TECHNICAL INFORMATION REPORT

The Reserve at Woodinville
15902 Woodinville-Redmond Road
Woodinville, WA 98072

Prepared for:
Panattoni Development Company
900 S.W. 16th Street, Suite 330
Renton, WA 98057
(206) 248-0280

January 13, 2016
Our Job No. 15985

1-13-16

JERRY JACOBS
STATE OF WASHINGTON
27694
REGISTERED
PROFESSIONAL ENGINEER

BARGHAUSEN CONSULTING ENGINEERS, INC.
18215 72ND AVENUE SOUTH KENT, WA 98032 (425) 251-6222 (425) 251-8782 FAX
BRANCH OFFICES ♦ TUMWATER, WA ♦ LONG BEACH, CA ♦ ROSEVILLE, CA ♦ SAN DIEGO, CA
www.barghausen.com

TABLE OF CONTENTS

1.0 PROJECT OVERVIEW

2.0 CONDITIONS AND REQUIREMENTS SUMMARY

3.0 OFF-SITE ANALYSIS

4.0 FLOW CONTROL AND WATER QUALITY FACILITY ANALYSIS AND DESIGN

5.0 CONVEYANCE SYSTEM ANALYSIS AND DESIGN

6.0 SPECIAL REPORTS AND STUDIES

7.0 OTHER PERMITS

8.0 CSWPPP ANALYSIS AND DESIGN

9.0 BOND QUANTITIES, FACILITY SUMMARIES, AND DECLARATION OF COVENANT

10.0 OPERATIONS AND MAINTENANCE MANUAL

Tab 1.0

1.0 PROJECT OVERVIEW

1.0 PROJECT OVERVIEW

The overall project site for this development is 13.869 acres in size, all of which has been previously developed. The project site is located within a portion of the northwest quarter of Section 15, Township 26 North, Range 5 East, Willamette Meridian, City of Woodinville, King County, Washington. More particularly, the site is located at 15902 Woodinville-Redmond Road, in Woodinville, Washington. The existing conditions on the site are such that the site has been previously developed with several outbuildings and hard impervious surface over the vast majority of the project site. Only one building will remain with this project, which is located at the far west end of the project site. The proposal for this project is to remove almost all of the buildings, regrade the site, and construct two proposed buildings totaling 199,700 square feet. Since this project is discharging directly into the Sammamish River off of the east property line of the site, no flow control is required for this development; however, the City has indicated that enhanced water quality must be applied to this project. Therefore, two separate treatment systems are proposed for this development, one of which is to construct a stormwater treatment wetland in the far southeast corner of the project site, treating runoff from the vast majority of the impervious surfaces on the project site exclusive of the roof runoff and a strip of asphalt along the ordinary high watermark setback on the eastern property line of the site, which will drain into an ecology embankment prior to discharge into the Sammamish River. Water quality will be provided for the entire development of the project site, including the existing building to remain and its associated parking.

TIR WORKSHEET

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 1 PROJECT OWNER AND PROJECT ENGINEER

Project Owner Panattoni Development Company
Phone (206) 248-0280
Address 900 S.W. 16th Street, Suite 330
Renton, WA 98057
Project Engineer Ali Sadr
Company Barghausen Consulting Engineers, Inc.
Phone (425) 251-6222

Part 2 PROJECT LOCATION AND DESCRIPTION

Project Name Woodinville Lumber Business Park
DDES Permit # _____
Location Township 26 N
Range 5 E
Section 15
Site Address 15902 Woodinville-Redmond Road, Woodinville, WA 98072

Part 3 TYPE OF PERMIT APPLICATION

☐ Landuse Services
Subdivision / Short Subd. / UPD
☒ Building Services
M/F / Commercial / SFR
☒ Clearing and Grading
☒ Right-of-Way Use
☐ Other _____

Part 4 OTHER REVIEWS AND PERMITS

☐ DFW HPA
☐ COE 404
☐ DOE Dam Safety
☒ FEMA Floodplain
☐ COE Wetlands
☐ Other _____
☒ Shoreline Management
☐ Structural Rockery/Vault/_____
☐ ESA Section 7

Part 5 PLAN AND REPORT INFORMATION

Technical Information Report

Type of Drainage Review (circle): Full / Targeted / Large Site
Date (include revision dates): _____
Date of Final: _____

Site Improvement Plan (Engr. Plans)

Type (circle one): Full / Modified / Small Site
Date (include revision dates): _____
Date of Final: _____

Part 6 ADJUSTMENT APPROVALS

Type (circle one): Standard / Complex / Preapplication / Experimental / Blanket
Description: (include conditions in TIR Section 2)
_____
_____
_____
Date of Approval: _____

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 7 MONITORING REQUIREMENTS

Monitoring Required: Yes / No

Start Date: _____

Completion Date: _____

Describe: Any runoff discharged from the site during construction must be monitored for water quality based on NPDES Permit.

Part 8 SITE COMMUNITY AND DRAINAGE BASIN

Community Plan : Woodinville

Special District Overlays: _____

Drainage Basin: Sammamish River

Stormwater Requirements: No flow control, direct discharge and enhanced water quality

Part 9 ONSITE AND ADJACENT SENSITIVE AREAS

- ☒ River/Stream
- ☐ Lake
- ☐ Wetlands
- ☐ Closed Depression
- ☒ Floodplain
- ☐ Other
- ☐ Steep Slope
- ☐ Erosion Hazard
- ☐ Landslide Hazard
- ☐ Coal Mine Hazard
- ☒ Seismic Hazard
- ☐ Habitat Protection
- ☐

Part 10 SOILS

Soil Type	Slopes	Erosion Potential
Earlmont Silt Loam		
Indianola loamy fine sand	4 to 15 %	

- ☐ High Groundwater Table (within 5 feet)
- ☐ Other
- ☐ Sole Source Aquifer
- ☐ Seeps/Springs

☐ Additional Sheets Attached

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 11 DRAINAGE DESIGN LIMITATIONS	
REFERENCE	LIMITATION / SITE CONSTRAINT
☐ Core 2 – Offsite Analysis	
☒ Sensitive/Critical Areas	
☒ SEPA	
☐ Other	
☐	
☐ Additional Sheets Attached	

Part 12 TIR SUMMARY SHEET (provide one TIR Summary Sheet per Threshold Discharge Area)	
Threshold Discharge Area: (name or description)	
Core Requirements (all 8 apply)	
Discharge at Natural Location	Number of Natural Discharge Locations: 2
Offsite Analysis	Level: 1 / 2 / 3 dated:
Flow Control (incl. facility summary sheet)	Level: 1 / 2 / 3 or Exemption Number Direct discharge Small Site BMPs
Conveyance System	Spill containment located at: Two manholes
Erosion and Sediment Control	ESC Site Supervisor: Contact Phone: After Hours Phone:
Maintenance and Operation	Responsibility: Private / Public If Private, Maintenance Log Required: Yes / No
Financial Guarantees and Liability	Provided: Yes / No
Water Quality (include facility summary sheet)	Type: Basic / Sens. Lake / Enhanced Basicm / Bog or Exemption No. Landscape Management Plan: Yes / No
Special Requirements (as applicable)	
Area Specific Drainage Requirements	Type: CDA / SDO / MDP / BP / LMP / Shared Fac. / None Name:
Floodplain/Floodway Delineation	Type: Major / Minor / Exemption / None 100-year Base Blood Elevation (or range): 25 to 26 Datum:
Flood Protection Facilities	Describe:
Source Control (comm./industrial landuse)	Describe landuse: Describe any structural controls:

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Oil Control	High-use Site: Yes / No Treatment BMP: _____ Maintenance Agreement: Yes / No with whom? _____
Other Drainage Structures	
Describe:	

Part 13 EROSION AND SEDIMENT CONTROL REQUIREMENTS

MINIMUM ESC REQUIREMENTS DURING CONSTRUCTION	MINIMUM ESC REQUIREMENTS AFTER CONSTRUCTION
☒ Clearing Limits	☒ Stabilize Exposed Surfaces
☐ Cover Measures	☒ Remove and Restore Temporary ESC Facilities
☒ Perimeter Protection	☒ Clean and Remove All Silt and Debris Ensure Operation of Permanent Facilities
☒ Traffic Area Stabilization	☐ Flag Limits of SAO and open space preservation areas
☒ Sediment Retention	☐ Other _____
☒ Surface Water Control	
☐ Dewatering Control	
☒ Dust Control	
☐ Flow Control	

Part 14 STORMWATER FACILITY DESCRIPTIONS (Note: Include Facility Summary and Sketch)

Flow Control	Type/Description	Water Quality	Type/Description
☐ Detention	_____	☐ Biofiltration	_____
☐ Infiltration	_____	☒ Wetpool	Treatment wetland
☐ Regional Facility	_____	☒ Media Filtration	Ecology Embankment
☐ Shared Facility	_____	☐ Oil Control	_____
☐ Flow Control BMPs	_____	☐ Spill Control	_____
☐ Other	_____	☒ Flow Control BMPs	Porous asphalt
		☐ Other	_____

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 15 EASEMENTS/TRACTS		Part 16 STRUCTURAL ANALYSIS
☐ Drainage Easement		☐ Cast in Place Vault
☐ Covenant		☐ Retaining Wall
☐ Native Growth Protection Covenant		☐ Rockery > 4' High
☐ Tract		☐ Structural on Steep Slope
☐ Other		☐ Other

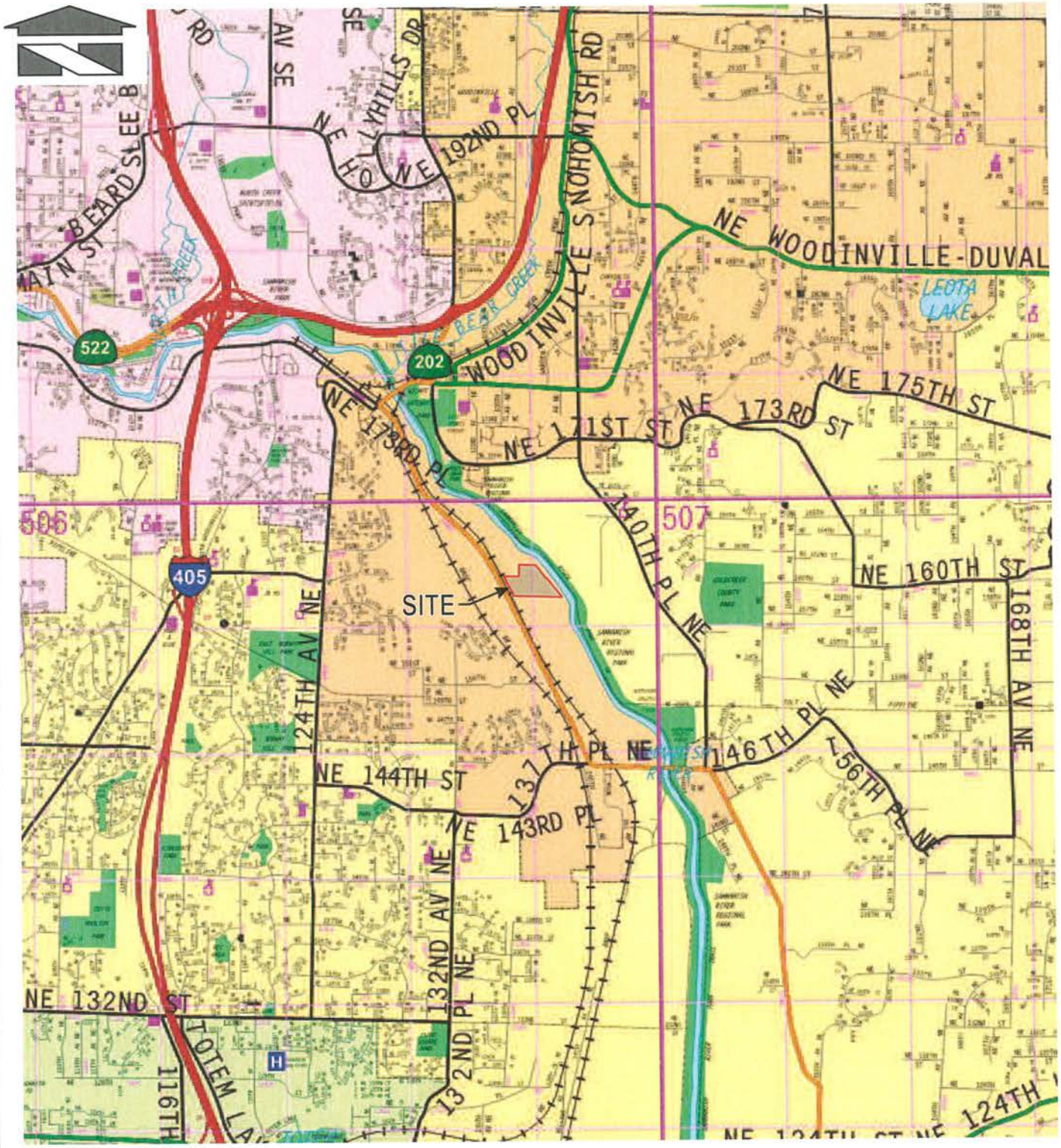
Part 17 SIGNATURE OF PROFESSIONAL ENGINEER

I, or a civil engineer under my supervision, have visited the site. Actual site conditions as observed were incorporated into this worksheet and the attached Technical Information Report. To the best of my knowledge the information provided here is accurate.

Jerry Jacobs 1-6-16

Signed/Date

SITE LOCATION



REFERENCE: Thomas Guide (2006)

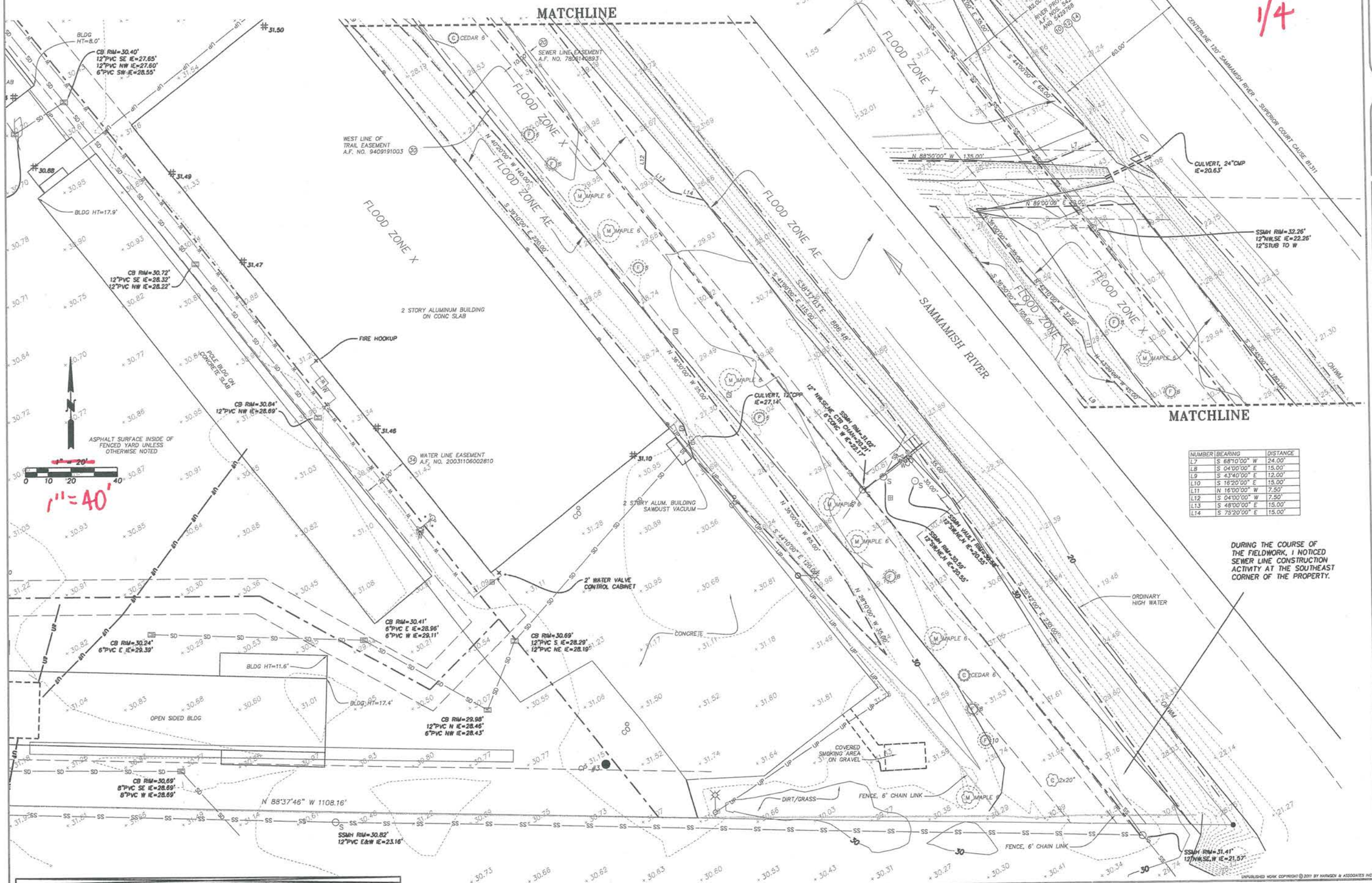
Scale: Horizontal: N.T.S. Vertical: N/A	For: DB Real Estate Distribution Building Woodinville, Washington	Job Number 15985
BARGHAUSEN CONSULTING ENGINEERS, INC. 18215 72ND AVENUE SOUTH KENT, WA 98032 (425) 251-6222 (425) 251-8782 CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES	Title: VICINITY MAP	DATE: 10/25/12

P:\15000s\15985\exhibit\graphics\15985 vmap.cdr

DRAINAGE BASIN, SUBBASINS, AND SITE CHARACTERISTICS

NW 1/4, SECTION 15, TOWNSHIP 26 NORTH, RANGE 5 EAST, W.M.

PREDEV BASIN MAP 1/4



NUMBER	BEARING	DISTANCE
L7	S 68°10'00" W	24.00'
L8	S 04°00'00" E	15.00'
L9	S 43°40'00" E	12.00'
L10	S 16°20'00" E	15.00'
L11	N 16°00'00" W	7.50'
L12	S 04°00'00" W	7.50'
L13	S 48°00'00" E	15.00'
L14	S 75°20'00" E	15.00'

REVISIONS
△ 2/13/12 REVISED LOCATION OF FLOOD PLAIN PER LETTER OF AMENDMENT CASE #11-10-1973A DATED 1/10/12

DWN. BY: RML/TLR
CHK. BY: JBM
DATE: 09-01-11
JOB #: 11-125
F/B #: 1056
SCALE: 1" = 20'

HARMSEN & ASSOCIATES INC
ENGINEERS • SURVEYORS • PLANNERS • LANDSCAPE ARCHITECTS
16778 146th Pl SE, Ste 104 (360) 794-7811
POST OFFICE BOX 516 (206) 343-5903
MONROE, WA 98272-0516 (360) 805-9732 (FAX)

Xref: \Stamps\

SCANNELL PROPERTIES
15900 WOODINVILLE REDMOND RD.
WOODINVILLE WA 98072

WOODINVILLE LUMBER
ALTA ASCM SURVEY

DRAWING: S2
SHEET: 2 OF 5

UNPUBLISHED WORK COPYRIGHT © 2011 BY HARMSEN & ASSOCIATES INC

REVISIONS

△ 2/13/12 REVISED LOCATION OF F PER LETTER OF AMENDM #11-10-1973A DATED 1,

DWN. BY: RML/TLR
CHK. BY: JBM
DATE: 09-01-11
JOB #: 11-125
F/B #: 1056
SCALE: 1" = 20'

HARMSEN & ASSOCIATES INC
ENGINEERS ~ SURVEYORS ~ PLANNERS ~ LANDSCAPE ARCHITECTS
16778 146th St SE, Ste 104 (360) 794-7811
POST OFFICE BOX 516 (206) 343-5903
MONROE, WA 98272-0516 (360) 805-9732 (FAX)

Xref: \Stamp\

SCANNELL PROPERTIES
15900 WOODINVILLE REDMOND RD.
WOODINVILLE WA 98072

WOODINVILLE LUMBER
ALTA/ACSM SURVEY

DRAWING:
S3

SHEET: 3 OF 5

NUMBER	BEARING	DISTANCE
L1	S 36°50'00" W	15.00'
L2	S 62°00'00" E	15.00'
L3	S 39°10'00" E	18.00'
L4	S 85°00'00" E	8.00'
L5	S 38°37'00" E	17.00'
L6	S 05°40'00" E	10.00'

REVISIONS
2/13/12 REVISED LOCATION OF FLOOD PLAIN PER LETTER OF AMENDMENT CASE #11-10-1975A DATED 1/10/12

DWN. BY: RML/TLR
CHK. BY: JBM
DATE: 09-01-11
JOB #: 11-125
F/B #: 1056
SCALE: 1" = 20'

HARMSEN & ASSOCIATES INC
ENGINEERS ~ SURVEYORS ~ PLANNERS ~ LANDSCAPE ARCHITECTS
16778 146th St SE, Ste 104 (360) 794-7811
POST OFFICE BOX 516 (206) 343-5903
MONROE, WA 98272-0516 (360) 805-9732 (FAX)

Xref: \Stamp\

SCANNELL PROPERTIES
15900 WOODINVILLE REDMOND RD.
WOODINVILLE WA 98072

WOODINVILLE LUMBER
ALTA ACSM SURVEY

DRAWING:
S4

SHEET: 4 OF 5

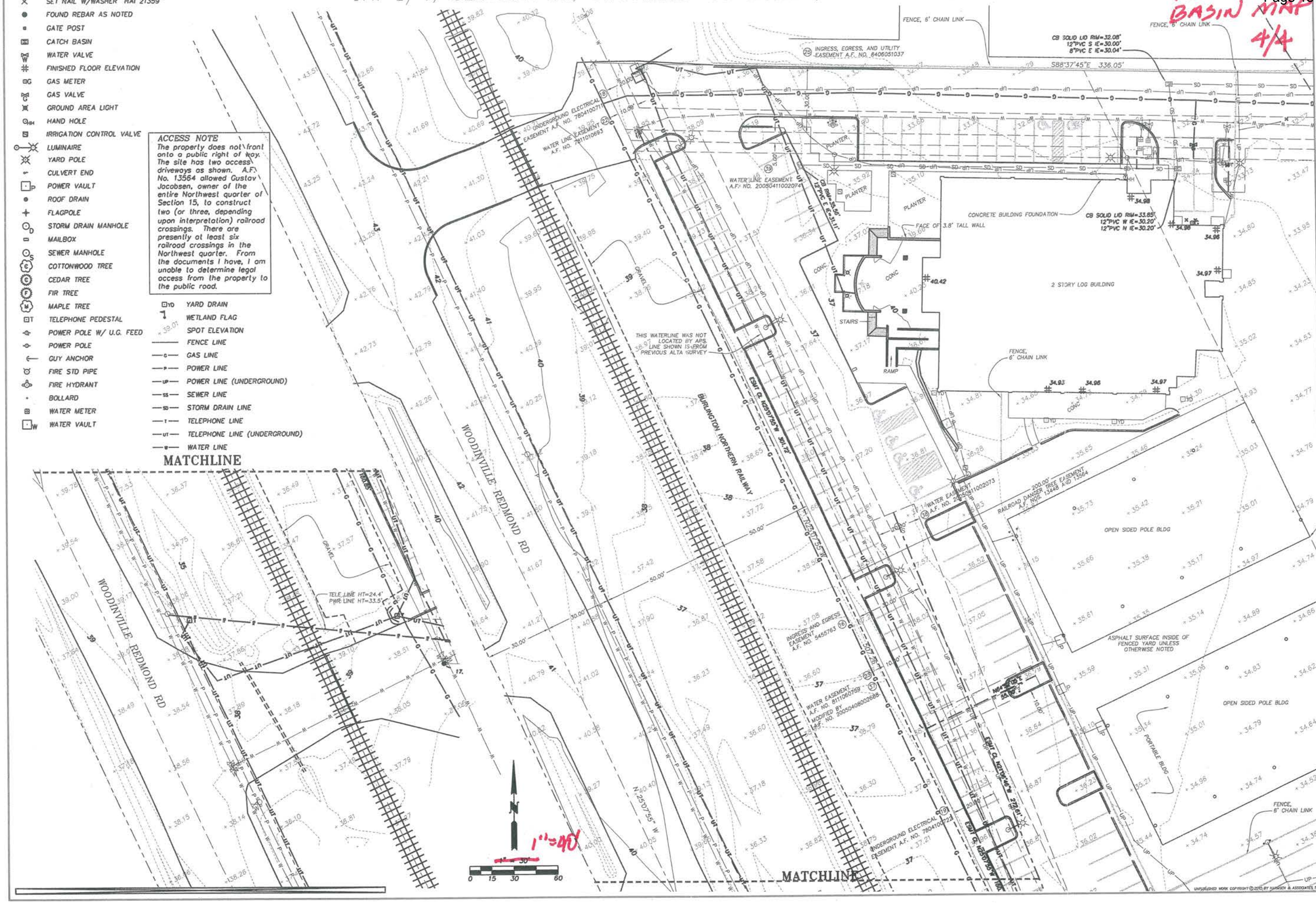
PREDEV BASIN MAP 4/4

NW 1/4, SECTION 15, TOWNSHIP 26 NORTH, RANGE 5 EAST, W.M.

LEGEND

- SET NAIL W/WASHER "HAI 21359"
- FOUND REBAR AS NOTED
- GATE POST
- CATCH BASIN
- WATER VALVE
- FINISHED FLOOR ELEVATION
- GAS METER
- GAS VALVE
- GROUND AREA LIGHT
- HAND HOLE
- IRRIGATION CONTROL VALVE
- LUMINAIRE
- YARD POLE
- CULVERT END
- POWER VAULT
- ROOF DRAIN
- FLAGPOLE
- STORM DRAIN MANHOLE
- MAILBOX
- SEWER MANHOLE
- COTTONWOOD TREE
- CEDAR TREE
- FIR TREE
- MAPLE TREE
- TELEPHONE PEDESTAL
- POWER POLE W/ U.G. FEED
- POWER POLE
- GUY ANCHOR
- FIRE STD PIPE
- FIRE HYDRANT
- BOLLARD
- WATER METER
- WATER VAULT
- YARD DRAIN
- WETLAND FLAG
- SPOT ELEVATION
- FENCE LINE
- GAS LINE
- POWER LINE
- POWER LINE (UNDERGROUND)
- SEWER LINE
- STORM DRAIN LINE
- TELEPHONE LINE
- TELEPHONE LINE (UNDERGROUND)
- WATER LINE

ACCESS NOTE
The property does not front onto a public right of way. The site has two access driveways as shown. A.F. No. 13564 allowed Gustav Jacobsen, owner of the entire Northwest quarter of Section 15, to construct two (or three, depending upon interpretation) railroad crossings. There are presently at least six railroad crossings in the Northwest quarter. From the documents I have, I am unable to determine legal access from the property to the public road.



REVISIONS
2/13/12 REVISED LOCATION OF FLOOD PLAIN PER LETTER OF AMENDMENT, CASE #11-10-1973A DATED 1/10/12

DWN. BY: RML/TLR
CHK. BY: JBM
DATE: 09/01/11
JOB #: 11-125
F/B #: 1056
SCALE: 1" = 20'

HARMSEN & ASSOCIATES INC
ENGINEERS • SURVEYORS • PLANNERS • LANDSCAPE ARCHITECTS
16778 146th St SE, Ste 104 (360) 794-7811
POST OFFICE BOX 516 (206) 343-5903
MONROE, WA 98272-0516 (360) 805-9732 (FAX)

Xref: \Stamp\

SCANNELL PROPERTIES
15900 WOODINVILLE REDMOND RD.
WOODINVILLE WA 98072

WOODINVILLE LUMBER
ALTA ACSM SURVEY

DRAWING: S5
SHEET: 5 OF 5

UNPUBLISHED WORK COPYRIGHT © 2010 BY HARMSEN & ASSOCIATES INC

UTILITY CONFLICT NOTE:

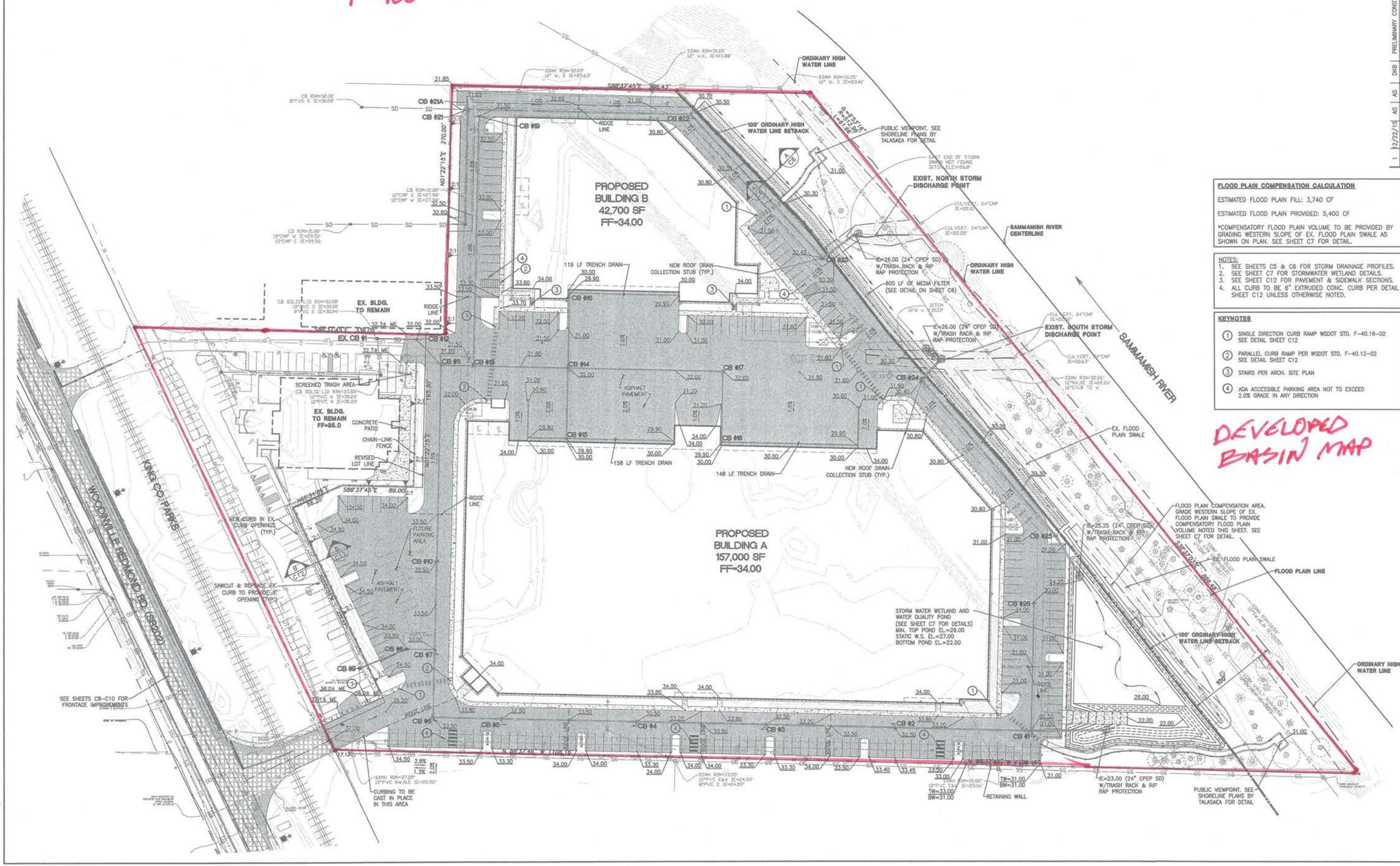
CAUTION:
THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THE LOCATION, DIMENSION, AND DEPTH OF ALL EXISTING UTILITIES WHETHER SHOWN ON THESE PLANS OR NOT BY POTHOLING THE UTILITIES AND SURVEYING THE HORIZONTAL AND VERTICAL LOCATION PRIOR TO CONSTRUCTION. THIS SHALL INCLUDE CALLING UTILITY LOCATE @ 1-800-424-5555 AND THEN POTHOLING ALL OF THE EXISTING UTILITIES AT LOCATIONS OF NEW UTILITY CROSSINGS TO PHYSICALLY VERIFY WHETHER OR NOT CONFLICTS EXIST. LOCATIONS OF SAID UTILITIES AS SHOWN ON THESE PLANS ARE BASED UPON THE UNVERIFIED PUBLIC INFORMATION AND ARE SUBJECT TO VARIATION.

GRADING PLAN
WOODINVILLE LUMBER BUSINESS PARK
PANATTONI DEVELOPMENT

NW 1/4, SECTION 15, TOWNSHIP 26 NORTH, RANGE 5 EAST, W.M.
CITY OF WOODINVILLE, KING COUNTY, WA

~~1"=50'~~
0 25 50 100
1"=100'

CALL BEFORE YOU DIG:
1-800-424-5555



DEVELOPED BASIN MAP

FLOOD PLAIN COMPENSATION CALCULATION

ESTIMATED FLOOD PLAIN FILL: 3,740 CF

ESTIMATED FLOOD PLAIN PROVIDED: 5,400 CF

*COMPENSATORY FLOOD PLAIN VOLUME TO BE PROVIDED BY GRADING WESTERN SLOPE OF EX. FLOOD PLAIN SWALE AS SHOWN ON PLAN. SEE SHEET C7 FOR DETAIL.

NOTES:
1. SEE SHEETS C5 & C6 FOR STORM DRAINAGE PROFILES.
2. SEE SHEET C7 FOR STORMWATER WETLAND DETAILS.
3. SEE SHEET C12 FOR PAVEMENT & SIDEWALK SECTIONS.
4. ALL CURB TO BE 6" EXTRUDED CONC. CURB PER DETAIL SHEET C12 UNLESS OTHERWISE NOTED.

KEYNOTES

1. SINGLE DIRECTION CURB RAMP WSDOT STD. F-40.16-02 SEE DETAIL SHEET C12
2. PARALLEL CURB RAMP PER WSDOT STD. F-40.12-02 SEE DETAIL SHEET C12
3. STAIRS PER ARCH. SITE PLAN
4. ADA ACCESSIBLE PARKING AREA NOT TO EXCEED 2.0% GRADE IN ANY DIRECTION

No.	Date	By	Chkd.	Appr.	Revisions
1	12/22/15	AS	AS	DKB	PRELIMINARY CONSTRUCTION SET

Title: GRADING PLAN WOODINVILLE LUMBER BUSINESS PARK PANATTONI DEVELOPMENT

For: PANATTONI DEVELOPMENTCOMPANY
900 SW 16TH ST., SUITE 330
RENTON, WA 98057
(206) 248-0280

DANIEL K. BALMELLI — STATE OF WASHINGTON — 25672 — REGISTERED PROFESSIONAL ENGINEER
12/22/2015

Scale: Horizontal 1"=50' Vertical N/A

Designed AS
Drawn MB
Checked AS
Approved DKB
Date 12/02/15

BARGHAUSEN CONSULTING ENGINEERS, INC.
18215 72ND AVENUE SOUTH
KENT, WA 98032
(425) 251-6222
(425) 251-8782 FAX
CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

Job Number 15985.1
Sheet C3 of 13

Plot:P:\15000s\15985\engineering\panatoni 15985.1-GM.dwg Date/Time:12/22/2015 10:47 AM Scale:1 = 1 BIRDUAL Xref: ----

SOILS MAP

REFERENCE: USDA, Natural Resources Conservation Service

LEGEND:
Ea = Earlmont silt loam
InC = Indianola loamy fine sand, 4-15% slopes

Scale:
Horizontal: N.T.S. Vertical: N/A

BARGHAUSEN CONSULTING ENGINEERS, INC.
18215 72ND AVENUE SOUTH
KENT, WA 98032
(425) 251-6222
(425) 251-8782
CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

For:
DB Real Estate Distribution Building
Woodinville, Washington

Title:
SOIL SURVEY MAP

Job Number
15985

DATE: 10/25/12

P:\15000s\15985\exhibit\graphics\15985 soil.cdr

Tab 2.0

2.0 CONDITIONS AND REQUIREMENTS SUMMARY

2.0 CONDITIONS AND REQUIREMENTS SUMMARY

Analysis of the eight core requirements:

Core Requirement No. 1 – Discharge to the Natural Location: This project will discharge to the same downstream drainage course as it does under existing conditions, which is into the Sammamish River at two different locations, which under existing conditions drain runoff from this site.

Core Requirement No. 2 – Off-Site Analysis: No off-site analysis has been prepared for this project site, as the downstream drainage course is approximately 100 feet in length, discharging directly into the Sammamish River, which precludes any requirement for an off-site analysis.

Core Requirement No. 3 – Flow Control: Flow control is not a requirement for this project site since this project is utilizing the direct discharge exemption from flow control. This project directly discharges to the Sammamish River.

Core Requirement No. 4 – Conveyance System: Since this project site is over 10 acres in size, a conveyance system will be sized according to SBUH methodology and will be provided with the final Technical Information Report (TIR) for this development.

Core Requirement No. 5 – Erosion and Sediment Control: This project is specifying clearing limits and providing perimeter protection and traffic area stabilization. It is also utilizing the proposed stormwater treatment wetland as a sediment pond in addition to a sediment trap located at the north end of the project site to provide erosion control. This will all be in accordance with the 2009 King County, Washington Surface Water Design Manual.

Core Requirement No. 6 – Maintenance and Operations: A maintenance and operations manual will be prepared for this project and submitted with the final TIR should the City of Woodinville require it.

Core Requirement No. 7 – Financial Guarantees and Liability: This project will concur with all financial guarantees and liability requirements of the City of Woodinville for projects of this nature.

Core Requirement No. 8 – Water Quality: The required water quality treatment menu to be followed for this project site is the Enhanced Basic Water Quality menu, which is complied with in the form of a stormwater treatment wetland. In addition, an ecology embankment will be utilized along the 100-foot ordinary high waterline setback from the project site and the Sammamish River. This ecology embankment will be approximately 15 feet wide and treat runoff from the adjoining asphalt surface.

Analysis of the Five Special Requirements:

Special Requirement No. 1 – Other Adopted Area-Specific Requirements: There are no known other adopted area-specific requirements prepared for this project site.

Special Requirement No. 2 – Flood Hazard Area Delineation: There is a flood hazard area for the Sammamish River, which encroaches on this project site, however, this will be taken into account with the development of this project.

Special Requirement No. 3 – Flood Protection Facilities: There are no flood protection facilities known to exist adjacent to or on this project site.

Special Requirement No. 4 – Source Controls: Source controls will be applied to this project site in the form of regular sweeping or vacuuming of the parking lot, educating the owner about the proper use of pesticides and fertilizers, and covering the trash enclosure at a minimum.

Special Requirement No. 5 – Oil Control: This project is not a site that has high-use site characteristics; therefore, this special requirement does not apply.

Tab 3.0

3.0 OFF-SITE ANALYSIS

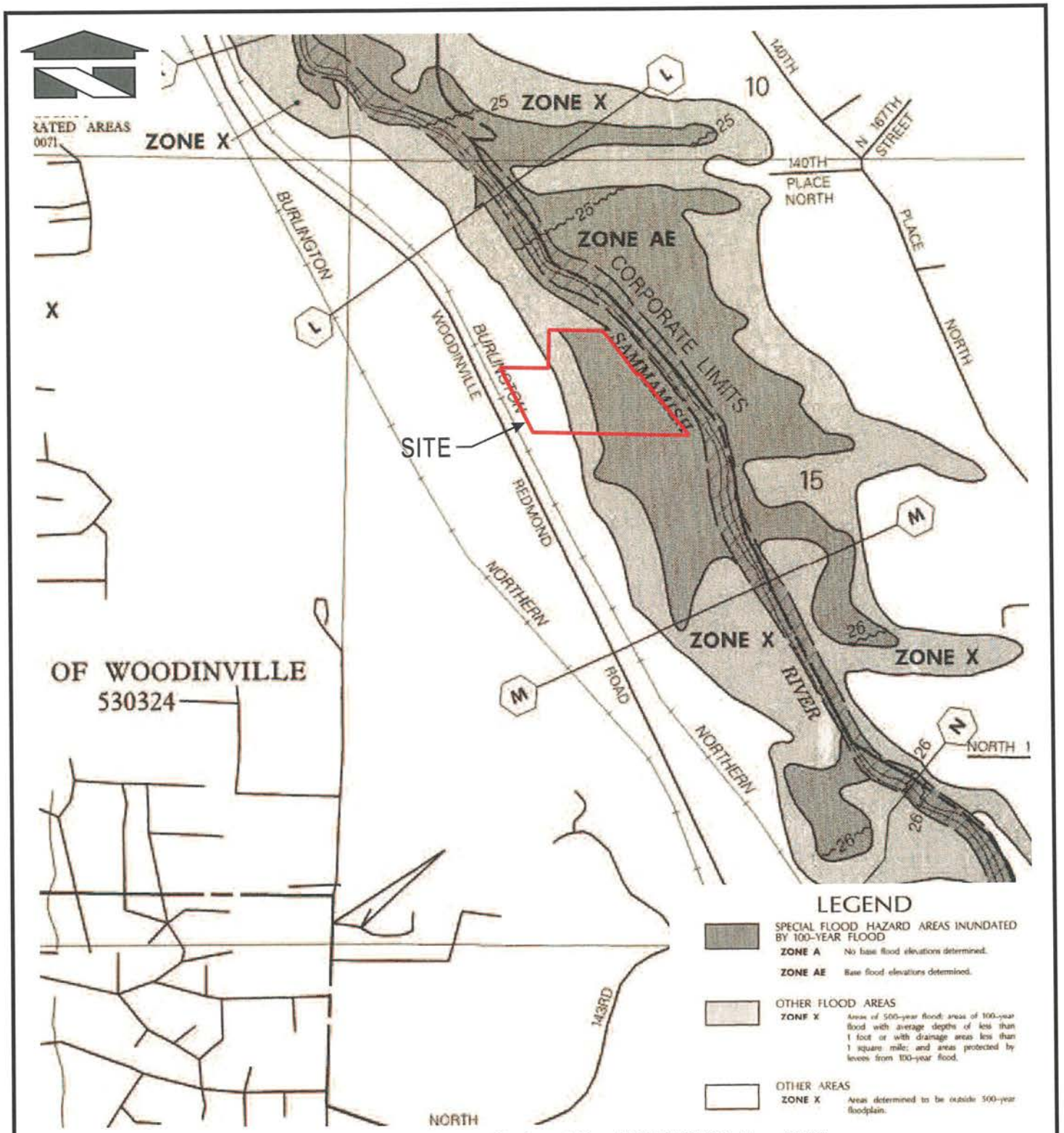
3.0 OFF-SITE ANALYSIS

As mentioned previously, no off-site analysis is prepared for this project as there is direct discharge to the Sammamish River. The FEMA Map for this project site has been copied and inserted into this report on the following pages, which shows that the project site is encroached by Zone AE, an area with flood elevations determined which will be mitigated for with this development. In addition to the FEMA Map, a sensitive areas folios map has been copied and placed into this section of the report and the only sensitive area on this project site is the Seismic Hazard Area, which shall be taken into account in the design of the building.

In addition to this Seismic Hazard Area, the Sammamish River, which is a Class 1 river, is located on the eastern property line of the site. Enhanced water quality will be applied to the project in order to mitigate for any contaminants that might otherwise be allowed to discharge to the river.

There is a 2.46-acre property at the northwest corner of the site that drains by pipe into the on-site bypass conveyance system around the proposed building and directly into the Sammamish River.

FEMA MAP

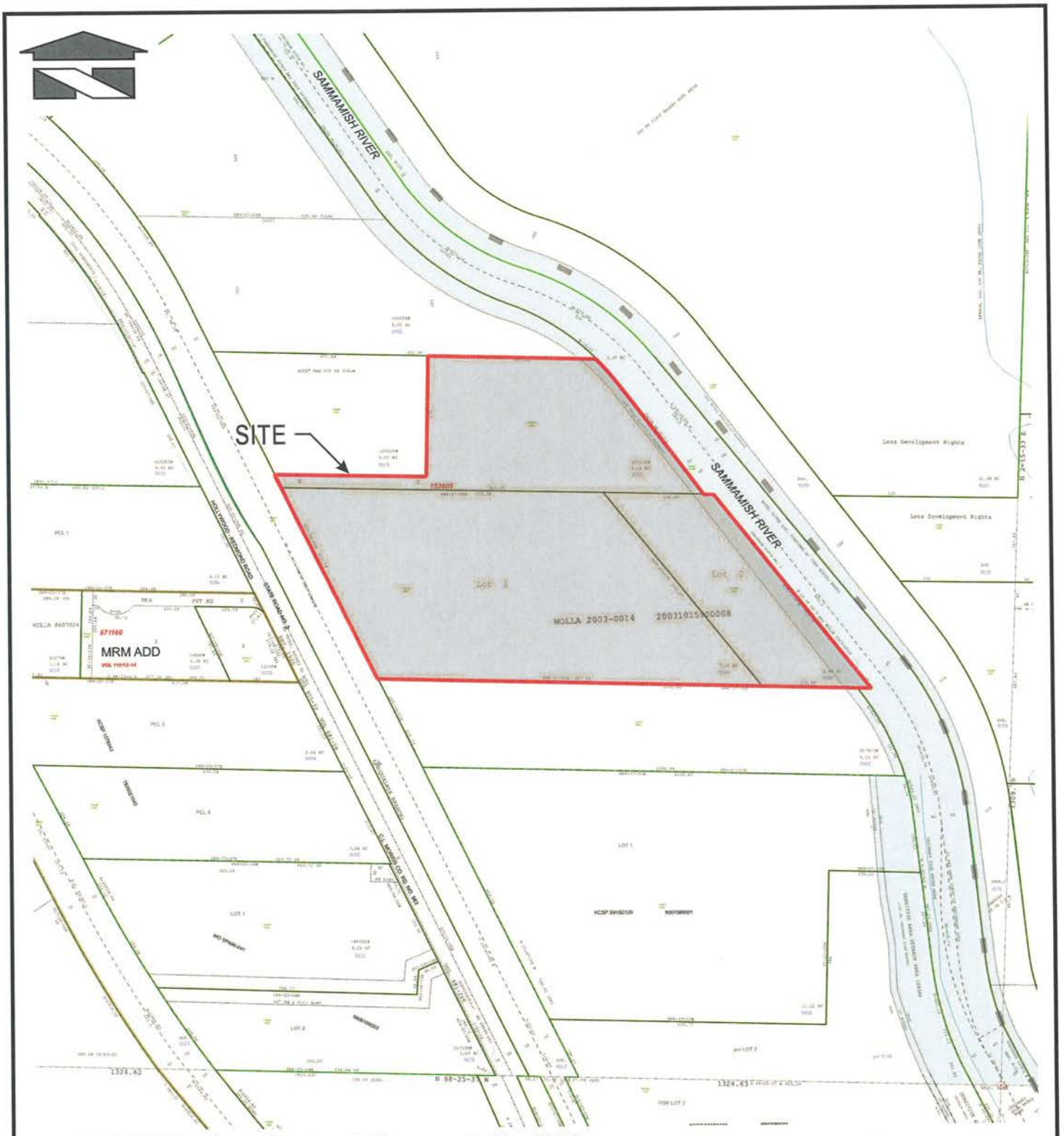


REFERENCE: Federal Emergency Management Agency (Portion of Map 53033C0360 G, Nov. 1999)

Scale: Horizontal: N.T.S. Vertical: N/A	For: DB Real Estate Distribution Building Woodinville, Washington	Job Number 15985
BARGHAUSEN CONSULTING ENGINEERS, INC. 18215 72ND AVENUE SOUTH KENT, WA 98032 (425) 251-6222 (425) 251-8782 CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES	Title: FEMA MAP	DATE: 10/25/12

P:\15000s\15985\exhibit\graphics\15985 fema.cdr

ASSESSOR'S MAP

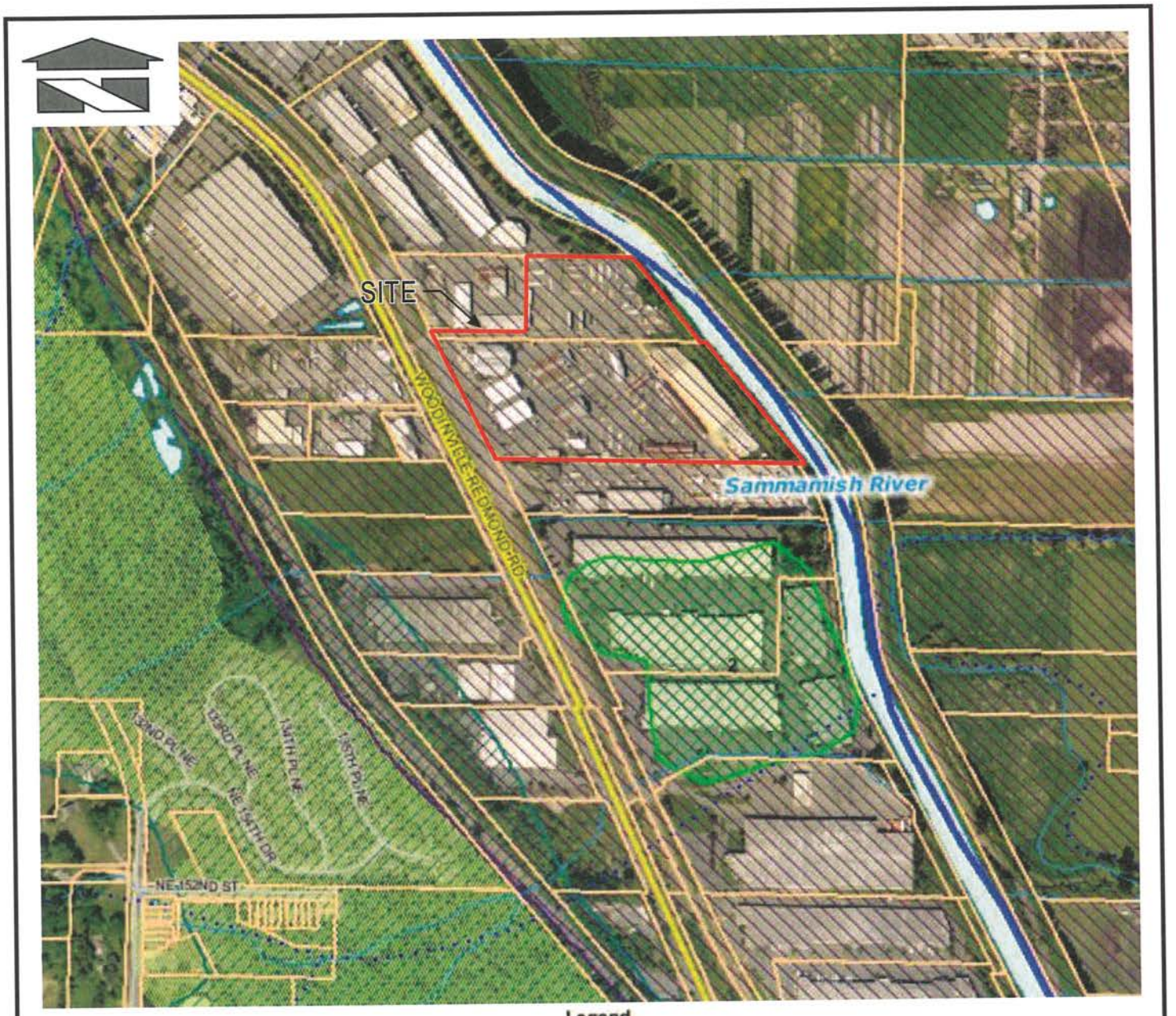


REFERENCE: King County Department of Assessments (Dec. 2010)

Scale: Horizontal: N.T.S. Vertical: N/A	For: DB Real Estate Distribution Building Woodinville, Washington	Job Number 15985
BARGHAUSEN CONSULTING ENGINEERS, INC. 18215 72ND AVENUE SOUTH KENT, WA 98032 (425) 251-6222 (425) 251-8782 CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES	Title: ASSESSOR MAP	DATE: 10/25/12

P:\15000s\15985\exhibit\graphics\15985 amap.cdr

SENSITIVE AREAS FOLIO



Legend

- County Boundary
- Mountain Peaks
- Highways
- Streets
  - Highway
  - Arterials
  - Local
- Parcels
- SAO Stream
  - Class 1
  - Class 2 Perennial
  - Class 2 Salmonid
  - Class 3
  - Unclassified
- Lakes and Large Rivers
- Streams
- SAO Wetland
- SAO Landslide
- SAO Coal Mine
- SAO Seismic
- SAO Erosion
- 2009 Color Aerial Photos (6in)
- 2009 Color Aerial Photos (12in)

REFERENCE: King County iMAP (2012)

Scale:
Horizontal: N.T.S. Vertical: N/A

For:
DB Real Estate Distribution Building
Woodinville, Washington

Job Number
15985

BARGHAUSEN CONSULTING ENGINEERS, INC.
18215 72ND AVENUE SOUTH
KENT, WA 98032
(425) 251-6222
(425) 251-8782
CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

Title:
SENSITIVE AREAS MAP

DATE: 10/25/12

P:\15000s\15985\exhibit\graphics\15985 sens.cdr

Tab 4.0

4.0 FLOW CONTROL AND WATER QUALITY FACILITY ANALYSIS AND DESIGN

4.0 FLOW CONTROL AND WATER QUALITY FACILITY ANALYSIS AND DESIGN

A. Existing Site Hydrology

Under existing conditions, the vast majority of the project site consists of impervious surface and has been fully developed previously. Flow control is not provided with the existing conditions on the project site; therefore, flow control will not be provided other than flow control BMPs under proposed developed conditions for this project.

B. Developed Site Hydrology

Under developed conditions, there will be two new buildings located on the project site. In addition, one of the existing buildings will remain, which is located along the far west end of the project site adjacent to Woodinville-Redmond Road. Portions of the proposed buildings will have dock-high loading combined with drive aisles, appropriate parking, and landscaping and water quality facilities all to provide the site with an aesthetically pleasing and functional proposed use of the buildings. In addition to water quality, flow control BMPs will be applied to this project site in the form of porous asphalt pavement for at least 10 percent of the overall project site.

C. Performance Standards

The area-specific flow control facility standards are not required for this project site as this project is proposing direct discharge into the Sammamish River; therefore, no flow control is required. The applicable conveyance system capacity standard is the SBUH methodology, which is included in Section 5.0 of this TIR. The applicable area-specific water quality treatment menus is Enhanced Basic Water Quality, which is proposed in the form of a stormwater treatment wetland treating runoff from the vast majority of the parking and drive aisles and then ecology embankments on the eastern property line of the site to treat runoff from adjoining parking and drive aisle areas and also along the SR-202 right-of-way improvements.

D. Flow Control Systems

As mentioned previously, flow control is not a requirement for this project.

E. Water Quality System

Please see the drawing on the following pages of this report that shows the two types of water quality facilities proposed for this development. The calculations to size the stormwater treatment wetland are also included on the following pages of this report.

The ecology embankment located at the ordinary high water line on the east side of the site treats runoff from an approximate 50-foot-wide area of asphalt and sidewalk. This area is designed to go through a series of water quality measures and landscaping prior to discharge to a bioswale, which ultimately discharges to the Sammamish River.

There is also an ecology embankment proposed to treat runoff from SR-202. The calculations to size both ecology embankments are included on the following pages of this report.

WATER QUALITY SIZING CALCULATIONS FOR THE STORMWATER TREATMENT WETLAND

UTILITY CONFLICT NOTE:

CAUTION:
THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THE LOCATION, DIMENSION, AND DEPTH OF ALL EXISTING UTILITIES WHETHER SHOWN ON THESE PLANS OR NOT BY POTHOLING THE UTILITIES AND SURVEYING THE HORIZONTAL AND VERTICAL LOCATION PRIOR TO CONSTRUCTION. THIS SHALL INCLUDE CALLING UTILITY LOCATE @ 1-800-424-5555 AND THEN POTHOLING ALL OF THE EXISTING UTILITIES AT LOCATIONS OF NEW UTILITY CROSSINGS TO PHYSICALLY VERIFY WHETHER OR NOT CONFLICTS EXIST. LOCATIONS OF SAID UTILITIES AS SHOWN ON THESE PLANS ARE BASED UPON THE UNVERIFIED PUBLIC INFORMATION AND ARE SUBJECT TO VARIATION.

STORM DRAINAGE PLAN
WOODINVILLE LUMBER BUSINESS PARK
PANATTONI DEVELOPMENT

NW 1/4, SECTION 15, TOWNSHIP 26 NORTH, RANGE 5 EAST, W.M.
CITY OF WOODINVILLE, KING COUNTY, WA

1"=50'
0 25 50 100
1"=100'

KEYNOTES

1. SINGLE DIRECTION CURB RAMP WSDOT STD. F-40.16-02 SEE DETAIL SHEET C12
2. PARALLEL CURB RAMP PER WSDOT STD. F-40.12-02 SEE DETAIL SHEET C12
3. STAIRS PER ARCH. SITE PLAN
4. ADA ACCESSIBLE PARKING AREA NOT TO EXCEED 2.0% GRADE IN ANY DIRECTION

FLOOD PLAIN COMPENSATION CALCULATION

ESTIMATED FLOOD PLAIN FILL: 3,740 CF

ESTIMATED FLOOD PLAIN PROVIDED: 5,400 CF

*COMPENSATORY FLOOD PLAIN VOLUME TO BE PROVIDED BY GRADING WESTERN SLOPE OF EX. FLOOD PLAIN SWALE AS SHOWN ON PLAN. SEE SHEET C7 FOR DETAIL.

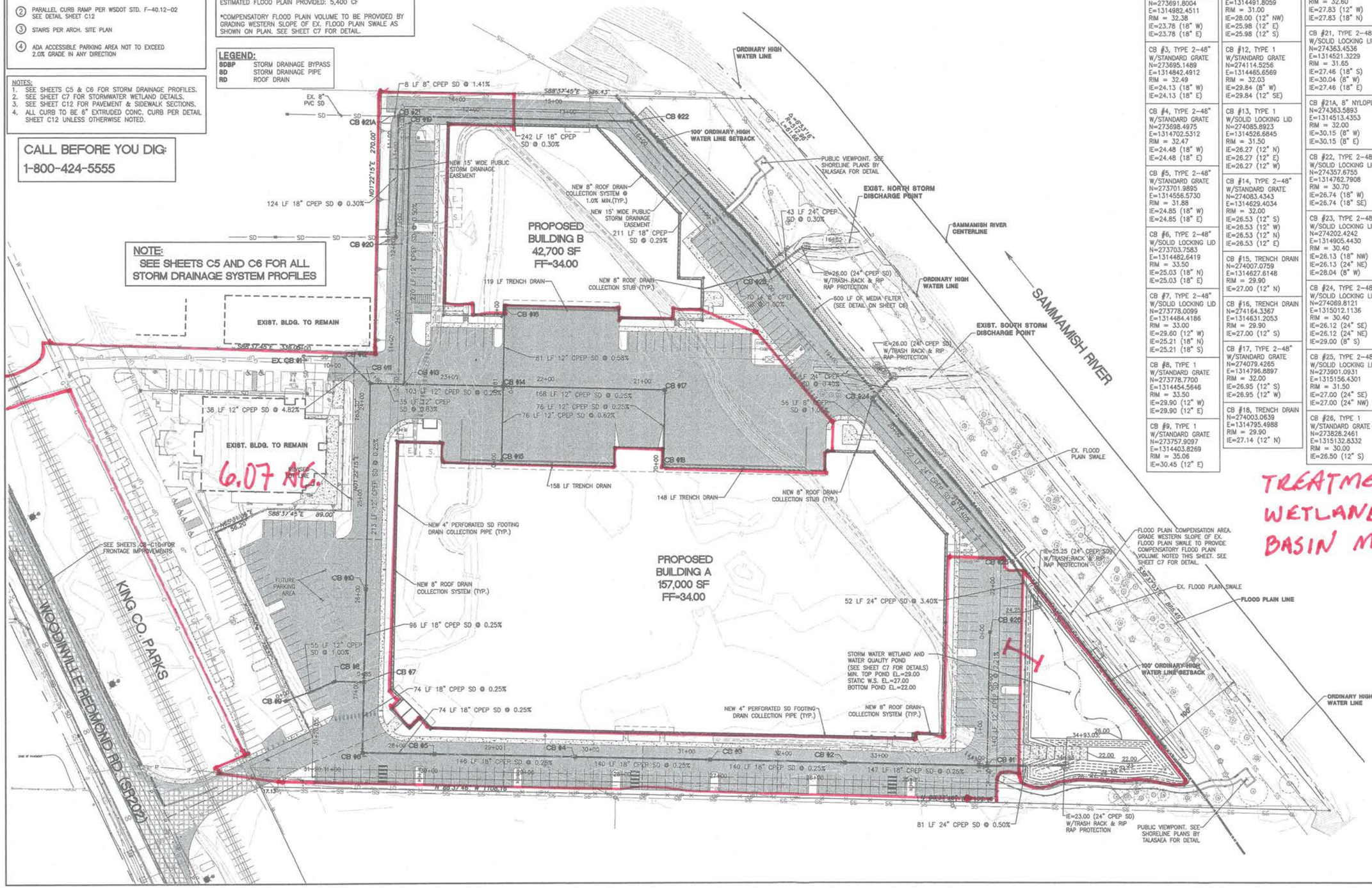
LEGEND:

SDBP	STORM DRAINAGE BYPASS
SD	STORM DRAINAGE PIPE
RD	ROOF DRAIN

NOTES:
1. SEE SHEETS C5 & C6 FOR STORM DRAINAGE PROFILES.
2. SEE SHEET C7 FOR STORMWATER WETLAND DETAILS.
3. SEE SHEET C12 FOR PAVEMENT & SIDEWALK SECTIONS.
4. ALL CURB TO BE 6" EXTRUDED CONC. CURB PER DETAIL SHEET C12 UNLESS OTHERWISE NOTED.

CALL BEFORE YOU DIG:
1-800-424-5555

NOTE:
SEE SHEETS C5 AND C6 FOR ALL STORM DRAINAGE SYSTEM PROFILES



PROPOSED CATCH BASIN TABLE

CATCH BASIN TABLE	CATCH BASIN TABLE	CATCH BASIN TABLE
CB #1, TYPE 2-48" W/STANDARD GRATE N=273688.2827 E=1315129.4840 RIM = 30.00 IE=23.41 (18" W) IE=23.41 (12" N) IE=23.41 (24" E)	CB #10, TYPE 2-48" W/SOLID LOCKING LID N=273873.9238 E=1314486.7138 RIM = 32.50 IE=25.45 (12" N) IE=25.45 (18" S)	CB #19, TYPE 1, W/STANDARD GRATE N=274355.8836 E=1314533.1452 RIM = 31.50 IE=27.61 (12" S)
CB #2, TYPE 2-48" W/STANDARD GRATE N=273691.8004 E=1314982.4511 RIM = 32.38 IE=23.78 (18" W) IE=23.78 (18" E)	CB #11, TYPE 1 W/STANDARD GRATE N=274086.7269 E=1314491.8059 RIM = 31.00 IE=28.00 (12" NW) IE=25.98 (12" E) IE=25.98 (12" S)	CB #20, TYPE 2-48" W/SOLID LOCKING LID N=274239.0489 E=1314518.3460 RIM = 32.60 IE=27.83 (12" W) IE=27.83 (18" N)
CB #3, TYPE 2-48" W/STANDARD GRATE N=273695.1489 E=1314842.4912 RIM = 32.49 IE=24.13 (18" W) IE=24.13 (18" E)	CB #12, TYPE 1 W/STANDARD GRATE N=274114.5256 E=1314465.6569 RIM = 32.03 IE=29.84 (8" W) IE=29.84 (12" SE)	CB #21, TYPE 2-48" W/SOLID LOCKING LID N=274363.4536 E=1314521.3229 RIM = 31.65 IE=27.46 (18" S) IE=30.04 (8" W) IE=27.46 (18" E)
CB #4, TYPE 2-48" W/STANDARD GRATE N=273698.4975 E=1314702.5312 RIM = 32.47 IE=24.48 (18" W) IE=24.48 (18" E)	CB #13, TYPE 1 W/SOLID LOCKING LID N=274085.8923 E=1314526.6845 RIM = 31.50 IE=26.27 (12" N) IE=26.27 (12" E) IE=26.27 (12" W)	CB #21A, 8" NYLOPLAST DRAIN BASIN N=274363.5893 E=1314513.4353 RIM = 32.00 IE=30.15 (8" W) IE=30.15 (8" E)
CB #5, TYPE 2-48" W/STANDARD GRATE N=273701.9895 E=1314556.5730 RIM = 31.88 IE=24.85 (18" W) IE=24.85 (18" E)	CB #14, TYPE 2-48" W/STANDARD GRATE N=274083.4343 E=1314629.4034 RIM = 32.00 IE=26.53 (12" S) IE=26.53 (12" W) IE=26.53 (12" N) IE=26.53 (12" E)	CB #22, TYPE 2-48" W/SOLID LOCKING LID N=274357.6755 E=1314762.7908 RIM = 30.70 IE=26.74 (18" W) IE=26.74 (18" SE)
CB #6, TYPE 2-48" W/SOLID LOCKING LID N=273703.7583 E=1314482.6419 RIM = 33.50 IE=25.03 (18" N) IE=25.03 (18" E)	CB #15, TRENCH DRAIN N=274007.0759 E=1314627.6148 RIM = 29.90 IE=27.00 (12" N)	CB #23, TYPE 2-48" W/SOLID LOCKING LID N=274202.4242 E=1314905.4430 RIM = 30.40 IE=26.13 (18" NW) IE=26.13 (24" NE) IE=28.04 (8" W)
CB #7, TYPE 2-48" W/SOLID LOCKING LID N=273778.0099 E=1314484.4186 RIM = 33.00 IE=29.60 (12" W) IE=25.21 (18" N) IE=25.21 (18" S)	CB #16, TRENCH DRAIN N=274164.3367 E=1314631.2053 RIM = 29.90 IE=27.00 (12" S)	CB #24, TYPE 2-48" W/SOLID LOCKING LID N=274069.8121 E=1315012.1136 RIM = 30.40 IE=26.12 (24" SE) IE=26.12 (24" NE) IE=29.00 (8" S)
CB #8, TYPE 1 W/STANDARD GRATE N=273778.7700 E=1314454.5646 RIM = 33.50 IE=29.90 (12" W) IE=29.90 (12" E)	CB #17, TYPE 2-48" W/STANDARD GRATE N=274079.4265 E=1314796.8897 RIM = 32.00 IE=26.95 (12" S) IE=26.95 (12" W)	CB #25, TYPE 2-48" W/SOLID LOCKING LID N=273901.0931 E=1315156.4301 RIM = 31.50 IE=27.00 (24" SE) IE=27.00 (24" NW)
CB #9, TYPE 1 W/STANDARD GRATE N=273757.9097 E=1314403.6269 RIM = 35.06 IE=30.45 (12" E)	CB #18, TRENCH DRAIN N=274003.0639 E=1314795.4988 RIM = 29.90 IE=27.14 (12" N)	CB #26, TYPE 1 W/STANDARD GRATE N=273828.2461 E=1315132.8332 RIM = 30.00 IE=26.50 (12" S)

No.	Date	By	Chkd.	Appr.	Revision
1	12/22/15	AS	AS	DKB	PRELIMINARY CONSTRUCTION SET

Title: GRADING PLAN
WOODINVILLE LUMBER BUSINESS PARK
PANATTONI DEVELOPMENT

For:
PANATTONI DEVELOPMENTCOMPANY
900 SW 16TH ST., SUITE 330
RENTON, WA 98057
(206) 248-0280

DANIEL K. BALMELLI, STATE OF WASHINGTON, 25672, REGISTERED PROFESSIONAL ENGINEER
12/22/2015

Scale: Horizontal 1"=50' Vertical N/A

Designed AS
Drawn MB
Checked AS
Approved DKB
Date 12/02/15

BARGHAUSEN CONSULTING ENGINEERS, INC.
18215 72ND AVENUE SOUTH
KENT, WA 98032
(425) 251-6222
(425) 251-8782 FAX
CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

Job Number 15985.1
Sheet C4 of 13

File=Y:\15000s\15985\engineering\panattoni 15985.1\engineering\15985.1-M.dwg Date/time:12/28/2015 11:36 AM Scale:1" = 1' MODEL/AL Xref: ----

SIZE THE STORMWATER TREATMENT WETLAND

Contributing Area = 6.07 ac

Impervious = 5.04 ac

Therefore, contributing till grass = 1.03 ac

Step 1: Determine volume of basic wet pond

$V_b = 3[0.9A_i + 0.25A_{tg}](0.039)(43{,}560)$

$= 3[(0.9)(5.04)+(0.25)(1.03)](0.039)(43{,}560) = 24{,}430$ cf

Step 6: Determine total S.A. required

Required S.A. = $V_b/3 = 24{,}430/3 = 8{,}143$ sf

Step 7: Volume of pre-settling cell = $V_b(0.33) = 24{,}430(0.33) = 8{,}062$ cf

Volume provided = 10,000 cf – So OK

Minimum S.A. of cell 1 = 8,062/4 = 2,016 sf

Step 8: Determine S.A. of wetland cell

S.A. = 8,143 sf – 2,016 sf = 6,127 sf

S.A. provided = 9,000 sf – So OK

WATER QUALITY SIZING CALCULATIONS FOR THE TWO ECOLOGY EMBANKMENTS

SIZE THE WSDOT MEDIA FILTER DRAIN ALONG SR-202

Use a generic contributing pavement runoff area (worst case) which is 25 feet of asphalt width contributing to 6 feet of width of media filter drain, 3 feet of which will be vegetated filter strip and the remaining 3 feet of media filter drain. Per the attached excerpts from the WSDOT Highway Runoff manual in almost every case the calculated width of the media filter drain does not exceed 1 foot; therefore, Table RT.07.1 recommends a minimum media filter drain width of 3 feet for contributing pavement widths of 20 feet to 35 feet. See the following pages.

Media Filter Drain Mix Bed Sizing Procedure

The media filter drain mix should be a minimum of 12 inches deep, including the section on top of the underdrain trench.

For runoff treatment, sizing the media filter drain mix bed is based on the requirement that the runoff treatment flow rate from the pavement area, $Q_{Highway}$, cannot exceed the long-term infiltration capacity of the media filter drain, $Q_{Infiltration}$:

$$Q_{Highway} \leq Q_{Infiltration}$$

For western Washington, $Q_{Highway}$ is the flow rate at or below which 91% of the runoff volume for the developed TDA will be treated, based on a 15-minute time step (see Section 4-3.1.1), and can be determined using the water quality data feature in MGSFlood. For eastern Washington, $Q_{Highway}$ is the peak flow rate predicted for the 6-month, short-duration storm under post-developed conditions for each TDA (see Appendix 4C), and can be determined by selecting the short-duration storm option in StormShed.

The long-term infiltration capacity of the media filter drain is based on the following equation:

$$\frac{LTIR * L * W}{C * SF} = Q_{Infiltration}$$

where:

$LTIR$ = Long-term infiltration rate of the media filter drain mix (use 10 inches per hour for design) (in/hr)

L = Length of media filter drain (parallel to roadway) (ft)

W = Width of the media filter drain mix bed (ft)

C = Conversion factor of 43200 ((in/hr)/(ft/sec))

SF = Safety Factor (equal to 1.0, unless unusually heavy sediment loading is expected)

Assuming that the length of the media filter drain is the same as the length of the contributing pavement, solve for the width of the media filter drain:

$$W \geq \frac{Q_{Highway} * C * SF}{LTIR * L} \qquad \textbf{(RT.07-1)}$$

Western Washington project applications of this design procedure have shown that, in almost every case, the calculated width of the media filter drain does not exceed 1.0 foot. Therefore, Table RT.07.1 was developed to simplify the design steps and should be used to establish an appropriate width.

Table RT.07.1. Western Washington design widths for media filter drains.

Pavement width that contributes runoff to the media filter drain	Minimum media filter drain width*
≤ 20 feet	2 feet
≥ 20 and ≤ 35 feet	3 feet
> 35 feet	4 feet

* Width does not include the required 1–3 foot gravel vegetation-free zone or the 3-foot filter strip width (see Figure RT.07.1).

Underdrain Design

Underdrain pipe can provide a protective measure to ensure free flow through the media filter drain (MFD) mix and is sized similar to storm drains. For MFD underdrain sizing, an additional step is required to determine the flow rate that can reach the underdrain pipe. This is done by comparing the contributing basin flow rate to the infiltration flow rate through the media filter mix and then using the smaller of the two to size the underdrain. The analysis described below considers the flow rate per foot of MFD, which allows you the flexibility of incrementally increasing the underdrain diameter where long lengths of underdrain are required. When underdrain pipe connects to a storm drain system, place the invert of the underdrain pipe above the 25-year water surface elevation in the storm drain to prevent backflow into the underdrain system.

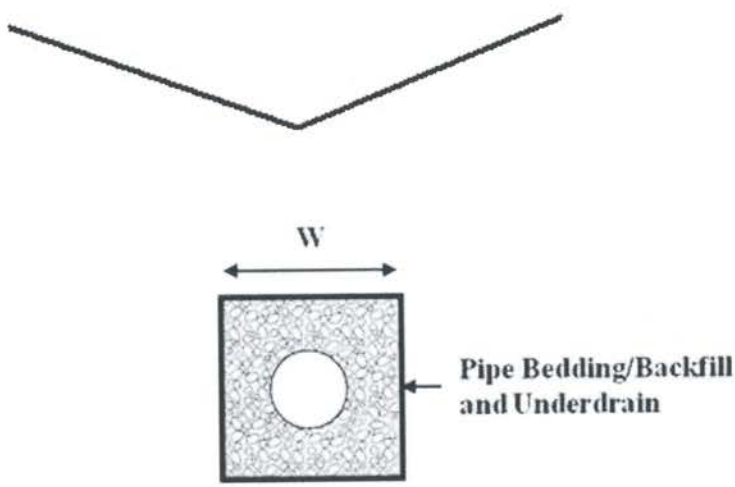


Figure RT.07.4 Media filter drain underdrain installation.

The following describes the procedure for sizing underdrains installed in combination with media filter drains.

1. Calculate the flow rate per foot from the contributing basin to the media filter drain. The design storm event used to determine the flow rate should be relevant to the purpose of the underdrain. For example, if the MFD installation is in western Washington and the underdrain will be used to convey treated runoff to a detention

Jake Jacobs

From: Maurer, Mark <MaurerM@wsdot.wa.gov>
Sent: Tuesday, January 08, 2013 6:59 AM
To: Jake Jacobs
Subject: RE: media filter drain

It would be the same for the media filter drain. Check the tables in Chapter 5 of the HRM.

Mark Maurer, PLA, PE
Highway Runoff Program Manager
Washington State Department of Transportation
360-705-7260
360-705-6815 (fax)
maurerm@wsdot.wa.gov
Visit our website at
http://www.wsdot.wa.gov/Environment/WaterQuality/Runoff/HighwayRunoffManual.htm
☯
"We might say that the earth has the spirit of growth; that its flesh is the soil." - Leonardo da Vinci

---

From: Jake Jacobs [mailto:jjacobs@barghausen.com]
Sent: Monday, January 07, 2013 4:57 PM
To: Maurer, Mark
Subject: RE: media filter drain

Hi Mark,

Do you have any O & M (maintenance) information for the WSDOT MMFD?

Am working on a site O & M manual and want to include information on this.

Thank you very much,

Jake

Jake Jacobs, P.E.
Project Engineer

Barghausen Consulting Engineers, Inc.
18215 72nd Avenue South
Kent, WA 98032

(425) 251-6222 - Phone
(425) 251-8782 - Fax

http://www.barghausen.com

From: Maurer, Mark [mailto:MaurerM@wsdot.wa.gov]
Sent: Thursday, January 03, 2013 4:08 PM

To: Jake Jacobs
Subject: RE: media filter drain

Yes, that's correct.

Mark Maurer, PLA, PE
Highway Runoff Program Manager
Washington State Department of Transportation
360-705-7260
360-705-6815 (fax)
maurerm@wsdot.wa.gov
Visit our website at
http://www.wsdot.wa.gov/Environment/WaterQuality/Runoff/HighwayRunoffManual.htm
☯
"We might say that the earth has the spirit of growth; that its flesh is the soil." - Leonardo da Vinci

---

From: Jake Jacobs [mailto:jjacobs@barghausen.com]
Sent: Thursday, January 03, 2013 4:08 PM
To: Maurer, Mark
Subject: RE: media filter drain

Thank you very much, Mark. I assume the ecology embankment is now the wsdot media filter drain?

Thanks again,

Jake

Jake Jacobs, P.E.
Project Engineer

Barghausen Consulting Engineers, Inc.
18215 72nd Avenue South
Kent, WA 98032

(425) 251-6222 - Phone
(425) 251-8782 - Fax

http://www.barghausen.com

From: Maurer, Mark [mailto:MaurerM@wsdot.wa.gov]
Sent: Thursday, January 03, 2013 3:49 PM
To: Jake Jacobs
Subject: media filter drain

Here you go. The pertinent design information is listed below.

-
- The flow dispersal feature shall be constructed such that flows are evenly distributed to each MMFD zone including consideration of the hydraulic gradient within the flow dispersal system.
- The MMFD mix area shall be sized to meet or exceed $W \geq \frac{Q * C * SF}{LTIR * L}$ where

- *LTIR* = Long-term infiltration rate of the media filter drain mix (using 10 inches per hour for design, actual is 20);
- *C* = Conversion factor of 43,200 ((in/hr)/(ft/sec));
- *Q* is based on the 2-year peak flow into the MMFD (after detention);
- *L* and *W* represent the length and width of the media filter drain area; and
- *SF, safety factor,* equals four (4.0).

- The MMFD mix area shall follow the *HRM* detail (Figure 1) for the standard MFD BMP complete with MFD mix: minimum thickness of 12-inches; geotextile for underground drainage; and underdrain components: gravel backfill for pipe zone bedding, underdrain pipe, and gravel backfill for drains. The no-vegetation zone and grass strip is not required because these have been functionally replaced by the level spreader distribution system and sediment storage in the flow control facility, respectively.

The standard MFD mix consists of 4 components: 3 cubic yards of aggregate, 1 cubic yard of Horticultural Grade Perlite, 40 pounds of Agricultural Grade Dolomite Lime, and 12 pounds of Agricultural Grade Gypsum. Our project used this mix in four configurations:

Mark Maurer, PLA, PE
Highway Runoff Program Manager
Washington State Department of Transportation
360-705-7260
360-705-6815 (fax)
maurerm@wsdot.wa.gov
Visit our website at
http://www.wsdot.wa.gov/Environment/WaterQuality/Runoff/HighwayRunoffManual.htm
☯
"We might say that the earth has the spirit of growth; that its flesh is the soil." - Leonardo da Vinci

*** eSafe1 scanned this email for malicious content ***
*** IMPORTANT: Do not open attachments from unrecognized senders ***

*** eSafe1 scanned this email for malicious content ***
*** IMPORTANT: Do not open attachments from unrecognized senders ***

SIZE THE WSDOT MEDIA FILTER DRAIN ALONG THE EAST SIDE OF THE PROPERTY

The worst case contributing area to the media filter drain is the northern 85 feet of the MFD.

Contributing Areas:	Impervious	=	0.117 Acre
	Till Grass	=	0.063 Acre

Since the contributing width of area exceeds what is shown in Table RT.07.1 use the equation to size the MFD.

$W \geq (Q)(C)(SF)/(LTIR)(L)$

Q	=	The 91st percentile 15-minute flow rate from KCRTS = 0.053 cfs
C	=	Conversion factor = 43,200((in/hr)/(ft/sec))
SF	=	Safety Factor = 1.0
LTIR	=	Long Term Infiltration Rate of the media = 10 Inches per hour
L	=	Length of MFD parallel to contributing area = 85 feet

$W \geq (0.053)(43{,}200)(1.0)/(10)(85) = 2.69$ feet

Use 4 feet to be conservative.

#15985
EAST MFD

```
                    KCRTS Command
                    -------------
                CREATE a new Time Series
                ------------------------
            Production of Runoff Time Series
   Project Location : Sea-Tac
    Computing Series : 15985eastMFDdev.tsf
Regional Scale Factor :    1.00
           Data Type : Reduced
Creating 15-minute Time Series File
          Loading Time Series File:C:\KC_SWDM\KC_DATA\STTG15R.srf    :
                     Flow Path: Length    85.00 ft @ Slope  0.010000
Till Grass            0.06 acres
          Loading Time Series File:C:\KC_SWDM\KC_DATA\STEI15R.srf    :
                     Flow Path: Length    95.00 ft @ Slope  0.017000
Impervious            0.12 acres
           --------------
        Total Area :    0.18 acres
Peak Discharge:  0.187 CFS at  6:30 on Jan  9 in Year 8
                     Storing Time Series File:15985eastMFDdev.tsf    :
                  Time Series Computed

                    KCRTS Command
                    -------------
            Enter the Analysis TOOLS Module
            -------------------------------

                Analysis Tools Command
                ----------------------
            Compute PEAKS and Flow Frequencies
            ----------------------------------
                Loading Stage/Discharge curve:15985eastmfddev.tsf    :
        Flow Frequency Analysis
        -------------------------------------------------------
  Time Series File:15985eastmfddev.tsf
  Project Location:Sea-Tac
            Frequencies & Peaks saved to File:15985eastMFDdev.pks    :

                Analysis Tools Command
                ----------------------
            Plot Probability EXCEEDENCE Curves
            ----------------------------------

                Analysis Tools Command
                ----------------------
                RETURN to Previous Menu
                -----------------------

                    KCRTS Command
                    -------------
                  eXit KCRTS Program
                  ------------------
```

Flow Frequency Analysis
Time Series File:15985eastmfddev.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---

Flow Rate (CFS)	Rank	Time of Peak
0.077	6	8/27/01 18:00
0.053	8	1/06/02 1:00
0.145	2	12/08/02 17:15
0.054	7	8/25/04 23:45
0.085	4	11/17/04 5:00
0.080	5	10/22/05 10:00
0.087	3	10/25/06 22:45
0.187	1	1/09/08 6:30

Computed Peaks

-----Flow Frequency Analysis-------

- - Peaks - - (CFS)	Rank	Return Period	Prob
0.187	1	100.00	0.990
0.145	2	25.00	0.960
0.087	3	10.00	0.900
0.085	4	5.00	0.800
0.080	5	3.00	0.667
0.077	6	2.00	0.500
0.054	7	1.30	0.231
0.053	8	1.10	0.091
0.173		50.00	0.980

GRADING PLAN

STORM DRAINAGE PLAN
WOODINVILLE LUMBER BUSINESS PARK
PANATTONI DEVELOPMENT

NW 1/4, SECTION 15, TOWNSHIP 26 NORTH, RANGE 5 EAST, W.M.
CITY OF WOODINVILLE, KING COUNTY, WA

UTILITY CONFLICT NOTE:

CAUTION:
THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THE LOCATION, DIMENSION, AND DEPTH OF ALL EXISTING UTILITIES WHETHER SHOWN ON THESE PLANS OR NOT BY POTHOLING THE UTILITIES AND SURVEYING THE HORIZONTAL AND VERTICAL LOCATION PRIOR TO CONSTRUCTION. THIS SHALL INCLUDE CALLING UTILITY LOCATE @ 1-800-424-5555 AND THEN POTHOLING ALL OF THE EXISTING UTILITIES AT LOCATIONS OF NEW UTILITY CROSSINGS TO PHYSICALLY VERIFY WHETHER OR NOT CONFLICTS EXIST. LOCATIONS OF SAID UTILITIES AS SHOWN ON THESE PLANS ARE BASED UPON THE UNVERIFIED PUBLIC INFORMATION AND ARE SUBJECT TO VARIATION.

~~1"=50'~~
0 25 50 100
1"=100'

KEYNOTES

1. SINGLE DIRECTION CURB RAMP WSDOT STD. F-40.16-02 SEE DETAIL SHEET C12
2. PARALLEL CURB RAMP PER WSDOT STD. F-40.12-02 SEE DETAIL SHEET C12
3. STAIRS PER ARCH. SITE PLAN
4. ADA ACCESSIBLE PARKING AREA NOT TO EXCEED 2.0% GRADE IN ANY DIRECTION

NOTES:
1. SEE SHEETS C5 & C6 FOR STORM DRAINAGE PROFILES.
2. SEE SHEET C7 FOR STORMWATER WETLAND DETAILS.
3. SEE SHEET C12 FOR PAVEMENT & SIDEWALK SECTIONS.
4. ALL CURB TO BE 6" EXTRUDED CONC. CURB PER DETAIL SHEET C12 UNLESS OTHERWISE NOTED.

FLOOD PLAIN COMPENSATION CALCULATION

ESTIMATED FLOOD PLAIN FILL: 3,740 CF

ESTIMATED FLOOD PLAIN PROVIDED: 5,400 CF

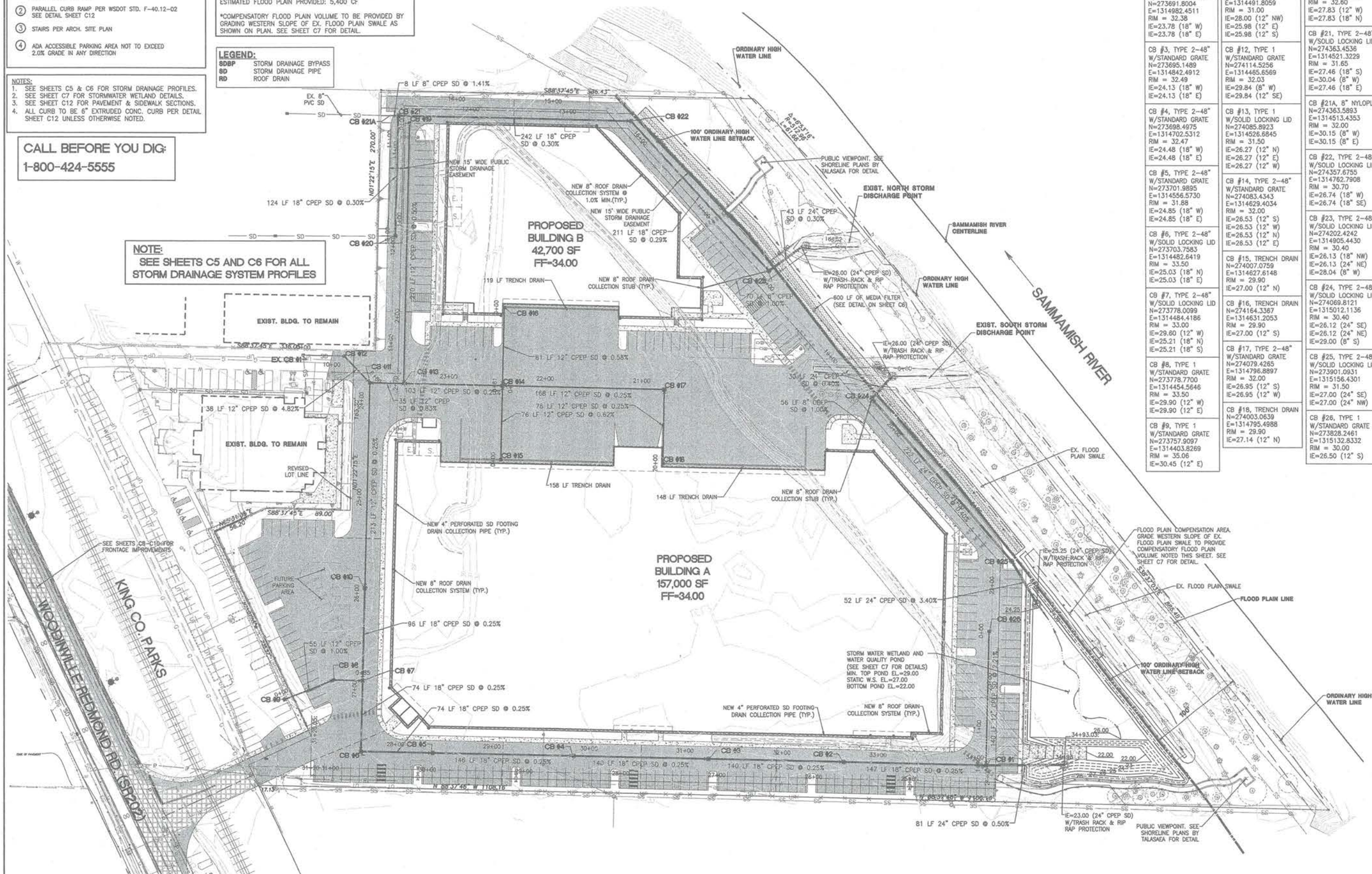
*COMPENSATORY FLOOD PLAIN VOLUME TO BE PROVIDED BY GRADING WESTERN SLOPE OF EX. FLOOD PLAIN SWALE AS SHOWN ON PLAN. SEE SHEET C7 FOR DETAIL.

LEGEND:

SDBP	STORM DRAINAGE BYPASS
SD	STORM DRAINAGE PIPE
RD	ROOF DRAIN

CALL BEFORE YOU DIG:
1-800-424-5555

NOTE:
SEE SHEETS C5 AND C6 FOR ALL STORM DRAINAGE SYSTEM PROFILES



PROPOSED CATCH BASIN TABLE

CATCH BASIN TABLE	CATCH BASIN TABLE	CATCH BASIN TABLE
CB #1, TYPE 2-48" W/STANDARD GRATE N=273688.2827 E=1315129.4840 RIM = 30.00 IE=23.41 (18" W) IE=23.41 (12" N) IE=23.41 (24" E)	CB #10, TYPE 2-48" W/SOLID LOCKING LID N=273873.9238 E=1314486.7138 RIM = 32.50 IE=25.45 (12" N) IE=25.45 (18" S)	CB #19, TYPE 1, W/STANDARD GRATE N=274355.8836 E=1314533.1452 RIM = 31.50 IE=27.61 (12" S)
CB #2, TYPE 2-48" W/STANDARD GRATE N=273691.8004 E=1314982.4511 RIM = 32.38 IE=23.78 (18" W) IE=23.78 (18" E)	CB #11, TYPE 1 W/STANDARD GRATE N=274086.7269 E=1314491.8059 RIM = 31.00 IE=28.00 (12" NW) IE=25.98 (12" E) IE=25.98 (12" S)	CB #20, TYPE 2-48" W/SOLID LOCKING LID N=274239.0489 E=1314518.3460 RIM = 32.60 IE=27.83 (12" W) IE=27.83 (18" N)
CB #3, TYPE 2-48" W/STANDARD GRATE N=273695.1489 E=1314842.4912 RIM = 32.49 IE=24.13 (18" W) IE=24.13 (18" E)	CB #12, TYPE 1 W/STANDARD GRATE N=274114.5256 E=1314465.6569 RIM = 32.03 IE=29.84 (8" W) IE=29.84 (12" SE)	CB #21, TYPE 2-48" W/SOLID LOCKING LID N=274363.4536 E=1314521.3229 RIM = 31.65 IE=27.46 (18" S) IE=30.04 (8" W) IE=27.46 (18" E)
CB #4, TYPE 2-48" W/STANDARD GRATE N=273698.4975 E=1314702.5312 RIM = 32.47 IE=24.48 (18" W) IE=24.48 (18" E)	CB #13, TYPE 1 W/SOLID LOCKING LID N=274085.8923 E=1314526.6845 RIM = 31.50 IE=26.27 (12" N) IE=26.27 (12" E) IE=26.27 (12" W)	CB #21A, 8" NYLOPLAST DRAIN BASIN N=274363.5893 E=1314513.4353 RIM = 32.00 IE=30.15 (8" W) IE=30.15 (8" E)
CB #5, TYPE 2-48" W/STANDARD GRATE N=273701.9895 E=1314556.5730 RIM = 31.88 IE=24.85 (18" W) IE=24.85 (18" E)	CB #14, TYPE 2-48" W/STANDARD GRATE N=274083.4343 E=1314629.4034 RIM = 32.00 IE=26.53 (12" S) IE=26.53 (12" W) IE=26.53 (12" N) IE=26.53 (12" E)	CB #22, TYPE 2-48" W/SOLID LOCKING LID N=274357.6755 E=1314762.7908 RIM = 30.70 IE=26.74 (18" W) IE=26.74 (18" SE)
CB #6, TYPE 2-48" W/SOLID LOCKING LID N=273703.7583 E=1314482.6419 RIM = 33.50 IE=25.03 (18" N) IE=25.03 (18" E)	CB #15, TRENCH DRAIN N=274007.0759 E=1314627.6148 RIM = 29.90 IE=27.00 (12" N)	CB #23, TYPE 2-48" W/SOLID LOCKING LID N=274202.4242 E=1314905.4430 RIM = 30.40 IE=26.13 (18" NW) IE=26.13 (24" NE) IE=28.04 (8" W)
CB #7, TYPE 2-48" W/SOLID LOCKING LID N=273778.0099 E=1314484.4186 RIM = 33.00 IE=29.60 (12" W) IE=25.21 (18" N) IE=25.21 (18" S)	CB #16, TRENCH DRAIN N=274164.3367 E=1314631.2053 RIM = 29.90 IE=27.00 (12" S)	CB #24, TYPE 2-48" W/SOLID LOCKING LID N=274069.8121 E=1315012.1136 RIM = 30.40 IE=26.12 (24" SE) IE=26.12 (24" NE) IE=29.00 (8" S)
CB #8, TYPE 1 N=273778.7700 E=1314454.5646 RIM = 33.50 IE=29.90 (12" W) IE=29.90 (12" E)	CB #17, TYPE 2-48" W/STANDARD GRATE N=274079.4265 E=1314796.8897 RIM = 32.00 IE=26.95 (12" S) IE=26.95 (12" W)	CB #25, TYPE 2-48" W/SOLID LOCKING LID N=273901.0931 E=1315156.4301 RIM = 31.50 IE=27.00 (24" SE) IE=27.00 (24" NW)
CB #9, TYPE 1 W/STANDARD GRATE N=273757.9097 E=1314403.8269 RIM = 35.06 IE=30.45 (12" E)	CB #18, TRENCH DRAIN N=274003.0639 E=1314795.4988 RIM = 29.90 IE=27.14 (12" N)	CB #26, TYPE 1 W/STANDARD GRATE N=273828.2461 E=1315132.8332 RIM = 30.00 IE=26.50 (12" S)

No.	Date	By	Chkd.	Appr.	Revisions
1	12/22/15	AS	AS	DKB	PRELIMINARY CONSTRUCTION SET

Title: GRADING PLAN
WOODINVILLE LUMBER BUSINESS PARK
PANATTONI DEVELOPMENT

For:
PANATTONI DEVELOPMENTCOMPANY
900 SW 16TH ST., SUITE 330
RENTON, WA 98057
(206) 248-0280

DANIEL K. BALMELLI — STATE OF WASHINGTON — 25672 — REGISTERED PROFESSIONAL ENGINEER
12/22/2015

Scale: Horizontal 1"=50' Vertical N/A

Designed AS
Drawn MB
Checked AS
Approved DKB
Date 12/02/15

BARGHAUSEN CONSULTING ENGINEERS, INC.
18215 72ND AVENUE SOUTH
KENT, WA 98032
(425) 251-6222
(425) 251-8782 FAX
CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

Job Number 15985.1
Sheet C4 of 13

File:P:\15000s\15985\engineering\panatoni 15985.1 engineering\15985.1-M.dwg Date/Time:12/28/2015 11:36 AM Scale:1" = 1' REDUCAL Xref:

Tab 5.0

5.0 CONVEYANCE SYSTEM ANALYSIS AND DESIGN

5.0 CONVEYANCE SYSTEM ANALYSIS AND DESIGN

Per the City of Woodinville's adopted 2009 King County Surface Water Design Manual and since the project is over 10 acres in size, Santa Barbara Urban Hydrograph (SBUH) methodology is the chosen conveyance sizing method. Stormshed 2G as developed by Engenious Systems, Inc. was the model used. The 100-year event was adequate conveyed in all pipes without overtopping any manholes or catch basins. Please see the calculations on the following pages of this report.

The north side bypass conveyance system receives runoff from 2.47 acres of mostly impervious surface from upstream of the site as well as the entire on-site new building roof. No on-site pollution generating impervious surface will drain to it. All on-site catch basins in this conveyance system will have solid locking lids to prevent runoff from pollution generating surfaces from being collected and conveyed. Therefore, water quality treatment is not required for this north side conveyance system. This system also meets the requirements for direct discharge exemption as follows:

1. The Sammamish River is considered a major receiving water.
2. The flow path from the project site discharge point is less than one-quarter mile to the major receiving water.
3. The conveyance system is constructed of manmade elements, pipes and ditches, and is within an easement.
4. The pipe conveyance calculations within this section of the report show adequate capacity in this system using full build-out of the contributing properties.
5. This conveyance system is and will be adequately stabilized to prevent erosion.
6. This direct discharge proposal will not divert flows for or increase flows to an existing wetland or stream sufficient to cause a significant adverse impact.

CONVEYANCE BASIN MAP

STORM DRAINAGE PLAN
WOODINVILLE LUMBER BUSINESS PARK
PANATTONI DEVELOPMENT

NW 1/4, SECTION 15, TOWNSHIP 26 NORTH, RANGE 5 EAST, W.M.
CITY OF WOODINVILLE, KING COUNTY, WA

UTILITY CONFLICT NOTE:
CAUTION:
THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THE LOCATION, DIMENSION, AND DEPTH OF ALL EXISTING UTILITIES WHETHER SHOWN ON THESE PLANS OR NOT BY POTHOLING THE UTILITIES AND SURVEYING THE HORIZONTAL AND VERTICAL LOCATION PRIOR TO CONSTRUCTION. THIS SHALL INCLUDE CALLING UTILITY LOCATE @ 1-800-424-5555 AND THEN POTHOLING ALL OF THE EXISTING UTILITIES AT LOCATIONS OF NEW UTILITY CROSSINGS TO PHYSICALLY VERIFY WHETHER OR NOT CONFLICTS EXIST. LOCATIONS OF SAID UTILITIES AS SHOWN ON THESE PLANS ARE BASED UPON THE UNVERIFIED PUBLIC INFORMATION AND ARE SUBJECT TO VARIATION.

~~1"=50'~~
0 25 50 100
1" = 100'

KEYNOTES
1. SINGLE DIRECTION CURB RAMP WSDOT STD. F-40.16-02 SEE DETAIL SHEET C12
2. PARALLEL CURB RAMP PER WSDOT STD. F-40.12-02 SEE DETAIL SHEET C12
3. STAIRS PER ARCH. SITE PLAN
4. ADA ACCESSIBLE PARKING AREA NOT TO EXCEED 2.0% GRADE IN ANY DIRECTION

FLOOD PLAIN COMPENSATION CALCULATION
ESTIMATED FLOOD PLAIN FILL: 3,740 CF
ESTIMATED FLOOD PLAIN PROVIDED: 5,400 CF
*COMPENSATORY FLOOD PLAIN VOLUME TO BE PROVIDED BY GRADING WESTERN SLOPE OF EX. FLOOD PLAIN SWALE AS SHOWN ON PLAN. SEE SHEET C7 FOR DETAIL.

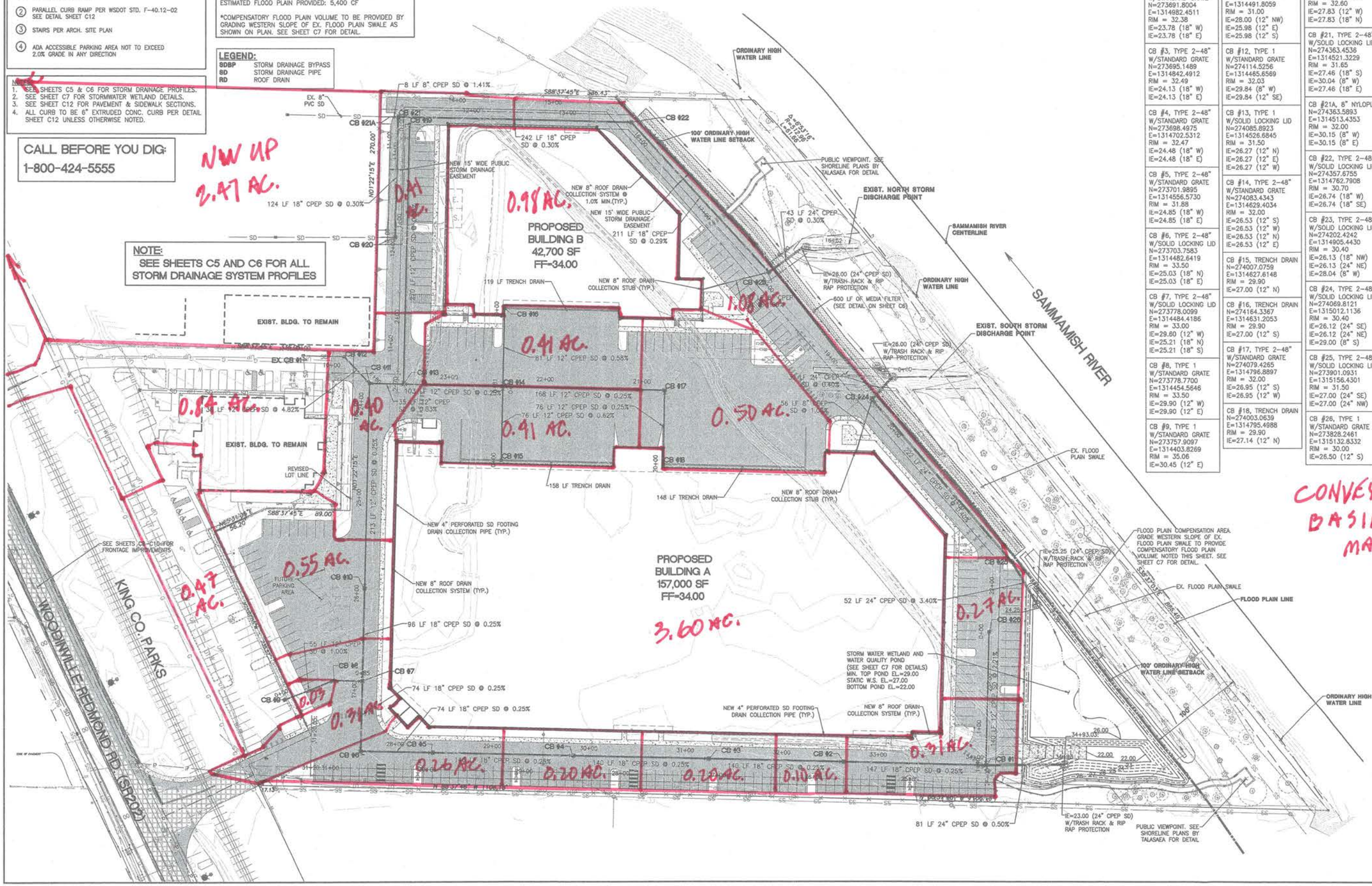
LEGEND:
SDBP STORM DRAINAGE BYPASS
SD STORM DRAINAGE PIPE
RD ROOF DRAIN

NOTES:
1. SEE SHEETS C5 & C6 FOR STORM DRAINAGE PROFILES.
2. SEE SHEET C7 FOR STORMWATER WETLAND DETAILS.
3. SEE SHEET C12 FOR PAVEMENT & SIDEWALK SECTIONS.
4. ALL CURB TO BE 6" EXTRUDED CONC. CURB PER DETAIL SHEET C12 UNLESS OTHERWISE NOTED.

CALL BEFORE YOU DIG:
1-800-424-5555

NW UP
2.47 AC.

NOTE:
SEE SHEETS C5 AND C6 FOR ALL STORM DRAINAGE SYSTEM PROFILES



CONVEYANCE BASIN MAP

PROPOSED CATCH BASIN TABLE

CATCH BASIN TABLE	CATCH BASIN TABLE	CATCH BASIN TABLE
CB #1, TYPE 2-48" W/STANDARD GRATE N=273688.2827 E=1315129.4840 RIM = 30.00 IE=23.41 (18" W) IE=23.41 (12" N) IE=23.41 (24" E)	CB #10, TYPE 2-48" W/SOLID LOCKING LID N=273873.9238 E=1314486.7138 RIM = 32.50 IE=25.45 (12" N) IE=25.45 (18" S)	CB #19, TYPE 1, W/STANDARD GRATE N=274355.8836 E=1314533.1452 RIM = 31.50 IE=27.61 (12" S)
CB #2, TYPE 2-48" W/STANDARD GRATE N=273691.8004 E=1314982.4511 RIM = 32.38 IE=23.78 (18" W) IE=23.78 (18" E)	CB #11, TYPE 1 W/STANDARD GRATE N=274086.7269 E=1314491.8059 RIM = 31.00 IE=28.00 (12" NW) IE=25.98 (12" E) IE=25.98 (12" S)	CB #20, TYPE 2-48" W/SOLID LOCKING LID N=274239.0489 E=1314518.3460 RIM = 32.60 IE=27.83 (12" W) IE=27.83 (18" N)
CB #3, TYPE 2-48" W/STANDARD GRATE N=273695.1489 E=1314842.4912 RIM = 32.49 IE=24.13 (18" W) IE=24.13 (18" E)	CB #12, TYPE 1 W/STANDARD GRATE N=274114.5256 E=1314465.6569 RIM = 32.03 IE=29.84 (8" W) IE=29.84 (12" SE)	CB #21, TYPE 2-48" W/SOLID LOCKING LID N=274363.4536 E=1314521.3229 RIM = 31.65 IE=27.46 (18" S) IE=30.04 (8" W) IE=27.46 (18" E)
CB #4, TYPE 2-48" W/STANDARD GRATE N=273698.4975 E=1314702.5312 RIM = 32.47 IE=24.48 (18" W) IE=24.48 (18" E)	CB #13, TYPE 1 W/SOLID LOCKING LID N=274085.8923 E=1314526.6845 RIM = 31.50 IE=26.27 (12" N) IE=26.27 (12" E) IE=26.27 (12" W)	CB #21A, 6" NYLOPLAST DRAIN BASIN N=274363.5893 E=1314513.4353 RIM = 32.00 IE=30.15 (8" W) IE=30.15 (8" E)
CB #5, TYPE 2-48" W/STANDARD GRATE N=273701.9895 E=1314556.5730 RIM = 31.88 IE=24.85 (18" W) IE=24.85 (18" E)	CB #14, TYPE 2-48" W/STANDARD GRATE N=274083.4343 E=1314629.4034 RIM = 32.00 IE=26.53 (12" S) IE=26.53 (12" W) IE=26.53 (12" N) IE=26.53 (12" E)	CB #22, TYPE 2-48" W/SOLID LOCKING LID N=274357.6755 E=1314762.7908 RIM = 30.70 IE=26.74 (18" W) IE=26.74 (18" SE)
CB #6, TYPE 2-48" W/SOLID LOCKING LID N=273703.7583 E=1314482.6419 RIM = 33.50 IE=25.03 (18" N) IE=25.03 (18" E)	CB #15, TRENCH DRAIN N=274007.0759 E=1314627.6148 RIM = 29.90 IE=27.00 (12" N)	CB #23, TYPE 2-48" W/SOLID LOCKING LID N=274202.4242 E=1314905.4430 RIM = 30.40 IE=26.13 (18" NW) IE=26.13 (24" NE) IE=28.04 (8" W)
CB #7, TYPE 2-48" W/SOLID LOCKING LID N=273778.0099 E=1314484.4186 RIM = 33.00 IE=29.60 (12" W) IE=25.21 (18" N) IE=25.21 (18" S)	CB #16, TRENCH DRAIN N=274164.3367 E=1314631.2053 RIM = 29.90 IE=27.00 (12" S)	CB #24, TYPE 2-48" W/SOLID LOCKING LID N=274069.8121 E=1315012.1136 RIM = 30.40 IE=26.12 (24" SE) IE=26.12 (24" NE) IE=29.00 (8" S)
CB #8, TYPE 1 W/STANDARD GRATE N=273778.7700 E=1314454.5646 RIM = 33.50 IE=29.90 (12" W) IE=29.90 (12" E)	CB #17, TYPE 2-48" W/STANDARD GRATE N=274079.4265 E=1314796.8897 RIM = 32.00 IE=26.95 (12" S) IE=26.95 (12" W)	CB #25, TYPE 2-48" W/SOLID LOCKING LID N=273901.0931 E=1315156.4301 RIM = 31.50 IE=27.00 (24" SE) IE=27.00 (24" NW)
CB #9, TYPE 1 W/STANDARD GRATE N=273757.9097 E=1314403.8269 RIM = 35.06 IE=30.45 (12" E)	CB #18, TRENCH DRAIN N=274003.0639 E=1314795.4988 RIM = 29.90 IE=27.14 (12" N)	CB #26, TYPE 1 W/STANDARD GRATE N=273828.2461 E=1315132.8332 RIM = 30.00 IE=26.50 (12" S)

No.	Date	By	Ckd.	Appr.	
1	12/22/15	AS	AS	DKB	PRELIMINARY CONSTRUCTION SET

Title: GRADING PLAN
WOODINVILLE LUMBER BUSINESS PARK
PANATTONI DEVELOPMENT

For:
PANATTONI DEVELOPMENTCOMPANY
900 SW 16TH ST., SUITE 330
RENTON, WA 98057
(206) 248-0280

DANIEL K. BALMELLI, STATE OF WASHINGTON, 25672, REGISTERED PROFESSIONAL ENGINEER
12/22/2015

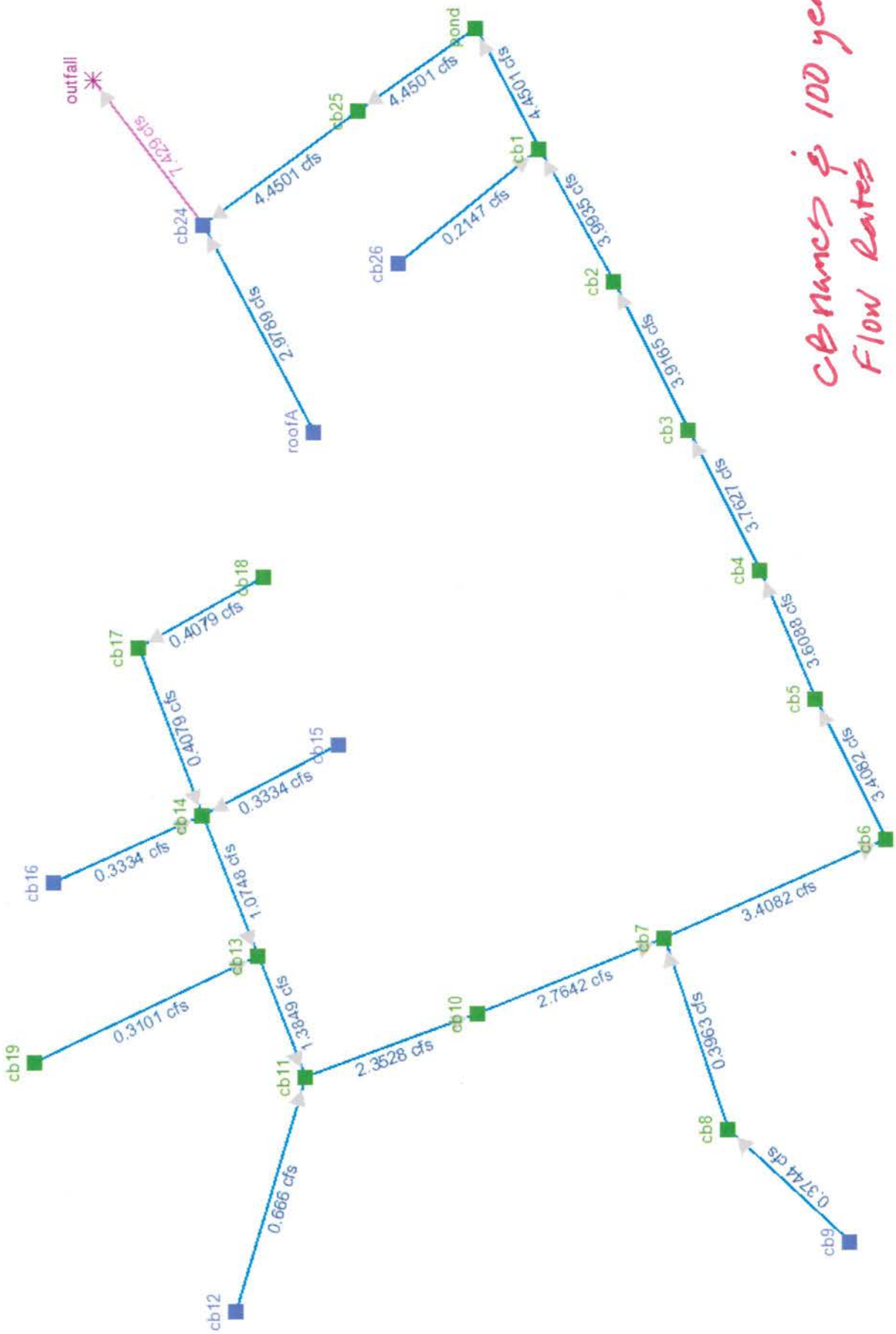
Scale: Horizontal 1"=50' Vertical N/A

Designed AS
Drawn MB
Checked AS
Approved DKB
Date 12/02/15

BARGHAUSEN CONSULTING ENGINEERS, INC.
18215 72ND AVENUE SOUTH
KENT, WA 98032
(425) 251-6222
(425) 251-8782 FAX
CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

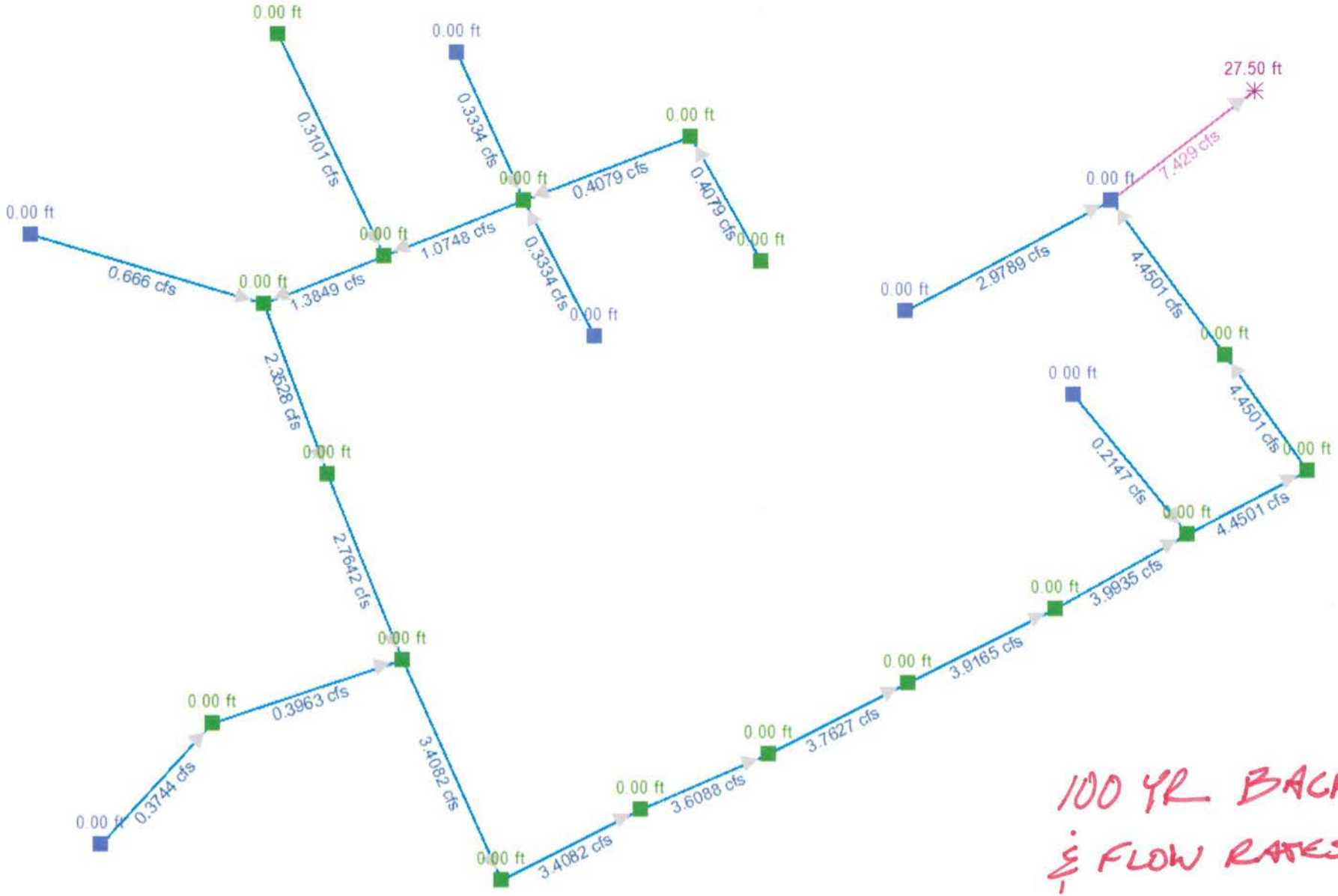
Job Number 15985.1
Sheet C4 of 13

CONVEYANCE CALCULATIONS FOR THE MAIN SYSTEM

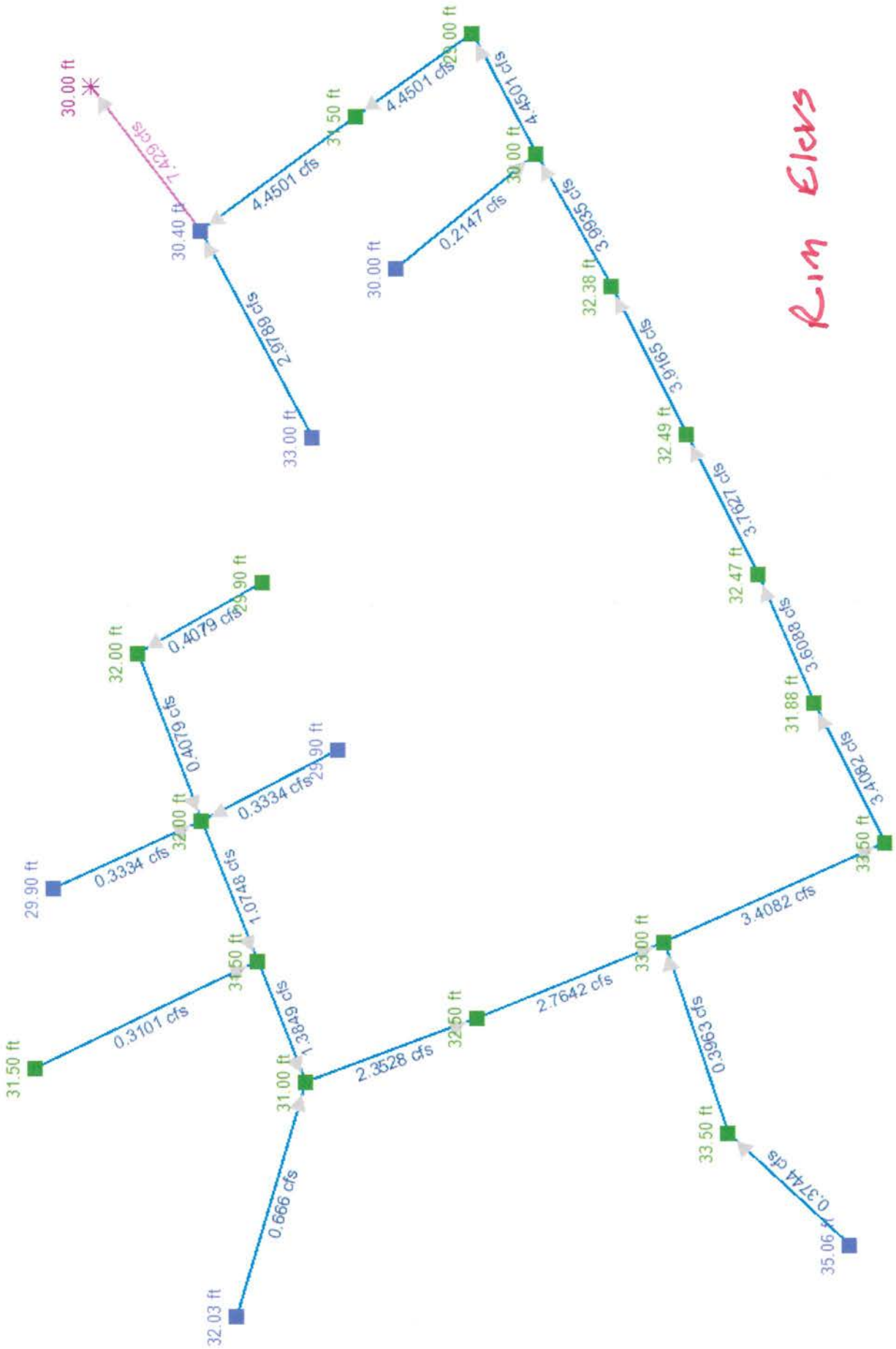


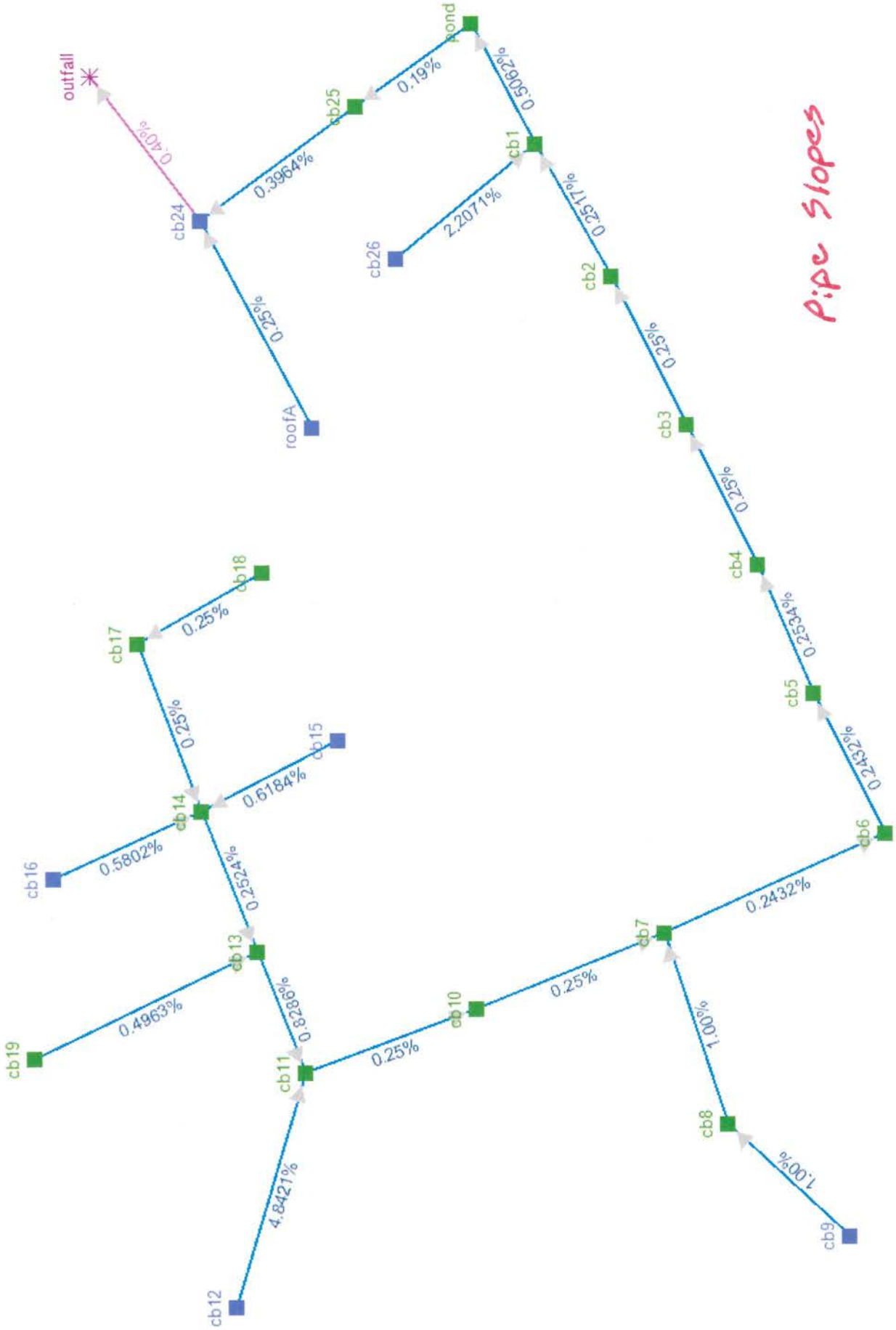
CB numbers & 100 year Flow Rates

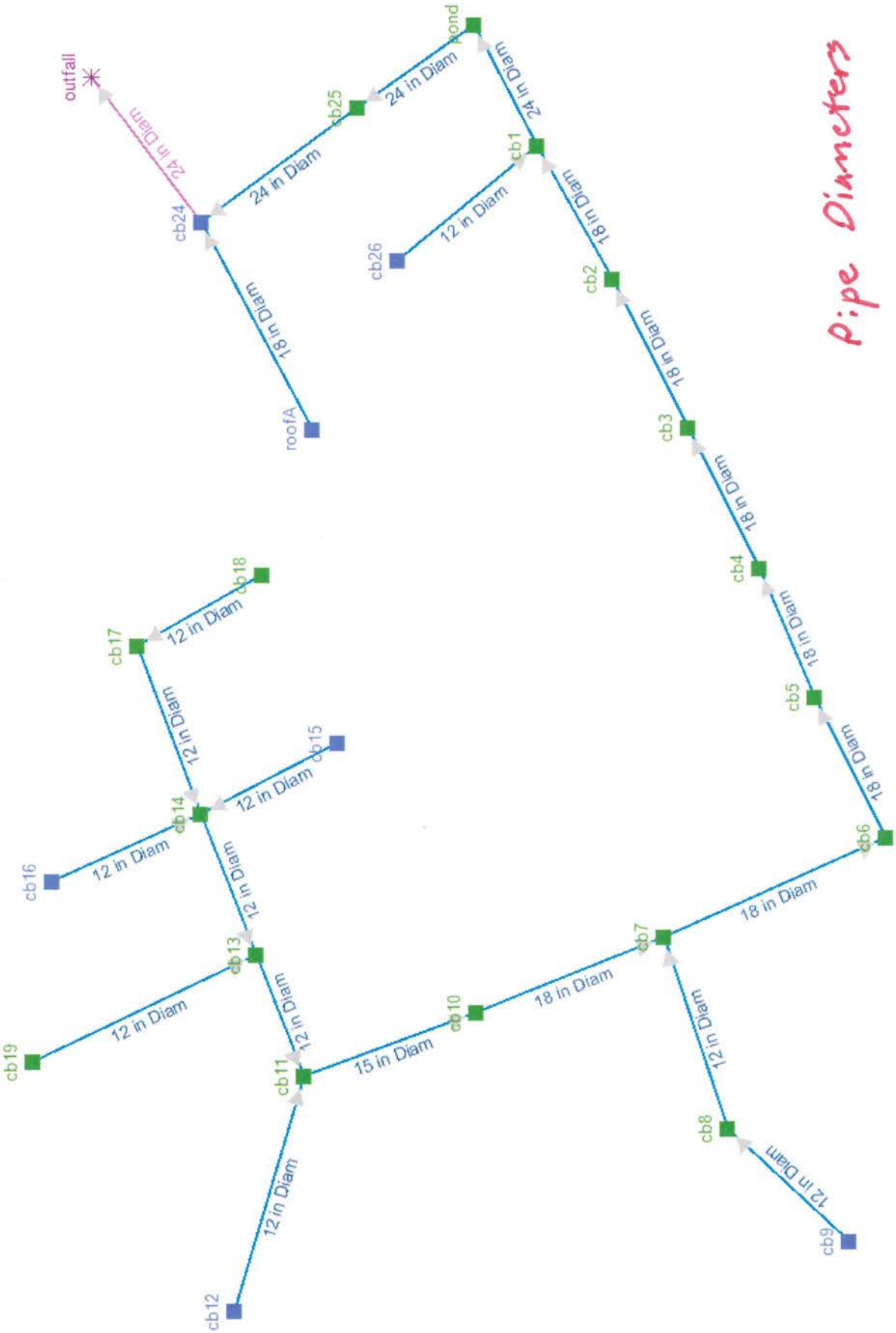
#15985

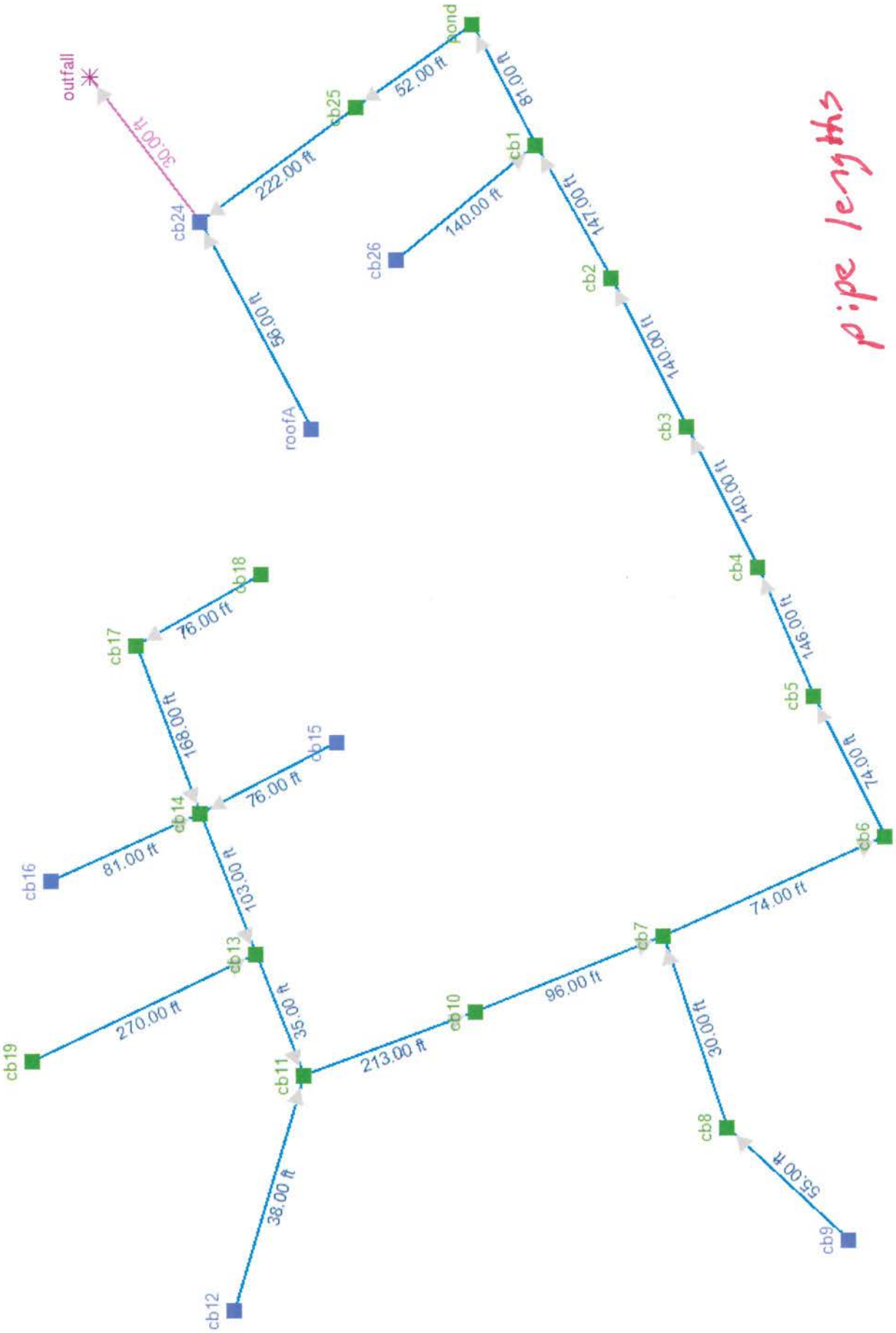


100 YR BACKWATER & FLOW RATES

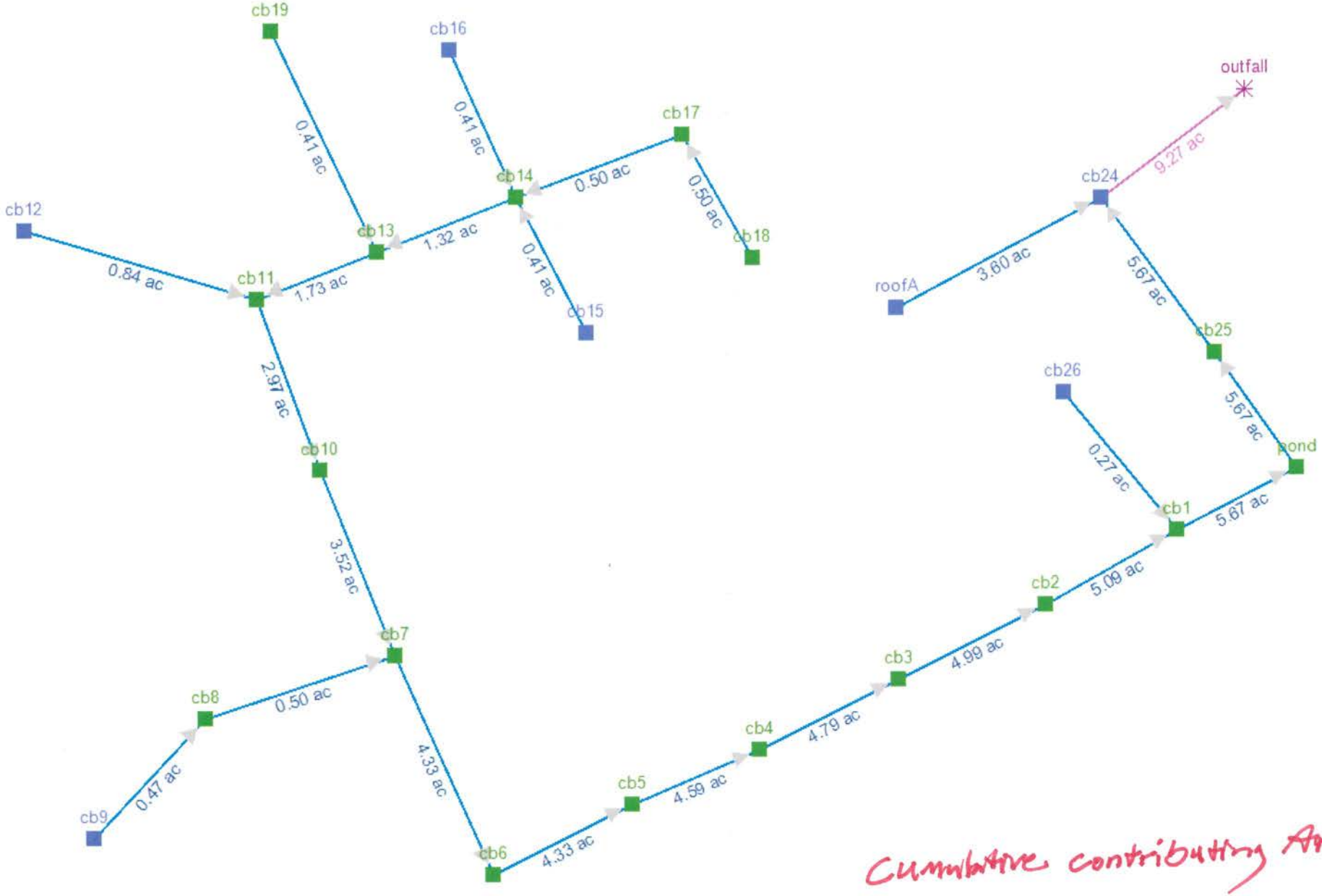

30.00 ft
7.429 cfs
30.40 ft
4.4501 cfs
31.50 ft
4.4501 cfs
29.00 ft
4.4501 cfs
30.00 ft
0.2147 cfs
30.00 ft
2.9789 cfs
33.00 ft
3.9935 cfs
32.38 ft
3.9195 cfs
32.49 ft
3.7627 cfs
32.47 ft
3.6088 cfs
31.88 ft
3.4082 cfs
33.50 ft
3.4082 cfs
33.00 ft
0.3993 cfs
33.50 ft
0.3744 cfs
35.06 ft
2.7642 cfs
32.50 ft
2.3528 cfs
31.00 ft
0.666 cfs
32.03 ft
1.3849 cfs
31.50 ft
0.3101 cfs
31.50 ft
1.0748 cfs
32.00 ft
0.3334 cfs
29.90 ft
0.3334 cfs
29.90 ft
0.4079 cfs
32.00 ft
0.4079 cfs
29.90 ft
Rim Elevs


Pipe Slopes
outfall
0.40%
pond
0.19%
cb25
0.3964%
cb24
0.25%
roofA
0.5062%
cb1
2.2071%
cb26
0.2517%
cb2
0.25%
cb3
0.25%
cb4
0.2534%
cb5
0.2432%
cb6
0.2432%
cb7
1.00%
cb8
1.00%
cb9
0.25%
cb10
0.25%
cb11
4.8421%
cb12
0.8286%
cb13
0.4963%
cb19
0.2524%
cb14
0.5802%
cb16
0.6184%
cb15
0.25%
cb17
0.25%
cb18

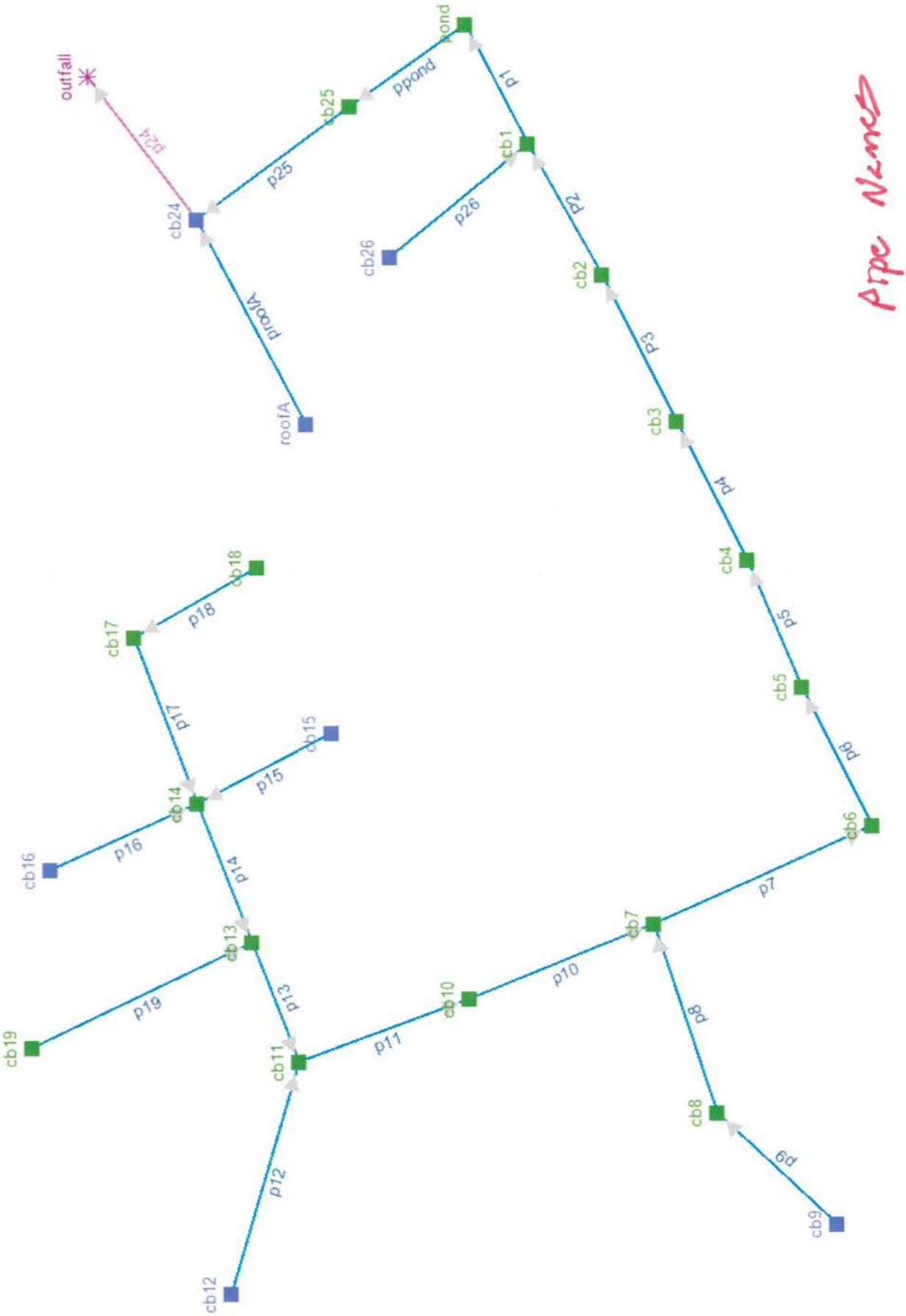

Pipe Diameters
outfall
24 in Diam
cb24
24 in Diam
cb25
24 in Diam
pond
24 in Diam
cb1
18 in Diam
cb2
18 in Diam
cb3
18 in Diam
cb4
18 in Diam
cb5
18 in Diam
cb6
18 in Diam
cb7
12 in Diam
cb8
12 in Diam
cb9
18 in Diam
cb10
15 in Diam
cb11
12 in Diam
cb12
12 in Diam
cb13
12 in Diam
cb14
12 in Diam
cb15
12 in Diam
cb16
12 in Diam
cb17
12 in Diam
cb18
12 in Diam
cb19
12 in Diam
cb26
18 in Diam
roofA



pipe lengths



Cumulative contributing Areas


outfall
p24
cb24
p25
cb25
ppond
pond
p1
cb1
p26
cb26
p2
cb2
p3
cb3
p4
cb4
p5
cb5
p6
cb6
p7
cb7
p8
cb8
p9
cb9
p10
cb10
p11
cb11
p12
cb12
p13
cb13
p14
cb14
p15
cb15
p16
cb16
p17
cb17
p18
cb18
p19
cb19
proofA
roofA

Pipe Names

Appended on: Monday, January 04, 2016 2:27:53 PM

ROUTEHYD [] THRU [15985site] USING [100 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
proofA	3.60	2.9789	5.2663	0.5656	0.8076	0.5384	18 in Diam	3.0712	2.9801	0.00	roofA
p26	0.27	0.2147	5.3073	0.0405	0.1373	0.1373	12 in Diam	3.3057	6.7574	0.00	cb26
p9	0.47	0.3744	3.5724	0.1048	0.218	0.218	12 in Diam	2.9602	4.5485	0.00	cb9
p8	0.50	0.3963	3.5724	0.1109	0.2249	0.2249	12 in Diam	2.9977	4.5485	0.00	cb8
p12	0.84	0.666	7.861	0.0847	0.1966	0.1966	12 in Diam	6.1053	10.0089	0.00	cb12
p19	0.41	0.3101	2.5167	0.1232	0.2372	0.2372	12 in Diam	2.1759	3.2044	0.00	cb19
p15	0.41	0.3334	2.8093	0.1187	0.2331	0.2331	12 in Diam	2.3971	3.5769	0.00	cb15
p16	0.41	0.3334	2.7211	0.1225	0.2366	0.2366	12 in Diam	2.348	3.4646	0.00	cb16
p18	0.50	0.4079	1.7862	0.2284	0.3247	0.3247	12 in Diam	1.845	2.2743	0.00	cb18
p17	0.50	0.4079	1.7862	0.2284	0.3247	0.3247	12 in Diam	1.845	2.2743	0.00	
p14	1.32	1.0748	1.7948	0.5988	0.5578	0.5578	12 in Diam	2.3863	2.2851	0.00	
p13	1.73	1.3849	3.2519	0.4259	0.4559	0.4559	12 in Diam	3.9723	4.1404	0.00	
p11	2.97	2.3528	3.2386	0.7265	0.7906	0.6325	15 in Diam	2.8758	2.639	0.00	cb11
p10	3.52	2.7642	5.2663	0.5249	0.7722	0.5148	18 in Diam	3.0147	2.9801	0.00	cb10
p7	4.33	3.4082	5.1942	0.6562	0.8862	0.5908	18 in Diam	3.1361	2.9393	0.00	cb7
p6	4.33	3.4082	5.1942	0.6562	0.8862	0.5908	18 in Diam	3.1361	2.9393	0.00	
p5	4.59	3.6088	5.302	0.6807	0.9082	0.6055	18 in Diam	3.2248	3.0003	0.00	cb5
p4	4.79	3.7627	5.2663	0.7145	0.9379	0.6253	18 in Diam	3.2368	2.9801	0.00	cb4
P3	4.99	3.9165	5.2663	0.7437	0.9643	0.6429	18 in Diam	3.2622	2.9801	0.00	cb3
P2	5.09	3.9935	5.2842	0.7557	0.9743	0.6496	18 in Diam	3.2868	2.9902	0.00	cb2

p1	5.67	4.4501	16.1386	0.2757	0.7179	0.359	24 in Diam	4.3877	5.1371	0.00	cb1
ppond	5.67	4.4501	9.8874	0.4501	0.9407	0.4704	24 in Diam	3.0642	3.1473	0.00	
p25	5.67	4.4501	14.2815	0.3116	0.765	0.3825	24 in Diam	4.0267	4.5459	0.00	
p24	9.27	7.429	14.3462	0.5178	1.0215	0.5107	24 in Diam	4.6035	4.5665	0.00	

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							27.50
cb24	outfall	27.9161	0.2518	0.3269	0.1052	28.0964	30.4000
roofA	cb24	28.1941	------	------	------	28.1941	33.0000
cb25	cb24	28.4516	0.1458	0.0009	------	28.3067	31.5000
No approach losses at node cb1 because inverts and/or crowns are offset.							
pond	cb25	28.5114	0.0312	0.0485	------	28.5287	29.0000
cb1	pond	28.5972	0.0793	0.0007	0.0035	28.5222	30.0000
cb26	cb1	28.5287	------	------	------	28.5287	30.0000
cb2	cb1	28.8286	0.0763	0.0009	------	28.7532	32.3800
cb3	cb2	29.0383	0.0704	0.0002	------	28.9681	32.4900
cb4	cb3	29.2312	0.0648	0.0010	------	29.1674	32.4700
cb5	cb4	29.4165	0.0578	0.0009	------	29.3597	31.8800
cb6	cb5	29.5065	0.0578	0.0816	------	29.5303	33.5000
cb7	cb6	29.6771	0.0380	0.0004	0.0043	29.6438	33.0000
cb8	cb7	30.2496	------	0.0255	------	30.2751	33.5000
cb9	cb8	30.7890	------	------	------	30.7890	35.0600
cb10	cb7	29.7555	0.0571	0.0005	------	29.6989	32.5000
cb11	cb10	30.0458	0.0483	0.0627	0.0157	30.0759	31.0000
cb12	cb11	30.2856	------	------	------	30.2856	32.0300
cb13	cb11	30.1864	0.0291	0.0001	0.0062	30.1636	31.5000
cb19	cb13	30.1868	------	------	------	30.1868	31.5000
cb14	cb13	30.2917	0.0042	0.0000	0.0031	30.2907	32.0000
cb15	cb14	30.3007	------	------	------	30.0000	29.9000
cb16	cb14	30.3011	------	------	------	30.0000	29.9000
cb17	cb14	30.3176	0.0042	0.0046	------	30.3180	32.0000
cb18	cb17	30.3329	------	------	------	30.0000	29.9000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
p24	1.7961	0.8980	7.43	1.5000	0.9686	1.0215	Outlet Control M1 Backwater

Subcritical, M-1 Profile

Subcritical flow starts at downstream end and progresses upstream until normal depth is reached.

y ft	A sf	R	V ft	Eft	dEft	Sf ft	Savg ft	So-Sf ft	dx ft	Station ft	Elev ft
1.50	2.5274	0.6034	2.9394	1.634159	0.00	0.00129	0.00	0.00	0.00	30.00	27.50
1.4809	2.494	0.6017	2.9787	1.618631	0.015527	0.00133	0.00131	0.00269	5.771866	24.2281	27.5039
1.4617	2.4603	0.5999	3.0196	1.603298	0.015333	0.001372	0.001351	0.002649	5.787898	18.4402	27.508
1.4426	2.4261	0.5978	3.062	1.58817	0.015128	0.001417	0.001395	0.002605	5.806447	12.6338	27.512
1.4234	2.3916	0.5955	3.1062	1.573261	0.014909	0.001466	0.001442	0.002558	5.82778	6.806	27.5162
1.4043	2.3568	0.593	3.1522	1.558584	0.014677	0.001518	0.001492	0.002508	5.852228	0.9538	27.5205
1.3852	2.3216	0.5904	3.1999	1.544154	0.01443	0.001574	0.001546	0.002454	5.880194	-4.9264	27.5249

The depth of flow at the **upper** end of the reach is **1.4012 ft**.
Flow has returned to normal. The flow depth returned to normal 0.00 ft from the downstream lower end of reach.

proofA	2.0741	1.3828	2.98	1.9764	0.6560	0.8076	Outlet Control
p25	1.4516	0.7258	4.45	1.9764	0.7415	0.7650	Outlet Control M1 Backwater

Subcritical, M-1 Profile

Subcritical flow starts at downstream end and progresses upstream until normal depth is reached.

y ft	A sf	R	V ft	Eft	dEft	Sf ft	Savg ft	So-Sf ft	dx ft	Station ft	Elev ft
1.9764	3.1348	0.5361	1.4196	2.007689	0.00	0.000352	0.00	0.00	0.00	222.00	28.0964
1.9279	3.1055	0.5627	1.433	1.959825	0.047864	0.000337	0.000344	0.00362	13.223524	208.7765	28.1004
1.8795	3.0641	0.5791	1.4523	1.912235	0.04759	0.000333	0.000335	0.003629	13.112159	195.6643	28.1039
1.831	3.014	0.5906	1.4765	1.864878	0.047357	0.000335	0.000334	0.00363	13.045324	182.619	28.1071
1.7826	2.9568	0.5986	1.505	1.817744	0.047134	0.000342	0.000338	0.003626	13.000086	169.6189	28.1102
1.7341	2.8936	0.6041	1.5379	1.77084	0.046905	0.000353	0.000347	0.003617	12.968505	156.6504	28.1132
1.6857	2.8254	0.6073	1.575	1.724178	0.046661	0.000367	0.00036	0.003604	12.946733	143.7037	28.116
1.6372	2.7527	0.6086	1.6166	1.677782	0.046396	0.000386	0.000376	0.003588	12.932645	130.771	28.1188
1.5887	2.6762	0.6081	1.6628	1.631681	0.046102	0.000409	0.000397	0.003567	12.925011	117.846	28.1216
1.5403	2.5962	0.6061	1.7141	1.585911	0.04577	0.000436	0.000422	0.003542	12.923149	104.9229	28.1244
1.4918	2.5132	0.6027	1.7707	1.540517	0.045393	0.000469	0.000452	0.003512	12.92676	91.9961	28.1272
1.4434	2.4276	0.5979	1.8331	1.495557	0.04496	0.000508	0.000488	0.003476	12.935855	79.0602	28.13
1.3949	2.3396	0.5918	1.9021	1.451098	0.044458	0.000554	0.000531	0.003433	12.950746	66.1095	28.1329
1.3465	2.2496	0.5844	1.9782	1.407227	0.043872	0.00061	0.000582	0.003382	12.972074	53.1374	28.1358
1.298	2.1579	0.5759	2.0623	1.364047	0.04318	0.000676	0.000643	0.003321	13.000897	40.1365	28.1389
1.2496	2.0647	0.5663	2.1554	1.321687	0.04236	0.000755	0.000715	0.003249	13.038844	27.0977	28.1421
1.2011	1.9703	0.5555	2.2586	1.280309	0.041378	0.00085	0.000803	0.003161	13.08839	14.0093	28.1456
1.1526	1.8749	0.5437	2.3735	1.240117	0.040192	0.000966	0.000908	0.003056	13.153345	0.856	28.1492
1.1042	1.7788	0.5309	2.5018	1.201368	0.038749	0.001108	0.001037	0.002927	13.239739	-12.3838	28.1533

The depth of flow at the **upper** end of the reach is **1.1495 ft**.
Flow has returned to normal. The flow depth returned to normal 0.00 ft from the downstream lower end of reach.

ppond	1.4114	0.7057	4.45	1.3067	0.7415	0.9407	Outlet Control M1 Backwater

Subcritical, M-1 Profile

Subcritical flow starts at downstream end and progresses upstream until normal depth is reached.

y ft	A sf	R	V ft	Eft	dEft	Sf ft	Savg ft	So-Sf ft	dx ft	Station ft	Elev ft
1.3067	2.1745	0.5775	2.0465	1.371771	0.00	0.000663	0.00	0.00	0.00	52.00	28.3079
1.2921	2.1466	0.5748	2.0731	1.358834	0.012937	0.000685	0.000674	0.001226	10.549957	41.45	28.3133
1.2775	2.1185	0.572	2.1006	1.345973	0.012861	0.000707	0.000696	0.001204	10.681976	30.7681	28.319
1.2628	2.0903	0.569	2.1289	1.333193	0.01278	0.000732	0.00072	0.00118	10.827034	19.941	28.3249
1.2482	2.062	0.566	2.1581	1.320497	0.012695	0.000757	0.000745	0.001155	10.986958	8.9541	28.3312
1.2335	2.0336	0.5628	2.1883	1.307892	0.012605	0.000784	0.000771	0.001129	11.163933	-2.2099	28.3377

The depth of flow at the **upper** end of the reach is **1.2364 ft**.
Flow has returned to normal. The flow depth returned to normal 0.00 ft from the downstream lower end of reach.

p1	5.5973	2.7986	4.45	5.5287	0.7415	0.7179	Outlet Control
p26	5.1186	5.1186	0.21	5.1122	0.1901	0.1373	Outlet Control
P2	5.4186	3.6124	3.99	5.1122	0.7651	0.9743	Outlet Control
P3	5.2583	3.5055	3.92	4.9732	0.7573	0.9643	Outlet Control
p4	5.1012	3.4008	3.76	4.8381	0.7415	0.9379	Outlet Control
p5	4.9365	3.2910	3.61	4.6874	0.7254	0.9082	Outlet Control
p6	4.6564	3.1043	3.41	4.5097	0.7039	0.8862	Outlet Control
p7	4.6471	3.0981	3.41	4.5003	0.7039	0.8862	Outlet Control
p8	0.3496	0.3496	0.40	0.2602	0.2602	0.2249	SuperCrit flow, Inlet end controls
p9	0.3390	0.3390	0.37	0.3751	0.2527	0.2180	SuperCrit flow, Inlet end controls
p10	4.5455	3.0303	2.76	4.4338	0.6312	0.7722	Outlet Control
p11	4.5983	3.6787	2.35	4.2489	0.6135	0.7906	Outlet Control
p12	0.4456	0.4456	0.67	2.0759	0.3402	0.1966	SuperCrit flow, Inlet end controls
p13	4.2064	4.2064	1.38	4.0959	0.4980	0.4559	Outlet Control
p19	3.9169	3.9169	0.31	3.8936	0.2295	0.2372	Outlet Control
p14	4.0217	4.0217	1.07	3.8936	0.4360	0.5578	Outlet Control
p15	3.7706	3.7706	0.33	3.7607	0.2380	0.2331	Outlet Control
p16	3.7711	3.7711	0.33	3.7607	0.2380	0.2366	Outlet Control
p17	3.7876	3.7876	0.41	3.7607	0.2640	0.3247	Outlet Control
p18	3.3829	3.3829	0.41	3.3680	0.2640	0.3247	Outlet Control

Node and Reach invert report

Node and Reach invert report

Node	roofA		Out ie	26.26 ft
	Reach	proofA	I.E. Out	26.26 ft
Node	cb26		Out ie	26.50 ft
	Reach	p26	I.E. Out	26.50 ft

Node	cb9		Out ie	30.45 ft
	Reach	p9	I.E. Out	30.45 ft
Node	cb8		Out ie	29.90 ft
	Reach	p9	I.E. In	29.90 ft
	Reach	p8	I.E. Out	29.90 ft
Node	cb12		Out ie	29.84 ft
	Reach	p12	I.E. Out	29.84 ft
Node	cb19		Out ie	27.61 ft
	Reach	p19	I.E. Out	27.61 ft
Node	cb15		Out ie	27.00 ft
	Reach	p15	I.E. Out	27.00 ft
Node	cb16		Out ie	27.00 ft
	Reach	p16	I.E. Out	27.00 ft
Node	cb18		Out ie	27.14 ft
	Reach	p18	I.E. Out	27.14 ft
Node	cb17		Out ie	26.95 ft
	Reach	p18	I.E. In	26.95 ft
	Reach	p17	I.E. Out	26.95 ft
Node	cb14		Out ie	26.53 ft
	Reach	p15	I.E. In	26.53 ft
	Reach	p16	I.E. In	26.53 ft
	Reach	p17	I.E. In	26.53 ft
	Reach	p14	I.E. Out	26.53 ft
Node	cb13		Out ie	26.27 ft
	Reach	p19	I.E. In	26.27 ft
	Reach	p14	I.E. In	26.27 ft
	Reach	p13	I.E. Out	26.27 ft
Node	cb11		Out ie	25.98 ft
	Reach	p12	I.E. In	28.00 ft
	Reach	p13	I.E. In	25.98 ft
	Reach	p11	I.E. Out	25.98 ft
Node	cb10		Out ie	25.45 ft
	Reach	p11	I.E. In	25.45 ft
	Reach	p10	I.E. Out	25.45 ft
Node	cb7		Out ie	25.21 ft
	Reach	p8	I.E. In	29.60 ft
	Reach	p10	I.E. In	25.21 ft
	Reach	p7	I.E. Out	25.21 ft
Node	cb6		Out ie	25.03 ft
	Reach	p7	I.E. In	25.03 ft
	Reach	p6	I.E. Out	25.03 ft
Node	cb5		Out ie	24.85 ft

	Reach	p6	I.E. In	24.85 ft
	Reach	p5	I.E. Out	24.85 ft
Node	cb4		Out ie	24.48 ft
	Reach	p5	I.E. In	24.48 ft
	Reach	p4	I.E. Out	24.48 ft
Node	cb3		Out ie	24.13 ft
	Reach	p4	I.E. In	24.13 ft
	Reach	P3	I.E. Out	24.13 ft
Node	cb2		Out ie	23.78 ft
	Reach	P3	I.E. In	23.78 ft
	Reach	P2	I.E. Out	23.78 ft
Node	cb1		Out ie	23.41 ft
	Reach	p26	I.E. In	23.41 ft
	Reach	P2	I.E. In	23.41 ft
	Reach	p1	I.E. Out	23.41 ft
Node	pond		Out ie	23.00 ft
	Reach	p1	I.E. In	23.00 ft
	Reach	ppond	I.E. Out	27.10 ft
Node	cb25		Out ie	27.00 ft
	Reach	ppond	I.E. In	27.00 ft
	Reach	p25	I.E. Out	27.00 ft
Node	cb24		Out ie	26.12 ft
	Reach	proofA	I.E. In	26.12 ft
	Reach	p25	I.E. In	26.12 ft
	Reach	p24	I.E. Out	26.12 ft

Appended on: Monday, January 04, 2016 2:31:38 PM

Layout Report: 15985site

Event	Precip (in)
6 month	1.12
2 yr 24 hr	1.75
10 year	2.60
25 year	3.05
100 year	3.63

Reach Records

Record Id: p1

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	pond	**UpNode**	cb1
Material	Closed Conduits, Concrete Pipe	**Size**	24 in Diam
Ent Losses	Groove End w/Headwall		
Length	81.00 ft	**Slope**	0.51%
Up Invert	23.41 ft	**Dn Invert**	23.00 ft

Conduit Constraints				
Min Vel	**Max Vel**	**Min Slope**	**Max Slope**	**Min Cover**
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p10

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb7	**UpNode**	cb10
Material	unspecified	**Size**	18 in Diam
Ent Losses	Groove End w/Headwall		
Length	96.00 ft	**Slope**	0.25%
Up Invert	25.45 ft	**Dn Invert**	25.21 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p11

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb10	**UpNode**	cb11
Material	unspecified	**Size**	15 in Diam
Ent Losses	Groove End w/Headwall		
Length	213.00 ft	**Slope**	0.25%
Up Invert	25.98 ft	**Dn Invert**	25.45 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p12

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb11	**UpNode**	cb12
Material	Closed Conduits, Concrete Pipe	**Size**	12 in Diam
Ent Losses	Groove End w/Headwall		
Length	38.00 ft	**Slope**	4.84%
Up Invert	29.84 ft	**Dn Invert**	28.00 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p13

Section Shape:	Circular		

Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb11	**UpNode**	cb13
Material	Closed Conduits, Concrete Pipe	**Size**	12 in Diam
Ent Losses	Groove End w/Headwall		
Length	35.00 ft	**Slope**	0.83%
Up Invert	26.27 ft	**Dn Invert**	25.98 ft

Conduit Constraints				
Min Vel	**Max Vel**	**Min Slope**	**Max Slope**	**Min Cover**
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p14

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb13	**UpNode**	cb14
Material	Closed Conduits, Concrete Pipe	**Size**	12 in Diam
Ent Losses	Groove End w/Headwall		
Length	103.00 ft	**Slope**	0.25%
Up Invert	26.53 ft	**Dn Invert**	26.27 ft

Conduit Constraints				
Min Vel	**Max Vel**	**Min Slope**	**Max Slope**	**Min Cover**
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p15

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb14	**UpNode**	cb15
Material	Closed Conduits, Concrete Pipe	**Size**	12 in Diam
Ent Losses	Groove End w/Headwall		
Length	76.00 ft	**Slope**	0.62%
Up Invert	27.00 ft	**Dn Invert**	26.53 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p16

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb14	**UpNode**	cb16
Material	Closed Conduits, Concrete Pipe	**Size**	12 in Diam
Ent Losses	Groove End w/Headwall		
Length	81.00 ft	**Slope**	0.58%
Up Invert	27.00 ft	**Dn Invert**	26.53 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p17

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb14	**UpNode**	cb17
Material	Closed Conduits, Concrete Pipe	**Size**	12 in Diam
Ent Losses	Groove End w/Headwall		
Length	168.00 ft	**Slope**	0.25%
Up Invert	26.95 ft	**Dn Invert**	26.53 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p18

Section Shape:	Circular		

Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb17	**UpNode**	cb18
Material	Closed Conduits, Concrete Pipe	**Size**	12 in Diam
Ent Losses	Groove End w/Headwall		
Length	76.00 ft	**Slope**	0.25%
Up Invert	27.14 ft	**Dn Invert**	26.95 ft

Conduit Constraints				
Min Vel	**Max Vel**	**Min Slope**	**Max Slope**	**Min Cover**
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p19

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb13	**UpNode**	cb19
Material	Closed Conduits, Concrete Pipe	**Size**	12 in Diam
Ent Losses	Groove End w/Headwall		
Length	270.00 ft	**Slope**	0.50%
Up Invert	27.61 ft	**Dn Invert**	26.27 ft

Conduit Constraints				
Min Vel	**Max Vel**	**Min Slope**	**Max Slope**	**Min Cover**
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: P2

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb1	**UpNode**	cb2
Material	Closed Conduits, Concrete Pipe	**Size**	18 in Diam
Ent Losses	Groove End w/Headwall		
Length	147.00 ft	**Slope**	0.25%
Up Invert	23.78 ft	**Dn Invert**	23.41 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p24

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	outfall	**UpNode**	cb24
Material	Closed Conduits, Concrete Pipe	**Size**	24 in Diam
Ent Losses	Groove End w/Headwall		
Length	30.00 ft	**Slope**	0.40%
Up Invert	26.12 ft	**Dn Invert**	26.00 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p25

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb24	**UpNode**	cb25
Material	Closed Conduits, Concrete Pipe	**Size**	24 in Diam
Ent Losses	Groove End w/Headwall		
Length	222.00 ft	**Slope**	0.40%
Up Invert	27.00 ft	**Dn Invert**	26.12 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p26

Section Shape:	Circular		

Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb1	**UpNode**	cb26
Material	Closed Conduits, Concrete Pipe	**Size**	12 in Diam
Ent Losses	Groove End w/Headwall		
Length	140.00 ft	**Slope**	2.21%
Up Invert	26.50 ft	**Dn Invert**	23.41 ft

Conduit Constraints				
Min Vel	**Max Vel**	**Min Slope**	**Max Slope**	**Min Cover**
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: P3

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb2	**UpNode**	cb3
Material	Closed Conduits, Concrete Pipe	**Size**	18 in Diam
Ent Losses	Groove End w/Headwall		
Length	140.00 ft	**Slope**	0.25%
Up Invert	24.13 ft	**Dn Invert**	23.78 ft

Conduit Constraints				
Min Vel	**Max Vel**	**Min Slope**	**Max Slope**	**Min Cover**
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p4

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb3	**UpNode**	cb4
Material	Closed Conduits, Concrete Pipe	**Size**	18 in Diam
Ent Losses	Groove End w/Headwall		
Length	140.00 ft	**Slope**	0.25%
Up Invert	24.48 ft	**Dn Invert**	24.13 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p5

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb4	**UpNode**	cb5
Material	Closed Conduits, Concrete Pipe	**Size**	18 in Diam
Ent Losses	Groove End w/Headwall		
Length	146.00 ft	**Slope**	0.25%
Up Invert	24.85 ft	**Dn Invert**	24.48 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p6

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb5	**UpNode**	cb6
Material	Closed Conduits, Concrete Pipe	**Size**	18 in Diam
Ent Losses	Groove End w/Headwall		
Length	74.00 ft	**Slope**	0.24%
Up Invert	25.03 ft	**Dn Invert**	24.85 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p7

Section Shape:	Circular		

Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb6	**UpNode**	cb7
Material	Closed Conduits, Concrete Pipe	**Size**	18 in Diam
Ent Losses	Groove End w/Headwall		
Length	74.00 ft	**Slope**	0.24%
Up Invert	25.21 ft	**Dn Invert**	25.03 ft

Conduit Constraints				
Min Vel	**Max Vel**	**Min Slope**	**Max Slope**	**Min Cover**
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p8

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb7	**UpNode**	cb8
Material	Closed Conduits, Concrete Pipe	**Size**	12 in Diam
Ent Losses	Groove End w/Headwall		
Length	30.00 ft	**Slope**	1.00%
Up Invert	29.90 ft	**Dn Invert**	29.60 ft

Conduit Constraints				
Min Vel	**Max Vel**	**Min Slope**	**Max Slope**	**Min Cover**
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p9

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb8	**UpNode**	cb9
Material	Closed Conduits, Concrete Pipe	**Size**	12 in Diam
Ent Losses	Groove End w/Headwall		
Length	55.00 ft	**Slope**	1.00%
Up Invert	30.45 ft	**Dn Invert**	29.90 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: ppond

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb25	**UpNode**	pond
Material	unspecified	**Size**	24 in Diam
Ent Losses	Groove End w/Headwall		
Length	52.00 ft	**Slope**	0.19%
Up Invert	27.10 ft	**Dn Invert**	27.00 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: proofA

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb24	**UpNode**	roofA
Material	Closed Conduits, Concrete Pipe	**Size**	18 in Diam
Ent Losses	Groove End w/Headwall		
Length	56.00 ft	**Slope**	0.25%
Up Invert	26.26 ft	**Dn Invert**	26.12 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Node Records

Record Id: cb1

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	23.41 ft	Max El.	30.00 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb10

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	25.45 ft	Max El.	32.50 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb11

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	25.98 ft	Max El.	31.00 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 1
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	3.97 sf
MH/CB Type Node			

Record Id: cb12

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	29.84 ft	Max El.	32.03 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 1
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	3.97 sf
MH/CB Type Node			

Record Id: cb13

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	26.27 ft	Max El.	31.50 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb14

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	26.53 ft	Max El.	32.00 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb15

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	27.00 ft	Max El.	29.90 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 1
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	3.97 sf
MH/CB Type Node			

Record Id: cb16

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	27.00 ft	Max El.	29.90 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 1
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	3.97 sf
MH/CB Type Node			

Record Id: cb17

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	26.95 ft	Max El.	32.00 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb18

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	27.14 ft	Max El.	29.90 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 1
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	3.97 sf
MH/CB Type Node			

Record Id: cb19

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	27.61 ft	Max El.	31.50 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 1
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	3.97 sf
MH/CB Type Node			

Record Id: cb2

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	23.78 ft	Max El.	32.38 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb24

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	26.12 ft	Max El.	30.40 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-60
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	19.634 sf
MH/CB Type Node			

Record Id: cb25

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	27.00 ft	Max El.	31.50 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb26

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	26.50 ft	Max El.	30.00 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 1
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	3.97 sf
MH/CB Type Node			

Record Id: cb3

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	24.13 ft	Max El.	32.49 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb4

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	24.48 ft	Max El.	32.47 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb5

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	24.85 ft	Max El.	31.88 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb6

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	25.03 ft	Max El.	33.50 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb7

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	25.21 ft	Max El.	33.00 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb8

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	29.90 ft	Max El.	33.50 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 1
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	3.97 sf
MH/CB Type Node			

Record Id: cb9

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	30.45 ft	Max El.	35.06 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 1
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	3.97 sf
MH/CB Type Node			

Record Id: outfall

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	26.00 ft	Max El.	30.00 ft
Void Ratio	100.00		
Dummy Type Node			

Record Id: pond

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	23.00 ft	Max El.	29.00 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-96
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	50.265 sf
MH/CB Type Node			

Record Id: roofA

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	26.26 ft	Max El.	33.00 ft

Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 1
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	3.97 sf
MH/CB Type Node			

Contributing Drainage Areas

Record Id: cb1

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.05 ac	**DCIA**	0.26 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Open spaces, lawns,parks (>75% grass)	0.05 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.26 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb10

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00

Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.15 ac	**DCIA**	0.40 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.15 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.40 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb11

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.10 ac	**DCIA**	0.30 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.10 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min

Pervious TC	5.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.30 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb12

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.10 ac	**DCIA**	0.74 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.10 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.74 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb15

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.02 ac	**DCIA**	0.39 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Open spaces, lawns,parks (>75% grass)	0.02 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.39 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb16

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.02 ac	**DCIA**	0.39 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Open spaces, lawns,parks (>75% grass)	0.02 ac	86.00

Pervious Composited CN (AMC 2)	86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.39 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb18

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.02 ac	**DCIA**	0.48 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.02 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.48 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb19

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.10 ac	**DCIA**	0.31 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Open spaces, lawns,parks (>75% grass)	0.10 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.31 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb2

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.02 ac	**DCIA**	0.08 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.02 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.08 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb26

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.03 ac	**DCIA**	0.24 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.03 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**

Impervious surfaces (pavements, roofs, etc)	0.24 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb3

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.04 ac	**DCIA**	0.16 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Open spaces, lawns,parks (>75% grass)	0.04 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.16 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb4

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00

Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.04 ac	**DCIA**	0.16 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.04 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.16 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb5

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.05 ac	**DCIA**	0.21 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.05 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min

Pervious TC	5.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.21 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb7

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.03 ac	**DCIA**	0.28 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.03 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.28 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb8

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.01 ac	**DCIA**	0.02 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Open spaces, lawns,parks (>75% grass)	0.01 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.02 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Record Id: cb9

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.05 ac	**DCIA**	0.42 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	5.00 min	**DC TC**	5.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Open spaces, lawns,parks (>75% grass)	0.05 ac	86.00

Pervious Composited CN (AMC 2)	86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.42 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

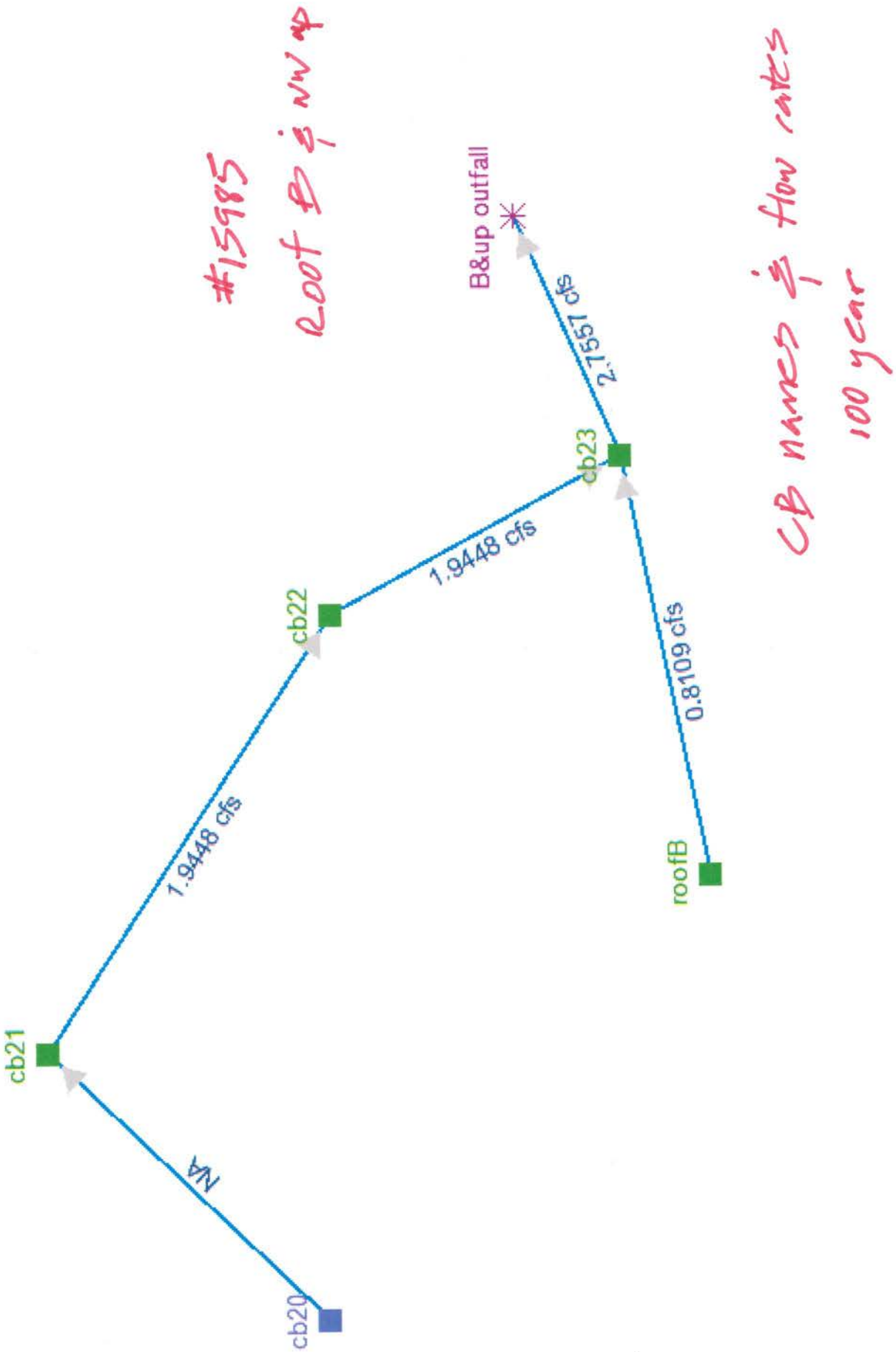
Record Id: roofA

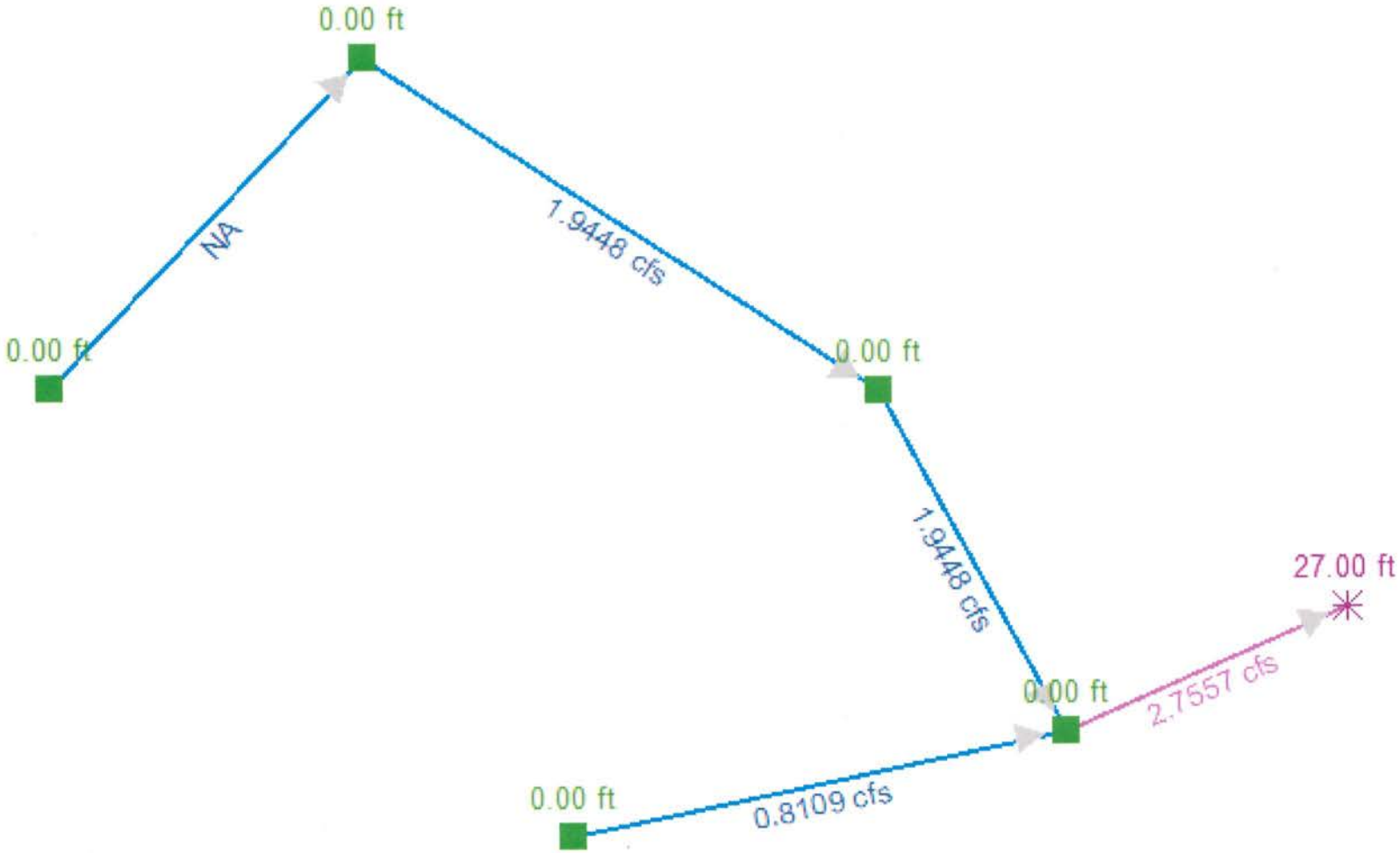
Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.00 ac	**DCIA**	3.60 ac
Pervious CN	0.00	**DC CN**	98.00
Pervious TC	0.00 min	**DC TC**	5.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	3.60 ac	98.00
DC Composited CN (AMC 2)		98.00

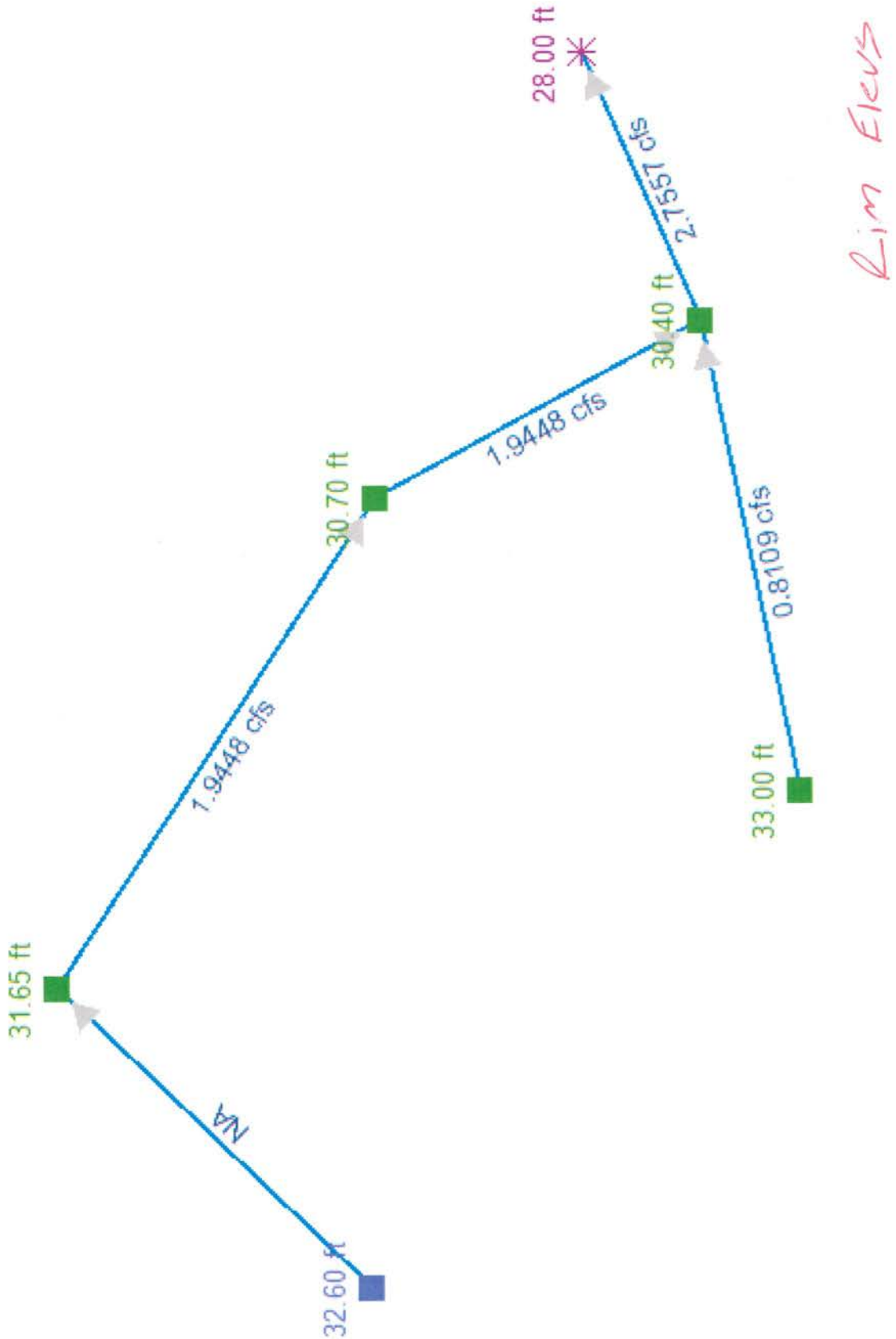
DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

CONVEYANCE CALCULATIONS FOR THE ROOF AND BYPASS SYSTEM

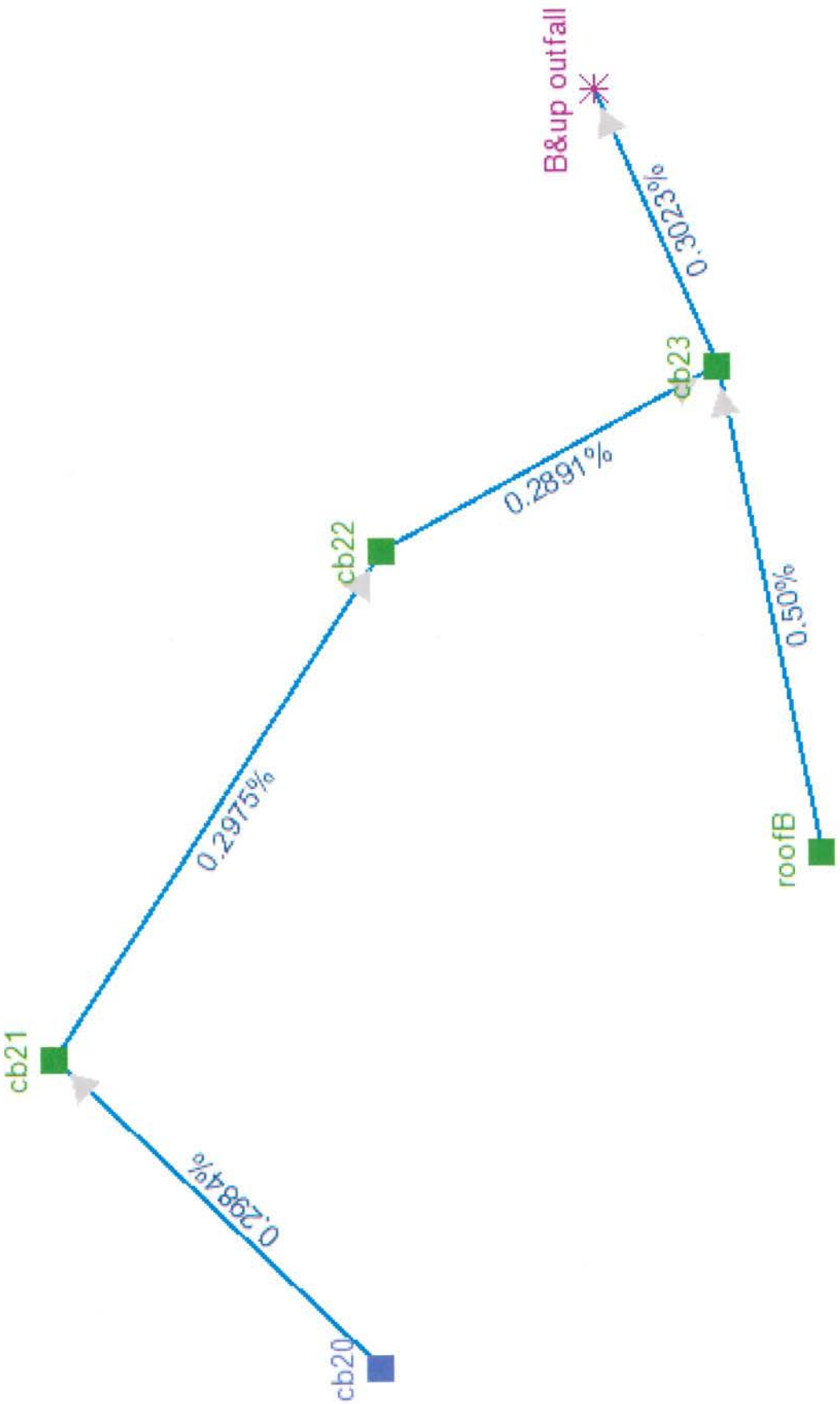

#15985
Roof B is NW of
B&up outfall
2.7557 cfs
cb23
1.9448 cfs
cb22
0.8109 cfs
roofB
1.9448 cfs
cb21
NA
cb20
CB names is flow rates
100 year



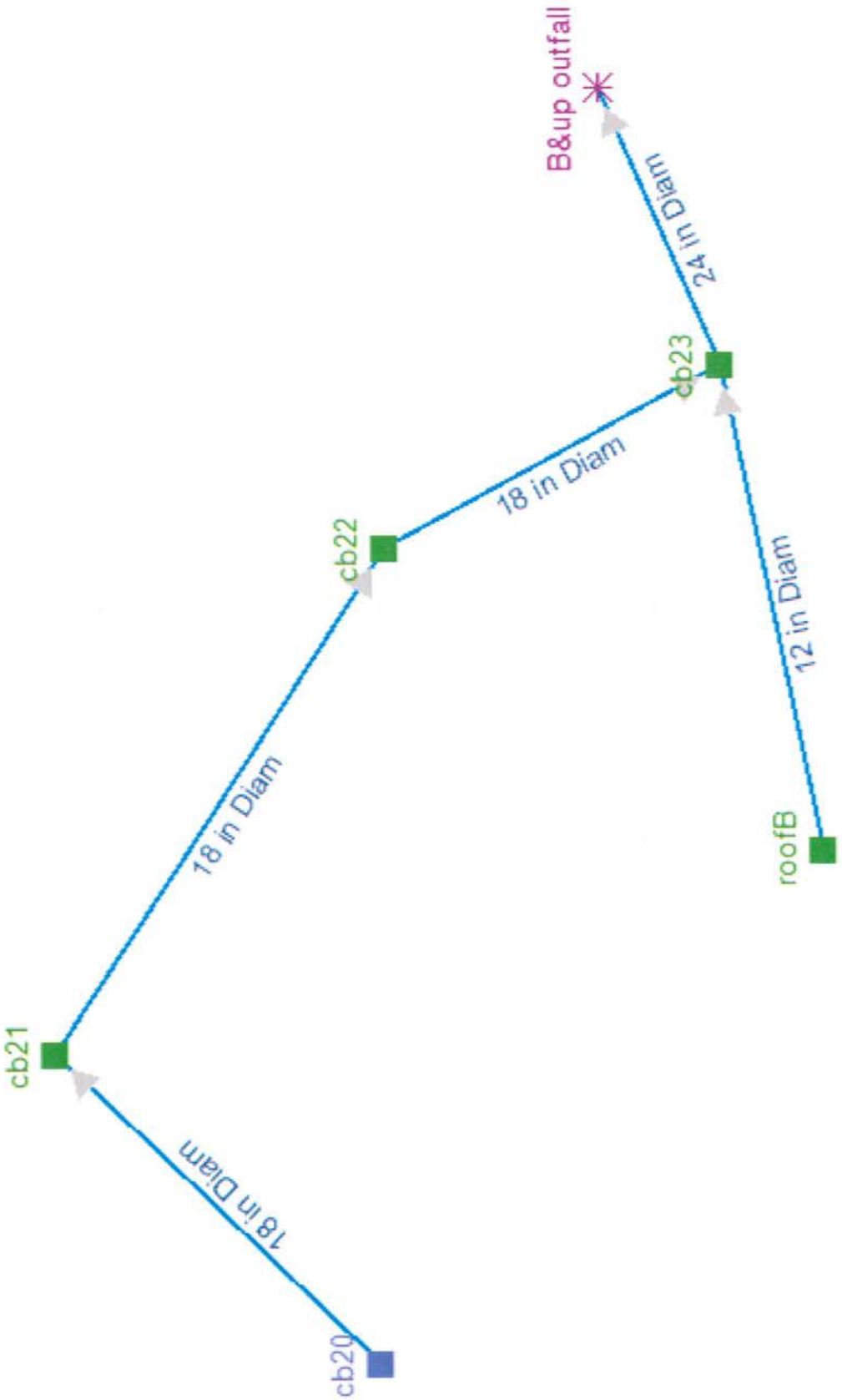
100 YR BACKWATER
& Peak flow rates


32.60 ft
NA
31.65 ft
1.9448 cfs
30.70 ft
1.9448 cfs
30.40 ft
2.7557 cfs
28.00 ft
0.8109 cfs
33.00 ft

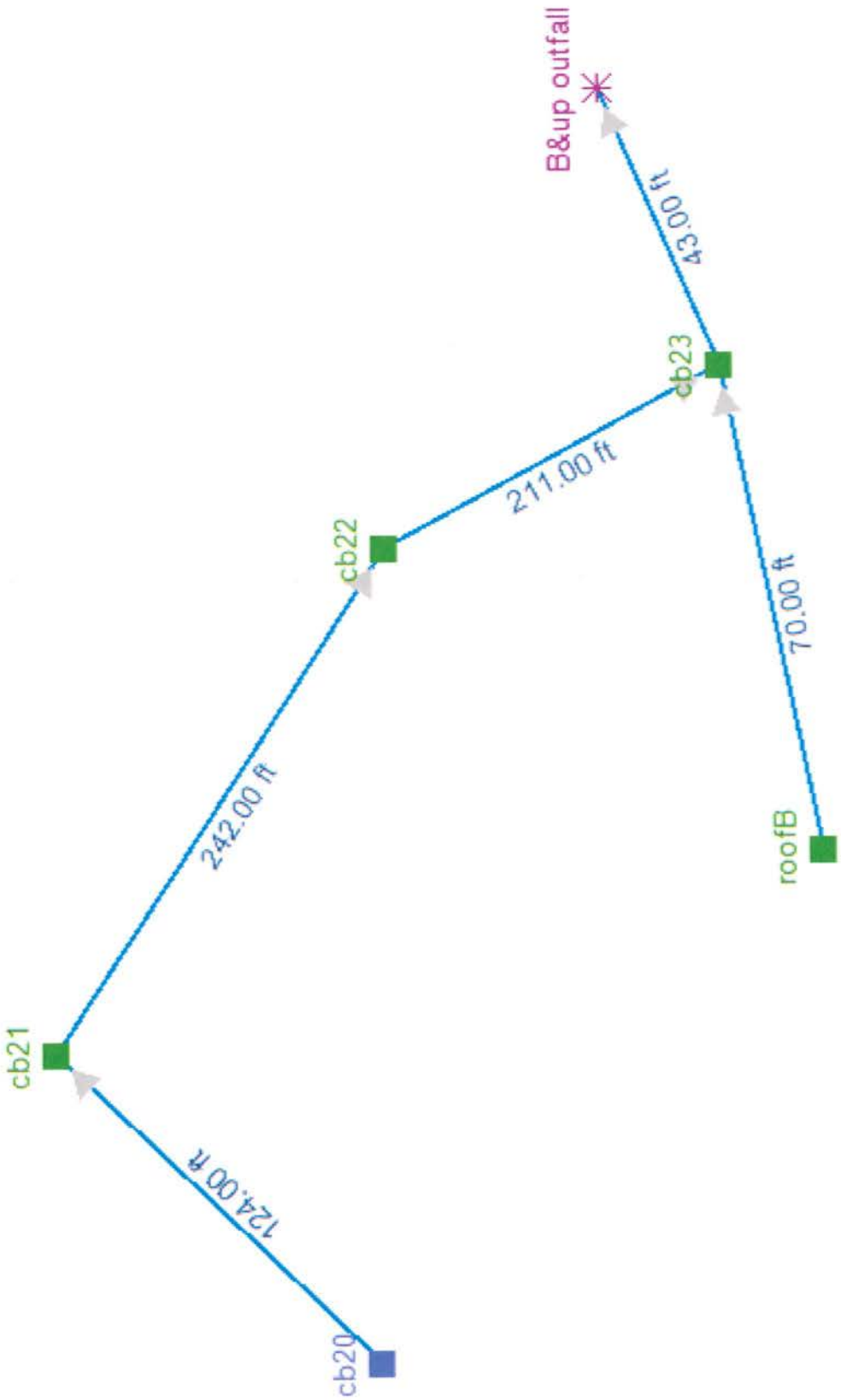
Lim Elevs


cb20
0.2984%
cb21
0.2975%
cb22
0.2891%
cb23
0.3023%
B&up outfall
0.50%
roofB

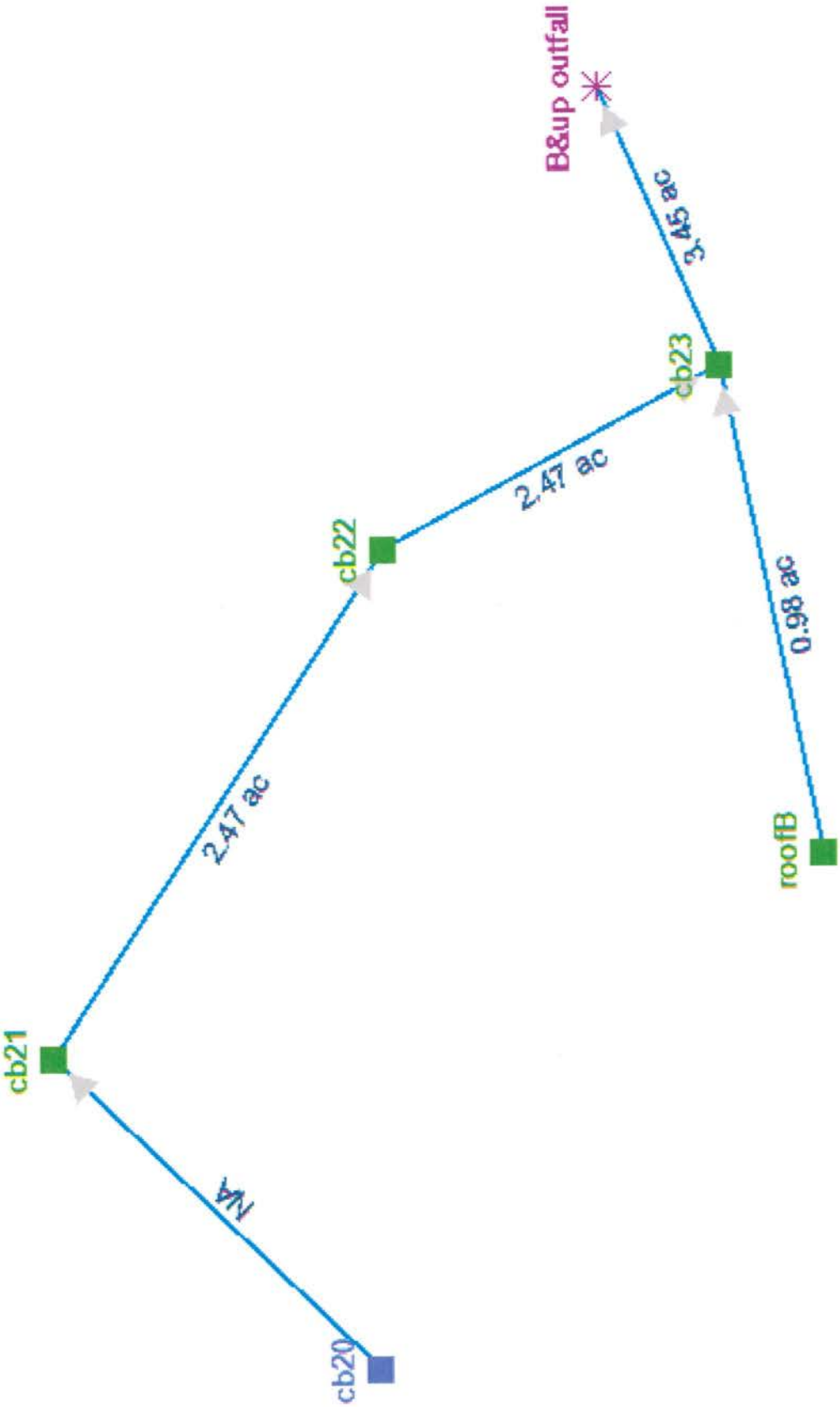
Pipe Slopes



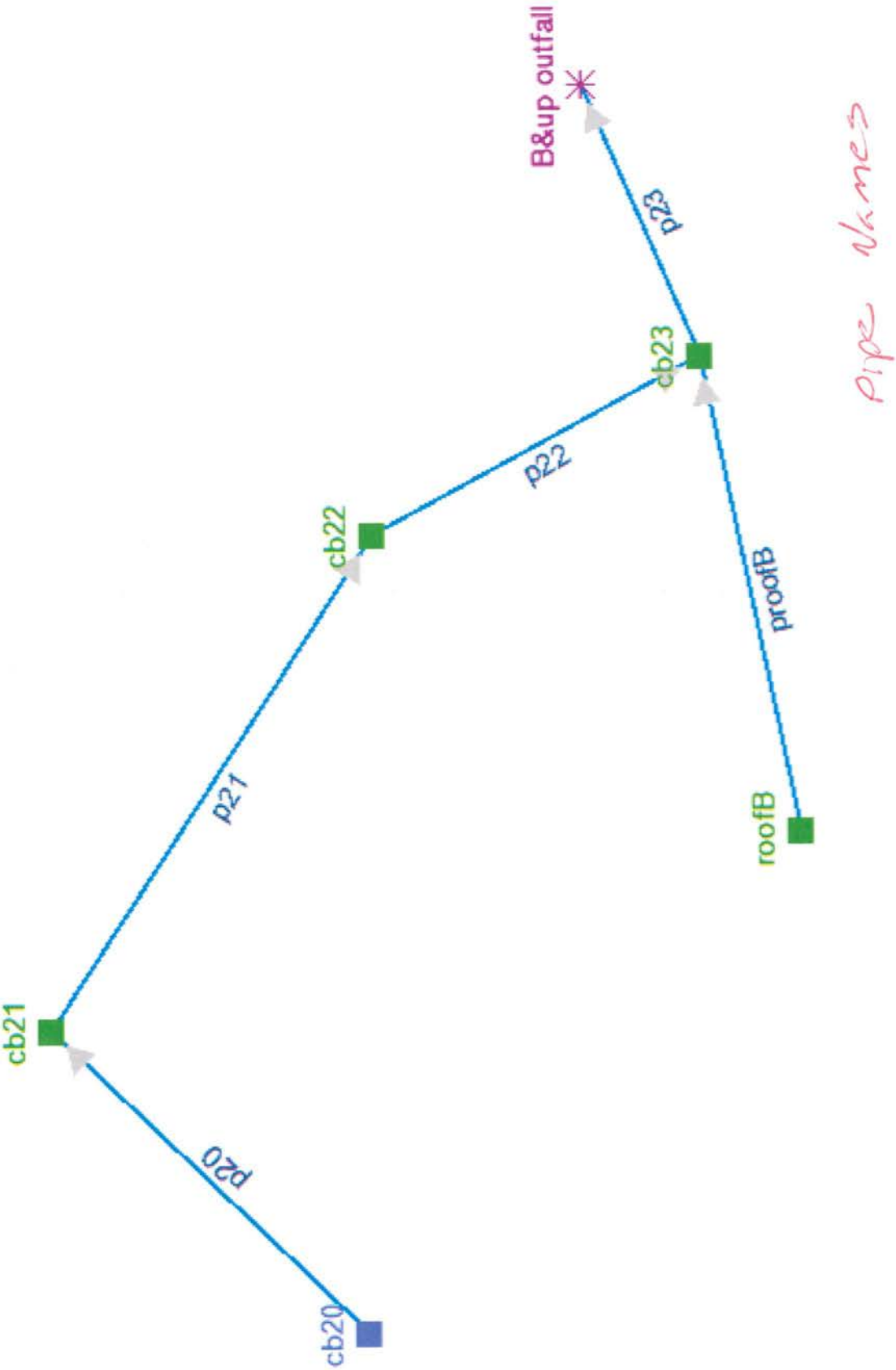
Pipe Diameters



Pipe Lengths



Cumulative Contributing Areas



pipe names

Appended on: Tuesday, January 05, 2016 10:00:14 AM

ROUTEHYD [] THRU [15985roofBand up] USING [100 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
p20	2.47	1.9448	5.7535	0.338	0.6011	0.4007	18 in Diam	2.9393	3.2558	0.00	nwup
p21	2.47	1.9448	5.7449	0.3385	0.6015	0.401	18 in Diam	2.9362	3.2509	0.00	
p22	2.47	1.9448	5.6632	0.3434	0.6061	0.4041	18 in Diam	2.9067	3.2047	0.00	
proofB	0.98	0.8109	2.5261	0.321	0.387	0.387	12 in Diam	2.8891	3.2163	0.00	roofB
p23	3.45	2.7557	12.4717	0.221	0.6393	0.3197	24 in Diam	3.1841	3.9699	0.00	

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							27.00
cb23	B&up outfall	27.2025	0.1312	0.1579	0.0379	27.2672	30.4000
cb22	cb23	27.5579	0.1339	0.0246	------	27.4487	30.7000
cb21	cb22	28.2222	0.1342	0.1411	------	28.2291	31.6500
cb20	cb21	28.5982	------	------	------	28.5982	32.6000
roofB	cb23	27.3231	------	------	------	27.3231	33.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
p23	1.0725	0.5363	2.76	1.0000	0.5788	0.6393	Outlet Control M1 Backwater

Subcritical, M-1 Profile

Subcritical flow starts at downstream end and progresses upstream until normal depth is reached.

y ft	A sf	R	V ft	Eft	dEft	Sf ft	Savg ft	So-Sf ft	dx ft	Station ft	Elev ft
1.00	1.5708	0.50	1.7543	1.047789	0.00	0.00059	0.00	0.00	0.00	43.00	27.00
0.9856	1.5419	0.4954	1.7871	1.035168	0.012621	0.00062	0.000605	0.002418	5.220453	37.7795	27.0014
0.9711	1.5131	0.4906	1.8212	1.02265	0.012517	0.000652	0.000636	0.002387	5.244868	32.5347	27.0028
0.9567	1.4843	0.4858	1.8566	1.010244	0.012406	0.000687	0.00067	0.002353	5.271806	27.2629	27.0043
0.9423	1.4554	0.481	1.8933	0.997958	0.012286	0.000724	0.000706	0.002317	5.301636	21.9612	27.0059
0.9279	1.4267	0.476	1.9316	0.985801	0.012157	0.000764	0.000744	0.002279	5.334799	16.6264	27.0076
0.9134	1.3979	0.4709	1.9713	0.973783	0.012018	0.000807	0.000786	0.002237	5.371829	11.2546	27.0094

0.899	1.3692	0.4658	2.0127	0.961915	0.011868	0.000854	0.000831	0.002192	5.413378	5.8412	27.0114
0.8846	1.3405	0.4606	2.0557	0.95021	0.011706	0.000904	0.000879	0.002144	5.460246	0.381	27.0134
0.8702	1.3119	0.4553	2.1006	0.938679	0.01153	0.000959	0.000932	0.002091	5.513432	-5.1324	27.0157

The depth of flow at the **upper** end of the reach is **0.8836 ft**.
Flow has returned to normal. The flow depth returned to normal 0.00 ft from the downstream lower end of reach.

p22	0.8179	0.5453	1.94	1.1372	0.5256	0.6061	Outlet Control M1 Backwater

Subcritical, M-1 Profile

Subcritical flow starts at downstream end and progresses upstream until normal depth is reached.

y ft	A sf	R	V ft	Eft	dEft	Sf ft	Savg ft	So-Sf ft	dx ft	Station ft	Elev ft
1.1372	1.4374	0.4535	1.353	1.165598	0.00	0.0004	0.00	0.00	0.00	211.00	27.2672
1.1159	1.4098	0.4518	1.3794	1.145477	0.020121	0.000418	0.000409	0.002482	8.106524	202.8935	27.2694
1.0947	1.3818	0.4497	1.4074	1.125446	0.020031	0.000438	0.000428	0.002463	8.131835	194.7616	27.2716
1.0734	1.3533	0.4474	1.4371	1.105514	0.019932	0.00046	0.000449	0.002442	8.160935	186.6007	27.274
1.0522	1.3243	0.4447	1.4685	1.085689	0.019825	0.000484	0.000472	0.002419	8.194279	178.4064	27.2764
1.031	1.2949	0.4416	1.5018	1.065981	0.019707	0.000511	0.000497	0.002394	8.23243	170.174	27.279
1.0097	1.2652	0.4383	1.5371	1.046403	0.019578	0.00054	0.000525	0.002366	8.276084	161.8979	27.2817
0.9885	1.2352	0.4347	1.5745	1.026967	0.019436	0.000573	0.000557	0.002334	8.326101	153.5718	27.2845
0.9672	1.2048	0.4308	1.6142	1.007689	0.019279	0.00061	0.000591	0.0023	8.383556	145.1883	27.2875
0.946	1.1742	0.4265	1.6563	0.988584	0.019105	0.00065	0.00063	0.002261	8.449798	136.7385	27.2907
0.9247	1.1433	0.422	1.701	0.969673	0.018911	0.000696	0.000673	0.002218	8.526543	128.2119	27.2941
0.9035	1.1122	0.4173	1.7486	0.950977	0.018696	0.000746	0.000721	0.00217	8.615994	119.5959	27.2977
0.8823	1.0809	0.4122	1.7992	0.932522	0.018455	0.000803	0.000775	0.002116	8.721029	110.8749	27.3017
0.861	1.0495	0.4069	1.8531	0.914336	0.018186	0.000867	0.000835	0.002056	8.845464	102.0294	27.306
0.8398	1.0179	0.4014	1.9105	0.896452	0.017884	0.000939	0.000903	0.001988	8.994468	93.035	27.3108
0.8185	0.9862	0.3955	1.9719	0.87891	0.017542	0.00102	0.000979	0.001912	9.17521	83.8598	27.3161
0.7973	0.9545	0.3894	2.0375	0.861753	0.017157	0.001111	0.001065	0.001826	9.39791	74.4618	27.322
0.776	0.9226	0.3831	2.1078	0.845034	0.016719	0.001216	0.001163	0.001728	9.677649	64.7842	27.3288
0.7548	0.8908	0.3765	2.1832	0.828814	0.01622	0.001335	0.001275	0.001616	10.037617	54.7466	27.3365
0.7336	0.8589	0.3697	2.2642	0.813164	0.01565	0.001471	0.001403	0.001488	10.515387	44.2312	27.3457
0.7123	0.8271	0.3626	2.3514	0.798169	0.014995	0.001628	0.001549	0.001342	11.17606	33.0551	27.3568
0.6911	0.7953	0.3553	2.4454	0.783929	0.01424	0.001809	0.001718	0.001173	12.143044	20.9121	27.3706
0.6698	0.7635	0.3478	2.547	0.770563	0.013366	0.002019	0.001914	0.000977	13.682033	7.2301	27.3889
0.6486	0.7319	0.34	2.6571	0.758214	0.012349	0.002265	0.002142	0.000749	16.488777	-9.2587	27.4154

The depth of flow at the **upper** end of the reach is **0.6605 ft**.
Flow has returned to normal. The flow depth returned to normal 0.00 ft from the downstream lower end of reach.

p21	0.7622	0.5081	1.94	0.7087	0.5256	0.6015	Outlet Control M1 Backwater

Subcritical, M-1 Profile

Subcritical flow starts at downstream end and progresses upstream until normal depth is reached.

y ft	A sf	R	V ft	Eft	dEft	Sf ft	Savg ft	So-Sf ft	dx ft	Station ft	Elev ft
0.7087	0.8217	0.3614	2.3668	0.795706	0.00	0.001656	0.00	0.00	0.00	242.00	27.4488
0.7044	0.8153	0.3599	2.3854	0.792793	0.002912	0.001692	0.001674	0.001301	2.238637	239.7614	27.4511
0.7001	0.8089	0.3585	2.4043	0.789914	0.00288	0.001728	0.00171	0.001265	2.276486	237.4849	27.4536
0.6959	0.8024	0.357	2.4236	0.787067	0.002846	0.001766	0.001747	0.001228	2.317785	235.1671	27.4562
0.6916	0.796	0.3555	2.4431	0.784255	0.002812	0.001804	0.001785	0.00119	2.363017	232.8041	27.459
0.6873	0.7896	0.354	2.4629	0.781479	0.002777	0.001844	0.001824	0.001151	2.412758	230.3913	27.4619
0.683	0.7832	0.3525	2.4831	0.778738	0.00274	0.001885	0.001865	0.00111	2.467703	227.9236	27.4649
0.6787	0.7768	0.351	2.5035	0.776036	0.002702	0.001927	0.001906	0.001069	2.528698	225.3949	27.4682
0.6744	0.7704	0.3494	2.5243	0.773372	0.002664	0.001971	0.001949	0.001026	2.596781	222.7981	27.4716
0.6701	0.764	0.3479	2.5455	0.770749	0.002624	0.002016	0.001994	0.000981	2.673243	220.1249	27.4753
0.6658	0.7576	0.3463	2.567	0.768166	0.002582	0.002062	0.002039	0.000936	2.759707	217.3652	27.4792
0.6616	0.7512	0.3448	2.5888	0.765626	0.00254	0.00211	0.002086	0.000889	2.858245	214.5069	27.4834
0.6573	0.7448	0.3432	2.611	0.76313	0.002496	0.00216	0.002135	0.00084	2.971541	211.5354	27.488
0.653	0.7385	0.3416	2.6335	0.76068	0.002451	0.002211	0.002185	0.00079	3.103139	208.4323	27.4929
0.6487	0.7321	0.34	2.6565	0.758276	0.002404	0.002263	0.002237	0.000738	3.257814	205.1744	27.4983
0.6444	0.7257	0.3384	2.6798	0.75592	0.002356	0.002318	0.002291	0.000684	3.442161	201.7323	27.5043
0.6401	0.7193	0.3368	2.7035	0.753615	0.002306	0.002374	0.002346	0.000629	3.665551	198.0667	27.5109
0.6358	0.713	0.3352	2.7276	0.751361	0.002254	0.002432	0.002403	0.000572	3.941759	194.125	27.5183
0.6315	0.7066	0.3336	2.7521	0.74916	0.002201	0.002492	0.002462	0.000513	4.291907	189.8331	27.5268
0.6273	0.7003	0.332	2.7771	0.747014	0.002146	0.002554	0.002523	0.000452	4.750105	185.083	27.5366
0.623	0.6939	0.3303	2.8024	0.744925	0.002089	0.002618	0.002586	0.000389	5.37525	179.7077	27.5483
0.6187	0.6876	0.3287	2.8283	0.742895	0.00203	0.002685	0.002652	0.000323	6.278542	173.4292	27.5627
0.6144	0.6813	0.327	2.8545	0.740926	0.001969	0.002754	0.002719	0.000256	7.698111	165.7311	27.5813
0.6101	0.675	0.3253	2.8813	0.73902	0.001906	0.002825	0.002789	0.000186	10.252433	155.4786	27.6076
0.6058	0.6686	0.3236	2.9085	0.737179	0.001841	0.002898	0.002861	0.000114	16.204496	139.2741	27.6515
0.6015	0.6623	0.3219	2.9362	0.735405	0.001774	0.002974	0.002936	0.000039	45.765409	93.5087	27.7833

The depth of flow at the **upper** end of the reach is **0.6015 ft**.
Flow has returned to normal. The flow depth returned to normal 148.4913 ft from the downstream lower end of reach.

p20	0.7682	0.5121	1.94	0.7691	0.5256	0.6011	Outlet Control M1 Backwater

Subcritical, M-1 Profile

Subcritical flow starts at downstream end and progresses upstream until normal depth is reached.

y ft	A sf	R	V ft	Eft	dEft	Sf ft	Savg ft	So-Sf ft	dx ft	Station ft	Elev ft
0.7691	0.9122	0.381	2.1318	0.839688	0.00	0.001253	0.00	0.00	0.00	124.00	28.2291
0.7624	0.9022	0.3789	2.1556	0.834552	0.005136	0.00129	0.001271	0.001713	2.999223	121.0008	28.2313
0.7557	0.8921	0.3768	2.18	0.82947	0.005082	0.001329	0.00131	0.001674	3.035498	117.9653	28.2337
0.749	0.882	0.3747	2.2049	0.824444	0.005025	0.00137	0.00135	0.001634	3.075172	114.8901	28.2361
0.7422	0.8719	0.3725	2.2304	0.819478	0.004966	0.001413	0.001392	0.001592	3.118722	111.7714	28.2387

0.7355	0.8618	0.3703	2.2565	0.814574	0.004904	0.001458	0.001435	0.001549	3.166719	108.6047	28.2414
0.7288	0.8518	0.3681	2.2832	0.809734	0.00484	0.001504	0.001481	0.001503	3.219854	105.3848	28.2443
0.7221	0.8417	0.3659	2.3106	0.804962	0.004772	0.001553	0.001529	0.001455	3.278963	102.1058	28.2474
0.7153	0.8316	0.3636	2.3386	0.80026	0.004702	0.001604	0.001578	0.001406	3.345076	98.7608	28.2506
0.7086	0.8215	0.3614	2.3672	0.795632	0.004628	0.001657	0.001631	0.001353	3.419472	95.3413	28.2541
0.7019	0.8115	0.3591	2.3966	0.791082	0.00455	0.001713	0.001685	0.001299	3.503761	91.8375	28.2579
0.6952	0.8014	0.3567	2.4267	0.786613	0.004469	0.001772	0.001743	0.001241	3.599998	88.2375	28.2619
0.6884	0.7914	0.3544	2.4575	0.782228	0.004384	0.001833	0.001802	0.001182	3.710844	84.5267	28.2662
0.6817	0.7813	0.352	2.4891	0.777933	0.004295	0.001898	0.001865	0.001119	3.839815	80.6869	28.271
0.675	0.7713	0.3496	2.5215	0.773731	0.004202	0.001965	0.001931	0.001053	3.991649	76.6952	28.2761
0.6683	0.7612	0.3472	2.5547	0.769627	0.004104	0.002036	0.002	0.000984	4.17289	72.5223	28.2819
0.6616	0.7512	0.3448	2.5888	0.765625	0.004001	0.00211	0.002073	0.000911	4.392835	68.1295	28.2883
0.6548	0.7412	0.3423	2.6237	0.761732	0.003893	0.002189	0.002149	0.000835	4.665157	63.4644	28.2955
0.6481	0.7312	0.3398	2.6596	0.757952	0.00378	0.002271	0.00223	0.000754	5.010823	58.4535	28.3037
0.6414	0.7212	0.3373	2.6964	0.754292	0.00366	0.002357	0.002314	0.00067	5.463697	52.9898	28.3133
0.6347	0.7113	0.3348	2.7342	0.750757	0.003535	0.002448	0.002403	0.000581	6.082268	46.9076	28.3247
0.6279	0.7013	0.3322	2.773	0.747354	0.003403	0.002544	0.002496	0.000488	6.976996	39.9306	28.3388
0.6212	0.6914	0.3296	2.8129	0.74409	0.003264	0.002645	0.002595	0.000389	8.384531	31.546	28.3571
0.6145	0.6814	0.327	2.8539	0.740973	0.003117	0.002752	0.002699	0.000285	10.919932	20.6261	28.383
0.6078	0.6715	0.3244	2.896	0.738011	0.002962	0.002864	0.002808	0.000176	16.836763	3.7893	28.4265
0.6011	0.6616	0.3218	2.9393	0.735212	0.002799	0.002983	0.002924	0.00006	46.362401	-42.5731	28.5581

The depth of flow at the **upper** end of the reach is **0.6072 ft**.
Flow has returned to normal. The flow depth returned to normal 0.00 ft from the downstream lower end of reach.

proofB	1.1931	1.1931	0.81	1.1372	0.3767	0.3870	Outlet Control

Node and Reach invert report

Node and Reach invert report				
Node	cb20		Out ie	27.83 ft
	Reach	p20	I.E. Out	27.83 ft
Node	cb21		Out ie	27.46 ft
	Reach	p20	I.E. In	27.46 ft
	Reach	p21	I.E. Out	27.46 ft
Node	cb22		Out ie	26.74 ft
	Reach	p21	I.E. In	26.74 ft
	Reach	p22	I.E. Out	26.74 ft
Node	roofB		Out ie	26.48 ft
	Reach	proofB	I.E. Out	26.48 ft
Node	cb23		Out ie	26.13 ft
	Reach	p22	I.E. In	26.13 ft
	Reach	proofB	I.E. In	26.13 ft
	Reach	p23	I.E. Out	26.13 ft

Licensed to: Barghausen Consulting Engineers

Appended on: Tuesday, January 05, 2016 10:01:43 AM

Layout Report: 15985roofBand up

Event	Precip (in)
6 month	1.12
2 yr 24 hr	1.75
10 year	2.60
25 year	3.05
100 year	3.63

Reach Records

Record Id: p20

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb21	**UpNode**	cb20
Material	Closed Conduits, Concrete Pipe	**Size**	18 in Diam
Ent Losses	Groove End w/Headwall		
Length	124.00 ft	**Slope**	0.30%
Up Invert	27.83 ft	**Dn Invert**	27.46 ft

Conduit Constraints				
Min Vel	**Max Vel**	**Min Slope**	**Max Slope**	**Min Cover**
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p21

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb22	**UpNode**	cb21
Material	Closed Conduits, Concrete Pipe	**Size**	18 in Diam
Ent Losses	Groove End w/Headwall		
Length	242.00 ft	**Slope**	0.30%
Up Invert	27.46 ft	**Dn Invert**	26.74 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p22

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb23	**UpNode**	cb22
Material	Closed Conduits, Concrete Pipe	**Size**	18 in Diam
Ent Losses	Groove End w/Headwall		
Length	211.00 ft	**Slope**	0.29%
Up Invert	26.74 ft	**Dn Invert**	26.13 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: p23

Section Shape:	Circular		
Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	B&up outfall	**UpNode**	cb23
Material	Closed Conduits, Concrete Pipe	**Size**	24 in Diam
Ent Losses	Groove End w/Headwall		
Length	43.00 ft	**Slope**	0.30%
Up Invert	26.13 ft	**Dn Invert**	26.00 ft

Conduit Constraints				
Min Vel	Max Vel	Min Slope	Max Slope	Min Cover
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Record Id: proofB

Section Shape:	Circular		

Uniform Flow Method:	Manning's	**Coefficient:**	0.013
Routing Method:	Travel Time Shift	**Contributing Hyd**	
DnNode	cb23	**UpNode**	roofB
Material	Closed Conduits, Concrete Pipe	**Size**	12 in Diam
Ent Losses	Groove End w/Headwall		
Length	70.00 ft	**Slope**	0.50%
Up Invert	26.48 ft	**Dn Invert**	26.13 ft

Conduit Constraints				
Min Vel	**Max Vel**	**Min Slope**	**Max Slope**	**Min Cover**
2.00 ft/s	15.00 ft/s	0.50%	2.00%	3.00 ft

Drop across MH	0.00 ft	**Ex/Infil Rate**	0.00 in/hr

Node Records

Record Id: B&up outfall

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	26.00 ft	Max El.	28.00 ft
Void Ratio	100.00		
Dummy Type Node			

Record Id: cb20

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	27.83 ft	Max El.	32.60 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb21

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	27.46 ft	Max El.	31.65 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf

MH/CB Type Node

Record Id: cb22

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	26.74 ft	Max El.	30.70 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: cb23

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	26.13 ft	Max El.	30.40 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 2-48
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	12.5664 sf
MH/CB Type Node			

Record Id: roofB

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	26.48 ft	Max El.	33.00 ft
Void Ratio	100.00		
Condition	Existing	Structure Type	CB-TYPE 1
		Channelization	No Special Shape
Catch	0.00 ft	Bottom Area	3.97 sf
MH/CB Type Node			

Contributing Drainage Areas

Record Id: nwup

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.00 ac	**DCIA**	2.47 ac

Pervious CN	0.00	**DC CN**	98.00
Pervious TC	0.00 min	**DC TC**	10.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	2.47 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	10.0	0.00 in	10.00 min
Pervious TC						10.00 min

Record Id: roofB

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.00 ac	**DCIA**	0.98 ac
Pervious CN	0.00	**DC CN**	98.00
Pervious TC	0.00 min	**DC TC**	5.00 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.98 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	5.0	0.00 in	5.00 min
Pervious TC						5.00 min

Tab 6.0

6.0 SPECIAL REPORTS AND STUDIES

GEOTECHNICAL REPORT

BD Real Estate Distribution Building
15900 Woodinville-Redmond Road
Woodinville, Washington

Project No. T-6636-1

Terra Associates, Inc.

Prepared for:

BD Real Estate, LLC
Woodinville, Washington

November 15, 2012

TERRA ASSOCIATES, Inc.
Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

November 15, 2012
Project No. T-6636-1

Mr. Jay Deutsch
BD Real Estate, LLC
15525 Woodinville-Redmond Road NE
Woodinville, Washington 98072

Subject: Geotechnical Report
BD Real Estate Distribution Building
15900 Woodinville-Redmond Road
Woodinville, Washington

Dear Mr. Deutsch:

As requested, we have conducted a geotechnical engineering study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

Our field exploration indicates the site is generally underlain by 5 to 12 inches of asphalt concrete overlying 2 to 5 ½ feet of granular fill material followed by alluvial sediments. In the central and western site area, the initial alluvium consists of a three- to six-foot layer of soft to stiff silt. Below the silt and the granular fill in the eastern area of the site, loose to medium dense layers of sand and silty sand were observed to the boring completion depths. We observed groundwater at depths ranging from 7 ½ feet to 11 feet below current site grades.

In our opinion, the upper loose fill and alluvial silt will not be suitable for immediate support of building foundations, floor slabs, or site pavements. To establish suitable support, we recommend all foundations be supported on a minimum of two feet of granular structural fill with floor slabs and pavements supported on a minimum of 18 inches of granular structural fill. Detailed discussion regarding implementing this recommendation along with other geotechnical design and construction considerations are summarized in the attached report.

12525 Willows Road, Suite 101, Kirkland, Washington 98034
Phone (425) 821-7777 • Fax (425) 821-4334

Mr. Jay Deutsch
November 15, 2012

We trust this information is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.

Carolyn S. Decker, P.E.
Project Engineer

11-15-12

Theodore J. Schepper, P.E.
President

cc: Mr. Bob Fadden, Lance Mueller Architects
Mr. Dan Balmelli, Barghausen Consulting Engineers
Len Holm

TABLE OF CONTENTS

Page No.

1.0 Project Description 1
2.0 Scope of Work 1
3.0 Site Conditions 2
3.1 Surface 2
3.2 Soils 2
3.3 Groundwater 3
4.0 Geologic Hazards 3
4.1 Seismic Considerations 3
4.2 Erosion Hazard Area 4
5.0 Discussion and Recommendations 5
5.1 General 5
5.2 Site Preparation and Grading 5
5.3 Excavation 6
5.4 Foundations 7
5.5 Slab-on-grade Construction 7
5.6 Lateral Earth Pressures for Wall Design 8
5.7 Water Quality Pond 8
5.8 Drainage 9
5.9 Utilities 9
5.10 Pavements 10
6.0 Additional Services 11
7.0 Limitations 11

Figures

Vicinity Map ..... Figure 1
Exploration Location Plan ..... Figure 2
Typical Wall Drainage Detail ..... Figure 3

Appendix

Field Exploration and Laboratory Testing ..... Appendix A

Geotechnical Report
BD Real Estate Distribution Building
15900 Woodinville-Redmond Road
Woodinville, Washington

1.0 PROJECT DESCRIPTION

The project will consist of redeveloping the property with an approximately 202,880 square-foot distribution warehouse and office building. We expect the building will be constructed using precast concrete wall panels with interior isolated columns supporting the roof framing. The building floor slab will be constructed at grade with dock high access along the west perimeter and in the southeast corner of the building. There is a proposed water quality pond in the southeast corner of the property. Preliminary grading plans prepared by Barghausen Consulting Engineers dated October 24, 2012 indicate grading to achieve finish floor and roadway grades will include cuts and fills from one to four feet.

The water quality pond in the southeast corner of the site will be formed by a combination of excavation below current site grade and construction of a fill containment berm along the east side of the pond. The excavation required to achieve the pond floor elevation of 22 will extend 8 to 9 feet below current site grades. The fill depth required to achieve the berm crest elevation of 30 will range from one to two feet.

Based on our experience with similar construction, we expected foundation loading on the distribution building will be light to moderate with continuous bearing walls caring 6 to 8 kips per foot and isolated column loadings in the range of 80 to 200 kips. Uniform distribution of loading on the slab-on-grade floors is not expected to exceed 300 pounds per square foot (psf).

The recommendations in the following sections of this report are based on our understanding of the design features outlined above. We should review design drawings as they become available to verify that our recommendations have been properly interpreted and to supplement them, if required.

2.0 SCOPE OF WORK

Our work was completed in accordance with our authorized proposal dated October 13, 2012. Using existing soil information obtained from exploration and laboratory testing completed for a previous planned development on-site, we performed analyses to develop geotechnical recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions
- Seismic site class per 2009 International Building Code (IBC)
- Geologic hazards per the City of Woodinville Municipal Code
- Site preparation and grading
- Structural fill and backfill
- Excavations

- Foundations
- Floor slabs on grade
- Lateral earth pressures for wall design
- Water quality pond
- Drainage
- Utilities
- Pavement

3.0 SITE CONDITIONS

3.1 Surface

The project site consists of 3 tax parcels totaling approximately 13.6 acres of land located at 15900 Woodinville-Redmond Road in Woodinville, Washington. The approximate location of the site is shown on Figure 1.

The property is currently developed as a lumber and related materials sales/service yard and includes several existing buildings and storage areas. Site topography is relatively flat with a gentle slope to the east. Local elevation relief across the building site is on the order of four to five feet. Most of the area outside of the existing buildings is paved with asphalt concrete pavement along with areas of Portland cement concrete pavement adjacent the buildings. The Samnamish River flows north along the east side of the property.

3.2 Soils

Underlying five to ten inches of asphalt concrete soil conditions observed in the upper portion of the test borings varied across the site. In general, at most borings we observed two to five of fill material composed of a mixture of gravel and silty sand with gravel in a loose to medium dense condition. Underlying the fill in the east southeastern site areas medium dense native alluvial sand and silty sand was observed to the termination depth of the test borings. Fill soils were not observed at Test Borings B-1, B-2, B-4, and B-7 to B-9. At these locations and below granular fill soils at Borings B-6, B-11, and B-15 advanced in the central and western site areas, a three- to five-foot thick layer of soft too stiff silt alluvium was observed. Medium dense silty sand alluvial soils followed this upper silt stratum to the boring termination depths.

We reviewed the *Geologic Map of the Kirkland Quadrangle, King County, Washington,* by J.P. Minard (1983). The map classifies the on-site soils as Younger Alluvium (Qyal). This mapped description is consistent with the native soils observed in the test borings.

The preceding discussion is intended as a brief summary of soil conditions observed at the test boring locations. For a more complete description, please refer to the Test Boring Logs attached in Appendix A.

3.3 Groundwater

We observed groundwater in each test boring at depths ranging from 7 ½ to 11 feet below current site grades. These depths correspond to site elevations ranging mostly from Elev. 21 to 22 feet in the central and eastern portions of the site and Elev. 23 to 25 feet to the southwest. The groundwater observed represents a regional groundwater table that is influenced by the Sammamish River flows located just east of the project site. Groundwater levels beneath the site will fluctuate seasonally and with fluctuations in the adjacent river flows. The rise in groundwater levels in response to increase river stages will be relatively rapid as the deeper native alluvium exhibits moderate permeability.

4.0 GEOLOGIC HAZARDS

4.1 Seismic Considerations

Section 21.06.536 of the Woodinville Municipal Code (WMC) defines Seismic Hazard areas as "areas in the City of Woodinville subject to severe risk of earthquake damage as a result of earthquake-induced ground shaking, slope failure, settlement, surface rupture, or soil liquefaction. (Ord. 481 § 6, 2009; Ord. 375 § 2, 2004; Ord. 175 § 1, 1997. Formerly 21.06.535)"

Soil Liquefaction

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in pore water pressure induced by vibrations from a seismic event. Liquefaction mainly affects geologically recent deposits of fine-grained sands that are below the groundwater table. Soils of this nature derive their strength from intergranular friction. The generated water pressure or pore pressure essentially separates the soil grains and eliminates this intergranular friction; thus, eliminating the soil's strength.

We completed a liquefaction analysis using procedures outlined by Seed and Idriss. The analysis was completed using a ground acceleration of .32g, which represents acceleration that could be expected for an earthquake having a 10 percent probability of occurring in 50 years (return period of once per 500 years). The results of the analysis indicate that the alluvial soils with N_{60} values of 17 and less could liquefy under this acceleration. The impact to site buildings and improvements should liquefaction occur will be in the form of surface subsidence or settlement. Estimated total potential settlement from our analysis is two inches or less. Given the variability of the soils, all of this settlement could be differential in nature. In our opinion, this amount of settlement would not structurally impact the buildings but would result in damage of a cosmetic nature.

Based on the results of our analysis and considering historic earthquakes experienced in the Puget Sound area, in our opinion, the liquefaction hazard at the site and the associated risk to buildings and infrastructure would be low.

Based on soil conditions observed in the test borings and our knowledge of the area geology, per Chapter 16 of the 2009 International Building Code (IBC), site class "D" should be used in structural design. Based on this site class, in accordance with the 2009 IBC, the following parameters should be used in computing seismic forces:

Seismic Design Parameters (IBC 2009)

Spectral response acceleration (Short Period), S_{ms}	1.208
Spectral response acceleration (1 – Second Period), S_{m1}	0.640
Five percent damped .2 second period, S_{Ds}	0.806
Five percent damped 1.0 second period, S_{D1}	0.427

Values determined using the United States Geological Survey (USGS) Ground Motion Parameter Calculator accessed on November 11, 2011 at the web site http://earthquake.usgs.gov/research/hazmaps/design/index.php.

4.2 Erosion Hazard Area

Section 21.06.213 of the WMC defines erosion hazard areas as "areas in City of Woodinville underlain by soils, which are subject to severe erosion when disturbed. Such soils include but are not limited to those classified as having a severe to very severe erosion hazard according to the USDA Natural Resource Conservation Service (NRCS), the 1973 King County Soils Survey or any subsequent revisions or addition by or to these sources. These soils include, but are not limited to, any occurrence of river wash (Rh) and the following when they occur on slopes 15 percent or steeper:

1. The Alderwood gravely sandy loam (AgD)
2. The Alderwood and Kitsap soils (AkF)
3. The Beausite gravely sandy loam (BeD and BeF)
4. The Kitsap silt loam (KpD)
5. The Ovall gravely loam (OvD and OvF)
6. The Ragnar fine sandy loam (RaD)
7. The Ragnar-Indianola Association (RdE). (Ord. 375 § 2, 2004; Ord. 175 § 1, 1997)"

The soils encountered on-site are classified as Earlmont silt loam by the United States Department of Agriculture Natural Resources Conservation Service. With the existing slope gradients, these soils will have a slight potential for erosion when exposed. Therefore, the site is not an erosion hazard as defined by the WMC. Regardless, erosion protection measures as required by the City of Woodinville will need to be in place prior to starting grading activities on the site. This would include perimeter silt fencing to contain erosion on-site and cover measures to prevent or reduce soil erosion during and following construction.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 General

Based on our study, in our opinion, development of the site as proposed is feasible from a geotechnical engineering standpoint. The primary geotechnical concern at the site is the presence of loose to medium dense granular fill soils and soft to stiff silt alluvium in the upper four to six feet of the soil profile. These soils will not be suitable for direct support of building foundations, slab-on-grade floors, or pavements. To establish suitable support we recommend all foundations bear on a minimum of two feet of structural fill replacing the existing fill or silt soils. Floor slabs and pavements should be supported on a minimum of 18 inches of new structural fill. The exception to this recommendation occurs in the vicinity of Test Boring B-8. Here, the soft silt alluvium observed to a depth of 3 ½ feet should be completely removed below the foundations, floor slabs, and pavements.

The soils observed at the site contain a significant amount of fines and will be difficult to compact as structural fill when too wet or dry. The native silt alluvium would not be suitable for use as structural fill or backfill, in our opinion. The ability to use native granular soils from site excavations as structural fill will depend on its moisture content and the prevailing weather conditions at the time of construction. If grading activities will take place during winter, the owner should be prepared to import clean granular material for use as structural fill and backfill. Alternatively, stabilizing the moisture in the native soil with cement kiln dust (CKD), cement, or lime can be considered.

Detailed recommendations regarding these issues and other geotechnical design considerations are provided in the following sections. These recommendations should be incorporated into the final design drawings and construction specifications.

5.2 Site Preparation and Grading

To prepare the site for construction, all vegetation, organic surface soils, asphalt, and other deleterious material should be stripped and removed from the site. Demolition of existing structures should include removal of existing foundations, floor slabs, and other buried utilities. Abandoned utility pipes that fall outside of new building areas can be left in place provided they are sealed to prevent intrusion of groundwater seepage and soil. Given current site conditions, we expect minimal stripping will be required to remove the vegetation. Based on the test borings asphalt pavement removal will range from 2 to up to 12 inches. We would note, however that conversations with on-site personal during our exploration indicated that there may be areas where the asphalt pavement thickness could approach 36 inches.

As discussed earlier the existing surface fill and near-surface alluvial silt would not be suitable for immediate support of spread footing foundations, slab-on-grade floors, or site pavements. In establishing building subgrade elevations grading should be completed that results in a minimum of 24 inches of granular structural fill below foundations and 18 inches of granular structural fill below floor slabs and site pavements. The granular structural fill should extend a minimum distance of 12 inches from the outside edge of all spread footings.

Where fill material is needed to establish building grade, prior to placing the fill, existing fill observed at the test borings should be overexcavated a minimum depth of two feet below current site grades and replaced in a structural manner. Existing soft silt alluvium observed to a depth of 3 ½ feet at Test Boring B-8 should be excavated and completely removed from below building elements.

A representative of Terra Associates, Inc. should observe all overexcavation and replacement areas to determine the lateral extent of the removal and to verify the soils below the overexcavation are as expected and suitable for support of new construction. Our representative may request a proofroll using heavy rubber-tired equipment to determine if any isolated soft and yielding areas are present. If excessively yielding areas are observed, and they cannot be stabilized in place by compaction, the affected soils should be excavated and removed to firm bearing and grade restored with new structural fill. If the depth of excavation to remove unstable soils is excessive, the use of geotextile fabrics, such as Mirafi 500X, or an equivalent fabric, can be used in conjunction with clean granular structural fill. Our experience has shown that, in general, a minimum of 18 inches of a clean, granular structural fill placed and compacted over the geotextile fabric should establish a stable bearing surface.

The upper silt alluvium will be very difficult to work with and generally is not considered suitable for use as structural fill or utility trench backfill. The ability to use native granular soils from site excavations as structural fill will depend on its moisture content and the prevailing weather conditions at the time of construction. If wet soils are encountered, the contractor will need to dry the soils by aeration during dry weather conditions. If grading activities are planned during the wet winter months, or if they are initiated during the summer and extend into fall and winter, the owner should be prepared to import wet weather structural fill. For this purpose, we recommend importing a granular soil that meets the following grading requirements:

U.S. Sieve Size	Percent Passing
6 inches	100
No. 4	75 maximum
No. 200	5 maximum*

* Based on the 3/4-inch fraction.

Prior to use, Terra Associates, Inc. should examine and test all materials imported to the site for use as structural fill.

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-698 (Standard Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this ASTM standard. In nonstructural areas, the degree of compaction can be reduced to 90 percent.

5.3 Excavation

All excavations at the site associated with confined spaces, such as utility trenches, must be completed in accordance with local, state, or federal requirements. Based on current Occupational Safety and Health Administration (OSHA) regulations, the native and existing fill soils would be classified as Type C soils. Temporary excavation side slopes in Type C soils can be laid back at a minimum slope inclination of 1.5:1 (Horizontal:Vertical). If there is insufficient room to complete the excavations in this manner, using temporary shoring to support the excavations may need to be considered. A properly designed and installed shoring trench box can be used to support utility trench excavation sidewalls.

Based on conditions we observed, groundwater will be encountered within excavations extending depths of eight to ten feet below existing surface grades. For excavation depths that extend two feet below the groundwater table, dewatering using conventional sump pumps along with collector trenches should be capable of maintaining a relatively dry excavation and would not be expected to impact the stability of the excavation when completed, as described above. For deeper excavations, dewatering by well point or deep pumped wells will be required to maintain a dry and stable excavation. The dewatering system should be designed and implemented by an experienced dewatering well contractor.

This information is provided solely for the benefit of the owner and other design consultants, and should not be construed to imply that Terra Associates, Inc. assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

5.4 Foundations

Spread Footings

In our opinion, the building may be supported on conventional spread footing foundations bearing on a minimum of two feet of structural fill, as recommended in Section 5.2 of this report. Foundations exposed to the weather should bear at a minimum depth of 1.5 feet below adjacent grades for frost protection. Interior foundations can be supported at any convenient depth below the floor slab, provided immediate support is obtained on a minimum of two feet of structural fill.

We recommend designing foundations for a net allowable bearing capacity of 3,000 psf. For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used. Total and differential settlements should not exceed one-inch and one-half inch, respectively. The predicted settlements would be immediate in nature occurring as building loads are applied.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressures acting on the sides of the footings can also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 300 pcf. We do not recommend including the upper 12 inches of soil in this computation because it can be affected by weather or disturbed by future grading activity. This value assumes the foundation will be backfilled with structural fill, as described in Section 5.2 of this report. The values recommended include a safety factor of 1.5.

5.5 Slab-on-Grade Construction

Slab-on-grade floors may be supported on subgrades prepared as recommended in Section 5.2 of this report. Immediately below the floor slabs, we recommend placing a four-inch thick capillary break layer of clean, free-draining, coarse sand or fine gravel that has less than three percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slabs.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer and then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction, and aid in uniform curing of the concrete slab. It should be noted that if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will be ineffective in assisting uniform curing of the slab, and can actually serve as a water supply for moisture transmission through the slab and affecting floor coverings. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided if floor slab construction occurs during the wet winter months and the layer cannot be effectively drained. We recommend floor designers and contractors refer to the 2003 American Concrete Institute (ACI) Manual of Concrete Practice, Part 2, 302.1R-96, for further information regarding vapor barrier installation below slab-on-grade floors.

We recommend the floors be designed using a subgrade modulus (k_s) of 200 pounds per cubic inch (pci).

5.6 Lateral Earth Pressures for Wall Design

The magnitude of earth pressure development on below-grade walls will partly depend on the quality of the wall backfill. We recommend placing and compacting wall backfill as structural fill as described in Section 5.2 of this report. To guard against hydrostatic pressure development, wall drainage must also be installed. A typical recommended wall drainage detail is shown on Figure 3.

With wall backfill placed and compacted as recommended and drainage properly installed, we recommend designing unrestrained walls for an active earth pressure equivalent to a fluid weighing 35 pcf. For restrained walls, an additional uniform lateral pressure of 100 psf should be included. For evaluation of below-grade walls under seismic loading, an additional uniform lateral pressure equivalent to 8H psf, where H is the height of the below-grade portion of the wall in feet, can be used.

These values assume a horizontal backfill condition and that no other surcharge loading such as traffic, sloping embankments, or adjacent buildings will act on the wall. If such conditions will exist, then the imposed loading must be included in the wall design. Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. Values for these parameters can be found in the preceding foundation section of this report.

5.7 Water Quality Pond

As mentioned above, a water quality pond is planned for the southeast corner of the site. The proposed pond floor is between eight and nine feet below existing site grades and is formed by a combination of excavation and fill containment berm construction. The fill depth for the berm construction is between one and two feet. Our field exploration indicates that the soils at the base of the proposed pond consist of medium dense sand. We would note that groundwater was observed at ten feet below current site grades in the vicinity of the proposed pond.

Fill used to form containment berms for the water quality pond should consist of silty sand with gravel placed and compacted as structural fill. If requirements of the King County Surface Water Design Manual apply, the fill in this area must be compacted to a minimum of 95 percent of the soils maximum dry density as determined by ASTM Test Designation D-1557 (Modified Proctor). Interior pond slopes below the stored water level are shown as 3:1 with exterior pond slopes at 2:1.

5.8 Drainage

Surface

Final exterior grades should promote free and positive drainage away from the site at all times. Water must not be allowed to pond or collect adjacent to foundations or within the immediate building areas. We recommend providing a gradient of at least three percent for a minimum distance of ten feet from the building perimeters. If this gradient cannot be provided, surface water should be collected adjacent to the structures and disposed to appropriate storm facilities.

Subsurface

We recommend installing perimeter foundation drains adjacent to shallow foundations where paved surfaces do not extend to building perimeter and positive drainage away from the structure is not provided. The drains can be laid to grade at an invert elevation equivalent to the bottom of footing grade. The drains can consist of four-inch diameter perforated PVC pipe that is enveloped in washed ¾-inch gravel sized drainage aggregate. The aggregate should extend six inches above and to the sides of the pipe. Roof and foundation drains should be tightlined separately to the storm drains. All drains should be provided with cleanouts at easily accessible locations.

5.9 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA), or City of Woodinville specifications. As a minimum, trench backfill should be placed and compacted as structural fill, as described in Section 5.2 of this report. The native alluvial soils will likely be excavated in a wet condition and would not be suitable for use as trench backfill unless dried back to a moisture content that will facilitate proper compaction. If utility construction takes place during the wet winter months, it will likely be necessary to import suitable wet weather fill for utility trench backfilling.

Excavations into the native soils below the groundwater table may expose soils that will be unstable and would not provide suitable support for the utility pipes when backfilled. When unstable soils are exposed, the utility contractor should be prepared to overexcavate and remove the soils and replace them with crushed rock or bedding aggregate to establish a stable pipe foundation.

5.10 Pavements

Pavement subgrade should be prepared as described in the Section 5.2 of this report. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. The subgrade should be proofrolled with heavy rubber-tired construction equipment such as a loaded 10-yard dump truck to verify this condition.

The pavement design section is dependent upon the supporting capability of the subgrade soils and the traffic conditions to which it will be subjected. We used the American Association of State Highway Transportation Officials (AASHTO) design methodology to determine the required pavement section. For design considerations, we have assumed traffic in parking and in car/light truck access pavement areas can be represented by an 18-kip Equivalent Single Axle Loading (ESAL) of 50,000 over a 20-year design life. For heavy traffic pavement areas, we have assumed an ESAL of 500,000 would be representative of the expected loading. These ESALs represent loading approximately equivalent to 3 and 29, loaded (80,000 pound GVW) tractor-trailer rigs traversing the pavement daily in each area, respectively.

The supporting capability of the pavement subgrade is represented in the AASHTO procedure by the resilient modulus (M_r). We performed California Bearing Ratio (CBR) tests on a representative sample of the near-surface materials that would serve as subgrade support for the pavement structure. The results of these tests are summarized in tabular form in Appendix A. Based on the results of this testing, we assigned the subgrade a M_r value of 20,000 psi.

Based on our analysis, we recommend the following pavement sections:

Light Traffic and Parking:

- Two inches of hot mix asphalt (HMA) over five inches of crushed rock base (CRB)
- Two inches of HMA over three inches of asphalt-treated base (ATB)

Heavy Traffic:

- Three inches of HMA over seven inches of CRB
- Three inches of HMA over four inches of ATB

AASHTO pavement design calculations are attached in Appendix B.

The paving materials used should conform to the Washington State Department of Transportation (WSDOT) specifications for ½-inch class HMA, ATB, and CRB.

Long-term pavement performance will depend on surface drainage. A poorly-drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability. For optimum pavement performance, we recommend surface drainage gradients of at least two percent. Some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

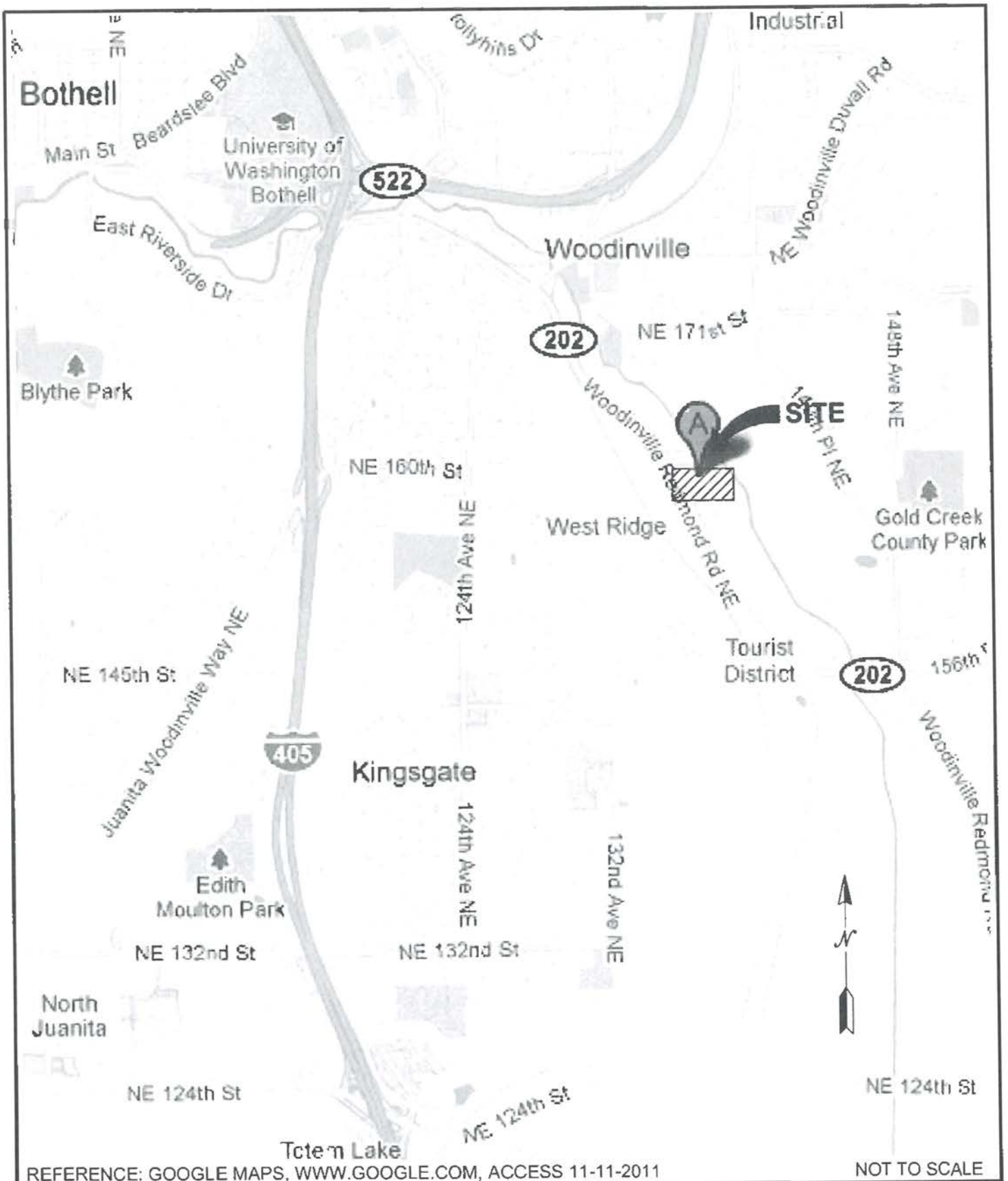
6.0 ADDITIONAL SERVICES

Terra Associates, Inc. should review the final design drawings and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and implemented in project design. We should also provide geotechnical services during construction to observe compliance with our design concepts, specifications, and recommendations. This will allow for design changes if subsurface conditions differ from those anticipated prior to the start of construction.

7.0 LIMITATIONS

We prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. This report is the copyrighted property of Terra Associates, Inc. and is intended for specific application to the BD Real Estate Distribution Building project in Woodinville, Washington. This report is for the exclusive use of BD Real Estate, LLC and their authorized representatives.

The analyses and recommendations presented in this report are based on data obtained from the test borings drilled on the site. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates, Inc. should be requested to reevaluate the recommendations in this report prior to proceeding with construction.



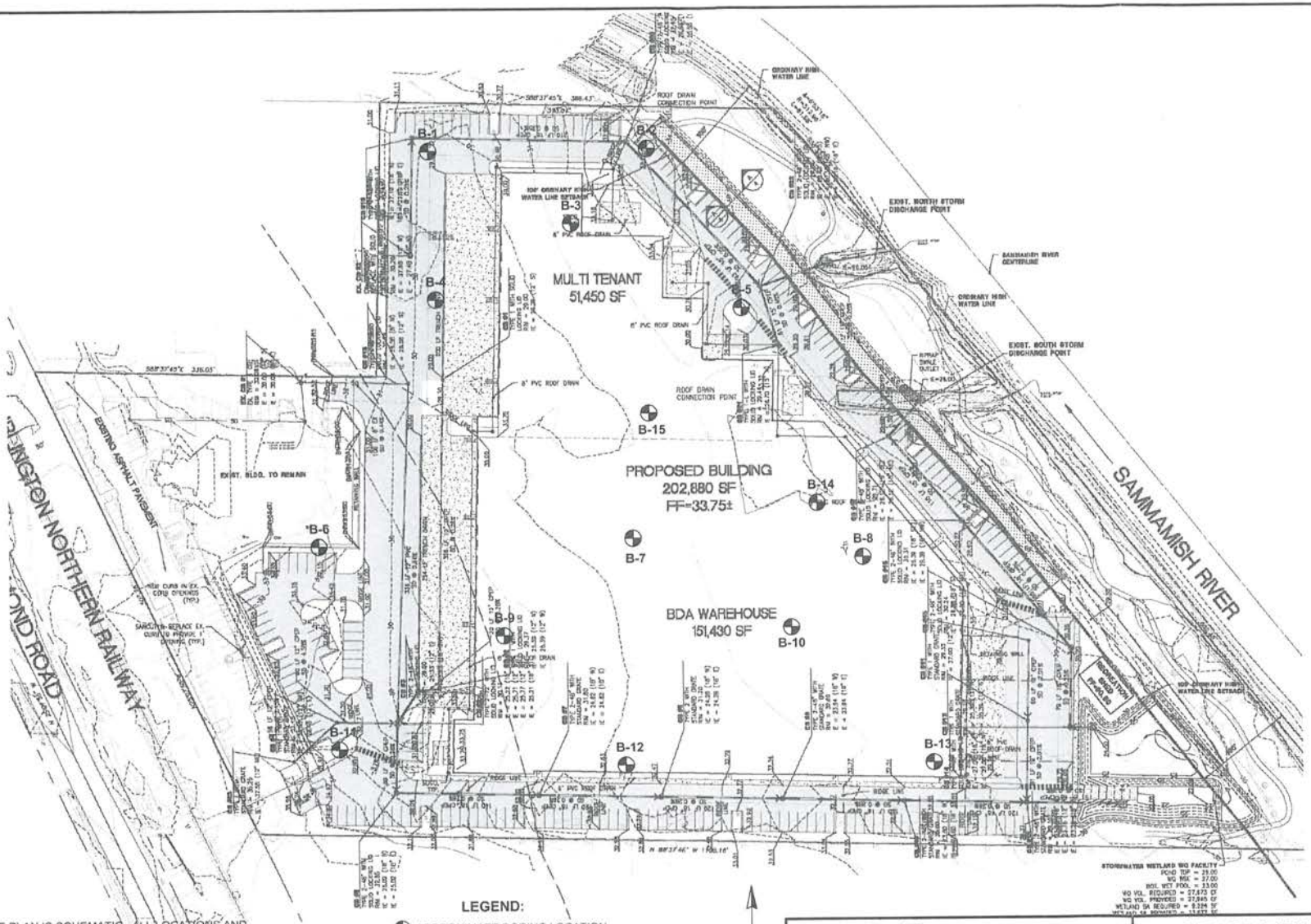
REFERENCE: GOOGLE MAPS, WWW.GOOGLE.COM, ACCESS 11-11-2011

NOT TO SCALE

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

VICINITY MAP
BD REAL ESTATE DISTRIBUTION BUILDING
WOODINVILLE, WASHINGTON

Proj. No.T-6636-1	Date NOV 2012	Figure 1



NOTE:

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

REFERENCE:

SITE PLAN PROVIDED BY BARHAUSEN CONSULTING ENGINEERS

LEGEND:

APPROXIMATE BORING LOCATION

0 100 200

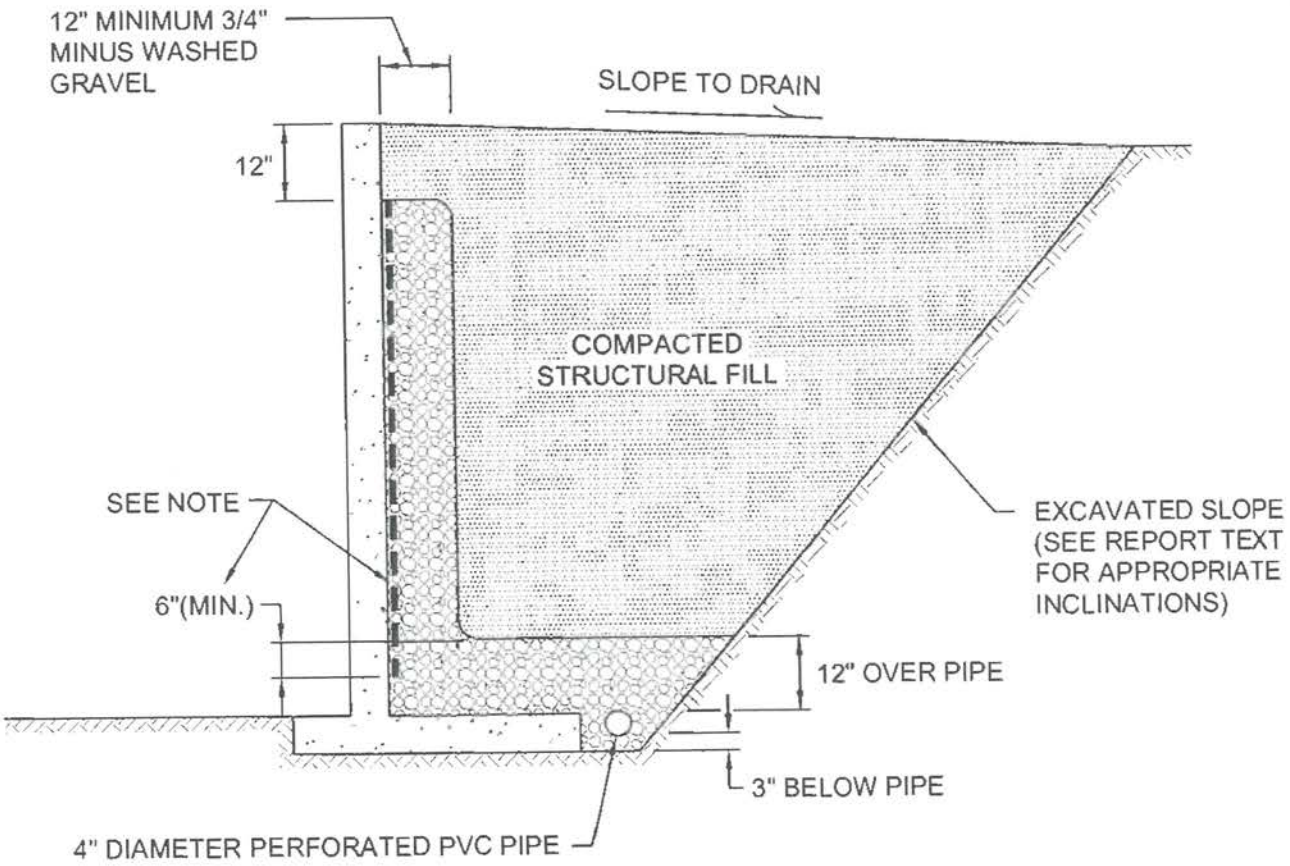
APPROXIMATE SCALE IN FEET

Terra Associates, Inc.

Consultants in Geotechnical Engineering Geology and Environmental Earth Sciences

EXPLORATION LOCATION PLAN
BD REAL ESTATE DISTRIBUTION BUILDING
WOODINVILLE, WASHINGTON

Proj. No.T-6636-1	Date NOV 2012	Figure 2



NOT TO SCALE

NOTE:

MIRADRAIN G100N PREFABRICATED DRAINAGE PANELS OR SIMILAR PRODUCT CAN BE SUBSTITUTED FOR THE 12-INCH WIDE GRAVEL DRAIN BEHIND WALL. DRAINAGE PANELS SHOULD EXTEND A MINIMUM OF SIX INCHES INTO 12-INCH THICK DRAINAGE GRAVEL LAYER OVER PERFORATED DRAIN PIPE.

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

TYPICAL WALL DRAINAGE DETAIL
BD REAL ESTATE DISTRIBUTION BUILDING
WOODINVILLE, WASHINGTON

Proj. No.T-6636-1	Date NOV 2012	Figure 3

APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

Distribution Facility
Woodinville, Washington

On October 27 and October 28, 2011, we observed the drilling of 15 soil test borings to a maximum depth of 41.5 feet below the existing site grades. The boring locations were determined in the field by measurements from existing site features. The approximate location of the test borings are shown on the attached Exploration Location Plan, Figure 2. Test Boring Logs are attached as Figures A-2 through A-16.

A geotechnical engineer from our office conducted the field exploration. Our representative classified the soil conditions encountered, maintained a log of each test boring, obtained representative soil samples, and recorded water levels observed during drilling. During drilling, soil samples were obtained in general accordance with ASTM Test Designation D-1586. Using this procedure, a 2-inch (outside diameter) split barrel sampler is driven into the ground 18 inches using a 140-pound hammer free falling a height of 30 inches. The number of blows required to drive the sampler 12 inches after an initial 6-inch set is referred to as the Standard Penetration Resistance value or N value. This is an index related to the consistency of cohesive soils and relative density of cohesionless materials. N values obtained for each sampling interval are recorded on the Boring Logs, Figures A-2 through A-16. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) described on Figure A-1.

Representative soil samples obtained from the borings were placed in closed containers and taken to our laboratory for further examination and testing. The moisture content of each sample was measured and is reported on the individual Boring Logs Grain size analyses and California bearing ratios were performed on selected samples. The results of the grain size analyses tests are shown on Figures A-17 through A-20 the results of the California bearing ratios are shown on Figure A-21.

LOG OF BORING NO. B-1

Figure No. A-2

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10-27-11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 32

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
		(8 inches ASPHALT)			
1		Gray elastic SILT, fine grained, moist, mottled. (MH)			
2			Medium Stiff	17.4	7
3			Loose		
4		Gray silty SAND with gravel, fine to medium grained, moist, mottled.			
5				13.1	10
6		Gray SAND with silt, fine to medium grained, moist. (SP-SM)			
7				9.2	16
8			Medium Dense		
9					
10				23.0	15
11		*At 11 feet soil becomes saturated, fine to coarse grained.			
12				25.4	18
13		*At 12.5 feet drilling mud added to hole to prevent heave.			
14		Brown silty SAND, fine to medium grained, saturated. (SM)			
15		*At 15 feet, soil becomes gray.	Medium Dense	35.0	18
16					
17					
18					
19				21.1	31
20		*See Next Page			

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-1

Figure No. A-2

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10-27-11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 32

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
21					
22					
23					
24					
25			Medium Dense	24.5	27
26		Gray silty SAND, fine to medium grained, saturated. (SM)			
27					
28					
29					
30				23.5	21
31					
32		Test boring terminated at 31.5 feet. Groundwater observed at 11 feet during drilling.			
33					
34					
35					
36					
37					
38					
39					
40					

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology

LOG OF BORING NO. B-2

Figure No. A-3

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10-27-11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 29.5

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
		(6 inches ASPHALT)			
1		Gray elastic SILT with some sand, fine to medium grained, moist to wet.	Stiff		
2				26.8	10
3					
4					
5				6.7	22
6		Brown SAND with silt, fine to medium grained, moist, trace silt. (SP-SM)			
7				20.9	20
8		*At 7.5 feet soil becomes saturated, fine to coarse grained.			
9					
10			Medium Dense	24.7	24
11					
12				26.4	26
13		*At 12.5 feet drilling mud was added to the hole to prevent heave.			
14					
15				23.3	20
16					
17					
18					
19		Gray silty SAND, fine to medium grained, saturated. (SM)	Medium Dense	26.2	23
20		*See Next Page			

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-2

Figure No. A-3

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10-27-11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 29.5

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer △ TSF △ 1 2 3 4 / SPT (N) Blows/ft • • 10 20 30 40
21					
22					
23					
24					
25			Medium Dense	21.6 x	30 •
26		Gray silty SAND, fine to medium grained, saturated. (SM)			
27					
28					
29				26.1 x	27 •
30					
31					
32		Test boring terminated at 31.5 feet. Groundwater observed at 7.5 feet during drilling.			
33					
34					
35					
36					
37					
38					
39					
40					

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology

LOG OF BORING NO. B-3

Figure No. A-4

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10-27-11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
		(5 inches ASPHALT)			
1		FILL: mix of gray sand and gray silty sand with gravel, fine to medium grained, moist.	Loose		
2				17.4	6
3					
4					
5			Medium Dense	15.6	13
6					
7		Brown SAND with silt, fine to medium grained, moist. (SP-SM)		21.8	17
8					
9					
10		*At 10 feet soil becomes saturated.		23.1	20
11					
12				21.9	34
13		*At 12.5 feet drilling mud was added to the hole to prevent heave.	Dense		
14					
15				22.9	36
16					
17					
18					
19				22.0	31
20		*See Next Page			

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-3

Figure No. A-4

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10-27-11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
21		Gray SAND with silt, fine to medium grained, saturated. (SP-SM)	Dense		
22					
23					
24					
25				23.3	37
26					
27		Gray silty SAND, fine to medium grained, saturated. (SM)			
28			Medium Dense		
29					
30				28.9	24
31					
32		Test boring terminated at 31.5 feet. Groundwater observed at 10 feet during drilling.			
33					
34					
35					
36					
37					
38					
39					
40					

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology

LOG OF BORING NO. B-4

Figure No. A-5

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 32.3

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
		(10 inches ASPHALT)			
1					
2		Gray elastic SILT, fine grained, wet, mottled. (MH)	Medium Stiff	36.4	6
3					
4					
5				15.1	10
6					
7				14.8	12
8		Brown SAND with silt, fine to coarse grained, saturated. (SP-SM)			
9					
10				21.3	14
11			Medium Dense		
12				20.3	21
13		*At 12.5 feet drilling mud was added to the hole to prevent heave.			
14					
15				22.7	18
16					
17					
18					
19				23.9	23
20		*See Next Page			

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-4

Figure No. A-5

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 32.3

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF △ 1 2 3 4 △ / SPT (N) Blows/ft • 10 20 30 40 •
21		Gray SAND with silt, fine to medium grained, saturated. (SP-SM)	Medium Dense		
22					
23					
24					
25				26.0	15
26					
27		Gray silty SAND, fine to medium grained, saturated. (SM)			
28			Medium Dense		
29					
30				24.9	21
31					
32		Test boring terminated at 31.5 feet. Groundwater observed at 10 feet during drilling.			
33					
34					
35					
36					
37					
38					
39					
40					

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology

LOG OF BORING NO. B-5

Figure No. A-6

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31.7

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % (Wp |-----x-----| Wl, 10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(5 inches ASPHALT)			
1					
2		FILL: mix of brown gravel and gray silty sand with gravel, fine to coarse grained, moist.	Loose	16.6	6
3					
4				16.7	14
5		Gray silt and sand, fine to coarse grained, moist to wet. (ML)	Stiff		
6					
7				6.1	18
8		Gray SAND with silt, fine to medium grained, moist. (SP-SM)			
9			Medium Dense	24.7	21
10		*At 10 feet soil becomes saturated.			
11					
12				23.7	22
13		*At 12.5 feet drilling mud was added to the hole to prevent heave.			
14					
15		Brown SAND with silt, fine to coarse grained, saturated. (SP-SM)	Medium Dense	23.0	31
16					
17					
18					
19		Gray silty SAND, fine to medium grained, saturated. (SM)	Medium Dense	26.7	24
20		*See Next Page			

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-5

Figure No. A-6

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31.7

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
21					
22					
23					
24					
25		Gray silty SAND, fine to medium grained, saturated. (SM)	Medium Dense	13.8	27
26					
27					
28					
29				26.2	17
30					
31					
32		Test boring terminated at 31.5 feet. Groundwater observed at 10 feet during drilling.			
33					
34					
35					
36					
37					
38					
39					
40					

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology

LOG OF BORING NO. B-6

Figure No. A-7

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 35

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
		(10 inches ASPHALT)			
1–4		FILL: gray silty sand with gravel, fine to medium grained, wet.	Medium Dense	19.2	19
5–6		Gray SILT, fine grained, moist to wet, mottled. (ML)	Stiff	27.2	8
7–9		Layered brown and gray sand and sand with silt, fine grained, moist to wet. (SP) and (SP-SM)	Medium Dense	27.0	11
10–11		Gray SAND, fine to medium grained, saturated. (SP)	Loose	28.0	9
12–21		*At 12.5 feet drilling mud added to the hole to prevent heave. Brown SAND with silt, fine to coarse grained, saturated. (SP-SM)	Medium Dense	29.3 22.3 27.6 22.3	18 19 31
22–25		Test boring terminated at 21.5 feet. Groundwater observed at 10 feet during drilling.			

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-7

Figure No. A-8

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31.3

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl (10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(9 inches ASPHALT)			
1		Gray elastic SILT, fine grained, moist to wet, mottled. (MH)			
2				41.8	7
3			Medium Stiff		
4				20.4	11
5					
6					
7		Brown SAND with silt, fine grained, wet. (SP-SM)	Medium Dense	23.0	16
8		*At 7.5 feet soil becomes fine to medium grained.			
9				26.5	14
10		*At 10 feet drilling mud added to the hole to prevent heave.			
11					
12				20.1	22
13					
14		Gray SAND with silt, fine to coarse grained, saturated. (SP-SM)		23.5	24
15			Medium Dense		
16					
17					
18					
19				21.3	30
20		*At 20 feet, soil becomes fine to medium grained.			
21					
22		Test boring terminated at 21.5 feet. Groundwater observed at 10 feet during drilling.			
23					
24					
25					

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-8

Figure No. A-9

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 30.7

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl (10 30 50)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(8 inches ASPHALT)			
1–2		Dark brown to brown silt, fine grained, wet, mottled, organics. (MH)	Soft	>7	20
4–5		Gray SAND, fine to medium grained, moist. (SP)	Medium Dense	8.4	19
6–8		Brown SAND with silt, fine to medium grained, moist, trace silt. (SP-SM) *At 8.5 feet soil becomes saturated.	Medium Dense	20.2	19
9–10				17.3	33
12–16		Gray SAND with silt, fine to medium grained, saturated. (SP-SM)	Medium Dense	25.1	28
				19.8	27
19–21			Dense	25.7	37
22–25		Test boring terminated at 21.5 feet. Groundwater observed at 8.5 feet during drilling.			

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-9

Figure No. A-10

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 33.6

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
		(12 inches ASPHALT)			
1–2		Brown and gray elastic SILT, fine grained, moist, mottled. (MH)	Medium Stiff	42.4	7
3–4					
4–5		Brown SAND with silt, fine to medium grained, moist. (SP-SM)		11.5	15
5–6					
6–7		*At 7.5 feet, soil becomes fine grained, wet.	Medium Dense	22.6	17
7–8					
8–9				21.8	20
9–10		*At 10 feet added drilling mud to the hole to prevent heave.			
10–11					
11–12		Gray silty SAND, fine grained, saturated. (SM)	Medium Dense	23.0	27
12–13					
13–14				23.8	29
14–15					
15–16		Brown silty SAND, fine to medium grained, saturated. (SM)	Medium Dense		
16–17					
17–18					
18–19		Gray silty SAND, fine grained, saturated. (SM)	Medium Dense	24.2	28
19–20					
20–21					
21–22		Test boring terminated at 21.5 feet. Groundwater observed at 10 feet during drilling.			
22–23					
23–24					
24–25					

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-10

Figure No. A-11

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 30.6

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
1		(6 inches ASPHALT) FILL: brown gravel, fine to coarse grained, moist.	Medium Dense		
2				26.5	15
3		FILL: gray silty sand with gravel, fine to medium grained, moist to wet.	Medium Dense		
4				7.9	28
5					
6		Brown SAND with silt, fine to medium grained, moist. (SP-SM)			
7			Medium Dense	24.5	19
8					
9		*At 8.5 feet soil becomes saturated.		21.3	28
10					
11					
12		Gray SAND with silt, fine to coarse grained, saturated, trace gravel. (SP-SM)		23.6	32
13					
14			Medium Dense	20.0	27
15		*At 15 feet added drilling mud to the hole to prevent heave.			
16					
17					
18					
19				26.4	25
20					
21					
22		Test boring terminated at 21.5 feet. Groundwater observed at 8.5 feet during drilling.			
23					
24					
25					

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-11

Figure No. A-12

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/27/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 34.5

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl (10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
1		(2.5 inches ASPHALT) FILL: brown silty sand with gravel, fine to medium grained, moist.	Medium Dense		
2				33.8	7
3					
4		Gray elastic SILT, fine grained, wet, mottled. (MH)	Medium Stiff	32.7	6
5					
6					
7				11.3	10
8		Brown SAND with silt, fine to medium grained, moist. (SP-SM)			
9				23.7	11
10					
11		*At 11 feet soil becomes saturated.			
12			Medium Dense	25.8	21
13					
14				20.1	29
15		*At 15 feet soil becomes fine to coarse grained.			
16					
17					
18					
19				27.4	23
20		*At 20 feet, soil becomes gray.			
21					
22		Test boring terminated at 21.5 feet. Groundwater observed at 11 feet during drilling.			
23					
24					
25					

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-12

Figure No. A-13

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31.7

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl (10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
1		(6 inches ASPHALT) FILL: gray gravel, fine to coarse grained, moist.	Medium Dense		
2				9.5	15
3					
4		(FILL?): mix of brown and gray sand with silt, fine to medium grained, moist.	Medium Dense	8.8	16
5					
6		Brown SAND with silt, fine grained, moist. (SP-SM) *At 7.5 feet, soil becomes fine to medium grained.			
7				16.6	22
8			Medium Dense		
9		*At 10 feet soil becomes fine to coarse grained, saturated. Drilling mud was added to the hole to prevent heave.		21.3	28
10					
11					
12				24.4	22
13					
14				21.8	33
15					
16		Gray SAND with silt, fine to medium grained, saturated. (SP-SM)	Medium Dense		
17					
18					
19				24.5	22
20					
21					
22		Test boring terminated at 21.5 feet. Groundwater observed at 10 feet during drilling.			
23					
24					
25					

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-13

Figure No. A-14

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 30.3

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl (10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(6 inches ASPHALT)			
1–2		FILL: gray silty sand with gravel, fine to medium grained, moist.	Medium Dense	12.1	13
3–6		Gray SAND fine to medium grained, moist. (SP)	Medium Dense	5.0	27
7–8		Brown SAND, fine to medium grained, saturated. (SP)		5.1	17
9–11		*At 10 feet soil becomes saturated. Drilling mud added to the hole to prevent heave.	Medium Dense	18.7	25
12–13				17.0	26
14–16		Gray SAND with silt, fine to coarse grained, saturated. (SP-SM)	Medium Dense	22.0	24
17–21		*At 20 feet soil becomes fine to medium grained.		27.6	24
22–25		Test boring terminated at 21.5 feet. Groundwater observed at 10 feet during drilling.			

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-14

Figure No. A-15

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 30

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer TSF 1 2 3 4 / SPT (N) Blows/ft 10 20 30 40
		(7 inches ASPHALT)		7.8	18
1		FILL: mix of brown and gray silty sand with gravel and brown sand with silt and gravel, fine to medium grained, moist to wet.			
2			Medium Dense	15.8	26
3					
4					
5		Brown SAND with silt, fine to coarse grained, moist. (SP-SM)	Medium Dense	9.9	23
6					
7		Test boring terminated at 6.5 feet.			
8					
9					
10					
11					
12					
13					
14					
15					

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-15

Figure No. A-16

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

Location: Woodinville, Washington **Approx. Elev:** 31.6

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl (10 20 30 40)	Pocket Penetrometer TSF (1 2 3 4) / SPT (N) Blows/ft (10 20 30 40)
		(8 inches ASPHALT)		6.4	14
1		FILL: mix of brown and gray gravel with sand and silt, fine to coarse grained, wet.	Medium Dense		
2				42.0	4
3		Brown SILT, fine grained, wet. (ML)	Soft		
4				11.3	10
5					
6		Brown SAND with silt, fine to medium grained, moist. (SP-SM)			
7					
8					
9					
10		*At 10 feet soil becomes saturated.	Medium Dense		
11					
12					
13					
14					
15		*At 15 feet drilling mud added to the hole to prevent heave.			
16					
17					
18					
19					
20					
21					
22		Gray silty SAND, fine grained, saturated. (SM)	Medium Dense		
23					
24					
25		*See Next Page			

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

LOG OF BORING NO. B-15

Figure No. A-16

Project: BD Real Estate Distribution Building **Project No:** T-6636-1 **Date Drilled:** 10/28/11

Client: BD Real Estate, LLC **Driller:** BorTec **Logged By:** CSD

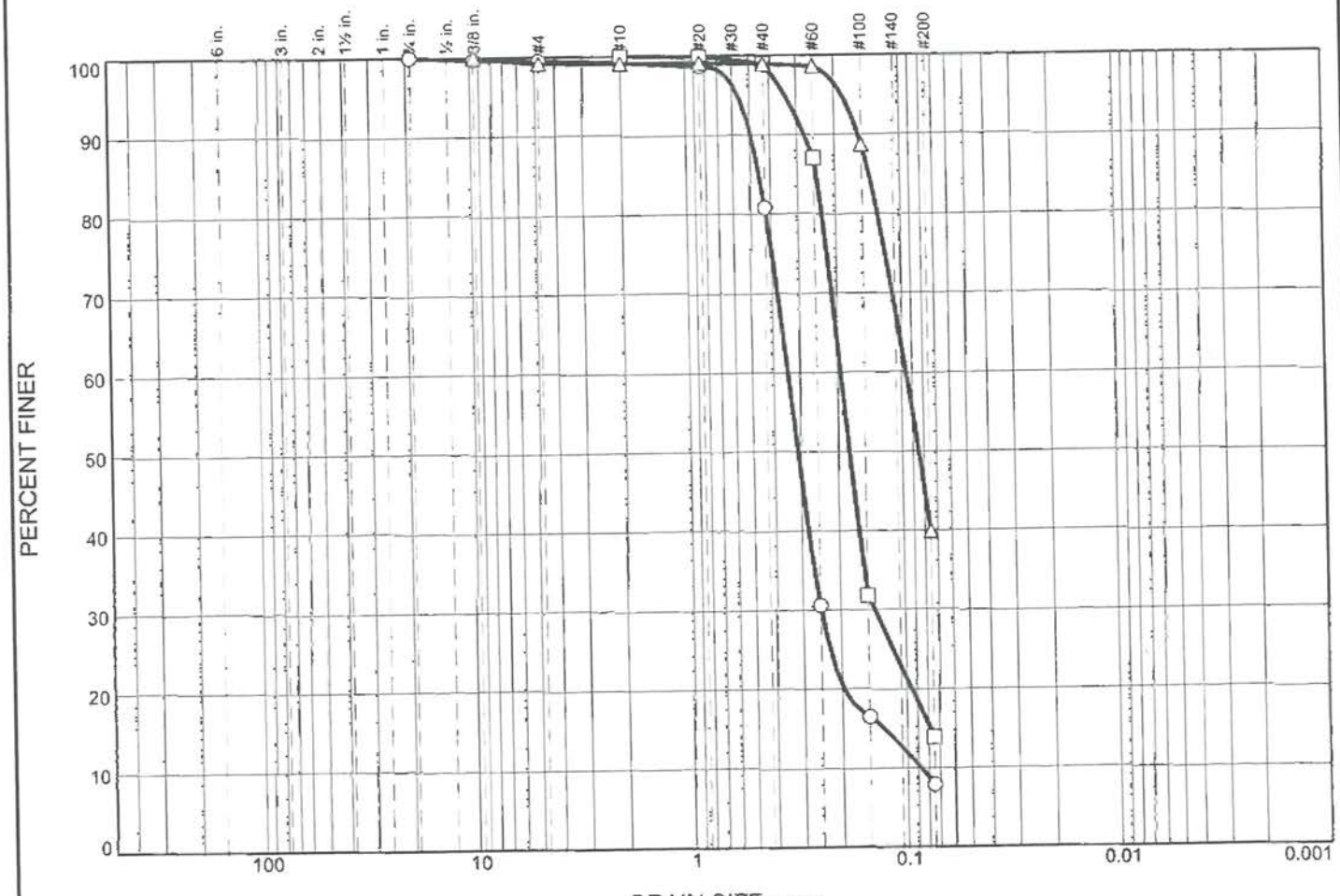
Location: Woodinville, Washington **Approx. Elev:** 31.6

Depth (ft)	Sample Interval	Soil Description	Consistency/ Relative Density	Moisture Content % Wp |-----x-----| Wl 10 20 30 40	Pocket Penetrometer △ TSF △ 1 2 3 4 / SPT (N) Blows/ft ● ● 10 20 30 40
26					
27					
28					
29				25.1 ×	29 ●
30					
31		Gray silty SAND, fine grained, saturated. (SM)	Medium Dense		
32					
33					
34				25.0 ×	19 ●
35					
36					
37					
38					
39		Gray SILT to sandy SILT, fine grained, saturated. (ML)	Very Stiff	31.7 ×	21 ●
40					
41					
42		Test boring terminated at 41.5 feet. Groundwater observed at 10 feet during drilling.			
43					
44					
45					
46					
47					
48					
49					
50					

Note: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.5	0.3	18.4	72.9	7.9	
□	0.0	0.0	0.0	0.0	1.1	85.0	13.9	
△	0.0	0.0	0.8	0.1	0.2	59.0	39.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.4509	0.3413	0.3102	0.2478	0.1288	0.0870	2.07	3.92
□			0.2439	0.1934	0.1780	0.1399	0.0783			
△			0.1386	0.0956	0.0846					

Material Description	USCS	AASHTO
○ Poorly graded SAND with silt	SP-SM	
□ Silty SAND	SM	
△ Silty SAND	SM	

Project No. T-6636-1 **Client:** BD Real Estate, LLC
Project: BD Real Estate Distribution Building
Woodinville, Washington
○ **Location:** Test Boring B-1 **Depth:** 7.5' **Sample Number:** 3
□ **Location:** Test Boring B-1 **Depth:** 12.5' **Sample Number:** 5
△ **Location:** Test Boring B-2 **Depth:** 30 **Sample Number:** 8

Remarks:
○ Tested on 11-3-11
□ Tested on 11-3-11
△ Tested on 11-3-11

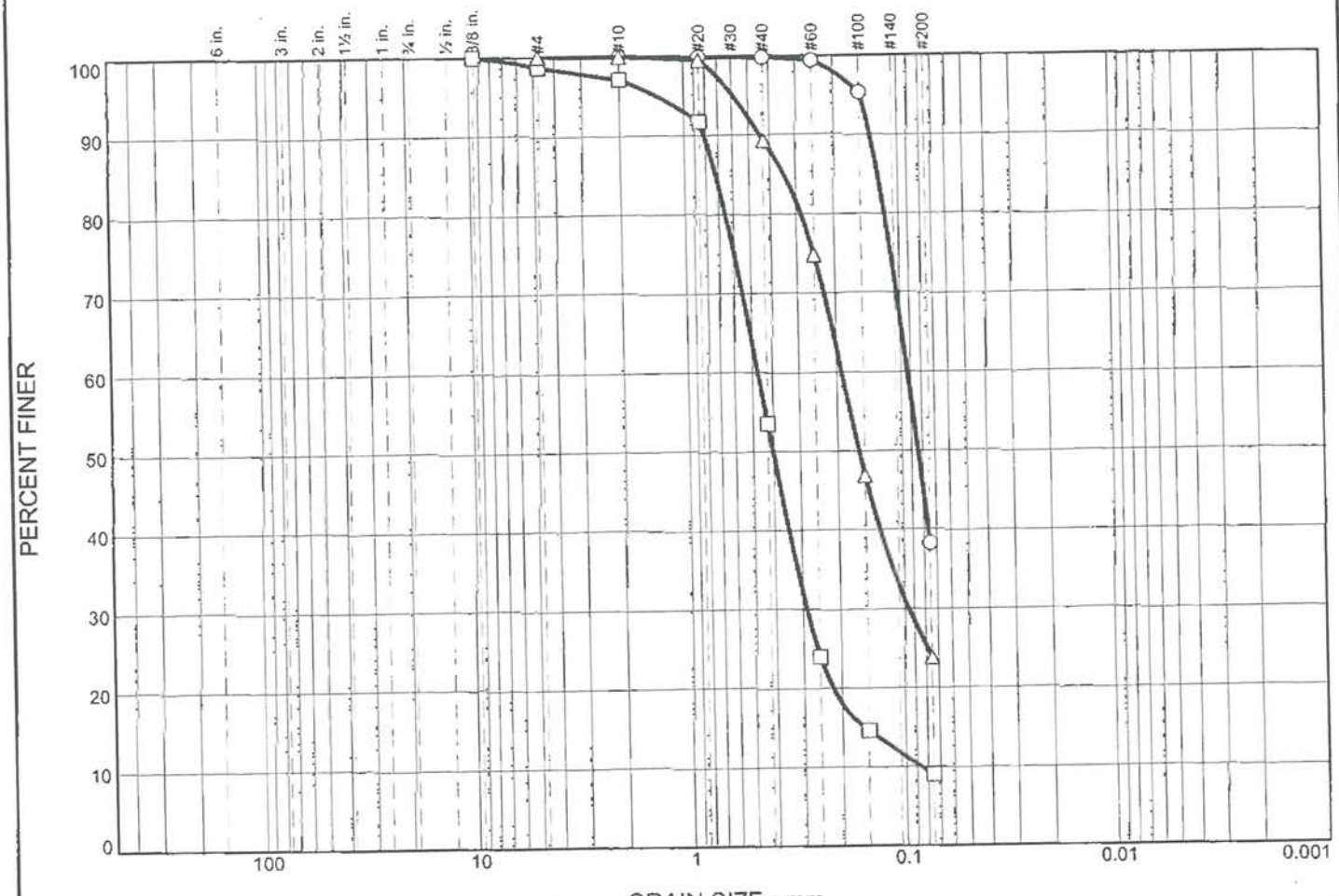
Terra Associates, Inc.

Kirkland, WA

Figure A-17

Tested By: CSD

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.2	61.5	38.3	
□	0.0	0.0	1.3	1.6	43.6	44.5	9.0	
△	0.0	0.0	0.0	0.0	10.7	65.5	23.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1242	0.0927	0.0840					
□			0.7190	0.4691	0.4029	0.2877	0.1570	0.0853	2.07	5.50
△			0.3430	0.1896	0.1592	0.0953				

Material Description	USCS	AASHTO
○ Silty SAND	SM	
□ Poorly graded SAND with silt	SP-SM	
△ Silty SAND	SM	

Project No. T-6636-1 **Client:** BD Real Estate, LLC
Project: BD Real Estate Distribution Building
Woodinville, Washington
○ **Location:** Test Boring B-3 **Depth:** 30 **Sample Number:** 9
□ **Location:** Test Boring B-8 **Depth:** 10 **Sample Number:** 4
△ **Location:** Test Boring B-9 **Depth:** 10 **Sample Number:** 4

Remarks:
○ Tested on 11-3-11
□ Tested on 11-3-11
△ Tested on 11-3-11

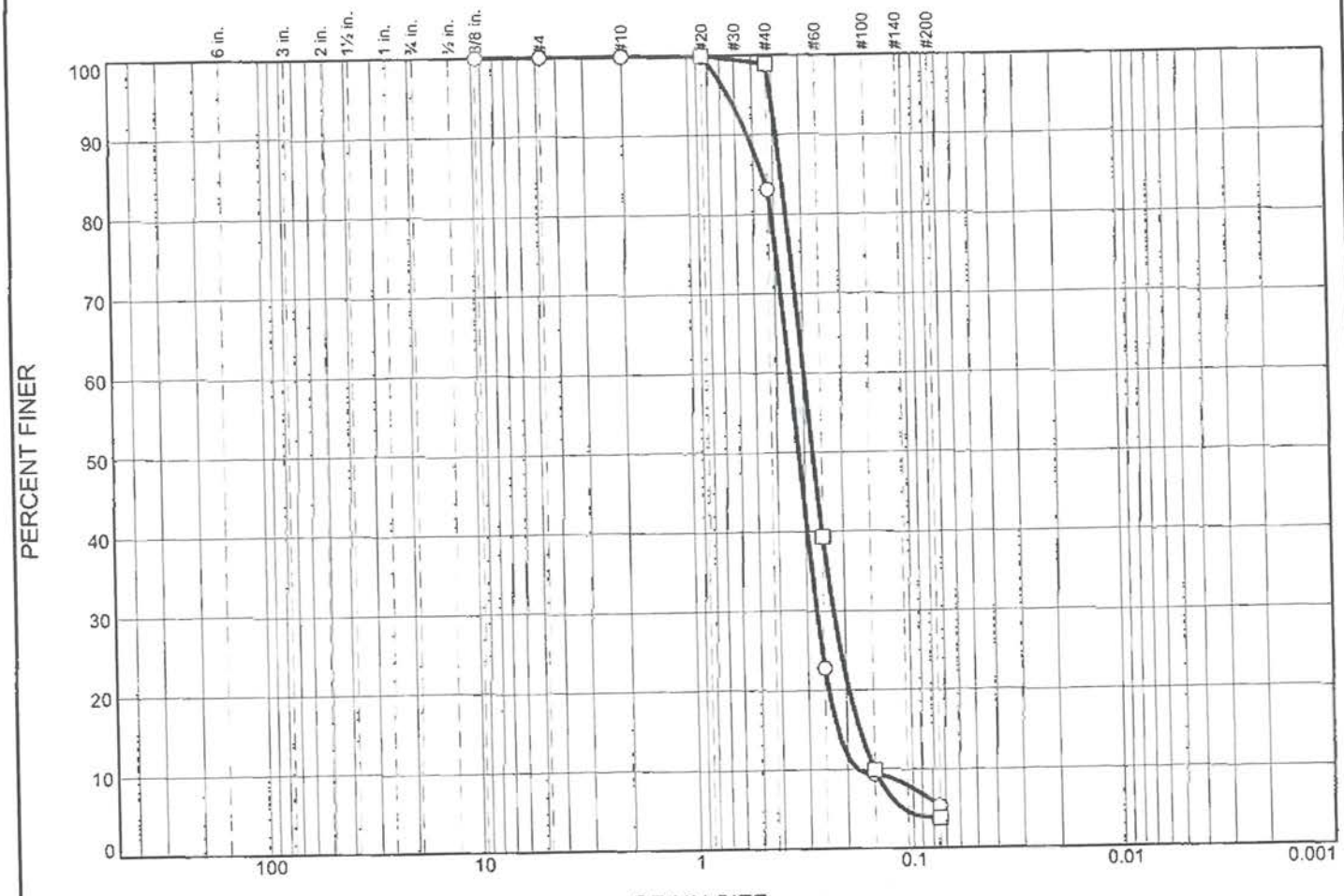
Terra Associates, Inc.

Kirkland, WA

Figure A-18

Tested By: CSD

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	16.9	77.8	5.3	
□	0.0	0.0	0.0	0.0	1.1	95.1	3.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.4493	0.3462	0.3200	0.2702	0.2205	0.1799	1.17	1.92
□			0.3672	0.2989	0.2754	0.2256	0.1751	0.1506	1.13	1.99

Material Description	USCS	AASHTO
○ Poorly graded SAND with silt	SP-SM	
□ Poorly graded SAND with silt	SP-SM	

Project No. T-6636-1 **Client:** BD Real Estate, LLC
Project: BD Real Estate Distribution Building
Woodinville, Washington
○ **Location:** Test Boring B-10 **Depth:** 12.5 **Sample Number:** 5
□ **Location:** Test Boring B-12 **Depth:** 20 **Sample Number:** 7

Remarks:
○ Tested on 11-3-11
□ Tested on 11-3-11

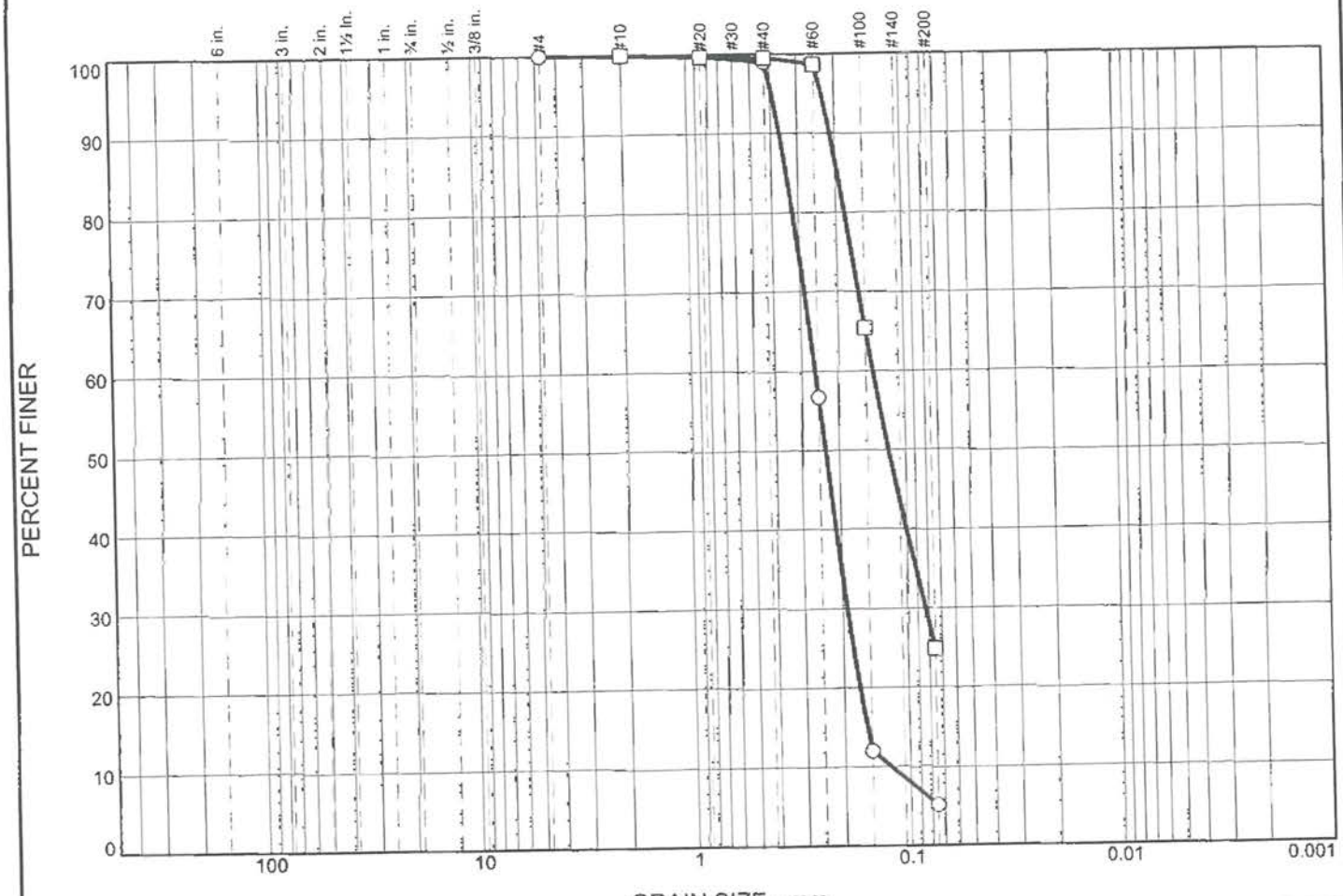
Terra Associates, Inc.

Kirkland, WA

Figure A-19

Tested By: CSD

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.1	0.9	93.9	5.1	
□	0.0	0.0	0.0	0.0	0.5	74.6	24.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.3392	0.2583	0.2340	0.1906	0.1577	0.1227	1.15	2.11
□			0.1953	0.1389	0.1189	0.0828				

Material Description	USCS	AASHTO
○ Poorly graded SAND with silt	SP-SM	
□ Silty SAND	SM	

Project No. T-6636-1 **Client:** BD Real Estate, LLC
Project: BD Real Estate Distribution Building
Woodinville, Washington
○ **Location:** Test Boring B-13 **Depth:** 20 **Sample Number:** 7
□ **Location:** Test Boring B-15 **Depth:** 35 **Sample Number:** 5

Remarks:
○ Tested on 11-3-11
□ Tested on 11-3-11

Terra Associates, Inc.

Kirkland, WA

Figure A-20

Tested By: CSD

APPENDIX B

AASHTO PAVEMENT DESIGN CALCULATIONS

==========

AASHTO -- Pavement Analysis Program

==========

Crushed Rock Base Heavy Traffic

********** Flexible Analysis **********

* Structural Number	=	2.28	Required
* Design E 18's	=	500,000	
* Reliability	=	95.00	percent
* Overall Deviation	=	0.45	
* Resilient Modulus	=	20,000.0	psi
* Initial Serviceability	=	4.50	
* Terminal Serviceablity	=	3.00	

Layer Number	Layer Coefficient	Drainage Coefficient	Layer Thickness	a(i)*Cd*t
======	== a (i) ==	==== Cd ===	=== t ===	=========
1	0.44	1.00	3.00	1.32
2	0.14	1.00	7.00	0.98

=========

Total SN = 2.30 > 2.28

==========

AASHTO -- Pavement Analysis Program

==========

Asphalt Treated Base Heavy Traffic

********** Flexible Analysis **********

* Structural Number	=	2.28	Required
* Design E 18's	=	500,000	
* Reliability	=	95.00	percent
* Overall Deviation	=	0.45	
* Resilient Modulus	=	20,000.0	psi
* Initial Serviceability	=	4.50	
* Terminal Serviceablity	=	3.00	

Layer Number	Layer Coefficient	Drainage Coefficient	Layer Thickness	a(i)*Cd*t
======	== a (i) ==	==== Cd ===	=== t ===	=========
1	0.44	1.00	3.00	1.32
2	0.30	1.00	3.50	1.05

=========

Total SN = 2.37 > 2.28

==========

AASHTO -- Pavement Analysis Program

==========

Crushed Rock Base Light Traffic

********** Flexible Analysis **********

* Structural Number	=	1.52	Required
* Design E 18's	=	50,000	
* Reliability	=	95.00	percent
* Overall Deviation	=	0.45	
* Resilient Modulus	=	20,000.0	psi
* Initial Serviceability	=	4.50	
* Terminal Serviceablity	=	3.00	

Layer Number	Layer Coefficient	Drainage Coefficient	Layer Thickness	a(i)*Cd*t
======	== a (i) ==	==== Cd ===	=== t ===	=========
1	0.44	1.00	2.00	0.88
2	0.14	1.00	5.00	0.70

=========

Total SN = 1.58 > 1.52

==========

AASHTO -- Pavement Analysis Program

==========

Asphalt Treated Base Light Traffic

********** Flexible Analysis **********

* Structural Number	=	1.52	Required
* Design E 18's	=	50,000	
* Reliability	=	95.00	percent
* Overall Deviation	=	0.45	
* Resilient Modulus	=	20,000.0	psi
* Initial Serviceability	=	4.50	
* Terminal Serviceablity	=	3.00	

Layer Number	Layer Coefficient	Drainage Coefficient	Layer Thickness	a(i)*Cd*t
======	== a (i) ==	==== Cd ===	=== t ===	=========
1	0.44	1.00	2.00	0.88
2	0.30	1.00	3.00	0.90

=========

Total SN = 1.78 > 1.52

California Bearing Ratio
Soil Tests Summary
BD Real Estate Distribution Building
Woodinville, WA

Sample Number:	1
Sample Location:	Test Boring B-14
Sample Depth (feet):	0'-5'
Soil Type:	Silty SAND with gravel
USCS Classification:	SM
Grain Size Distribution:	
Gravel Fraction:	17
Sand Fraction:	58
Fines Fraction:	25
Laboratory Moisture Density:	
Method of Test:	ASTM D1557
Maximum Dry Density (pcf):	122.8
Optimum Moisture Content (%):	12.5
California Bearing Ratio (CBR):	
Remolded Unit Weight (pcf):	122.4
Remolded Moisture Content (%):	12.5
Surcharge Weight (lbs.):	10
Percent Swell (48 hrs. soak):	0
CBR .1" penetration:	24
CBR .2" penetration:	34
Soaked Moisture Content (%):	13.4

Tab 7.0

7.0 OTHER PERMITS

7.0 OTHER PERMITS

Other permits for this project site include a Clear and Grade Permit, Site Development Permit, Building Permit, Waterline Extension Permit, Sanitary Sewer Extension Permit, and NPDES General Permit.

Tab 8.0

8.0 CSWPPP ANALYSIS AND DESIGN

Stormwater Pollution Prevention Plan

For
Woodinville Lumber Business Park

Prepared For
Panattoni Development Company
900 S.W. 16th Street, Suite 330
Renton, WA 98057

Owner
Panattoni Development Company
900 S.W. 16th Street, Suite 330
Renton, WA 98057

Developer
Panattoni Development Company
900 S.W. 16th Street, Suite 330
Renton, WA 98057

Operator/Contractor
TBD

Project Site Location
15902 Woodinville-Redmond Road
Woodinville, Washington

Early Grading Permit Outside of 200-foot Shoreline
Certified Erosion and Sediment Control Lead

TBD

SWPPP Prepared By
Barghausen Consulting Engineers, Inc.
18215 - 72nd Avenue South
Kent, WA 98032
(425) 251-6222
Ali Sadr, Senior Project Engineer

SWPPP Preparation Date
March 14, 2013
Revised January 5, 2016

Approximate Project Construction Dates
May 2016
November 2016

Contents

1.0 Introduction 1
2.0 Site Description 3
2.1 Existing Conditions 3
2.2 Proposed Construction Activities 3
3.0 Construction Stormwater BMPs 4
3.1 The 14 BMP Elements 4
3.1.1 Element #1 – Mark Clearing Limits 4
3.1.2 Element #2 – Establish Construction Access 4
3.1.3 Element #3 – Control Flow Rates 5
3.1.4 Element #4 – Install Sediment Controls 5
3.1.5 Element #5 – Stabilize Soils 6
3.1.6 Element #6 – Protect Slopes 7
3.1.7 Element #7 – Protect Drain Inlets 7
3.1.8 Element #8 – Stabilize Channels and Outlets 8
3.1.9 Element #9 – Control Pollutants 8
3.1.10 Element #10 – Control Dewatering 9
3.1.11 Element #11 – Maintain BMPs 10
3.1.12 Element #12 – Manage the Project 10
3.1.13 Element #13 – Construction Stormwater Chemical Treatment 12
3.1.14 Element #14 – Construction Stormwater Filtration 18
3.2 Site Specific BMPs 19
4.0 Construction Phasing and BMP Implementation 20
5.0 Pollution Prevention Team 21
5.1 Roles and Responsibilities 21
5.2 Team Members 22
6.0 Site Inspections and Monitoring 23
6.1 Site Inspection 23
6.1.1 Site Inspection Frequency 23
6.1.2 Site Inspection Documentation 23
6.2 Stormwater Quality Monitoring 24
6.2.1 Turbidity Sampling 24
6.2.2 pH Sampling 25
7.0 Reporting and Recordkeeping 26
7.1 Recordkeeping 26
7.1.1 Site Log Book 26
7.1.2 Records Retention 26
7.1.3 Access to Plans and Records 26
7.1.4 Updating the SWPPP 26
7.2 Reporting 27
7.2.1 Discharge Monitoring Reports 27
7.2.2 Notification of Noncompliance 27

Appendix A **Site Plans**

Appendix B **Construction BMPs**

Appendix C **Alternative BMPs**

Appendix D **General Permit**

Appendix E **Site Inspection Forms (and Site Log)**

Appendix F **Engineering Calculations**

1.0 Introduction

This Stormwater Pollution Prevention Plan (SWPPP) has been prepared as part of the NPDES stormwater permit requirements for the Woodinville Lumber Business Park project in Woodinville, Washington. The proposed site is located at 15902 Woodinville-Redmond Road in Woodinville, Washington.

Construction activities will include the addition of two buildings, asphalt parking lots, landscaping, utility work, including power, telephone, gas, cable television, water, sewer, and storm appurtenances with catch basin collection, pipe conveyance and stormwater quality facilities, etc. **The purpose of this SWPPP is to describe the proposed construction activities and all temporary and permanent erosion and sediment control (TESC) measures, pollution prevention measures, inspection/monitoring activities, and recordkeeping that will be implemented during the proposed construction project. The objectives of the SWPPP are to:**

1. **Implement Best Management Practices (BMPs) to prevent erosion and sedimentation, and to identify, reduce, eliminate or prevent stormwater contamination and water pollution from construction activity.**
2. **Prevent violations of surface water quality, ground water quality, or sediment management standards.**
3. **Prevent, during the construction phase, adverse water quality impacts including impacts on beneficial uses of the receiving water by controlling peak flow rates and volumes of stormwater runoff at the Permittee's outfalls and downstream of the outfalls.**

This SWPPP was prepared using the Ecology SWPPP Template downloaded from the Ecology website on July 2, 2005. T**his SWPPP was prepared based on the requirements set forth in the Construction Stormwater General Permit, *Stormwater Management Manual for Western Washington* (SWMMWW 2005).** The report is divided into seven main sections with several appendices that include stormwater related reference materials. The topics presented in the each of the main sections are:

- Section 1 – INTRODUCTION. This section provides a summary description of the project, and the organization of the SWPPP document.
- Section 2 – SITE DESCRIPTION. This section provides a detailed description of the existing site conditions, proposed construction activities, and calculated stormwater flow rates for existing conditions and post-construction conditions.
- Section 3 – CONSTRUCTION BMPs. This section provides a detailed description of the BMPs to be implemented based on the 12 required elements of the SWPPP (SWMMEW 2004).

- Section 4 – CONSTRUCTION PHASING AND BMP IMPLEMENTATION. This section provides a description of the timing of the BMP implementation in relation to the project schedule.
- Section 5 – POLLUTION PREVENTION TEAM. This section identifies the appropriate contact names (emergency and non-emergency), monitoring personnel, and the onsite temporary erosion and sedimentation control inspector
- Section 6 – INSPECTION AND MONITORING. This section provides a description of the inspection and monitoring requirements such as the parameters of concern to be monitored, sample locations, sample frequencies, and sampling methods for all stormwater discharge locations from the site.
- Section 7 – RECORDKEEPING. This section describes the requirements for documentation of the BMP implementation, site inspections, monitoring results, and changes to the implementation of certain BMPs due to site factors experienced during construction.

Supporting documentation and standard forms are provided in the following Appendices:

Appendix A – Site Plans
Appendix B – Construction BMPs
Appendix C – Alternative BMPs
Appendix D – General Permit
Appendix E – Site Inspection Forms (and Site Log)
Appendix F – Engineering Calculations

2.0 Site Description

2.1 Existing Conditions

Under existing conditions, the vast majority of the project site consists of impervious surface and has been fully developed previously. Flow control is not provided with the existing conditions on the project site, therefore, flow control will not be provided other than flow control BMPs under proposed developed conditions for this project.

2.2 Proposed Construction Activities

The overall project site for this development is 13.869 acres in size, all of which has been previously developed. The project site is located within a portion of the northwest quarter of Section 15, Township 26 North, Range 5 East, Willamette Meridian, City of Woodinville, King County, Washington. The existing conditions on the site are such that the site has been previously developed with several outbuildings and hard impervious surface over the vast majority of the project site. Only one building will remain with this project, which is located at the far west end of the site. The proposal for this Early Grading Permit is to prepare the site outside of the 200-foot shoreline for future development of the site. Since this project is discharging directly into the Sammamish River off of the east property line of the site, no flow control is required for this development; however, the City has indicated that enhanced water quality must be applied to this project. Therefore, two separate treatment systems are proposed for this development, one of which is to construct a stormwater treatment wetland in the far southeast corner of the project site, treating runoff from the vast majority of the impervious surfaces on the project site exclusive of the roof runoff and a strip of asphalt along the ordinary high watermark setback on the eastern property line of the site, which will drain into a filter strip prior to discharge into the Sammamish River. Water quality will be provided for the entire development of the project site, including the existing building to remain and its associated parking. There will be no drainage to or from adjacent properties.

Construction activities will include site preparation, TESC installation, building construction, stormwater and utility appurtenance installation, and asphalt paving. The schedule and phasing of BMPs during construction is provided in Section 4.0.

Stormwater runoff rates were calculated using the KCRTS hydrology model and the water quality features were was sized by treating the water quality flow rate as delineated in the 2009 KCSWDM.

The following summarizes details regarding site areas:

- Total site area: 13.87 acres
- Percent impervious area before construction: 95%
- Percent impervious area after construction: 95%
- Disturbed area during construction: 13.87 acres
- Disturbed area that is characterized as impervious (i.e., access roads, staging, parking): 1.0 acre

All stormwater flow calculations are provided in Appendix F.

3.0 Construction Stormwater BMPs

3.1 The 14 BMP Elements

3.1.1 Element #1 – Mark Clearing Limits

To protect adjacent properties and to reduce the area of soil exposed to construction, the limits of construction will be clearly marked before land-disturbing activities begin. Areas that are to be preserved, as well as all sensitive areas and their buffers, shall be clearly delineated, both in the field and on the plans. The BMPs relevant to marking the clearing limits that will be applied for this project include:

- High Visibility Plastic or Metal Fence (BMP C103)

The clearing limits shall be as shown on the plans and all vegetation outside of the clearing limits preserved.

Alternate BMPs for marking clearing limits are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

3.1.2 Element #2 – Establish Construction Access

Construction access or activities occurring on unpaved areas shall be minimized, yet where necessary, access points shall be stabilized to minimize the tracking of sediment onto public roads and street sweeping and street cleaning shall be employed to prevent sediment from entering state waters. All wash wastewater shall be controlled on site. The specific BMPs related to establishing construction access that will be used on this project include:

- The roads shall be swept daily should sediment collect on them.

Alternate construction access BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

3.1.3 Element #3 – Control Flow Rates

In order to protect the properties and waterways downstream of the project site, stormwater discharges from the site will be controlled by construction of sediment ponds as one of the first items of construction.

Alternate flow control BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, the project must comply with Minimum Requirement 7 (Ecology 2005).

In general, discharge rates of stormwater from the site will be controlled where increases in impervious area or soil compaction during construction could lead to downstream erosion, or where necessary to meet local agency stormwater discharge requirements (e.g., discharge to combined sewer systems).

3.1.4 Element #4 – Install Sediment Controls

All stormwater runoff from disturbed areas shall pass through an appropriate sediment removal BMP before leaving the construction site or prior to being discharged to the downstream drainage course. The specific BMPs to be used for controlling sediment on this project include:

- Silt Fence (BMP C233)
- Sediment Pond (BMP C241)

A silt fence shall be installed along the downstream perimeter of the proposed site. Alternate sediment control BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

In addition, sediment will be removed from paved areas in and adjacent to construction work areas manually or using mechanical sweepers, as needed, to minimize tracking of sediments on vehicle tires away from the site and to minimize washoff of sediments from adjacent streets in runoff.

Whenever possible, sediment-laden water shall be discharged into onsite, relatively level, vegetated areas (BMP C240 paragraph 5, page 4-102).

In some cases, sediment discharge in concentrated runoff can be controlled using permanent stormwater BMPs (e.g., infiltration swales, ponds, trenches). Sediment loads can limit the effectiveness of some permanent stormwater BMPs, such as those used for infiltration or biofiltration; however, those BMPs designed to remove solids by settling (wet ponds or sediment ponds) can be used during the construction phase. When permanent stormwater BMPs will be used to control sediment discharge during construction, the structure will be protected from excessive sedimentation with adequate erosion and sediment control BMPs. Any accumulated sediment shall be removed after construction is complete and the remainder of the site has been stabilized.

The following BMPs will be implemented as end-of-pipe sediment controls as required to meet permitted turbidity limits in the site discharge(s). Prior to the implementation of these technologies, sediment sources and erosion control and soil stabilization BMP efforts will be maximized to reduce the need for end-of-pipe sedimentation controls.

- Temporary Sediment Pond (BMP C241)
- Construction Stormwater Filtration (BMP C251)
- Construction Stormwater Chemical Treatment (BMP C 250) (implemented only with prior written approval from Ecology).

3.1.5 Element #5 – Stabilize Soils

Exposed and unworked soils shall be stabilized with the application of effective BMPs to prevent erosion throughout the life of the project. The specific BMPs for soil stabilization that shall be used on this project include:

- Temporary and Permanent Seeding (BMP C120)
- Mulching (BMP C121)
- Dust Control (BMP C 140)

Seeding shall occur on all areas to remain unworked pursuant to below. Dust shall be controlled if construction occurs during the summer. Alternate soil stabilization BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, no soils shall remain exposed and unworked for more than 7 days during the dry season (May 1 to September 30) and 2 days during the wet season (October 1 to April 30). Regardless of the time of year, all soils shall be stabilized at the end of the shift before a holiday or weekend if needed based on weather forecasts.

In general, cut and fill slopes will be stabilized as soon as possible and soil stockpiles will be temporarily covered with plastic sheeting. All stockpiled soils shall be stabilized from erosion, protected with sediment trapping measures, and where possible, be located away from storm drain inlets, waterways, and drainage channels.

3.1.6 Element #6 – Protect Slopes

All cut and fill slopes will be designed, constructed, and protected in a manner that minimizes erosion. The following specific BMPs will be used to protect slopes for this project:

- Temporary and Permanent Seeding (BMP C 120)

Temporary and permanent seeding shall be used at all exposed areas pursuant to the prior mentioned schedule (seasonal restrictions).

Alternate slope protection BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

3.1.7 Element #7 – Protect Drain Inlets

All storm drain inlets and culverts made operable during construction shall be protected to prevent unfiltered or untreated water from entering the drainage conveyance system. However, the first priority is to keep all access roads clean of sediment and keep street wash water separate from entering storm drains until treatment can be provided. Storm Drain Inlet Protection (BMP C220) will be implemented for all drainage inlets and culverts that could potentially be impacted by sediment-laden runoff on and near the project site. The following inlet protection measures will be applied on this project:

- Excavated Drop Inlet Protection
- Block and Gravel Drop Inlet Protection
- Gravel and Wire Drop Inlet Protection
- Catch Basin Filters
- Culvert Inlet Sediment Trap

If the BMP options listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D), or if no BMPs are listed above but deemed necessary during construction, the Certified Erosion and Sediment Control Lead shall implement one or more of the alternative BMP inlet protection options listed in Appendix C.

3.1.8 Element #8 – Stabilize Channels and Outlets

Where site runoff is to be conveyed in channels, or discharged to a stream or some other natural drainage point, efforts will be taken to prevent downstream erosion. The specific BMPs for channel and outlet stabilization that shall be used on this project include:

- Site runoff shall be discharged to a sediment pond

Alternate channel and outlet stabilization BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

The project site is located west of the Cascade Mountain Crest. As such, all temporary on-site conveyance channels shall be designed, constructed, and stabilized to prevent erosion from the expected peak 10 minute velocity of flow from a Type 1A, 10-year, 24-hour recurrence interval storm for the developed condition. Alternatively, the 10-year, 1-hour peak flow rate indicated by an approved continuous runoff simulation model, increased by a factor of 1.6, shall be used. Stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent streambanks, slopes, and downstream reaches shall be provided at the outlets of all conveyance systems.

3.1.9 Element #9 – Control Pollutants

All pollutants, including waste materials and demolition debris, that occur onsite shall be handled and disposed of in a manner that does not cause contamination of stormwater. Good housekeeping and preventative measures will be taken to ensure that the site will be kept clean, well organized, and free of debris. If required, BMPs to be implemented to control specific sources of pollutants are discussed below. Vehicles, construction equipment, and/or petroleum product storage/dispensing:

- All vehicles, equipment, and petroleum product storage/dispensing areas will be inspected regularly to detect any leaks or spills, and to identify maintenance needs to prevent leaks or spills.
- On-site fueling tanks and petroleum product storage containers shall include secondary containment.
- Spill prevention measures, such as drip pans, will be used when conducting maintenance and repair of vehicles or equipment.
- In order to perform emergency repairs on site, temporary plastic will be placed beneath and, if raining, over the vehicle.

- Contaminated surfaces shall be cleaned immediately following any discharge or spill incident.

Demolition:

- Dust released from demolished sidewalks, buildings, or structures will be controlled using Dust Control measures (BMP C140).
- Storm drain inlets vulnerable to stormwater discharge carrying dust, soil, or debris will be protected using Storm Drain Inlet Protection (BMP C220 as described above for Element 7).
- Process water and slurry resulting from sawcutting and surfacing operations will be prevented from entering the waters of the State by implementing Sawcutting and Surfacing Pollution Prevention measures (BMP C152).

Concrete and grout:

- Process water and slurry resulting from concrete work will be prevented from entering the waters of the State by implementing Concrete Handling measures (BMP C151).

3.1.10 Element #10 – Control Dewatering

All dewatering water from open cut excavation, tunneling, foundation work, trench, or underground vaults shall be discharged into a controlled conveyance system prior to discharge to the downstream drainage course. Channels will be stabilized, per Element #8. Clean, non-turbid dewatering water will not be routed through stormwater sediment ponds, and will be discharged to systems tributary to the receiving waters of the State in a manner that does not cause erosion, flooding, or a violation of State water quality standards in the receiving water. Highly turbid dewatering water from soils known or suspected to be contaminated, or from use of construction equipment, will require additional monitoring and treatment as required for the specific pollutants based on the receiving waters into which the discharge is occurring. Such monitoring is the responsibility of the contractor.

However, the dewatering of soils known to be free of contamination will trigger BMPs to trap sediment and reduce turbidity. At a minimum, geotextile fabric socks/bags/cells will be used to filter this material. Other BMPs to be used for sediment trapping and turbidity reduction include the following:

- Concrete Handling (BMP C151)

Concrete shall be handled pursuant to BMP C151 wherever and whenever concrete is mixed and poured at the project site.

Alternate dewatering control BMPs are included in Appendix C as a quick reference tool for the onsite inspector in the event the BMP(s) listed above are deemed ineffective or inappropriate

during construction to satisfy the requirements set forth in the General NPDES Permit (Appendix D). To avoid potential erosion and sediment control issues that may cause a violation(s) of the NPDES Construction Stormwater permit (as provided in Appendix D), the Certified Erosion and Sediment Control Lead will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix C after the first sign that existing BMPs are ineffective or failing.

3.1.11 Element #11 – Maintain BMPs

All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. Maintenance and repair shall be conducted in accordance with each particular BMP's specifications. Visual monitoring of the BMPs will be conducted at least once every calendar week and within 24 hours of any rainfall event that causes a discharge from the site. If the site becomes inactive, and is temporarily stabilized, the inspection frequency will be reduced to once every month.

All temporary erosion and sediment control BMPs shall be removed within 30 days after the final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil resulting from removal of BMPs or vegetation shall be permanently stabilized.

3.1.12 Element #12 – Manage the Project

Erosion and sediment control BMPs for this project have been designed based on the following principles:

- Design the project to fit the existing topography, soils, and drainage patterns.
- Emphasize erosion control rather than sediment control.
- Minimize the extent and duration of the area exposed.
- Keep runoff velocities low.
- Retain sediment on site.
- Thoroughly monitor site and maintain all ESC measures.
- Schedule major earthwork during the dry season.

In addition, project management will incorporate the key components listed below:

As this project site is located west of the Cascade Mountain Crest, the project will be managed according to the following key project components:

Phasing of Construction

- The construction project is being phased to the extent practicable in order to prevent soil erosion, and, to the maximum extent possible, the transport of sediment from the site during construction.

- Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities during each phase of construction, per the Scheduling BMP (C 162).

Seasonal Work Limitations

- From October 1 through April 30, clearing, grading, and other soil disturbing activities shall only be permitted if shown to the satisfaction of the local permitting authority that silt-laden runoff will be prevented from leaving the site through a combination of the following:
  - ☐ Site conditions including existing vegetative coverage, slope, soil type, and proximity to receiving waters; and
  - ☐ Limitations on activities and the extent of disturbed areas; and
  - ☐ Proposed erosion and sediment control measures.
- Based on the information provided and/or local weather conditions, the local permitting authority may expand or restrict the seasonal limitation on site disturbance.
- The following activities are exempt from the seasonal clearing and grading limitations:
  - ☐ Routine maintenance and necessary repair of erosion and sediment control BMPs;
  - ☐ Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil; and
  - ☐ Activities where there is 100 percent infiltration of surface water runoff within the site in approved and installed erosion and sediment control facilities.

Coordination with Utilities and Other Jurisdictions

- Care has been taken to coordinate with utilities, other construction projects, and the local jurisdiction in preparing this SWPPP and scheduling the construction work.

Inspection and Monitoring

- All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections shall be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. This person has the necessary skills to:
  - ☐ Assess the site conditions and construction activities that could impact the quality of stormwater, and

- ☐ Assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.

- A Certified Erosion and Sediment Control Lead shall be on-site or on-call at all times.
- Whenever inspection and/or monitoring reveals that the BMPs identified in this SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMPs or design changes shall be implemented as soon as possible.

Maintaining an Updated Construction SWPPP

- This SWPPP shall be retained on-site or within reasonable access to the site.
- The SWPPP shall be modified whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.
- The SWPPP shall be modified if, during inspections or investigations conducted by the owner/operator, or the applicable local or state regulatory authority, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP shall be completed within seven (7) days following the inspection.

3.1.13 Element #13 – Construction Stormwater Chemical Treatment

Turbidity is difficult to control once fine particles are suspended in stormwater runoff from a construction site. Sedimentation ponds are effective at removing larger particulate matter by gravity settling, but are ineffective at removing smaller particulates such as clay and fine silt. Sediment ponds are typically designed to remove sediment no smaller than medium silt (0.02 mm). Chemical treatment may be used to reduce the turbidity of stormwater runoff.

Chemical treatment can reliably provide exceptional reductions of turbidity and associated pollutants. Very high turbidities can be reduced to levels comparable to what is found in streams during dry weather. Traditional BMPs used to control soil erosion and sediment loss from sites under development may not be adequate to ensure compliance with the water quality standard for turbidity in the receiving water. Chemical treatment may be required to protect streams from the impact of turbid stormwater discharges, especially when construction is to proceed through the wet season.

Formal written approval from Ecology and the Local Permitting Authority is required for the use of chemical treatment regardless of site size. The intention to use Chemical

Treatment shall be indicated on the Notice of Intent for coverage under the General Construction Permit. Chemical treatment systems should be designed as part of the Construction SWPPP, not after the fact. Chemical treatment may be used to correct problem sites in limited circumstances with formal written approval from Ecology and the Local Permitting Authority.

The SEPA review authority must be notified at the application phase of the project review (or the time that the SEPA determination on the project is performed) that chemical treatment is proposed. If it is added after this stage, an addendum will be necessary and may result in project approval delay.

See Appendix II-B for background information on chemical treatment.

Criteria for Chemical Treatment Product Use

Chemically treated stormwater discharged from construction sites must be nontoxic to aquatic organisms. The following protocol shall be used to evaluate chemicals proposed for stormwater treatment at construction sites. Authorization to use a chemical in the field based on this protocol does not relieve the applicant from responsibility for meeting all discharge and receiving water criteria applicable to a site.

- Treatment chemicals must be approved by EPA for potable water use.
- Petroleum-based polymers are prohibited.
- Prior to authorization for field use, jar tests shall be conducted to demonstrate that turbidity reduction necessary to meet the receiving water criteria can be achieved. Test conditions, including but not limited to raw water quality and jar test procedures, should be indicative of field conditions. Although these small-scale tests cannot be expected to reproduce performance under field conditions, they are indicative of treatment capability.
- Prior to authorization for field use, the chemically treated stormwater shall be tested for aquatic toxicity. Applicable procedures defined in Chapter 173-205 WAC, Whole Effluent Toxicity Testing and Limits, shall be used. Testing shall use stormwater from the construction site at which the treatment chemical is proposed for use or a water solution using soil from the proposed site.
- The proposed maximum dosage shall be at least a factor of five lower than the no observed effects concentration (NOEC).
- The approval of a proposed treatment chemical shall be conditional, subject to full-scale bioassay monitoring of treated stormwater at the construction site where the proposed treatment chemical is to be used.

- Treatment chemicals that have already passed the above testing protocol do not need to be reevaluated. Contact the Department of Ecology Regional Office for a list of treatment chemicals that have been evaluated and are currently approved for use.

Treatment System Design Considerations

The design and operation of a chemical treatment system should take into consideration the factors that determine optimum, cost-effective performance. It may not be possible to fully incorporate all of the classic concepts into the design because of practical limitations at construction sites. Nonetheless, it is important to recognize the following:

- The right chemical must be used at the right dosage. A dosage that is either too low or too high will not produce the lowest turbidity. There is an optimum dosage rate. This is a situation where the adage "adding more is always better" is not the case.

- The coagulant must be mixed rapidly into the water to insure proper dispersion.

- A flocculation step is important to increase the rate of settling, to produce the lowest turbidity, and to keep the dosage rate as low as possible.

- Too little energy input into the water during the flocculation phase results in flocs that are too small and/or insufficiently dense. Too much energy can rapidly destroy floc as it is formed.

- Since the volume of the basin is a determinant in the amount of energy per unit volume, the size of the energy input system can be too small relative to the volume of the basin.

- Care must be taken in the design of the withdrawal system to minimize outflow velocities and to prevent floc discharge. The discharge should be directed through a physical filter such as a vegetated swale that would catch any unintended floc discharge.

Treatment System Design

Chemical treatment systems shall be designed as batch treatment systems using either ponds or portable trailer-mounted tanks. Flow-through continuous treatment systems are not allowed at this time.

A chemical treatment system consists of the stormwater collection system (either temporary diversion or the permanent site drainage system), a storage pond, pumps, a chemical feed system, treatment cells, and interconnecting piping.

The treatment system shall use a minimum of two lined treatment cells. Multiple treatment cells allow for clarification of treated water while other cells are being filled or emptied. Treatment cells may be ponds or tanks. Ponds with constructed earthen embankments greater than six feet high require special engineering analyses. Portable tanks may also be suitable for some sites.

The following equipment should be located in an operations shed:

- the chemical injector;
- secondary containment for acid, caustic, buffering compound, and treatment chemical;
- emergency shower and eyewash, and
- monitoring equipment which consists of a pH meter and a turbidimeter.

Sizing Criteria

The combination of the storage pond or other holding area and treatment capacity should be large enough to treat stormwater during multiple day storm events. It is recommended that at a minimum the storage pond or other holding area should be sized to hold 1.5 times the runoff volume of the 10-year, 24-hour storm event. Bypass should be provided around the chemical treatment system to accommodate extreme storm events. Runoff volume shall be calculated using the methods presented in Volume 3, Chapter 2. If no hydrologic analysis is required for the site, the Rational Method may be used.

Primary settling should be encouraged in the storage pond. A forebay with access for maintenance may be beneficial.

There are two opposing considerations in sizing the treatment cells. A larger cell is able to treat a larger volume of water each time a batch is processed. However, the larger the cell the longer the time required to empty the cell. A larger cell may also be less effective at flocculation and therefore require a longer settling time. The simplest approach to sizing the treatment cell is to multiply the allowable discharge flow rate times the desired drawdown time. A 4-hour drawdown time allows one batch per cell per 8-hour work period, given 1 hour of flocculation followed by two hours of settling.

The permissible discharge rate governed by potential downstream effect can be used to calculate the recommended size of the treatment cells. The following discharge flow rate limits shall apply:

- If the discharge is directly or indirectly to a stream, the discharge flow rate shall not exceed 50 percent of the peak flow rate of the 2-year, 24-hour event for all storm events up to the 10-year, 24-hour event.

- If discharge is occurring during a storm event equal to or greater than the 10-year, 24-hour event, the allowable discharge rate is the peak flow rate of the 10-year, 24-hour event.

- Discharge to a stream should not increase the stream flow rate by more than 10 percent.

- If the discharge is directly to a lake, a major receiving water listed in Appendix C of Volume I, or to an infiltration system, there is no discharge flow limit.

- If the discharge is to a municipal storm drainage system, the allowable discharge rate may be limited by the capacity of the public system. It may be necessary to clean the municipal storm drainage system prior to the start of the discharge to prevent scouring solids from the drainage system.

- Runoff rates shall be calculated using the methods presented in Volume 3, Chapter 2 for the pre-developed condition. If no hydrologic analysis is required for the site, the Rational Method may be used.

Monitoring

The following monitoring shall be conducted. Test results shall be recorded on a daily log kept on site:

Operational Monitoring

- pH, conductivity (as a surrogate for alkalinity), turbidity and temperature of the untreated stormwater
- Total volume treated and discharged
- Discharge time and flow rate
- Type and amount of chemical used for pH adjustment
- Amount of polymer used for treatment
- Settling time

Compliance Monitoring

- pH and turbidity of the treated stormwater

- pH and turbidity of the receiving water

Biomonitoring: Treated stormwater shall be tested for acute (lethal) toxicity. Bioassays shall be conducted by a laboratory accredited by Ecology, unless otherwise approved by Ecology. **The**

performance standard for acute toxicity is no statistically significant difference in survival between the control and 100 percent chemically treated stormwater.

Acute toxicity tests shall be conducted with the following species and protocols:

- Fathead minnow, Pimephales *promelas* (96 hour static-renewal test, method: EPA/600/4-90/027F). Rainbow trout, Oncorhynchus mykiss (96 hour static-renewal test, method: EPA/600/4-90/027F) may be used as a substitute for fathead minnow.

- Daphnid, *Ceriodaphnia* dubia, *Daphnia pulex, or Daphnia magna (48* hour static test, method: EPA/600/4-90/027F).

All toxicity tests shall meet quality assurance criteria and test conditions in the most recent versions of the EPA test method and Ecology Publication # WO-R-95-80, Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria.

Bioassays shall be performed on the *first* five batches and on every tenth batch thereafter, or as otherwise approved by Ecology. Failure to meet the performance standard shall be immediately reported to Ecology.

Discharge Compliance: **Prior to discharge, each batch of treated stormwater must be sampled and tested for compliance with pH and turbidity limits**. These limits may be established by the water quality standards or a site-specific discharge permit. Sampling and testing for other pollutants may also be necessary at some sites. Turbidity must be within 5 NTUs of the background turbidity. Background is measured in the receiving water, upstream from the treatment process discharge point. pH must be within the range of 6.5 to 8.5 standard units and not cause a change in the pH of the receiving water of more than 0.2 standard units. It is often possible to discharge treated stormwater that has a lower turbidity than the receiving water and that matches the pH.

Treated stormwater samples and measurements shall be taken from the discharge pipe or another location representative of the nature of the treated stormwater discharge. Samples used for determining compliance with the water quality standards in the receiving water shall not be taken from the treatment pond prior to decanting. Compliance with the water quality standards is determined in the receiving water.

Operator Training

Each contractor who intends to use chemical treatment shall be trained by an experienced contractor on an active site for at least 40 hours.

Standard BMPs

Surface stabilization BMPs should be implemented on site to prevent significant erosion. All sites shall use a truck wheel wash to prevent tracking of sediment off site.

Sediment Removal and Disposal

- Sediment shall be removed from the storage or treatment cells as necessary. Typically, sediment removal is required at least once during a wet season and at the decommissioning of the cells. Sediment remaining in the cells between batches may enhance the settling process and reduce the required chemical dosage.

- Sediment may be incorporated into the site away from drainages.

3.1.14 Element #14 – Construction Stormwater Filtration

Filtration removes sediment from runoff originating from disturbed areas of the site.

Traditional BMPs used to control soil erosion and sediment loss from sites under development may not be adequate to ensure compliance with the water quality standard for turbidity in the receiving water. Filtration may be used in conjunction with gravity settling to remove sediment as small as fine silt (0.5 µm). The reduction in turbidity will be dependent on the particle size distribution of the sediment in the stormwater. In some circumstances, sedimentation and filtration may achieve compliance with the water quality standard for turbidity.

Unlike chemical treatment, the use of construction stormwater filtration does not require approval from Ecology.

Filtration may also be used in conjunction with polymer treatment in a portable system to assure capture of the flocculated solids.

Design and Installation Specifications – Background Information

Filtration with sand media has been used for over a century to treat water and wastewater. The use of sand filtration for treatment of stormwater has developed recently, generally to treat runoff from streets, parking lots, and residential areas. The application of filtration to construction stormwater treatment is currently under development.

Two types of filtration systems may be applied to construction stormwater treatment: rapid and slow. Rapid sand filters are the typical system used for water and wastewater treatment. They can achieve relatively high hydraulic flow rates, on the order of 2 to 20 gpm/sf, because they have automatic backwash systems to remove accumulated solids. In contrast, slow sand filters have very low hydraulic rates, on the order of 0.02 gpm/sf, because they do not have backwash systems. To date, slow sand filtration has generally been used to treat stormwater. Slow sand filtration is mechanically simple in comparison to rapid sand filtration but requires a much larger filter area.

Filtration Equipment

Sand media filters are available with automatic backwashing features that can filter to 50 µm particle size. Screen or bag filters can filter down to 5 µm. Fiber wound filters can remove

particles down to 0.5 µm. Filters should be sequenced from the largest to the smallest pore opening. Sediment removal efficiency will be related to particle size distribution in the stormwater.

Treatment Process Description

Stormwater is collected at interception point(s) on the site and is diverted to a sediment pond or tank for removal of large sediment and storage of the stormwater before it is treated by the filtration system. The stormwater is pumped from the trap, pond, or tank through the filtration system in a rapid sand filtration system. Slow sand filtration systems are designed as flow through systems using gravity.

If large volumes of concrete are being poured, pH adjustment may be necessary.

Maintenance Standards

Rapid sand filters typically have automatic backwash systems that are triggered by a pre-set pressure drop across the filter. If the backwash water volume is not large or substantially more turbid than the stormwater stored in the holding pond or tank, backwash return to the pond or tank may be appropriate. However, land application or another means of treatment and disposal may be necessary.

- Screen, bag, and fiber filters must be cleaned and/or replaced when they become clogged.
- Sediment shall be removed from the storage and/or treatment ponds as necessary. Typically, sediment removal is required once or twice during a wet season and at the decommissioning of the ponds.

3.2 Site Specific BMPs

Site specific BMPs are shown on the TESC Plan Sheets and Details in Appendix A. These site specific plan sheets will be updated annually.

4.0 Construction Phasing and BMP Implementation

The BMP implementation schedule will be driven by the construction schedule. The following provides a sequential list of the proposed construction schedule milestones and the corresponding BMP implementation schedule. The list contains key milestones such as wet season construction.

The BMP implementation schedule listed below is keyed to proposed phases of the construction project, and reflects differences in BMP installations and inspections that relate to wet season construction. The project site is located west of the Cascade Mountain Crest. As such, the dry season is considered to be from May 1 to September 30 and the wet season is considered to be from October 1 to April 30.

- Estimate of Construction start date: May 2016
- Estimate of Construction finish date: November 2016
- Mobilize equipment on site: _____
- Mobilize and store all ESC and soil stabilization products (store materials on hand BMP C150): _____
- Install ESC measures: _____
- Install stabilized construction entrance: _____
- Begin clearing and grubbing: _____
- Temporary erosion control measures (hydroseeding): _____
- Site inspections reduced to monthly: _____
- Begin concrete pour and implement BMP C151: _____
- Excavate and install new utilities and services (Phase 1): _____
- Complete utility construction: _____
- Begin implementing soil stabilization and sediment control BMPs throughout the site in preparation for wet season: _____
- **WET SEASON STARTS:** **October 1, 2016**

5.0 Pollution Prevention Team

5.1 Roles and Responsibilities

The pollution prevention team consists of personnel responsible for implementation of the SWPPP, including the following:

- Certified Erosion and Sediment Control Lead (CESCL) – primary contractor contact, responsible for site inspections (BMPs, visual monitoring, sampling, etc.); to be called upon in case of failure of any ESC measures.
- Resident Engineer – For projects with engineered structures only (sediment ponds/traps, sand filters, etc.): site representative for the owner that is the project's supervising engineer responsible for inspections and issuing instructions and drawings to the contractor's site supervisor or representative
- Emergency Ecology Contact – individual to be contacted at Ecology in case of emergency. Go to the following website to get the name and number for the Ecology contact information: http://www.ecy.wa.gov/org.html.
- Emergency Owner Contact – individual that is the site owner or representative of the site owner to be contacted in the case of an emergency.
- Non-Emergency Ecology Contact – individual that is the site owner or representative of the site owner than can be contacted if required.
- Monitoring Personnel – personnel responsible for conducting water quality monitoring; for most sites this person is also the Certified Erosion and Sediment Control Lead.

5.2 Team Members

Names and contact information for those identified as members of the pollution prevention team are provided in the following table.

Title	Name(s)	Phone Number
Certified Erosion and Sediment Control Lead (CESCL)	TBD	
Resident Engineer	Ali Sadr	(425) 251-6222
Emergency Ecology Contact	Clay Keown	(360) 407-6048
Emergency Owner Contact	TBD	
Non-Emergency Ecology Contact	Ali Sadr	(425) 251-6222
Monitoring Personnel	TBD	

6.0 Site Inspections and Monitoring

Monitoring includes visual inspection, monitoring for water quality parameters of concern, and documentation of the inspection and monitoring findings in a site log book. A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements;
- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form and water quality monitoring forms included in this SWPPP include the required information for the site log book. This SWPPP may function as the site log book if desired, or the forms may be separated and included in a separate site log book. However, if separated, the site log book but must be maintained on-site or within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

6.1 Site Inspection

All BMPs will be inspected, maintained, and repaired as needed to assure continued performance of their intended function. The inspector will be a Certified Erosion and Sediment Control Lead (CESCL) per BMP C160. The name and contact information for the CESCL is provided in Section 5 of this SWPPP.

Site inspection will occur in all areas disturbed by construction activities and at all stormwater discharge points. Stormwater will be examined for the presence of suspended sediment, turbidity, discoloration, and oily sheen. The site inspector will evaluate and document the effectiveness of the installed BMPs and determine if it is necessary to repair or replace any of the BMPs to improve the quality of stormwater discharges. All maintenance and repairs will be documented in the site log book or forms provided in this document. All new BMPs or design changes will be documented in the SWPPP as soon as possible.

6.1.1 Site Inspection Frequency

Site inspections will be conducted at least once a week and within 24 hours following any rainfall event which causes a discharge of stormwater from the site. For sites with temporary stabilization measures, the site inspection frequency can be reduced to once every month.

6.1.2 Site Inspection Documentation

The site inspector will record each site inspection using the site log inspection forms provided in Appendix E. The site inspection log forms may be separated from this SWPPP document, but will be maintained on-site or within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

6.2 Stormwater Quality Monitoring

6.2.1 Turbidity Sampling

Monitoring requirements for the proposed project will include either turbidity or water transparency sampling to monitor site discharges for water quality compliance with the 2005 Construction Stormwater General Permit (Appendix D). Sampling will be conducted at all discharge points at least once per calendar week.

Turbidity or transparency monitoring will follow the analytical methodologies described in Section S4 of the 2005 Construction Stormwater General Permit (Appendix D). The key benchmark values that require action are 25 NTU for turbidity (equivalent to 32 cm transparency) and 250 NTU for turbidity (equivalent to 6 cm transparency). If the 25 NTU benchmark for turbidity (equivalent to 32 cm transparency) is exceeded, the following steps will be conducted:

1. Ensure all BMPs specified in this SWPPP are installed and functioning as intended.
2. Assess whether additional BMPs should be implemented, and document revisions to the SWPPP as necessary.
3. Sample discharge location daily until the analysis results are less than 25 NTU (turbidity) or greater than 32 cm (transparency).

If the turbidity is greater than 25 NTU (or transparency is less than 32 cm) but less than 250 NTU (transparency greater than 6 cm) for more than 3 days, additional treatment BMPs will be implemented within 24 hours of the third consecutive sample that exceeded the benchmark.

If the 250 NTU benchmark for turbidity (or less than 6 cm transparency) is exceeded at any time, the following steps will be conducted:

1. Notify Ecology by phone within 24 hours of analysis (see Section 5.0 of this SWPPP for contact information).
2. Continue daily sampling until the turbidity is less than 25 NTU (or transparency is greater than 32 cm).
3. Initiate additional treatment BMPs such as off-site treatment, infiltration, filtration and chemical treatment within 24 hours of the first 250 NTU exceedance.
4. Implement additional treatment BMPs as soon as possible, but within 7 days of the first 250 NTU exceedance.
5. Describe inspection results and remedial actions taken in the site log book and in monthly discharge monitoring reports as described in Section 7.0 of this SWPPP.

6.2.2 pH Sampling

Stormwater runoff will be monitored for pH starting on the first day of any activity that includes more than 40 yards of poured or recycled concrete, or after the application of "Engineered Soils" such as Portland cement treated base, cement kiln dust, or fly ash. This does not include fertilizers. For concrete work, pH monitoring will start the first day concrete is poured and continue until 3 weeks after the last pour. For engineered soils, the pH monitoring period begins when engineered soils are first exposed to precipitation and continue until the area is fully stabilized.

Stormwater samples will be collected daily from all points of discharge from the site and measured for pH using a calibrated pH meter, pH test kit, or wide range pH indicator paper. If the measured pH is 8.5 or greater, the following steps will be conducted:

1. Prevent the high pH water from entering storm drains or surface water.
2. Adjust or neutralize the high pH water if necessary using appropriate technology such as CO_2 sparging (liquid or dry ice).
3. Contact Ecology if chemical treatment other than CO_2 sparging is planned.

7.0 Reporting and Recordkeeping

7.1 Recordkeeping

7.1.1 Site Log Book

A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements;
- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form and water quality monitoring forms included in this SWPPP include the required information for the site logbook.

7.1.2 Records Retention

Records of all monitoring information (site log book, inspection reports/checklists, etc.), this Stormwater Pollution Prevention Plan, and any other documentation of compliance with permit requirements will be retained during the life of the construction project and for a minimum of three years following the termination of permit coverage in accordance with permit condition S5.C.

7.1.3 Access to Plans and Records

The SWPPP, General Permit, Notice of Authorization letter, and Site Log Book will be retained on site or within reasonable access to the site and will be made immediately available upon request to Ecology or the local jurisdiction. A copy of this SWPPP will be provided to Ecology within 14 days of receipt of a written request for the SWPPP from Ecology. Any other information requested by Ecology will be submitted within a reasonable time. A copy of the SWPPP or access to the SWPPP will be provided to the public when requested in writing in accordance with Permit Condition S5.G.

7.1.4 Updating the SWPPP

In accordance with Conditions S3, S4.B, and S9.B.3 of the General Permit, this SWPPP will be modified if the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site or there has been a change in design, construction, operation, or maintenance at the site that has a significant effect on the discharge, or potential for discharge, of pollutants to the waters of the State. The SWPPP will be modified within seven days of determination based on inspection(s) that additional or modified BMPs are necessary to correct problems identified, and an updated timeline for BMP implementation will be prepared.

7.2 Reporting

7.2.1 Discharge Monitoring Reports

Discharge Monitoring Report (DMR) forms will be submitted to Ecology because water quality sampling is being conducted at the site.

7.2.2 Notification of Noncompliance

If any of the terms and conditions of the permit are not met, and it causes a threat to human health or the environment, the following steps will be taken in accordance with permit section S5.F:

1. Ecology will be immediately notified of the failure to comply.
2. Immediate action will be taken to control the noncompliance issue and to correct the problem. If applicable, sampling and analysis of any noncompliance will be repeated immediately and the results submitted to Ecology within five (5) days of becoming aware of the violation.
3. A detailed written report describing the noncompliance will be submitted to Ecology within five (5) days, unless requested earlier by Ecology.

Appendix A – Site Plans

UTILITY CONFLICT NOTE:

CAUTION:
THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THE LOCATION, DIMENSION, AND DEPTH OF ALL EXISTING UTILITIES WHETHER SHOWN ON THESE PLANS OR NOT BY POTHOLING THE UTILITIES AND SURVEYING THE HORIZONTAL AND VERTICAL LOCATION PRIOR TO CONSTRUCTION. THIS SHALL INCLUDE CALLING UTILITY LOCATE @ 1-800-424-5555 AND THEN POTHOLING ALL OF THE EXISTING UTILITIES AT LOCATIONS OF NEW UTILITY CROSSINGS TO PHYSICALLY VERIFY WHETHER OR NOT CONFLICTS EXIST. LOCATIONS OF SAID UTILITIES AS SHOWN ON THESE PLANS ARE BASED UPON THE UNVERIFIED PUBLIC INFORMATION AND ARE SUBJECT TO VARIATION.

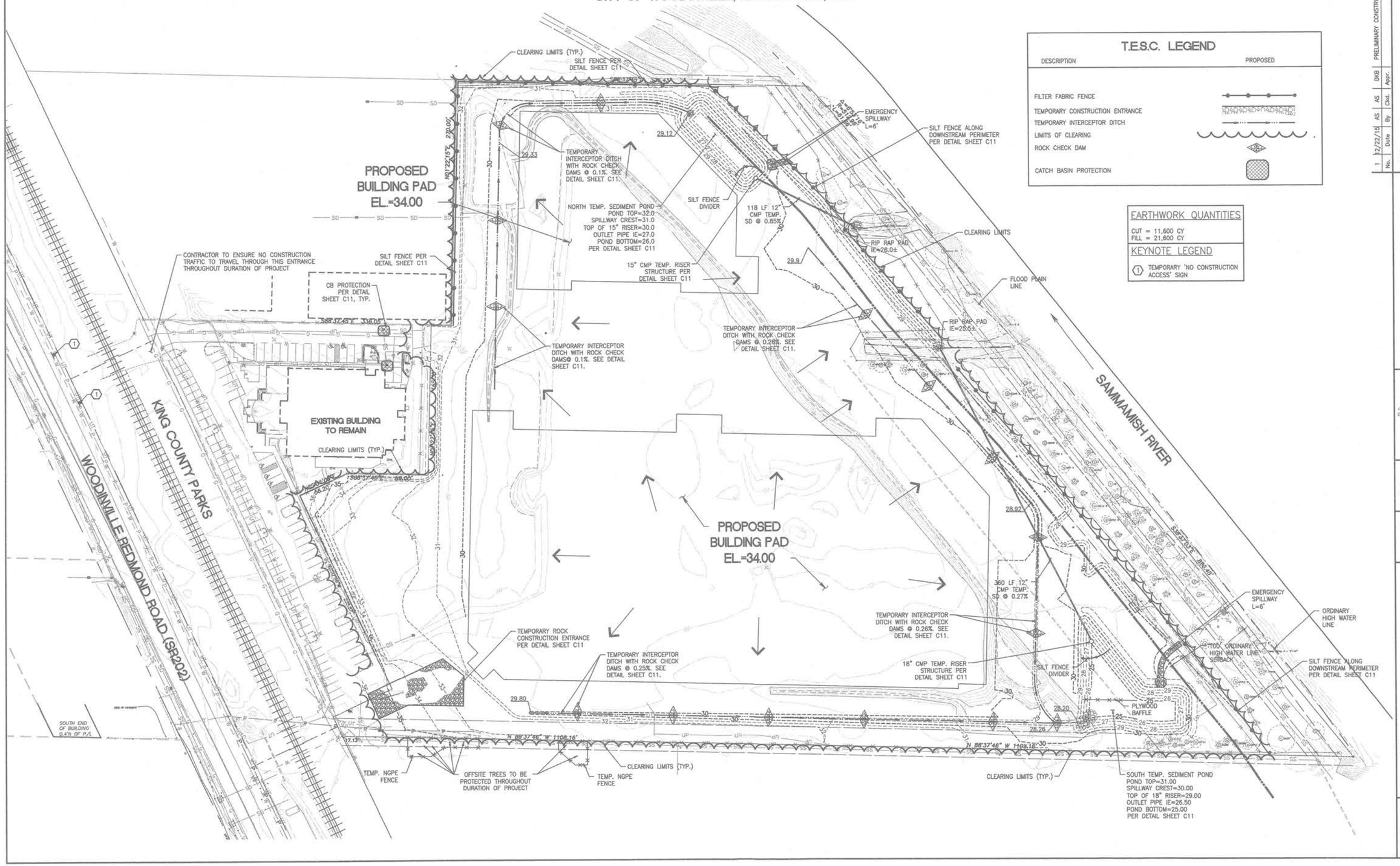
1"=50'

0 25 50 100

T.E.S.C. PLAN
WOODINVILLE LUMBER BUSINESS PARK
PANATTONI DEVELOPMENT

NW 1/4, SECTION 15, TOWNSHIP 26 NORTH, RANGE 5 EAST, W.M.
CITY OF WOODINVILLE, KING COUNTY, WA

CALL BEFORE YOU DIG:
1-800-424-5555



T.E.S.C. LEGEND

DESCRIPTION	PROPOSED
FILTER FABRIC FENCE	
TEMPORARY CONSTRUCTION ENTRANCE	
TEMPORARY INTERCEPTOR DITCH	
LIMITS OF CLEARING	
ROCK CHECK DAM	
CATCH BASIN PROTECTION	

EARTHWORK QUANTITIES

CUT = 11,600 CY
FILL = 21,600 CY

KEYNOTE LEGEND

1. TEMPORARY 'NO CONSTRUCTION ACCESS' SIGN

No.	Date	By	Ckd.	Appr.	Revision
1	12/22/15	AS	AS	DKB	PRELIMINARY CONSTRUCTION SET

Title: T.E.S.C. PLAN
WOODINVILLE LUMBER BUSINESS PARK
PANATTONI DEVELOPMENT

For:
PANATTONI DEVELOPMENTCOMPANY
900 SW 16TH ST., SUITE 330
RENTON, WA 98057
(206) 248-0280

DANIEL K. BALMELLI
STATE OF WASHINGTON
25672
REGISTERED PROFESSIONAL ENGINEER
12/22/2015

Designed	AS	Scale:
Drawn	MB	Horizontal 1"=50'
Checked	AS	Vertical N/A
Approved	DKB	
Date	12/02/15	

BARGHAUSEN CONSULTING ENGINEERS, INC.
18215 72ND AVENUE SOUTH
KENT, WA 98032
(425) 251-6222
(425) 251-8782 FAX
CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

Job Number 15985.1
Sheet C2 of 13

File:P:\15000s\15985\engineering\panatoni 15985.1-E.dwg Date/time:12/28/2015 10:37 AM Scale:1" = 1'

Appendix B – Construction BMPs

Stabilized Construction Entrance (BMP C105)

Temporary Sediment Pond (BMP C241

Silt Fence (BMP C233)

Temporary and Permanent Seeding (BMP C120)

Mulching (BMP C121)

Dust Control (BMP C140)

Check Dams (BMP C207)

Construction Stormwater Chemical Treatment (BMP C250)

Construction Stormwater Filtration (BMP C251)

Appendix C – Alternative BMPs

The following includes a list of possible alternative BMPs for each of the 12 elements not described in the main SWPPP text. This list can be referenced in the event a BMP for a specific element is not functioning as designed and an alternative BMP needs to be implemented.

Element #1 - Mark Clearing Limits

Element #2 - Establish Construction Access

Element #3 - Control Flow Rates

Element #4 - Install Sediment Controls

Advanced BMPs:

Element #5 - Stabilize Soils

Element #6 - Protect Slopes

Element #8 - Stabilize Channels and Outlets

Element #10 - Control Dewatering

Additional Advanced BMPs to Control Dewatering:

Appendix D – General Permit

Appendix E – Site Inspection Forms (and Site Log)

The results of each inspection shall be summarized in an inspection report or checklist that is entered into or attached to the site log book. It is suggested that the inspection report or checklist be included in this appendix to keep monitoring and inspection information in one document, but this is optional; however, it is mandatory that this SWPPP and the site inspection forms be kept onsite at all times during construction, and that inspections be performed and documented as outlined below.

At a minimum, each inspection report or checklist shall include:

a. Inspection date/times

b. Weather information: general conditions during inspection, approximate amount of precipitation since the last inspection, and approximate amount of precipitation within the last 24 hours.

c. A summary or list of all BMPs that have been implemented, including observations of all erosion/sediment control structures or practices.

d. The following shall be noted:

   i. locations of BMPs inspected,

   ii. locations of BMPs that need maintenance,

   iii. the reason maintenance is needed,

   iv. locations of BMPs that failed to operate as designed or intended, and

   v. locations where additional or different BMPs are needed, and the reason(s) why

e. A description of stormwater discharged from the site. The presence of suspended sediment, turbid water, discoloration, and/or oil sheen shall be noted, as applicable.

f. A description of any water quality monitoring performed during inspection, and the results of that monitoring.

g. General comments and notes, including a brief description of any BMP repairs, maintenance or installations made as a result of the inspection.

h. A statement that, in the judgment of the person conducting the site inspection, the site is either in compliance or out of compliance with the terms and conditions of the SWPPP and the NPDES permit. If the site inspection indicates that the site is out of compliance, the inspection report shall include a summary of the remedial actions required to bring the site back into compliance, as well as a schedule of implementation.

i. Name, title, and signature of person conducting the site inspection; and the following statement: "I certify under penalty of law that this report is true, accurate, and complete, to the best of my knowledge and belief".

When the site inspection indicates that the site is not in compliance with any terms and conditions of the NPDES permit, the Permittee shall take immediate action(s) to: stop, contain, and clean up the unauthorized discharges, or otherwise stop the noncompliance; correct the

problem(s); implement appropriate Best Management Practices (BMPs), and/or conduct maintenance of existing BMPs; and achieve compliance with all applicable standards and permit conditions. In addition, if the noncompliance causes a threat to human health or the environment, the Permittee shall comply with the Noncompliance Notification requirements in Special Condition S5.F of the permit.

Site Inspection Form

General Information

Project Name: Woodinville Lumber Business Park
Inspector Name: TBD **Title:**
CESCL # :
Date: **Time:**
Inspection Type:
- ☐ After a rain event
- ☐ Weekly
- ☐ Turbidity/transparency benchmark exceedance
- ☐ Other

Weather
Precipitation Since last inspection In last 24 hours
Description of General Site Conditions:

Inspection of BMPs

Element 1: Mark Clearing Limits

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

Element 2: Establish Construction Access

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

Element 3: Control Flow Rates

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

Element 4: Install Sediment Controls

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

Element 5: Stabilize Soils

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

Element 6: Protect Slopes

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

BMP:

Location	Inspected Y	Inspected N	Functioning Y	Functioning N	Functioning NIP	Problem/Corrective Action

Element 7: Protect Drain Inlets

BMP:

Location	Inspected Y N	Functioning Y	N	NIP	Problem/Corrective Action

BMP:

Location	Inspected Y N	Functioning Y	N	NIP	Problem/Corrective Action

BMP:

Location	Inspected Y N	Functioning Y	N	NIP	Problem/Corrective Action

Element 8: Stabilize Channels and Outlets

BMP:

Location	Inspected Y N	Functioning Y	N	NIP	Problem/Corrective Action

BMP:

Location	Inspected Y N	Functioning Y	N	NIP	Problem/Corrective Action

BMP:

Location	Inspected Y N	Functioning Y	N	NIP	Problem/Corrective Action

BMP:

Location	Inspected Y N	Functioning Y	N	NIP	Problem/Corrective Action

Element 9: Control Pollutants

BMP:

Location	Inspected Y N	Functioning Y	N	NIP	Problem/Corrective Action

BMP:

Location	Inspected Y N	Functioning Y	N	NIP	Problem/Corrective Action

Element 10: Control Dewatering

BMP:

Location	Inspected Y N	Functioning Y	N	NIP	Problem/Corrective Action

BMP:

Location	Inspected Y N	Functioning Y	N	NIP	Problem/Corrective Action

BMP:

Location	Inspected Y N	Functioning Y	N	NIP	Problem/Corrective Action

Stormwater Discharges From the Site

	Observed? Y N	Problem/Corrective Action
Location		
Turbidity		
Discoloration		
Sheen		
Location		
Turbidity		
Discoloration		
Sheen		

Water Quality Monitoring
Was any water quality monitoring conducted? ☐ Yes ☐ No If water quality monitoring was conducted, record results here:
If water quality monitoring indicated turbidity 250 NTU or greater; or transparency 6 cm or less, was Ecology notified by phone within 24 hrs? ☐ Yes ☐ No
If Ecology was notified, indicate the date, time, contact name and phone number below: Date: Time: Contact Name: Phone #:
General Comments and Notes Include BMP repairs, maintenance, or installations made as a result of the inspection.
Were Photos Taken? ☐ Yes ☐ No If photos taken, describe photos below:

Appendix F – Engineering Calculations

```
                    KCRTS Command
                    -------------
                CREATE a new Time Series
                ------------------------
            Production of Runoff Time Series
    Project Location : Sea-Tac
     Computing Series : 15985ESCnorth.tsf
Regional Scale Factor :    1.00
            Data Type : Reduced
Creating 15-minute Time Series File
          Loading Time Series File:C:\KC_SWDM\KC_DATA\STTG15R.srf    :
                     Flow Path: Length    30.00 ft @ Slope  0.020000
Till Grass              0.20 acres
Time of Concentration (21.827) exceeds maximum (10.) for EI
          Loading Time Series File:C:\KC_SWDM\KC_DATA\STEI15R.rnf    :
                     Flow Path: Length   830.00 ft @ Slope  0.007200
Impervious              3.83 acres
           --------------
         Total Area :    4.03 acres
Peak Discharge:   4.62 CFS at  6:30 on Jan  9 in Year 8
                      Storing Time Series File:15985ESCnorth.tsf    :
                 Time Series Computed

                    KCRTS Command
                    -------------
            Enter the Analysis TOOLS Module
            -------------------------------

                Analysis Tools Command
                ----------------------
           Compute PEAKS and Flow Frequencies
           ----------------------------------
                Loading Stage/Discharge curve:15985escnorth.tsf    :
        Flow Frequency Analysis
        -------------------------------------------------------
  Time Series File:15985escnorth.tsf
  Project Location:Sea-Tac
            Frequencies & Peaks saved to File:15985ESCnorth.pks    :

                Analysis Tools Command
                ----------------------
                RETURN to Previous Menu
                -----------------------

                    KCRTS Command
                    -------------
                CREATE a new Time Series
                ------------------------
            Production of Runoff Time Series
    Project Location : Sea-Tac
     Computing Series : 15985ESCsouth.tsf
Regional Scale Factor :    1.00
            Data Type : Reduced
```

```
Creating 15-minute Time Series File
                    Loading Time Series File:C:\KC_SWDM\KC_DATA\STTG15R.srf    :
                                Flow Path: Length    30.00 ft @ Slope  0.020000
Till Grass              0.34 acres
Time of Concentration (21.119) exceeds maximum (10.) for EI
                    Loading Time Series File:C:\KC_SWDM\KC_DATA\STEI15R.rnf    :
                                Flow Path: Length   850.00 ft @ Slope  0.008200
Impervious              6.54 acres
                     --------------
         Total Area :    6.89 acres
Peak Discharge:   7.88 CFS at  6:30 on Jan  9 in Year 8
                                 Storing Time Series File:15985ESCsouth.tsf    :
                             Time Series Computed

                                 KCRTS Command
                                 -------------
                        Enter the Analysis TOOLS Module
                        -------------------------------

                            Analysis Tools Command
                            ----------------------
                      Compute PEAKS and Flow Frequencies
                      ----------------------------------
                            Loading Stage/Discharge curve:15985escsouth.tsf    :
          Flow Frequency Analysis
          -------------------------------------------------------
  Time Series File:15985escsouth.tsf
  Project Location:Sea-Tac
                        Frequencies & Peaks saved to File:15985ESCsouth.pks    :

                            Analysis Tools Command
                            ----------------------
                            RETURN to Previous Menu
                            -----------------------

                                 KCRTS Command
                                 -------------
                              eXit KCRTS Program
                              ------------------
```

Flow Frequency Analysis
Time Series File:15985escnorth.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---			-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	Rank	Return Period	Prob
1.83	6	8/27/01 18:00	4.62	1	100.00	0.990
1.27	8	9/17/02 17:45	3.51	2	25.00	0.960
3.51	2	12/08/02 17:15	2.48	3	10.00	0.900
1.47	7	8/23/04 14:30	2.06	4	5.00	0.800
1.95	5	10/28/04 16:00	1.95	5	3.00	0.667
2.06	4	10/27/05 10:45	1.83	6	2.00	0.500
2.48	3	10/25/06 22:45	1.47	7	1.30	0.231
4.62	1	1/09/08 6:30	1.27	8	1.10	0.091
Computed Peaks			4.25		50.00	0.980

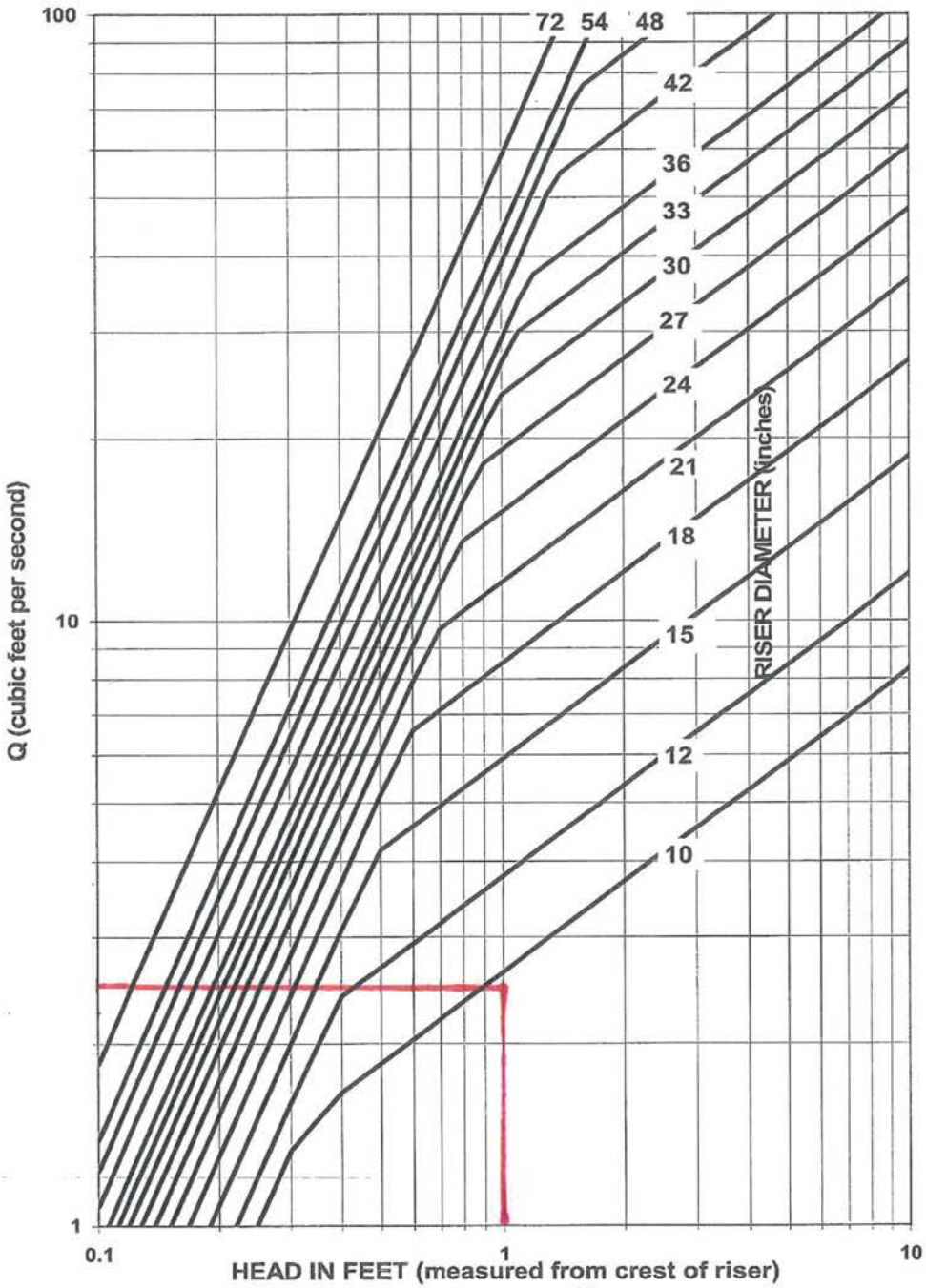
Flow Frequency Analysis
Time Series File:15985escsouth.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---			-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	Rank	Return Period	Prob
3.12	6	8/27/01 18:00	7.88	1	100.00	0.990
2.17	8	9/17/02 17:45	6.00	2	25.00	0.960
6.00	2	12/08/02 17:15	4.24	3	10.00	0.900
2.51	7	8/23/04 14:30	3.51	4	5.00	0.800
3.32	5	10/28/04 16:00	3.32	5	3.00	0.667
3.51	4	10/27/05 10:45	3.12	6	2.00	0.500
4.24	3	10/25/06 22:45	2.51	7	1.30	0.231
7.88	1	1/09/08 6:30	2.17	8	1.10	0.091
Computed Peaks			7.25		50.00	0.980

Riser Overflow

The nomograph in Figure 5.3.4.H may be used to determine the head (in feet) above a riser of given diameter and for a given flow (usually the 100-year peak flow for developed conditions).

FIGURE 5.3.4.H RISER INFLOW CURVES



$Q_{weir}=9.739\ DH^{3/2}$

$Q_{orifice}=3.782\ D^2H^{1/2}$

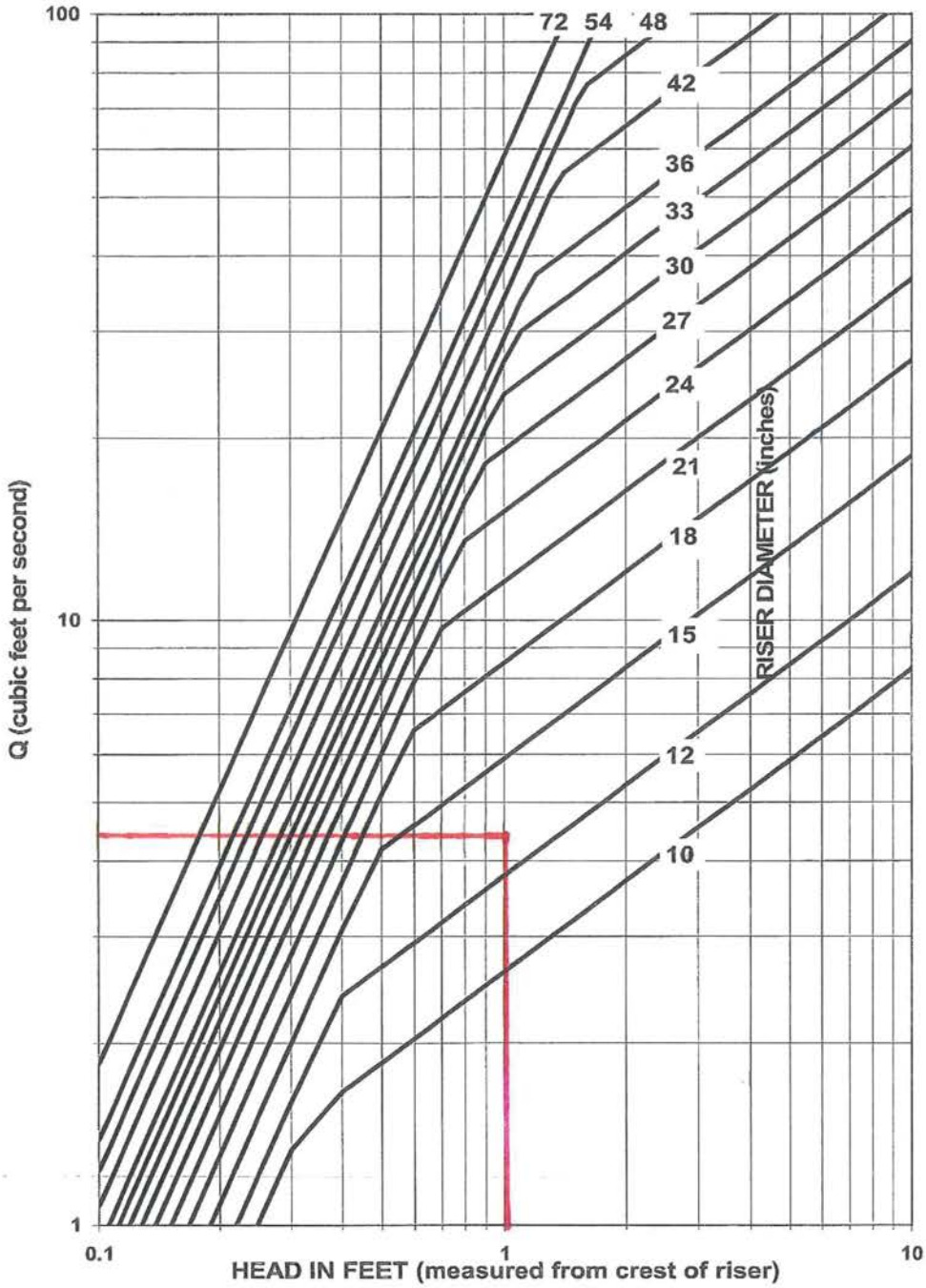
Q in cfs, D and H in feet

Slope change occurs at weir-orifice transition

Riser Overflow

The nomograph in Figure 5.3.4.H may be used to determine the head (in feet) above a riser of given diameter and for a given flow (usually the 100-year peak flow for developed conditions).

FIGURE 5.3.4.H RISER INFLOW CURVES



SOUTH POND

$Q_{weir}=9.739\ DH^{3/2}$

$Q_{orifice}=3.782\ D^2H^{1/2}$

Q in cfs, D and H in feet

Slope change occurs at weir-orifice transition

SIZE THE SEDIMENT PONDS AND APPURTENANCES

North Pond:

Surface area required at top of riser:

S.A. = 2,080 Q_2 = 2,080(1.83) = 3,806 sf

Provided = 3,888 sf – So OK

Principal Spillway:

Q_{10} = 2.48 cfs and Let h = 1-foot – See Figure 5.3.4.H

10-inch diameter required – Use 15-inch diameter

Emergency Overflow Spillway:

$L = [Q^{100}/((3.21)(H^{1.5}))] - 2.4(H) = [(4.62)/((3.21)(0.5)^{1.5})] - 2.4(0.5)$

L = 2.87 feet – Use 6-foot minimum

Orifice Sizing:

Head = 3-foot

A_S = 3,806 sf

$A_O = (4.81)(10^{-6})(A_S)(h)^{0.5} = (4.81)(10^{-6})(3{,}806)(3)^{0.5} = 0.0317$ sf

$D = 13.54(A_O)^{0.5} = 13.54(0.0317)^{0.5} = 2.4110$-inches

Use 2-13/32-inch diameter

South Pond:

Surface area required at top of riser:

S.A. = 2,080 Q_2 = 2,080(3.12) = 6,490 sf

Provided = 8,090 sf – So OK

Principal Spillway:

Q_{10} = 4.24 cfs and Let h = 1-foot – See Figure 5.3.4.H

15-inch diameter required – Use 18-inch diameter

Emergency Overflow Spillway:

$L = [(7.88)/((3.21)(0.5)^{1.5})] - 2.4(0.5)$

L = 5.74 feet – Use 6-foot minimum

Orifice Sizing:

Head = 2.5-foot

A_S = 6,490 sf

$A_O = (4.81)(10^{-6})(6{,}490)(2.5)^{0.5} = 0.0494$ sf

$D = 13.54(A_O)^{0.5} = 13.54(0.0494)^{0.5} = 3.0081$-inches

Use 3-inch diameter

Tab 9.0

9.0 BOND QUANTITIES, FACILITY SUMMARIES, AND DECLARATION OF COVENANT

IF THE BOND QUANTITIES, FACILITY SUMMARIES, AND DECLARATION OF COVENANT ARE REQUIRED THEN THEY WILL BE SUBMITTED WITH THE FINAL TECHNICAL INFORMATION REPORT PREPARED FOR THIS PROJECT

Tab 10.0

10.0 OPERATIONS AND MAINTENANCE MANUAL

IF AN OPERATIONS AND MAINTENANCE MANUAL IS REQUIRED THEN IT WILL BE SUBMITTED WITH THE FINAL TECHNICAL INFORMATION REPORT PREPARED FOR THIS PROJECT