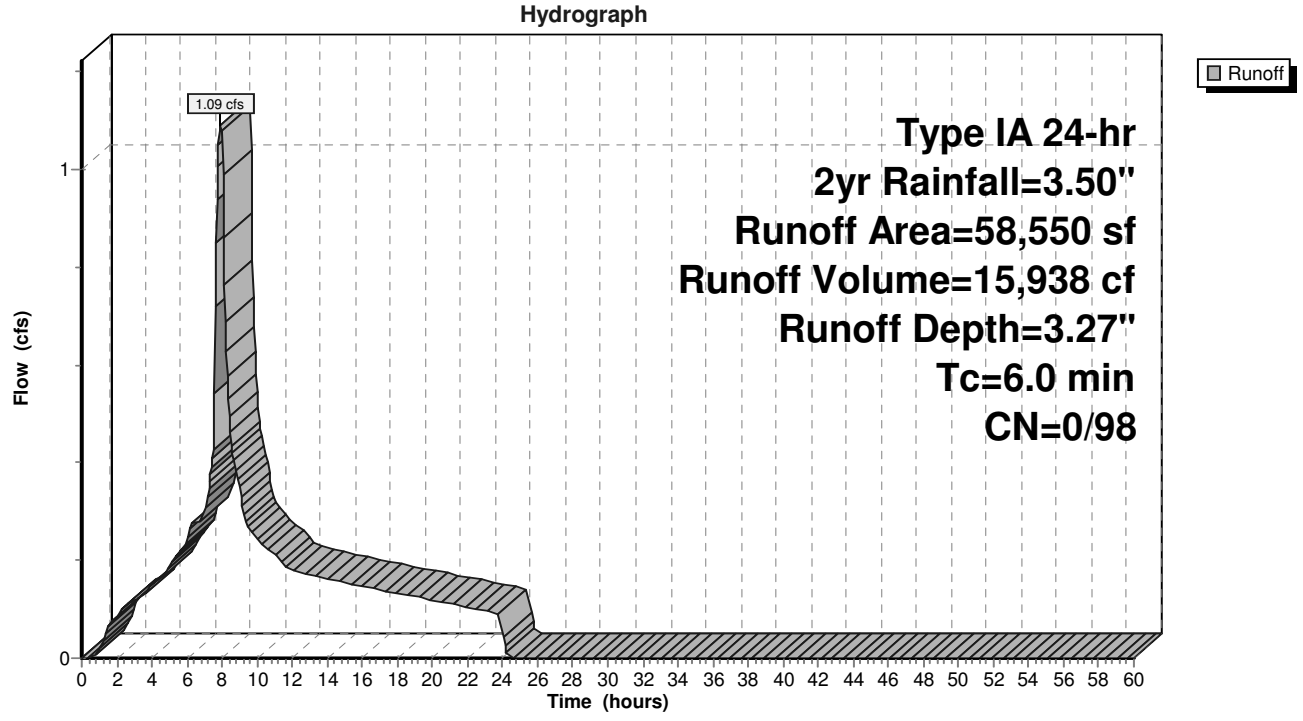
Runoff = 1.09 cfs @ 7.92 hrs, Volume= 15,938 cf, Depth= 3.27"
Routed to Pond 4P : 48" Detention Basin

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2yr Rainfall=3.50"

	Area (sf)	CN	Description
*	41,740	98	Asphalt
*	11,320	98	Roof Area
*	5,490	98	Sidewalk
	58,550	98	Weighted Average
	58,550		100.00% Impervious Area

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

Subcatchment 3S: Impervious basin



Summary for Subcatchment 6S: Pre Construction Runoff for Total Impervious Area

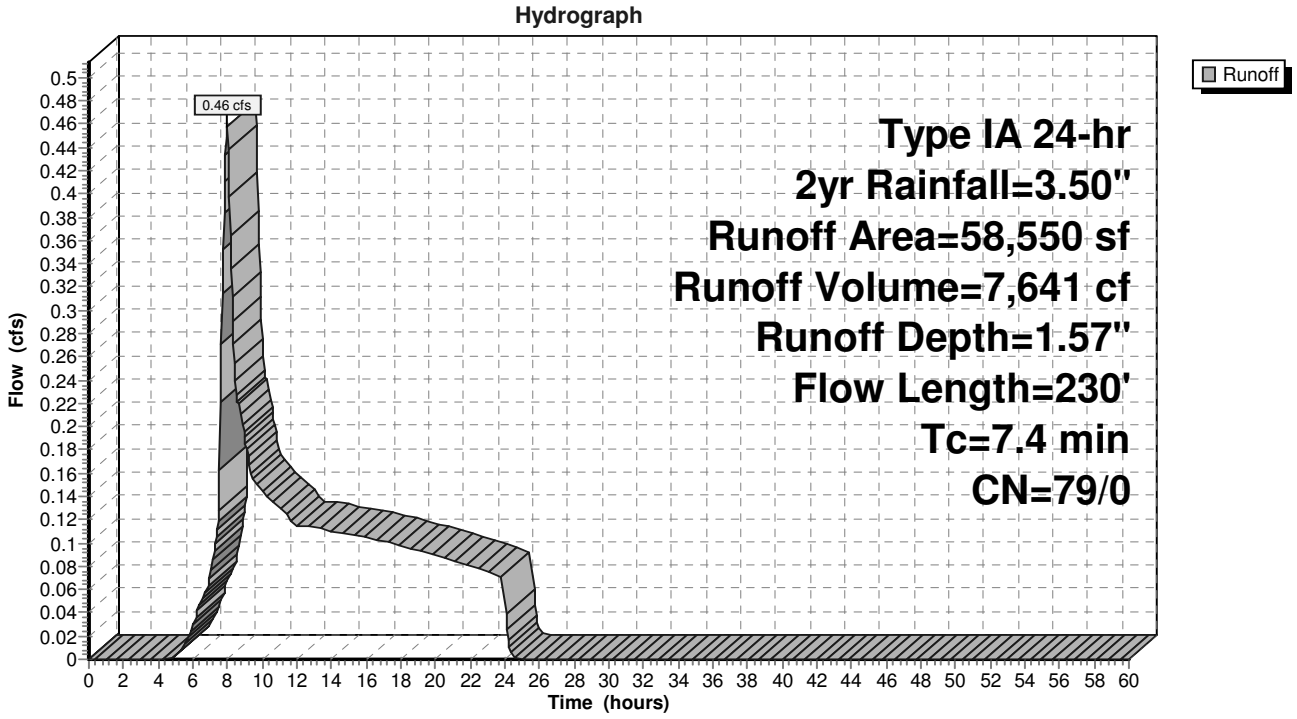
Runoff = 0.46 cfs @ 7.99 hrs, Volume= 7,641 cf, Depth= 1.57"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2yr Rainfall=3.50"

	Area (sf)	CN	Description
*	58,550	79	Woods/grass comb., Poor, HSG C
	58,550		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	100	0.0500	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.9	130	0.1200	2.42		**Shallow Concentrated Flow, Shallow** Short Grass Pasture Kv= 7.0 fps
7.4	230	Total			

Subcatchment 6S: Pre Construction Runoff for Total Impervious Area



Summary for Pond 4P: 48" Detention Basin

Inflow Area = 58,550 sf,100.00% Impervious, Inflow Depth = 3.27" for 2yr event
Inflow = 1.09 cfs @ 7.92 hrs, Volume= 15,938 cf
Outflow = 0.45 cfs @ 8.47 hrs, Volume= 15,938 cf, Atten= 59%, Lag= 33.4 min
Primary = 0.45 cfs @ 8.47 hrs, Volume= 15,938 cf

Routing by Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 2.33' @ 8.47 hrs Surf.Area= 1,230 sf Storage= 1,927 cf

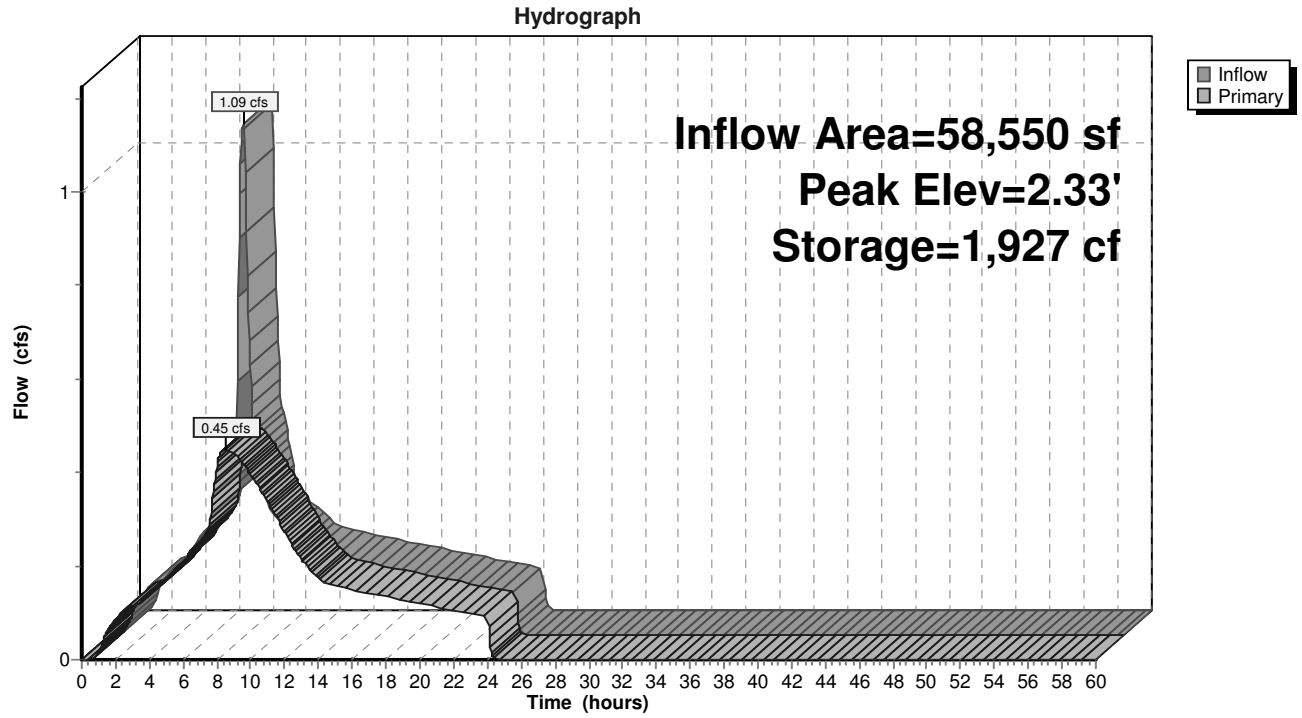
Plug-Flow detention time= 26.7 min calculated for 15,938 cf (100% of inflow)
Center-of-Mass det. time= 26.7 min (691.7 - 665.0)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	4,909 cf	**60.0" Round Pipe Storage** L= 250.0' S= 0.0020 '/'

Device	Routing	Invert	Outlet Devices		
#1	Primary	0.00'	**3.4" Vert. Orifice/Grate**	C= 0.600	Limited to weir flow at low heads
#2	Primary	2.50'	**4.4" Vert. Orifice/Grate**	C= 0.600	Limited to weir flow at low heads

Primary OutFlow Max=0.45 cfs @ 8.47 hrs HW=2.32' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 0.45 cfs @ 7.11 fps)
└─**2=Orifice/Grate** (Controls 0.00 cfs)

Pond 4P: 48" Detention Basin



Time span=0.00-60.00 hrs, dt=0.05 hrs, 1201 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 3S: Impervious basin Runoff Area=58,550 sf 100.00% Impervious Runoff Depth=4.26"
Tc=6.0 min CN=0/98 Runoff=1.41 cfs 20,805 cf

Subcatchment 6S: Pre Construction Runoff Runoff Area=58,550 sf 0.00% Impervious Runoff Depth=2.38"
Flow Length=230' Tc=7.4 min CN=79/0 Runoff=0.74 cfs 11,595 cf

Pond 4P: 48" Detention Basin Peak Elev=2.90' Storage=2,644 cf Inflow=1.41 cfs 20,805 cf
Outflow=0.74 cfs 20,805 cf

Total Runoff Area = 117,100 sf Runoff Volume = 32,400 cf Average Runoff Depth = 3.32"
50.00% Pervious = 58,550 sf 50.00% Impervious = 58,550 sf

Summary for Subcatchment 3S: Impervious basin

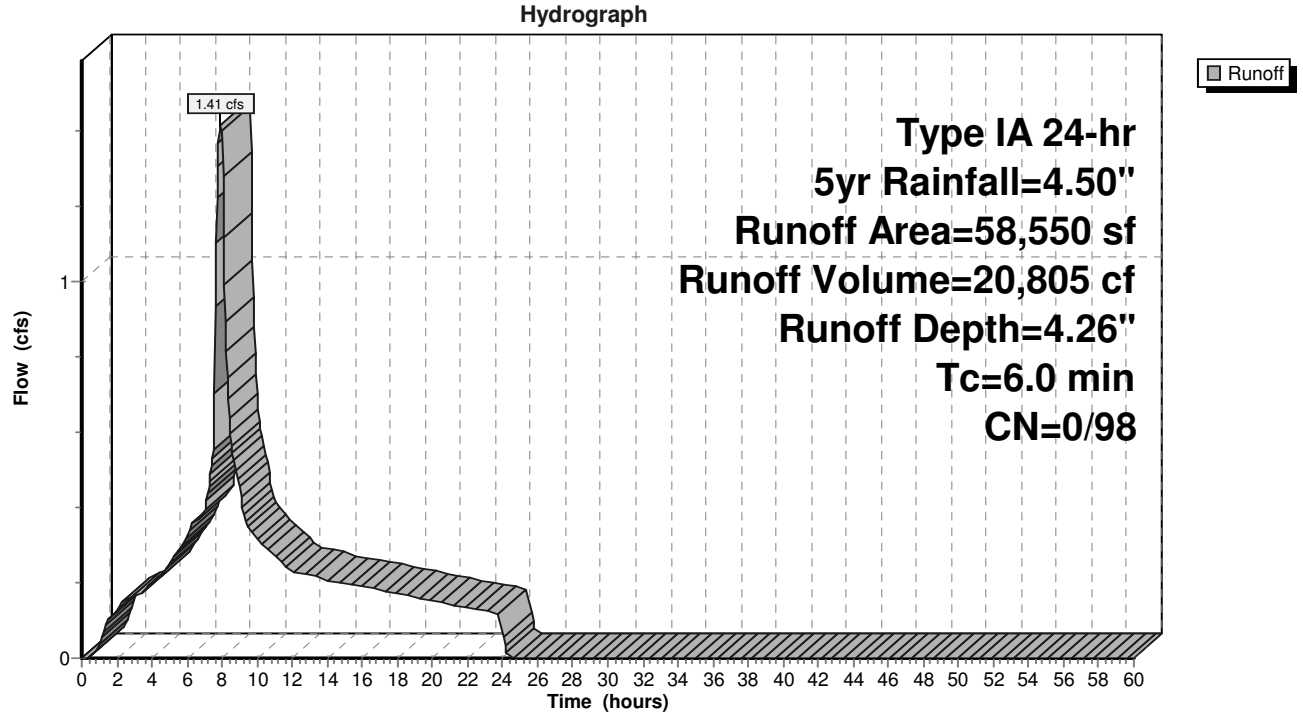
Runoff = 1.41 cfs @ 7.92 hrs, Volume= 20,805 cf, Depth= 4.26"
Routed to Pond 4P : 48" Detention Basin

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=4.50"

	Area (sf)	CN	Description
*	41,740	98	Asphalt
*	11,320	98	Roof Area
*	5,490	98	Sidewalk
	58,550	98	Weighted Average
	58,550		100.00% Impervious Area

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

Subcatchment 3S: Impervious basin



Summary for Subcatchment 6S: Pre Construction Runoff for Total Impervious Area

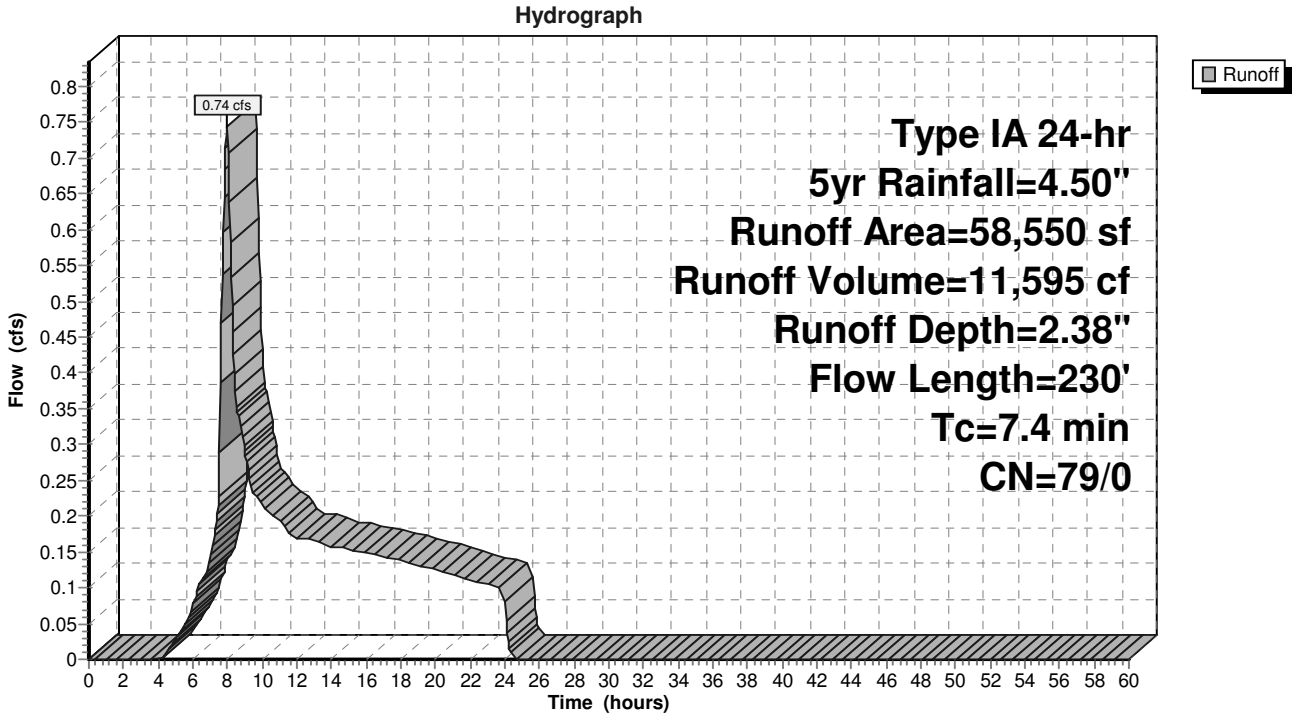
Runoff = 0.74 cfs @ 7.99 hrs, Volume= 11,595 cf, Depth= 2.38"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=4.50"

	Area (sf)	CN	Description
*	58,550	79	Woods/grass comb., Poor, HSG C
	58,550		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	100	0.0500	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.9	130	0.1200	2.42		**Shallow Concentrated Flow, Shallow** Short Grass Pasture Kv= 7.0 fps
7.4	230	Total			

Subcatchment 6S: Pre Construction Runoff for Total Impervious Area



Summary for Pond 4P: 48" Detention Basin

Inflow Area = 58,550 sf,100.00% Impervious, Inflow Depth = 4.26" for 5yr event
Inflow = 1.41 cfs @ 7.92 hrs, Volume= 20,805 cf
Outflow = 0.74 cfs @ 8.31 hrs, Volume= 20,805 cf, Atten= 48%, Lag= 23.4 min
Primary = 0.74 cfs @ 8.31 hrs, Volume= 20,805 cf

Routing by Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 2.90' @ 8.31 hrs Surf.Area= 1,246 sf Storage= 2,644 cf

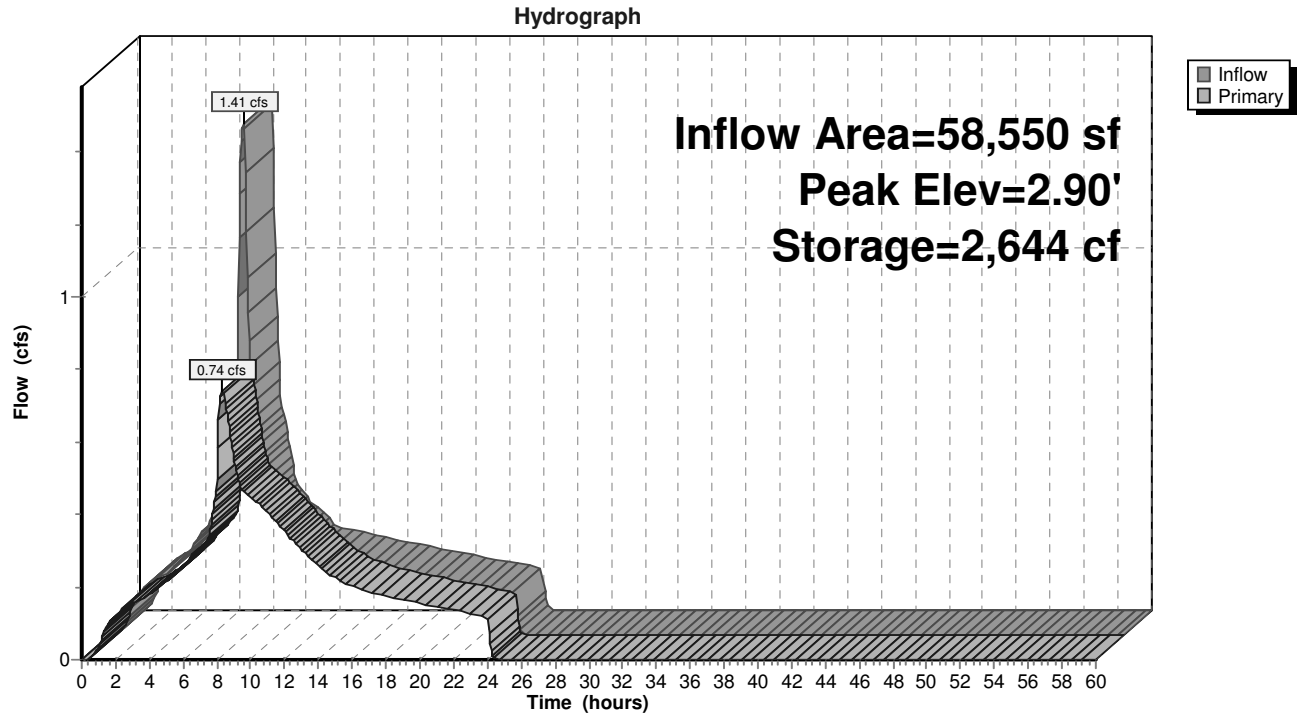
Plug-Flow detention time= 34.5 min calculated for 20,805 cf (100% of inflow)
Center-of-Mass det. time= 34.5 min (693.6 - 659.1)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	4,909 cf	**60.0" Round Pipe Storage** L= 250.0' S= 0.0020 '/'

Device	Routing	Invert	Outlet Devices		
#1	Primary	0.00'	**3.4" Vert. Orifice/Grate**	C= 0.600	Limited to weir flow at low heads
#2	Primary	2.50'	**4.4" Vert. Orifice/Grate**	C= 0.600	Limited to weir flow at low heads

Primary OutFlow Max=0.74 cfs @ 8.31 hrs HW=2.90' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 0.50 cfs @ 8.00 fps)
└**2=Orifice/Grate** (Orifice Controls 0.24 cfs @ 2.25 fps)

Pond 4P: 48" Detention Basin



Time span=0.00-60.00 hrs, dt=0.05 hrs, 1201 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 3S: Impervious basin Runoff Area=58,550 sf 100.00% Impervious Runoff Depth=4.56"
Tc=6.0 min CN=0/98 Runoff=1.51 cfs 22,266 cf

Subcatchment 6S: Pre Construction Runoff Runoff Area=58,550 sf 0.00% Impervious Runoff Depth=2.63"
Flow Length=230' Tc=7.4 min CN=79/0 Runoff=0.83 cfs 12,834 cf

Pond 4P: 48" Detention Basin Peak Elev=3.05' Storage=2,829 cf Inflow=1.51 cfs 22,266 cf
Outflow=0.83 cfs 22,266 cf

Total Runoff Area = 117,100 sf Runoff Volume = 35,100 cf Average Runoff Depth = 3.60"
50.00% Pervious = 58,550 sf 50.00% Impervious = 58,550 sf

Summary for Subcatchment 3S: Impervious basin

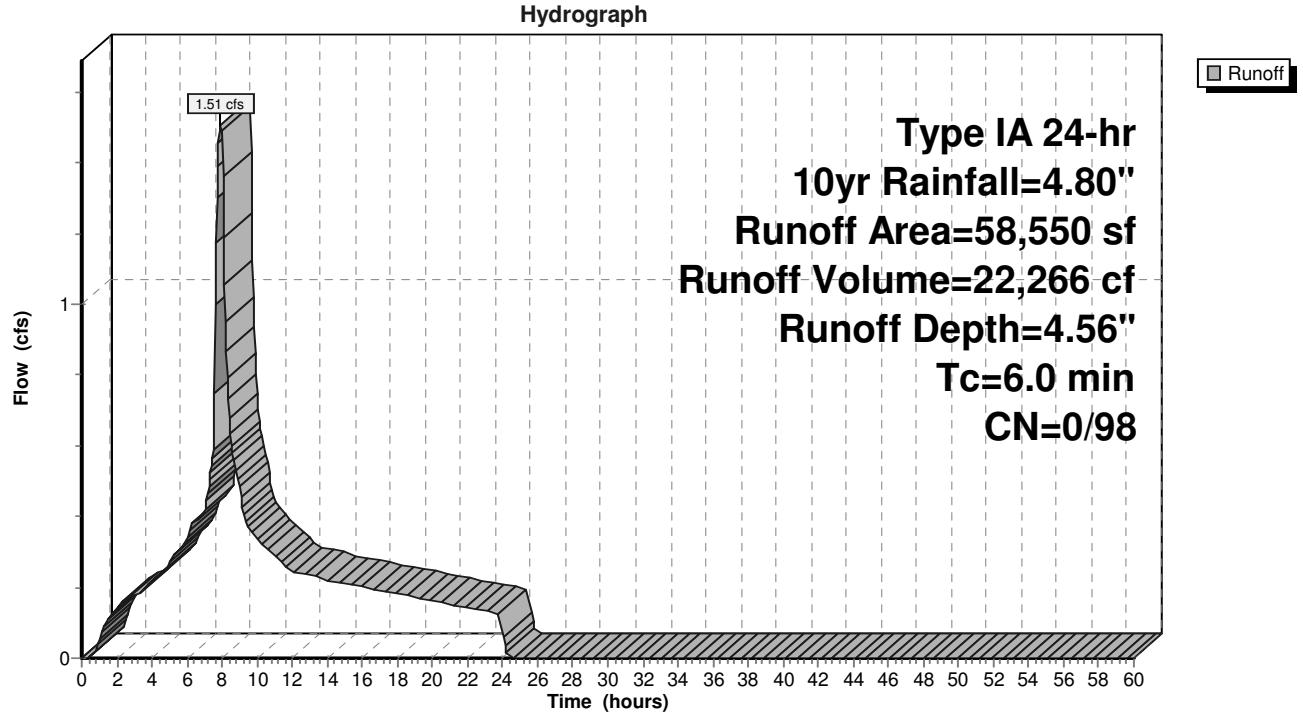
Runoff = 1.51 cfs @ 7.91 hrs, Volume= 22,266 cf, Depth= 4.56"
Routed to Pond 4P : 48" Detention Basin

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10yr Rainfall=4.80"

	Area (sf)	CN	Description
*	41,740	98	Asphalt
*	11,320	98	Roof Area
*	5,490	98	Sidewalk
	58,550	98	Weighted Average
	58,550		100.00% Impervious Area

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

Subcatchment 3S: Impervious basin



Summary for Subcatchment 6S: Pre Construction Runoff for Total Impervious Area

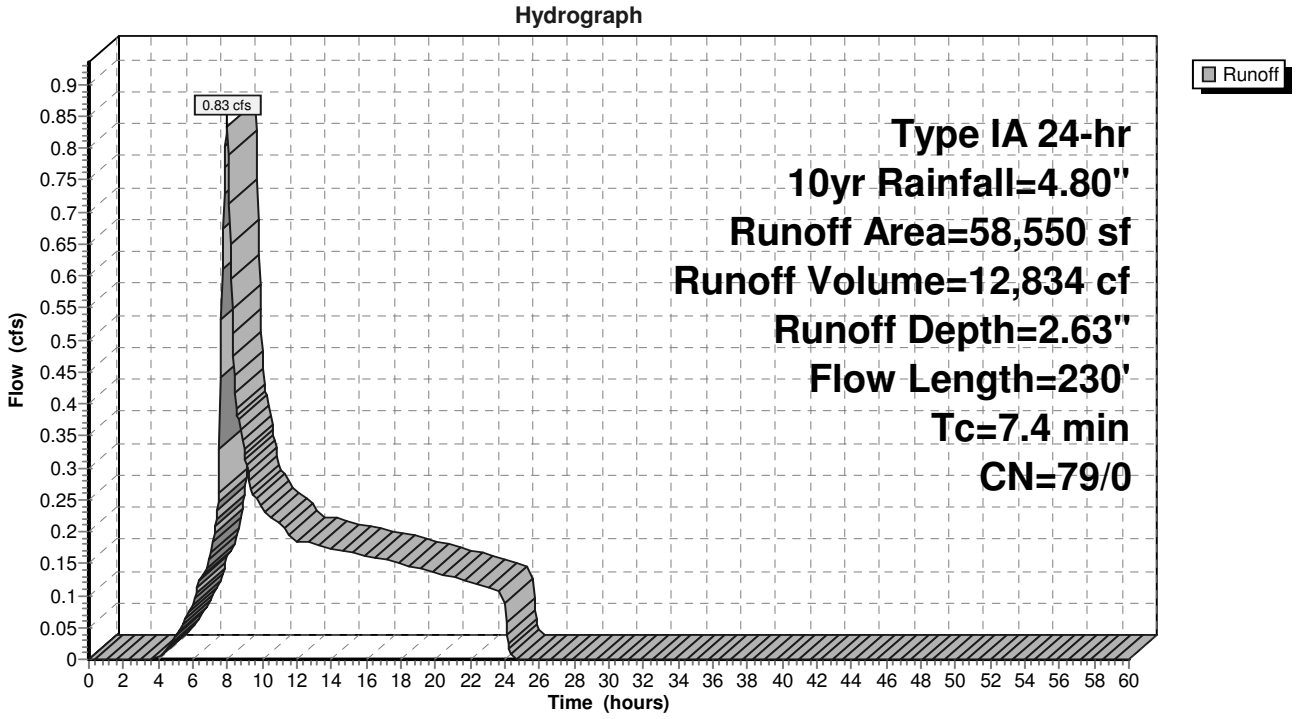
Runoff = 0.83 cfs @ 7.98 hrs, Volume= 12,834 cf, Depth= 2.63"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10yr Rainfall=4.80"

	Area (sf)	CN	Description
*	58,550	79	Woods/grass comb., Poor, HSG C
	58,550		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	100	0.0500	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.9	130	0.1200	2.42		**Shallow Concentrated Flow, Shallow** Short Grass Pasture Kv= 7.0 fps
7.4	230	Total			

Subcatchment 6S: Pre Construction Runoff for Total Impervious Area



Summary for Pond 4P: 48" Detention Basin

Inflow Area = 58,550 sf,100.00% Impervious, Inflow Depth = 4.56" for 10yr event
Inflow = 1.51 cfs @ 7.91 hrs, Volume= 22,266 cf
Outflow = 0.83 cfs @ 8.28 hrs, Volume= 22,266 cf, Atten= 45%, Lag= 21.9 min
Primary = 0.83 cfs @ 8.28 hrs, Volume= 22,266 cf

Routing by Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 3.05' @ 8.28 hrs Surf.Area= 1,239 sf Storage= 2,829 cf

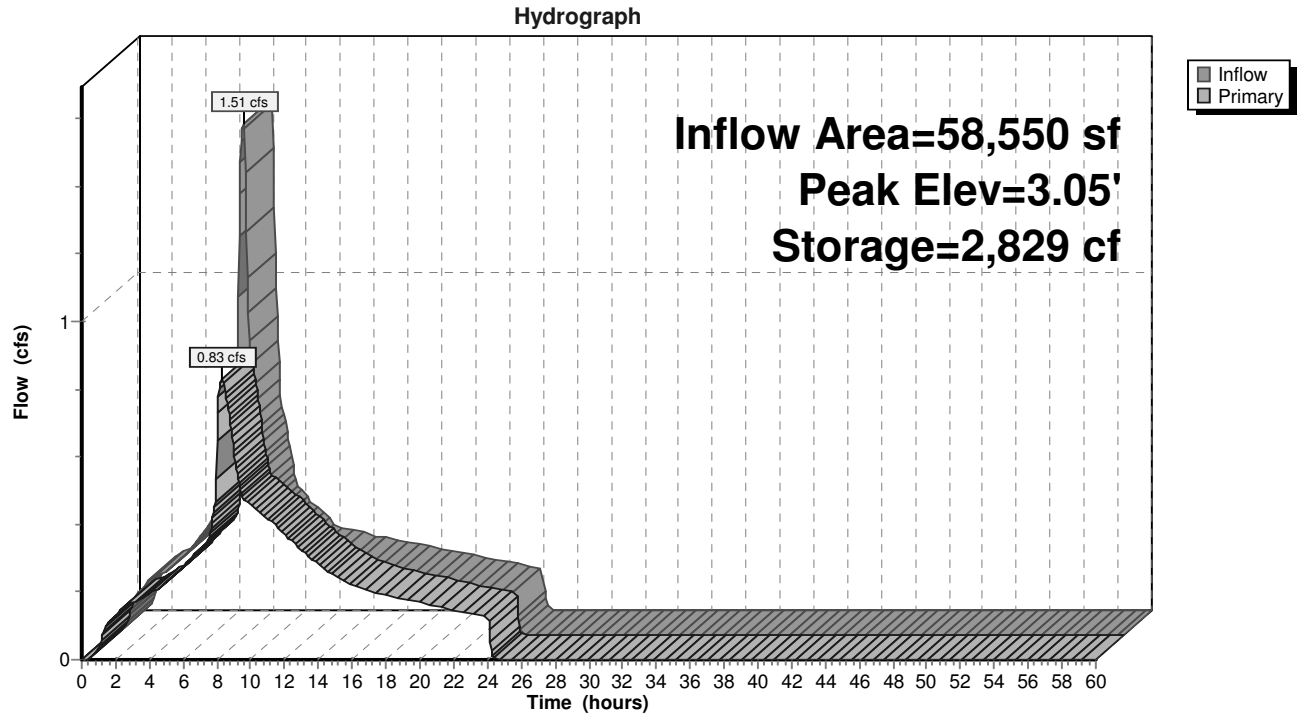
Plug-Flow detention time= 36.0 min calculated for 22,248 cf (100% of inflow)
Center-of-Mass det. time= 36.0 min (693.7 - 657.7)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	4,909 cf	**60.0" Round Pipe Storage** L= 250.0' S= 0.0020 '/'

Device	Routing	Invert	Outlet Devices		
#1	Primary	0.00'	**3.4" Vert. Orifice/Grate**	C= 0.600	Limited to weir flow at low heads
#2	Primary	2.50'	**4.4" Vert. Orifice/Grate**	C= 0.600	Limited to weir flow at low heads

Primary OutFlow Max=0.83 cfs @ 8.28 hrs HW=3.05' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 0.52 cfs @ 8.21 fps)
└**2=Orifice/Grate** (Orifice Controls 0.31 cfs @ 2.91 fps)

Pond 4P: 48" Detention Basin



Time span=0.00-60.00 hrs, dt=0.05 hrs, 1201 points
Runoff by SBUH method, Split Pervious/Imperv.
Reach routing by Stor-Ind method - Pond routing by Stor-Ind method

Subcatchment 3S: Impervious basin Runoff Area=58,550 sf 100.00% Impervious Runoff Depth=5.26"
Tc=6.0 min CN=0/98 Runoff=1.73 cfs 25,676 cf

Subcatchment 6S: Pre Construction Runoff Runoff Area=58,550 sf 0.00% Impervious Runoff Depth=3.24"
Flow Length=230' Tc=7.4 min CN=79/0 Runoff=1.05 cfs 15,792 cf

Pond 4P: 48" Detention Basin Peak Elev=3.43' Storage=3,293 cf Inflow=1.73 cfs 25,676 cf
Outflow=0.99 cfs 25,676 cf

Total Runoff Area = 117,100 sf Runoff Volume = 41,469 cf Average Runoff Depth = 4.25"
50.00% Pervious = 58,550 sf 50.00% Impervious = 58,550 sf

Summary for Subcatchment 3S: Impervious basin

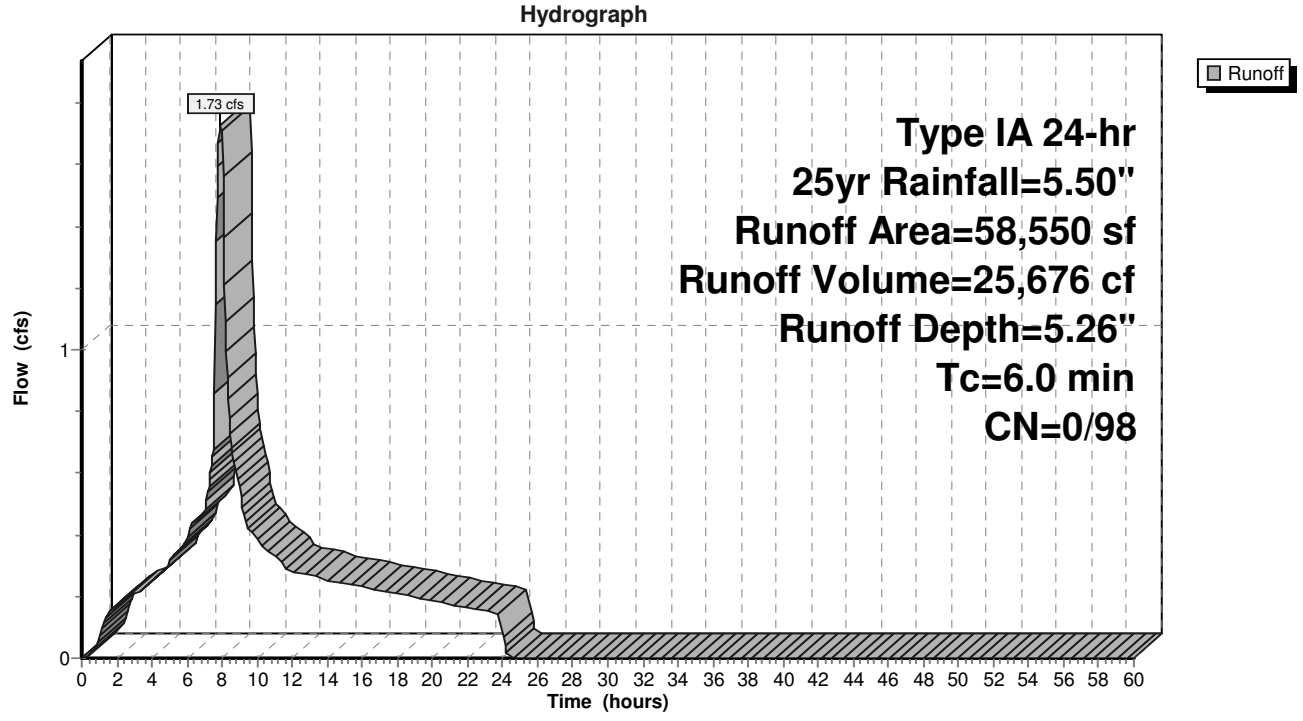
Runoff = 1.73 cfs @ 7.91 hrs, Volume= 25,676 cf, Depth= 5.26"
Routed to Pond 4P : 48" Detention Basin

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25yr Rainfall=5.50"

	Area (sf)	CN	Description
*	41,740	98	Asphalt
*	11,320	98	Roof Area
*	5,490	98	Sidewalk
	58,550	98	Weighted Average
	58,550		100.00% Impervious Area

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

Subcatchment 3S: Impervious basin



Summary for Subcatchment 6S: Pre Construction Runoff for Total Impervious Area

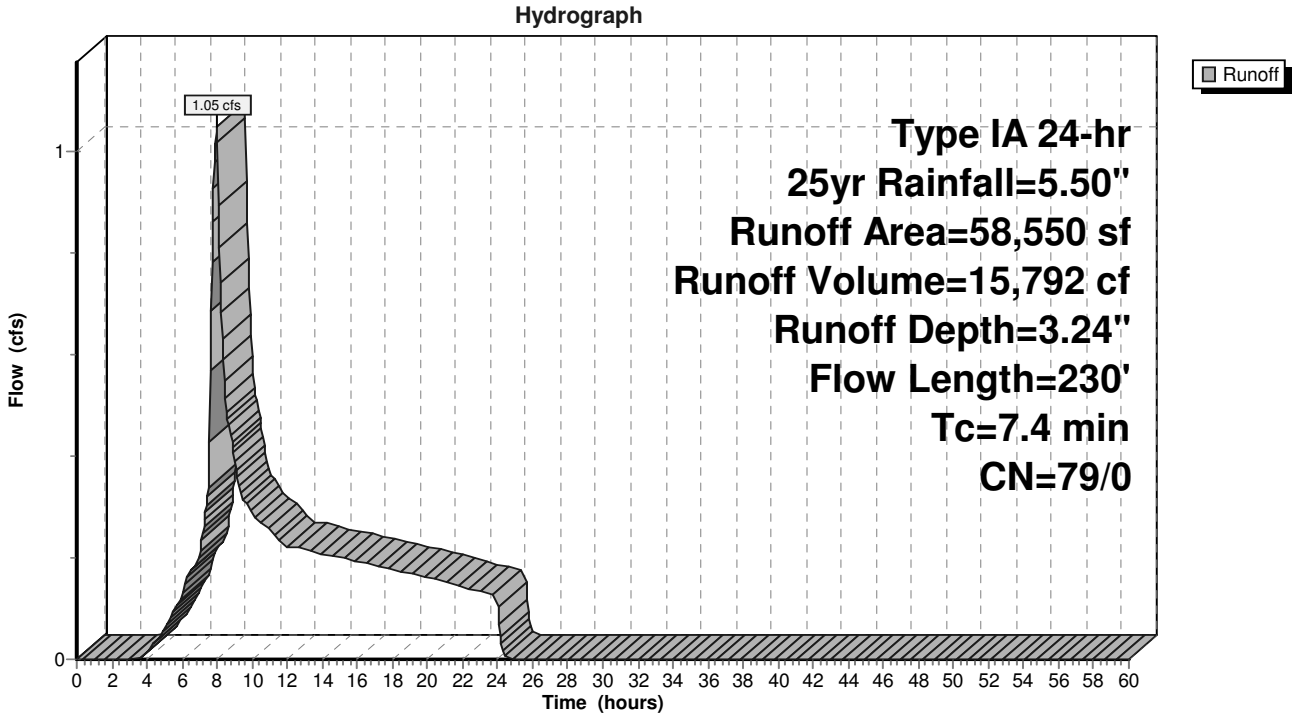
Runoff = 1.05 cfs @ 7.98 hrs, Volume= 15,792 cf, Depth= 3.24"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25yr Rainfall=5.50"

	Area (sf)	CN	Description
*	58,550	79	Woods/grass comb., Poor, HSG C
	58,550		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	100	0.0500	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.50"
0.9	130	0.1200	2.42		**Shallow Concentrated Flow, Shallow** Short Grass Pasture Kv= 7.0 fps
7.4	230	Total			

Subcatchment 6S: Pre Construction Runoff for Total Impervious Area



Summary for Pond 4P: 48" Detention Basin

Inflow Area = 58,550 sf,100.00% Impervious, Inflow Depth = 5.26" for 25yr event
Inflow = 1.73 cfs @ 7.91 hrs, Volume= 25,676 cf
Outflow = 0.99 cfs @ 8.26 hrs, Volume= 25,676 cf, Atten= 43%, Lag= 20.5 min
Primary = 0.99 cfs @ 8.26 hrs, Volume= 25,676 cf

Routing by Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 3.43' @ 8.26 hrs Surf.Area= 1,200 sf Storage= 3,293 cf

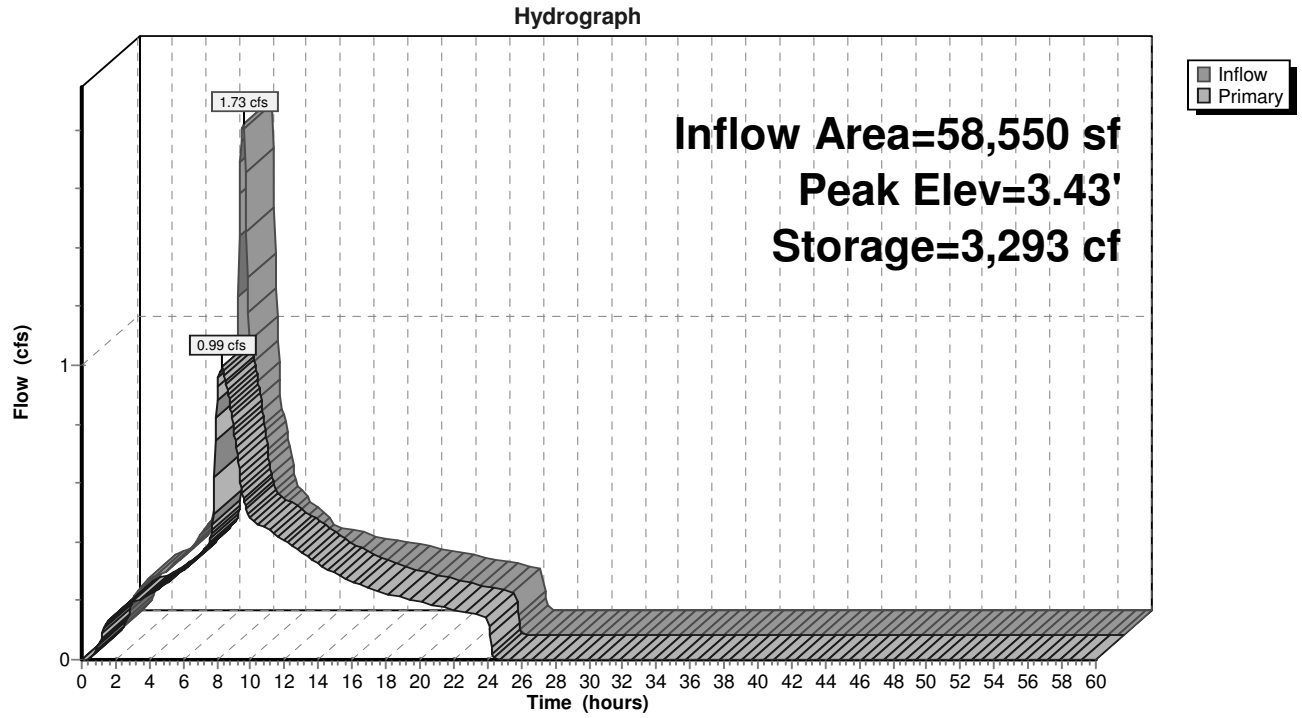
Plug-Flow detention time= 39.7 min calculated for 25,676 cf (100% of inflow)
Center-of-Mass det. time= 39.7 min (694.8 - 655.1)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	4,909 cf	**60.0" Round Pipe Storage** L= 250.0' S= 0.0020 '/'

Device	Routing	Invert	Outlet Devices		
#1	Primary	0.00'	**3.4" Vert. Orifice/Grate**	C= 0.600	Limited to weir flow at low heads
#2	Primary	2.50'	**4.4" Vert. Orifice/Grate**	C= 0.600	Limited to weir flow at low heads

Primary OutFlow Max=0.99 cfs @ 8.26 hrs HW=3.43' (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 0.55 cfs @ 8.73 fps)
└**2=Orifice/Grate** (Orifice Controls 0.44 cfs @ 4.16 fps)

Pond 4P: 48" Detention Basin



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 Clackamas County Area, Oregon

January 28, 2022

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://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

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 Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

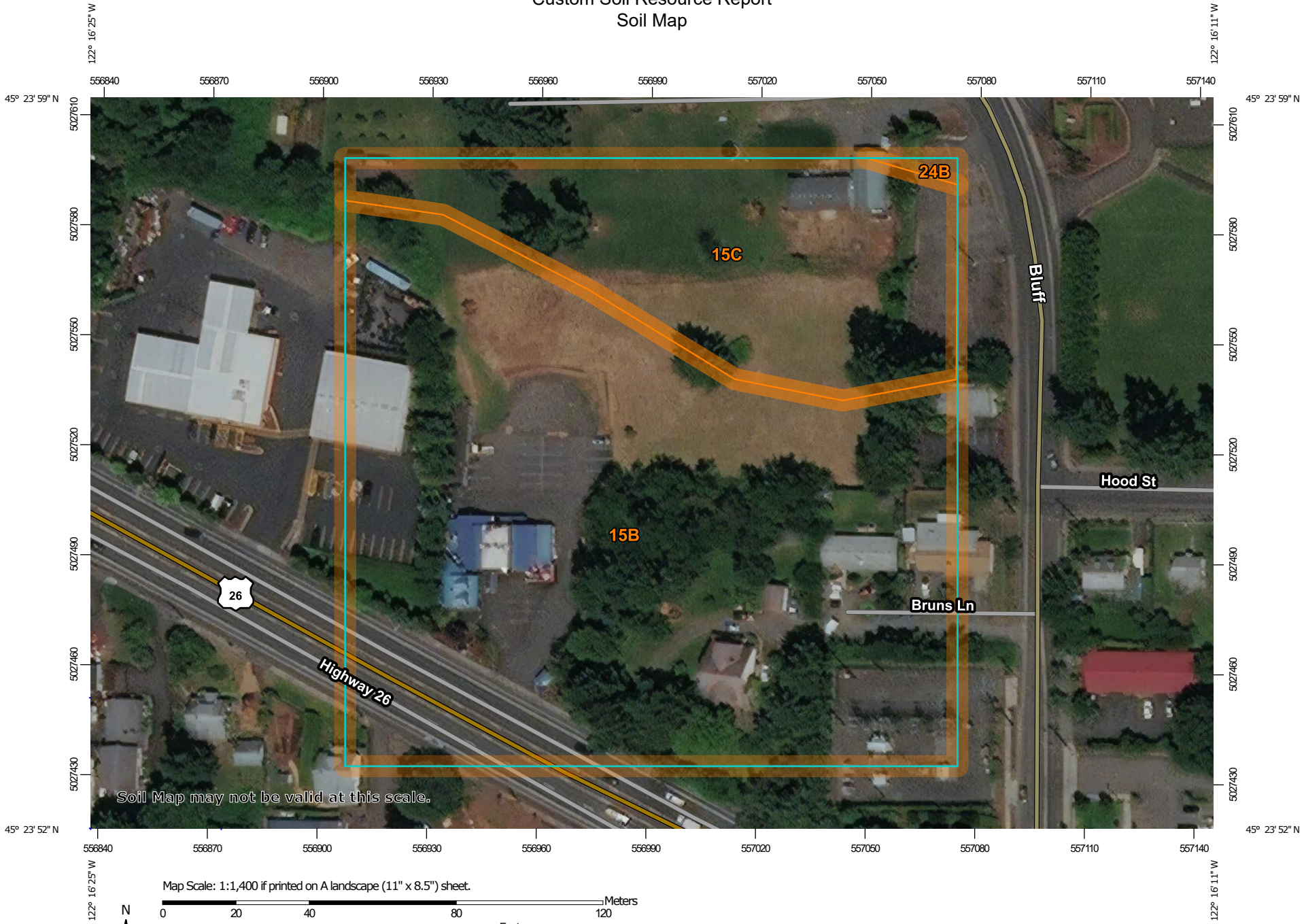
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

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: 1:1,400 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 Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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: Clackamas County Area, Oregon
Survey Area Data: Version 18, Oct 27, 2021

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

Date(s) aerial images were photographed: Jul 2, 2015—Sep 21, 2016

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
15B	Cazadero silty clay loam, 0 to 7 percent slopes	5.1	74.2%
15C	Cazadero silty clay loam, 7 to 12 percent slopes	1.8	25.4%
24B	Cottrell silty clay loam, 2 to 8 percent slopes	0.0	0.3%
Totals for Area of Interest		**6.9**	**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.

Clackamas County Area, Oregon

15B—Cazadero silty clay loam, 0 to 7 percent slopes

Map Unit Setting

National map unit symbol: 223c
Elevation: 300 to 900 feet
Mean annual precipitation: 48 to 85 inches
Mean annual air temperature: 50 to 52 degrees F
Frost-free period: 140 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Cazadero and similar soils: 85 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cazadero

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Old mixed alluvium

Typical profile

H1 - 0 to 21 inches: silty clay loam
H2 - 21 to 75 inches: clay

Properties and qualities

Slope: 0 to 7 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: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: F003XC003OR - Glaciated Western Cascades Mesic Udic Forest Group
Forage suitability group: Well drained < 15% Slopes (G002XY002OR)
Other vegetative classification: Well drained < 15% Slopes (G002XY002OR)
Hydric soil rating: No

Minor Components

Borges

Percent of map unit: 2 percent
Landform: Hillslopes, depressions on terraces

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: Poorly Drained (G002XY006OR)
Hydric soil rating: Yes

15C—Cazadero silty clay loam, 7 to 12 percent slopes

Map Unit Setting

National map unit symbol: 223d
Elevation: 600 to 900 feet
Mean annual precipitation: 60 to 85 inches
Mean annual air temperature: 50 to 52 degrees F
Frost-free period: 140 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Cazadero and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cazadero

Setting

Landform: Terraces
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Old mixed alluvium

Typical profile

H1 - 0 to 21 inches: silty clay loam
H2 - 21 to 75 inches: clay

Properties and qualities

Slope: 7 to 12 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: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: F003XC003OR - Glaciated Western Cascades Mesic Udic Forest Group

Forage suitability group: Well drained < 15% Slopes (G002XY002OR)
Other vegetative classification: Well drained < 15% Slopes (G002XY002OR)
Hydric soil rating: No

24B—Cottrell silty clay loam, 2 to 8 percent slopes

Map Unit Setting

National map unit symbol: 223v
Elevation: 300 to 900 feet
Mean annual precipitation: 45 to 80 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 140 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Cottrell and similar soils: 90 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cottrell

Setting

Landform: Hillslopes, terraces
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Interfluve, base slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Old alluvium

Typical profile

H1 - 0 to 24 inches: silty clay loam
H2 - 24 to 55 inches: silty clay
H3 - 55 to 86 inches: silty clay loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately 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 24 to 35 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 10.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C
Ecological site: F002XB006OR - Foothill Group
Forage suitability group: Moderately Well Drained < 15% Slopes (G002XY004OR)

Other vegetative classification: Moderately Well Drained < 15% Slopes (G002XY004OR)
Hydric soil rating: No

Minor Components

Borges

Percent of map unit: 4 percent
Landform: Hillslopes, depressions on terraces
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: Poorly Drained (G002XY006OR)
Hydric soil rating: Yes

Aquults

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

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