PACIFIC FAMILY DENTAL PARKING LOT EXPANSION

PRELIMINARY STORMWATER REPORT

DATE: July 17, 2013

CLIENT: Nathan Doyel
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Sherwood, OR 97140

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6-17-13

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TABLE OF CONTENTS

1.0 PURPOSE OF REPORT

2.0 PROJECT LOCATION/DESCRIPTION

3.0 REGULATORY DESIGN CRITERIA
- 3.1 STORMWATER QUANTITY MANAGEMENT CRITERIA
- 3.2 STORMWATER QUALITY MANAGEMENT CRITERIA
- 3.3 FLOOD PLAIN

4.0 SUMMARY OF ON-SITE STORMWATER DETENTION RESULTS

5.0 SOURCES OF INFORMATION AND DESIGN METHODOLOGY

6.0 DESIGN PARAMETERS
- 6.1 DESIGN STORM
  - 6.1.1 STORMWATER DETENTION FACILITY DESIGN
  - 6.1.2 INLET AND CONDUIT SIZING
- 6.2 PRE-DEVELOPED SITE TOPOGRAPHY AND LAND USE
  - 6.2.1 SITE TOPOGRAPHY
  - 6.2.2 LAND USE
  - 6.2.3 PRE-DEVELOPED INPUT PARAMETERS
- 6.3 SOIL TYPE
- 6.4 POST-DEVELOPED SITE TOPOGRAPHY AND LAND USE
  - 6.4.1 SITE TOPOGRAPHY
  - 6.4.2 LAND USE
  - 6.4.3 POST-DEVELOPED INPUT PARAMETERS
- 6.5 DESCRIPTION OF OFF-SITE CONTRIBUTORY BASINS

7.0 CALCULATION METHODOLOGY
- 7.1 PROPOSED STORMWATER CONDUIT SIZING AND INLET SPACING
- 7.2 PROPOSED STORMWATER QUANTITY CONTROL FACILITY DESIGN
- 7.3 PROPOSED STORMWATER QUALITY CONTROL FACILITY DESIGN
- 7.4 ENERGY DISSIPATER CALCULATIONS
- 7.5 DOWNSTREAM ANALYSIS

8.0 STORMWATER QUANTITY CONTROL FACILITY OPERATION

9.0 STORMWATER QUALITY FACILITY OPERATION

APPENDIX 1-1 VICINITY MAP

APPENDIX 1-2 CATCHMENT MAPS

APPENDIX 2-1 PRE-DEVELOPED 25-YEAR STORM CALCULATIONS (3.90”)

APPENDIX 2-2 POST-DEVELOPED 25-YEAR STORM CALCULATIONS (3.90”)

APPENDIX 3-1 WATER QUALITY AND VEGETATED SWALE CALCULATIONS

APPENDIX 3-2 FLOWMASTER ANALYSIS OF VEGETATED SWALE

APPENDIX 4-1 DOWNSTREAM ANALYSIS AND CALCULATIONS

APPENDIX 5-1 RELEVANT INFORMATION FROM THE KING COUNTY SURFACE WATER MANAGEMENT MANUAL

APPENDIX 6-1 USDA SOIL SURVEY OF WASHINGTON COUNTY, OREGON

APPENDIX 7-1 CEDAR BROOK PROFESSIONAL BUILDING STORMWATER REPORT

STORMWATER REPORT

PROJECT: PACIFIC FAMILY DENTAL PARKING LOT EXPANSION

1.0 PURPOSE OF REPORT

The purpose of this report is to document the criteria for which the stormwater system for this site was designed to meet, the sources of information upon which the analysis is based, the design methodology, and the results of the analysis.

2.0 PROJECT LOCATION/DESCRIPTION

The proposed development is on approximately 2.83 acres in Sections 30 and 31, Township 2 South, Range 1 West, Willamette Meridian, City of Sherwood, Washington County, Oregon (Tax Lot 2100, Tax Map 2S 1 31BA and Tax Lot 1600, Tax Map 2S 1 30CD). The site is located southeast of the intersection of SW Cedar Brook Way and SW Handley Street.

A dental office is located on Tax Lot 1600. This project consists of constructing additional parking area on Tax Lot 2100, south of the existing dental office. A vegetated swale is located along the western portion of the south boundary of the property and provides water quality treatment for most of the dental office and parking area. Due to topography, the existing west parking lot stormwater runoff is discharged into underground storm drainage pipes and routed to and treated in the Wyndham Ridge stormwater facility, located on the east side of SW Roellich Avenue. The Wyndham Ridge Stormwater facility discharges into a tributary of Cedar Creek. Treated stormwater runoff from the existing vegetated swale flows through underground storm drainage pipes and through the Wyndham Ridge Stormwater facility, into the Cedar Creek tributary.

The parking lot expansion requires a paved connection from the existing west parking lot to the new south parking lot over the existing swale. Approximately 30 feet of the existing vegetated swale will need be routed through a culvert under the connection. To mitigate for the loss of vegetated swale water quality treatment and provide water quality treatment for the new parking lot impervious area, approximately 37 feet of new vegetated swale will be added to the remaining existing vegetated swale.

3.0 REGULATORY DESIGN CRITERIA

3.1 STORMWATER QUANTITY MANAGEMENT CRITERIA

A downstream analysis has been performed; please see attached Hydrocad report and downstream analysis calculations that show stormwater detention is not necessary in accordance with *Clean Water Services Design and Construction Standards for Sanitary Sewer and Surface Water Management (R&O 07-20)*. The analysis shows that the additional flows created by the development of this property constitute less than 5% of the total tributary drainage flow downstream from this site at the discharge point from the Wyndham Ridge stormwater facility into the Cedar Creek tributary. The downstream drainage has been visually investigate for ¼ mile downstream, and there does not appear to be any potential downstream impacts to structures.

3.2 STORMWATER QUALITY MANAGEMENT CRITERIA

Stormwater quality management criteria has been addressed in the existing development in two ways. An existing vegetated swale, designed to meet the requirements of *Clean Water Services Design and Construction Standards for Sanitary Sewer and Surface Water Management (R&O 07-20),* was constructed

to address stormwater quality for the existing dental office and parking areas. Stormwater from the existing east parking lot and existing dental office is conveyed to the existing vegetated swale. Due to the site configuration and existing topography, stormwater from the west parking lot could not be conveyed to the existing vegetated swale and was directly routed to the storm sewer in SW Handley Street, and ultimately to the Wyndham Ridge stormwater facility. Untreated stormwater from the 5,500 square foot existing west parking lot exceeded the capacity of the Wyndham Ridge stormwater facility by 550 square feet. A "fee-in-lieu" was paid to mitigate for the extra untreated stormwater. The stormwater report for the existing dental office development is included in Appendix 7-1.

The addition of the south parking lot requires 30 feet of the existing swale to be removed and routed through a culvert to provide access from the new south parking lot to the existing west parking lot. The vegetated swale will be extended approximately 37 feet. The partial removal of the existing swale and the proposed additional length will result in a total length of 107 feet. The extension of the existing vegetated swale will meet the length, hydraulic residence time, maximum depth, freeboard, and velocity requirements of *Clean Water Services Design and Construction Standards for Sanitary Sewer and Surface Water Management (R&O 07-20)* for the stormwater runoff from the new parking area, existing building, and the existing parking area that flow into the existing vegetated swale. The existing west parking area will continue to be treated for water quality in the Wyndham Ridge Stormwater facility.

3.3 FLOOD PLAIN

The Flood Insurance Rate Map (FIRM) produced by the Federal Emergency Management Agency (FEMA) indicates that the project does not lie within any floodplain.

4.0 SUMMARY OF ON-SITE STORMWATER DETENTION RESULTS

There are no known downstream stormwater deficiencies; therefore, on-site stormwater detention is not required. See Section 7.5 DOWNSTREAM ANALYSIS.

5.0 SOURCES OF INFORMATION AND DESIGN METHODOLOGY

The vegetated swale was designed by using Manning's equation base on the water quality flow and peak flow for the 25-year event. FlowMaster computer software aided in the analysis.

The Santa Barbara Urban Hydrograph (SBUH) Method is utilized for the stormwater analysis. This method utilizes the SCS Type 1A 24-hour storm. Hydrocad software aided in the analysis.

6.0 DESIGN PARAMETERS

6.1 DESIGN STORM

6.1.1 STORMWATER DETENTION FACILITY DESIGN

There are no known downstream stormwater deficiencies; therefore, stormwater detention is not required.

6.1.2 INLET AND CONDUIT SIZING

The stormwater inlets (catch basins) for the parking lot expansion are placed according to the grading (at all low points in grade and other necessary locations) and will adequately handle the stormwater for the site.

The stormwater pipes are sized to adequately handle stormwater runoff from the 25-year storm event during final engineering.

6.2 PRE-DEVELOPED SITE TOPOGRAPHY AND LAND USE

6.2.1 SITE TOPOGRAPHY

A dental office is located on Tax Lot 1600. This project consists of constructing additional parking area on Tax Lot 2100, south of the existing dental office. The existing topography of the parking lot expansion

area is currently graveled and slopes gently to the west. There is an existing garage that will be removed for the expansion.

The remainder of Tax Lot 2100 consists of a single family residential building that will remain. The remainder of the site slopes to a Cedar Creek tributary to the west.

6.2.2 LAND USE

The site has an existing commercial building and two parking lots on Tax Lot 1600 and a single family residential building and accessory buildings on Tax Lot 2100.

6.2.3 PRE-DEVELOPED INPUT PARAMETERS

The pre-developed input parameters are not necessary because detention is not required.

6.3 SOIL TYPE

The soil for the site consists primarily of Quatama Loam, which belongs to hydrologic soil group "C". Less than 2% of the site is Huberly Silt Loam at the northwest corner of the site. The Huberly Silt Loam belongs to the hydrologic soil group "C/D". This area is not being developed. This information is identified in the USDA SCS Soil Survey of Washington County, Oregon. The applicable information is provided in this report.

6.4 POST-DEVELOPED SITE TOPOGRAPHY AND LAND USE

6.4.1 SITE TOPOGRAPHY

A dental office is located on Tax Lot 1600. This project consists of constructing additional parking area on Tax Lot 2100, south of the existing dental office. The topography of the remainder of Tax 2100 will not change.

6.4.2 LAND USE

The post-developed land use consists of an office building, parking spaces, landscaping, and a vegetated swale.

6.4.3 POST-DEVELOPED INPUT PARAMETERS

The input parameters are shown for the site on the catchment map and area identified as subcatchments 10, 20, 30, and 50.

6.5 DESCRIPTION OF OFF-SITE CONTRIBUTORY BASINS

There are no off-site upstream basins.

7.0 CALCULATION METHODOLOGY

7.1 PROPOSED STORMWATER CONDUIT SIZING AND INLET SPACING

The pipes are sized to have adequate capacity to convey stormwater runoff from the 25-year storm event.

7.2 PROPOSED STORMWATER QUANTITY CONTROL (DETENTION) FACILITY DESIGN

There are no know downstream deficiencies; therefore, stormwater detention is not required.

7.3 PROPOSED STORMWATER QUALITY CONTROL FACILITY DESIGN

The input parameters for the subcatchment (basin) are shown in this report. They were determined by topographic survey information, design, and analysis. The hydrographs were created with Hydrocad software. The stormwater quality facility is a vegetated swale designed in accordance to the *Clean Water Services Design and Construction Standards for Sanitary Sewer and Surface Water Management (R&O 07-20).*

7.4 ENERGY DISSIPATER CALCULATIONS

Riprap will be placed at several locations, including the inlet and outlet of the vegetated swale, to act as an energy dissipater. The required riprap size shall be a minimum of Class 50.

7.5 DOWNSTREAM ANALYSIS

From the site, stormwater is routed through an existing storm sewer to the existing stormwater facility for Wyndham Ridge. Based on the pipe sizing analysis included in the Wyndham Ridge stormwater report, the existing downstream storm sewer pipes were analyzed for capacity. All downstream pipes are sufficient to convey stormwater for the 25-year storm. From the existing facility, stormwater is discharged into a tributary of Cedar Creek. The additional flow generated from this development constitutes less than 5% of the total tributary drainage flow. The downstream drainage has been visually investigate for ¼ mile downstream, and there does not appear to be any potential downstream impacts to structures.

8.0 STORMWATER QUANTITY CONTROL FACILITY OPERATION

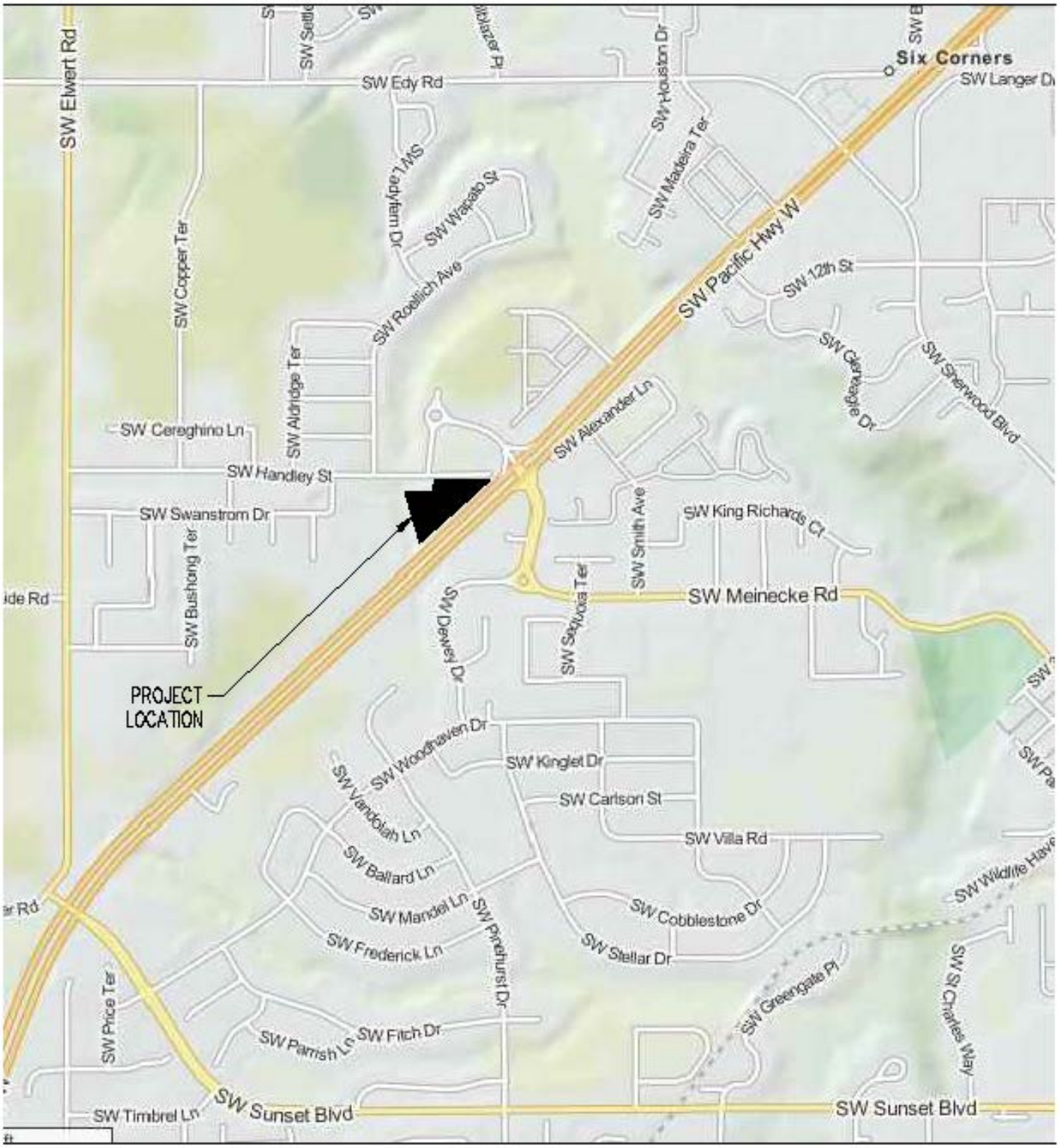
Stormwater detention is not required.

9.0 STORMWATER QUALITY CONTROL FACILITY OPERATION

Stormwater will be routed through catch basins and stormwater pipes into the vegetated swale (except for the west parking lot, see Section 3.2) designed per Clean Water Services standards.

The stormwater facility will be privately owned and maintained by the owner of the site.

APPENDIX 1-1
VICINITY MAP



PACIFIC FAMILY DENTAL PARKING LOT EXPANSION

NORTH

VICINITY MAP

DESIGNED BY:	RSW
DRAWN BY:	RSW
CHECKED BY:	MBH
DRAWING NO.:	2201 VICINITY MAP
SCALE:	1"=20'
DATE:	07-17-2013

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SUITE 100
SHERWOOD, OR 97140
PHONE: 503-925-8799
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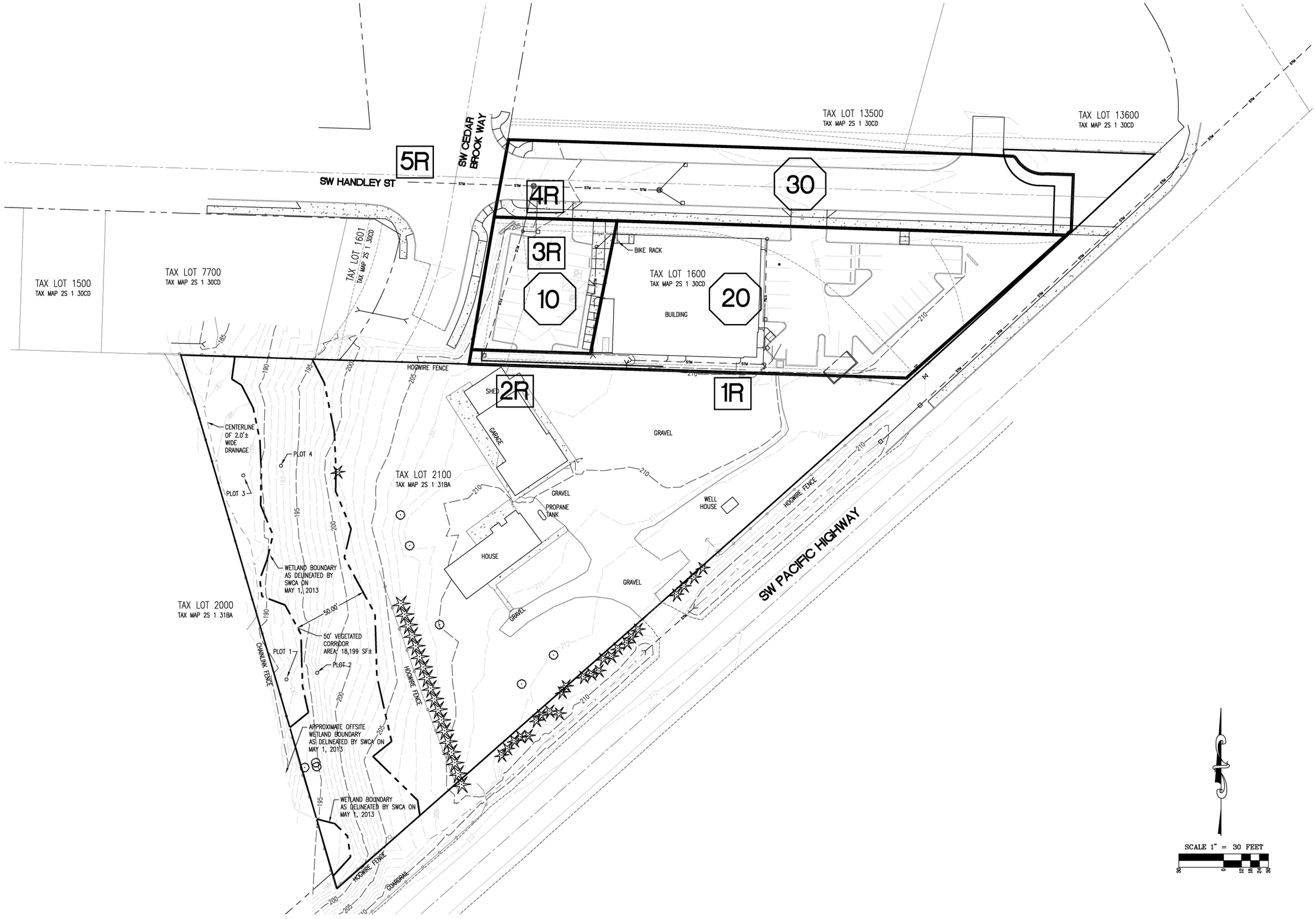
APPENDIX 1-2
CATCHMENT MAPS



PRE-DEVELOPED CATCHMENT PLAN

PACIFIC FAMILY DENTAL PARKING LOT EXPANSION

SHERWOOD OREGON

TAX LOTS 1600 AND 2100 WASHINGTON COUNTY TAX MAP 2S 1 30CD AND 2S 1 31BA

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13910 SW GALBRAITH DR.,
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SHERWOOD, OR 97140
PHONE: (503) 925-8799
FAX: (503) 925-8969

DESIGNED BY:	RSW
DRAWN BY:	RSW
CHECKED BY:	MBH
DRAWING:	2721 CATCHMENT PLAN
SCALE:	AS NOTED

PREPARED FOR:

NATHAN DOYEL
17680 SW HANDLEY ST #101
SHERWOOD, OR 97140

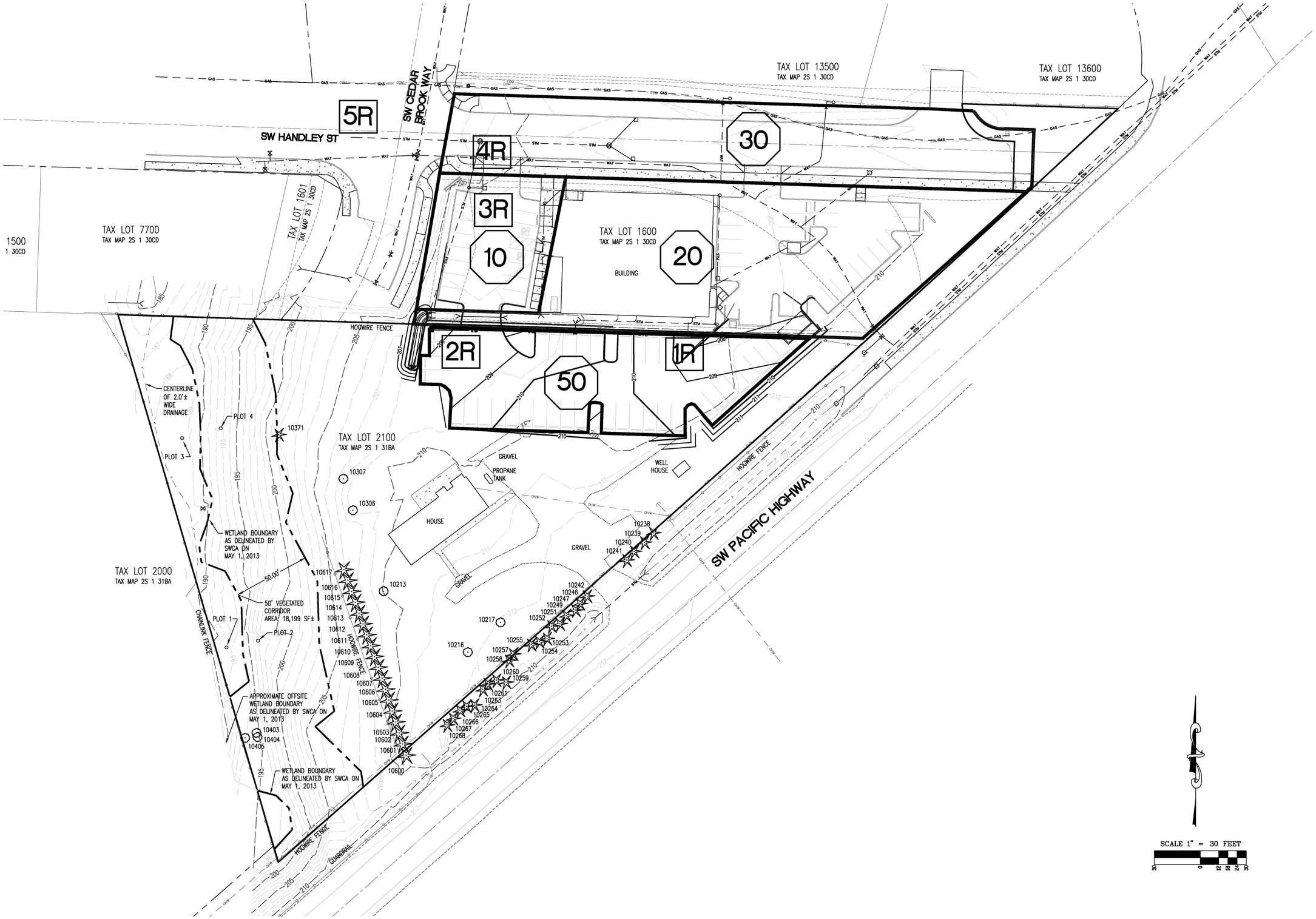
DATE: 07/15/13

REGISTERED PROFESSIONAL ENGINEER
PRELIMINARY
NOT FOR CONSTRUCTION
OREGON
JULY 9, 2002
MONTGOMERY B. HURLEY

RENEWAL DATE: 6/30/15

JOB NUMBER
2721

SHEET
1



POST-DEVELOPED CATCHMENT PLAN

PACIFIC FAMILY DENTAL PARKING LOT EXPANSION

SHERWOOD OREGON
TAX LOTS 1600 AND 2100 WASHINGTON COUNTY TAX MAP 2S 1 30CD AND 2S 1 31BA

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PHONE: (503) 925-8799
FAX: (503) 925-8969

DESIGNED BY:	RSW
DRAWN BY:	RSW
CHECKED BY:	MBH
DRAWING:	2721 CATCHMENT PLAN
SCALE:	AS NOTED

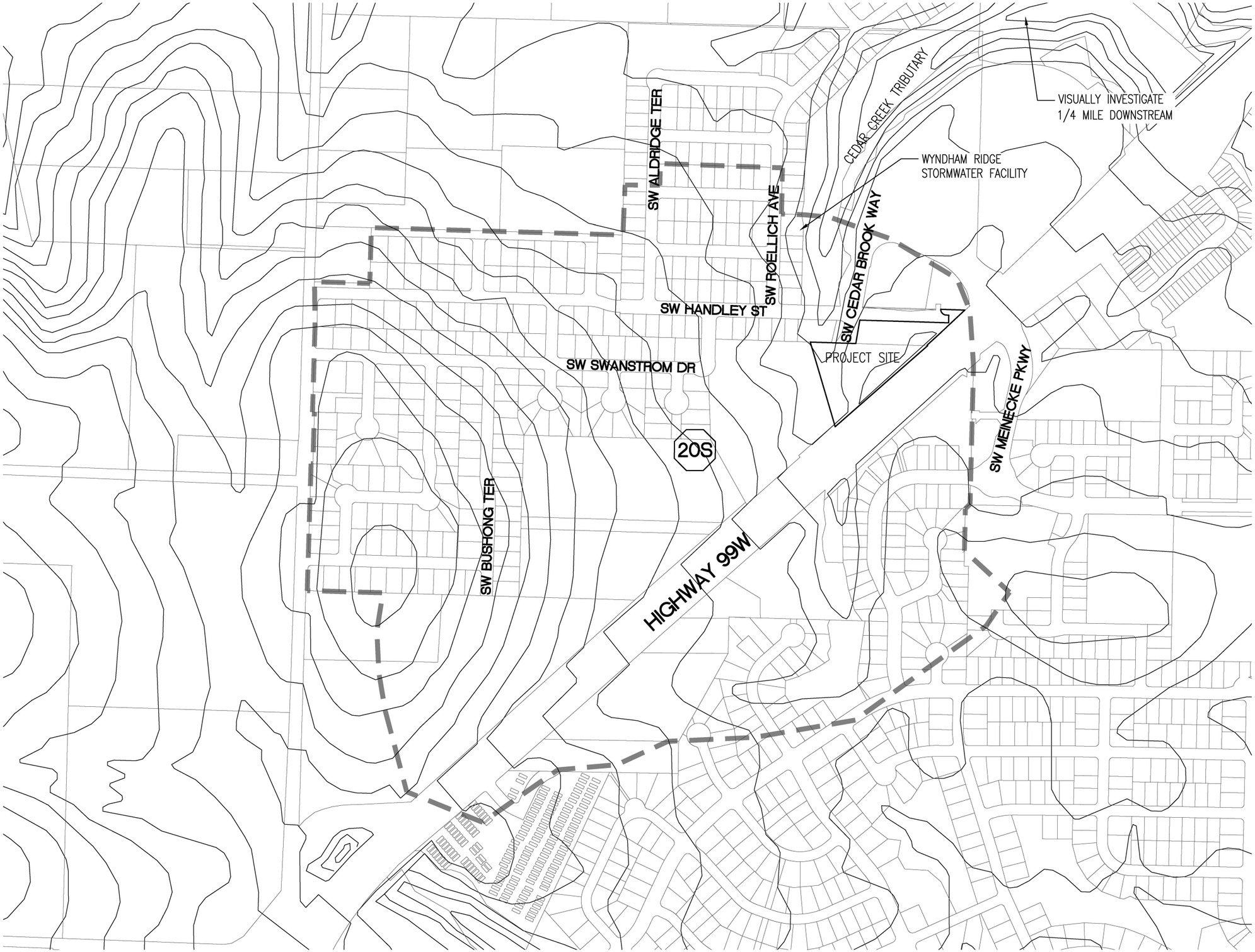
PREPARED FOR:
NATHAN DOYEL
17680 SW HANDLEY ST #101
SHERWOOD, OR 97140

DATE: 07/15/13

REGISTERED PROFESSIONAL ENGINEER
OREGON
OCT. 5, 2012
MONTGOMERY B. HUNTER
PRELIMINARY NOT FOR CONSTRUCTION
RENEWAL DATE: 6/30/15

JOB NUMBER
2721

SHEET
2



BASIN MAP

PACIFIC FAMILY DENTAL PARKING LOT EXPANSION

SHERWOOD OREGON
TAX LOTS 1600 AND 2100 WASHINGTON COUNTY TAX MAP 2S 1 3DCD AND 2S 1 31BA

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SHERWOOD, OR 97140
PHONE: (503) 925-8799
FAX: (503) 925-8969

DESIGNED BY:	RSW
DRAWN BY:	RSW
CHECKED BY:	MBH
DRAWING NO.:	DRAINAGE BASIN
SCALE:	AS NOTED

PREPARED FOR:
NATHAN DOYEL
17680 SW HANDLEY ST #101
SHERWOOD, OR 97140

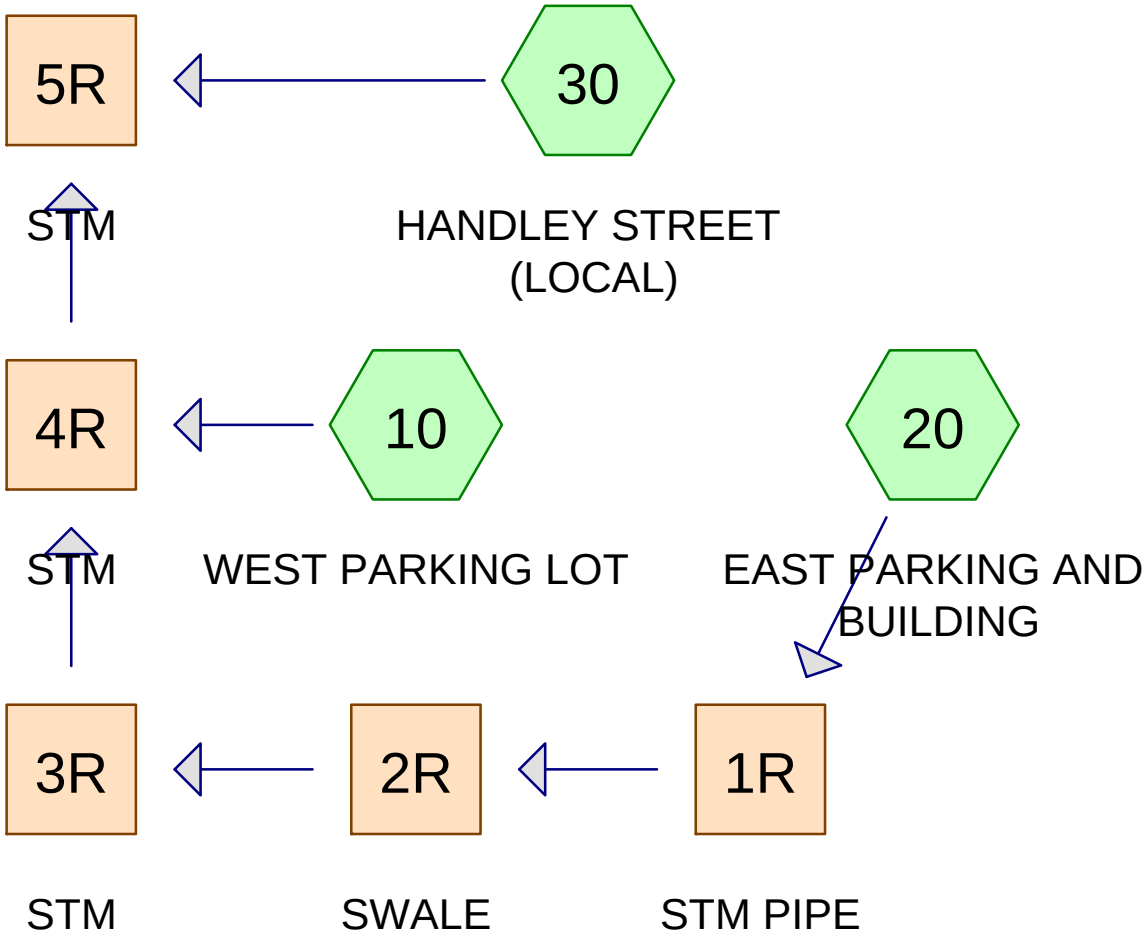
DATE: 07/15/13

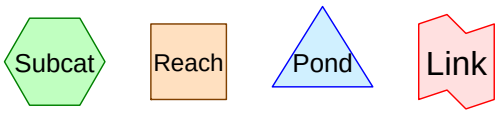
REGISTERED PROFESSIONAL ENGINEER
OREGON
JULY 9, 2002
MONTGOMERY B. HURLEY
PRELIMINARY
NOT FOR CONSTRUCTION
RENEWAL DATE: 6/30/15

JOB NUMBER
2721

SHEET
3

APPENDIX 2-1
PRE-DEVELOPED 25-YEAR STORM CALCULATIONS (3.90”)





Drainage Diagram for 2721-PRE
Prepared by AKS Engineering & Forestry, LLC., Printed 7/18/2013
HydroCAD® 8.50 s/n 005096 © 2007 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
15,991	86	PERVIOUS (10,20,30)
37,105	98	IMPERVIOUS (10,20,30)
53,096		**TOTAL AREA**

Summary for Subcatchment 10: WEST PARKING LOT

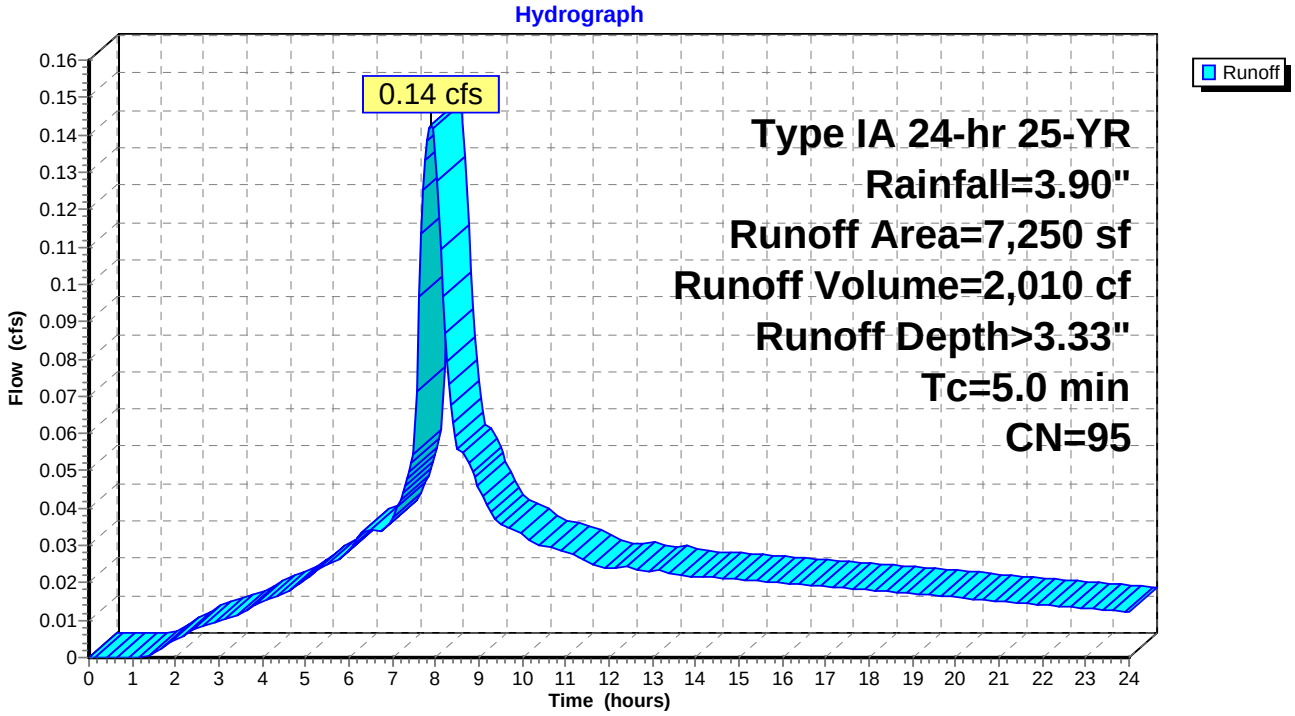
Runoff = 0.14 cfs @ 7.91 hrs, Volume= 2,010 cf, Depth> 3.33"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	5,500	98	IMPERVIOUS
*	1,750	86	PERVIOUS
	7,250	95	Weighted Average
	1,750		Pervious Area
	5,500		Impervious Area

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

Subcatchment 10: WEST PARKING LOT



Summary for Subcatchment 20: EAST PARKING AND BUILDING

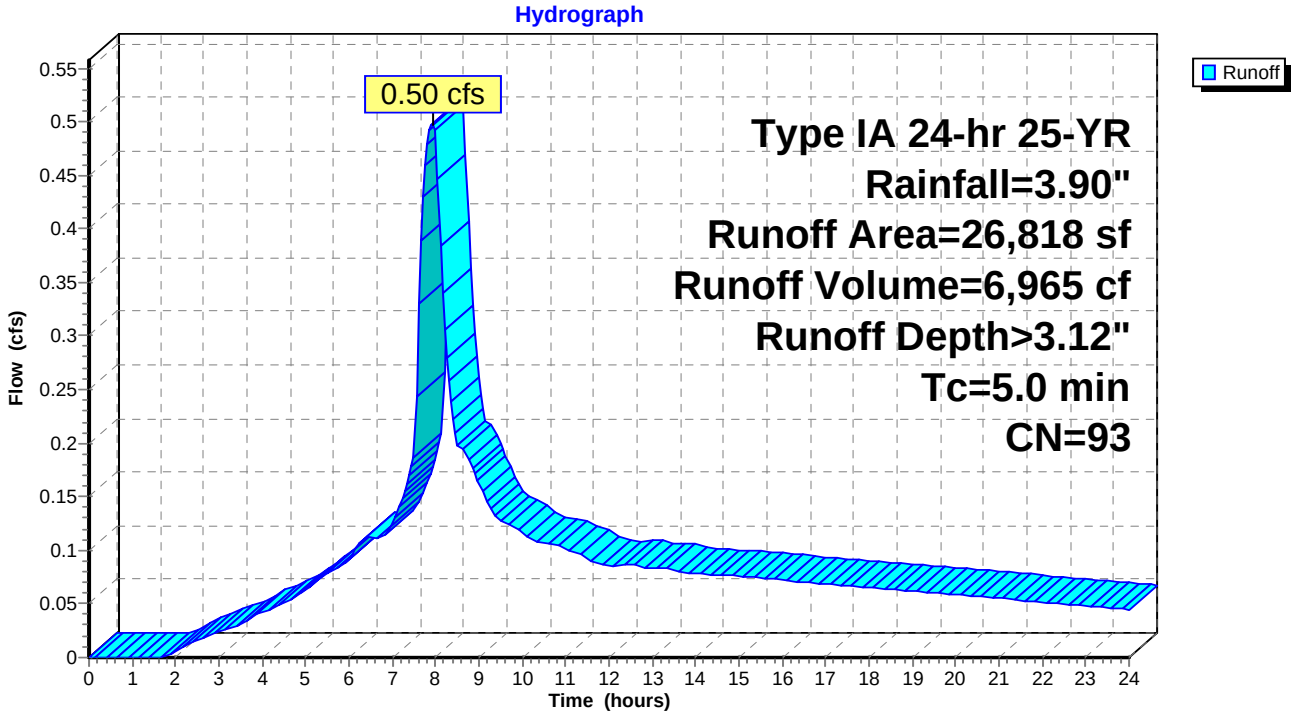
Runoff = 0.50 cfs @ 7.92 hrs, Volume= 6,965 cf, Depth> 3.12"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	16,500	98	IMPERVIOUS
*	10,318	86	PERVIOUS
	26,818	93	Weighted Average
	10,318		Pervious Area
	16,500		Impervious Area

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

Subcatchment 20: EAST PARKING AND BUILDING



Summary for Subcatchment 30: HANDLEY STREET (LOCAL)

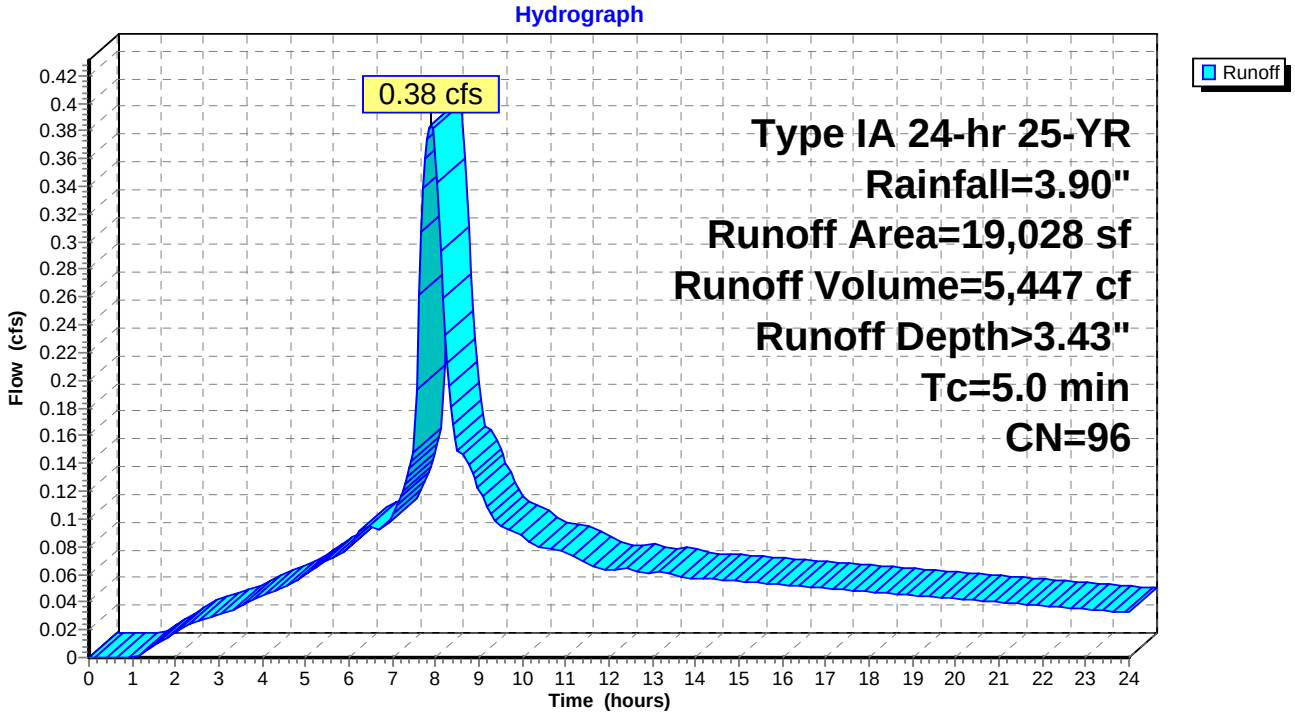
Runoff = 0.38 cfs @ 7.90 hrs, Volume= 5,447 cf, Depth> 3.43"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	15,105	98	IMPERVIOUS
*	3,923	86	PERVIOUS
	19,028	96	Weighted Average
	3,923		Pervious Area
	15,105		Impervious Area

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

Subcatchment 30: HANDLEY STREET (LOCAL)



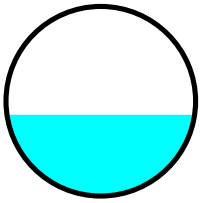
Summary for Reach 1R: STM PIPE

Inflow Area = 26,818 sf, 61.53% Impervious, Inflow Depth > 3.12" for 25-YR event
Inflow = 0.50 cfs @ 7.92 hrs, Volume= 6,965 cf
Outflow = 0.50 cfs @ 7.93 hrs, Volume= 6,962 cf, Atten= 0%, Lag= 0.8 min

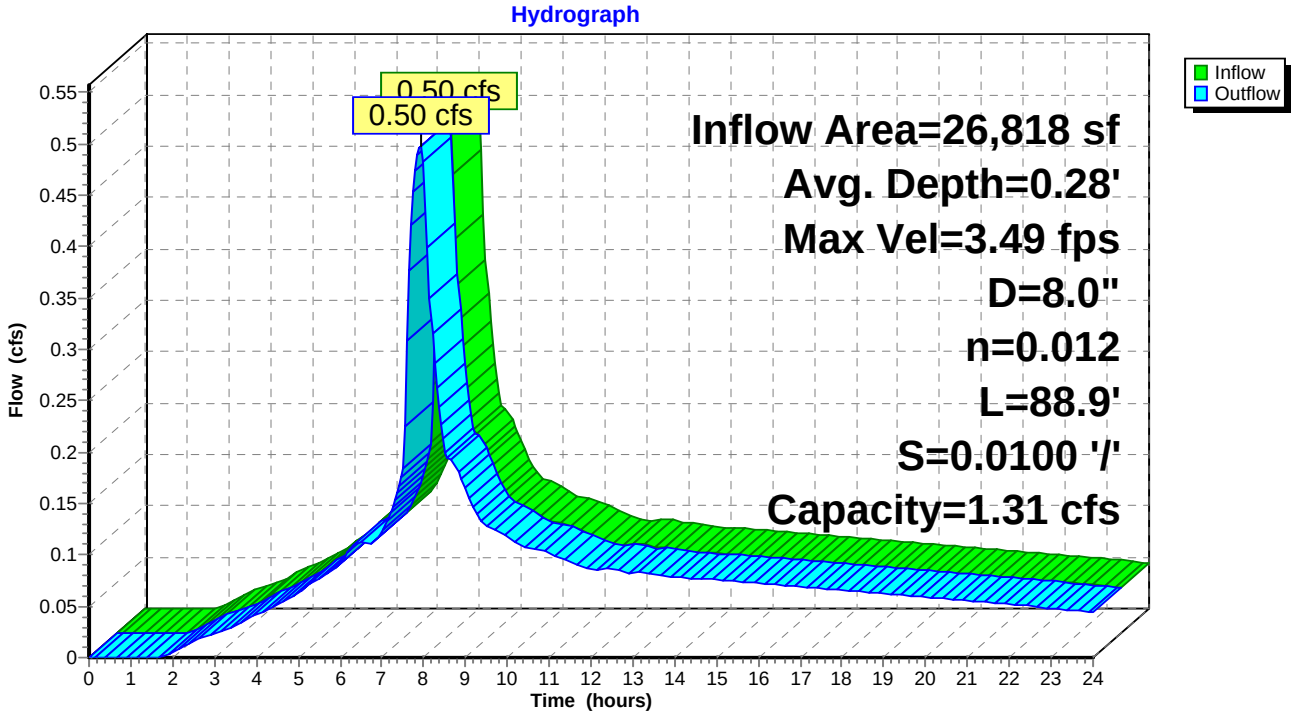
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.49 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.02 fps, Avg. Travel Time= 0.7 min

Peak Storage= 13 cf @ 7.92 hrs, Average Depth at Peak Storage= 0.28'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 1.31 cfs

8.0" Diameter Pipe, n= 0.012
Length= 88.9' Slope= 0.0100 '/'
Inlet Invert= 205.18', Outlet Invert= 204.29'



Reach 1R: STM PIPE



Summary for Reach 2R: SWALE

Inflow Area = 26,818 sf, 61.53% Impervious, Inflow Depth > 3.12" for 25-YR event
Inflow = 0.50 cfs @ 7.93 hrs, Volume= 6,962 cf
Outflow = 0.50 cfs @ 8.03 hrs, Volume= 6,933 cf, Atten= 0%, Lag= 5.8 min

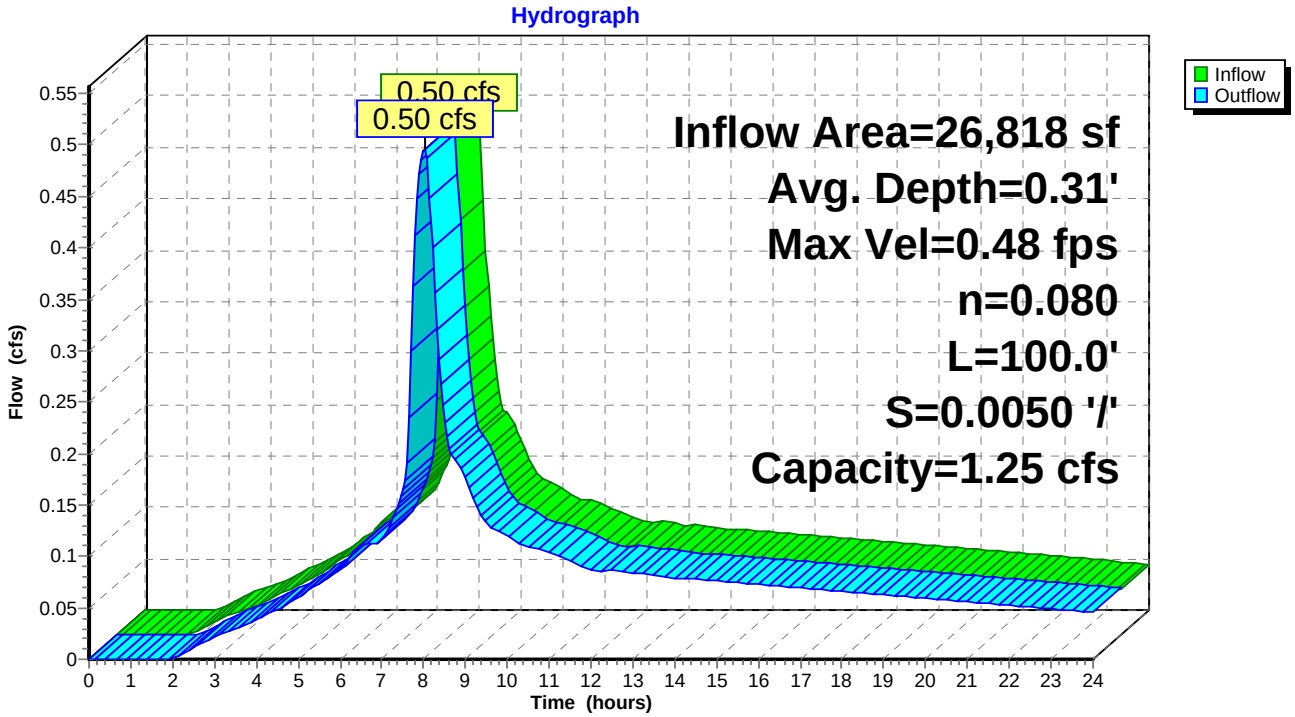
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.48 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 0.27 fps, Avg. Travel Time= 6.2 min

Peak Storage= 102 cf @ 7.97 hrs, Average Depth at Peak Storage= 0.31'
Bank-Full Depth= 0.50', Capacity at Bank-Full= 1.25 cfs

2.00' x 0.50' deep channel, n= 0.080
Side Slope Z-value= 4.0 '/' Top Width= 6.00'
Length= 100.0' Slope= 0.0050 '/'
Inlet Invert= 204.29', Outlet Invert= 203.79'

‡

Reach 2R: SWALE



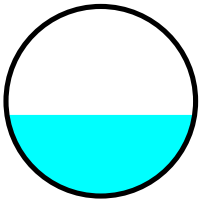
Summary for Reach 3R: STM

Inflow Area = 26,818 sf, 61.53% Impervious, Inflow Depth > 3.10" for 25-YR event
Inflow = 0.50 cfs @ 8.03 hrs, Volume= 6,933 cf
Outflow = 0.49 cfs @ 8.04 hrs, Volume= 6,929 cf, Atten= 0%, Lag= 0.5 min

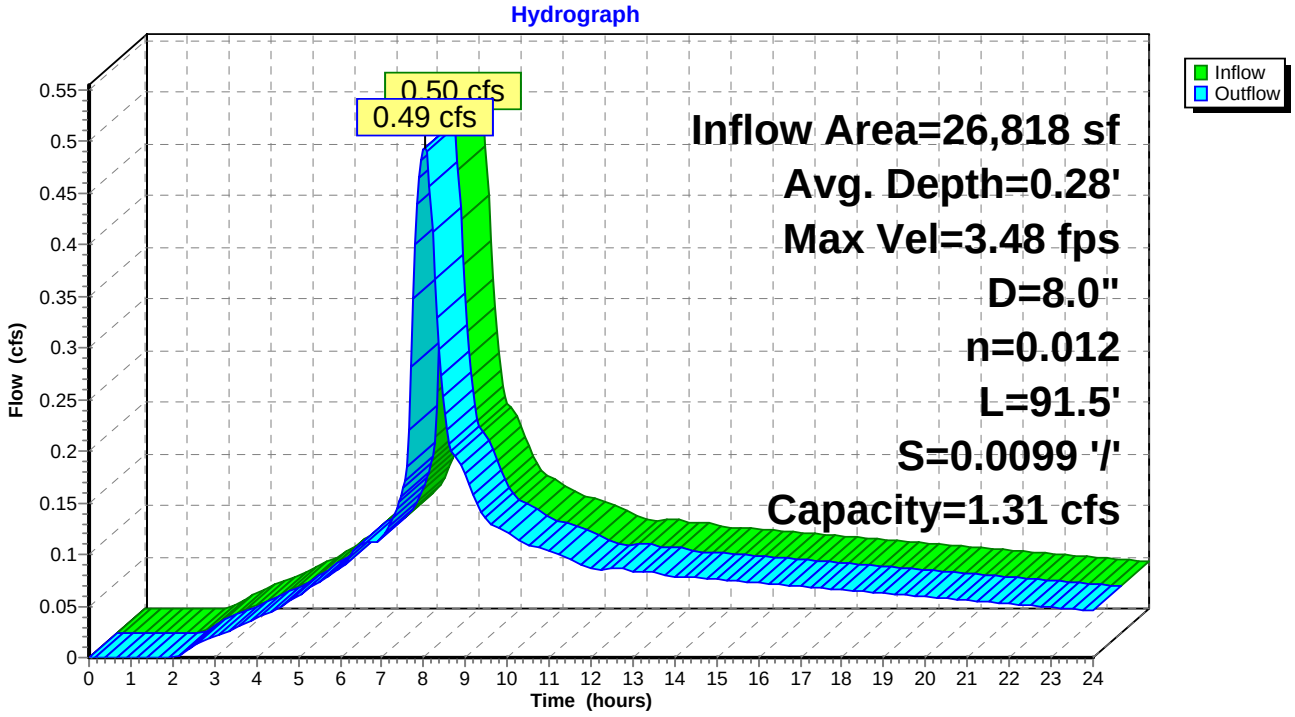
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.48 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.02 fps, Avg. Travel Time= 0.8 min

Peak Storage= 13 cf @ 8.03 hrs, Average Depth at Peak Storage= 0.28'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 1.31 cfs

8.0" Diameter Pipe, n= 0.012
Length= 91.5' Slope= 0.0099 '/'
Inlet Invert= 200.00', Outlet Invert= 199.09'



Reach 3R: STM



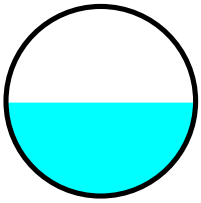
Summary for Reach 4R: STM

Inflow Area = 34,068 sf, 64.58% Impervious, Inflow Depth > 3.15" for 25-YR event
Inflow = 0.63 cfs @ 8.00 hrs, Volume= 8,939 cf
Outflow = 0.63 cfs @ 8.00 hrs, Volume= 8,938 cf, Atten= 0%, Lag= 0.1 min

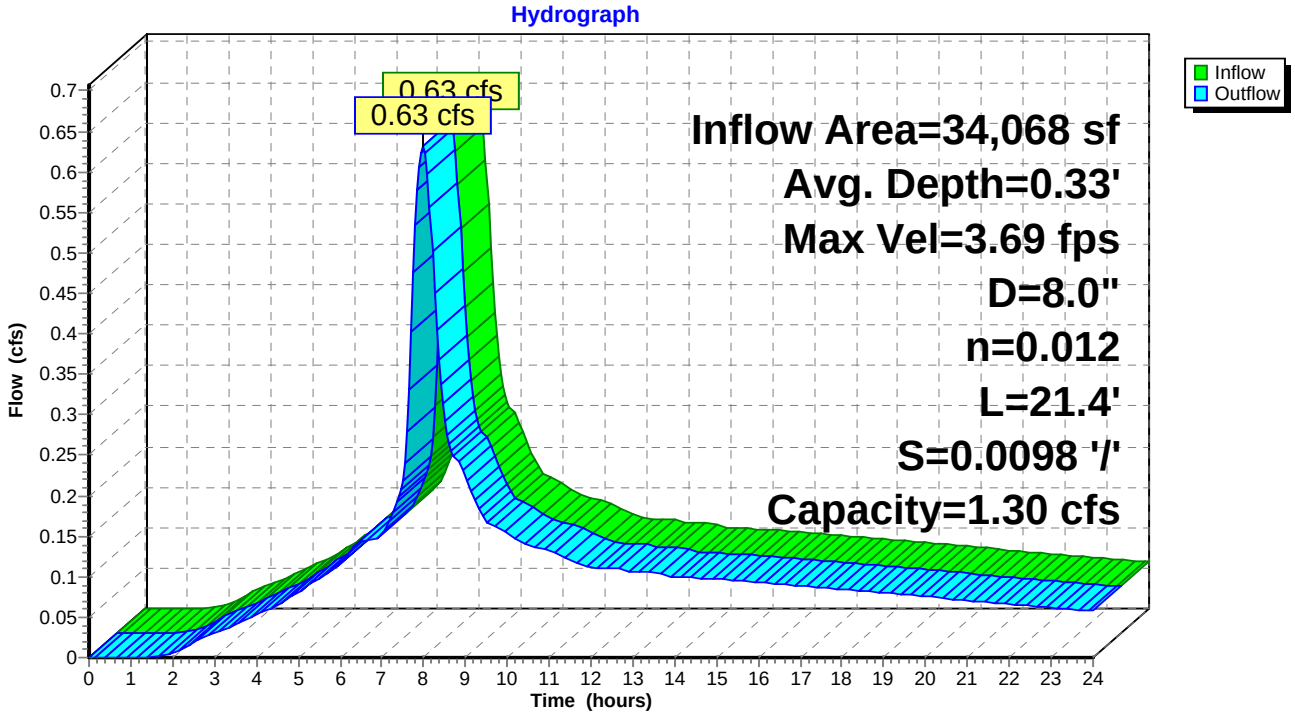
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.69 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.13 fps, Avg. Travel Time= 0.2 min

Peak Storage= 4 cf @ 8.00 hrs, Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 1.30 cfs

8.0" Diameter Pipe, n= 0.012
Length= 21.4' Slope= 0.0098 '/'
Inlet Invert= 199.04', Outlet Invert= 198.83'



Reach 4R: STM



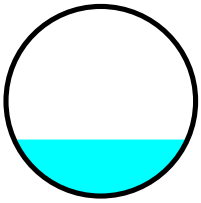
Summary for Reach 5R: STM

Inflow Area = 53,096 sf, 69.88% Impervious, Inflow Depth > 3.25" for 25-YR event
Inflow = 1.01 cfs @ 7.98 hrs, Volume= 14,385 cf
Outflow = 1.01 cfs @ 7.99 hrs, Volume= 14,372 cf, Atten= 0%, Lag= 0.7 min

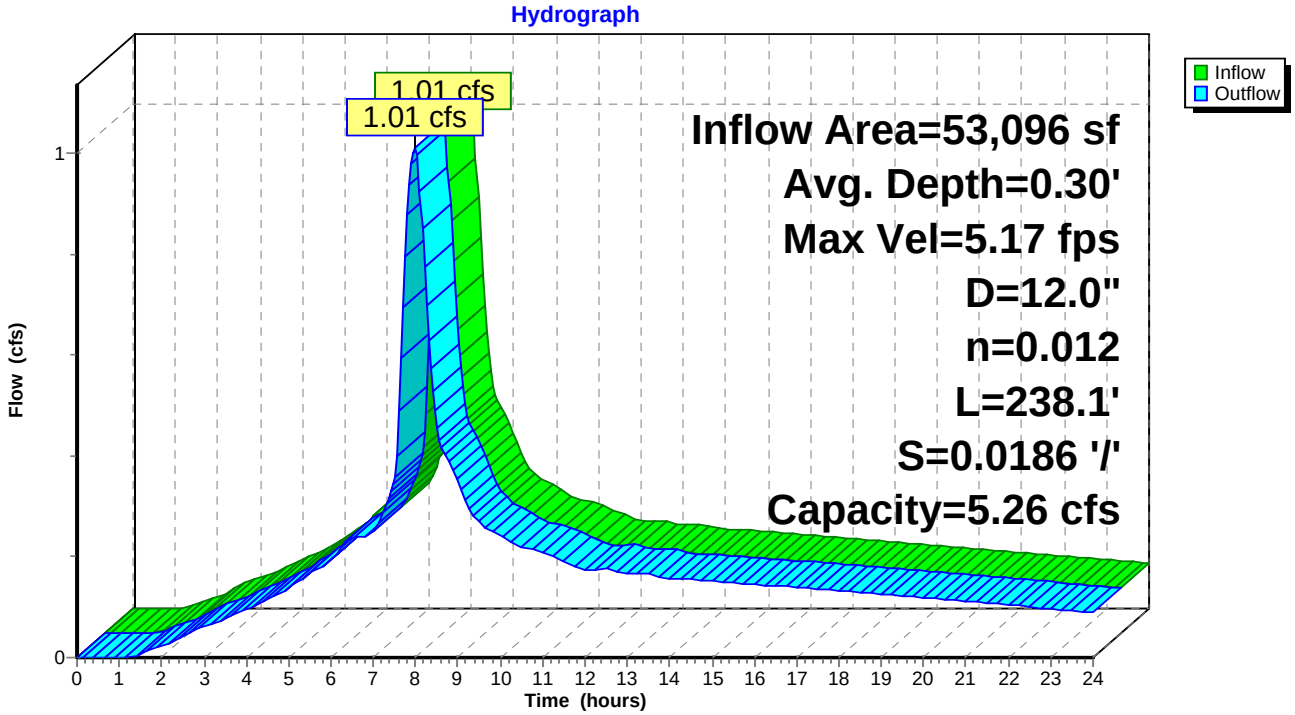
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.17 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 2.93 fps, Avg. Travel Time= 1.4 min

Peak Storage= 47 cf @ 7.98 hrs, Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.26 cfs

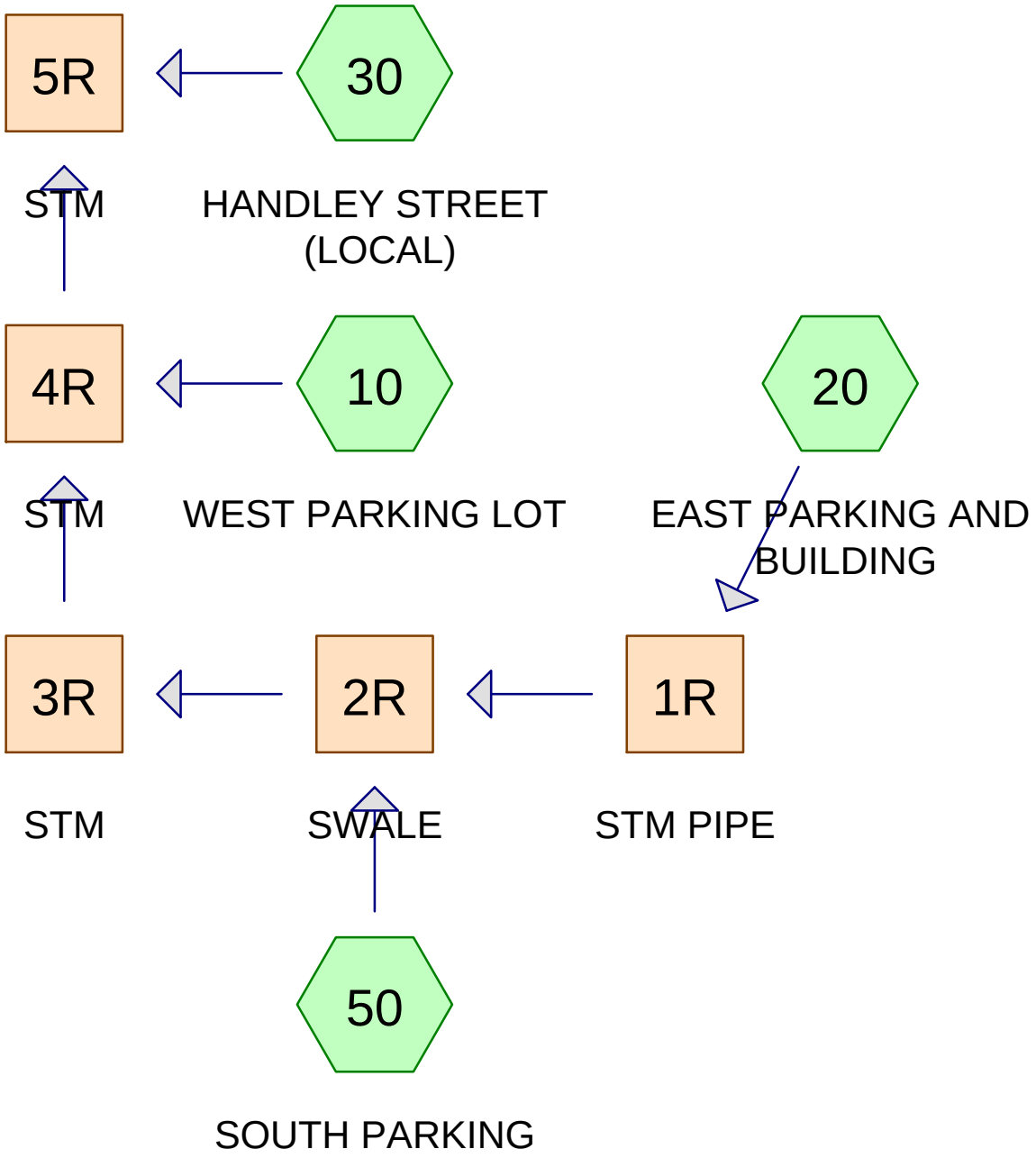
12.0" Diameter Pipe, n= 0.012
Length= 238.1' Slope= 0.0186 '/'
Inlet Invert= 198.63', Outlet Invert= 194.21'

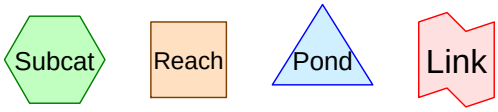


Reach 5R: STM



APPENDIX 2-2
POST-DEVELOPED 25-YEAR STORM CALCULATIONS (3.90”)





Drainage Diagram for 2721-POST
Prepared by AKS Engineering & Forestry, LLC., Printed 7/18/2013
HydroCAD® 8.50 s/n 005096 © 2007 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.367	86	PERVIOUS (10,20,30)
1.182	98	IMPERVIOUS (10,20,30,50)
1.549		**TOTAL AREA**

Summary for Subcatchment 10: WEST PARKING LOT

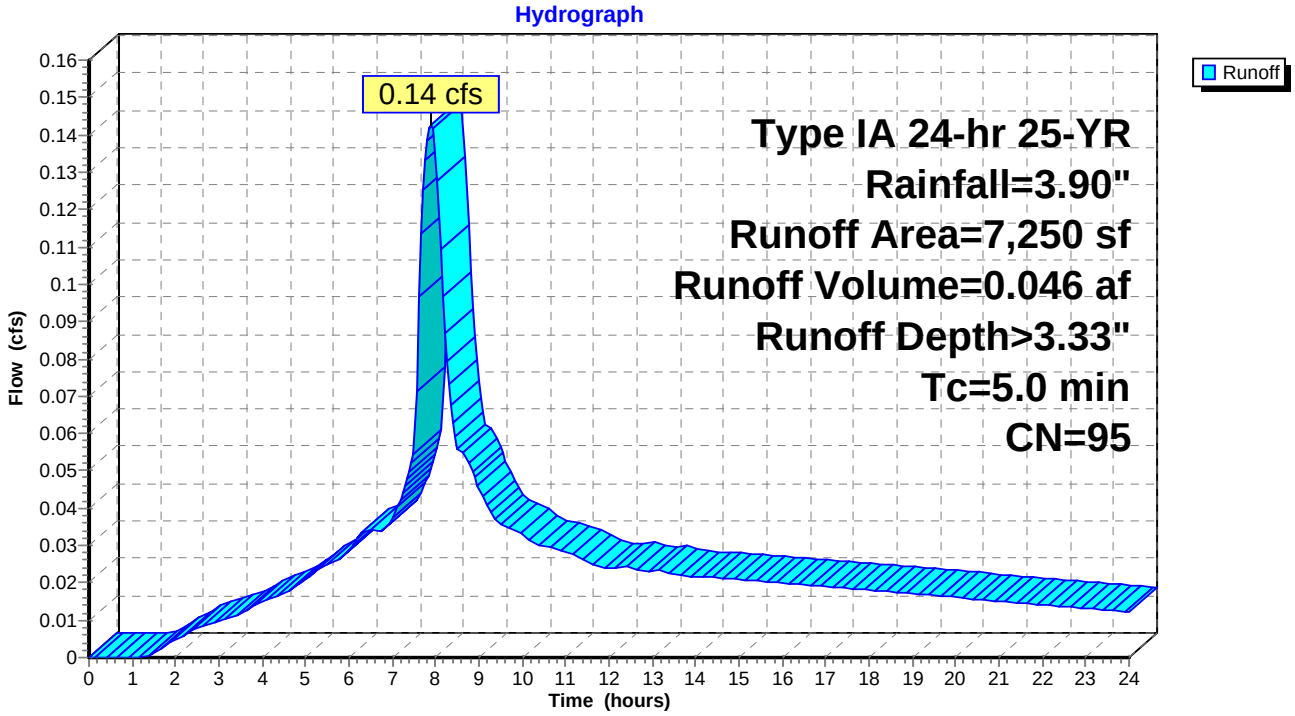
Runoff = 0.14 cfs @ 7.91 hrs, Volume= 0.046 af, Depth> 3.33"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	5,500	98	IMPERVIOUS
*	1,750	86	PERVIOUS
	7,250	95	Weighted Average
	1,750		Pervious Area
	5,500		Impervious Area

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

Subcatchment 10: WEST PARKING LOT



Summary for Subcatchment 20: EAST PARKING AND BUILDING

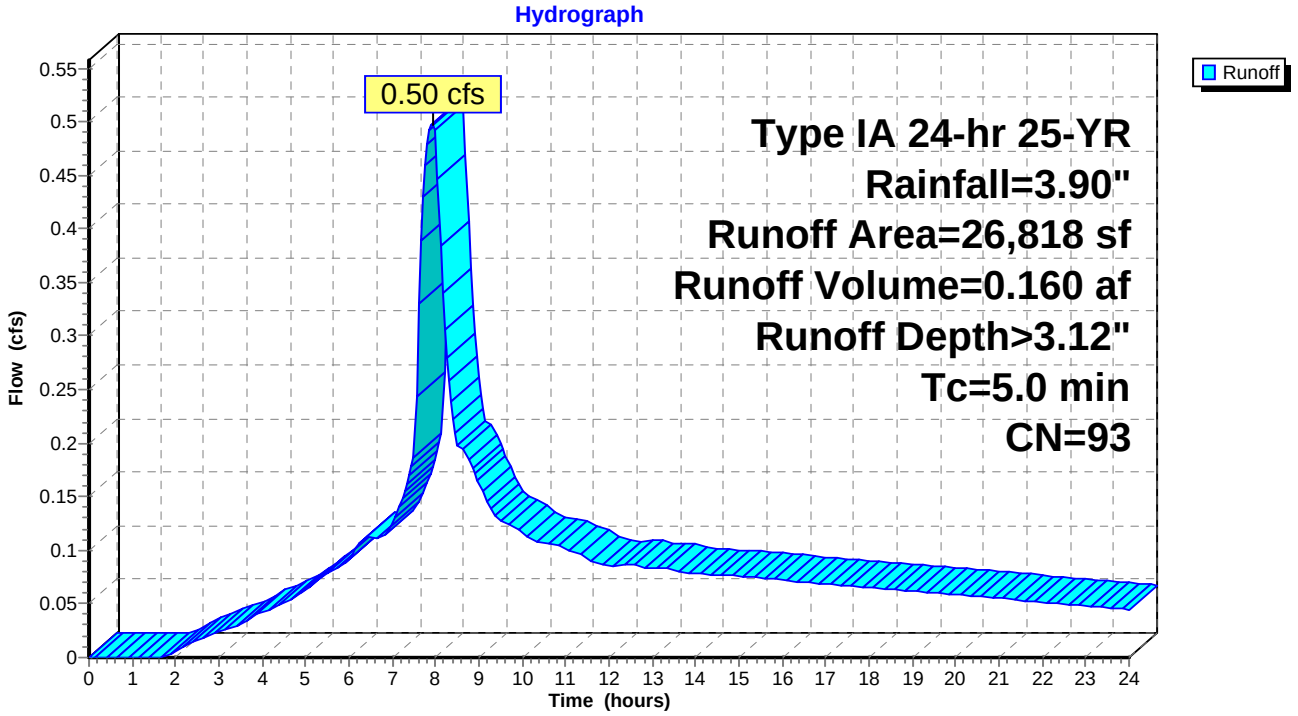
Runoff = 0.50 cfs @ 7.92 hrs, Volume= 0.160 af, Depth> 3.12"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	16,500	98	IMPERVIOUS
*	10,318	86	PERVIOUS
	26,818	93	Weighted Average
	10,318		Pervious Area
	16,500		Impervious Area

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

Subcatchment 20: EAST PARKING AND BUILDING



Summary for Subcatchment 30: HANDLEY STREET (LOCAL)

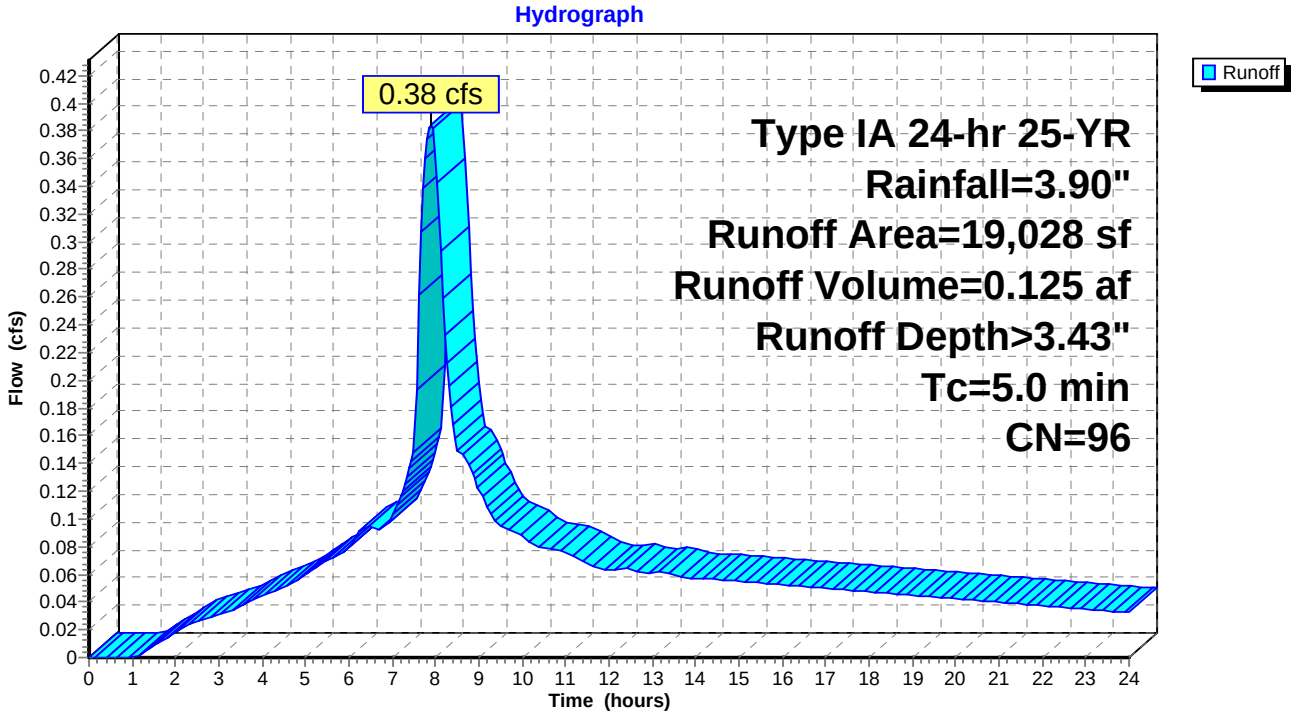
Runoff = 0.38 cfs @ 7.90 hrs, Volume= 0.125 af, Depth> 3.43"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	15,105	98	IMPERVIOUS
*	3,923	86	PERVIOUS
	19,028	96	Weighted Average
	3,923		Pervious Area
	15,105		Impervious Area

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

Subcatchment 30: HANDLEY STREET (LOCAL)



Summary for Subcatchment 50: SOUTH PARKING

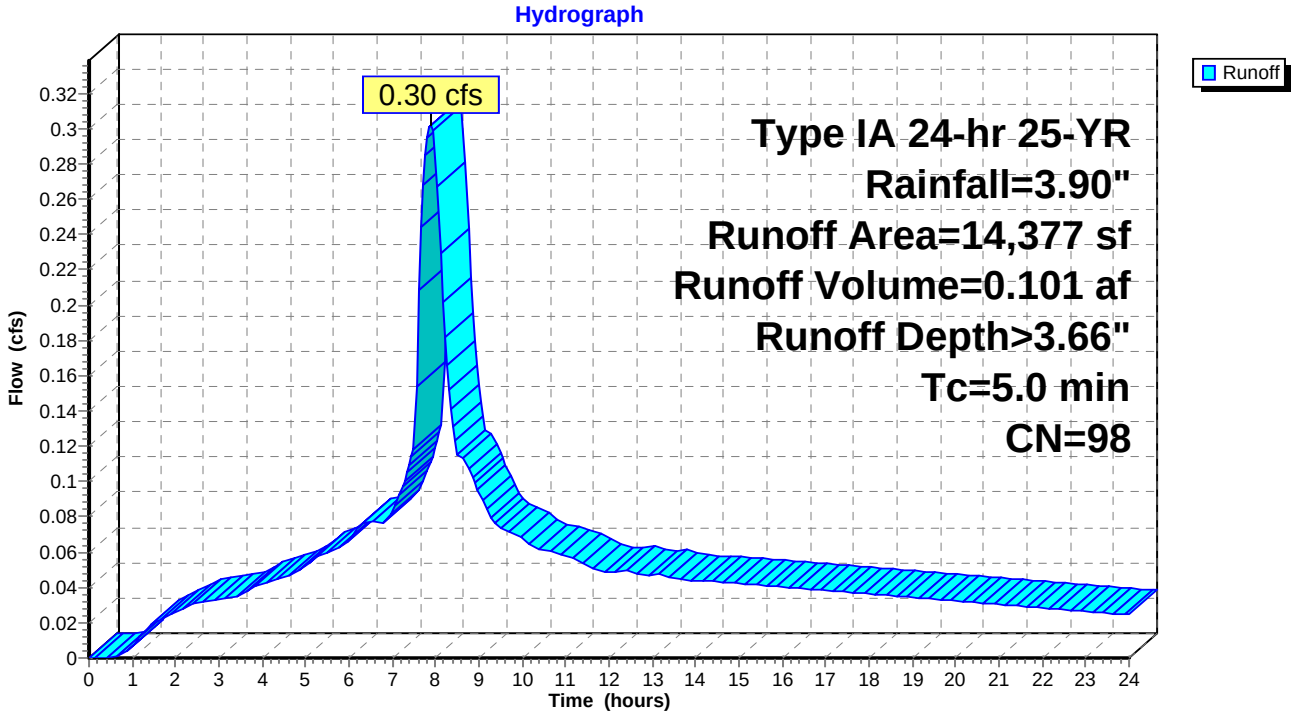
Runoff = 0.30 cfs @ 7.90 hrs, Volume= 0.101 af, Depth> 3.66"

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YR Rainfall=3.90"

	Area (sf)	CN	Description
*	14,377	98	IMPERVIOUS
	14,377		Impervious Area

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

Subcatchment 50: SOUTH PARKING



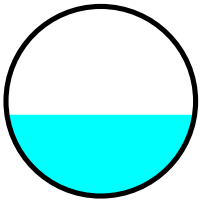
Summary for Reach 1R: STM PIPE

Inflow Area = 0.616 ac, 61.53% Impervious, Inflow Depth > 3.12" for 25-YR event
Inflow = 0.50 cfs @ 7.92 hrs, Volume= 0.160 af
Outflow = 0.50 cfs @ 7.93 hrs, Volume= 0.160 af, Atten= 0%, Lag= 0.8 min

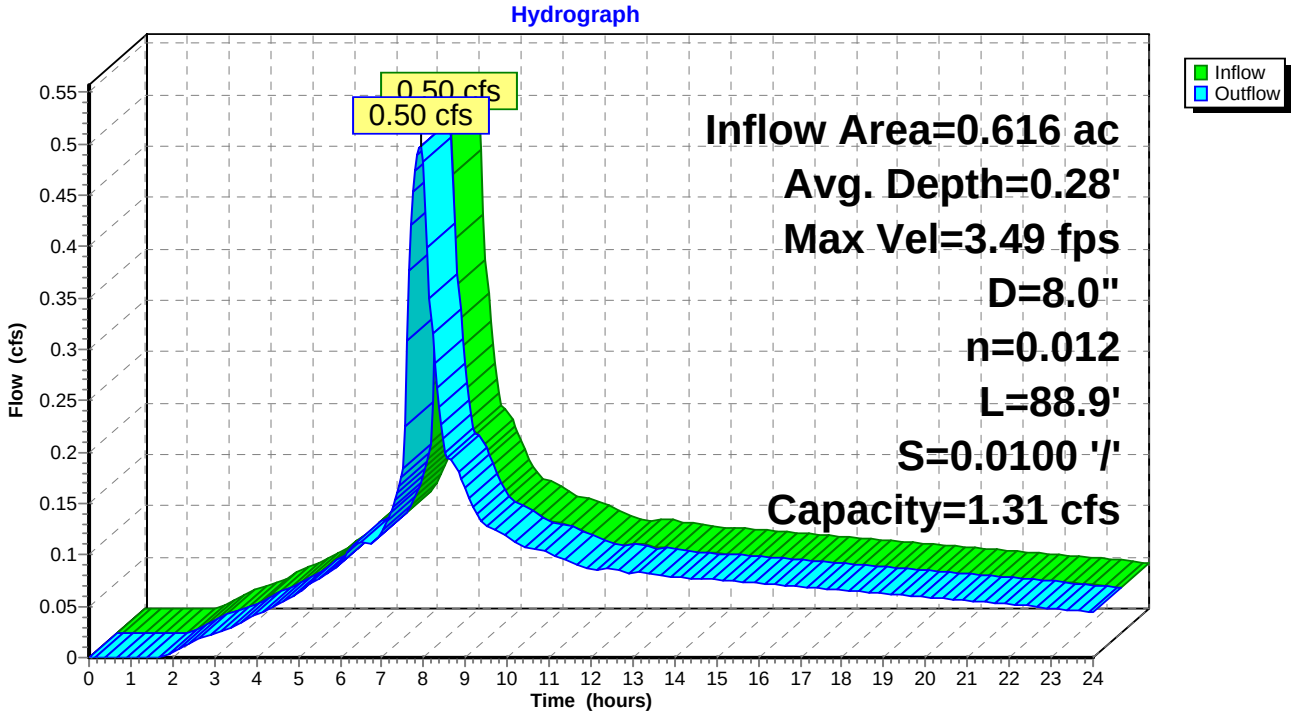
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.49 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.02 fps, Avg. Travel Time= 0.7 min

Peak Storage= 13 cf @ 7.92 hrs, Average Depth at Peak Storage= 0.28'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 1.31 cfs

8.0" Diameter Pipe, n= 0.012
Length= 88.9' Slope= 0.0100 '/'
Inlet Invert= 205.18', Outlet Invert= 204.29'



Reach 1R: STM PIPE



Summary for Reach 2R: SWALE

Inflow Area = 0.946 ac, 74.95% Impervious, Inflow Depth > 3.31" for 25-YR event
Inflow = 0.80 cfs @ 7.92 hrs, Volume= 0.260 af
Outflow = 0.79 cfs @ 8.03 hrs, Volume= 0.259 af, Atten= 1%, Lag= 6.8 min

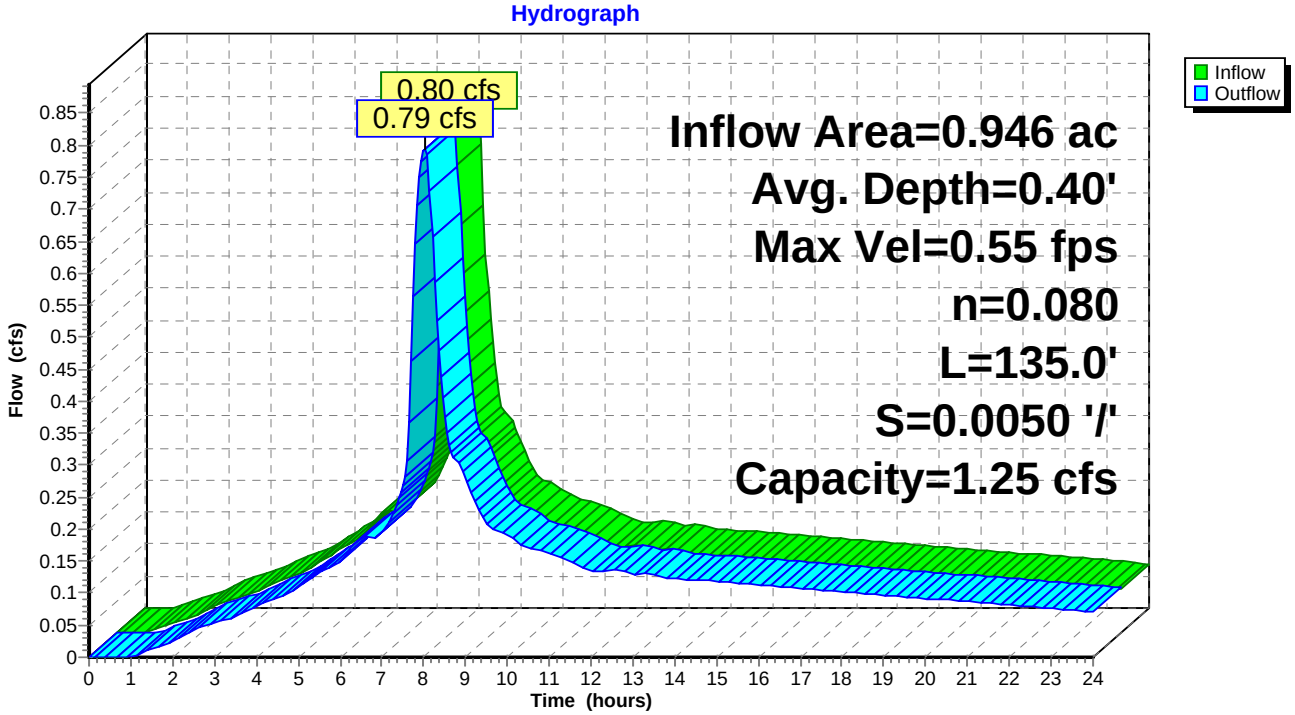
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.55 fps, Min. Travel Time= 4.1 min
Avg. Velocity = 0.31 fps, Avg. Travel Time= 7.3 min

Peak Storage= 194 cf @ 7.97 hrs, Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 0.50', Capacity at Bank-Full= 1.25 cfs

2.00' x 0.50' deep channel, n= 0.080
Side Slope Z-value= 4.0 '/' Top Width= 6.00'
Length= 135.0' Slope= 0.0050 '/'
Inlet Invert= 204.29', Outlet Invert= 203.61'

‡

Reach 2R: SWALE



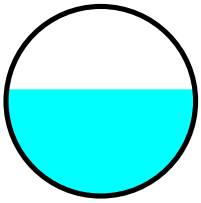
Summary for Reach 3R: STM

Inflow Area = 0.946 ac, 74.95% Impervious, Inflow Depth > 3.29" for 25-YR event
Inflow = 0.79 cfs @ 8.03 hrs, Volume= 0.259 af
Outflow = 0.79 cfs @ 8.04 hrs, Volume= 0.259 af, Atten= 0%, Lag= 0.5 min

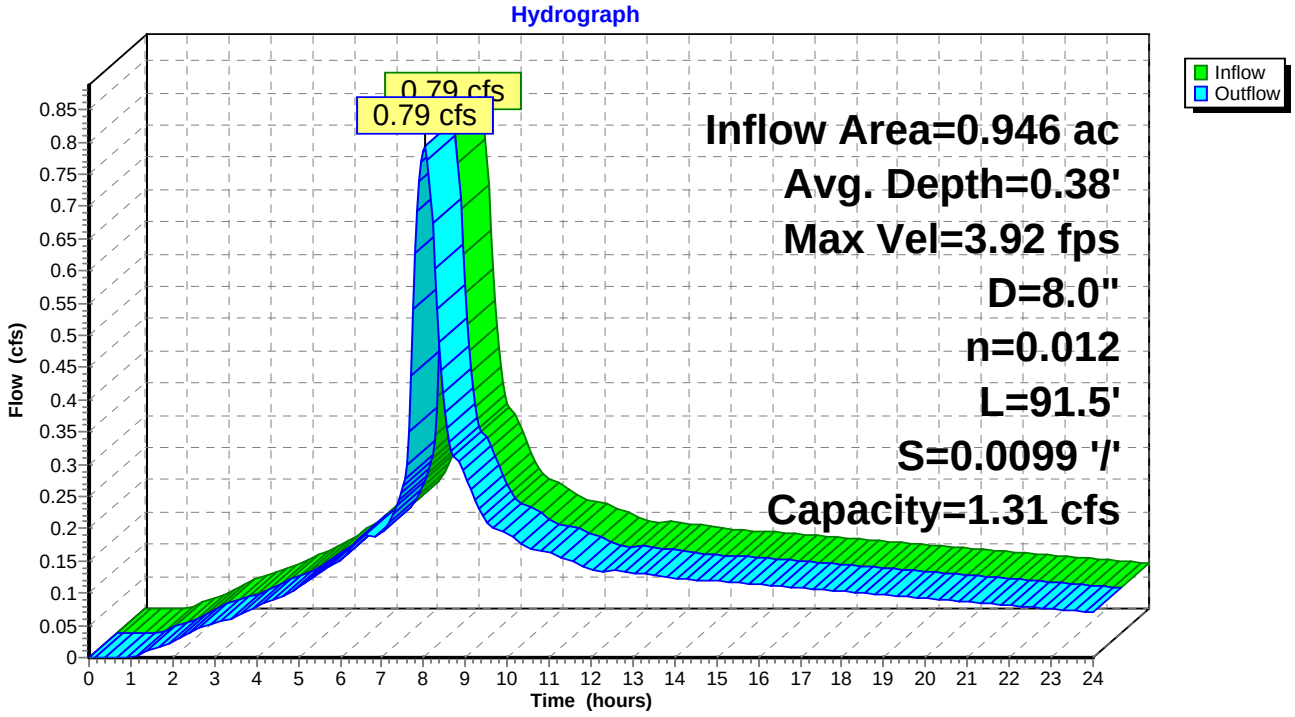
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.92 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.28 fps, Avg. Travel Time= 0.7 min

Peak Storage= 19 cf @ 8.04 hrs, Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 1.31 cfs

8.0" Diameter Pipe, n= 0.012
Length= 91.5' Slope= 0.0099 '/'
Inlet Invert= 200.00', Outlet Invert= 199.09'



Reach 3R: STM



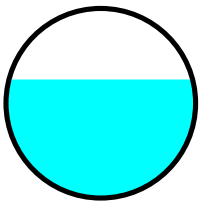
Summary for Reach 4R: STM

Inflow Area = 1.112 ac, 75.09% Impervious, Inflow Depth > 3.29" for 25-YR event
Inflow = 0.93 cfs @ 8.01 hrs, Volume= 0.305 af
Outflow = 0.93 cfs @ 8.01 hrs, Volume= 0.305 af, Atten= 0%, Lag= 0.2 min

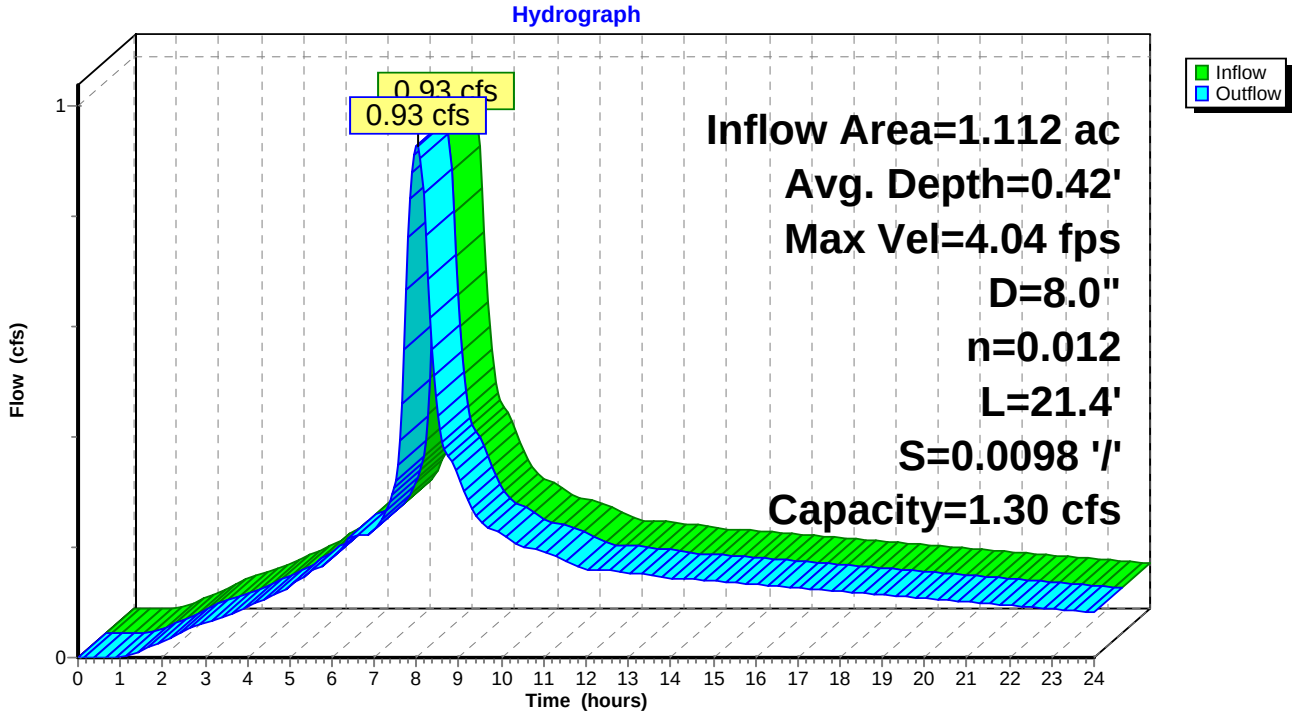
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.04 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.38 fps, Avg. Travel Time= 0.1 min

Peak Storage= 5 cf @ 8.01 hrs, Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 1.30 cfs

8.0" Diameter Pipe, n= 0.012
Length= 21.4' Slope= 0.0098 '/'
Inlet Invert= 199.04', Outlet Invert= 198.83'



Reach 4R: STM



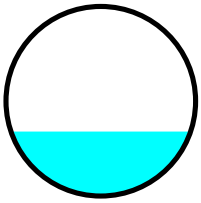
Summary for Reach 5R: STM

Inflow Area = 1.549 ac, 76.30% Impervious, Inflow Depth > 3.33" for 25-YR event
Inflow = 1.30 cfs @ 7.98 hrs, Volume= 0.430 af
Outflow = 1.30 cfs @ 8.00 hrs, Volume= 0.430 af, Atten= 0%, Lag= 0.9 min

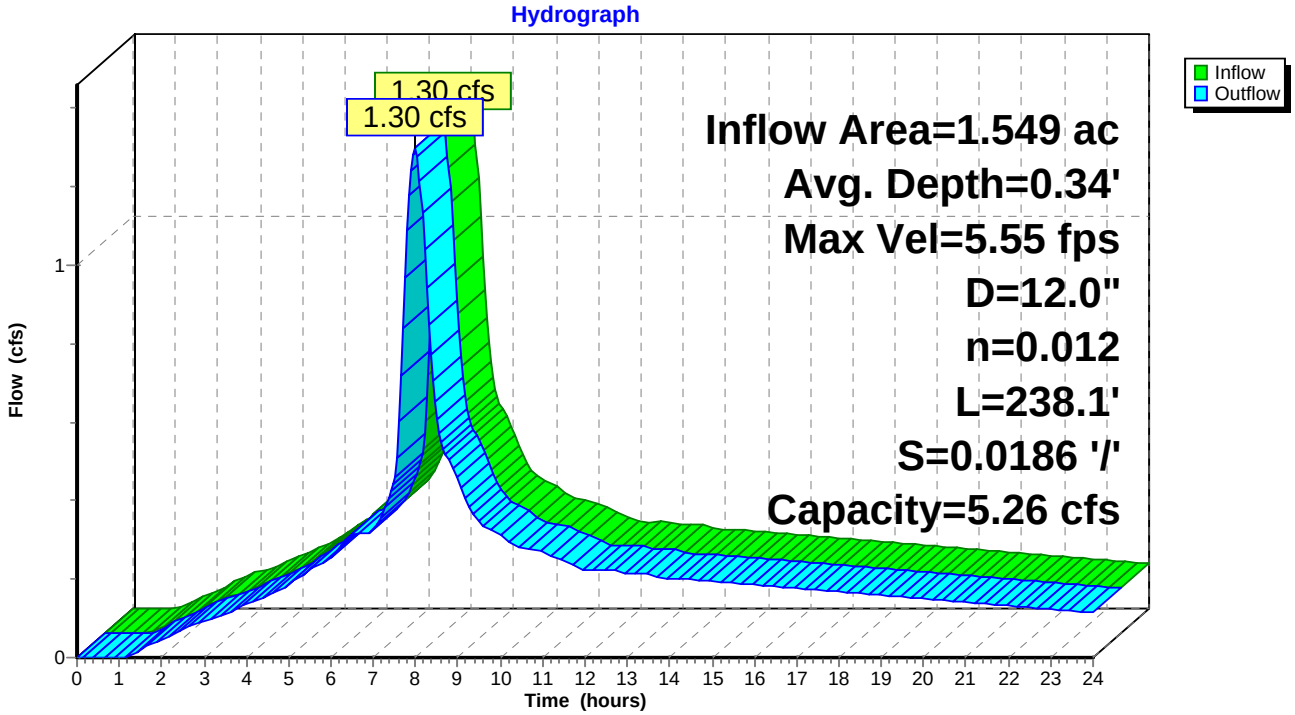
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.55 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 3.16 fps, Avg. Travel Time= 1.3 min

Peak Storage= 56 cf @ 7.99 hrs, Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.26 cfs

12.0" Diameter Pipe, n= 0.012
Length= 238.1' Slope= 0.0186 '/'
Inlet Invert= 198.63', Outlet Invert= 194.21'



Reach 5R: STM



APPENDIX 3-1
WATER QUALITY AND VEGETATED SWALE CALCULATIONS

22065 SW Pacific Highway – Pacific Family Dental

Post-Developed Stormwater Swale Calculations

Total Site Area = 123,136 sf

Impervious Area = 30,877 sf

Water Quality Volume = $\frac{0.36''\left(30{,}877\ ft^2\right)}{12''}$ = 926 cf

Water Quality Flow = $\frac{926\ ft^3}{14{,}400\,\text{sec}}$ = 0.0643 cfs

Hydraulic Analysis (See FlowMaster Analysis Appendix 3-2)

Water Quality Storm Event:

Hydraulic Residence Time (*Req. 9 min*) = $\frac{Length = 107\ ft}{Velocity = 0.12\ ft/\text{sec}} = 891.7\,\text{sec} = 14.9\,\text{min}$

Water Depth (*Max 0.50 ft*) = 0.19 ft

Freeboard (*Min 1 ft*) = 2.81 ft

25-Year Storm Event:

Velocity (*Max 2.0 fps*) = 0.25 fps

Freeboard (*Min 1 ft*) = 2.32 ft

APPENDIX 3-2
FLOWMASTER ANALYSIS OF VEGETATED SWALE

WATER QUALITY FLOW

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.240	
Channel Slope	0.00500	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	0.06	ft^3/s

Results

Normal Depth	0.19	ft
Flow Area	0.53	ft^2
Wetted Perimeter	3.57	ft
Hydraulic Radius	0.15	ft
Top Width	3.52	ft
Critical Depth	0.03	ft
Critical Slope	2.73556	ft/ft
Velocity	0.12	ft/s
Velocity Head	0.00	ft
Specific Energy	0.19	ft
Froude Number	0.06	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.19	ft
Critical Depth	0.03	ft
Channel Slope	0.00500	ft/ft

WATER QUALITY FLOW

GVF Output Data

Critical Slope	2.73556	ft/ft

25-YR STORM EVENT

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.240	
Channel Slope	0.00500	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	0.80	ft^3/s

Results

Normal Depth	0.68	ft
Flow Area	3.24	ft^2
Wetted Perimeter	7.64	ft
Hydraulic Radius	0.42	ft
Top Width	7.47	ft
Critical Depth	0.15	ft
Critical Slope	1.70937	ft/ft
Velocity	0.25	ft/s
Velocity Head	0.00	ft
Specific Energy	0.68	ft
Froude Number	0.07	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

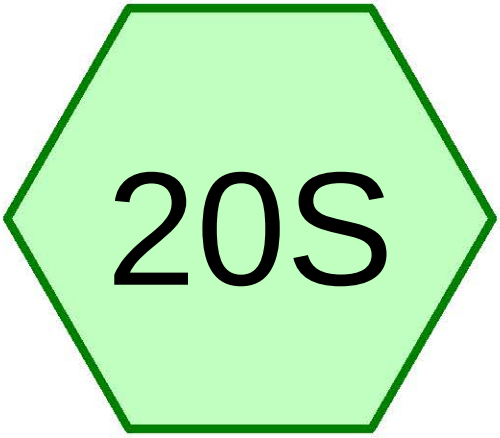
Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.68	ft
Critical Depth	0.15	ft
Channel Slope	0.00500	ft/ft

25-YR STORM EVENT

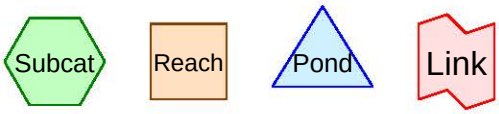
GVF Output Data

Critical Slope	1.70937	ft/ft

APPENDIX 4-1
DOWNSTREAM ANALYSIS AND CALCULATIONS



BASIN AREA



Drainage Diagram for 2721 DRAINAGE BASIN
Prepared by AKS ENGINEERING & FORESTRY, LLC, Printed 7/17/2013
HydroCAD® 8.50 s/n 001338 © 2007 HydroCAD Software Solutions LLC

Summary for Subcatchment 20S: BASIN AREA

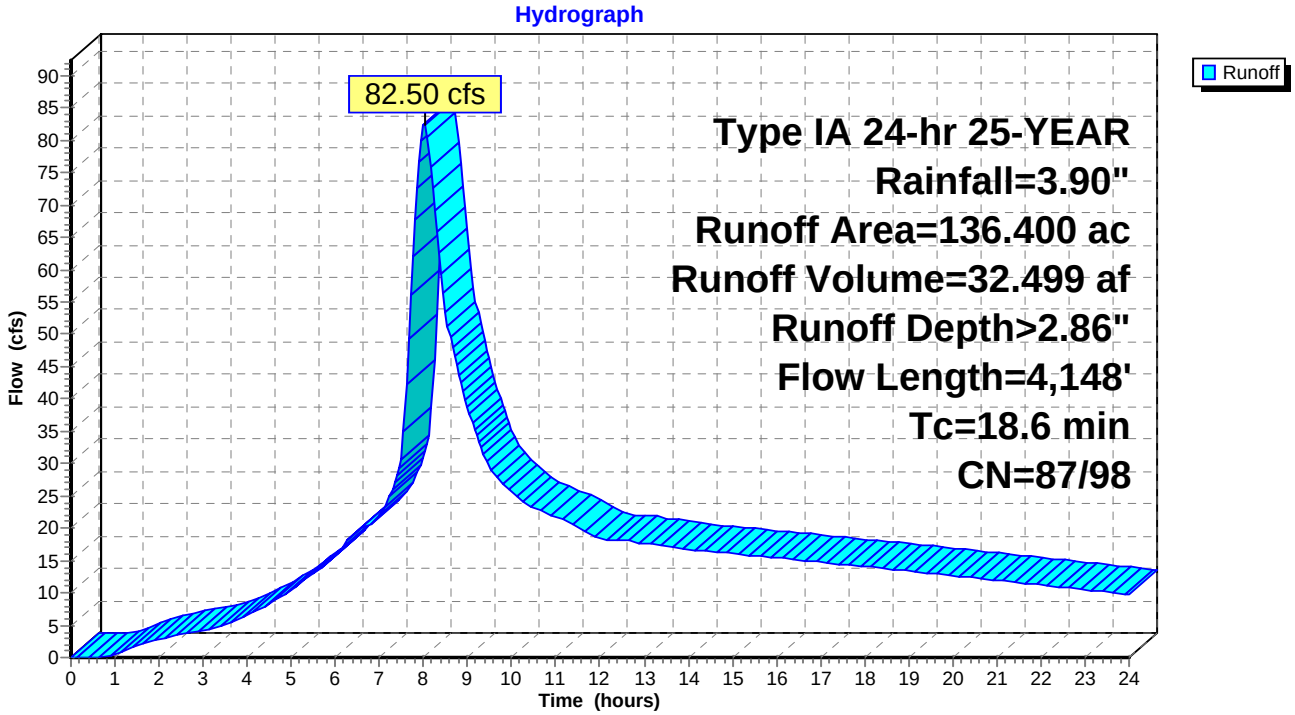
Runoff = 82.50 cfs @ 8.02 hrs, Volume= 32.499 af, Depth> 2.86"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 25-YEAR Rainfall=3.90"

	Area (ac)	CN	Description
*	40.900	98	DEVELOPED IMPERVIOUS
*	73.400	86	DEVELOPED PERVIOUS
*	22.100	89	UNDEVELOPED PERVIOUS
	136.400	90	Weighted Average
	95.500	87	Pervious Area
	40.900	98	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	300	0.0667	2.45		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.50"
5.2	675	0.0963	2.17		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.1	1,290	0.0310	2.64		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
3.3	1,883	0.0319	9.58	57.48	**Channel Flow,** Area= 6.0 sf Perim= 7.0' r= 0.86' n= 0.025
18.6	4,148	Total			

Subcatchment 20S: BASIN AREA



PACIFIC FAMILY DENTAL PARKING LOT EXPANSION

Downstream Analysis Calculations

25-Year Storm Flow Rates

Catchments	Flow Rate (CFS)
Catchment 20S =	82.50

Total Pre-Developed Flows = **82.50 CFS**

On-Site Pre-Developed Flows (10, 20, 30) = 1.01 CFS

On-Site Post-Developed Flows (10, 20, 30, 50) = 1.31 CFS

Additional flow created from this project = (1.31-1.01) = **0.30 CFS**

Percent of additional flow from development = $\left[\frac{0.30}{82.50}\right]$ = 0.00364 = **0.364%**

0.364% < 5.00% => Visually investigate for ¼ mile.

=> Visual investigation does not show any downstream impacts to structures.

APPENDIX 5-1
RELEVANT INFORMATION FROM THE KING COUNTY SURFACE WATER MANAGEMENT MANUAL

TABLE 3.5.2B SCS WESTERN WASHINGTON RUNOFF CURVE NUMBERS

SCS WESTERN WASHINGTON RUNOFF CURVE NUMBERS (Published by SCS in 1982)					
Runoff curve numbers for selected agricultural, suburban and urban land use for Type 1A rainfall distribution, 24-hour storm duration.					
LAND USE DESCRIPTION		CURVE NUMBERS BY HYDROLOGIC SOIL GROUP			
		A	B	C	D
Cultivated land(1):	winter condition	86	91	94	95
Mountain open areas:	low growing brush and grasslands	74	82	89	92
Meadow or pasture:		65	78	85	89
Wood or forest land:	undisturbed or older second growth	42	64	76	81
Wood or forest land:	young second growth or brush	55	72	81	86
Orchard:	with cover crop	81	88	92	94
Open spaces, lawns, parks, golf courses, cemeteries, landscaping.					
good condition:	grass cover on 75% or more of the area	68	80	86	90
fair condition:	grass cover on 50% to 75% of the area	77	85	90	92
Gravel roads and parking lots		76	85	89	91
Dirt roads and parking lots		72	82	87	89
Impervious surfaces, pavement, roofs, etc.		98	98	98	98
Open water bodies:	lakes, wetlands, ponds, etc.	100	100	100	100
Single Family Residential (2)					
Dwelling Unit/Gross Acre	% Impervious (3)	Separate curve number shall be selected for pervious and impervious portion of the site or basin			
1.0 DU/GA	15				
1.5 DU/GA	20				
2.0 DU/GA	25				
2.5 DU/GA	30				
3.0 DU/GA	34				
3.5 DU/GA	38				
4.0 DU/GA	42				
4.5 DU/GA	46				
5.0 DU/GA	48				
5.5 DU/GA	50				
6.0 DU/GA	52				
6.5 DU/GA	54				
7.0 DU/GA	56				
Planned unit developments, condominiums, apartments, commercial business and industrial areas.	% impervious must be computed				

(1) For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Section 4, Hydrology, Chapter 9, August 1972.
(2) Assumes roof and driveway runoff is directed into street/storm system.
(3) The remaining pervious areas (lawn) are considered to be in good condition for these curve numbers.

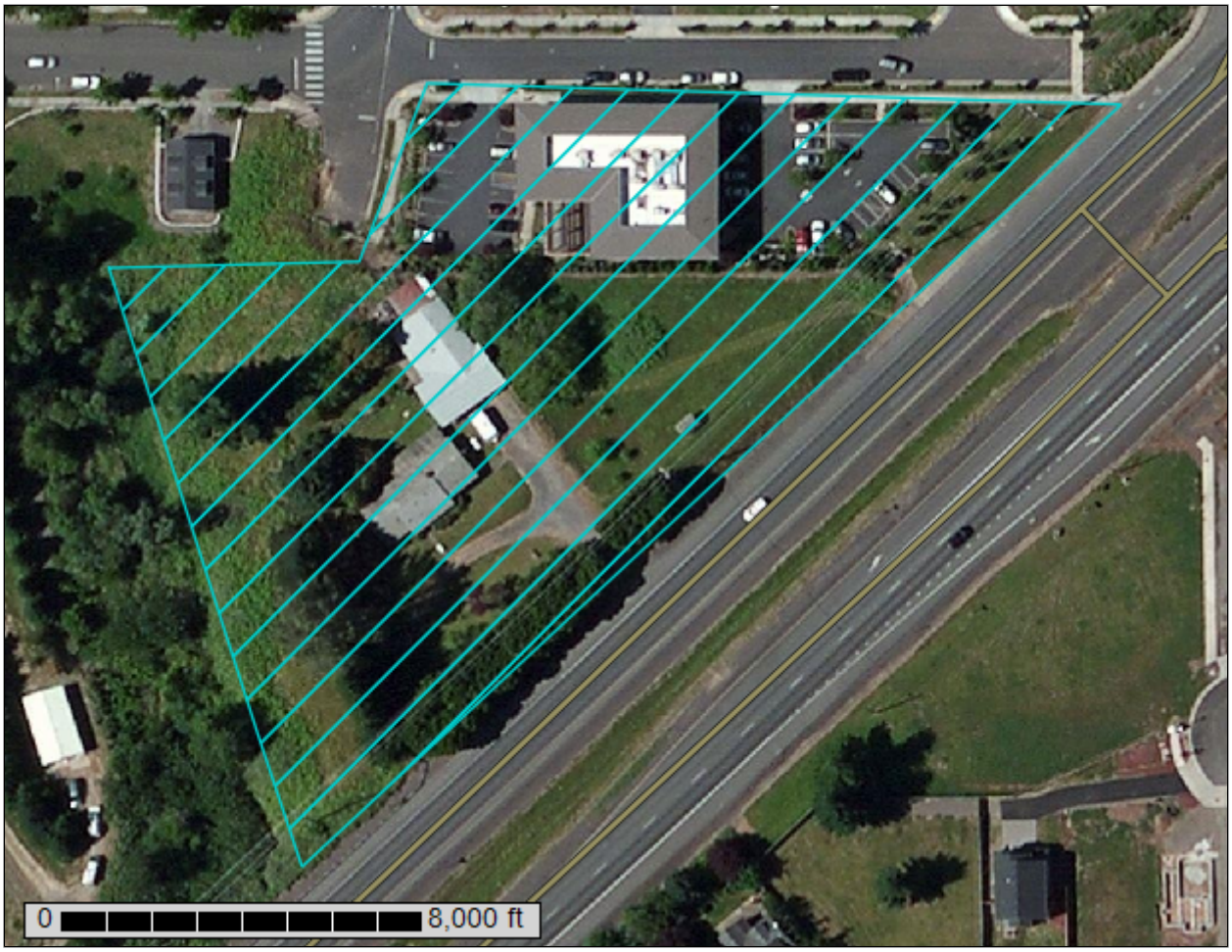
APPENDIX 6-1
USDA SOIL SURVEY OF WASHINGTON COUNTY

United States Department of Agriculture

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 Washington County, Oregon



July 17, 2013

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: 1:1,500 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: http://websoilsurvey.nrcs.usda.gov
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 10, Aug 20, 2012

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

Date(s) aerial images were photographed: Jul 8, 2010—Sep 4, 2011

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

Washington County, Oregon (OR067)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
22	Huberly silt loam	0.1	1.8%
37A	Quatama loam, 0 to 3 percent slopes	1.1	36.8%
37C	Quatama loam, 7 to 12 percent slopes	0.7	24.4%
37D	Quatama loam, 12 to 20 percent slopes	1.1	36.9%
Totals for Area of Interest		**2.9**	**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.

Washington County, Oregon

22—Huberly silt loam

Map Unit Setting

Elevation: 150 to 300 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 165 to 210 days

Map Unit Composition

Huberly and similar soils: 90 percent
Minor components: 3 percent

Description of Huberly

Setting

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

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 20 to 30 inches to fragipan
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.0 inches)

Interpretive groups

Farmland classification: Prime farmland if drained
Land capability classification (irrigated): 3w
Land capability (nonirrigated): 3w
Hydrologic Soil Group: C/D

Typical profile

0 to 8 inches: Silt loam
8 to 25 inches: Silt loam
25 to 60 inches: Silt loam

Minor Components

Verboort

Percent of map unit: 3 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

37A—Quatama loam, 0 to 3 percent slopes

Map Unit Setting

Elevation: 140 to 250 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 165 to 210 days

Map Unit Composition

Quatama and similar soils: 85 percent
Minor components: 4 percent

Description of Quatama

Setting

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

Properties and qualities

Slope: 0 to 3 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 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 8.8 inches)

Interpretive groups

Farmland classification: All areas are prime farmland
Land capability classification (irrigated): 2w
Land capability (nonirrigated): 2w
Hydrologic Soil Group: C

Typical profile

0 to 15 inches: Loam
15 to 30 inches: Clay loam
30 to 62 inches: Loam

Minor Components

Huberly

Percent of map unit: 4 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear

Across-slope shape: Linear

37C—Quatama loam, 7 to 12 percent slopes

Map Unit Setting

Elevation: 140 to 250 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 165 to 210 days

Map Unit Composition

Quatama and similar soils: 85 percent
Minor components: 4 percent

Description of Quatama

Setting

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

Properties and qualities

Slope: 7 to 12 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 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 8.8 inches)

Interpretive groups

Farmland classification: Farmland of statewide importance
Land capability classification (irrigated): 3e
Land capability (nonirrigated): 3e
Hydrologic Soil Group: C

Typical profile

0 to 15 inches: Loam
15 to 30 inches: Clay loam
30 to 62 inches: Loam

Minor Components

Huberly

Percent of map unit: 4 percent
Landform: Terraces
Landform position (three-dimensional): Tread

Down-slope shape: Linear
Across-slope shape: Linear

37D—Quatama loam, 12 to 20 percent slopes

Map Unit Setting

Elevation: 140 to 250 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 165 to 210 days

Map Unit Composition

Quatama and similar soils: 85 percent
Minor components: 4 percent

Description of Quatama

Setting

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

Properties and qualities

Slope: 12 to 20 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 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 8.8 inches)

Interpretive groups

Farmland classification: Farmland of statewide importance
Land capability (nonirrigated): 4e
Hydrologic Soil Group: C

Typical profile

0 to 15 inches: Loam
15 to 30 inches: Clay loam
30 to 62 inches: Loam

Minor Components

Huberly

Percent of map unit: 4 percent
Landform: Terraces
Landform position (three-dimensional): Tread

Down-slope shape: Linear
Across-slope shape: Linear

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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.

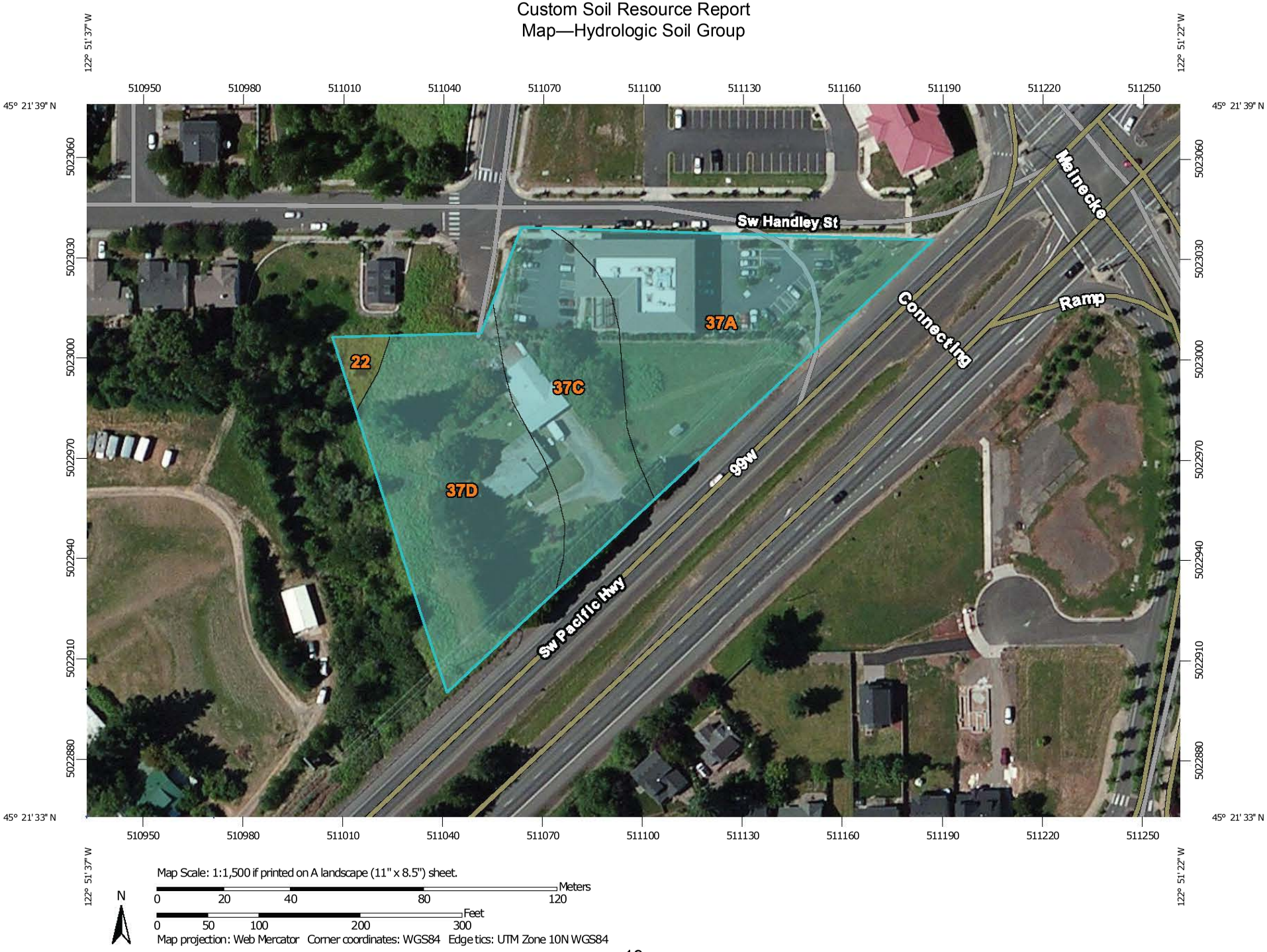
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

Map—Hydrologic Soil Group



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: http://websoilsurvey.nrcs.usda.gov
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 10, Aug 20, 2012

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

Date(s) aerial images were photographed: Jul 8, 2010—Sep 4, 2011

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.

Table—Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Washington County, Oregon (OR067)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
22	Huberly silt loam	C/D	0.1	1.8%
37A	Quatama loam, 0 to 3 percent slopes	C	1.1	36.8%
37C	Quatama loam, 7 to 12 percent slopes	C	0.7	24.4%
37D	Quatama loam, 12 to 20 percent slopes	C	1.1	36.9%
Totals for Area of Interest			**2.9**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX 7-1
CEDAR BRROK PROFESSIONAL BUILDING STORMWATER REPORT

CEDAR BROOK PROFESSIONAL BUILDING
STORMWATER REPORT

AKS JOB #1213

DATE:	MARCH 20, 2007
CLIENT:	NATHAN DOYEL 15425 PLEASANT HILL RD. SHERWOOD, OR 97140
ENGINEERING CONTACT:	HAYES McCOY/MONTY HURLEY
ENGINEERING FIRM:	AKS ENGINEERING & FORESTRY, LLC

13910 SW GALBREATH DRIVE, SUITE 100
SHERWOOD, OR 97140
PHONE: (503) 925-8799
FAX: (503) 925-8969

REGISTERED PROFESSIONAL ENGINEER
58842PE
OREGON
JULY 8, 2002
MONTGOMERY B. HURLEY

RENEWAL DATE: 6-30-09

STORMWATER REPORT

PROJECT: PACIFIC FAMILY DENTAL

1.0 PURPOSE OF REPORT

The purpose of this report is to document the criteria for which the stormwater for this site was designed to meet, the sources of information upon which the analysis is based, the design methodology, and the results of the analysis.

2.0 PROJECT LOCATION/DESCRIPTION

The proposed development is on approximately 0.78 acres, not including existing public right-of-ways. The site is located at the intersection of SW Cedar Brook Way and SW Handley Street.

3.0 REGULATORY DESIGN CRITERIA

3.1 STORMWATER QUANTITY MANAGEMENT CRITERIA

No known downstream deficiencies exist; therefore, no on-site detention is required.

3.2 STORMWATER QUALITY MANAGEMENT CRITERIA

The stormwater quality design storm is 0.36 inches of precipitation falling in 4 hours with an average storm return period of 96 hours.

The existing storm sewer in SW Handley Street collects stormwater and routes it to the existing stormwater facility for the Wyndham Ridge subdivision. In analyzing the drainage report for Wyndham Ridge, the stormwater facility (as originally designed) does not appear to contain any extra capacity for treating stormwater. However, the amount of impervious area that will be routed to the Wyndham Ridge stormwater facility has decreased due to the recent street vacation of part of SW Handley Street and reducing the street classification to a local street. Originally, SW Handley Street (east of the intersection with SW Cedar Brook Way) had approximately 0.48 acres of impervious area. With the vacation and the proposed improvements for SW Handley Street, there is approximately 0.36 acres of impervious area (including the adjacent property owner's sidewalk). The decrease in impervious area creates additional capacity in the Wyndham Ridge stormwater facility (~5,300 square feet) for water quality treatment. The areas are summarized as follows:

Former impervious area on vacated portion of this project site: 3,350 square feet
Former impervious area on vacated portion of adjacent property: 350 square feet
Former impervious area on improved SW Handley Street right-of-way: 1,600 square feet*

(*The existing (former) SW Handley Street is wider and contained more impervious area than the proposed improvements for the revised SW Handley Street.)

Due to the configuration of the site and the existing topography, the west parking lot cannot be routed to an on site stormwater facility. This impervious area (5,500 square feet) will be directly routed to the storm sewer in SW Handley Street and ultimately to the Wyndham Ridge stormwater facility. Of the available capacity in the Wyndham Ridge stormwater facility (5,300 square feet), 4,950 square feet can be credited to this project (3,350 square feet for the project site and 1,600 square feet for the SW Handley Street improvements). This leaves 550 square feet that must be covered by a 'fee-in-lieu' of stormwater treatment.

Stormwater from the building and the east parking lot will be routed to a vegetated swale that will be constructed at the southwest corner of the site. The vegetated swale was designed according to Clean Water Services Design and Construction Standards.

Along with the improvements for SW Handley Street, SW Cedar Brook Way will be extended per the City Engineer. Presently, stormwater from SW Cedar Brook Way (south of SW Handley Street) is untreated and is discharged into a small ditch due to the existing topography and relatively small amount of area that is untreated. The streets ends sloping down into a cut bank. Due to the topography, the small amount of street extended, and the existing grade at the end of SW Cedar Brook Way, treating stormwater from SW Cedar Brook Way (south of SW Handley Street) is not practical. The project site is approximately 5 to 6 feet above SW Cedar Brook Way at the end. However, extending SW Cedar Brook Way will add less than 2,000 square feet of impervious area. We recommend that a new ditch be constructed with a small amount of river rock that routes stormwater from SW Cedar Brook Way towards a natural drainage (as was done before). When SW Cedar Brook Way is extended, a future stormwater facility can be collect this street's stormwater and treat it properly according to CWS standards. A 'fee-in-lieu' of stormwater management for the extension of SW Cedar Brook Way may be applicable in this instance.

3.3 FLOOD PLAIN

The Flood Insurance Rate Map (FIRM) produced by the Federal Emergency Management Agency (FEMA) indicates that the project does not lie within any floodplain

4.0 SUMMARY OF ON-SITE STORMWATER DETENTION RESULTS

There are no known downstream stormwater facilities; therefore, on-site stormwater detention is not required.

5.0 SOURCES OF INFORMATION AND DESIGN METHODOLOGY

The Santa Barbara Urban Hydrograph (SBUH) Method is utilized for the stormwater analysis. This method utilizes the SCS Type 1A 24-hour storm. Hydrocad software aided in the analysis.

6.0 DESIGN PARAMETERS

6.1 DESIGN STORM

6.1.1 STORMWATER DETENTION FACILITY DESIGN

There are no known downstream stormwater facilities; therefore, stormwater detention is not required.

6.1.2 INLET AND CONDUIT SIZING

The stormwater inlets (catch basins) for the site are placed according to the grading (at all low points in grade and other necessary locations) and will adequately handle the stormwater for the site. The distance between catch basins is generally 250 feet or less.

The stormwater pipes are sized to adequately handle stormwater runoff from the 25-year storm event during final engineering.

6.2 PRE-DEVELOPED SITE TOPOGRAPHY AND LAND USE

6.2.1 SITE TOPOGRAPHY

The site is approximately 0.78 acres (not including existing public right-of-ways) and is located at the intersection of SW Cedar Brook Way and SW Handley Street. Pacific Highway (99W) is adjacent to the site along the east property line.

The site slopes to the northwest. The slopes are generally less than 5%; however, slopes are steeper near SW Cedar Brook way due to the recent street improvements. These steeper areas comprise a small portion of the area. The site is vacant and consists of a few trees and tall grass.

6.2.2 LAND USE

The existing site is vacant.

6.2.3 PRE-DEVELOPED INPUT PARAMETERS

The pre-developed input parameters are not necessary because detention is not required.

6.3 SOIL TYPE

The soil for the site consists primarily of Quatama loam, which belongs to hydrologic soil group "C". This information is identified in the USDA SCS Soil Survey of Washington County, Oregon. The applicable information is provided in this report.

6.4 POST-DEVELOPED SITE TOPOGRAPHY AND LAND USE

6.4.1 SITE TOPOGRAPHY

The post-developed site topography will not change substantially; however, the site will be developed with an office building and parking spaces.

6.4.2 LAND USE

The post-developed land use consists of an office building, parking spaces, landscaping, and a vegetated swale.

6.4.3 POST-DEVELOPED INPUT PARAMETERS

The input parameters are shown for the site on the catchment map and area identified as subcatchments 10, 20, and 30.

6.5 DESCRIPTION OF OFF-SITE CONTRIBUTORY BASINS

There are no off-site upstream basins.

7.0 CALCULATION METHODOLOGY

7.1 PROPOSED STORMWATER CONDUIT SIZING AND INLET SPACING

As stated in Section 6.1.2, the pipes are sized to have adequate capacity to convey stormwater runoff from the 25-year storm event.

7.2 PROPOSED STORMWATER QUANTITY CONTROL (DETENTION) FACILITY DESIGN

There are no know downstream deficiencies; therefore, stormwater detention is not required.

7.3 PROPOSED STORMWATER QUALITY CONTROL FACILITY DESIGN

The input parameters for the subcatchment (basin) are shown in this report. They were determined by topographic survey information, design, and analysis. The hydrographs were created with Hydrocad software. The stormwater quality facility is a vegetated swale designed in accordance with Section 3.1 of Appendix B of the Clean Water Services Design and Construction Standards for Sanitary Sewer and Surface Water Management (March 2004) manual.

7.4 ENERGY DISSIPATER CALCULATIONS

Riprap will be placed at several locations, including the inlet and outlet of the vegetated swale, to act as an energy dissipater. The required riprap size shall be a minimum of Class 50.

7.5 DOWNSTREAM ANALYSIS

From the site, stormwater is routed through an existing storm sewer to the existing stormwater facility for Wyndham Ridge. Based on the pipe sizing analysis included in the Wyndham Ridge stormwater report, the existing downstream storm sewer pipes were analyzed for capacity. All downstream pipes are sufficient to convey stormwater for the 25-year storm. From the existing facility, stormwater is discharged into a tributary of Cedar Creek. The additional flow generated from this development constitutes less than 5% of the total tributary drainage flow.

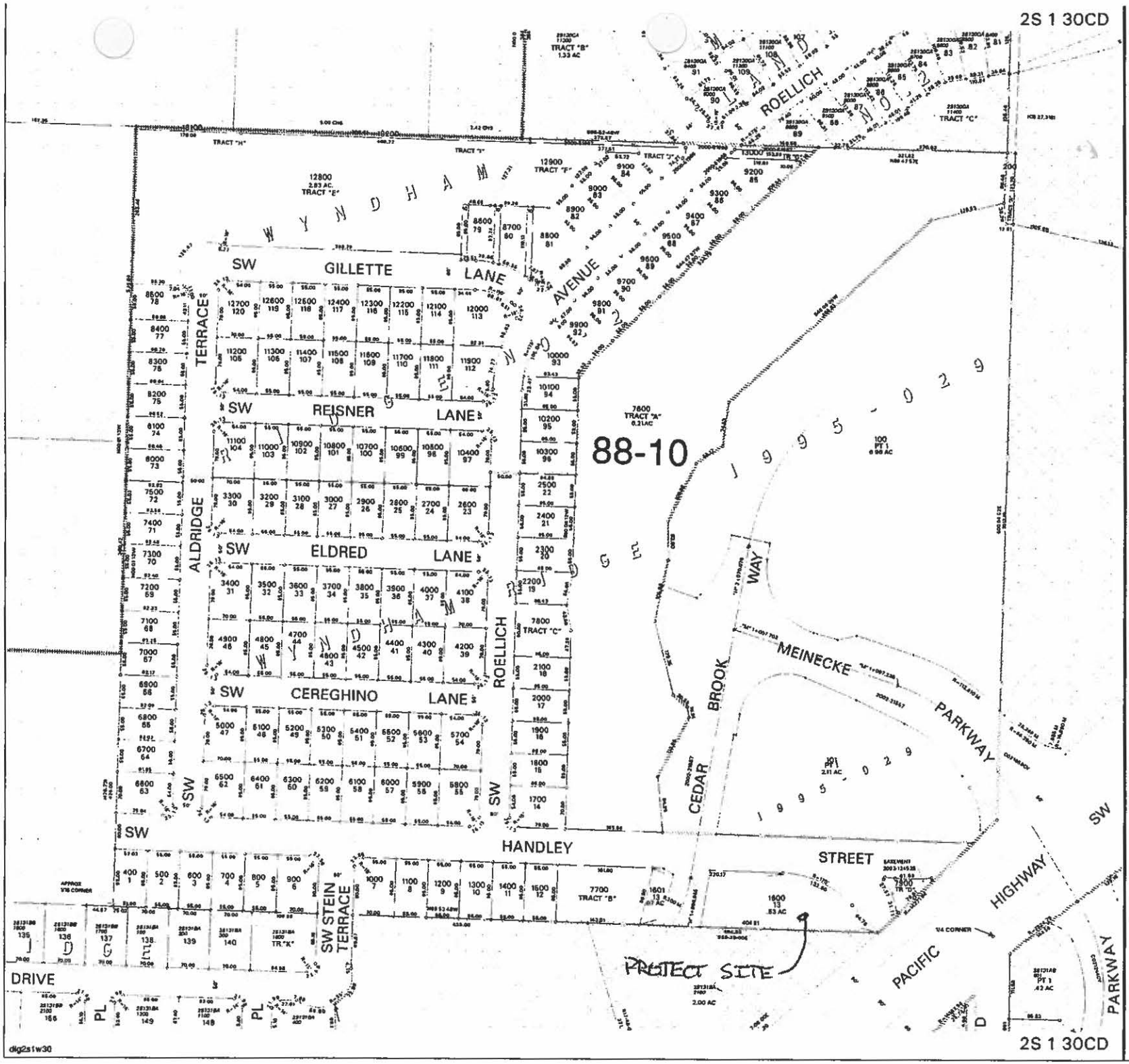
8.0 STORMWATER QUANTITY CONTROL FACILITY OPERATION

Stormwater detention is not required.

9.0 STORMWATER QUALITY CONTROL FACILITY OPERATION

Stormwater will be routed through catch basins and stormwater pipes into the vegetated swale (except for the west parking lot, see Section 3.2) designed per Clean Water Services standards.

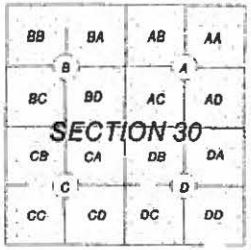
The stormwater facility will be privately owned and maintained by the owner of the site.



WASHINGTON COUNTY OREGON
SE1/4 SW1/4 SECTION 30 T2S R1W W.M.
SCALE 1" = 100'

36	31	32	33	34	35	36	31
1	6	5	4	3	2	1	6
12	7	8	9	10	11	12	7
13	18	17	16	15	14	13	18
24	19	20	21	22	23	24	19
25	30	29	28	27	26	25	30
36	31	32	33	34	35	36	31
1	6	5	4	3	2	1	6

FOR ADDITIONAL MAPS VISIT OUR WEBSITE AT www.co.washington.or.us



Cancelled Taxlots For: 2S130CD
300,13300,

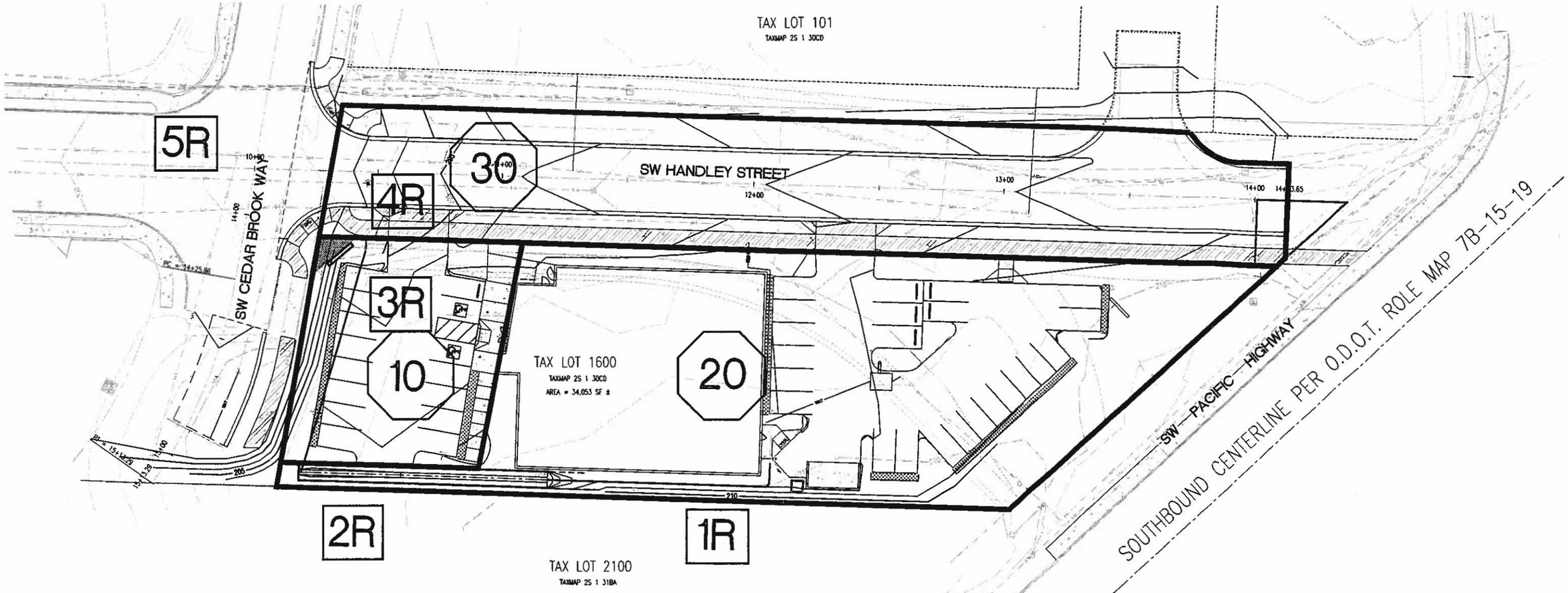
ASSESSMENT CARTOGRAPHY TOMATION

PLOT DATE: November 07, 2003

FOR ASSESSMENT PURPOSES ONLY - DO NOT RELY ON FOR OTHER USE

Map areas delineated by either gray shading or a cross-hatched pattern are for reference only and may not indicate the most current property boundaries. Please consult the appropriate map for the most current information.

SHERWOOD
2S 1 30CD



LEGEND

EXISTING GROUND CONTOUR (1 FT)

EXISTING GROUND CONTOUR (5 FT) — 100 —

FINISHED GRADE CONTOUR (1 FT)

FINISHED GRADE CONTOUR (5 FT) — 100 —

SCALE 1" = 20 FEET

DATE: 3-20-07 mlt

REVISIONS:

CATCHMENT PLAN

AKS ENGINEERING & FORESTRY
ENGINEERING · PLANNING · SURVEYING · FORESTRY
LICENSED IN OR, WA & AK
13910 SW GALBREATH DRIVE SUITE 100
SHERWOOD, OR 97140
PHONE: (503) 925-8799 FAX: (503) 925-8969

DESIGNED BY:	HAM	DRAWING NO.	S1
DRAWN BY:	HAM	SCALE:	AS NOTED
CHECKED BY:	HAM		

PREPARED FOR: NATHAN DOYEL
15425 PLEASANT HILL RD.
SHERWOOD, OR
(503) 349-6656
FAX: (503)

PACIFIC FAMILY DENTAL

SHERWOOD OREGON
TAX LOT 1600 WASHINGTON COUNTY TAXMAP 2S 1 30CD

JOB NUMBER 1213

SHEET 1 OF 1

SUBJECT CEDAR BROOK PROFESSIONAL BUILDING
WATER QUALITY CALCULATIONS
DATE 2/7/07 BY KM PROJECT NO. 1213

AKS Engineering & Forestry
13910 SW Galbreath Drive, Suite100
Sherwood, OR 97140
Phone (503) 925-8799 Fax (503) 925-8969

Located In:
Sherwood, OR
Vancouver, WA

ORIGINAL IMPERVIOUS AREA ON SW HANDLEY STREET = 0.48 AC
(EAST OF SW CEDAR BROOK WAY)

SW HANDLEY WILL BE CONSTRUCTED AS A LOCAL STREET AND PART OF ITS RIGHT-OF-WAY HAS BEEN VACATED

NEW IMPERVIOUS AREA : 0.36 AC
(SUBCATCHMENT 30)

EXTRA CAPACITY IN WINDHAM RIDGE STORMWATER FACILITY THAT CAN BE CREDITED TO THIS PROJECT : 1,950 SF

550 SF MUST BE ACCOUNTED FOR WITH A 'FEE-IN-LIEU' OF STORMWATER QUALITY TREATMENT.

SUBCATCHMENT 10 IMPERVIOUS AREA = 5,500 SF
(WEST PARKING LOT)

WEST PARKING MUST DISCHARGE INTO EX STORM SEWER IN SW HANDLEY.

SUBCATCHMENT 20 IMPERVIOUS AREA : 16,500 SF (WATER QUALITY AREA)

$$WQ\ STORM = 0.36'' \Rightarrow WQV = \frac{16{,}500\,(0.36'')}{12} = 495\ CF$$

RELEASE OVER 4 HOURS TO DETERMINE WATER QUALITY FLOW

$$\frac{495\ CF}{14400\ SEC} = 0.03\ CFS$$

CRITERIA = DETENTION = 9 MIN OR 540 SEC.

MAXIMUM FLOW DEPTH : 0.50'

MIN SLOPE = 0.5%

MIN LENGTH = 100'

SEE FOLLOWING SHEETS FOR WQ CALCULATIONS

1213 - PACIFIC FAMILY DENTAL
WQ SWALE CALC'S
6/3/06 TLA

Worksheet for Trapezoidal Channel - 1

Project Description		
Flow Element:	Trapezoidal Channel	
Friction Method:	Manning Formula	
Solve For:	Normal Depth	

Input Data		
Roughness Coefficient:	0.240 - PER CWS STDS	
Channel Slope:	0.00500 - PER GRADING PLAN	ft/ft
Left Side Slope:	4.00 - PER CWS STDS	ft/ft (H:V)
Right Side Slope:	4.00 - PER CWS STDS	ft/ft (H:V)
Bottom Width:	2.00 - PER SITE PLAN	ft
Discharge:	0.03	ft^3/s

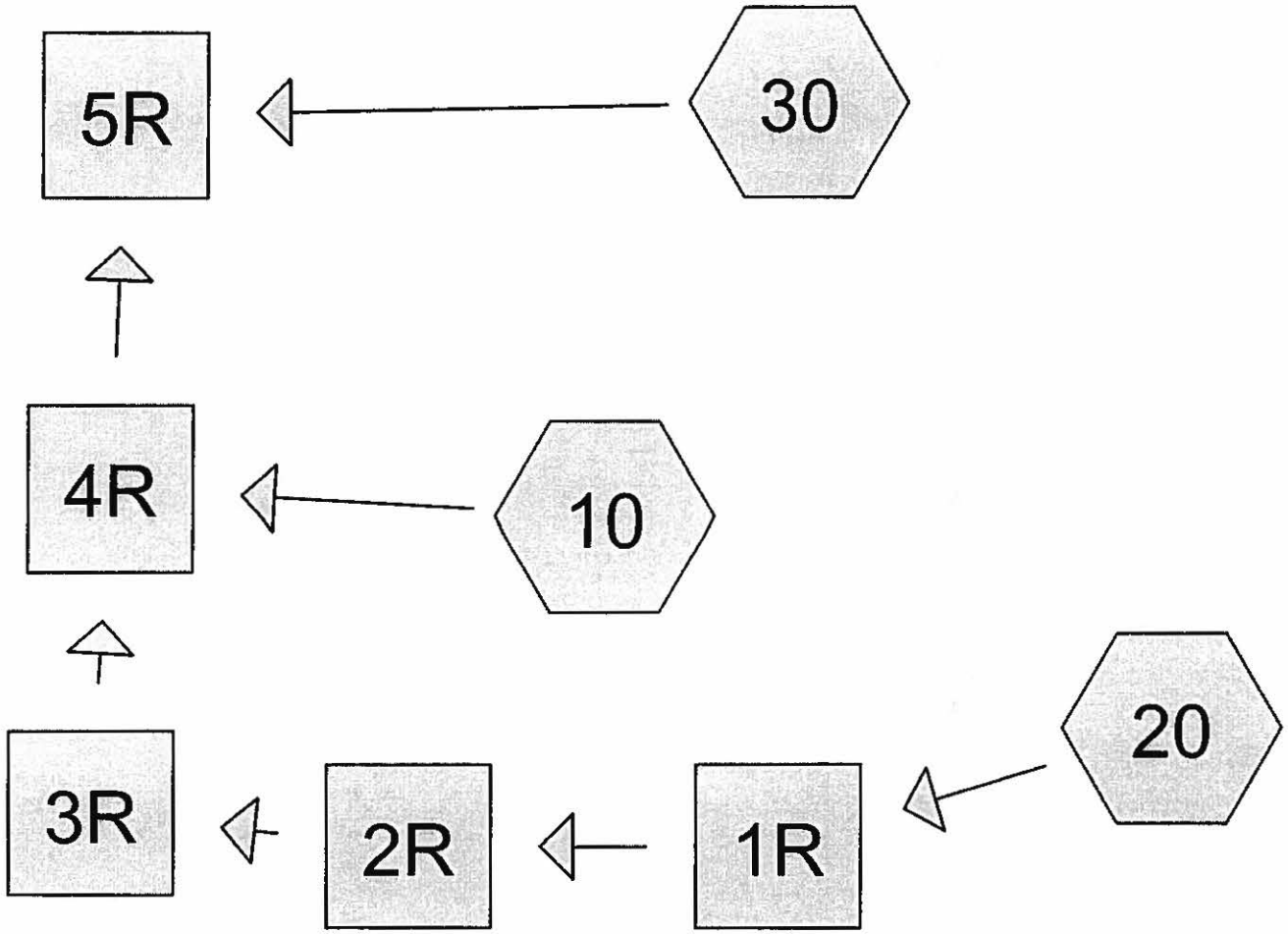
Results		
Normal Depth:	0.12 <0.5' OK	ft
Flow Area:	0.31	ft^2
Wetted Perimeter:	3.03	ft
Top Width:	3.00	ft
Critical Depth:	0.02	ft
Critical Slope:	3.19543	ft/ft
Velocity:	0.10 OVER 100' $= \frac{100'}{0.1'/sec} = 1000$ SEC > 540 SEC (OK)	ft/s
Velocity Head:	0.00	ft
Specific Energy:	0.12	ft
Froude Number:	0.05	
Flow Type:	Subcritical	

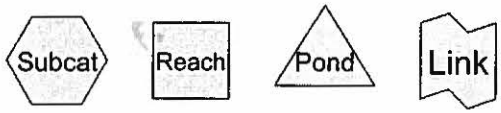
GVF Input Data		
Downstream Depth:	0.00	ft
Length:	0.00	ft
Number Of Steps:	0	

GVF Output Data		
Upstream Depth:	0.00	ft
Profile Description:	N/A	
Headloss:	0.00	ft
Downstream Velocity:	0.00	ft/s
Upstream Velocity:	0.00	ft/s
Normal Depth:	0.12	ft
Critical Depth:	0.02	ft
Channel Slope:	0.00500	ft/ft

Worksheet for Trapezoidal Channel - 1

Critical Slope:	3.19543	ft/ft





Drainage Diagram for 1213-POST
Prepared by {AKS ENGINEERING & FORESTRY, LLC} 3/20/2007
HydroCAD® 6.00 s/n 001338 © 1986-2001 Applied Microcomputer Systems

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SBUH method, Type IA 24-hr Rainfall=3.90"
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 10: WEST PARKING LOT
Tc=5.0 min CN=95 Area=7,250 sf Runoff= 0.14 cfs 0.046 af

Subcatchment 20: EAST PARKING AND BUILDING
Tc=5.0 min CN=93 Area=26,818 sf Runoff= 0.50 cfs 0.160 af

Subcatchment 30: HANDLEY STREET (LOCAL)
Tc=5.0 min CN=96 Area=19,028 sf Runoff= 0.38 cfs 0.125 af

Reach 1R: STM PIPE Inflow= 0.50 cfs 0.160 af
Length= 88.9' Max Vel= 3.5 fps Capacity= 1.31 cfs Outflow= 0.50 cfs 0.160 af

Reach 2R: SWALE Inflow= 0.50 cfs 0.160 af
Length= 100.0' Max Vel= 0.5 fps Capacity= 1.25 cfs Outflow= 0.50 cfs 0.159 af

Reach 3R: STM Inflow= 0.50 cfs 0.159 af
Length= 91.5' Max Vel= 3.5 fps Capacity= 1.31 cfs Outflow= 0.49 cfs 0.159 af

Reach 4R: STM Inflow= 0.63 cfs 0.205 af
Length= 21.4' Max Vel= 3.7 fps Capacity= 1.30 cfs Outflow= 0.63 cfs 0.205 af

Reach 5R: STM Inflow= 1.01 cfs 0.330 af
Length= 238.1' Max Vel= 5.2 fps Capacity= 5.26 cfs Outflow= 1.01 cfs 0.330 af

Runoff Area = 1.219 ac Volume = 0.331 af Average Depth = 3.26"

Subcatchment 10: WEST PARKING LOT

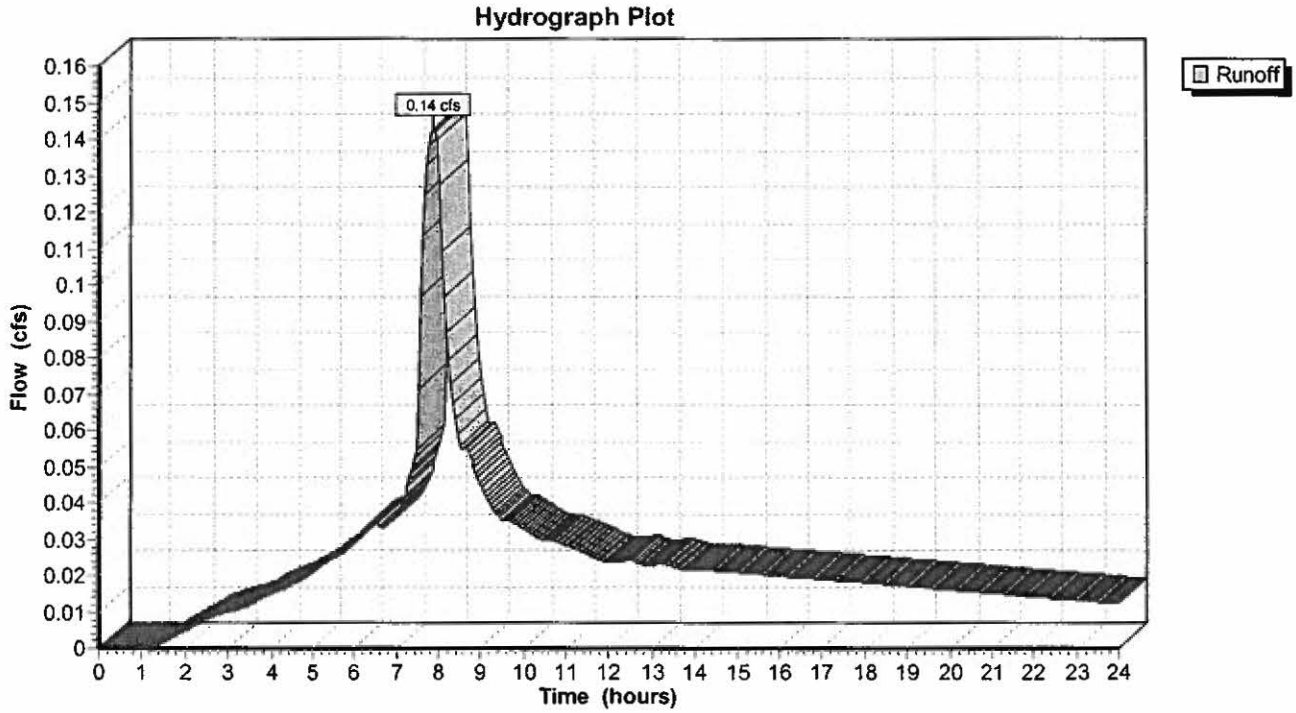
Runoff = 0.14 cfs @ 7.91 hrs, Volume= 0.046 af

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=3.90"

Area (sf)	CN	Description
5,500	98	IMPERVIOUS
1,750	86	PERVIOUS
7,250	95	Weighted Average

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

Subcatchment 10: WEST PARKING LOT



Subcatchment 20: EAST PARKING AND BUILDING

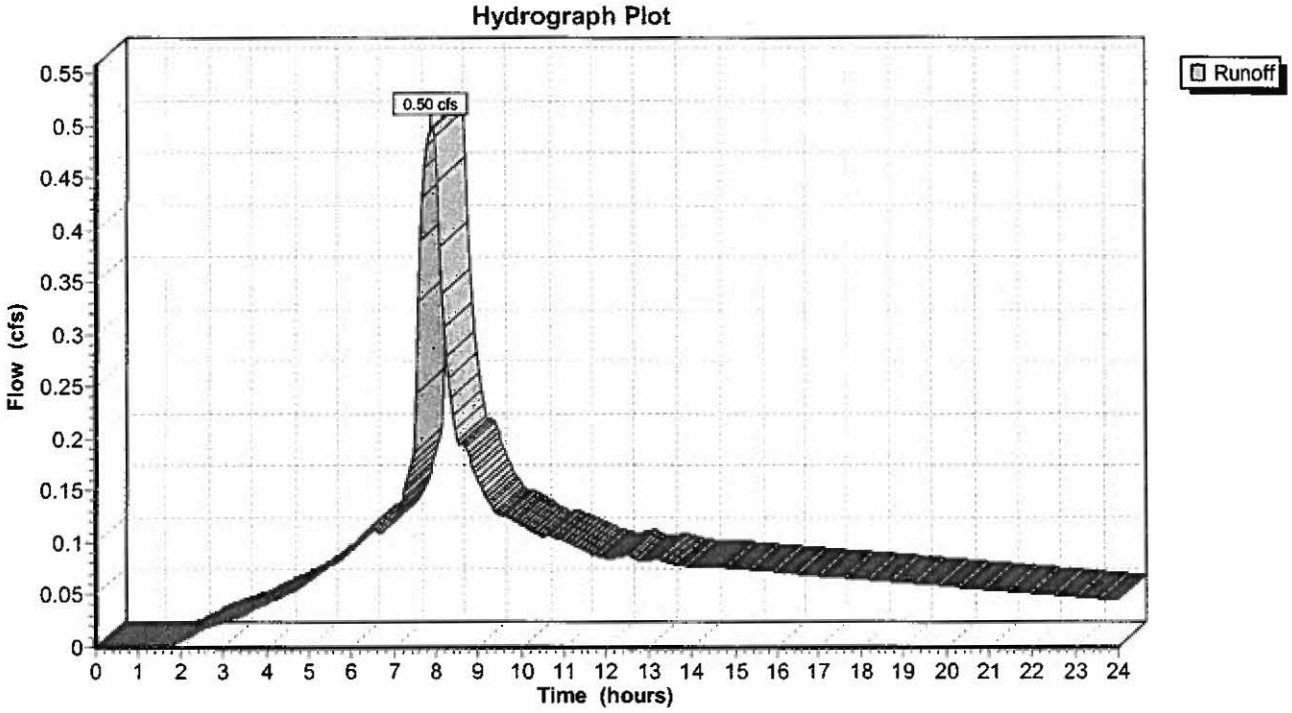
Runoff = 0.50 cfs @ 7.92 hrs, Volume= 0.160 af

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=3.90"

Area (sf)	CN	Description
16,500	98	IMPERVIOUS
10,318	86	PERVIOUS
26,818	93	Weighted Average

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

Subcatchment 20: EAST PARKING AND BUILDING



Subcatchment 30: HANDLEY STREET (LOCAL)

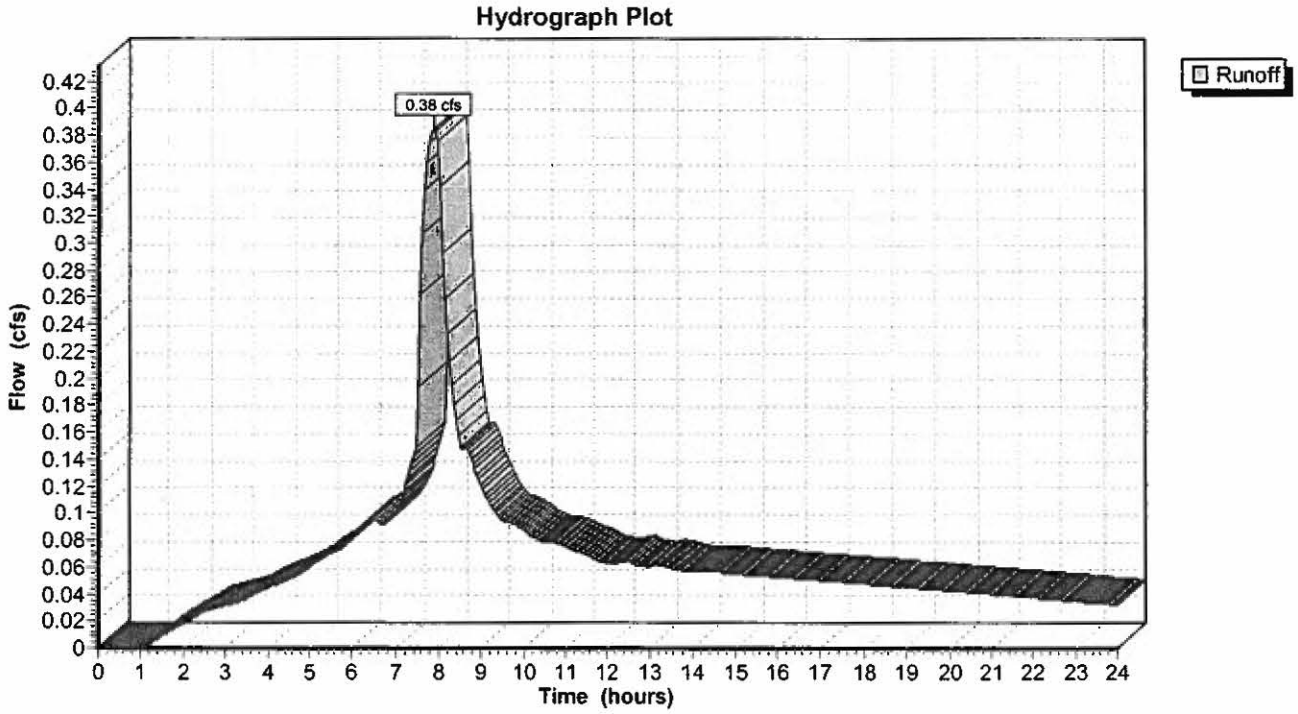
Runoff = 0.38 cfs @ 7.90 hrs, Volume= 0.125 af

Runoff by SBUH method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr Rainfall=3.90"

Area (sf)	CN	Description
15,105	98	IMPERVIOUS
3,923	86	PERVIOUS
19,028	96	Weighted Average

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

Subcatchment 30: HANDLEY STREET (LOCAL)



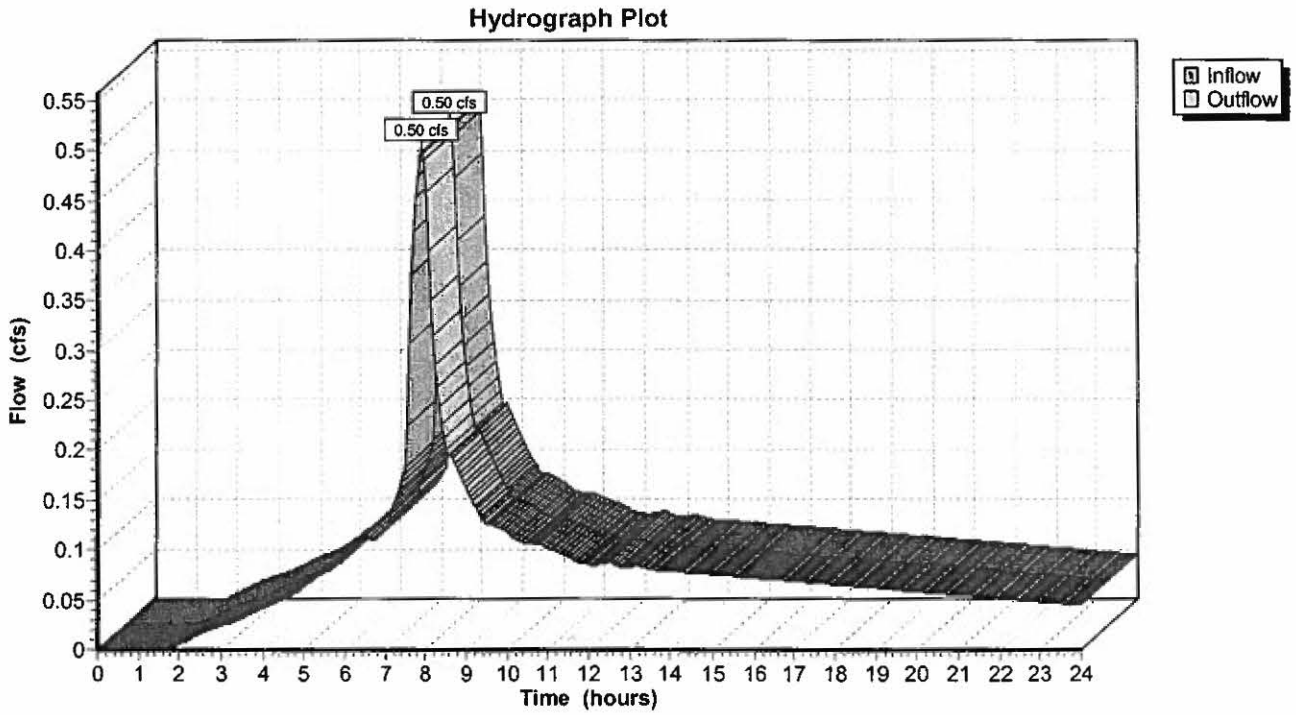
Reach 1R: STM PIPE

Inflow	=	0.50 cfs @	7.92 hrs, Volume=	0.160 af	
Outflow	=	0.50 cfs @	7.93 hrs, Volume=	0.160 af, Atten= 0%, Lag= 0.8 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.5 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.0 fps, Avg. Travel Time= 0.7 min

Peak Depth= 0.28'
Capacity at bank full= 1.31 cfs
Inlet Invert= 205.18', Outlet Invert= 204.29'
8.0" Diameter Pipe n= 0.012 Length= 88.9' Slope= 0.0100 '/'

Reach 1R: STM PIPE



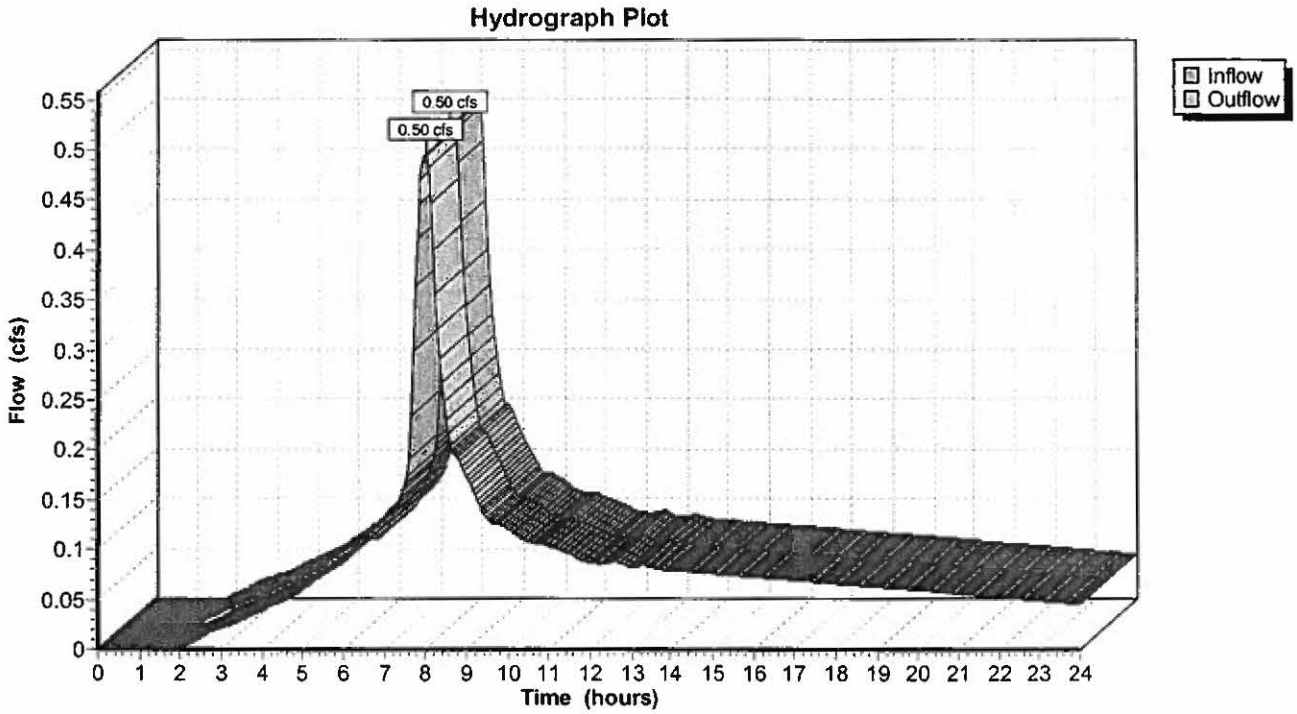
Reach 2R: SWALE

Inflow	=	0.50 cfs @	7.93 hrs, Volume=	0.160 af	
Outflow	=	0.50 cfs @	8.03 hrs, Volume=	0.159 af, Atten= 0%, Lag= 5.8 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.5 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 0.3 fps, Avg. Travel Time= 6.2 min

Peak Depth= 0.31'
Capacity at bank full= 1.25 cfs
Inlet Invert= 204.29', Outlet Invert= 203.79'
2.00' x 0.50' deep channel, n= 0.080 Length= 100.0' Slope= 0.0050 '/'
Side Slope Z-value= 4.0 '/'

Reach 2R: SWALE



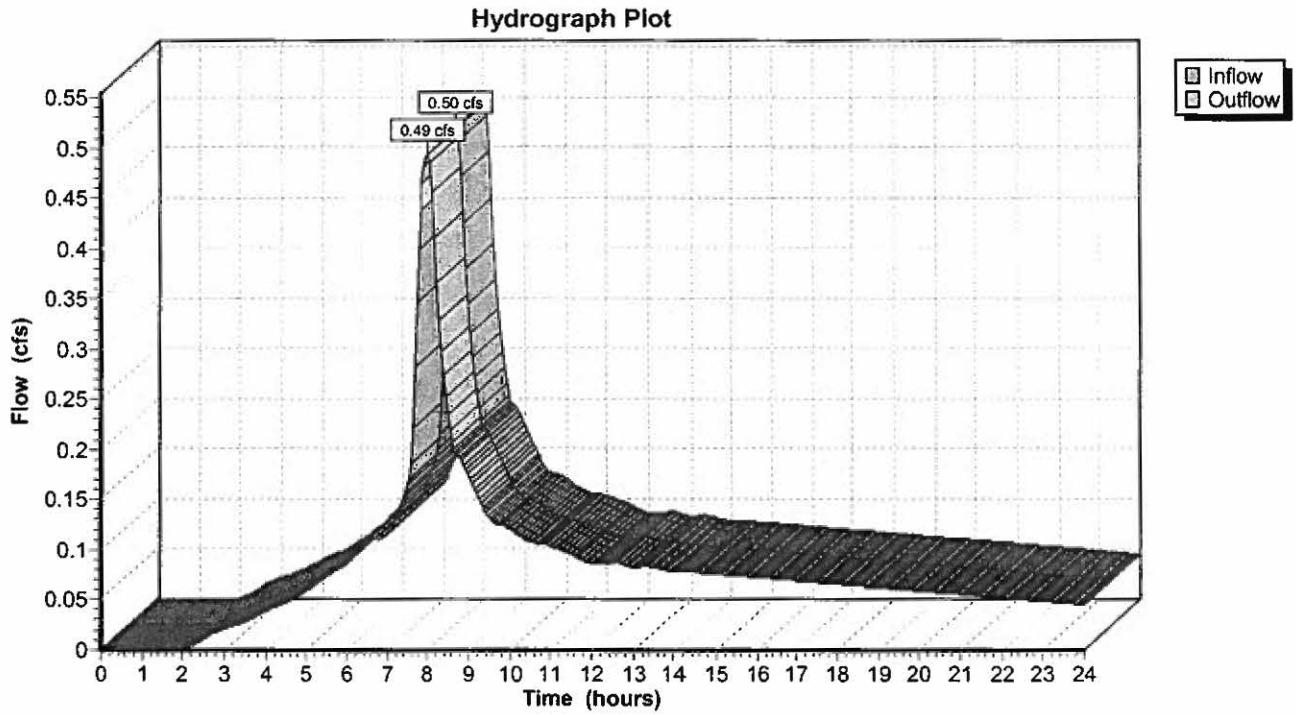
Reach 3R: STM

Inflow	=	0.50 cfs @	8.03 hrs, Volume=	0.159 af	
Outflow	=	0.49 cfs @	8.04 hrs, Volume=	0.159 af, Atten= 0%, Lag= 0.5 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.5 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.0 fps, Avg. Travel Time= 0.8 min

Peak Depth= 0.28'
Capacity at bank full= 1.31 cfs
Inlet Invert= 200.00', Outlet Invert= 199.09'
8.0" Diameter Pipe n= 0.012 Length= 91.5' Slope= 0.0099 '/'

Reach 3R: STM



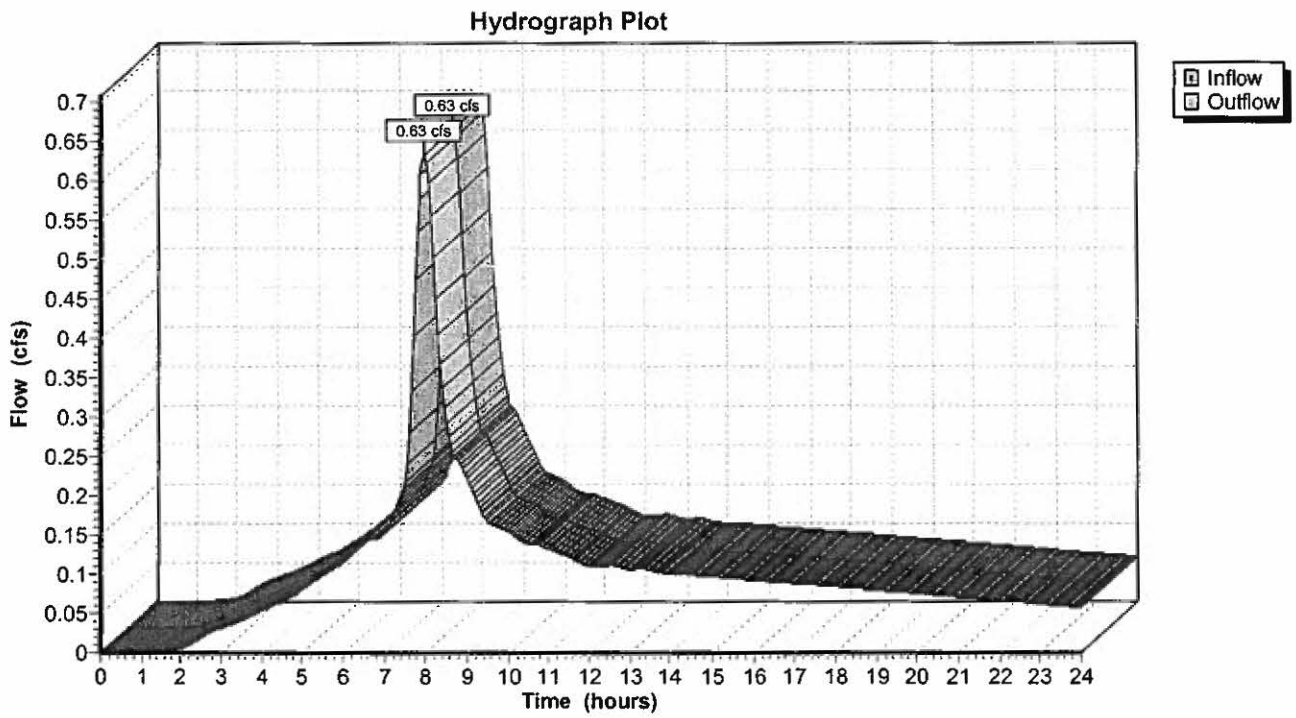
Reach 4R: STM

Inflow	=	0.63 cfs @	8.00 hrs,	Volume=	0.205 af
Outflow	=	0.63 cfs @	8.00 hrs,	Volume=	0.205 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.7 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.1 fps, Avg. Travel Time= 0.2 min

Peak Depth= 0.33'
Capacity at bank full= 1.30 cfs
Inlet Invert= 199.04', Outlet Invert= 198.83'
8.0" Diameter Pipe n= 0.012 Length= 21.4' Slope= 0.0098 '/'

Reach 4R: STM



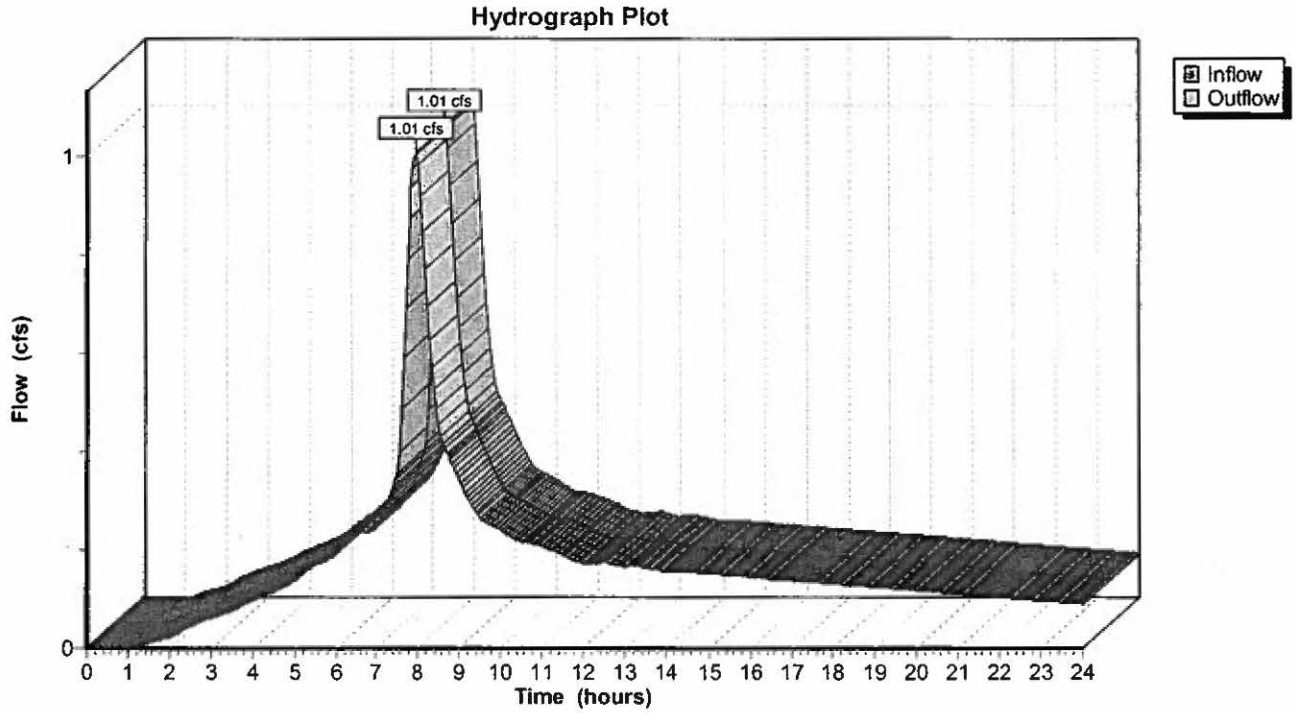
Reach 5R: STM

Inflow	=	1.01 cfs @	7.98 hrs, Volume=	0.330 af	
Outflow	=	1.01 cfs @	7.99 hrs, Volume=	0.330 af, Atten= 0%, Lag= 0.7 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.2 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 2.9 fps, Avg. Travel Time= 1.4 min

Peak Depth= 0.30'
Capacity at bank full= 5.26 cfs
Inlet Invert= 198.63', Outlet Invert= 194.21'
12.0" Diameter Pipe n= 0.012 Length= 238.1' Slope= 0.0186 '/'

Reach 5R: STM



STORM SEWER DESIGN FORM
JOB: 309-00
PROJECT: WYNDHAM RIDGE PHASE #1
KING COUNTY WASHINGTON, SANTA BARBRA URBAN HYDROGRAPH, TYPE IA SCS METHOD

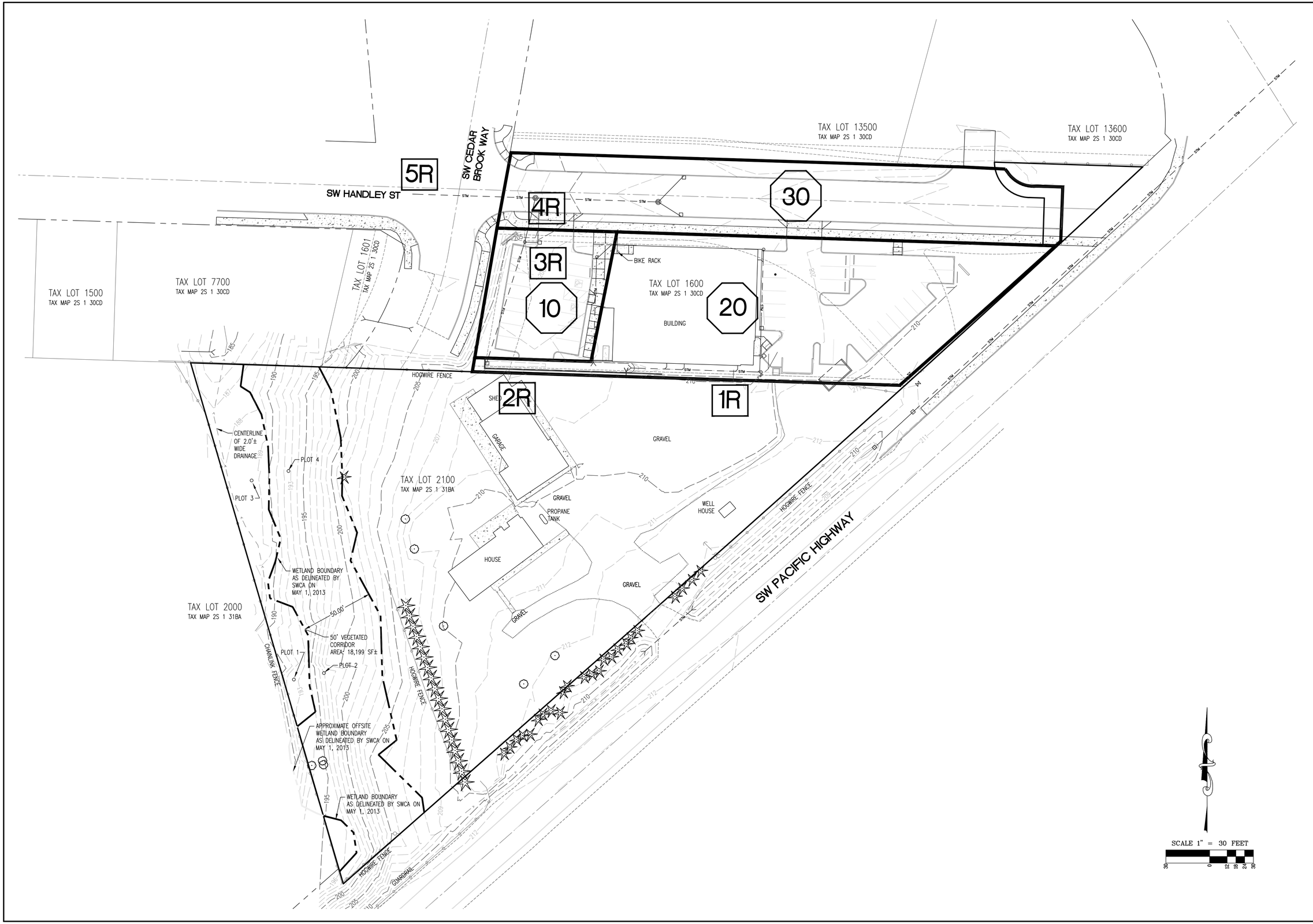
MH - MH	INCR. AREA (ACRES)	ACCU AREA (ACRES)	% IMP.	AREA PERV. (ACRES)	CN PER.	AREA IMP. (ACRES)	CN IMP.	TIME (MIN)	Q (CFS)	SIZE PIPE	SLOPE (FT/FT)	Q FULL (CFS)	Q/QI (%)	VEL. FULL (FPS)	V/VI (%)	ACT. VEL. (FPS)	LENGTH (FEET)	INCR. TIME (MIN)	INV. ELEV. IN.	INV. ELEV OUT
MH#5-MH#4	0.25	0.25	46	0.14	86	0.12	98	10.00	0.19	12	0.0300	6.19	0.03	7.88	0.23	1.82	165.27	1.52	211.96	207.00
MH#4-MH#3	1.50	1.75	46	0.95	86	0.81	98	11.52	1.33	12	0.0649	9.10	0.15	11.59	0.35	4.01	264.73	1.10	206.80	189.62
MH#20-MH#19	0.47	0.47	46	0.25	86	0.22	98	10.00	~~0.87~~ 1.01	12	0.0210	5.18	~~0.17~~ 0.20	6.59	0.27	1.79	288.00	2.68	196.66	190.61
MH#19-MH#3	0.86	1.33	46	0.72	86	0.61	98	12.68	~~0.99~~ 1.63	12	0.0045	2.40	~~0.41~~ 0.68	3.05	0.61	1.87	176.00	1.57	190.41	189.62
MH#3-MH#2	1.20	4.28	46	2.31	86	1.97	98	12.62	~~3.20~~ 3.84	15	0.0048	4.49	~~0.71~~ 0.86	3.66	0.91	3.34	245.00	1.22	189.42	188.24
MH#10-MH#9	0.74	0.74	46	0.40	86	0.34	98	10.00	0.58	12	0.0447	7.55	0.08	9.62	0.28	2.66	243.02	1.52	210.49	199.63
MH#9-MH#2A	1.20	1.94	46	1.05	86	0.89	98	11.52	1.48	12	0.0447	7.55	0.20	9.62	0.40	3.81	228.95	1.00	199.43	189.20
MH#2A-MH#2	1.42	3.36	46	1.81	86	1.55	98	12.52	2.52	12	0.0210	5.18	0.49	6.59	0.69	4.53	36.05	0.13	189.00	188.24
MH#2-MH#1	0.00	7.64	46	4.13	86	3.51	98	12.66	~~5.71~~ 6.35	18	0.0040	6.66	~~0.86~~ 0.95	3.77	1.06	3.99	85.00	0.36	188.04	187.7
MH#8-MH#7	0.97	0.97	46	0.52	86	0.45	98	10.00	0.76	12	0.0148	4.35	0.17	5.53	0.37	2.07	243.02	1.95	201.79	198.20
MH#7-MH#6A	1.20	2.17	46	1.17	86	1.00	98	11.95	1.64	12	0.0365	6.82	0.24	8.69	0.44	3.83	228.95	1.00	198.00	189.64
MH#6A-MH#6	1.25	3.42	46	1.85	86	1.57	98	12.95	2.56	12	0.0100	3.57	0.72	4.55	0.92	4.17	36.05	0.14	189.44	189.08
MH#6-MH#1	0.00	3.42	46	1.85	86	1.57	98	13.09	2.56	12	0.0076	3.11	0.82	3.97	1.02	4.05	155.00	0.64	188.88	187.7
MH#1-MH#11	1.84	12.90	46	6.97	86	5.93	98	13.01	~~9.69~~ 10.23	18	0.0750	28.84	~~0.33~~ 0.35	16.32	0.53	8.69	85.00	0.16	188.20	181.83
MH#11-OUTFALL	0.00	12.90	46	6.97	86	5.93	98	13.17	~~9.89~~ 10.23	18	0.0550	24.70	~~0.38~~ 0.41	13.98	0.59	8.22	55.00	0.11	181.63	178.60

FROM WYNDHAM RIDGE, PHASE 1

ASSUME ADDITIONAL 0.64 CFS OF FLOW

WYNDHAM RIDGE ASSUMED 0.37 CFS - SUM OF SUBCATCHMENTS 10, 20, 30 (CALCULATED AT REACH 5R, SEE HYDROCAD) = 1.01 CFS A = 0.64 CFS

NO PIPES EXCEED CAPACITY



PRE-DEVELOPED CATCHMENT PLAN

PACIFIC FAMILY DENTAL PARKING LOT EXPANSION

SHERWOOD OREGON
TAX LOTS 1600 AND 2100 WASHINGTON COUNTY TAX MAP 2S 1 30CD AND 2S 1 31BA

AKS ENGINEERING & FORESTRY
ENGINEERING · PLANNING
SURVEYING · FORESTRY
13910 SW GALBRAITH DR.,
SUITE 100
SHERWOOD, OR 97140
PHONE: (503) 925-8799
FAX: (503) 925-8969

DESIGNED BY:	RSW
DRAWN BY:	RSW
CHECKED BY:	MBH
DRAWING:	2721 CATCHMENT PLAN
SCALE:	AS NOTED

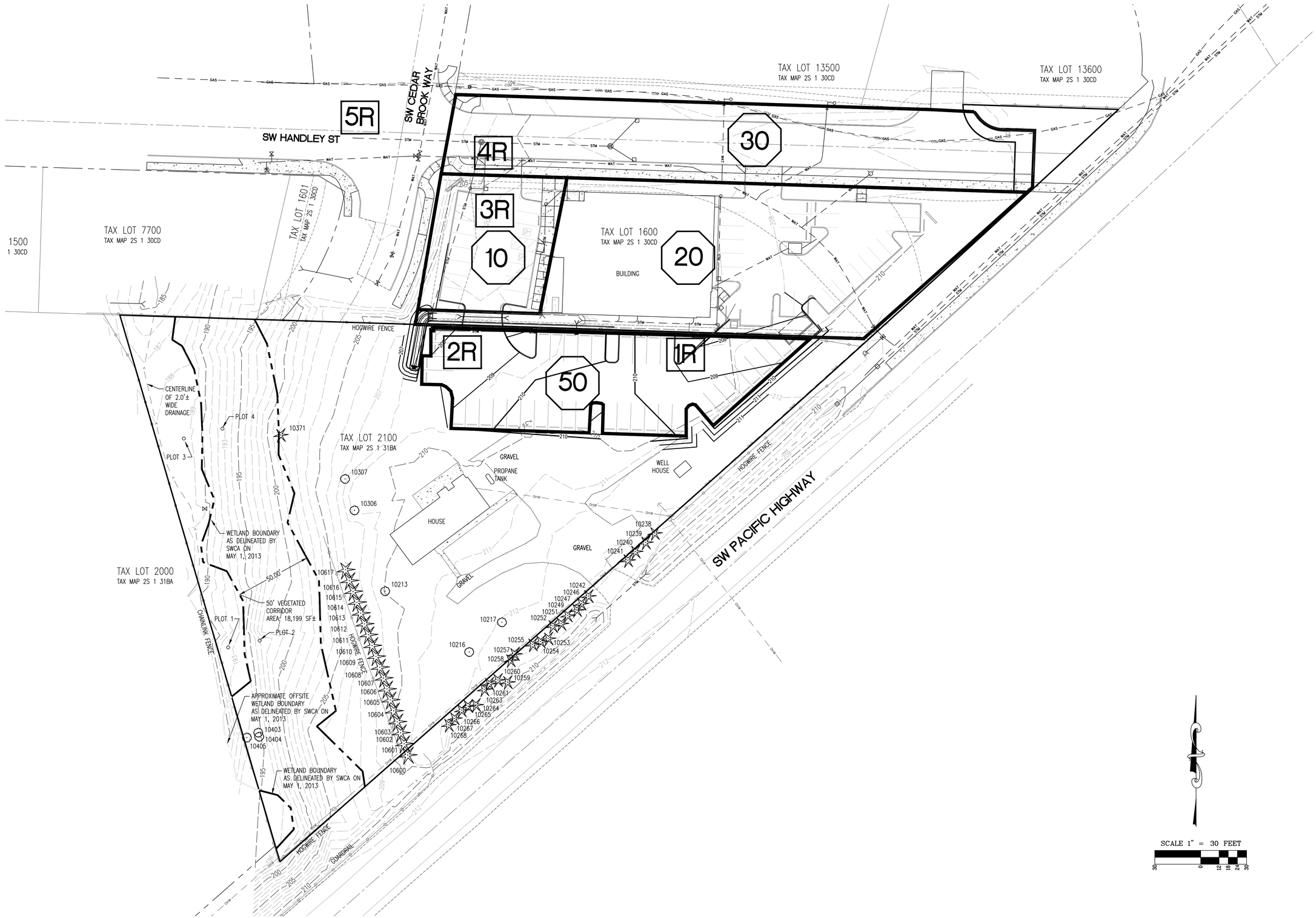
PREPARED FOR:
NATHAN DOYEL
17680 SW HANDLEY ST #101
SHERWOOD, OR 97140

DATE: 07/15/13

REGISTERED PROFESSIONAL ENGINEER
PRELIMINARY
NOT FOR CONSTRUCTION
OREGON
JULY 9, 2002
MONTGOMERY B. HURLEY
RENEWAL DATE: 6/30/15

JOB NUMBER
2721

SHEET
1



POST-DEVELOPED CATCHMENT PLAN

PACIFIC FAMILY DENTAL PARKING LOT EXPANSION

SHERWOOD OREGON
TAX LOTS 1600 AND 2100 WASHINGTON COUNTY TAX MAP 2S 1 30CD AND 2S 1 31BA

AKS ENGINEERING & FORESTRY
ENGINEERING · PLANNING
SURVEYING · FORESTRY
13910 SW GALBREATH DR.,
SUITE 100
SHERWOOD, OR 97140
PHONE: (503) 925-8799
FAX: (503) 925-8969

DESIGNED BY:	RSW
DRAWN BY:	RSW
CHECKED BY:	MBH
DRAWING:	2721 CATCHMENT PLAN
SCALE:	AS NOTED

PREPARED FOR:
NATHAN DOYEL
17680 SW HANDLEY ST #101
SHERWOOD, OR 97140

DATE: 07/15/13

REGISTERED PROFESSIONAL ENGINEER
OREGON
JULY 5, 2002
MONTGOMERY B. HURLEY
PRELIMINARY
NOT FOR CONSTRUCTION
RENEWAL DATE: 6/30/15

JOB NUMBER
2721

SHEET
2

BASIN MAP

PACIFIC FAMILY DENTAL PARKING LOT EXPANSION

SHERWOOD OREGON

TAX LOTS 1600 AND 2100 WASHINGTON COUNTY TAX MAP 2S 1 30CD AND 2S 1 31BA

AKS ENGINEERING & FORESTRY

ENGINEERING · PLANNING
SURVEYING · FORESTRY

13910 SW GALBREATH DR.,
SUITE 100
SHERWOOD, OR 97140
PHONE: (503) 925-8799
FAX: (503) 925-8969

DESIGNED BY:	RSW
DRAWN BY:	RSW
CHECKED BY:	MBH
DRAWING NO.:	DRAINAGE BASIN
SCALE:	AS NOTED

PREPARED FOR:

NATHAN DOYEL
17680 SW HANDLEY ST #101
SHERWOOD, OR 97140

DATE: 07/15/13

REGISTERED PROFESSIONAL ENGINEER
OREGON
JULY 9, 2013
MONTGOMERY B. HURLEY

PRELIMINARY
NOT FOR
CONSTRUCTION

RENEWAL DATE: 6/30/15

JOB NUMBER
2721

SHEET
3