PRELIMINARY

STORM DRAINAGE REPORT

FOR

VINTAGE AT MILL CREEK

CITY OF MILL CREEK IN SNOHOMISH COUNTY, WASHINGTON

MICHAEL A. MOODY
STATE OF WASHINGTON
41843
REGISTERED
PROFESSIONAL ENGINEER

1/11/2016

Project Manager:	**David E. Cayton. P.E.**
Prepared by:	**Preston J. Longoni, E.I.T.**
Approved by:	**Michael A. Moody, P.E.**
Date:	**March 2015**
Revised:	**May 2015, January 2016**
Core No.:	**15008**

CORE DESIGN

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SECTION 1: PROJECT OVERVIEW

Vintage at Mill Creek is a proposed mixed-use development consisting of apartments, retail/commercial space, parking garages, and associated on-site roadways and utilities. The project is part of the City of Mill Creek's East Gateway Urban Village (EGUV) project and is located within the western portion of the EGUV. The project is bordered by 132nd Street SE (SR 96) to the north, single-family residences to the west and south, and essentially vacant land to the west that is to also be developed in the near future as part of the EGUV project. See *Figure 1-1: Vicinity Map* on the following page.

The entire project site currently sheet flows runoff from east to west onto the neighboring properties for approximately a quarter of a mile before ultimately entering the wetlands adjacent to Penny Creek. There is no evidence of concentrated surface flow prior to entering the wetlands. The 3.80-acre property currently consists of grass, and a few fir trees located around the outskirts of the property. There are no existing structures or pavement on the site.

The runoff from the developed site will be temporarily treated and detained by a combined detention/wetpond located within an easement on the neighboring parcel near the southwest corner of the project site. When the neighboring development is constructed, its detention vault will be sized to account for the entire Vintage at Mill Creek site, and the temporary detention/wetpond will be eliminated. The detention and water quality facilities will be designed per the Washington State Department of Ecology's Stormwater Management Manual for Western Washington, 2005 Edition (DOE Manual).

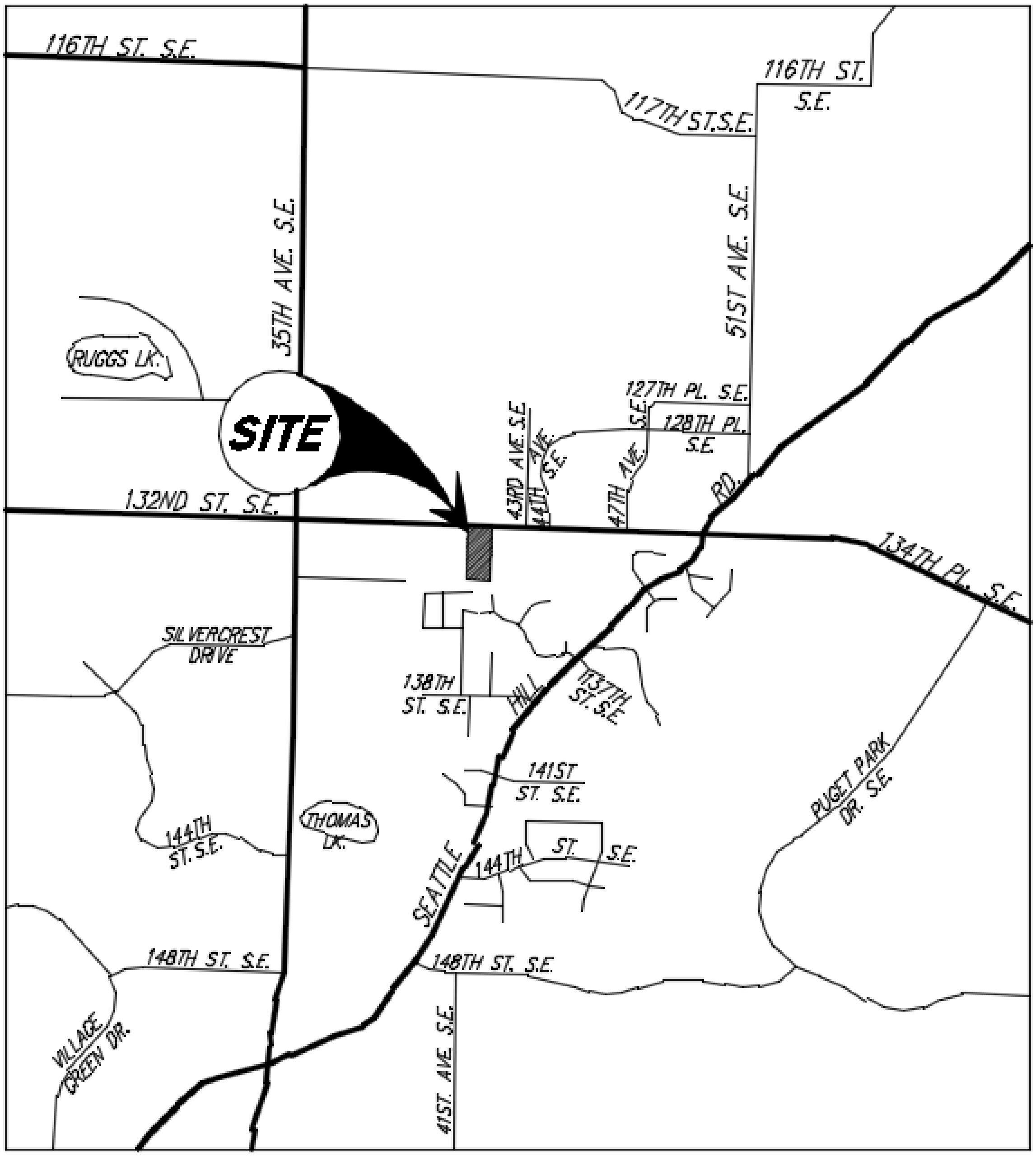


Figure 1-1: Vicinity Map

SECTION 2: CONDITIONS AND REQUIREMENTS SUMMARY

The proposed development is classified as a "New Development" project and therefore all nine minimum requirements will be addressed per Appendix I of the 2012 NPDES Western Washington Phase II Municipal Stormwater Permit and the 2005 edition of the State Department of Ecology's Stormwater Management Manual for Western Washington.

2.1 Minimum Requirements

2.1.1 Minimum Requirement #1: Preparation of Stormwater Site Plans

Preliminary Civil Plans under separate cover and a Preliminary Storm Drainage Report herein have been prepared for the subject project.

2.1.2 Minimum Requirement #2: Construction Stormwater Pollution Prevention Plan (SWPPP)

A SWPPP will be prepared and submitted during final design.

2.1.3 Minimum Requirement #3: Source Control of Pollution

This minimum requirement will be addressed during final design.

2.1.4 Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls

The project proposes to discharge its stormwater onto the neighboring parcel to the west, preserving the natural drainage system. Runoff from the site currently sheet flows to the west and eventually enters the wetland adjacent to Penny Creek near the intersection of 132nd Street SE and 35th Avenue SE. This existing condition will be mimicked.

2.1.5 Minimum Requirements #5: On-Site Stormwater Management

Roof downspout controls are not feasible for the subject project due to minimum required setbacks, lot size, and/or flow path. Therefore, roof stubs will be solid PVC and will be connected to the permanent storm drain system.

2.1.6 Minimum Requirement #6: Runoff Treatment

Preliminary design of the water quality treatment facility is included in Section 4 of this report. It is proposed that a temporary detention/wetpond facility will be utilized until the detention vault for the neighboring development is constructed.

2.1.7 Minimum Requirement #7: Flow Control

Design of the flow control facility is described in Section 4 of this report. A detention pond is proposed in order to provide adequate flow control, which requires that the developed condition discharge durations match the existing condition durations from 50% of the 2-year to the 50-year storm events and that the developed 2-year and 10-year peak discharge rates do not exceed the existing 2-year and 10-year peak discharge rates, respectively.

2.1.8 Minimum Requirement #8: Wetlands Protection
There are no wetlands on the property.

2.1.9 Minimum Requirement #9: Operation and Maintenance
Operations and Maintenance Guidelines will be provided during final design.

SECTION 3: OFFSITE ANALYSIS

Date of Field Inspection: January 28th, 2015

Weather Conditions: Overcast, approximately 50 degrees Fahrenheit

Upstream:

There is no effective upstream drainage tributary to the site.

Downstream:

The existing project site is currently grassland, with a few fir trees along the outskirts of the property. There are no existing structures on the site. The topography is gently rolling and generally slopes from east to west. Most of the rainwater permeates into the ground, but any runoff would sheet flow to the west across the undeveloped neighboring properties and eventually to a large wetland area adjacent to Penny Creek approximately 1/4 mile downstream. There are no defined drainage courses that would concentrate surface water prior to entering the large wetland area. The slope across these neighboring properties is fairly constant from the site down to the wetland. It is proposed that the discharge from the project site is designed and constructed in a manner that would allow the future development to the west to pick up the relatively low developed flows from the site. There are no signs of erosion or flooding issues. Refer to *Figure 3-1: Downstream Map* included at the end of this section.

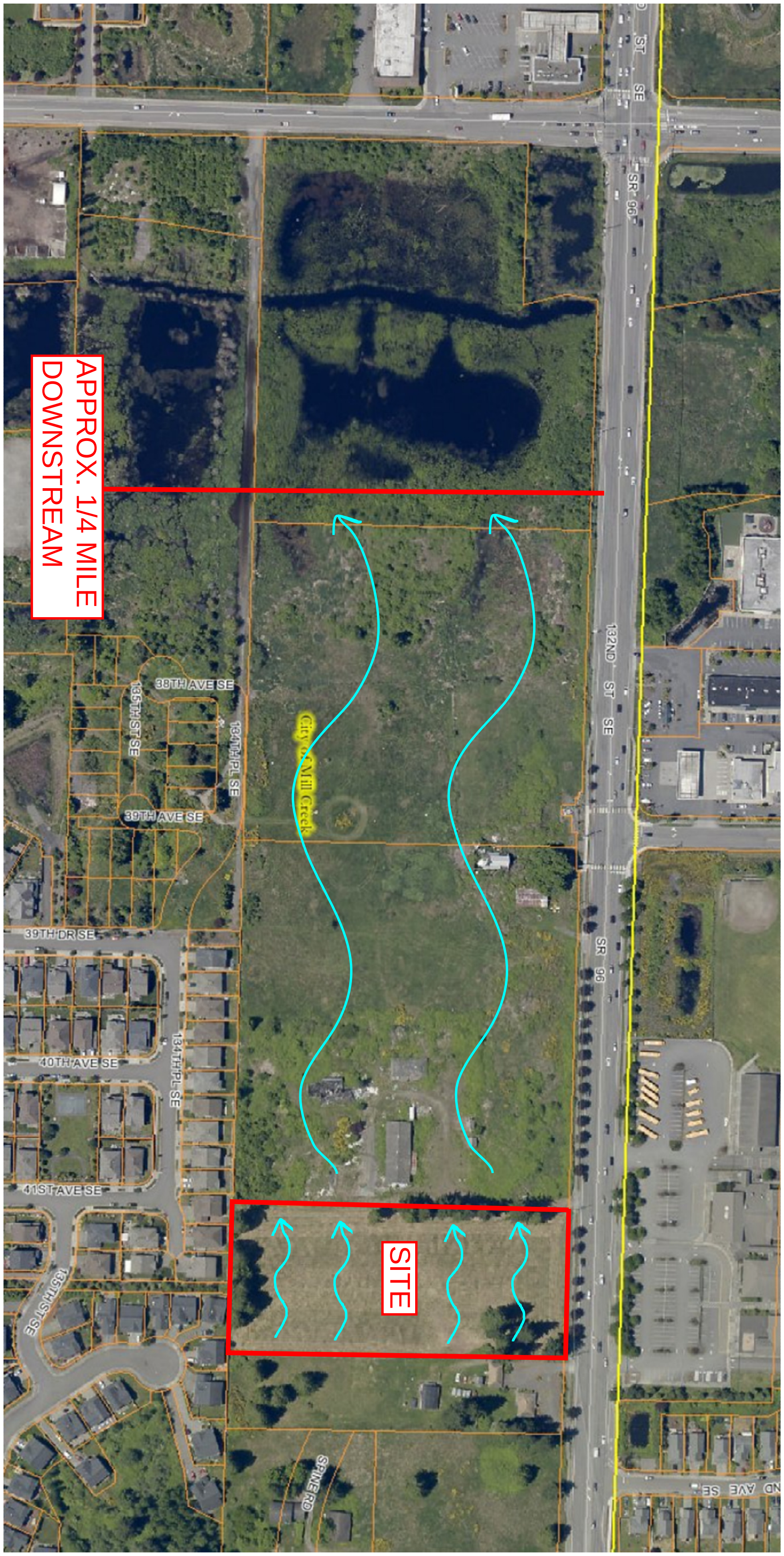


FIGURE 3-1: DOWNSTREAM MAP

SECTION 4: FLOW CONTROL AND WATER QUALITY DESIGN

4.1 Hydraulic Analysis

The drainage analysis was modeled using the WWHM 2012 software. The on-site soils are Alderwood gravelly sandy loam per the USDA NRCS Soils Map included in this section. This soil type has a SCS Hydrologic Soil Group classification of "C".

4.1.1 Project LID Feasibility

Site Soils

Based on a review of the proposed project, the soils on site are entirely Alderwood Gravelly Sandy Loam (AgC) soils, a till soil (hydrologic soil group C). Appendix A of the *Geotechnical Engineering Study* discusses observed high perched groundwater ranging from 4 feet to 8 foot depths. LID elements constructed on till soils do not typically perform well due to their reliance on infiltration (glacial till soils, unless weathered, typically have low permeability). However, the Puget Sound Partnership's *LID Technical Guidance Manual for Puget Sound* notes that:

1) Bioretention facilities and permeable pavements can perform adequately in soils exhibiting minimum infiltration rates as low as 0.1 in/hr; and
2) Hydrologic soil groups A, B and C are considered to be appropriate for implementing LID elements.

Due to the Hydrologic Soils Group C soils and based on guidance in both the 2005 DOE Manual and the LID Technical Guidance Manual, vegetated roofs, limited bioretention facilities, and limited permeable pavements are feasible for the proposed project site.

Hydrology

One of the primary considerations for applying and integrating LID elements into a project is the hydrologic impact. Since a primary objective of sustainable site design and LID is to better mimic the natural hydrologic cycle, the overall impact a project has on its environment is theoretically reduced by managing the stormwater very near to the point where it falls.

The City of Mill Creek provides some direct benefit to the hydrologic modeling (detention facility sizing), required of a project, when LID elements are proposed. The proposed project requires flow control and water quality treatment, so the hydrologic credits given for the application of LID BMPs may benefit the project.

Soil Map—Snohomish County Area, Washington

Map Scale: 1:1,120 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 15, 30, 60, 90

Feet: 0, 50, 100, 200, 300

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

MAP LEGEND

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

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 12, Sep 30, 2014

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

Date(s) aerial images were photographed: Jul 7, 2014—Jul 8, 2014

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

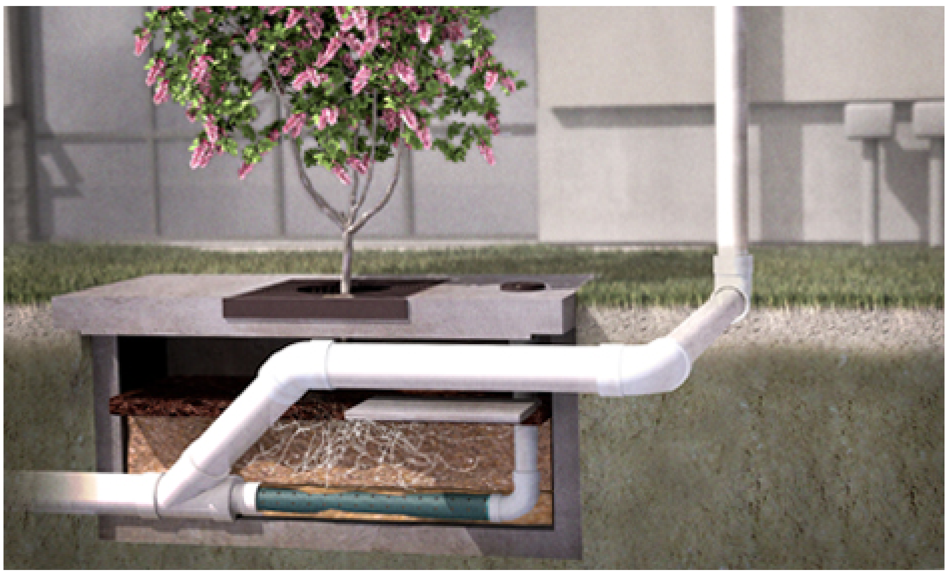
Map Unit Legend

Snohomish County Area, Washington (WA661)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1	Alderwood gravelly sandy loam, 0 to 8 percent slopes	4.1	100.0%
Totals for Area of Interest		**4.1**	**100.0%**

Feasible Project-specific LID Elements

Bioretention (Rain Gardens)

The City of Mill Creek, through its adoption of the Stormwater Management Manual for Western Washington recognizes bioretention facilities (rain gardens or swales) as providing effective stormwater management for both flow control (detention) and water quality. Based on site characteristics, rain gardens are a feasible solution for limited application. Alternatively, the Filterra system, also feasible, is functionally equivalent to rain gardens and provides effective bioretention without typical infiltration limitations.



Filterra Roof Drain Vault Schematic

Bioretention facilities are not proposed for this project due to low permeability soils and observed high perched groundwater ranging from 4 feet to 8 foot depths (Appendix A, *Geotechnical Engineering Study*). In addition, high maintenance costs associated with box unit alternative rain gardens (i.e. Filterra) make these alternative designs infeasible for the project.

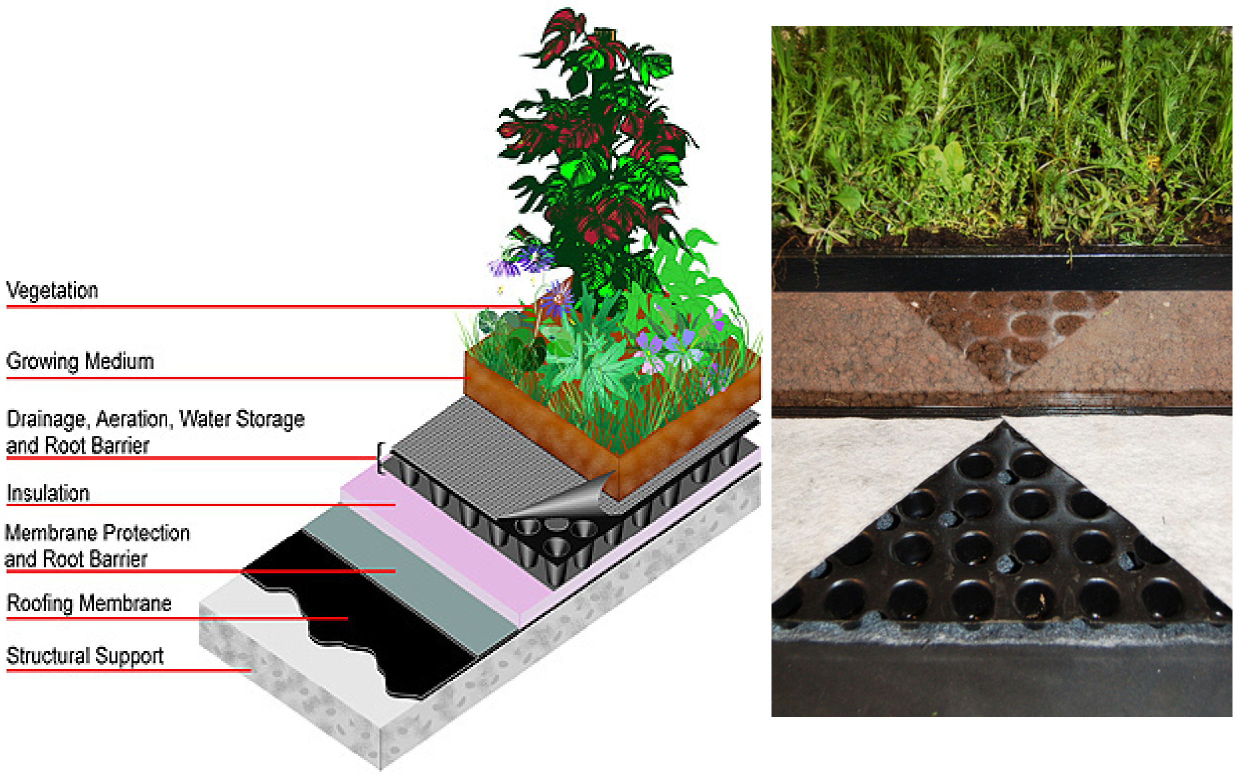
Permeable Pavements

The hydrologic benefit of applying Permeable Pavement varies depending on the specific design elements chosen, ranging from a 50/50 split (pervious/impervious) to 100% impervious routed to an infiltration basin (disconnected from detention facility, maximum benefit).

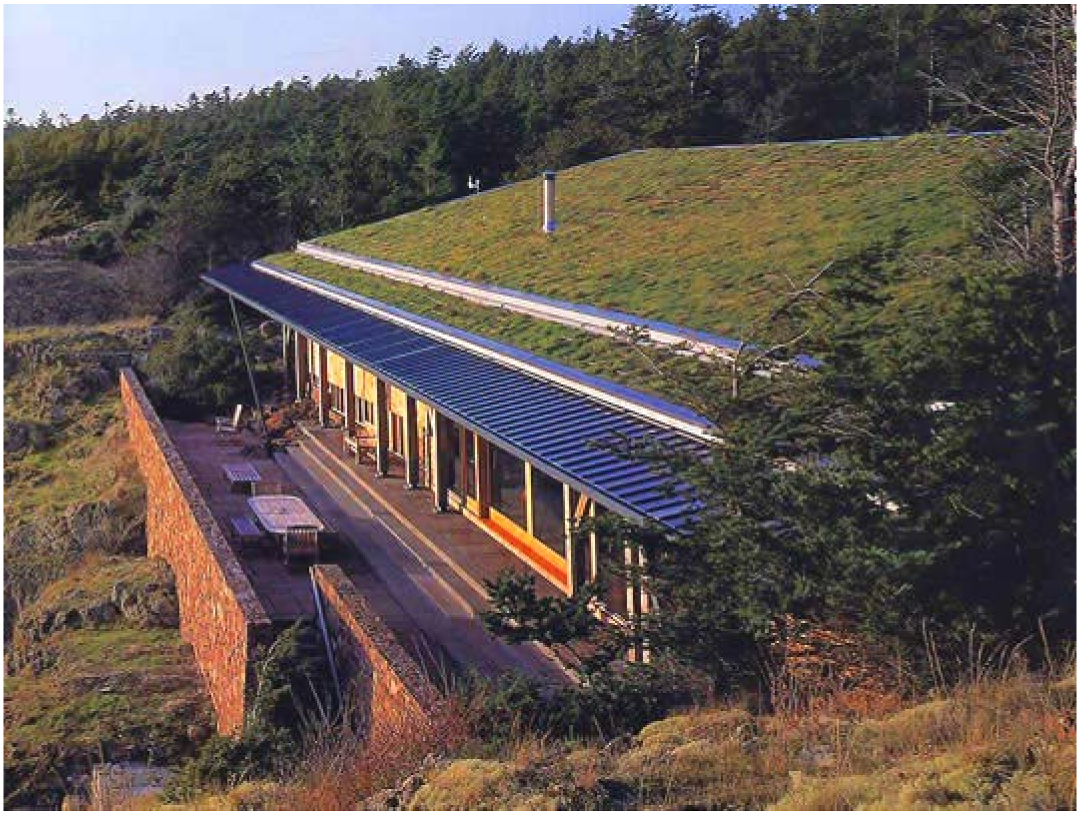
Vegetated Rooftops

Vegetated rooftops have grown in popularity in the United States in recent years. The City of Mill Creek follows the guidance within the DOE Manual for applying hydrologic benefits, if applicable. Extensive monitoring on existing vegetated rooftops within the region (City of Seattle and City of Portland) has resulted in a better understanding of stormwater management benefits.

Although feasible for this project, vegetated rooftops are not proposed due to significant increase in cost combined with limited hydrologic benefit and marketing appeal.



Vegetated Roof Component Example Detail and Photo



Established Traditional Vegetated Rooftop

4.1.2 Existing Conditions

The subject property is 3.80 acres in total area and is currently covered in grass, with a few trees along the property lines. There are no existing structures or other impervious surfaces located on-site. Any runoff currently sheet flows to the west onto the neighboring properties and eventually enters wetlands adjacent to Penny Creek. The topography of the site is gently rolling, with a gentle slope from east to west. The entire site is identified to be within one drainage basin. In the existing condition, the entire site will be modeled as forest. Refer to Table 4.1 (below) for a summary of the existing conditions, and *Figure 4-1: Existing Conditions Exhibit*.

Table 4.1: Existing Conditions Summary

Surface Cover Type	Area (acres)
C-Forest	3.80
Total	**3.80**

The areas in Table 4.1 were used as inputs to WWHM in order to produce the pre-developed condition. The full WWHM report is included In Appendix A of this report.

4.1.3 Developed Conditions

The proposed development includes the construction of two 5-story buildings, three 1-story parking garages, and associated roadways, parking lots, and utilities. The 5-story buildings consist of ground level covered parking and retail/commercial space, with four stories of apartment units above. Flow control will be provided by a detention pond located within an easement on the neighboring parcel near the southwest corner of the project site. The proposed runoff treatment method is a two-facility treatment train consisting of a wetpool followed by Contech Stormfilter. The wetpool is located within the detention pond, beneath the live storage. Runoff from the roadways, sidewalks, and landscaped areas will be collected by catch basins and conveyed to the detention/water quality facilities via 12-inch PVC pipe. Roof and footing drains will by tight-lined to the conveyance system. On-site BMPs are not feasible due to the soil characteristics and setback requirements.

Table 4.2 (below) summarizes the developed basin areas. Also, refer to *Figure 4-2: Developed Conditions Exhibit*.

Table 4.2: Developed Conditions Summary

Surface Cover Type	Area (acres)
C – Grass	0.92
Impervious	2.88
Total	**3.80**

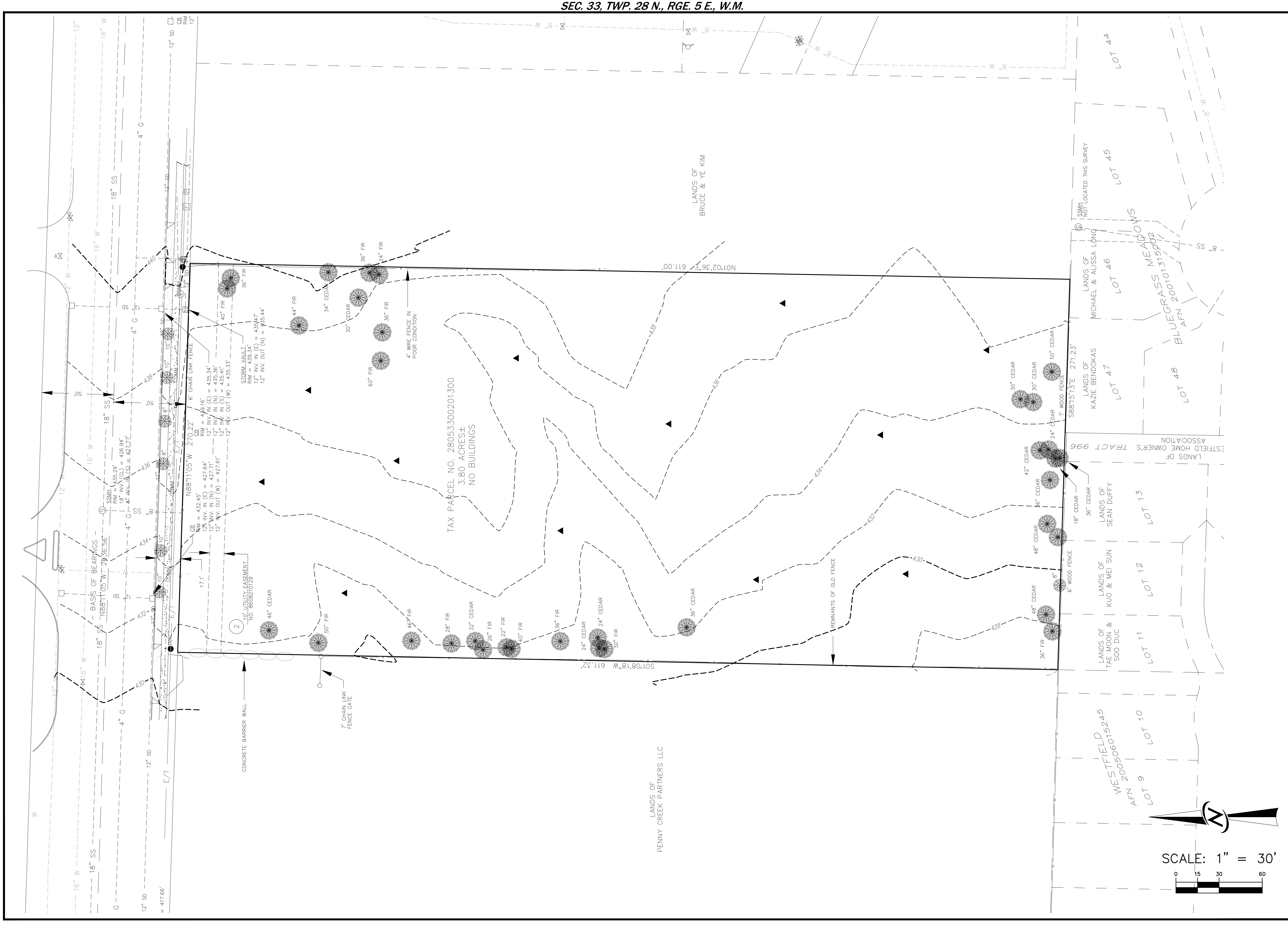


FIGURE 4-1: EXISTING CONDITIONS EXHIBIT

VINTAGE AT MILL CREEK

RYAN PATTERSON

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DATE	FEBRUARY 2015
DESIGNED	PRESTON J. LONGONI, E.I.T.
DRAWN	PRESTON J. LONGONI, E.I.T.
APPROVED	DAVID E. CAYTON, P.E.
	DAVID E. CAYTON, P.E. PROJECT MANAGER
SHEET	C1
OF	
PROJECT NUMBER	15008

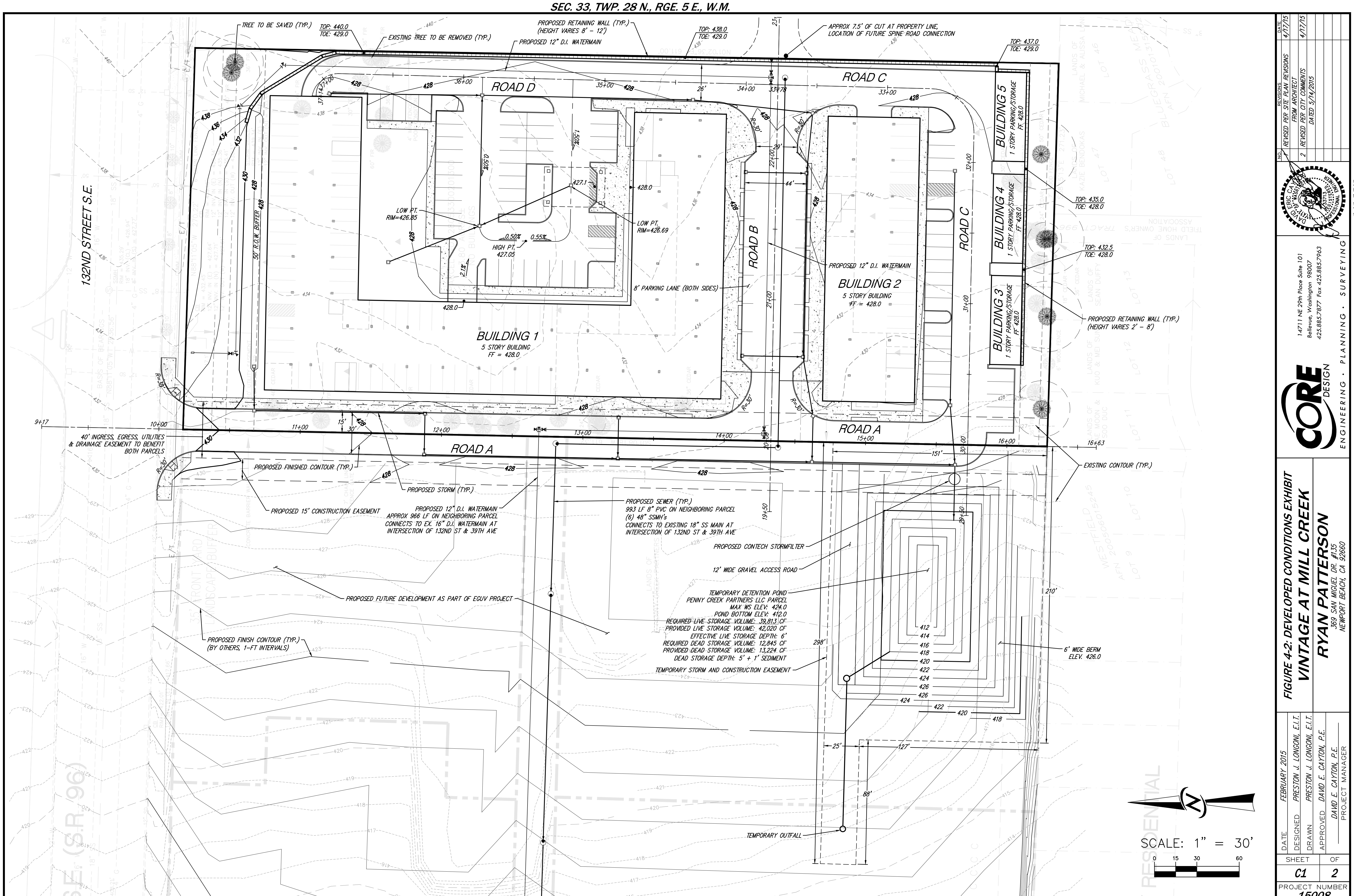
SEC. 33, TWP. 28 N., RGE. 5 E., W.M.
TREE TO BE SAVED (TYP.)
EXISTING TREE TO BE REMOVED (TYP.)
TOP: 440.0 TOE: 429.0
PROPOSED RETAINING WALL (TYP.) (HEIGHT VARIES 8' - 12')
PROPOSED 12" D.I. WATERMAIN
TOP: 438.0 TOE: 429.0
APPROX 7.5' OF CUT AT PROPERTY LINE, LOCATION OF FUTURE SPINE ROAD CONNECTION
TOP: 437.0 TOE: 429.0
ROAD D
ROAD C
ROAD B
ROAD A
132ND STREET S.E.
30' R.O.W. BUFFER
LOW PT. RIM=426.85
LOW PT. RIM=426.69
HIGH PT. 427.05
8' PARKING LANE (BOTH SIDES)
BUILDING 1
5 STORY BUILDING
FF = 428.0
BUILDING 2
5 STORY BUILDING
FF = 428.0
PROPOSED 12" D.I. WATERMAIN
BUILDING 3
1 STORY PARKING/STORAGE
FF 428.0
BUILDING 4
1 STORY PARKING/STORAGE
FF 428.0
BUILDING 5
1 STORY PARKING/STORAGE
FF 428.0
TOP: 435.0 TOE: 428.0
TOP: 432.5 TOE: 428.0
PROPOSED RETAINING WALL (TYP.) (HEIGHT VARIES 2' - 8')
40' INGRESS, EGRESS, UTILITIES & DRAINAGE EASEMENT TO BENEFIT BOTH PARCELS
PROPOSED FINISHED CONTOUR (TYP.)
PROPOSED STORM (TYP.)
PROPOSED 15' CONSTRUCTION EASEMENT
PROPOSED 12" D.I. WATERMAIN APPROX 966 LF ON NEIGHBORING PARCEL CONNECTS TO EX. 16" D.I. WATERMAIN AT INTERSECTION OF 132ND ST & 39TH AVE
PROPOSED SEWER (TYP.) 993 LF 8" PVC ON NEIGHBORING PARCEL (6) 48" SSMH's CONNECTS TO EXISTING 18" SS MAIN AT INTERSECTION OF 132ND ST & 39TH AVE
EXISTING CONTOUR (TYP.)
PROPOSED CONTECH STORMFILTER
12' WIDE GRAVEL ACCESS ROAD
TEMPORARY DETENTION POND
PENNY CREEK PARTNERS LLC PARCEL
MAX WS ELEV: 424.0
POND BOTTOM ELEV: 412.0
REQUIRED LIVE STORAGE VOLUME: 39,813 CF
PROVIDED LIVE STORAGE VOLUME: 42,020 CF
EFFECTIVE LIVE STORAGE DEPTH: 6'
REQUIRED DEAD STORAGE VOLUME: 12,845 CF
PROVIDED DEAD STORAGE VOLUME: 13,224 CF
DEAD STORAGE DEPTH: 5' + 1' SEDIMENT
TEMPORARY STORM AND CONSTRUCTION EASEMENT
PROPOSED FUTURE DEVELOPMENT AS PART OF EGUV PROJECT
PROPOSED FINISH CONTOUR (TYP.) (BY OTHERS, 1-FT INTERVALS)
6' WIDE BERM ELEV. 426.0
TEMPORARY OUTFALL
N
SCALE: 1" = 30'
0 15 30 60
REVISIONS
1 REVISED PER SITE PLAN REVISIONS FROM ARCHITECT 4/17/15
2 REVISED PER CITY COMMENTS DATED 5/14/2015 4/17/15
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FIGURE 4-2: DEVELOPED CONDITIONS EXHIBIT
VINTAGE AT MILL CREEK
RYAN PATTERSON
369 SAN MIGUEL DR. #135
NEWPORT BEACH, CA 92660
DATE FEBRUARY 2015
DESIGNED PRESTON J. LONGONI, E.I.T.
DRAWN PRESTON J. LONGONI, E.I.T.
APPROVED DAVID E. CAYTON, P.E.
DAVID E. CAYTON, P.E. PROJECT MANAGER
SHEET C1 OF 2
PROJECT NUMBER 15008

4.2 Detention Facility Design

Per the DOE manual, the standard flow control requirement is such that the developed (mitigated) condition discharge durations match the existing condition durations from 50% of the 2-year to the 50-year storm events and that the developed 2-year and 10-year peak discharge rates do not exceed the existing 2-year and 10-year peak discharge rates, respectively. A combined detention/wetpool facility will be utilized to meet the flow control requirement for this site. The project proposes to discharge stormwater from the pond onto the neighboring property to the west using a bubble-up structure for energy dissipation, preserving the natural discharge location. This property to the west will be developed in the near future as part of the EGUV master plan and the new detention vault will be sized in order to sufficiently replace the temporary detention pond for the Vintage at Mill Creek site.

The detention vault was sized per the DOE manual and modeled using the WWHM software. The full report of the detention sizing produced by WWHM is included in Appendix A. A summary of the vault and control structure is included below:

The proposed detention pond required storage volume at the top of the riser is 39,813 cubic feet with a riser height/depth of 5.5 feet. The provided volume is 42,020 cubic feet at the top of the riser. The control structure will consist of a 12-inch diameter riser pipe with three orifices: a 15/16-inch diameter orifice in the bottom plate of the riser pipe, approximately two feet below the invert elevation of the outlet pipe; a 1-inch diameter orifice 3.3 feet above the outlet invert elevation; and a 1-5/16-inch diameter orifice located four feet above the outlet invert elevation. The top of the riser pipe shall also have a rectangular notch that is 0.85-feet long and ½-inch wide. The invert elevation of the outlet pipe is located at the live/dead interface (LWS elevation) which is proposed to be set at an elevation of 418.00.

4.3 Water Quality Facility Design

Since the site ultimately discharges to a fresh water source, Penny Creek, and is a multi-family project, Enhanced Treatment is required. A two-facility treatment train is proposed, consisting of a Contech Stormfilter followed by a wetpond. The wetvault will function as a wetpool located beneath the live storage within the detention vault.

Wetpool Sizing

WWHM was used to calculate the required water quality storage volume of 0.2949 acre-feet, or 12,845 cubic feet. The provided volume in the wetpond is 13,224 cubic feet at a depth of five feet and sediment storage depth of one foot.

Contech Stormfilter Sizing

The required sizing information was sent to Contech who then was responsible for sizing the Stormfilter vault and size/number of cartridges needed. The Stormfilter will be located upstream of the detention facility. Utilizing the option that required 3.05 feet of head, a 96-inch Contech Stormfilter Manhole with 12 – 27-inch filter cartridges would provide adequate water quality.

SECTION 5: CONVEYANCE SYSTEM ANALYSIS AND DESIGN

5.1 Backwater Analysis

This section will be completed during final engineering design.

SECTION 6: SPECIAL REPORTS AND STUDIES

- Geotechnical Engineering Report (included in Appendix B)
  Prepared for: Vintage Housing Development, LLC
  Prepared by: Raymond A. Coglas, P.E.
  Dated: March 24, 2005
  Earth Solutions NW, LLC
  1805 136th Place NE, Suite 201
  Bellevue, WA 98005

APPENDIX

Appendix A – WWHM Detention/Water Quality Calculations

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	15008 WWHM Offsite Pond
Site Name:	
Site Address:	
City:	
Report Date:	1/8/2016
Gage:	Everett
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.00
Version:	2015/06/05

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data
Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
C, Forest, Mod	3.8
Pervious Total	3.8
Impervious Land Use	Acres
Impervious Total	0
Basin Total	3.8

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
C, Lawn, Mod	0.92
Pervious Total	0.92
Impervious Land Use	Acres
ROADS MOD	2.88
Impervious Total	2.88
Basin Total	3.8

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1		

Routing Elements
Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

Bottom Length:	90.00 ft.
Bottom Width:	50.00 ft.
Depth:	6 ft.
Volume at riser head:	0.9135 acre-ft.
Side slope 1:	3 To 1
Side slope 2:	3 To 1
Side slope 3:	3 To 1
Side slope 4:	3 To 1
Discharge Structure	
Riser Height:	5.5 ft.
Riser Diameter:	12 in.
Notch Type:	Rectangular
Notch Width:	0.040 ft.
Notch Height:	0.850 ft.
Orifice 1 Diameter:	0.94 in. Elevation:0 ft.
Orifice 2 Diameter:	1 in. Elevation:3.3 ft.
Orifice 3 Diameter:	1.3125 in Elevation:4 ft.
Element Flows To:	
Outlet 1	Outlet 2

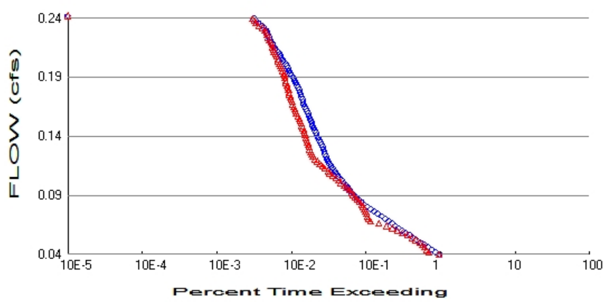
Pond Hydraulic Table

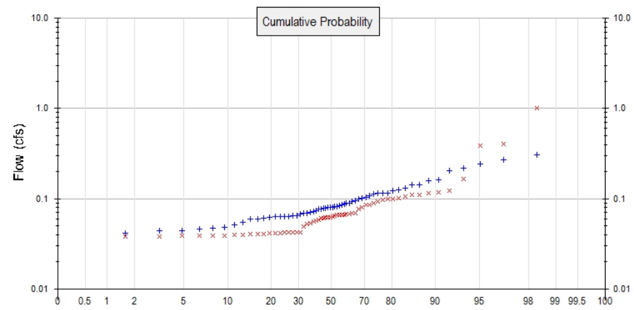
Stage(ft)	**Area(ac)**	**Volume(ac-ft)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.103	0.000	0.000	0.000
0.0667	0.104	0.006	0.006	0.000
0.1333	0.105	0.013	0.008	0.000
0.2000	0.107	0.021	0.010	0.000
0.2667	0.108	0.028	0.012	0.000
0.3333	0.109	0.035	0.013	0.000
0.4000	0.111	0.042	0.015	0.000
0.4667	0.112	0.050	0.016	0.000
0.5333	0.113	0.057	0.017	0.000
0.6000	0.115	0.065	0.018	0.000
0.6667	0.116	0.073	0.019	0.000
0.7333	0.117	0.081	0.020	0.000
0.8000	0.119	0.089	0.021	0.000
0.8667	0.120	0.097	0.022	0.000
0.9333	0.122	0.105	0.023	0.000
1.0000	0.123	0.113	0.024	0.000
1.0667	0.124	0.121	0.024	0.000
1.1333	0.126	0.129	0.025	0.000
1.2000	0.127	0.138	0.026	0.000
1.2667	0.129	0.146	0.027	0.000
1.3333	0.130	0.155	0.027	0.000
1.4000	0.131	0.164	0.028	0.000
1.4667	0.133	0.173	0.029	0.000
1.5333	0.134	0.182	0.029	0.000
1.6000	0.136	0.191	0.030	0.000
1.6667	0.137	0.200	0.031	0.000
1.7333	0.139	0.209	0.031	0.000
1.8000	0.140	0.218	0.032	0.000
1.8667	0.142	0.228	0.032	0.000
1.9333	0.143	0.237	0.033	0.000

2.0000	0.145	0.247	0.033	0.000
2.0667	0.146	0.257	0.034	0.000
2.1333	0.148	0.266	0.035	0.000
2.2000	0.149	0.276	0.035	0.000
2.2667	0.151	0.286	0.036	0.000
2.3333	0.152	0.297	0.036	0.000
2.4000	0.154	0.307	0.037	0.000
2.4667	0.155	0.317	0.037	0.000
2.5333	0.157	0.328	0.038	0.000
2.6000	0.159	0.338	0.038	0.000
2.6667	0.160	0.349	0.039	0.000
2.7333	0.162	0.360	0.039	0.000
2.8000	0.163	0.370	0.040	0.000
2.8667	0.165	0.381	0.040	0.000
2.9333	0.167	0.392	0.041	0.000
3.0000	0.168	0.404	0.041	0.000
3.0667	0.170	0.415	0.042	0.000
3.1333	0.171	0.426	0.042	0.000
3.2000	0.173	0.438	0.042	0.000
3.2667	0.175	0.450	0.043	0.000
3.3333	0.176	0.461	0.048	0.000
3.4000	0.178	0.473	0.052	0.000
3.4667	0.180	0.485	0.055	0.000
3.5333	0.181	0.497	0.058	0.000
3.6000	0.183	0.509	0.060	0.000
3.6667	0.185	0.522	0.062	0.000
3.7333	0.186	0.534	0.064	0.000
3.8000	0.188	0.546	0.065	0.000
3.8667	0.190	0.559	0.067	0.000
3.9333	0.191	0.572	0.069	0.000
4.0000	0.193	0.585	0.070	0.000
4.0667	0.195	0.598	0.084	0.000
4.1333	0.197	0.611	0.090	0.000
4.2000	0.198	0.624	0.095	0.000
4.2667	0.200	0.637	0.100	0.000
4.3333	0.202	0.651	0.104	0.000
4.4000	0.204	0.664	0.108	0.000
4.4667	0.205	0.678	0.111	0.000
4.5333	0.207	0.692	0.115	0.000
4.6000	0.209	0.706	0.118	0.000
4.6667	0.211	0.720	0.122	0.000
4.7333	0.213	0.734	0.127	0.000
4.8000	0.214	0.748	0.135	0.000
4.8667	0.216	0.762	0.143	0.000
4.9333	0.218	0.777	0.152	0.000
5.0000	0.220	0.792	0.161	0.000
5.0667	0.222	0.806	0.171	0.000
5.1333	0.224	0.821	0.181	0.000
5.2000	0.225	0.836	0.191	0.000
5.2667	0.227	0.851	0.202	0.000
5.3333	0.229	0.867	0.213	0.000
5.4000	0.231	0.882	0.223	0.000
5.4667	0.233	0.897	0.234	0.000
5.5333	0.235	0.913	0.306	0.000
5.6000	0.237	0.929	0.577	0.000
5.6667	0.239	0.945	0.949	0.000
5.7333	0.241	0.961	1.363	0.000
5.8000	0.243	0.977	1.759	0.000

5.8667	0.244	0.993	2.086	0.000
5.9333	0.246	1.009	2.314	0.000
6.0000	0.248	1.026	2.459	0.000
6.0667	0.250	1.043	2.629	0.000

Analysis Results
POC 1





+ Predeveloped   x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 3.8
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.92
Total Impervious Area: 2.88

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.084658
5 year	0.129593
10 year	0.161897
25 year	0.205265
50 year	0.239277
100 year	0.27466

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.063258
5 year	0.110709
10 year	0.15579
25 year	0.233129
50 year	0.30916
100 year	0.404528

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.046	0.050
1950	0.090	0.062
1951	0.081	0.040
1952	0.062	0.039
1953	0.048	0.040
1954	0.241	0.056
1955	0.124	0.098
1956	0.108	0.100
1957	0.124	0.080
1958	0.087	0.043

1959	0.092	0.059
1960	0.077	0.068
1961	0.081	0.090
1962	0.070	0.042
1963	0.102	0.042
1964	0.072	0.038
1965	0.081	0.061
1966	0.044	0.041
1967	0.099	0.042
1968	0.116	0.068
1969	0.115	0.043
1970	0.063	0.042
1971	0.103	0.109
1972	0.079	0.061
1973	0.065	0.063
1974	0.142	0.062
1975	0.064	0.040
1976	0.061	0.057
1977	0.051	0.052
1978	0.064	0.039
1979	0.141	0.054
1980	0.074	0.038
1981	0.060	0.041
1982	0.077	0.109
1983	0.132	0.041
1984	0.080	0.122
1985	0.114	0.085
1986	0.270	0.386
1987	0.116	0.167
1988	0.064	0.107
1989	0.064	0.039
1990	0.084	0.086
1991	0.090	0.063
1992	0.068	0.067
1993	0.045	0.039
1994	0.042	0.066
1995	0.086	0.102
1996	0.160	0.093
1997	0.304	1.000
1998	0.054	0.040
1999	0.078	0.069
2000	0.047	0.114
2001	0.014	0.035
2002	0.082	0.070
2003	0.060	0.066
2004	0.094	0.118
2005	0.069	0.064
2006	0.205	0.098
2007	0.161	0.077
2008	0.218	0.402
2009	0.068	0.067

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.3043	1.0004
2	0.2703	0.4022
3	0.2414	0.3856

4	0.2179	0.1670
5	0.2049	0.1221
6	0.1611	0.1176
7	0.1601	0.1141
8	0.1418	0.1093
9	0.1410	0.1092
10	0.1317	0.1068
11	0.1241	0.1023
12	0.1236	0.1000
13	0.1163	0.0982
14	0.1158	0.0975
15	0.1146	0.0934
16	0.1139	0.0897
17	0.1079	0.0859
18	0.1028	0.0855
19	0.1018	0.0796
20	0.0993	0.0767
21	0.0942	0.0698
22	0.0921	0.0691
23	0.0900	0.0683
24	0.0897	0.0682
25	0.0873	0.0669
26	0.0858	0.0667
27	0.0843	0.0661
28	0.0823	0.0658
29	0.0812	0.0644
30	0.0809	0.0633
31	0.0806	0.0627
32	0.0800	0.0623
33	0.0793	0.0623
34	0.0783	0.0614
35	0.0775	0.0608
36	0.0770	0.0587
37	0.0740	0.0573
38	0.0718	0.0563
39	0.0703	0.0538
40	0.0693	0.0520
41	0.0685	0.0495
42	0.0683	0.0427
43	0.0649	0.0425
44	0.0643	0.0424
45	0.0641	0.0422
46	0.0640	0.0420
47	0.0636	0.0419
48	0.0635	0.0414
49	0.0619	0.0412
50	0.0612	0.0410
51	0.0599	0.0404
52	0.0598	0.0402
53	0.0542	0.0401
54	0.0512	0.0397
55	0.0477	0.0393
56	0.0467	0.0392
57	0.0460	0.0391
58	0.0446	0.0391
59	0.0440	0.0382
60	0.0417	0.0381
61	0.0142	0.0347

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0423	20677	20499	99	Pass
0.0443	18362	14715	80	Pass
0.0463	16300	13888	85	Pass
0.0483	14427	13079	90	Pass
0.0503	12880	12127	94	Pass
0.0523	11479	11169	97	Pass
0.0543	10243	10019	97	Pass
0.0563	9135	8838	96	Pass
0.0582	8183	7691	93	Pass
0.0602	7270	6631	91	Pass
0.0622	6492	5655	87	Pass
0.0642	5831	4849	83	Pass
0.0662	5251	4036	76	Pass
0.0682	4750	3155	66	Pass
0.0702	4295	2460	57	Pass
0.0722	3863	2293	59	Pass
0.0742	3461	2233	64	Pass
0.0761	3069	2173	70	Pass
0.0781	2714	2104	77	Pass
0.0801	2449	2037	83	Pass
0.0821	2209	1948	88	Pass
0.0841	2008	1866	92	Pass
0.0861	1842	1740	94	Pass
0.0881	1707	1616	94	Pass
0.0901	1571	1520	96	Pass
0.0921	1455	1445	99	Pass
0.0941	1362	1362	100	Pass
0.0960	1289	1280	99	Pass
0.0980	1212	1169	96	Pass
0.1000	1145	1084	94	Pass
0.1020	1074	992	92	Pass
0.1040	1001	924	92	Pass
0.1060	937	842	89	Pass
0.1080	894	760	85	Pass
0.1100	849	701	82	Pass
0.1120	811	659	81	Pass
0.1139	763	599	78	Pass
0.1159	721	555	76	Pass
0.1179	689	514	74	Pass
0.1199	664	476	71	Pass
0.1219	641	439	68	Pass
0.1239	625	418	66	Pass
0.1259	604	402	66	Pass
0.1279	586	387	66	Pass
0.1299	571	378	66	Pass
0.1319	554	368	66	Pass
0.1338	540	361	66	Pass
0.1358	523	351	67	Pass
0.1378	507	343	67	Pass
0.1398	484	336	69	Pass
0.1418	465	329	70	Pass
0.1438	450	320	71	Pass
0.1458	439	314	71	Pass

0.1478	424	307	72	Pass
0.1498	412	296	71	Pass
0.1517	403	287	71	Pass
0.1537	390	278	71	Pass
0.1557	376	272	72	Pass
0.1577	365	260	71	Pass
0.1597	357	248	69	Pass
0.1617	343	242	70	Pass
0.1637	335	237	70	Pass
0.1657	323	229	70	Pass
0.1677	312	221	70	Pass
0.1696	304	218	71	Pass
0.1716	300	211	70	Pass
0.1736	293	207	70	Pass
0.1756	285	201	70	Pass
0.1776	275	197	71	Pass
0.1796	269	194	72	Pass
0.1816	259	191	73	Pass
0.1836	251	186	74	Pass
0.1856	244	182	74	Pass
0.1876	235	178	75	Pass
0.1895	228	174	76	Pass
0.1915	213	172	80	Pass
0.1935	205	169	82	Pass
0.1955	198	164	82	Pass
0.1975	190	159	83	Pass
0.1995	185	152	82	Pass
0.2015	178	146	82	Pass
0.2035	168	143	85	Pass
0.2055	163	140	85	Pass
0.2074	154	135	87	Pass
0.2094	148	130	87	Pass
0.2114	141	125	88	Pass
0.2134	132	121	91	Pass
0.2154	126	120	95	Pass
0.2174	120	118	98	Pass
0.2194	115	113	98	Pass
0.2214	111	107	96	Pass
0.2234	108	104	96	Pass
0.2254	104	101	97	Pass
0.2273	101	99	98	Pass
0.2293	98	94	95	Pass
0.2313	91	87	95	Pass
0.2333	86	78	90	Pass
0.2353	77	71	92	Pass
0.2373	70	68	97	Pass
0.2393	68	64	94	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.2949 acre-feet
On-line facility target flow:	0.5291 cfs.
Adjusted for 15 min:	0.5291 cfs.
Off-line facility target flow:	0.2985 cfs.
Adjusted for 15 min:	0.2985 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Trapezoidal Pond 1 POC	☐	417.03			☐	0.00			
Total Volume Infiltrated		417.03	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

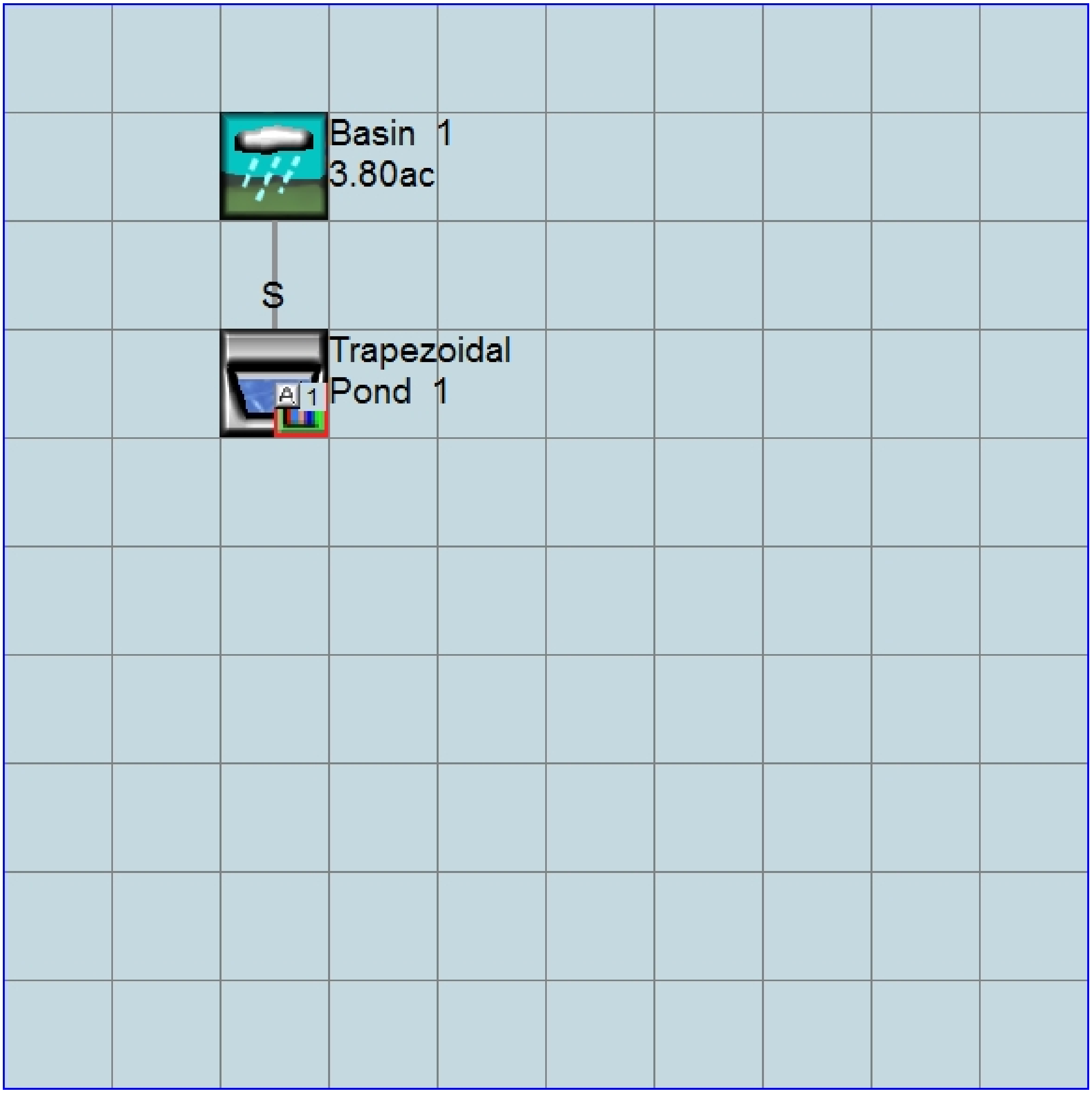
No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic

Mitigated Schematic



Predeveloped UCI File

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   15008 WWHM Offsite Pond.wdm
MESSU      25   Mit15008 WWHM Offsite Pond.MES
           27   Mit15008 WWHM Offsite Pond.L61
           28   Mit15008 WWHM Offsite Pond.L62
           30   POC15008 WWHM Offsite Pond1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      17
      IMPLND       2
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Trapezoidal Pond  1         MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1        1    1
  501        1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                            User  t-series Engl Metr ***
                                             in  out           ***
   17     C, Lawn, Mod           1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   17         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
```

```
  17         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
  17         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
  17              0       4.5      0.03       400       0.1       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
  17              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                     ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
  17            0.1      0.25      0.25         6       0.5      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
  17              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    2      ROADS/MOD              1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    2         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    2         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2            400      0.05       0.1      0.08
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
```

```
    # -  # ***PETMAX    PETMIN
    2          0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2          0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  17                        0.92     RCHRES   1      2
IMPLND   2                        2.88     RCHRES   1      5

******Routing******
PERLND  17                        0.92     COPY     1     12
IMPLND   2                        2.88     COPY     1     15
RCHRES   1                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1


<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                              in  out                        ***
    1     Trapezoidal Pond-006    1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1        1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1        4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1             1      0.02       0.0       0.0       0.5       0.0
  END HYDR-PARM2
```

```
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                                ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1           0          4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   91    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.103306  0.000000  0.000000
  0.066667  0.104595  0.006930  0.006191
  0.133333  0.105892  0.013946  0.008756
  0.200000  0.107196  0.021049  0.010723
  0.266667  0.108507  0.028239  0.012382
  0.333333  0.109826  0.035517  0.013844
  0.400000  0.111152  0.042883  0.015165
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WDM      1 EVAP      ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP      ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

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RCHRES   1 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
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RCHRES     ROFLOW                          COPY            INPUT  MEAN
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END MASS-LINK

END RUN
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Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

Legal Notice

Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

Appendix B – Geotechnical Engineering Report

Earth Solutions NW LLC

Geotechnical Engineering
Geology
Environmental Scientists
Construction Monitoring

GEOTECHNICAL ENGINEERING STUDY
EAST GATEWAY URBAN VILLAGE
MUTLI-FAMILY DEVELOPMENT
132ND STREET SOUTHEAST
MILL CREEK, WASHINGTON

ES-3732

1805 - 136th Place N.E., Suite 201 Bellevue, WA 98005
(425) 449-4704 Fax (425) 449-4711
www.earthsolutionsnw.com

PREPARED FOR

VINTAGE HOUSING DEVELOPMENT, LLC

February 23, 2015

Henry T. Wright, E.I.T.
Project Engineer

Raymond A. Coglas, P.E.
Principal

GEOTECHNICAL ENGINEERING STUDY
EAST GATEWAY URBAN VILLAGE
MULTI-FAMILY DEVELOPMENT
132ND STREET SOUTHEAST
MILL CREEK, WASHINGTON

ES-3732

Earth Solutions NW, LLC
1805 - 136th Place Northeast, Suite 201
Bellevue, Washington 98005
Phone: 425-449-4704 Fax: 425-449-4711
Toll Free: 866-336-8710

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

IIGER06045.0M

Earth Solutions NW LLC

• Geotechnical Engineering
• Construction Monitoring
• Environmental Sciences

February 23, 2015
ES-3732

Vintage Housing Development, LLC
369 San Miguel Drive, #135
Newport Beach, California 92660

Attention: Mr. Ryan Patterson

Dear Mr. Patterson:

Earth Solutions NW, LLC (ESNW) is pleased to present this report titled "Geotechnical Engineering Study, East Gateway Urban Village Multi-Family Development, 132nd Street Southeast, Mill Creek, Washington". Based on the results of our study, the proposed development is feasible from a geotechnical standpoint.

Based on the conditions observed during our fieldwork, the subject site is underlain primarily by native soils consisting of medium dense to very dense glacial till deposits. Based on the results of our study, the proposed structures can be supported on conventional spread and continuous foundations bearing on undisturbed competent native soil anticipated to be exposed throughout the excavations for the proposed building structures.

This report provides recommendations for foundation subgrade preparation, foundation and retaining wall design parameters, drainage, the suitability of the on-site soils for use as structural fill, and other geotechnical recommendations.

The opportunity to be of service to you is appreciated. If you have any questions regarding the content of this geotechnical engineering study, please call.

Sincerely,

EARTH SOLUTIONS NW, LLC

Raymond A. Coglas, P.E.
Principal

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GEOTECHNICAL ENGINEERING STUDY
EAST GATEWAY URBAN VILLAGE
MULTI-FAMILY DEVELOPMENT
132ND STREET SOUTHEAST
MILL CREEK, WASHINGTON

ES-3732

INTRODUCTION

General

This geotechnical engineering study was prepared for the proposed multi-family development to be constructed southwest of the intersection between 42nd Avenue Southeast and 132nd Street Southeast in Mill Creek, Washington. The approximate location of the subject property is depicted on the Vicinity Map (Plate 1). The purpose of this study was to explore subsurface conditions throughout the subject property and prepare geotechnical recommendations for the proposed development. Our scope of services for completing this geotechnical engineering study included the following:

- Subsurface exploration and characterization of the soil and groundwater conditions;
- Laboratory testing of soil samples obtained during subsurface exploration;
- Engineering analyses and recommendations for the proposed development, and;
- Preparation of this report.

The following documents were reviewed as part of preparing this geotechnical engineering study:

- Boundary & Topographic Survey, Vintage at Mill Creek, prepared by Duryea & Associates, P.S., dated February 2015;
- Geologic Map of the Everett 7.5 – Minute Quadrangle, Snohomish County Washington, prepared by James P. Minard, dated 1985;
- Mill Creek Municipal Code, and;
- Stormwater Management in Western Washington, Volume III, prepared by Washington State Department of Ecology Water Quality Program, dated February 2005.

Project Description

We understand construction of a multi-family apartment complex is planned for the subject property. Based on the referenced concept site plan, the multi-family development will consist of two five-story apartment structures, three one-story structures, parking areas, and associated improvements. We anticipate grading activities will include cuts and fills of up to two to four feet to establish building pad and roadway elevations and likely deeper cuts for the stormwater vault excavation. Final grading plans were not available at the time this report was prepared. We anticipate stormwater design will incorporate onsite detention facilities. Site improvements will also include underground utility installations.

At the time this report was prepared, specific building load values were not available. However, we anticipate the proposed three-story structures will consist of relatively lightly-loaded wood framing supported on conventional foundations. The proposed five-story building structures will incorporate a post-tensioned slab for support of the upper floor levels. Based on our experience with similar developments, we estimate wall loads on the order of two kips per linear foot and slab-on-grade loading of 150 pounds per square foot (psf). The buildings that may incorporate post-tensioned slabs would be expected to have higher column loading requirements on the order of 250 to 350 kips.

If the above design assumptions are incorrect or change, ESNW should be contacted to review the recommendations in this report. ESNW should review the final design to confirm that our geotechnical recommendations have been incorporated into the final design.

Surface

The subject site is located southwest of the intersection between 42nd Avenue Southeast and 132nd Street Southeast in Mill Creek, Washington, as illustrated on the Vicinity Map (Plate 1). The site consists of one tax parcel (Snohomish County number 28053300201300) covering approximately 3.96 acres of land area. The property is currently undeveloped and consists mostly of cleared pasture area. The site gently descends to the west with slight undulations throughout. The Test Pit Location Plan (Plate 2) illustrates the overall limits of the property.

Subsurface

Subsurface conditions at the site were explored by excavating 12 test pits throughout the site. Please refer to the test pit logs provided in Appendix A for a more detailed description of the subsurface conditions.

Topsoil

Topsoil was observed in the upper approximately 2 to 12 inches and was generally thicker within the local depressions. The topsoil was characterized by dark brown color and the presence of fine organic material.

Native Soil

Underlying the topsoil, native soils consisting primarily of medium dense to very dense silty sand with gravel (Unified Soil Classification SM) glacial till deposits were encountered extending to the maximum exploration depth of 18 feet below existing grades. The density of the native soil generally increased with depth. The weathered till zone extended to depths of approximately three to four feet below existing grades.

Geologic Setting

The referenced geologic map resource indicates the site is underlain by glacial till (Qvt) deposits. The native soil conditions observed at the test pit locations are generally consistent with glacial till deposits.

The National Resources Conservation Service (NRCS) Soil Survey identifies Alderwood gravelly sandy loam across the site. The native soil conditions observed are generally consistent with Alderwood series soils.

Groundwater

Light groundwater seepage was observed at test pit locations TP-1, TP-8, TP-9, and TP-12 (generally within the local depression areas) at depths of approximately four to eight feet below existing grades. In general, seasonal perched groundwater seepage zones are expected to be encountered at some locations throughout the site. It should be noted that groundwater elevations fluctuate depending on many factors, including precipitation duration and intensity, the time of year, and soil conditions. In general, groundwater levels are generally higher during the wetter, winter months. We anticipate temporary dewatering of excavations using standard construction practices (sumps/collection basins) will suffice for the project, if necessary. Large scale dewatering efforts are not expected to be necessary for this site.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our study, construction of the proposed multi-family development is feasible from a geotechnical standpoint. The primary geotechnical considerations associated with the proposed development include mass grading activities, temporary erosion control, foundation and pavement subgrade preparation, and structural fill placement and compaction. In our opinion, the proposed structures can be supported on conventional foundations bearing on the competent native soil expected to be exposed throughout the excavations for the building foundations. Recommendations for site preparation, temporary excavations, structural fill placement, foundations, drainage, and other pertinent geotechnical recommendations are provided in the following sections of this study.

This geotechnical engineering study has been prepared for the exclusive use of Vintage Housing Development, LLC and their representatives. The study has been prepared specifically for the subject project. No warranty, expressed or implied, is made. This study has been prepared in a manner consistent with the level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area.

Site Preparation and Earthwork

The primary geotechnical considerations with respect to earthwork are related to mass grading activities, temporary erosion control, temporary excavations, foundation and pavement subgrade preparation, and structural fill placement and compaction. The soils encountered in the building excavations should largely consist of medium dense to dense silty sand with gravel glacial till deposits.

Temporary Erosion Control

Temporary construction entrances, consisting of at least one foot of quarry spalls can be considered in order to minimize off-site soil tracking and to provide a temporary road surface. Silt fences should be placed along the margins of the property as well as the margins of the proposed wetland buffers. Erosion control measures such as swales, temporary ponds, and straw wattles may be necessary to control surface water. Soil stockpiles and temporary excavation slopes should be protected as necessary to minimize erosion.

In-Situ Soils

From a geotechnical standpoint, the native soils encountered at the test locations are generally suitable for use as structural fill provided the moisture content is at or near optimum. The native soils will be difficult to use as structural fill if exposed to excessive wet conditions. Suitability of the native soils for use as structural fill should be confirmed by ESNW at the time of construction. The site soils were generally in a moist condition at the time of exploration on February 3, 2015. Imported soil intended for use as structural fill should consist of a well-graded granular soil with a moisture content that is at or near the optimum level. During wet weather conditions, imported soil intended for use as structural fill should consist of a well-graded granular soil with a fines content of 5 percent or less defined as the percent passing the Number 200 sieve, based on the minus three-quarter inch fraction.

Building and Pavement Subgrade Preparation

Subgrade conditions expected to be exposed throughout the majority of the proposed building and pavement areas will likely be comprised of native glacial till soils. The soils exposed throughout subgrade areas should be observed by ESNW to confirm stability and support characteristics.

The subgrade throughout pavement areas should exhibit a firm and unyielding condition when subjected to proofrolling with a loaded dump truck. Structural fill soils placed throughout slab and pavement areas should be placed over a firm base. Loose or unsuitable areas exposed at slab and pavement subgrade elevations should be recompacted to structural fill requirements or overexcavated and replaced with a suitable structural fill material. Where fill is required to construct foundation subgrade areas (particularly for the heavier five-story buildings), two-inch crushed rock placed over competent native soils should be used. Foundation subgrade areas should be protected from disturbance, construction traffic, and excessive moisture.

Structural Fill

Soils placed in structural areas should be placed in loose lifts of 12 inches or less and compacted to a relative compaction of 90 percent, based on the laboratory maximum dry density as determined by the Modified Proctor Method (ASTM D-1557). For soil placed in utility trenches underlying structural areas, compaction requirements are dictated by the local city, county, or utility district, and in general are specified as 95 percent relative compaction. The upper 12 inches of pavement sidewalk subgrade areas should be compacted to a relative compaction of at least 95 percent. As mentioned above, fills used to construct foundation subgrade areas for the heavier five-story buildings should consist of two-inch crushed rock placed over competent native soil.

Excavations and Slopes

The Federal Occupation Safety and Health Administration (OSHA) and the Washington Industrial Safety and Health Act (WISHA) provide soil classification in terms of temporary slope inclinations. Based on the soil conditions encountered at the test pit locations, the weathered native soils encountered in the upper approximately three to four feet of the test pit locations and where fill and/or groundwater seepage is exposed are classified as Type C by OSHA/WISHA. Temporary slopes over four feet in height in Type C soils must be sloped no steeper than 1.5H:1V (Horizontal:Vertical). Dense unweathered glacial till soils encountered below approximately three to four feet where no groundwater seepage is exposed would be classified as Type A by OSHA/WISHA. Temporary slopes over four feet in height in Type A soils must be sloped no steeper than 0.75H:1V. The presence of perched groundwater may cause caving of the temporary slopes due to hydrostatic pressure. ESNW should observe site excavations to confirm the soil type and allowable slope inclination are appropriate for the soil exposed by the excavation. If the recommended temporary slope inclination cannot be achieved, temporary shoring may be necessary to support excavations.

Permanent slopes should maintain a gradient of 2H:1V, or flatter, and should be planted with vegetation to enhance stability and to minimize erosion. A representative of ESNW should observe temporary and permanent slopes to confirm the slope inclinations are suitable for the exposed soil conditions, and to provide additional excavation and slope recommendations, as necessary.

Retaining Walls

Retaining walls for the project will likely consist of conventional concrete retaining and building foundation walls. Retaining walls should be designed to resist earth pressures and any applicable surcharge loads. The following values should be used for concrete retaining and foundation wall design:

- Active Earth Pressure (Yielding Wall) — 35 pcf (equivalent fluid / granular fill)
- At-Rest Earth Pressure (Restrained Wall) — 50 pcf
- Traffic Surcharge (Passenger Vehicles) — 70 psf (rectangular distribution)
- Passive Resistance — 350 pcf (equivalent fluid)
- Allowable Soil Bearing Capacity — 5,000 psf*
- Coefficient of Friction — 0.40
- Seismic Surcharge (where applicable) — 6H (psf)

*Assumes competent native till or two-inch crushed rock bearing conditions.

Additional surcharge loading from foundations, sloped backfill, or other loading should be included in the retaining wall design, as appropriate. Drainage should be provided behind retaining walls such that hydrostatic pressures do not develop. If drainage is not provided, hydrostatic pressures should be included in the wall design, as appropriate. The geotechnical engineer should review retaining wall designs to confirm that appropriate earth pressure values have been incorporated into the design and to provide additional recommendations, as necessary.

Concrete retaining and foundations walls should be backfilled with free draining material that extends along the height of the wall, and a distance of at least 18 inches behind the wall. The upper one foot of the wall backfill can consist of a less permeable (surface seal) soil, if desired. A perforated drainpipe should be placed along the base of the wall, and connected to an appropriate discharge location.

Foundations

Based on the results of our study, the proposed structures can be supported on a conventional foundation system bearing on the competent native glacial till soil anticipated to be exposed at the building foundation subgrade elevations. Based on subsurface exploration, we anticipate competent native soil to be exposed at a depth of approximately two to three feet below existing grades. ESNW should observe exposed foundation subgrade conditions to provide supplemental recommendations for foundation support, if necessary. As mentioned above, where fill is required to establish foundation subgrade elevations (particularly for the five-story buildings), two-inch crushed rock placed over competent native soils should be utilized.

Provided the proposed structures will be supported as described above, the following parameters can be used for design of the new foundations:

- Allowable soil bearing capacity 5,000 psf
- Passive earth pressure 350 pcf (equivalent fluid)
- Coefficient of friction 0.40

A one-third increase in the allowable soil bearing capacity can be assumed for short-term wind and seismic loading conditions.

With structural loading as expected, total settlement in the range of one inch is anticipated, with differential settlement of about one-half inch between a typical column bay, or roughly 50 feet. The majority of the settlements should occur during construction, as dead loads are applied.

Seismic Considerations

The 2012 IBC recognizes ASCE for seismic site class definitions. Based on the observed subsurface conditions and geologic mapping, and in accordance with Table 20.3-1 of ASCE, Minimum Design Loads for Buildings and Other Structures, Site Class C, should be used for design.

Based on the subsurface exploration and geologic mapping, the site would be characterized as possessing a negligible susceptibility to liquefaction. The native soil relative density and the absence of an established shallow groundwater table is the primary basis for this opinion.

Slab-On-Grade Floors

Slab-on-grade floors should be supported on a firm and unyielding subgrade consisting of competent native soil, recompacted native soil, new structural fill. Unstable or yielding areas of the subgrade should be recompacted or overexcavated and replaced with suitable structural fill prior to construction of the slab. ESNW should observe exposed slab subgrade conditions at the time of construction and provide supplement recommendations, as necessary. The slab should be provided with minimum 4-inches of a “clean” capillary break material. Installation of a vapor retarder should also be considered for slabs within interior (occupied) spaces.

Drainage

Light groundwater seepage was observed at the time of the fieldwork on February 3, 2015. The presence of zones of perched groundwater seepage should be expected in site excavations. Where localized zones of groundwater seepage are encountered, temporary measures to control groundwater seepage may be needed. Temporary measures to control groundwater seepage and surface water runoff during construction will likely involve passive elements such as interceptor trenches and sumps, as necessary.

Surface grades must be designed to direct water away from the buildings. The grade adjacent to the buildings should be sloped away from the buildings at a gradient of at least 2 percent for a horizontal distance of 10 feet. In our opinion, perimeter footing drains should be installed at or below the invert of the building footings. A typical footing drain detail is illustrated on Plate 3 of this report.

Detention Vaults

Competent native soils suitable for support of vault foundations are anticipated to be exposed at subgrade elevations for proposed detention vault structures. For design, the following geotechnical parameters should be used:

- Allowable Soil Bearing Capacity — 5,000 psf (dense native)
- Active Earth Pressure (Yielding Wall) — 35 pcf
- At-Rest Earth Pressure (Restrained Wall) — 50 pcf
- Soil Unit Weight — 125 pcf
- Active Earth Pressure Coefficient (Ka) — 0.28
- At-Rest Earth Pressure Coefficient (Ko) — 0.40

The geotechnical engineer should observe the vault excavation to confirm soil and groundwater conditions. As necessary, supplement geotechnical recommendations for foundation support will be provided.

Utility Trench Backfill

In our opinion, the soils observed at the test sites are generally suitable for support of utilities. Excessively loose or unstable soils encountered in the trench excavations should not be used for supporting utilities. In general, the on-site soils observed at the test sites should be suitable for use as structural backfill in the utility trench excavations, provided they are at or near the optimum moisture content at the time of placement and compaction. Moisture conditioning of the onsite soils may be necessary at some locations prior to use as structural fill. Utility trench backfill should be placed and compacted to the specifications of structural fill provided in this report, or to the applicable specifications of the city or county jurisdictions, as appropriate.

Pavement Sections

The performance of site pavements is largely related to the condition of the underlying subgrade. To ensure adequate pavement performance, the subgrade should be in a firm and unyielding condition when subjected to proofrolling with a loaded dump truck. Structural fill in pavement areas should be compacted to the specifications detailed in the *Site Preparation and Earthwork* section of this report. It is possible that soft, wet, or otherwise unsuitable subgrade areas may still exist after base grading activities. Areas containing unsuitable or yielding subgrade conditions may require remedial measures such as overexcavation and thicker crushed rock or structural fill sections prior to pavement.

For relatively lightly loaded pavements subjected to automobiles and occasional truck traffic, the following sections can be considered:

- Two inches of hot mix asphalt (HMA) placed over four inches of crushed rock base (CRB), or;
- Two inches of HMA placed over three inches of asphalt treated base (ATB).

Heavier truck-traffic areas generally require thicker pavement sections depending on site usage, pavement life expectancy, and site traffic.. For preliminary design purposes, the following pavement sections for heavy traffic areas can be considered:

- Three inches of HMA placed over six inches of CRB, or;
- Three inches of HMA placed over four and one-half inches of ATB.

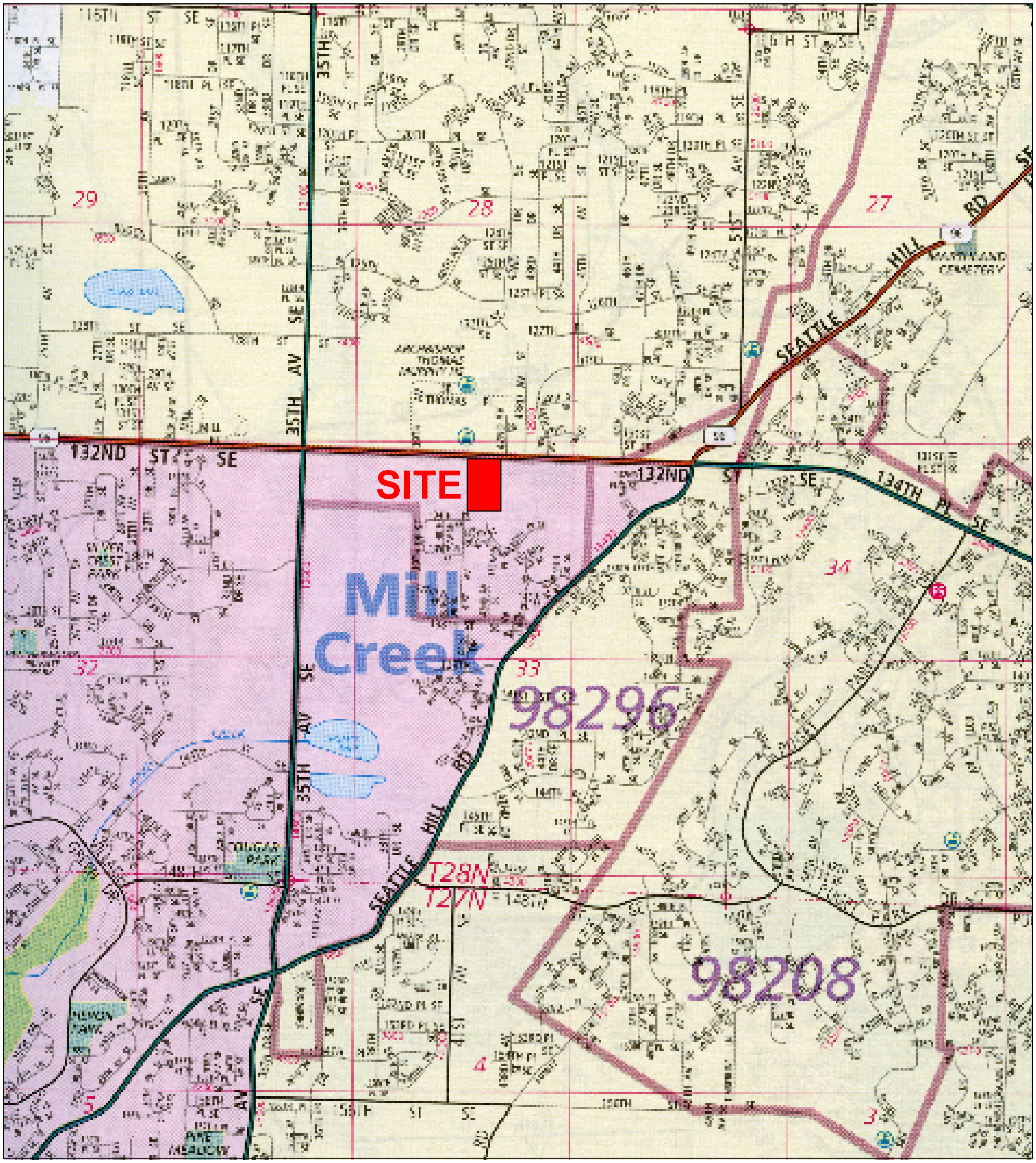
The HMA, CRB and ATB materials should conform to WSDOT specifications. Mill Creek pavement standards may supersede the recommendations provided in this report.

LIMITATIONS

The recommendations and conclusions provided in this geotechnical engineering study are professional opinions consistent with the level of care and skill that is typical of other members in the profession currently practicing under similar conditions in this area. A warranty is not expressed or implied. Variations in the soil and groundwater conditions observed at the test pit locations may exist, and may not become evident until construction. ESNW should reevaluate the conclusions in this geotechnical engineering study if variations are encountered.

Additional Services

ESNW should have an opportunity to review the final design with respect to the geotechnical recommendations provided in this report. ESNW should also be retained to provide testing and consultation services during construction.



NORTH

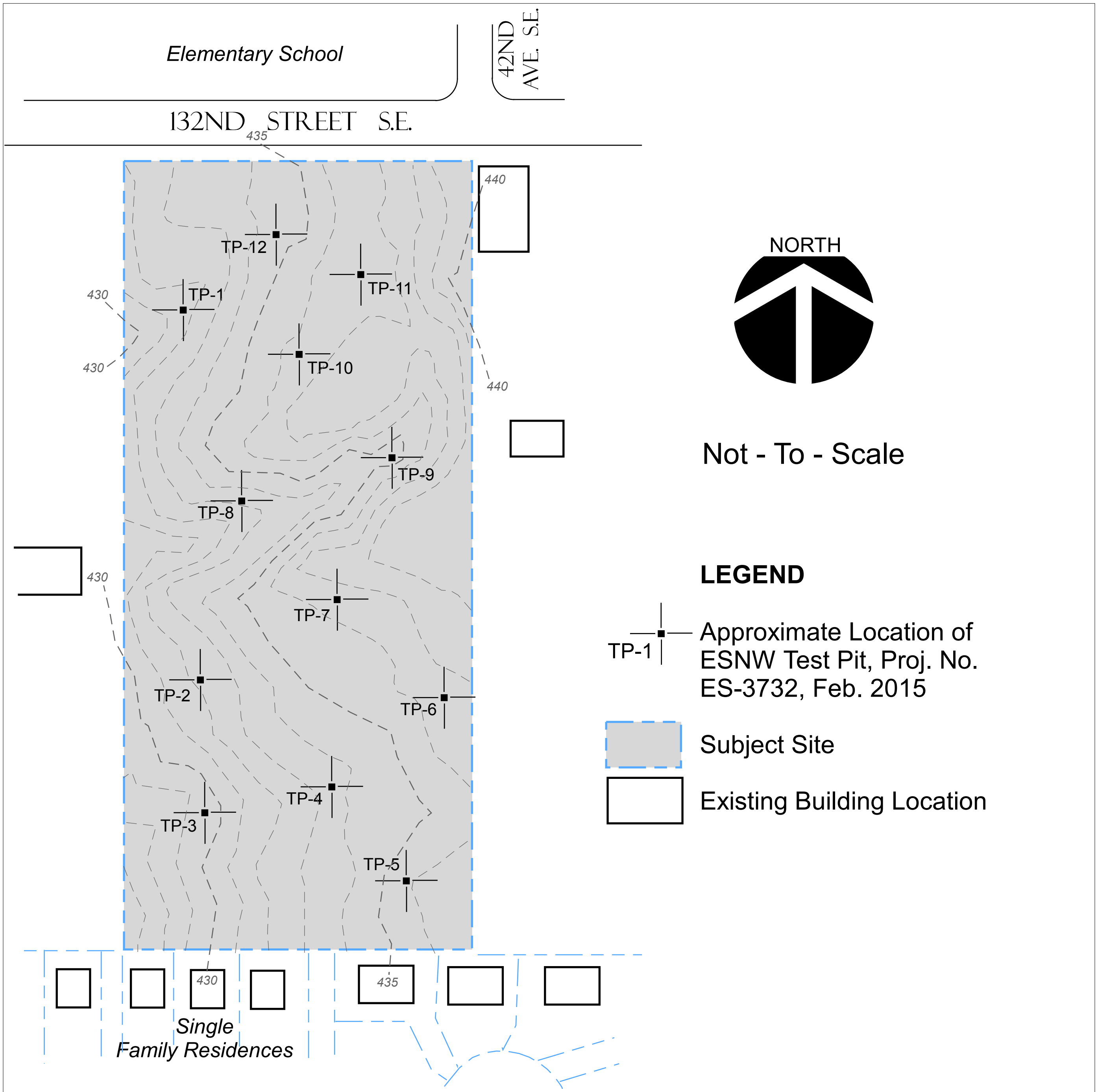
Reference:
Snohomish County, Washington
Map 436
By The Thomas Guide
Rand McNally
32nd Edition

Earth Solutions NW LLC
Geotechnical Engineering, Construction Monitoring and Environmental Sciences

Vicinity Map
East Gateway Urban Village
Mill Creek, Washington

Drwn. GLS	Date 02/17/2015	Proj. No. 3732
Checked BTS	Date Feb. 2015	Plate 1

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.



NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided by the client at the time of our study. ESNW cannot be responsible for subsequent design changes or interpretation of the data by others.

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

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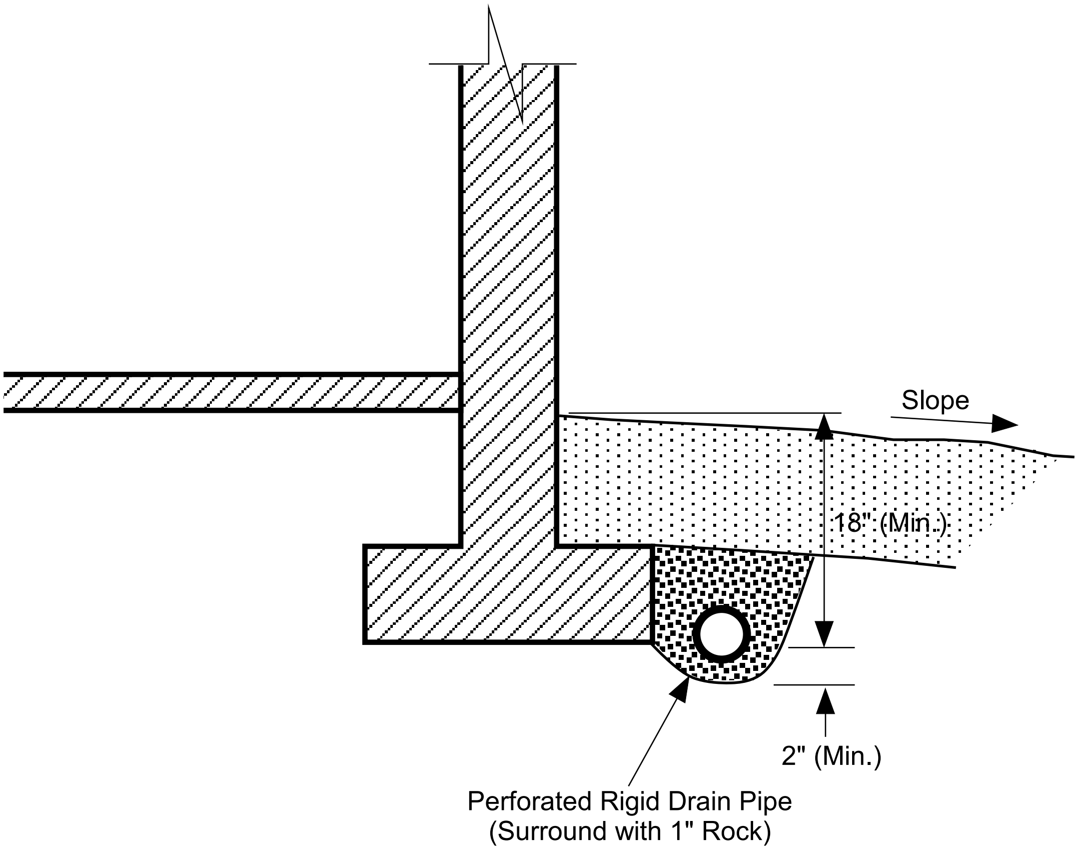
Geotechnical Engineering, Construction Monitoring and Environmental Sciences

Test Pit Location Plan
East Gateway Urban Village
Mill Creek, Washington

Drwn. GLS	Date 02/19/2015	Proj. No. 3732
Checked BTS	Date Feb. 2015	Plate 2



NOTES:

- Do NOT tie roof downspouts to Footing Drain.
- Surface Seal to consist of 12" of less permeable, suitable soil. Slope away from building.

LEGEND:

Surface Seal; native soil or other low permeability material.

1" Drain Rock

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

Earth Solutions NW LLC
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FOOTING DRAIN DETAIL
East Gateway Urban Village
Mill Creek, Washington

Drwn. GLS	Date 02/18/2015	Proj. No. 3732
Checked BTS	Date Feb. 2015	Plate 3

Appendix A

Subsurface Exploration

ES-3732

The subsurface conditions at the site were explored by excavating 12 test pits at the approximate locations illustrated on Plate 2 of this report. The test pits were advanced to a maximum depth of 18 feet below existing grades. The test pit logs are provided in this Appendix. The subsurface exploration was completed on February 3, 2015.

Logs of the test pits excavated by ESNW are presented in Appendix A. The final logs represent the interpretations of the field logs and the results of laboratory analyses. The stratification lines on the logs represent the approximate boundaries between soil types. In actuality, the transitions may be more gradual.

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SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

DUAL SYMBOLS are used to indicate borderline soil classifications.

The discussion in the text of this report is necessary for a proper understanding of the nature of the material presented in the attached logs.

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TEST PIT NUMBER TP-1

CLIENT Vintage Housing Development, Inc.
PROJECT NAME East Gateway Urban Village
PROJECT NUMBER 3732
PROJECT LOCATION Mill Creek, Washington
DATE STARTED 2/3/15 **COMPLETED** 2/3/15
GROUND ELEVATION 433 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY BTS **CHECKED BY** BTS
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 10": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND with gravel, medium dense, moist to wet (Weathered Till)
		MC = 23.50% Fines = 31.10%			[USDA Classification: sandy LOAM] -decreased gravel content
		MC = 19.40% Fines = 30.90%			-mottled texture [USDA Classification: fine sandy LOAM] -becomes gray, dense, moist -light seepage
5		MC = 15.20% Fines = 16.80%			-increased sand and gravel (unweathered till) [USDA Classification: very gravelly loamy SAND]
					-light perched seepage
					-becomes very dense
10					
12.0					421.0
					Test pit terminated at 12.0 feet below existing grade. Groundwater seepage encountered at 5.0 and 8.0 feet during excavation. Bottom of test pit at 12.0 feet.

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TEST PIT NUMBER TP-2

CLIENT Vintage Housing Development, Inc.
PROJECT NAME East Gateway Urban Village
PROJECT NUMBER 3732
PROJECT LOCATION Mill Creek, Washington
DATE STARTED 2/3/15 **COMPLETED** 2/3/15
GROUND ELEVATION 433 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY BTS **CHECKED BY** BTS
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 8" - 10": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					Brown silty SAND, medium dense, moist to wet (Weathered Till)
		MC = 21.00%			
					-becomes gray, dense to very dense, moist (unweathered till)
5			SM		
		MC = 14.50%			-sand layer
10					10.0 — 423.0
					Test pit terminated at 10.0 feet below existing grade. No groundwater encountered during excavation.
					Bottom of test pit at 10.0 feet.

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TEST PIT NUMBER TP-3

CLIENT Vintage Housing Development, Inc.
PROJECT NAME East Gateway Urban Village
PROJECT NUMBER 3732
PROJECT LOCATION Mill Creek, Washington
DATE STARTED 2/3/15 COMPLETED 2/3/15
GROUND ELEVATION 430 ft TEST PIT SIZE
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY BTS CHECKED BY BTS
AT END OF EXCAVATION ---
NOTES Depth ofTopsoil & Sod 8" - 10": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND, medium dense, moist (Weathered Till)
		MC = 12.40%			
					-becomes gray, dense (unweathered till)
5					-sand layer
		MC = 16.20%			-becomes very dense
10					
11.0					419.0
					Test pit terminated at 11.0 feet below existing grade. No groundwater encountered during excavation.
					Bottom of test pit at 11.0 feet.

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TEST PIT NUMBER TP-4

CLIENT Vintage Housing Development, Inc.
PROJECT NAME East Gateway Urban Village
PROJECT NUMBER 3732
PROJECT LOCATION Mill Creek, Washington
DATE STARTED 2/3/15 **COMPLETED** 2/3/15
GROUND ELEVATION 434 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION —
LOGGED BY BTS **CHECKED BY** BTS
AT END OF EXCAVATION —
NOTES Depth of Topsoil & Sod 6": grass
AFTER EXCAVATION —

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND, medium dense, moist (Weathered Till)
		MC = 17.60%			-mottled texture
					-becomes gray, dense (unweathered till)
5		MC = 15.00%			
				7.0	427.0
					Test pit terminated at 7.0 feet below existing grade. No groundwater encountered during excavation. Bottom of test pit at 7.0 feet.

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TEST PIT NUMBER TP-5

CLIENT Vintage Housing Development, Inc.
PROJECT NAME East Gateway Urban Village
PROJECT NUMBER 3732
PROJECT LOCATION Mill Creek, Washington
DATE STARTED 2/3/15 **COMPLETED** 2/3/15
GROUND ELEVATION 437 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY BTS **CHECKED BY** BTS
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 8" - 10": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND, medium dense, moist (Weathered Till)
		MC = 20.30%			
					-increased sand content
					-becomes gray, dense (unweathered till)
5		MC = 13.20%			
					-becomes very dense (cemented)
10				10.0	427.0
					Test pit terminated at 10.0 feet below existing grade. No groundwater encountered during excavation.
					Bottom of test pit at 10.0 feet.

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TEST PIT NUMBER TP-6

CLIENT Vintage Housing Development, Inc.
PROJECT NAME East Gateway Urban Village
PROJECT NUMBER 3732
PROJECT LOCATION Mill Creek, Washington
DATE STARTED 2/3/15 **COMPLETED** 2/3/15
GROUND ELEVATION 437 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY BTS **CHECKED BY** BTS
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 8": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND, medium dense, moist (Weathered Till)
		MC = 20.60%			
					-mottled texture
					-becomes gray, dense to very dense (unweathered till)
5		MC = 14.70%			
					-sand layer
				9.0	428.0
					Test pit terminated at 9.0 feet below existing grade. No groundwater encountered during excavation.
					Bottom of test pit at 9.0 feet.

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TEST PIT NUMBER TP-7

CLIENT Vintage Housing Development, Inc.
PROJECT NAME East Gateway Urban Village
PROJECT NUMBER 3732
PROJECT LOCATION Mill Creek, Washington
DATE STARTED 2/3/15 **COMPLETED** 2/3/15
GROUND ELEVATION 436 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY BTS **CHECKED BY** BTS
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 4": grass
AFTER EXCAVATION —

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND, medium dense, moist (Weathered Till)
		MC = 19.80% Fines = 23.40%			[USDA Classification: loamy SAND]
					-mottled texture -becomes gray, dense, moist (unweathered till)
5		MC = 14.60%			
				8.0	428.0
					Test pit terminated at 8.0 feet below existing grade. No groundwater encountered during excavation. Bottom of test pit at 8.0 feet.

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TEST PIT NUMBER TP-8

CLIENT Vintage Housing Development, Inc.
PROJECT NAME East Gateway Urban Village
PROJECT NUMBER 3732
PROJECT LOCATION Mill Creek, Washington
DATE STARTED 2/3/15 **COMPLETED** 2/3/15
GROUND ELEVATION 434 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY BTS **CHECKED BY** BTS
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 10" - 12": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					Brown silty SAND with gravel, medium dense, moist to wet (Weathered Till)
		MC = 25.30%			
					-mottled texture
					-becomes gray, dense, moist (unweathered till)
5					
		MC = 18.20%	SM		-light seepage
					-sand and gravel layer
		MC = 10.20%			-moderate seepage
			SM		-becomes very dense (cemented)
10		MC = 11.00%			
15					
		MC = 11.00%			
18.0					416.0
					Test pit terminated at 18.0 feet below existing grade. Groundwater seepage encountered at 6.0 and 8.0 feet during excavation. Bottom of test pit at 18.0 feet.

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TEST PIT NUMBER TP-9

CLIENT Vintage Housing Development, Inc. **PROJECT NAME** East Gateway Urban Village
PROJECT NUMBER 3732 **PROJECT LOCATION** Mill Creek, Washington
DATE STARTED 2/3/15 **COMPLETED** 2/3/15 **GROUND ELEVATION** 438 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY BTS **CHECKED BY** BTS **AT END OF EXCAVATION** ---
NOTES Depth of Topsoil & Sod 12": grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND with gravel, medium dense, moist to wet (Weathered Till)
		MC = 22.00%			-mottled texture
					-light seepage
5					-becomes gray, dense (unweathered till)
		MC = 14.90%			
					-sand layer
					-becomes very dense (cemented)
10					
14.0					424.0
					Test pit terminated at 14.0 feet below existing grade. Groundwater seepage encountered at 4.0 feet during excavation. Bottom of test pit at 14.0 feet.

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TEST PIT NUMBER TP-10

CLIENT Vintage Housing Development, Inc.
PROJECT NAME East Gateway Urban Village
PROJECT NUMBER 3732
PROJECT LOCATION Mill Creek, Washington
DATE STARTED 2/3/15 **COMPLETED** 2/3/15
GROUND ELEVATION 436 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY BTS **CHECKED BY** BTS
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 2" - 4": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION	
0		SM			Brown silty SAND, medium dense, moist (Weathered Till)	
					-becomes gray, dense (unweathered till)	
5				6.0	-becomes very dense (cemented)	430.0
					Test pit terminated at 6.0 feet below existing grade. No groundwater encountered during excavation. Bottom of test pit at 6.0 feet.	

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TEST PIT NUMBER TP-11

CLIENT Vintage Housing Development, Inc.
PROJECT NAME East Gateway Urban Village
PROJECT NUMBER 3732
PROJECT LOCATION Mill Creek, Washington
DATE STARTED 2/3/15 **COMPLETED** 2/3/15
GROUND ELEVATION 438 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY BTS **CHECKED BY** BTS
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 4": grass
AFTER EXCAVATION —

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND with gravel, medium dense, moist (Weathered Till)
		MC = 21.80%			
					-becomes gray, dense (unweathered till)
5					
					-becomes very dense (cemented)
9.0					429.0
					Test pit terminated at 9.0 feet below existing grade. No groundwater encountered during excavation. Bottom of test pit at 9.0 feet.

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TEST PIT NUMBER TP-12

CLIENT Vintage Housing Development, Inc.
PROJECT NAME East Gateway Urban Village
PROJECT NUMBER 3732
PROJECT LOCATION Mill Creek, Washington
DATE STARTED 2/3/15 **COMPLETED** 2/3/15
GROUND ELEVATION 436 ft **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY BTS **CHECKED BY** BTS
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 4" - 6": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0		SM		Brown silty SAND, medium dense, moist (Weathered Till)
				-mottled texture
				-becomes gray, dense (unweathered till)
5				
				-light seepage
				-becomes very dense (cemented)
10				
			13.0	423.0
				Test pit terminated at 13.0 feet below existing grade. Groundwater seepage encountered at 6.0 feet during excavation.
				Bottom of test pit at 13.0 feet.

Appendix B

Laboratory Test Results

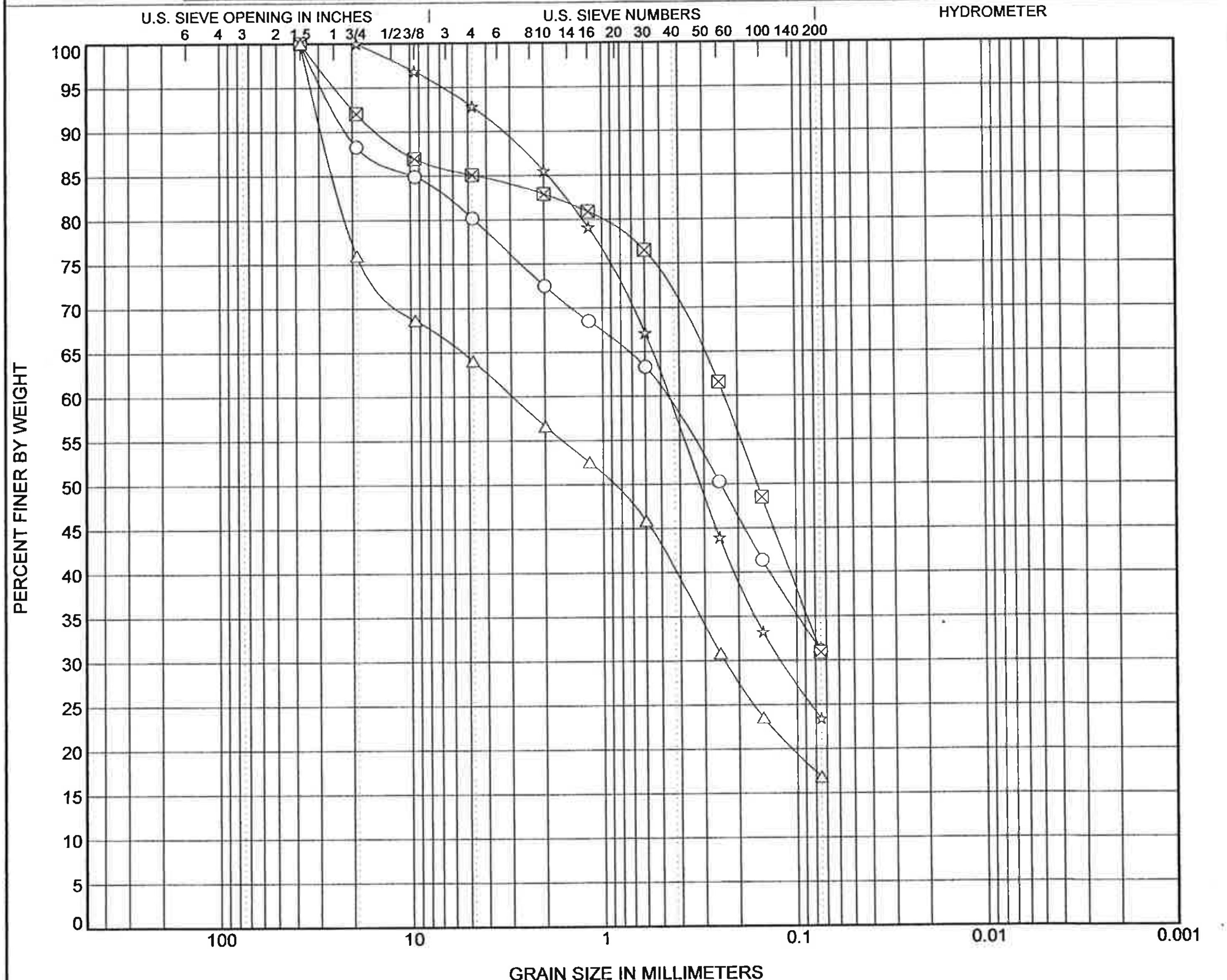
ES-3732

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, WA 98005
Telephone: 425-284-3300

GRAIN SIZE DISTRIBUTION

CLIENT Vintage Housing Development LLC **PROJECT NAME** East Gateway Urban Village

PROJECT NUMBER ES-3732 **PROJECT LOCATION** Mill Creek



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	Cc	Cu
○	TP-1	2.5ft.	USDA: Brown Sandy Loam. USCS: SM w Gravel.		
⊠	TP-1	4.0ft.	USDA: Brown Gravelly Fine Sandy Laom. USCS: SM.		
△	TP-1	6.0ft.	USDA: Gray Very Gravelly Loamy Sand. USCS: SM w Gravel.		
☆	TP-7	2.0ft.	USDA: Brown Loamy Sand. USCS: SM.		

Specimen Identification			D100	D60	D30	D10			%Silt	%Clay
○	TP-1	2.5ft.	37.5	0.48					31.1	
⊠	TP-1	4.0ft.	37.5	0.235					30.9	
△	TP-1	6.0ft.	37.5	2.963	0.236				16.8	
☆	TP-7	2.0ft.	19	0.458	0.119				23.4	

Report Distribution

ES-3732

EMAIL ONLY

Vintage Housing Development, LLC
369 San Miguel Drive, # 135
Newport Beach, California 92660

Attention: Mr. Ryan Patterson

Vintage at Mill Creek, LLC
1620 North Mamer Road, Suite B
Spokane, Washington 99216

Attention: Mr. Mark Ossello