PRELIMINARY
STORM DRAINAGE REPORT

FOR

MAPLEWOOD SHORT PLAT

REDMOND, WASHINGTON

Prepared By:	Garrett C. Benson E.I.T
Approved By:	Michael A. Moody, P.E., LEED AP
Date:	December, 2015
Core No.:	15099
Revised:	March, 2016

14711 NE 29Th Place, Suite 101 • Bellevue, Washington 98007 • Ph 425.885.7877 Fx 425.885.7963 • www.coredesigninc.com

Table of Contents

SECTION 1. Project Overview 1-1
Wellhead Protection Zone Limitations 1-3
SECTION 2. Conditions and Requirements Summary 2-1
SECTION 3. Off Site Analysis 3-1
Upstream: 3-1
Downstream Field Investigation: 3-1
SECTION 4. Flow Control and Water Quality Analysis and Design 4-1
A. Hydrologic Analysis 4-1
B. Detention Calculations 4-2
C. Water Quality Design 4-2
SECTION 5. Conveyance System Analysis and Design 5-1
SECTION 6. Special Reports and Studies 6-1
PROJECT LID FEASIBILITY 6-2
SECTION 7. Other Permits 7-1
SECTION 8. CSWPPP Analysis and Design 8-1
SECTION 9. Bond Quantities, Facility Summaries, and Declaration of Covenant 9-1
SECTION 10. Operations and Maintenance Manual 10-1
SECTION 11. Appendix 11-1

SECTION 1. Project Overview

The Maplewood project is a tract from the Shaughnessy Heights development. The tract consists of a single parcel to the northwest of the Shaughnessy Heights development and the project was previously called Shaughnessy Heights West. Therefore, some of the attached reports will reference the Shaughnessy Heights West project. The project is now called Maplewood. The site is located in Section 1, Township 25 North, Range 5 East, W.M, on the south side of NE 85th Street and just east of 167th Avenue NE (see Figure 1-1 - Vicinity Map). The subject property is 2.34 acres in size. The total area to be developed is 0.43 acres; this includes future frontage improvements and excludes area preserved as open space (Tract A). To the east of the site is the Shaughnessy Heights Plat single family project. To the south of the site is a multi- family project called "The Retreat". The north side of the site is bounded by the Central Park storm drainage facility while the west side is bounded by 167th Avenue NE. This project is located within the City of Redmond. The proposed site consists of a single parcel as follows:

King County Parcel ID & Areas
Parcel 1: 0125059114; 100,816 sf

The property is currently forested. The project site runoff is described in the downstream conveyance analysis completed by Northwest Hydraulic Consultants (included in Section 3 of this report).

Proposed development of the property will include the construction of an 8 unit multi-family development with associated frontage improvements along 167th Avenue NE, utilities, and open space. The open space areas are to remain in the existing condition and are excluded from the developed area calculations. This project will be routed to the public drainage and water quality facility located downstream of the project site. All upstream runoff is collected in the detention facility on the adjacent property.

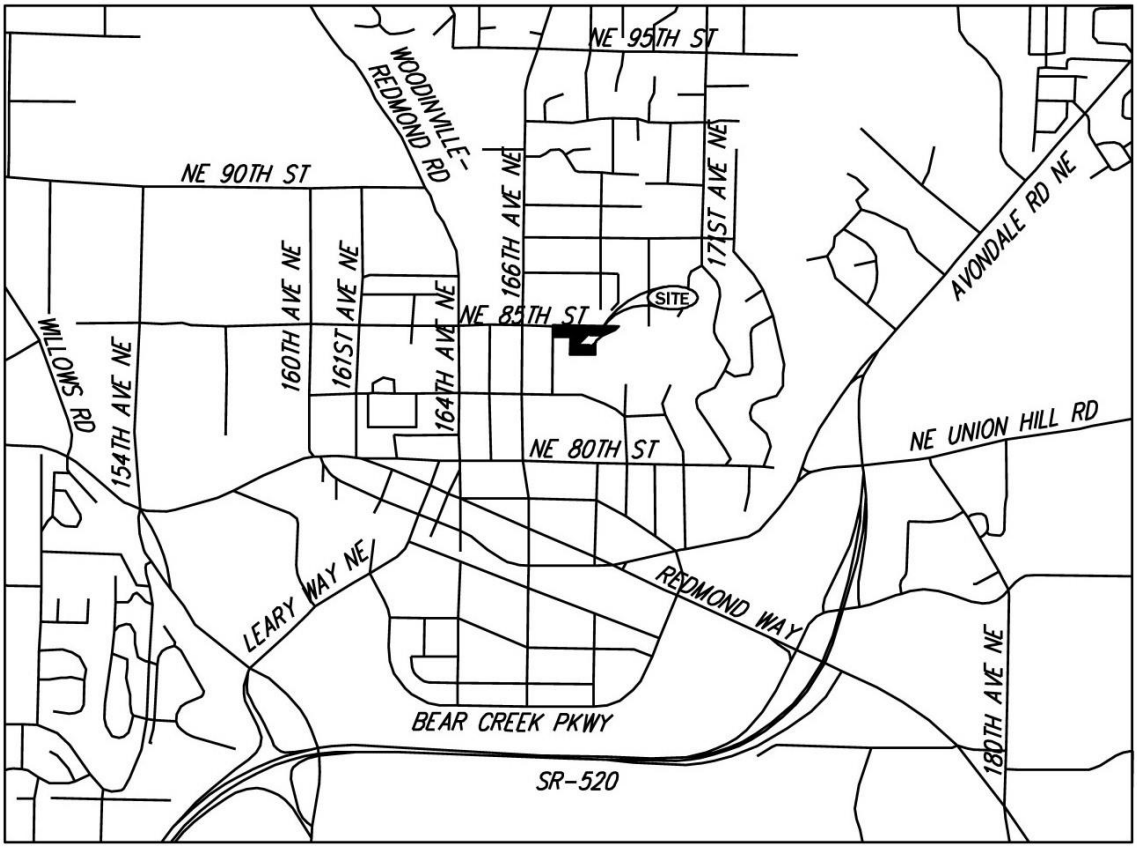


Figure 1-1: Vicinity Map

Wellhead Protection Zone Limitations

The project site, per the City of Redmond's Wellhead Protection Zone Map (shown below) is within Wellhead Protection Zone 2. See Figure 1-2: City of Redmond Wellhead Protection Zone Map included below.

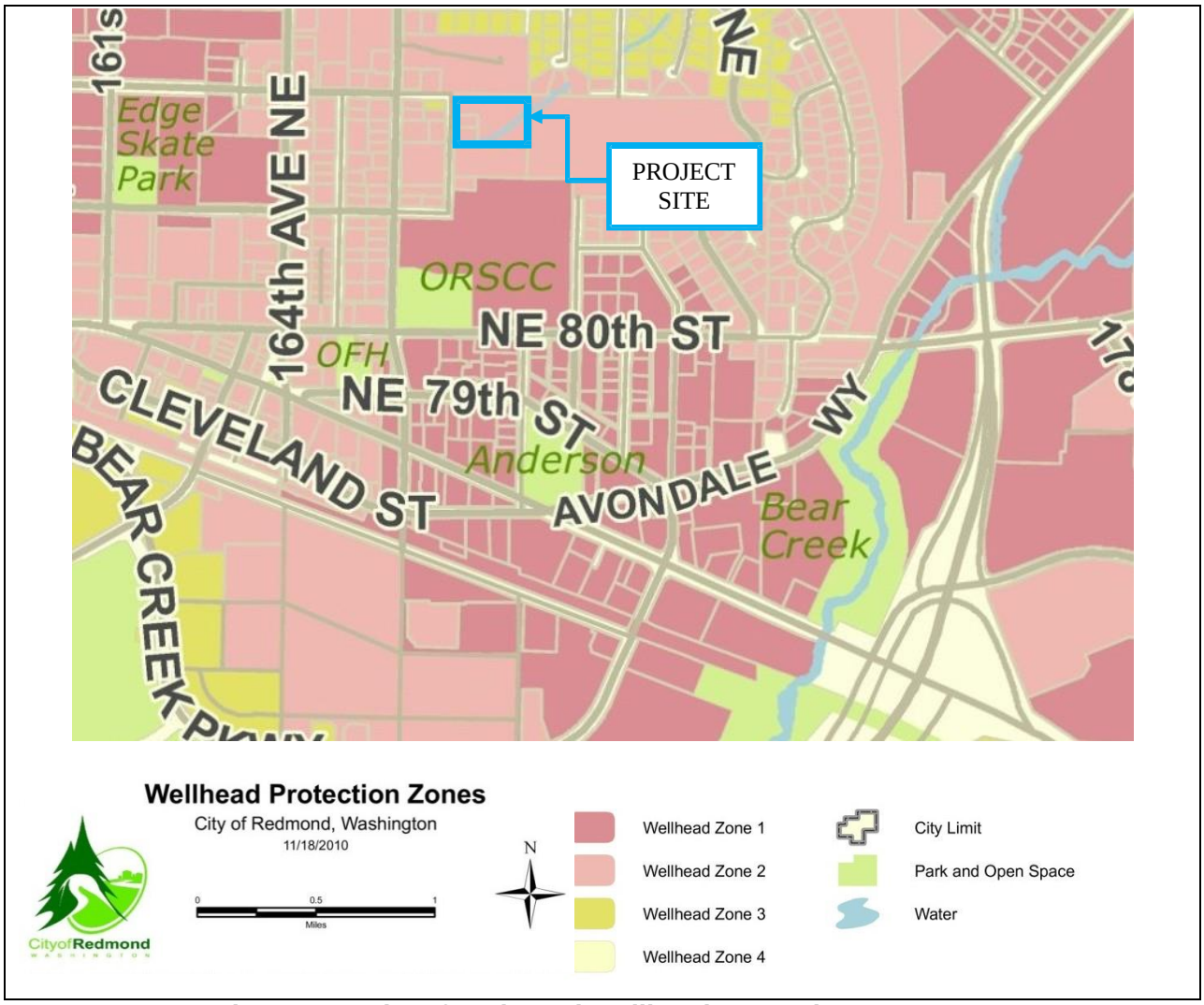


Figure 1-2: City of Redmond Wellhead Protection Zone Map

The City of Redmond Clearing, Grading, and Stormwater Management Technical Notebook, Issue Number 6 discusses wellhead protection within the City and corresponding restrictions and limitations.

Section 2.5.5, beginning on page 24 of the Technical Notebook, provides the following summary regarding **Groundwater Protection** in all Wellhead Protection Zones:

> "Protection of the City's shallow unconfined drinking water aquifer needs to be considered when managing stormwater runoff from pollution generating impervious surfaces. Except for single-family residential projects, infiltrating runoff from pollution generating impervious surfaces in Wellhead Protection Zones 1 and 2 is prohibited Single-family residential projects in Wellhead Protection Zones 1 and 2 can infiltrate runoff from pollution generating impervious surfaces after enhanced treatment using a BMP that is exposed to the surface (such as bioretention in view of sidewalk or roads)."
>
> "In Wellhead Protection Zone 3, runoff from pollution generating impervious surfaces can be infiltrated with treatment prior to infiltration based on land use (see Minimum requirement #6). Native soils cannot be assumed to provide treatment. In Wellhead Protection Zone 4, runoff from pollution generating impervious surfaces can be infiltrated without treatment provided the soil profile provides treatment per Chapter 3.3 of Volume III of the 2005 Ecology Manual. Infiltration of runoff from non-pollution generating impervious areas considered to be clean, including most roofs and sidewalks, is strongly encouraged where feasible."

As noted above, infiltration is encouraged in Wellhead Protection Zone 2 from non- pollution generating surfaces only (roofs, sidewalks, etc) or form PGIS after an enhanced treatment surface BMP. Refer to section 6 of this report for a discussion of LID feasibility.

SECTION 2. Conditions and Requirements Summary

The proposed project is classified as a "Large Project" per Section 3.5, page 57, within the City of Redmond Clearing, Grading, and Stormwater Management Technical Notebook, Issue No. 6 (Technical Notebook). Per Figure 3.2 (shown below) and Section 3.5, "all minimum requirements apply to the new impervious surfaces and converted pervious surfaces."

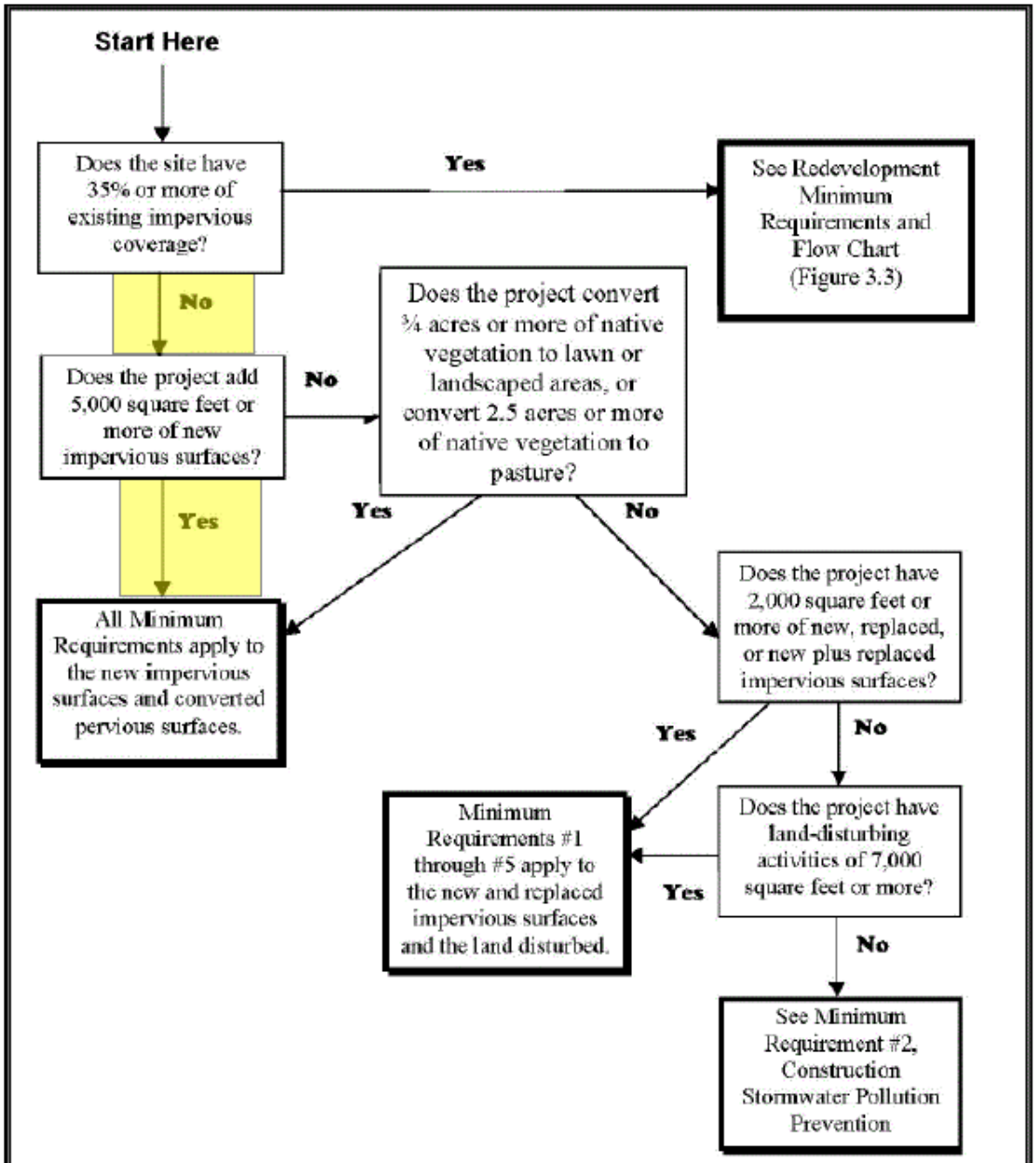


Figure 3.2 Flow Chart for Determining Requirements for New Development

The proposed project is classified as a "Large Project" per Chapter 3 within the City of Redmond Technical Notebook. Therefore, all ten minimum requirements will be addressed per Section 2.5 in the Technical Notebook. Section 2.5 in Volume I of the Washington State Department of Ecology's Stormwater Management Manual for Western Washington (SMMWW) lists the 10 Minimum Requirements for Development. Chapter 2 of the City of Redmond Technical Notebook lists any modifications to the DOE minimum requirements. The ten minimum requirements and how each requirement is addressed are listed below.

Minimum Requirement #1: Preparation of Stormwater Site Plans: Final Civil Plans under separate cover and Final Storm Drainage Report herein have been prepared for the subject project.

Minimum Requirement #2: Construction Stormwater Pollution Prevention: See Section 8 of this Report for the ESC analysis and design. See ESC plans under separate cover. See SWPPP report under separate cover.

Minimum Requirement #3: Source Control Pollution: Since the subject project is a residential project, Source Control is not applicable per Section 4.2 in Volume I of the 2005 DOE Manual.

Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls: Discharge from the site is to the existing natural discharge location. See Section 3 of this Report for the Downstream Analysis. The proposed discharge from the site will be to the natural discharge location near the southwest property corner. The proposed drainage for the site is routed to the new tight line storm drainage system in 167th Ave NE, which was proposed and built for the neighboring property "The Retreat".

Minimum Requirement #5: On-Site Stormwater Management: Roof/footing drains will be connected to perforated stub out connections per SMMWW section 3.1.3. Other BMPs are not feasible due to setbacks and site constraints. See the Geotechnical Findings and Recommendations & Downspout Infiltration Suitability Assessment letter report, by AESI, included under separate cover.

Compost amended soil per Appendix Q of the 2007 (Issue #5) Redmond Stormwater Technical Notebook, "Guidelines for Landscaping with Compost-Amended Soils," the 2012 City of Redmond Standard Drawing #632, "Soil Amendment and Depth," or DOE BMP T5.13, "Post-Construction Soil Quality and Depth," will be used for the landscaped areas.

Minimum Requirement #6: Runoff Treatment: Runoff treatment will be provided in the City of Redmond facility located offsite. No other on site treatment is required.

Minimum Requirement #7: Flow Control: Flow control will be provided in the City of Redmond facility located offsite. No other on site flow control is required.

Minimum Requirement #8: Wetlands Protection: There are no wetlands located on site or off site in proximity to the project. No additional protection measures are required.

Minimum Requirement #9: Basin/Watershed Planning: The subject site drains to a City Regional Stormwater Facility. A contribution to the regional facility will be required.

Minimum Requirement #10: Operations and Maintenance: As no stormwater management facility is required for this project and no private on site stormwater management facilities are proposed there is no operations and maintenance manual required or provided herein.

SECTION 3. Off Site Analysis

Upstream:

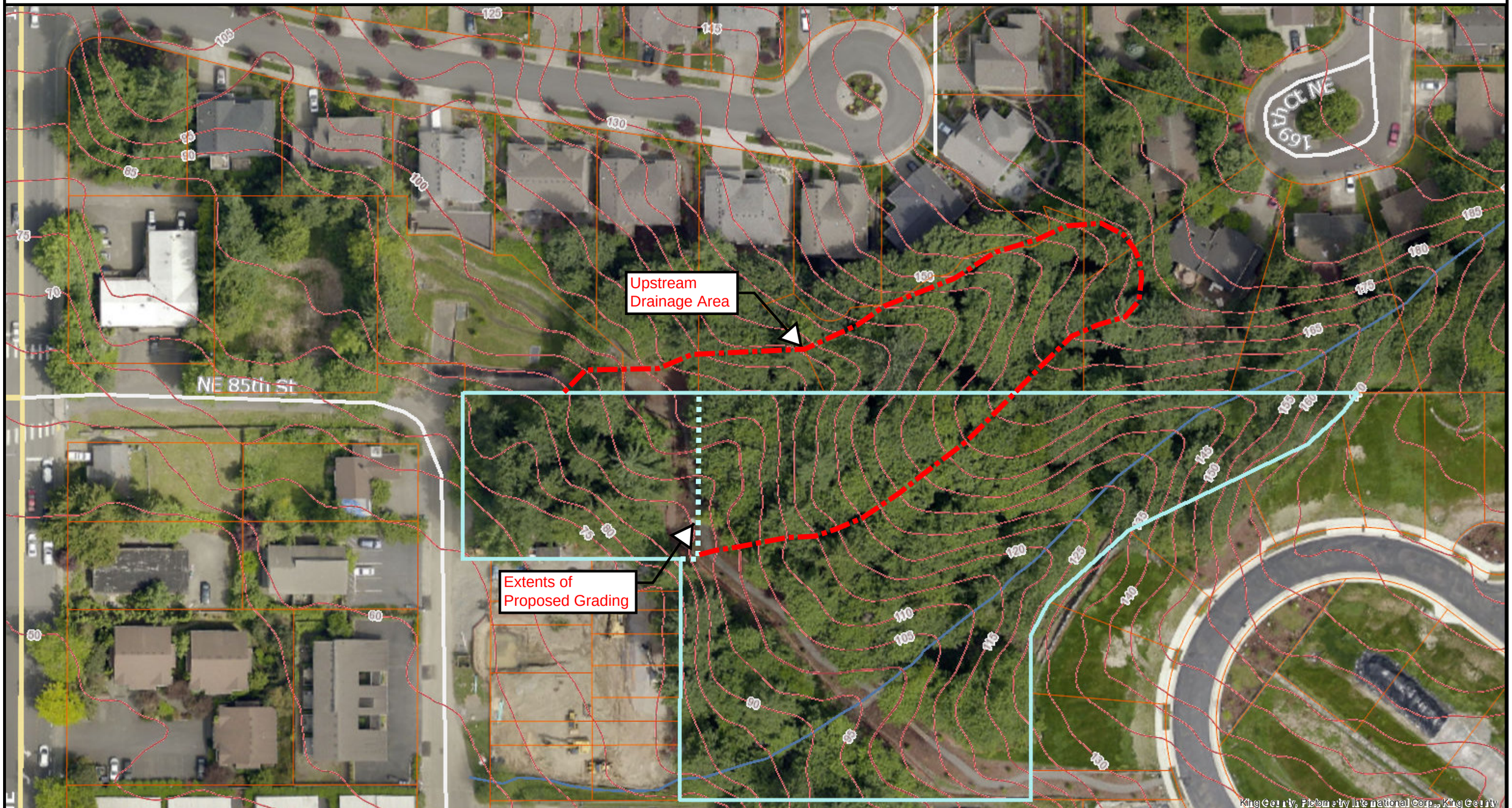
The upstream analysis was performed on December 16th, 2015. The weather conditions were clear.

The site receives upstream runoff from the north and northeast. A majority of the runoff from the north of the site is collected and detained in the Central Park stormwater management facility owned and maintained by the City of Redmond located on parcel 1283800190. However, due to the topography the some area neighboring the north property line is not collected in the stormwater management facility. Any runoff not collected sheet flows on to the site across grass and shrubs. An additional upstream area is defined by a small ravine approximately 100 feet wide, located northeast of the property line. The ravine runs to the southwest towards the southeast property corner where runoff flows over the existing gravel pathway towards the neighboring property "The Retreat" in the south. Refer to the upstream drainage exhibit at the end of this section.

Downstream Field Investigation:

See the "Shaughnessy Heights West Conveyance Analysis, Task Order 12-01" by Northwest Hydraulic Consultants, dated November 5, 2012, included at the end of this section for the downstream field investigation and conveyance analysis.

Drainage Exhibit



The information included on this map has been compiled by King County staff from a variety of sources and is subject to change without notice. King County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a survey product. King County shall not be liable for any general, special, indirect, incidental, or consequential damages including, but not limited to, lost revenues or lost profits resulting from the use or misuse of the information contained on this map. Any sale of this map or information on this map is prohibited except by written permission of King County.

Date: 12/15/2015

Notes:

N

King County
GIS Center

16300 Christensen Rd., Ste. 350 | Seattle, WA 98188 | 206.241.6000 | www.nhcweb.com

nhc
northwest hydraulic consultants

File: 21864

November 5th, 2012

To: Jeff Dendy
MS: 2SPW
15670 NE 85th St.
Redmond, WA 98052-9710

From: Derek Stuart, P.E. Derek Stuart

Re: Shaughnessy Heights West Conveyance Analysis, Task Order 12-01

The City of Redmond has requested that NHC provide hydraulic and hydrologic analysis of the proposed Shaughnessy Heights West development, located in the Downtown Redmond watersheds. The analysis is intended to determine if the municipal conveyance system downstream of the development has adequate capacity to convey runoff generated from a 50-year average recurrence interval storm event without increasing flooding downstream. This memorandum documents the requested analysis including model configuration and the results.

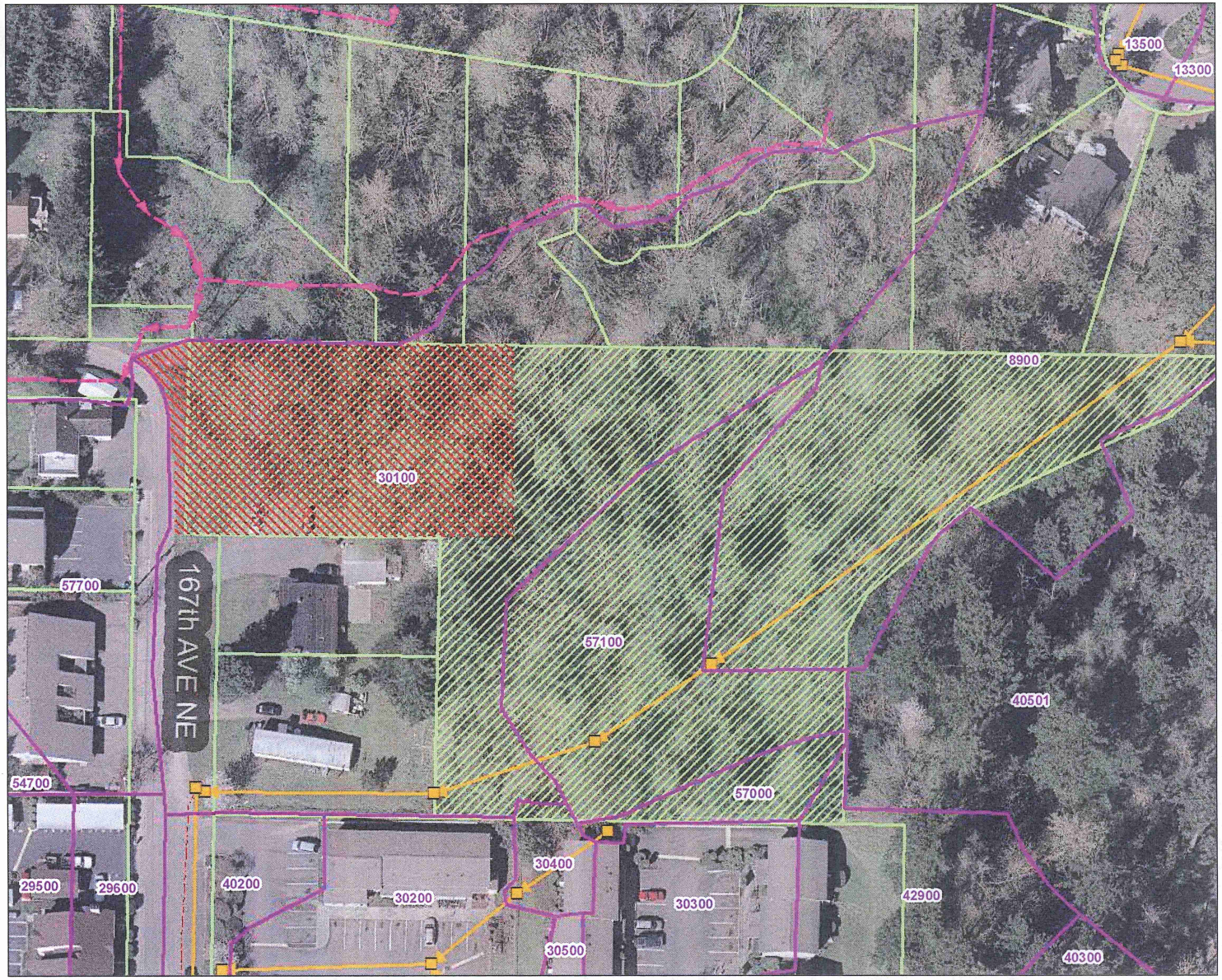
Background Information

The Shaughnessy Heights West development project site is located immediately southeast of the intersection between 167th Avenue NE and 85th Street. This site should not be confused with the larger Shaugnessy Heights development that NHC analyzed in 2011 (see NHC, 2011a); that site was located north of the intersection of NE 82nd Street and 166th Avenue. The current project is a 2 lot short plat that includes the west edge of parcel #0125059114. The approximate extents of the short plat lots are hatched red in the attached Figure 1. The project site description provided by the developer's engineer, Core Designs Inc., on September 11, 2012 follows:

> *..."The site is currently forested. Parcel number 0125059114. The entire property of the shaughnessy hts west short plat is 2.31 acres of existing forested land, of which only 19,534 sf or 0.45 acres will be converted to lots. The remaining 79,036 sf will be preserved as open space and 2,270 sf will be dedicated as right of way..."*

While the project parcel lies within multiple sub-basins in the Redmond Downtown SWMM model, the 0.5 acres of the parcel being cleared, and an additional 0.03 acres of existing ROW being replaced, are limited to sub-basin# 30100. It should be noted that the northern and western boundaries of sub-basin 30100 were updated as part of this analysis as follows:

1) On the northern boundary, recent changes associated with a drainage swale and curb that were part of the Central Park Plat in 2005 were incorporated. The curb intercepts runoff from the hill slope north of the proposed Shaughnessy Heights West development site and routes it west to the 85th Street basin, away from the Downtown Watersheds basin.



City of Redmond Development Services

Shaughnessy Heights West
Project Location and Basin Boundary

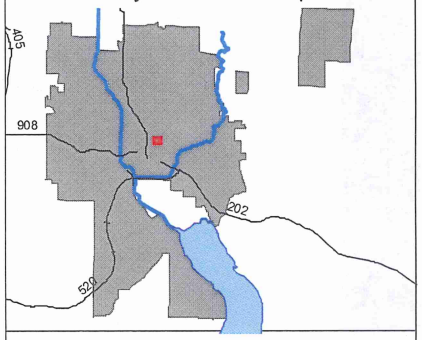
Scale - 1:700

40 20 0 40 80 Feet

N

Northwest Hydraulic Consultants	project no. X-XXXX	29-Oct-2012

City Reference Map



Legend

- Sub-Basins
- Junctions
- Conduits and Channels (85th Street Basin)
- Conduits and Channels (Downtown Basin)
- Overflows (existing)
- Shaughnessy Heights West Site (Approximate)
- Parcel 0125059114
- Parcels

Background Image: 2004 City of Redmond orthophoto

Figure 1

2) On the western boundary, routing of runoff was adjusted to conform with the observation from a field visit by City staff that most of the runoff from the existing forested project site flows south along the eastern edge of 167th Avenue NE, rather than crossing 167th Avenue NE and either flowing south along the western edge of 167th Avenue NE or west to 166th Avenue NE, as previously represented in the model. This observation was incorporated into the model by splitting sub-basin 57700 along the eastern edge of 167th Avenue NE, and merging the area west of 167th Avenue NE into sub-basin #30100. This change resulted in all of Shaughnessy Heights West being located in sub-basin# 30100 rather than being split between sub-basins# 30100 and 57700.

Land Cover

The proposed development project will modify the existing land cover of the project site as described in the following text provided by the developer's engineer, Core Designs Inc., on September 11, 2012 is as follows:

> *"...The impervious area is based on the allowed impervious area per the zoning code at 60% for R-5 zone. The two lots will therefore produce 11,720 sf of impervious surface and the roadway will create 2,561 sf of impervious (561 sidewalk and 2,000 sf of roadway (half in existing right of way and half in new right of way). The total new impervious area is 14,281 sf."*

The land cover assumptions inferred from the description above and used in this analysis are summarized in Table 1 below.

Table 1: Proposed Shaughnessy Heights West Land Cover

Density ID	Impervious Areas			Pervious Areas			Total (acres)	% Effective Impervious Area
	Total (acres)	ROW (acres)	Lot (acres)	Total (acres)	ROW (acres)	Lot (acres)		
Shaughnessy 3	0.328	0.059[1]	0.269	0.202	0.023	0.179	0.530	61.9%

[1] Half of the created ROW impervious area comes from the existing ROW and half is to be dedicated from parcel #0125059114.

All of the impervious area included in the short plat (rooftops, sidewalks and roadways) has been described as 100% connected to the stormwater conveyance system. If all of the impervious area is considered "effective", then the proposed land use change corresponds to an increase in effective impervious area from 5.1% to 19.7% in basin# 30100.

It should be noted that the facilities plan modeling (NHC, 2010) assumed that dispersion would be applied in this R5 zoned area when in fact that is not the case. If all R5 development is implemented with no dispersion, then higher effective impervious areas will result and the model will begin indicating that the sizing and design of the downstream north-south interceptor and east-west trunkline are inadequate to meet the full build-out condition of the basin. What is more likely is that some dispersion will actually take place in these developments, even if the developments are not provided credit for it [due to not being formally incorporated into the design]. To address this inconsistency, the City may want to consider: A) formally incorporating dispersion into the development regulations and designs so that it is more consistent with the facilities plan modeling, or B) As development and redevelopment continue in the basin, and simulated capacity in the north-south interceptor or east-west trunkline is exhausted, the City could re-evaluate the actual effective impervious areas of these developments and consider updating or recalibrating the model to observed flows to more accurately represent the hydrologic response.

PC-SWMM Model Geometries

As mentioned earlier, prior to this current work NHC provided hydrologic and hydraulic modeling support to the City of Redmond Department of Development Services for the downstream capacity analysis of the Shaugnessy Heights development (NHC, 2011a). A quick re-cap of that, and other related work with the Downtown Watershed SWMM model, is as follows:

- The original Downtown Watersheds SWMM model was developed to perform a conveyance analysis and create an inventory of drainage improvements required for the build-out condition in the Downtown Watersheds basin. The proposed trunkline and abandonment of the Bear Creek outfall were included in that model. This work was documented in NHC (2010).

- The Shaughnessy Heights development was proposed and NHC was asked to add the development to a version of the NHC (2010) SWMM model and evaluate the downstream conveyance capacity impacts of the proposed development. For this work, the NHC (2010) model had to be modified to represent the land use condition that would occur in the basin at the time of development construction (i.e. something of a blend between what was considered existing and future land use and system conditions as represented in the 2010 work). The Shaughnessy Heights work, documented in NHC (2011a), identified several downstream improvements that needed to be constructed.

- The City of Redmond implemented CIP improvement project #101420 on 79th Street. That improvement project was incorporated into the NHC (2010) future conditions model and is documented in an October 14, 2010 email to Anisha Prasad from NHC.

- The Redmond Square Apartments development was proposed and NHC was asked to add the development to the SWMM model but also requested that the Shaughnessy Heights development and associated conveyance improvements not be included in the basin model since they had not been constructed at the time of the analysis. For this work NHC added the 79th Street improvement project to the base condition (or without improvements) geometry used in the NHC (2011a) analysis [without the Shaughnessy Heights land use changes] and then evaluated the downstream impacts of the proposed Redmond Square Apartments development. This work, documented in NHC (2011b), did not identify any needed downstream improvements.

Now, for the evaluation of the downstream conveyance capacity impacts of the proposed Shaughnessy Heights West development the NHC (2011a) and NHC (2011b) SWMM models were combined so that the Shaughnessy Heights development, the 79th Street improvements, and the Redmond Square development were included in the baseline condition model. This baseline model is summarized in Table 2 below as model scenario 1 and the "with Shaughnessy Heights West" as scenario 2. Scenario 3 in Table 2, the NHC (2010) future "Build-out" condition model, was not directly used in this analysis and is only included in the table for reference.

Table 2: Redmond Downtown PC-SWMM Model Scenarios			
Model Attribute	**(1) Baseline Model**	**(2) with Shaughnessy Heights West Model**	**(3) Future "Build-out" Condition Model**
Land Cover	2004 Arial Photos + Shaughnessy Heights	2004 Arial Photos + Shaughnessy Heights + Shaughnessy Heights West	Zoning based build-out
E-W Trunk-line/ N-S Interceptor	In-Place	In-Place	In-Place
Drainage Basins	Similar to future condition but with revised drainage associated with Shaughnessy Heights	Similar to future condition but with revised drainage associated with Shaughnessy Heights and proposed Shaughnessy Heights West developments	Based on existing GIS inventory plus Safeway and other areas captured by trunk-line
Bear Creek Outfall	Flows re-routed to Sammamish River outfall	Flows re-routed to Sammamish River outfall	Flows re-routed to Sammamish River outfall
Infiltration Infrastructure	Active	Active	Removed
Other Improvements[1]	Only NHC (2011) recommendations In-Place, other NHC (2010) recommendations not implemented	Only NHC (2011) recommendations In-Place, other NHC (2010) recommendations not implemented	NHC (2010) recommendations In-Place
Purpose	Identification of Flooding Locations	Identification of Flooding Locations	Facilities Planning
[1] NHC (2010) includes 14 CIP improvement projects, including Education Hill bypass and others			

Precipitation

The precipitation time-series used by the SWMM model to calculate runoff is the same 50-year design storm developed and applied in previous Downtown Watershed applications. The design storm, detailed in NHC (2010) as the 50-year conveyance design storm, was developed to match rainfall depths corresponding to the 50-year average recurrence interval at durations of 15-minutes, 30-minutes, 1-hour, 2-hours, and 3-hours. These durations were selected over a set with longer durations because, in the buildout condition, peak flows are expected to concentrate at the basin outlet at timescales that are much shorter than three hours. The rainfall depths used in the design storm were developed through frequency analysis of peak annual rainfall depths from rainfall data at the King County raingage at Marymoor Park . The frequency analysis resulted in 50-year rainfall depths of 0.47, 0.66, 0.79, 1.05, and 1.26 inches for the 15-minute, 30-minute, 1-hour, 2-hour and 3-hour durations respectively. All of these durations were nested into a single design storm. The 15-minute rainfall depth of 0.47 inches, the shortest duration included in the design storm, is similar to depths recorded during historic storms on September 8, 2000 and May 27, 2004 of 0.48 and 0.46 inches respectively. The intensity of the design storm should not be considered overly high because flooding conditions simulated with the design storm are only slightly more severe than those using the observed precipitation from these two historic storms as inputs.

Runoff

Runoff from the 50-year conveyance design storm was simulated using NRCS curve number infiltration routines available in the SWMM runoff module. Soils in the study area are assumed to be fair and were assigned curve numbers according to land cover and hydrologic soils group. The soils above the valley floor are mapped as

hydrologic soils Group C and most of the valley floor as alluvial Group A soils. The Shaughnessy Heights West development is split nearly evenly between these two soil types, the northeast half being Group C soils and the southeast half being Group A soils.

Routing of flows from Shaughnessy Heights West

Runoff from the project site will be routed south down 167th Avenue via a new conveyance system to be constructed by the applicant. That conveyance system will connect to an existing structure on the east side of 167th Avenue about 150 feet south of the site. The existing conveyance system flows south from here until it reaches NE 83rd Street; the conveyance system along 83rd Street, between 167th Avenue and the 166th Avenue North-South interceptor, was recently improved as part of the Shaughnessy Heights off-site improvements.

Results - Simulated Flooding Locations

Results from the 'with Shaughnessy Heights West' model scenario simulation indicate that there are locations in the municipal system that will exhibit increased flooding as a result of introducing increased runoff from the Shaughnessy Heights West site. The most significant flooding increases were along 167th Avenue between the location where the Shaughnessy Heights West stormwater system will be connected to the existing stormwater system and the larger conveyance system along 83rd Street. Figure 2 below highlights the undersized pipes along this stretch of pipe. In addition to flooding on 167th Street, there were also two other locations in the system with less significant flooding increases that are remote from Shaughnessy Heights West. At these locations the depth of simulated flooding at existing flooding locations was increased by less than 0.02 feet. The simulated flooding problems at these locations will be corrected when other planned City CIP projects are completed (e.g. 170th Avenue NE and Avondale, NE 80th Street, etc.).

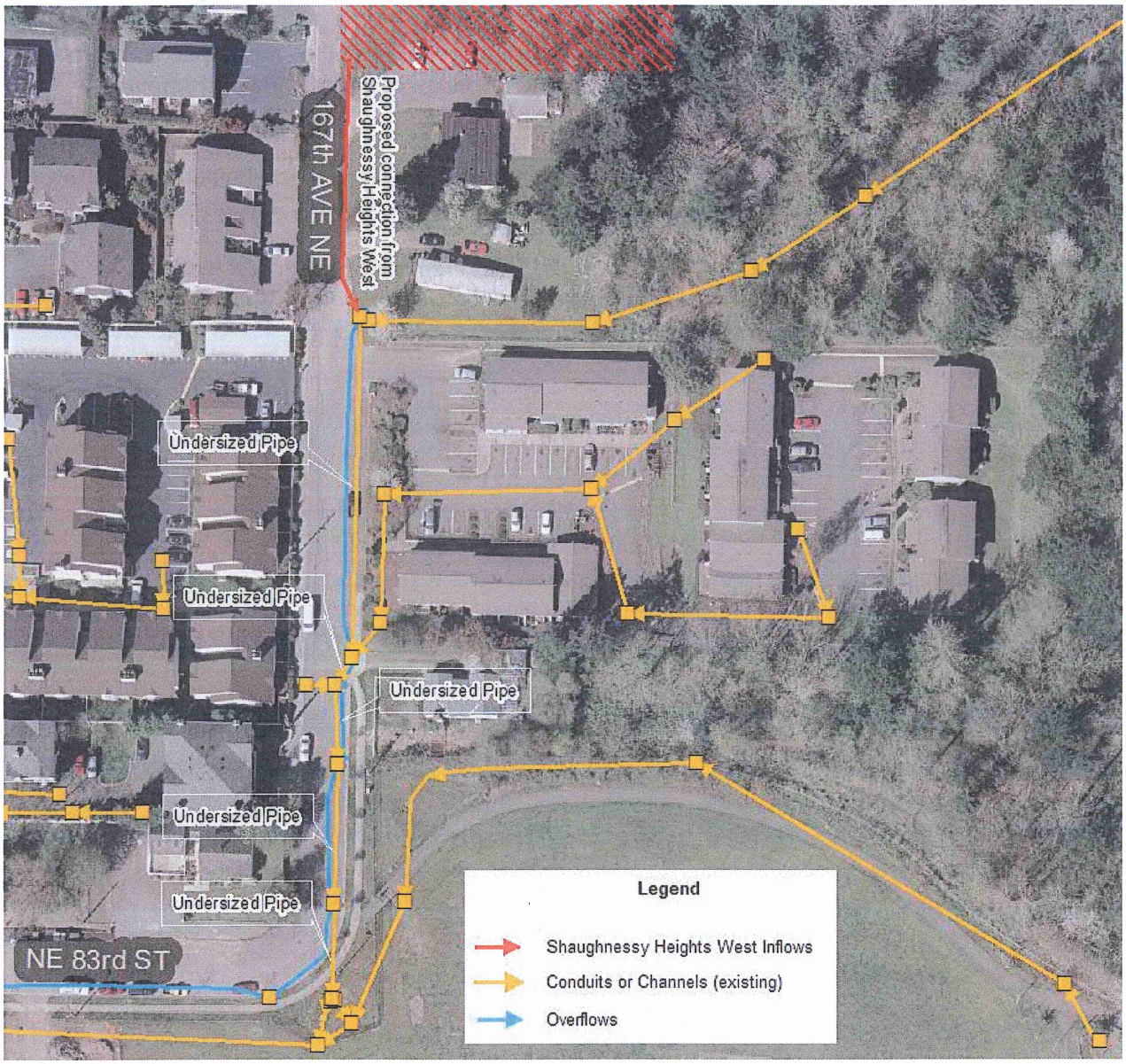


Figure 2: Existing 167th Avenue NE Conveyance System

Conclusion

The proposed Shaughnessy Heights development will increase peak runoff to the municipal stormwater system. In order to prevent increased simulated flooding along NE 167th Avenue under the 50-year design storm, the pipes along this street need to be replaced as recommended in NHC (2010). The other simulated flooding locations, with less than 0.02 feet of increased flooding depth, may or may not be considered negligible increases in flooding depth. We defer this determination to City staff.

If you have any questions regarding this analysis please do not hesitate to contact me at (206) 241-6000.

References

NHC (2010). DRAFT Comprehensive Summary of Stormwater Capacity Analysis of the Downtown Watersheds Prepared by Northwest Hydraulic Consultants for the City of Redmond Department of Natural Resources. October 4th, 2010.

NHC (2011a), Shaugnessy Heights Analysis Results, Amendment #1 to Task Order 10-01. Prepared by Northwest Hydraulic Consultants for the City of Redmond Department of Development Services. January 12th, 2011.

NHC (2011b), Redmond Square Analysis Results, Task Order 11-01. Prepared by Northwest Hydraulic Consultants for the City of Redmond Department of Development Services. June 3rd, 2011.

SECTION 4. Flow Control and Water Quality Analysis and Design

A. Hydrologic Analysis

A hydrologic analysis was not conducted for this project since it lies within a Regional Surcharge Area and will therefore contribute to the regional facility connection fees in lieu of providing on site stormwater detention. The land cover assumptions, however, are provided below, for the existing and developed conditions.

Pre-Developed Conditions

Existing conditions for the project site have been analyzed assuming 100% pervious ground cover consisting of second growth forest as defined in the City of Redmond code under the definition of Pre-Development Conditions. The existing site is 2.34 acres, however only 0.43 acres (including some frontage improvements in 167th Avenue NE that will be collected in the off-site detention facility) will be developed. The remaining on-site area is to remain undeveloped (Tract A).

The following table shows the area break down for the existing conditions.

EXISTING CONDITIONS	Total Area = 0.43 acres
GROUND COVER	AREA(acre)
Till-Forest	0.43

The peak uncontrolled runoff flow rates for the existing, pre-developed condition are shown below.

```
  Flow Frequency Analysis
  Time Series File:predev.tsf
  Project Location:Sea-Tac

  ---Annual Peak Flow Rates---      -----Flow Frequency Analysis-------
 Flow Rate  Rank  Time of Peak       - - Peaks - -  Rank  Return  Prob
   (CFS)                               (CFS)             Period
   0.027      2   2/09/01 18:00       0.035         1  100.00   0.990
   0.007      7   1/06/02  3:00       0.027         2   25.00   0.960
   0.020      4   2/28/03  3:00       0.021         3   10.00   0.900
   0.001      8   3/24/04 20:00       0.020         4    5.00   0.800
   0.012      6   1/05/05  8:00       0.018         5    3.00   0.667
   0.021      3   1/18/06 21:00       0.012         6    2.00   0.500
   0.018      5  11/24/06  4:00       0.007         7    1.30   0.231
   0.035      1   1/09/08  9:00       0.001         8    1.10   0.091
Computed Peaks                        0.032             50.00   0.980
```

Developed Conditions

Proposed development of the property will include construction of an 8 unit multi-family development along with associated frontage improvements along 167th Avenue NE, utilities, and open space. The open space areas are to remain in the existing condition and are excluded from the developed area calculations. This project will be routed to the public drainage and water quality facility located downstream of the project site. The majority of the upstream runoff is collected in the detention facility on the adjacent property. All upstream runoff tributary to the site will be collected and conveyed around the site to the storm public storm system in 167th Ave NE.

The total area being developed is 0.43 acres, which includes future frontage improvements and excludes the open spaces that will not be developed.

The developed conditions of the project site were calculated using the method outlined in section 8.6.2 of the Redmond 2007 Stormwater Technical Notebook. The City of Redmond Code says that the maximum impervious surface area for Zone R-18 is 75% of the total lot area. The Redmond Technical Notebook provides guidance to take 80% of the maximum allowed lot impervious coverage for purposes of detention calculations. The remaining site would be modeled as landscaping, or lawn/grass. The breakdown of the site characteristics can be seen below.

DEVELOPED SITE CHARACTERISTICS (TO OFF-SITE REGIONAL FACILITY)		
Total Area = 0.43 acres		
AREA DESIGNATION	Pervious (acres)	Impervious (acres)
Right-Of-Way (including frontage improvements in 167th Avenue NE)	0.02	0.06
Lots (80% of 75% impervious)	0.08	0.27
Total	**0.10**	**0.33**

The peak uncontrolled runoff flow rates for the developed condition are shown below.

```
  Flow Frequency Analysis
  Time Series File:dev.tsf
  Project Location:Sea-Tac

  ---Annual Peak Flow Rates---      -----Flow Frequency Analysis-------
 Flow Rate  Rank  Time of Peak       - - Peaks - -  Rank  Return  Prob
   (CFS)                               (CFS)              Period
   0.089      6   2/09/01  2:00        0.177          1  100.00   0.990
   0.075      8   1/05/02 16:00        0.123          2   25.00   0.960
   0.107      3   2/27/03  7:00        0.107          3   10.00   0.900
   0.084      7   8/26/04  2:00        0.100          4    5.00   0.800
   0.100      4  10/28/04 16:00        0.095          5    3.00   0.667
   0.095      5   1/18/06 16:00        0.089          6    2.00   0.500
   0.123      2  10/26/06  0:00        0.084          7    1.30   0.231
   0.177      1   1/09/08  6:00        0.075          8    1.10   0.091
Computed Peaks                         0.159             50.00   0.980
```

B. Detention Calculations

No detention calculations are required for this project since it will be discharging into the regional facility and contributing a fee in lieu of providing on site stormwater management.

C. Water Quality Design

No water quality calculations are required for this project since it will be discharging into the regional facility and contributing a fee in lieu of providing on site stormwater management.

SECTION 5. Conveyance System Analysis and Design

A conveyance analysis will be prepared during final engineering.

SECTION 6. Special Reports and Studies

- Project LID Feasibility
  Discussion included in this section (see below).

- Shaughnessy Heights West Conveyance Analysis, Task Order 12-01
  Prepared for: Shaughnessy Heights West
  Prepared by: Derek Stuart, P.E.
  Dated: November 5, 2012
  Northwest Hydraulic Consultants
  16300 Christensen Road, Suite 350
  Seattle, WA 98188
  (Copy provided in section 3 herein and under separate cover)

- Subsurface Exploration, Geologic Hazard, and Technical Engineering Report
  Prepared for: Maplewood (Formerly Shaughnessy Heights West)
  Prepared by: Stephen A. Siebert, P.E
  Dated: October 21, 2015
  Associated Earth Sciences, Inc. 911 Fifth Avenue
  Kirkland, WA 98033
  (Copy provided in appendix herein and under separate cover)

- Ground Water Recharge Evaluation
  Prepared for: Maplewood (Formerly Shaughnessy Heights West)
  Prepared by: Curtis J. Koger, L.G., L.E.G. L.Hg
  Dated: December 21, 2012
  Associated Earth Sciences, Inc.
  911 Fifth Avenue
  Kirkland, WA 98033
  (Copy provided under separate cover)

PROJECT LID FEASIBILITY

Site Soils

The development is classified as a large project and therefore, a discussion of LID feasibility is included in this report per the City of Redmond Technical Notebook Section 8.7.5. The feasibility of dispersion and infiltration LID options are discussed below with referenced to the 2005 DOE manual Vol III Appendix C.

Based on the 2005 DOE, the site does not meet the full dispersion requirements since 65 percent of the total area is not preserved in the forested native condition. In addition, the site does not meet the minimum requirements of limited dispersion which requires a vegetative flow path through undisturbed native landscape or lawn area.

The project Geotechnical Engineer conducted infiltration suitability analyses to determine the feasibility of the on-site soils for supporting infiltration. The recommendation from the Geotechnical Engineer (see report included in the attached Appendix) is that on site infiltration is not feasible. Therefore, infiltration facilities are not proposed on the Maplewood project.

Wellhead Protection Zones

The City of Redmond has identified four (4) Wellhead Protection Zones throughout the City in order to help manage the variable, and often shallow, groundwater impacts to land development activities. The City Wellhead Protection Zone map in the project vicinity is included in Section 1 of this report.

The Maplewood project is located in Wellhead Protection Zone 2. Once identified on the City map, the applicable Wellhead Protection Zone sets or modifies two key design parameters including:

- Soil classification for hydrologic analysis (detention facility sizing)
- Infiltration limitations

The Maplewood project, therefore, will be limited in any application of LID features that rely on infiltration. Flow control credits are provided based on clear demonstration of the site suitability criteria for the soils. Infiltration within Wellhead Protection Zone 2 is allowed by the City of Redmond for non-pollution generating impervious surfaces (roofs, sidewalks, etc.) and only for pollution generating impervious surfaces that are treated prior to infiltration under the enhanced treatment menu. The onsite sidewalks are adjacent and flush with the road. Therefore, the sidewalks are also considered pollution generating impervious area and cannot be infiltrated without treatment.

Feasible Project-specific LID Elements

Compost Amended Soil (Soil Quality and Depth – COR STD 632))

Although no other LID techniques are feasible or proposed for the Maplewood project, Compost Amended Soil, per the 2012 City of Redmond Standard Drawing #632, “Soil Amendment and Depth,” or DOE BMP T5.13, “Post-Construction Soil Quality and Depth,” is feasible and will be used for the landscaped areas across the project.

SECTION 7. Other Permits

Additional permits will be addressed during the final plat phase and may include the following:

- Right-Of-Way Use Permit

SECTION 8. CSWPPP Analysis and Design

Design of the ESC plan was completed in conformance with Minimum Requirement #2 per the 2005 DOE Manual. Compliance with the 12 minimum requirements is demonstrated in the Construction Stormwater Pollution Prevention Plan report provided under separate cover.

The site will follow Chapter 4 of Volume II in the 2005 Washington State Department of Ecology's Stormwater Management Manual for Western Washington (DOE Manual) for the erosion and sedimentation control design to reduce the discharge of sediment-laden runoff from the site. Clearing limits will be established prior to any earthwork on the project site. Perimeter protection will be provided by silt fencing along the downstream perimeter of the disturbed areas to limit the downstream transport of sediment to streams, wetlands and neighboring properties.

Dust control, if required, will be provided by a water truck. A Certified Erosion and Sediment Control Lead inspector will be present onsite during earthwork activities. The inspector shall determine frequency of watering of the project site and will authorize and direct any additional erosion and sediment control measures as needed during all construction activities.

The plan will be comprised of temporary measures (stabilized construction entrance, silt fence, etc.) as well as permanent measures (hydroseeding, etc.). In general, construction activities will be sequenced such that soil disturbance and erosion is minimized to better control erosion impacts.

Additional BMPs will be implemented on site during construction activities when deemed appropriate and necessary.

SECTION 9. Bond Quantities, Facility Summaries, and Declaration of Covenant

An engineering cost estimate will be prepared during final engineering.

SECTION 10. Operations and Maintenance Manual

As no stormwater management facility is required for this project and no private on site stormwater management facilities are proposed there is no operations and maintenance manual required.

-

SECTION 11. Appendix

King County Assessor Parcel Report

Geotechnical Report by Associated Earth Sciences

KCRTS Input

-

Department of Assessments

500 Fourth Avenue, Suite ADM-AS-0708, Seattle, WA 98104

Office Hours: Mon - Fri 8:30 a.m. to 4:30 p.m.

TEL: 206-296-7300
FAX: 206-296-5107
TTY: 206-296-7888

Send us mail

PARCEL

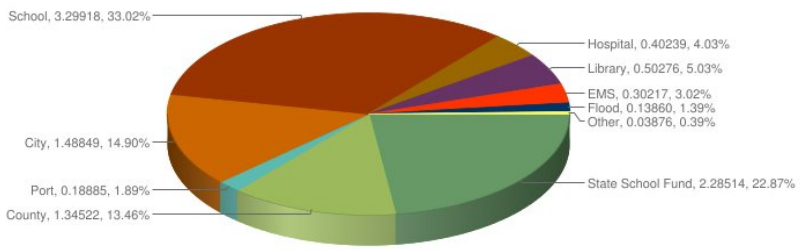
Parcel Number	012505-9114
Name	AMALANI L L C+IBBO L L C
Site Address	8420 167TH AVE NE 98052
Legal	PCL A REDMOND BLA #L060367 REC #20070226900021 SD BLA BEING POR N 1/2 OF SE 1/4 OF SW 1/4 TGW POR NE 1/4 OF SW 1/4 OF SW 1/4 STR 01-25-05

BUILDING 1

Year Built	
Total Square Footage	
Number Of Bedrooms	
Number Of Baths	
Grade	
Condition	
Lot Size	100816
Views	No
Waterfront	

TOTAL LEVY RATE DISTRIBUTION

Tax Year: 2015 **Levy Code:** 2020 **Total Levy Rate:** $9.99156 **Total Senior Rate:** $6.43376



35.61% Voter Approved

Click here to see levy distribution comparison by year.

TAX ROLL HISTORY

Valued Year	Tax Year	Appraised Land Value ($)	Appraised Imps Value ($)	Appraised Total ($)	Taxable Land Value ($)	Taxable Imps Value ($)	Taxable Total ($)
2015	2016	222,000	0	222,000	222,000	0	222,000
2014	2015	207,000	0	207,000	207,000	0	207,000
2013	2014	455,000	0	455,000	455,000	0	455,000
2012	2013	416,000	0	416,000	416,000	0	416,000
2011	2012	414,000	0	414,000	414,000	0	414,000
2010	2011	440,000	0	440,000	440,000	0	440,000
2009	2010	440,000	0	440,000	440,000	0	440,000
2008	2009	518,000	0	518,000	518,000	0	518,000
2007	2008	235,000	0	235,000	235,000	0	235,000
2006	2007	212,500	0	212,500	212,500	0	212,500
2005	2006	418,000	0	418,000	418,000	0	418,000
2004	2005	191,000	0	191,000	191,000	0	191,000
2003	2004	182,000	0	182,000	182,000	0	182,000
2002	2003	182,000	0	182,000	182,000	0	182,000
2001	2002	169,000	0	169,000	169,000	0	169,000
2000	2001	160,000	0	160,000	160,000	0	160,000
1999	2000	142,000	0	142,000	142,000	0	142,000

Reference Links:

- King County Taxing Districts Codes and Levies (.PDF)
- King County Tax Links
- Property Tax Advisor
- Washington State Department of Revenue (External link)
- Washington State Board of Tax Appeals (External link)
- Board of Appeals/Equalization
- Districts Report
- iMap
- Recorder's Office

Scanned images of surveys and other map documents

Notice mailing date: 09/10/2015

1998	1999	0	0	0	128,000	0	128,000
1997	1998	0	0	0	468,200	0	468,200
1996	1997	0	0	0	468,200	0	468,200
1994	1995	0	0	0	468,200	0	468,200
1992	1993	0	0	0	468,200	0	468,200
1990	1991	0	0	0	374,500	0	374,500
1988	1989	0	0	0	280,900	0	280,900
1986	1987	0	0	0	260,300	0	260,300
1984	1985	0	0	0	234,100	0	234,100
1982	1983	0	0	0	114,600	0	114,600

Updated: April 22, 2015

Share Tweet Email Print

Information for...

Residents
Businesses
Job seekers
Volunteers
King County employees

Do more online

Trip Planner
Property tax information & payment
Jail inmate look up
Parcel viewer or iMap
Public records
More online tools...

Contact us

206-296-0100
Email us
Staff directory
Customer service
Report a problem
Subscribe to alerts

Stay connected! View King County social media

King County

© King County, WA 2015 Privacy Accessibility Terms of use

Information for... **Do more online**
Contact us

March 23, 2016
Project No. KE120383B

IBBO, LLC and Amalani, LLC
105 South Main Street, Suite 230
Seattle, Washington 98104

Attention: Mr. Barry Margolese

Subject: Stormwater Infiltration Feasibility
Maplewood (formerly Shaughnessy Heights West)
167th Avenue NE and NE 85th Street
Redmond, Washington

Dear Mr. Margolesse:

This letter responds to the City of Redmond's request during the 60% PREP meeting on January 7, 2016 for evaluation of infiltration at the southwest corner of the property. This letter supplements our Technical Memorandum – Groundwater Recharge Evaluation dated December 21, 2015 and "Subsurface Exploration, Geologic Hazards, and Preliminary Geotechnical Engineering Report" dated October 21, 2015 for the proposed development. Our work has been completed in accordance with generally accepted geotechnical engineering and hydrogeologic practices. This letter was prepared for the exclusive use of IBBO, LLC and Amalani, LLC and their authorized agents, for specific application to this project. No other warranty, express or implied is made.

PROJECT AND SITE DESCRIPTION

The proposed Maplewood project site is located on the south side of NE 85th Street extended and just east of 167th Avenue NE in Redmond, Washington (see Figure 1, "Vicinity Map"). The subject property is an approximately 2.34-acre undeveloped parcel. Approximately 1.69 acres of the parcel will remain undeveloped and the remaining 0.65 acres will be developed with an eight-unit townhome complex along with associated driveways, retaining walls, sidewalks, utilities, and frontage improvements along 167th Avenue NE. The townhomes would have partial below-grade levels. Based on finished floor elevations of the townhomes provided by CORE Design (CORE) we expect cuts from 10 to 15 feet will be required to reach final grades. Retaining walls from 4 to 12 feet in height are proposed on the north and south sides of the tract. We understand that a dry well is being considered at the southwest corner of the site.

Based on information provided by CORE, the drywell would be 72 inches in diameter and be 72 inches deep. Top of the drywell would roughly correspond to an elevation of 65 feet, the approximate current elevation of 167th Avenue NE near the southwest corner of the site.

The existing site is currently an undeveloped forested parcel. On the 0.65-acre tract proposed for townhomes, the ground surface elevation ranges from about 65 feet above mean sea level (amsl) in the southwest corner rising to about 125 feet amsl on the eastern edge. The ground surface generally slopes to the west/southwest across most of the site. A steep slope inclined at greater than 40 percent is present on the eastern portion of the tract. Remnants of a man-made steep slope created as a result of previous grading are present in the southwest portion of the site and south of the site. There is a faint remnant drainage located in the eastern portion of the tract, oriented roughly northeast-southwest, that creates a linear localized depression. Vegetation on the tract consists of both large evergreen and deciduous trees with a moderately dense understory.

SUBSURFACE CONDITIONS

As described in our previous reports for the project completed to date referenced in our Technical Memorandum, the subject site is located at the southwestern base of the Education Hill upland. The upland is mantled by Vashon lodgement till and till sediments were encountered on site at or within a few feet of ground surface. Areas of Vashon recessional outwash are mapped near the base of the slope and areas of thin outwash were encountered on the slope. Till-like pre-Fraser-age low-permeability deposits are also mapped on the upland margin in the vicinity of the site and were encountered generally less than 10 feet below ground surface.

Our recent exploration boring EBW-7 (attached) was located in the location of the planned drywell at approximately an elevation of 71 feet which is about 6 feet above the top of the proposed dry well. The boring which extended to depth of 26.5 feet was completed as a 2-inch-diameter monitoring well and encountered approximately 7 feet of recessional outwash overlying lodgement till and pre-Fraser-age fine-grained soils.

At the time of drilling (January 30, 2016), our recent exploration boring encountered ground water at a depth of 7 feet. Several days after the monitoring well was installed and developed, AESI measured the water level on February 3, 2016 to be 4½ feet below existing ground surface.

CONCLUSIONS

The purpose of our deep exploration at the southwest corner of the site was to evaluate the feasibility of infiltration since a stormwater infiltration facility has been constructed and is in use at the development known as “The Retreat” immediately south of the site. In our opinion, infiltration is not feasible at the site in the southwest corner for the following reasons:

- Recessional outwash soils which could provide a favorable receptor for stormwater were encountered above the depth of the drywell and very low-permeability lodgement till was observed within the zone of infiltration.

- Shallow ground water was encountered within the boring that corresponds to the top of the planned drywell resulting in insufficient vertical separation between the base of the infiltration feature and the ground water table.

CLOSURE

We appreciate the opportunity to be of continued service to you on this project. Should you have any questions, or require additional information, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

STEPHEN A. SIEBERT
STATE OF WASHINGTON
36329
REGISTERED
PROFESSIONAL ENGINEER

3/23/16

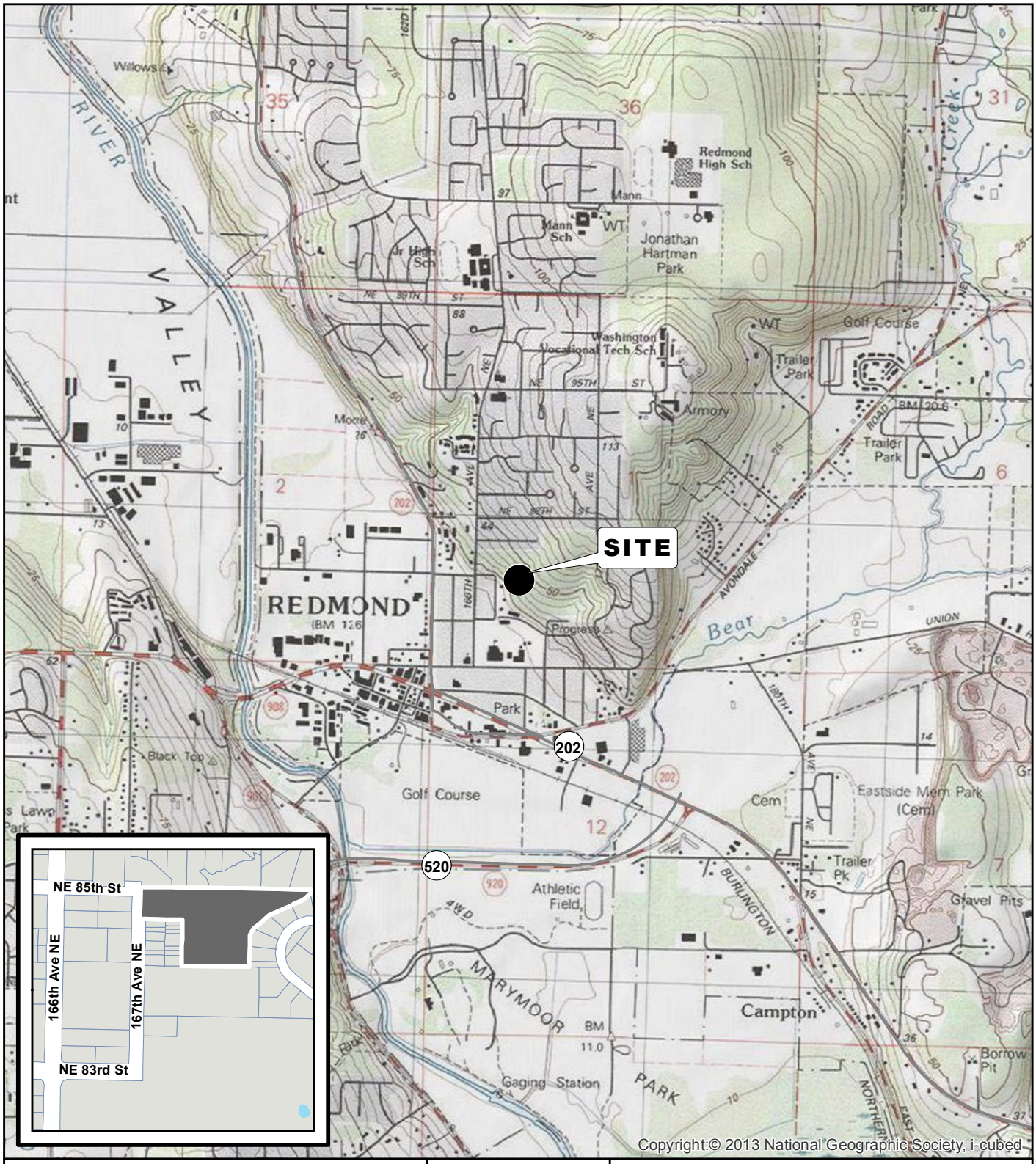
-FOR-

Stephen A. Siebert, P.E.
Associate Geotechnical Engineer

Curtis J. Koger, L.G., L.E.G., L.Hg.
Senior Principal Geologist/Hydrogeologist

Attachments: Figure 1. Vicinity Map
Figure 2. Site and Exploration Plan
Boring EBW-7

SAS/ld
KE120383B12
Projects\20120383\KE\WP



Copyright:© 2013 National Geographic Society, i-cubed

DATA SOURCES / REFERENCES:
USGS: 24K SERIES TOPOGRPAHIC MAPS
KING CO: STREETS, PARCELS

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N

0 1000 2000
FEET

NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

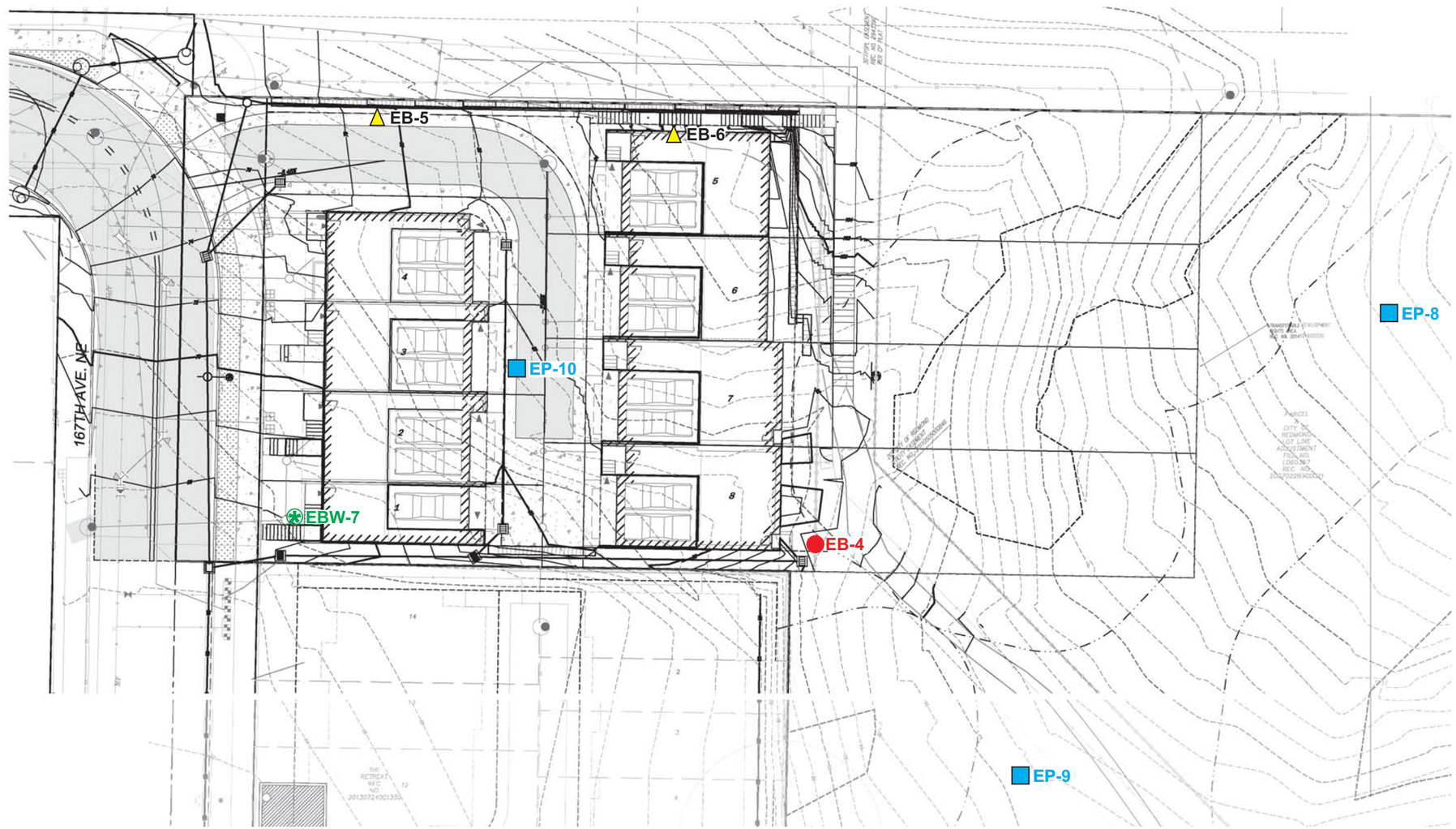
associated earth sciences incorporated

VICINITY MAP

MAPLEWOOD
REDMOND, WASHINGTON

PROJ NO.	DATE:	FIGURE:
KE120383B	3/16	1

Document Path: G:\GIS_Projects\aTemplates\NTRP\aVM_Template\160XXX Fig1 ProjectVicinity_KingNTRP.mxd



N

0 15 30

FEET

LEGEND:

- EB — EXPLORATION BORING BY AESI - 2006
- EB — EXPLORATION BORING BY AESI - 2015
- EP — EXPLORATION PIT BY AESI -2004
- EPW — MONITORING WELL BY AESI - 2016

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:
1. BASE MAP REFERENCE: CORE DESIGN, MAPLEWOOD, UNDATED

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

associated earth sciences incorporated

SITE AND EXPLORATION PLAN

MAPLEWOOD
REDMOND, WASHINGTON

PROJ NO.	DATE:	FIGURE:
KE120383B	3/16	2

120383 Maplewood \ 120383 F2 Site and Explor Plan 3-21-16.cdr

associated earth sciences incorporated

Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
KE120383B	EBW-7	1 of 1

Project Name	Maplewood	Location	Redmond, WA
Elevation (Top of Well Casing)	~74	Surface Elevation (ft)	~74
Water Level Elevation		Date Start/Finish	1/30/16,1/30/16
Drilling/Equipment	Bortec / Track-Mounted	Hole Diameter (in)	8 inches
Hammer Weight/Drop	140# / 30"		

Depth (ft)	Water Level	WELL CONSTRUCTION	ST	Blows/ 6"	Graphic Symbol	DESCRIPTION
		Flush mount monument J plug Concrete surface seal 0 to 1 foot Bentonite chips 1 to 4 feet				**Vashon Recessional Outwash**
		2-inch I.D. Schedule 40 PVC casing: 0 to 5 feet		4 7 9		Very moist, tan, silty, very gravelly SAND (SM).
5				4 8 8		(poor recovery)
	▼					**Vashon Lodgement Till (?)**
		10/20 silica sand 4 to 17 feet		5 50/5"		Wet, mottled gray and tan, gravelly, silty, fine SAND (SM). (gravelly drilling action)
10		2-inch I.D., Schedule 40 PVC, machine well screen, 0.010-inch slot width, 5 to 15 feet		26 50/5"		(no recovery - rock stuck in end of sampler; sample shoe broken off) (gravelly drilling action)
				50/5"		(poor recovery - rock stuck in tip of sampler) (gravelly drilling action) Becomes very moist, tan, and very gravelly.
15		Threaded end cap		37 50/5"		**Possession (?) Glaciomarine**
		Well tag #BIT 780				Very moist, grayish brown, SILT, some fine sand; slight reaction with HCl (ML). (smooth drilling action)
				13 22 21		Becomes blue gray, trace fine sand; slight reaction with HCl.
		Bentonite chips 17 to 25 feet				
20				14 21 21		Becomes brown. Becomes blue gray.
				50/6"		(poor recovery - no change in drilling action)
25		Native slough 25 to 26.5		17 24 23		Sample ribbon-like - suggests presence of scattered gravel.

Boring terminated at 26.5 feet.
Well completed at 15 feet on 1/30/16.

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample

M - Moisture
Water Level ()
Water Level at time of drilling (ATD)

Logged by: TJP
Approved by: JHS

associated
earth sciences
incorporated

Subsurface Exploration, Geologic Hazard,
and Geotechnical Engineering Report

MAPLEWOOD (FORMERLY SHAUGHNESSY HEIGHTS WEST)

Redmond, Washington

Prepared For:

IBBO, LLC and AMALANI, LLC

Project No. KE120383B
October 9, 2015
Revised October 21, 2015

Associated Earth Sciences, Inc.
911 5th Avenue
Kirkland, WA 98033
P (425) 827 7701
F (425) 827 5424

associated
earth sciences
incorporated

October 9, 2015
Revised October 21, 2015
Project No. KE120383B

IBBO, LLC and Amalani, LLC
105 South Main Street, Suite 230
Seattle, Washington 98104

Attention: Mr. Barry Margolese

Subject: Subsurface Exploration, Geologic Hazard,
and Geotechnical Engineering Report
Maplewood (formerly Shaughnessy Heights West)
167th Avenue NE and NE 85th Street
Redmond, Washington

Dear Mr. Margolese:

We are pleased to present the enclosed copies of the above-referenced report. This report summarizes the results of our subsurface exploration, geologic hazard, and geotechnical engineering studies, and offers recommendations for the design and development of the proposed project.

We have enjoyed working with you on this study and are confident that the recommendations presented in this report will aid in the successful completion of your project. If you should have any questions, or if we can be of additional help to you, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Stephen A. Siebert, P.E.
Associate Geotechnical Engineer

SAS/ld
KE120383B7
Projects\20120383\KE\WP

SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, AND GEOTECHNICAL ENGINEERING REPORT

MAPLEWOOD
(FORMERLY SHAUGHNESSY HEIGHTS WEST)

Redmond, Washington

Prepared for:
IBBO, LLC and Amalani, LLC
105 South Main Street, Suite 230
Seattle, Washington 98104

Prepared by:
Associated Earth Sciences, Inc.
911 5th Avenue
Kirkland, Washington 98033
425-827-7701
Fax: 425-827-5424

October 9, 2015
Revised October 21, 2015
Project No. KE120383B

I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of our subsurface exploration, geologic hazard, and geotechnical engineering study for the proposed residence. The location of the site is shown on the "Vicinity Map," Figure 1, and the approximate locations of the explorations accomplished for this study are presented on the "Site and Exploration Plan," Figure 2. In the event that any changes in the nature, design, or location of the proposed development are planned, the conclusions and recommendations contained in this report should be reviewed and modified, or verified, as necessary.

1.1 Purpose and Scope

The purpose of this study was to provide subsurface data and geotechnical design recommendations to be utilized in the design and development of the subject project. Our study included a review of available geologic and past project literature, drilling two exploration borings, and performing geologic studies to assess the type, thickness, distribution, and physical properties of the subsurface sediments and shallow ground water conditions. Geologic hazard evaluations and geotechnical engineering studies were also conducted to determine the type of suitable foundation, allowable foundation soil bearing pressures, anticipated foundation settlements, lateral earth pressures, floor support recommendations, temporary shoring recommendations, and drainage considerations. This report summarizes our current fieldwork and offers development recommendations based on our present understanding of the project.

1.2 Authorization

Authorization to proceed with this study was granted by Mr. Barry Margolese of Amalani, LLC. Our study was accomplished in general accordance with our proposal dated September 14, 2015. This report has been prepared for the exclusive use of IBBO, LLC and Amalani, LLC and their agents for specific application to this project. Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the owner.

2.0 PROJECT AND SITE DESCRIPTION

The project site is the northwest rectangular terminus of an undeveloped property located at the southeast corner of the intersection of 167th Avenue NE and NE 85th Street in Redmond, Washington (Figure 1). The total site area being developed is 28,196 square feet (0.65 acres).

The ground surface elevation ranges from 70 feet above mean sea level (amsl) in the southwest corner of the site to 125 feet amsl in the east portion of the site. The ground surface generally slopes to the west/southwest across most of the site. A steep slope inclined at greater than 40 percent is present on the east end of the parcel. A man-made steep slope created as a result of previous grading extends into the south end of the site from the neighboring property. There is a faint, remnant stream channel, located in the eastern portion of the site, oriented roughly northeast-southwest, that creates a linear localized depression. Vegetation on the property consists of both large evergreen and deciduous trees with a moderately dense understory of ferns, low brush, vines, blackberries, and small saplings.

We understand that the project would include dividing the site into eight lots for construction of new multi-story townhomes with a central north-south trending driveway that exits onto 167th Avenue NE. The townhomes would have partial below-grade levels. Based on finished floor elevations of the townhomes provided by CORE Design, Inc. (CORE Design) we expect cuts from 10 to 15 feet will be required to reach final grades. Temporary slopes or shoring may be needed to reach final grades, especially in the northeast corner of the site. Retaining walls from 4 to 12 feet in height are planned along the north and south sides of the site. We understand that low impact development storm water features are being considered for the project.

3.0 SITE EXPLORATION

In 2004, Associated Earth Sciences, Inc. (AESI) conducted a site reconnaissance and observed the excavation of 10 exploration pits completed across the original 17.5-acre "Shaughnessy Heights" project area (AESI, 2004), which includes the 0.65-acre area currently being proposed for development. In 2006, AESI drilled five exploration borings in the vicinity of several steep slopes located within the original "Shaughnessy Heights" project area (AESI, 2006). Exploration EP-10 was located in between the currently proposed "Maplewood" Lots 2 and 3, and exploration boring EB-4 was completed near the southeast corner of proposed Lot 8. For our current phase of study, an additional two exploration borings (EB-5 and EB-6) were advanced along the north property line, in the location of the proposed retaining wall and on the north side of proposed Lot 5. The locations of the explorations are shown on Figure 2. The various types of materials and sediments encountered in the explorations, as well as the depths where characteristics of these materials changed, are indicated on the exploration logs presented in Appendix A of this report.

The conclusions and recommendations presented in this report are based on the explorations completed to date at the site. The locations and depths of the explorations were completed within site and budgetary constraints. It should be noted that differing subsurface conditions may sometimes be present due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of any variations beyond the

field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.

3.1 Exploration Borings

Borings EB-5 and EB-6 were completed on the property using a limited-access tracked drill rig advancing a 4.25-inch, inside-diameter, hollow-stem auger. During the drilling process, samples were obtained at 2.5- to 5-foot intervals. The borings were continuously observed and logged by a geologist from our firm. The exploratory boring logs presented in the Appendix are based on the field logs, drilling action, and inspection of the samples secured.

Disturbed, but representative samples were obtained by using the Standard Penetration Test (SPT) procedure in accordance with *American Society for Testing and Materials* (ASTM):D 1586. This test and sampling method consists of driving a standard 2-inch, outside-diameter, split-barrel sampler a distance of 18 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches. The number of blows for each 6-inch interval is recorded, and the number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance ("N") or blow count. If a total of 50 blows are recorded at or before the end of one 6-inch interval, the blow count is recorded as the number of blows for the corresponding number of inches of penetration. The resistance, or N-value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils. These values are plotted on the attached boring logs.

The samples obtained from the split-barrel sampler were classified in the field, and representative portions placed in watertight containers. The samples were then transported to our laboratory for further visual classification and geotechnical laboratory testing, as necessary.

The various types of soil and ground water elevations, as well as the depths where soil and ground water characteristics changed, are indicated on the exploration boring logs presented in Appendix A of this report. Our explorations were approximately located by measuring from known site features.

4.0 SUBSURFACE CONDITIONS

Subsurface conditions at the project site were inferred from the field explorations completed to date at the site and review of applicable geologic literature. As shown on the field logs, the exploration borings generally encountered granular glacial sediments. The following section and Geologic Cross-Section A-A' (Figure 3) presents more detailed subsurface information.

4.1 Stratigraphy

Vashon Recessional Outwash

This unit was encountered below the surficial topsoil layer at the locations of exploration pit EP-10 and borings EB-5 and EB-6. These sediments generally consisted of loose to medium dense, tan to brown sand, with variable amounts of silt and gravel. The upper 1½ to 2½ feet of this unit in EP-10 was weathered to a tannish orange color. The recessional outwash sediments were deposited by meltwater streams emanating from the retreating glacial ice during the latter part of the Vashon Stade of the Fraser Glaciation, approximately 12,500 years ago. This unit generally extended to a depth of 5 feet, but at the location of exploration boring EB-6 it extended to a depth of approximately 9.5 feet. Recessional outwash sediments were not encountered in boring EB-4.

Vashon Lodgement Till

Sediments interpreted as Vashon lodgement till were encountered below the recessional outwash in EP-10, EB-5, and EB-6, and at ground surface in EB-4. The sediments consisted of medium dense to very dense, tan silty sand with variable amounts of gravel, and displayed an unsorted texture. Vashon lodgement till was deposited at the base of an active continental glacier and were subsequently overrun and compacted by about 3,000 feet of glacial ice in the project area during the Vashon Stade of the Fraser Glaciation, approximately 15,000 years ago.

Possession (?) Glaciomarine

These sediments were encountered below the Vashon lodgement till deposits in borings EB-5 and EB-6. These sediments generally consisted of very stiff to hard, unsorted bluish gray silt to sandy silt with scattered dropstones, which exhibited a somewhat fractured texture, were slightly moist to moist, and reacted chemically with hydrochloric acid. These sediments are tentatively interpreted to be representative of Possession-aged deposits, which were possibly deposited in a marine environment. This unit has been glacially consolidated.

Possession (?) Drift

Sediments encountered below the Possession (?) glaciomarine at the location of boring EB-6, and below the Vashon lodgement till in EB-4 consisted of very dense, stratified silty sand and sandy silt with trace gravel. These sediments are tentatively interpreted to be representative of Possession-age drift deposits. These sediments were subsequently overridden by the Possession ice sheet and consolidated.

4.2 Geologic Mapping

The subject site is located at the southwestern base of the upland plateau. According to reports published by the City of Redmond (Parametrix et al., 1997) and other published geologic maps for the area, including *Geologic Map of the Redmond Quadrangle, Washington* (Minard and Booth, 1988), the *Geologic Map of King County, Washington* (Booth et al., 2006), and the *Geologic Map of the Redmond Bear Creek Area* (Booth, Troost, and Wisher, 2007), the Redmond plateau is mantled by Vashon lodgement till. Areas of Vashon recessional outwash are mapped near the base of the slope. Pre-Fraser deposits are also mapped on the slopes of the plateau in the vicinity of the site.

The review of the geologic mapping is consistent with the conditions encountered in explorations conducted at the site by AESI during our current and previous studies at the site.

4.3 Hydrology

Ground water was only encountered in our recent boring EB-6 at a depth of 25 feet below ground surface (bgs) (approximately 82 feet amsl). Since boring EB-6 was completed at a depth of 26.5 feet bgs, it is unknown whether the water encountered is representative of a ground water table within the drift deposit, or is simply residual water in a slightly sandy interbed within the unit. It should be noted that the water encountered in this unit may be pressurized and care should be taken if construction excavations extend into this unit.

We expect ground water seepage across much of the site to be limited to interflow. Interflow occurs when surface water percolates down through the surficial weathered or higher-permeability sediments and becomes perched atop underlying, lower-permeability sediments. It should be noted that the occurrence and level of ground water seepage at the site may vary in response to such factors as changes in season, precipitation, and site use.

II. GEOLOGIC HAZARDS AND MITIGATIONS

The following discussion of potential geologic hazards is based on the geologic conditions, as observed and discussed herein.

4.0 SLOPE STABILITY ASSESSMENT

Our geologic research, site reconnaissance, and site explorations indicate that the subject site is underlain by recessional outwash and glacially consolidated sediments. No emergent seepage was observed during our reconnaissance of the on-site slope. No evidence indicative of historical landslide activity on the slope was observed, such as scarps, tension cracks, or unusual topography.

We evaluated slope stability across the site using the computer software program Slope/W Version 5.20. We developed a cross-section of the slope using a topographic survey of the site developed by CORE Design. The location of the Cross-Section AA-AA' is shown on Figure 2. The effects of seismic accelerations on the slope during a potential earthquake were also evaluated using a pseudostatic lateral acceleration value of 0.26g.

Soil parameters used for our stability analyses are summarized in Table 1. These parameters were derived based on the soils encountered in our borings, established correlations, and previous experience in similar soils in the Puget Sound area.

Table 1
Summary of Soil Parameters for Stability Analysis

Soil Unit	Friction Angle (degrees)	Cohesion (psf)	Unit Weight (pcf)
Recessional Outwash	30	0	115
Lodgement Till	32	250	130
Possession Sediments	29	500	125

psf = pounds per square foot
pcf = pounds per cubic foot

The elevation of the water table assumed for the stability analysis is based on the levels observed in our explorations completed to date.

Our stability analysis indicates safety factors equal to or greater than 1.5 for the static loading case and greater than 1.1 for the seismic loading case for critical deep-seated failure surfaces at the location evaluated. Our stability analyses focused on failure surfaces located at the edge of

the recommended 25-foot buffer from the base of the steep slope. Details of our stability analysis are included in Appendix B.

5.0 SEISMIC HAZARDS AND MITIGATION

Earthquakes occur in the Puget Lowland with great regularity. The vast majority of these events are small and are usually not felt by people. However, large earthquakes do occur, as evidenced by the 1949, 7.2-magnitude event; the 1965, 6.5-magnitude event; and the 2001, 6.8-magnitude event. The 1949 earthquake appears to have been the largest in this area during recorded history. Evaluation of return rates indicates that an earthquake of a magnitude between 6.0 and 7.0 is likely within a given 25- to 40-year period.

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture, 2) seismically induced landslides, 3) liquefaction, and 4) ground motion. The potential for each of these hazards to adversely impact the proposed project is discussed below.

5.1 Surficial Ground Rupture

The nearest known fault traces to the project site are the South Whidbey Island Fault Zone (SWIFZ) located approximately 1 mile to the southwest, and the Seattle Fault Zone located approximately 6 miles to the south.

A 2005 study by the U.S. Geological Survey (USGS) (Sherrod et al., 2005, *Holocene Fault Scarps and Shallow Magnetic Anomalies Along the Southern Whidbey Island Fault Zone near Woodinville, Washington*, Open-File Report 2005-1136, March 2005) reported that "strong" evidence of prehistoric earthquake activity has been observed along two fault strands thought to be part of the southeastward extension of the SWIFZ. The study suggests as many as nine earthquake events along the SWIFZ may have occurred within the last 16,400 years. The recognition of this fault splay is relatively new, and data pertaining to it are limited with the studies still ongoing. The recurrence interval of movement along this fault system is still unknown, although it is hypothesized to be in excess of one thousand years.

Studies of the Seattle Fault Zone by USGS (e.g., Johnson et al., 1994, *Origin and Evolution of the Seattle Fault and Seattle Basin*, *Washington*, Geology, v. 22, pp. 71-74; and Johnson et al., 1999, *Active Tectonics of the Seattle Fault and Central Puget Sound Washington - Implications for Earthquake Hazards*, Geological Society of America Bulletin, July 1999, v. 111, n. 7, pp. 1042-1053) have provided evidence of surficial ground rupture along a northern splay of the Seattle Fault. According to the USGS studies, the latest movement of this fault was about 1,100 years ago when about 20 feet of surficial displacement took place. This displacement can presently be seen in the form of raised, wave-cut beach terraces along Alki Point in West Seattle and

Restoration Point at the south end of Bainbridge Island. The recurrence interval of movement along this fault system is still unknown, although it is hypothesized to be in excess of several thousand years.

Due to the suspected long recurrence intervals for both fault zones, the potential for surficial ground rupture is considered to be low during the expected life of the proposed structures.

5.2 Seismically Induced Landslides

The risk of damage to the proposed project by seismically induced landsliding is low based on the results of our slope stability analysis as previously discussed. A 25-foot buffer is recommended for the landslide hazard area. In our opinion, no additional specific mitigation of landslide hazards is warranted.

5.3 Liquefaction

The encountered stratigraphy has a low potential for liquefaction due to the absence of adverse ground water conditions and generally medium or denser conditions. Therefore, no liquefaction mitigation efforts are needed, in our opinion.

5.4 Ground Motion

It is our opinion that any earthquake damage to the proposed structures, when founded on suitable bearing strata in accordance with the recommendations contained herein, will be caused by the intensity and acceleration associated with the event and not any of the above-discussed impacts. Structural design of the buildings should follow 2012 *International Building Code* (IBC) standards using Site Class "D" as defined in Table 1613.5.2.

6.0 EROSION HAZARDS AND MITIGATION

The recessional outwash soils contain a variable percentage of silt and fine sand and are highly sensitive to erosion. In order to control erosion and reduce the amount of sediment transport off the site during construction, the following recommendations should be followed:

1. Properly embedded silt fencing should be placed around the lower perimeter of the cleared area(s). The fencing should be periodically inspected and maintained, as necessary, to ensure proper function.

2. Construction access should be stabilized with gravel to minimize tracking sediment off-site.

3. If possible, construction should proceed during the drier periods of the year.

4. Areas stripped of vegetation during construction should be mulched and hydroseeded, replanted as soon as possible, or otherwise protected. During winter construction, hydroseeded areas should be covered with clear plastic to facilitate grass growth.

5. Surface runoff and discharge should be controlled during and following construction. Uncontrolled discharge may promote erosion and sediment transport.

6. If excavated soils are to be stockpiled on the site for reuse, measures should be taken to reduce the potential for erosion from the stockpile. These could include, but are not limited to, covering the pile with plastic sheeting, and the use of straw bales/silt fences around stockpile perimeters.

III. DESIGN RECOMMENDATIONS

7.0 INTRODUCTION

Our explorations indicate that, from a geotechnical standpoint, the parcel is suitable for the proposed development provided the recommendations contained herein are properly followed. The foundation bearing stratum is relatively shallow, and conventional spread footing foundations may be utilized for the new residences. Consequently, foundations bearing on either the medium dense to dense, natural sediments, or on structural fill placed over these sediments, are capable of providing suitable structure support. Site soils are feasible for temporary open cuts; however, temporary shoring may be required in some areas due lack of space.

8.0 SITE PREPARATION

Site preparation should include removal of all trees, brush, debris, and any other deleterious material within the proposed building footprints.

In our opinion, stable, temporary construction slopes should be the responsibility of the contractor and should be determined during construction based on soil and ground water conditions encountered at that time. For planning purposes, we anticipate that temporary, unsupported cut slopes in loose to medium dense, recessional outwash natural sediments can be made at a maximum slope of 1.5H:1V (Horizontal:Vertical) whereas slopes in underlying dense glacial till can be made at a maximum slope of 1H:1V. Flatter, temporary cut slopes are recommended in areas of ground water seepage. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. In addition, WISHA/OSHA regulations should be followed at all times.

Due to the depth of the lowest level of the proposed structures along the north side of the property, it appears that temporary cut slopes may not be feasible for portions of the excavation. Therefore, a shoring system, such as a soldier pile wall, would be needed to provide temporary excavation support. Recommendations for a soldier pile wall shoring system are provided in Section 14.0.

9.0 STRUCTURAL FILL

Structural fill may be necessary to backfill around foundations, below-grade walls, and underground utilities. All references to structural fill in this report refer to subgrade preparation, fill type, placement, and compaction of materials, as discussed in this section. If a

percentage of compaction is specified under another section of this report, the value given in that section should be used.

After overexcavation/stripping has been performed to the satisfaction of the geotechnical engineer/engineering geologist, the exposed ground should be recompacted to a firm and unyielding condition. If the subgrade contains too much moisture, adequate recompaction may be difficult or impossible to obtain, and should probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with washed rock or quarry spalls to act as a capillary break between the new fill and the wet subgrade. Where the exposed ground remains soft and further overexcavation is impractical, placement of an engineering stabilization fabric may be necessary.

After stripping and subgrade preparation of the exposed ground is approved, or a free-draining rock course is laid, structural fill may be placed. Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts, with each lift being compacted to 95 percent of the modified Proctor maximum density using ASTM:D 1557 as the standard.

The contractor should note that any proposed fill soils must be evaluated by AESI prior to their use in fills. This would require that we have a sample of the material 72 hours in advance to perform a Proctor test and determine its field compaction standard. Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. Use of moisture-sensitive soil in structural fills should be limited to favorable dry weather and dry subgrade conditions. In addition, construction equipment traversing the site when the soils are wet can cause considerable disturbance.

The on-site soils are generally suitable for reuse as structural fill. The recessional outwash is considered to be moderately moisture-sensitive whereas the underlying glacially overridden sediments are considered highly moisture-sensitive due to high silt content. Should construction occur during wet weather and additional fill is required, we recommend that a select, import material consisting of a clean, free-draining gravel and/or sand be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction.

A representative from our firm should inspect the stripped subgrade and be present during placement of structural fill to observe the work and perform a representative number of in-place density tests. In this way, the adequacy of the earthwork may be evaluated as filling progresses and any problem areas may be corrected at that time. It is important to understand that taking random compaction tests on a part-time basis will not assure uniformity or acceptable performance of a fill. As such, we are available to aid the owner in developing a suitable monitoring and testing frequency.

10.0 FOUNDATIONS

Spread footings may be utilized for building support when founded either directly on the medium dense to dense natural sediments, or on structural fill placed over these natural sediments. Prior to placement of foundations or structural fill, the natural sediments should be compacted to a firm and unyielding condition. Sediments suitable for foundation support were encountered in our explorations at the planned elevation of the lowest levels. If structural fill is placed below footing areas, we recommend that the fill extend horizontally outward from the footing edges a distance equal to or greater than the thickness of the fill below the footings.

For footings bearing directly on the dense natural sediments or on AESI-approved structural fill, an allowable soil bearing pressure of 3,000 pounds per square foot (psf) may be used for design purposes, including both dead and live loads. An increase of one-third may be used for short-term wind or seismic loading. Perimeter footings for the proposed building should be buried a minimum of 18 inches into the surrounding soil for frost protection. No minimum burial depth is required for interior footings; however, all footings must penetrate to the prescribed stratum, and no footings should be founded in or above loose, organic, or existing fill soils.

It should be noted that the area bounded by lines extending downward at 1H:1V from any footing must not intersect another footing or intersect a filled area that has not been compacted to at least 95 percent of ASTM:D 1557. In addition, a 1.5H:1V line extending down from any footing must not daylight because sloughing or raveling may eventually undermine the footing. Thus, footings should not be placed near the edge of steps or cuts in the bearing soils.

Anticipated settlement of footings founded as described above should be less than 1 inch. However, disturbed soil not removed from footing excavations prior to footing placement could result in increased settlements. All footing areas should be inspected by AESI prior to placing concrete to verify that the design bearing capacity of the soils has been attained and that construction conforms with the recommendations contained in this report. Such inspections may be required by the governing municipality. Perimeter footing drains should be provided, as discussed under the “Drainage Considerations” section of this report.

11.0 LATERAL WALL PRESSURES

All backfill behind walls or around foundation units should be placed as per our recommendations for structural fill and as described in this section of the report. Horizontally backfilled walls that are free to yield laterally at least 0.1 percent of their height may be designed using an equivalent fluid equal to 35 pounds per cubic foot (pcf). Fully restrained, horizontally backfilled, rigid walls that cannot yield should be designed for an equivalent fluid of 50 pcf.

In accordance with the 2012 IBC, retaining wall design should include seismic design parameters. Based on the site soils and assumed wall backfill materials, we recommend a seismic surcharge pressure in addition to the equivalent fluid pressures presented above. A rectangular pressure distribution of 8H and 10H psf (where H is the height of the wall in feet) should be included in design for "active" and "at-rest" loading conditions, respectively. The resultant of the rectangular seismic surcharge should be applied at the midpoint of the walls.

The lateral pressures presented above are based on the conditions of a uniform granular backfill compacted to 92 percent of ASTM:D 1557. A higher degree of compaction is not recommended, as this will increase the pressure acting on the wall. Surcharges from adjacent footings or heavy construction equipment or sloping ground must be added to the above values. It is imperative that proper drainage be provided so that hydrostatic pressures do not develop against the walls. Perimeter footing drains should be provided for all retaining walls, as discussed under the "Drainage Considerations" section of this report.

11.1 Passive Resistance and Friction Factor

Lateral loads can be resisted by friction between the foundation and the competent natural sediments or supporting structural fill soils, and/or by passive earth pressure acting on the buried portions of the foundations. The foundations must be backfilled with compacted structural fill to achieve the passive resistance provided below. We recommend the following allowable design parameters.

- Passive equivalent fluid = 350 pcf
- Coefficient of friction = 0.35

12.0 FLOOR SUPPORT

Slab-on-grade floors may be constructed either directly on the medium dense to dense natural sediments, or on structural fill placed over these materials. Areas of the slab subgrade that are disturbed (loosened) during construction should be recompacted to an unyielding condition prior to placing the pea gravel, as described below.

If moisture intrusion through slab-on-grade floors is to be limited, the floors should be constructed atop a capillary break consisting of a minimum thickness of 4 inches of washed pea gravel. The pea gravel should be overlain by a 10-mil (minimum thickness) plastic vapor retarder.

13.0 DRAINAGE CONSIDERATIONS

All retaining and perimeter footing walls should be provided with a drain at the footing elevation. Drains should consist of rigid, perforated, polyvinyl chloride (PVC) pipe surrounded by washed pea gravel or drain rock. The level of the perforations in the pipe should be set approximately 2 inches below the bottom of the footing and should be constructed with sufficient gradient to allow gravity discharge away from the buildings. In addition, all retaining walls should be lined with a minimum, 12-inch-thick, washed gravel blanket provided over the full height of the wall that ties into the footing drain. Roof and surface runoff should not discharge into the footing drain system, but should be handled by a separate, rigid, tightline drain. In planning, exterior grades adjacent to walls should be sloped downward away from the structure to achieve surface drainage. All collected runoff must be tightlined to a City-approved location.

14.0 SOLDIER PILE WALLS

We anticipate that a cantilever soldier pile shoring wall, consisting of wide-flange steel piles, suitably embedded in the underlying dense soils, will provide the necessary lateral support of planned excavations where temporary slopes are not feasible. Alternatively, soldier pile walls could be used as a permanent wall. Treated timber lagging should be used to support the soil between the piles; plywood should not be used for lagging. A structural engineer should design the wall system based on the soil parameters provided in this report.

The construction sequence for soldier pile systems typically involves installing each pile to the minimum specified embedment depth below the base of excavation under the observation of the geotechnical engineer or designated field representative. Drilled and grouted piles should be allowed to set for at least 72 hours prior to beginning excavation. Once the piles have been installed to the satisfaction of the geotechnical engineer, excavation may proceed in vertical sections of 4 feet or less. The actual height of the excavated sections that provide a stable excavation face should be adjusted in the field, depending on actual soil and ground water conditions at the time of excavation, but should not exceed 4 feet. Treated timber lagging, as specified by the structural engineer, should be installed and backfilled with permeable soils to prevent the buildup of water behind the lagging boards. No excavation sections should be left open overnight.

We recommend that the temporary and permanent cantilever system be designed to resist an active lateral earth pressure of 35(H) psf, presented as a triangular distribution for a level backslope. The active earth pressure acts over the pile spacing above the excavation base. For permanent walls a seismic surcharge pressure should be added as described in Section 11.0. An allowable passive resistance of 350(D) psf can also be assumed to act over twice the pile diameter (or grouted diameter) below the excavation base. The upper 2 feet on the passive

side of the piles should be neglected and truncated from a triangular distribution. These recommendations for lateral earth pressures are illustrated on Figure 4.

If adjacent structures, slopes, heavy construction traffic, materials stockpiling, or other substantial surcharges are to be applied during construction, these surcharges should also be included in the design.

We recommend a minimum depth of embedment of 15 feet below the base of the excavation for all piles. Soil conditions may differ from those described in this report. All sediments of glacial origin may contain large cobbles or boulders at random locations.

The drilling contractor should be prepared to use casing, drilling slurry, or other methods of stabilizing the hole in the case of caving. If more than 6 inches of standing water or slough is present at the bottom of the boring prior to grout placement, the contractor should be prepared to use a tremie pipe to place grout continuously from the bottom up. Grout may consist of lean-mix concrete or controlled density fill (CDF), as specified by the structural engineer, to ease chipping for lagging installation.

Timber lagging can be designed to resist reduced lateral earth pressures as a result of soil arching between piles. For the site soils, the lagging can be designed to resist 50 percent of the calculated lateral load at any given point. Caving could be experienced when excavating and installing lagging between piles. Overexcavation of soils behind the lagging should be avoided. Excavation should extend just far enough to allow lagging installation. Any void spaces behind lagging should be filled with pea gravel or other suitable free-draining material to prevent caving and loss of support for adjacent ground.

15.0 STORM WATER INFILTRATION

Favorable receptor soils for storm water infiltration comprised of recessional outwash were encountered in several explorations at the site. However, based on our review of current grades for the proposed townhouse units, it appears that the majority of this soil will be removed during excavation exposing relatively impervious lodgement till sediments. The one exception is the planned driveway area where final grades are at a higher elevation and could allow the use of permeable pavement. However, there would be higher risk for the units on Lots 1 through 4 that are downgradient to the west associated with ground water flow associated with infiltration.

16.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

At the time of this report, site grading, structural plans, and construction methods have not been finalized. We are available to provide additional geotechnical consultation as the project design develops and possibly changes from that upon which this report is based. We recommend that AESI perform a geotechnical review of the plans prior to final design completion. In this way, our earthwork and foundation recommendations may be properly interpreted and implemented in the design.

We are also available to provide geotechnical engineering and monitoring services during construction. The integrity of the foundation depends on proper site preparation and construction procedures. These inspections will be required by the City of Redmond as a part of the building permit conditions. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent. Construction monitoring services are not part of this current scope of work. If these services are desired, please let us know, and we will prepare a cost proposal.

We have enjoyed working with you on this study and are confident that these recommendations will aid in the successful completion of your project. If you should have any questions or require further assistance, please do not hesitate to call.

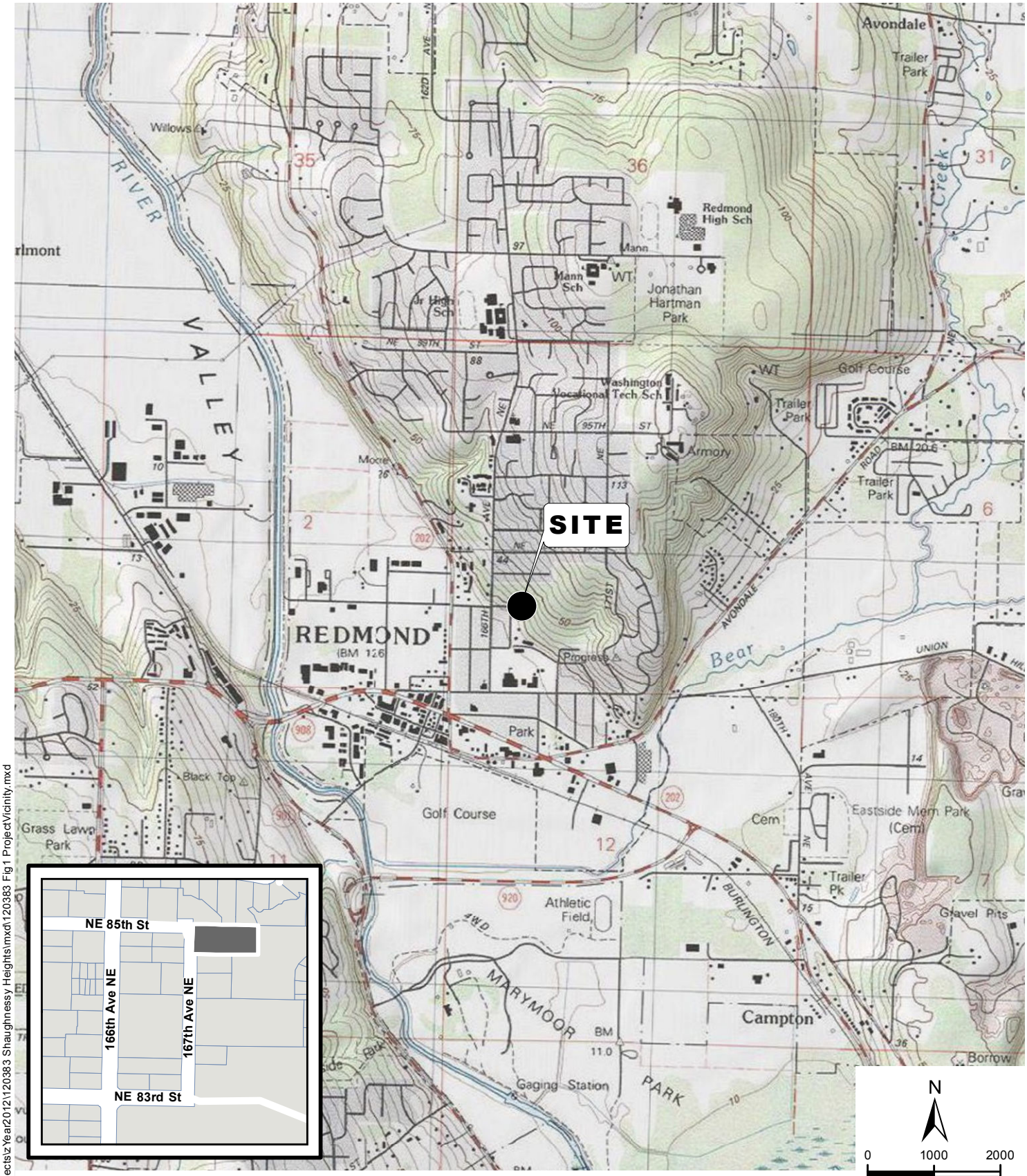
Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

STEPHEN A. SIEBERT
STATE OF WASHINGTON
30320
REGISTERED
PROFESSIONAL ENGINEER
10/21/15

Bruce L. Blyton, P.E.
Senior Principal Engineer

Stephen A. Siebert, P.E
Associate Geotechnical Engineer

Attachments:
- Figure 1: Vicinity Map
- Figure 2: Site and Exploration Plan
- Figure 3: Geologic Cross-Section A-A'
- Figure 4: Soldier Pile Wall Design Criteria
- Appendix A: Exploration Logs and Laboratory Test Results
- Appendix B: Slope Stability Results



N

0 1000 2000

FEET

REFERENCE: USGS, KING CO

NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

Document Path: H:\GIS_Projects\z Year2012\120383 Shaughnessy Heights\mxd\120383 Fig 1 ProjectVicinity.mxd

associated earth sciences incorporated

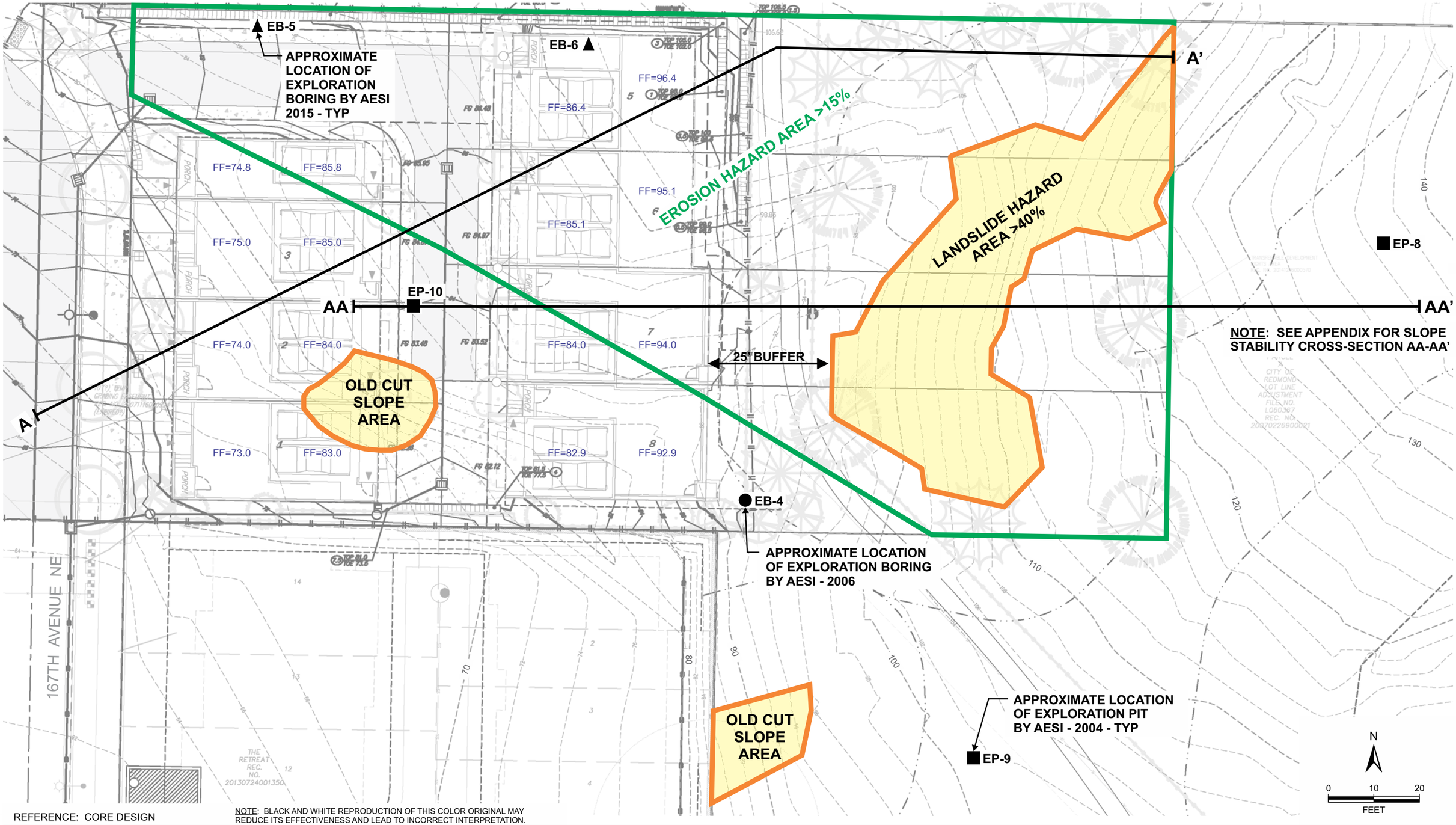
VICINITY MAP

MAPLEWOOD
REDMOND, WASHINGTON

FIGURE 1

DATE 10/15

PROJ. NO. KE120383B



REFERENCE: CORE DESIGN

NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

120383 Shaunessey Heights West \ 120383 F23 S-E 10-15 .cdr PAGE 1: F2

associated earth sciences incorporated

SITE AND EXPLORATION PLAN

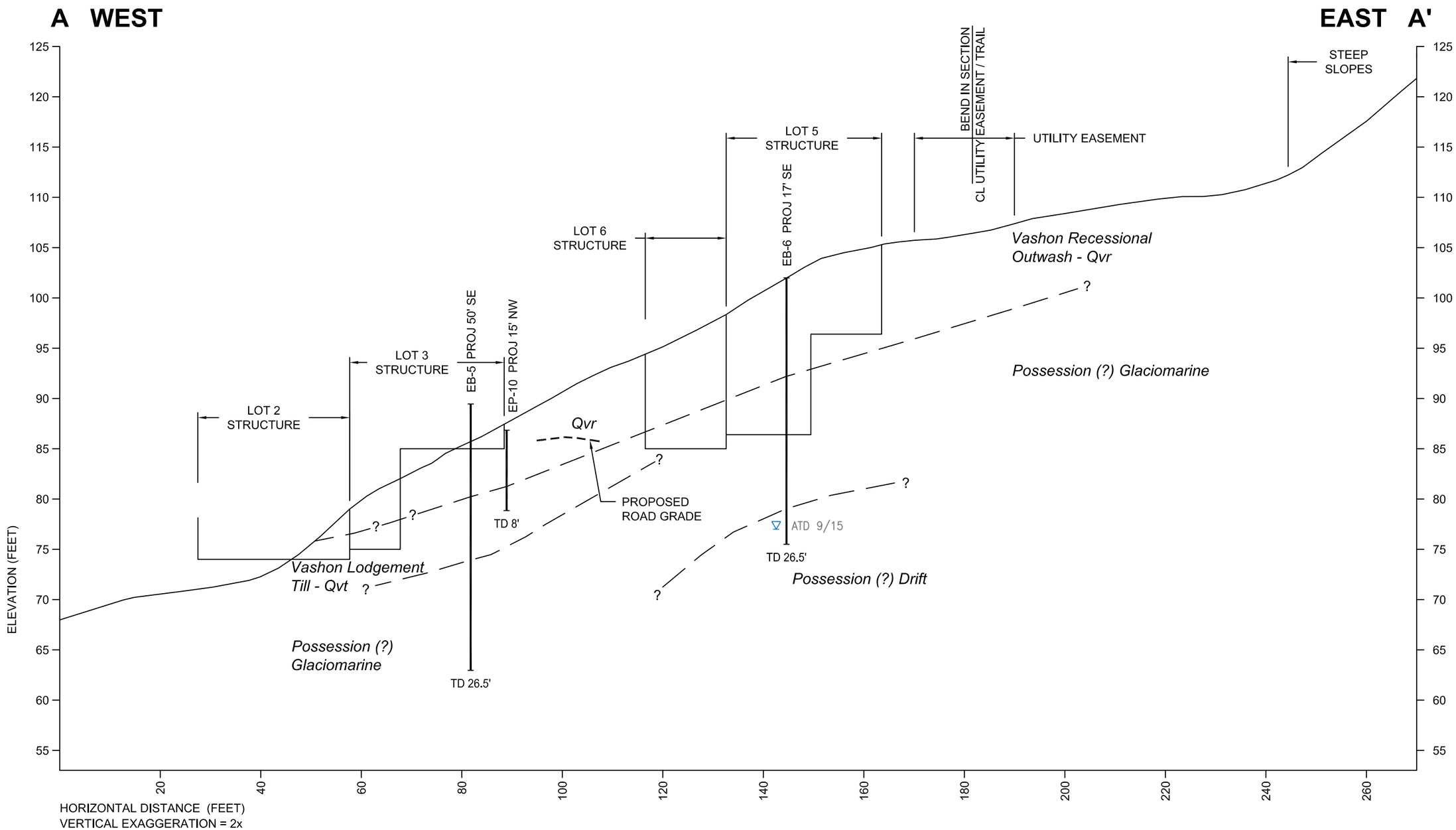
MAPLEWOOD

REDMOND, WASHINGTON

FIGURE 2

DATE 10/15

PROJ. NO. KE120383B

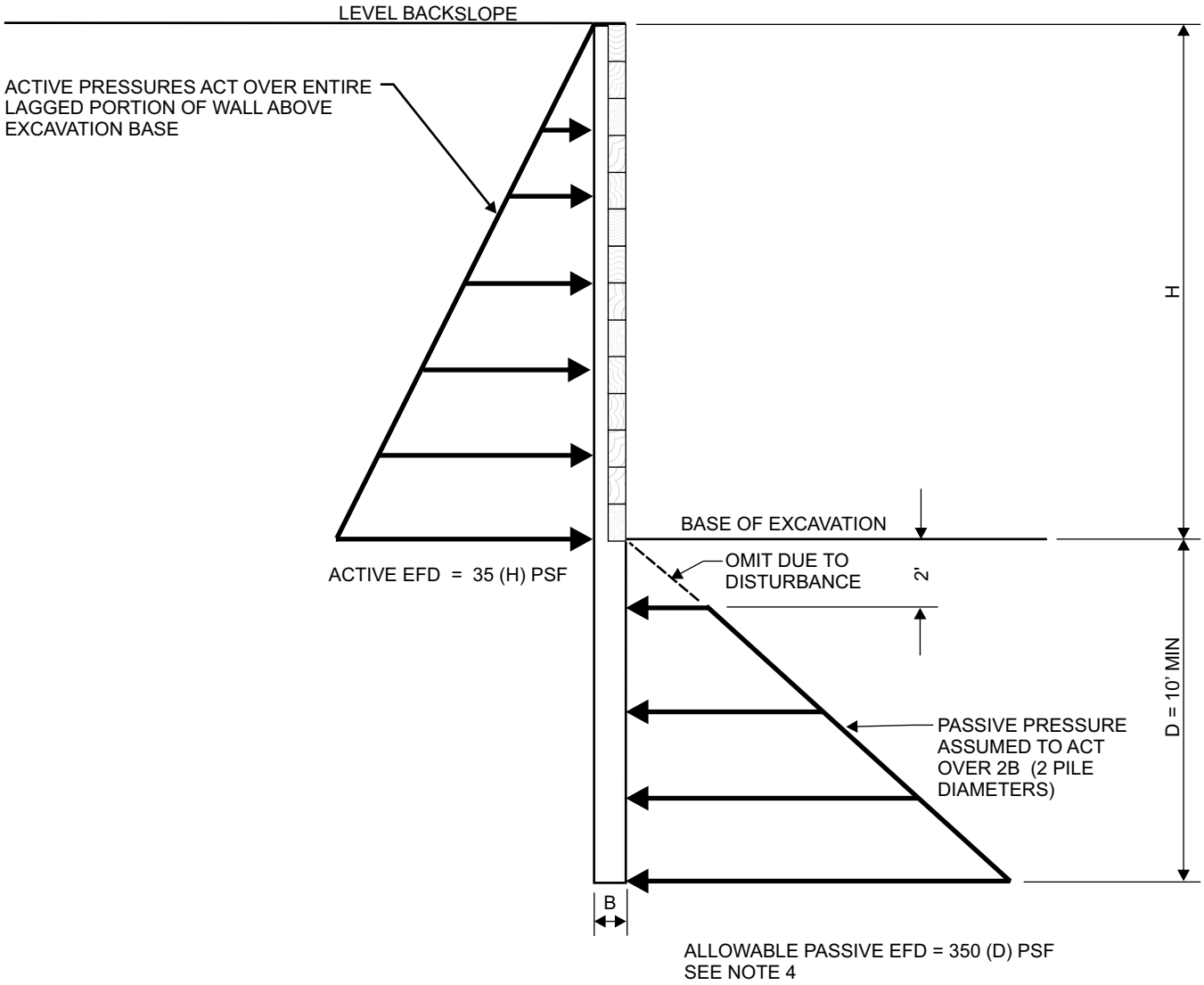


120383 Shaughnessy Heights West \ 120383 Geo Sects.dwg LAYOUT: F3 Section A-A

associated earth sciences incorporated

GEOLOGIC CROSS-SECTION A - A'
MAPLEWOOD
REDMOND, WASHINGTON

FIGURE 3
DATE 10/15
PROJECT NO. KE120383B



NOTES:

1. PILE EMBEDMENT DEPTH 'D' SHOULD CONSIDER NECESSARY VERTICAL CAPACITY, KICKOUT, AND OVERTURNING RESISTANCE.

2. DIAGRAM DOES NOT INCLUDE HYDROSTATIC PRESSURES AND ASSUMES WALLS ARE SUITABLY DRAINED TO PREVENT BUILDUP OF HYDROSTATIC PRESSURE.

3. DIAGRAM DOES NOT INCLUDE PRESSURES DUE TO SURFACE SURCHARGES FROM ANY ADJACENT STRUCTURES, SLOPES, OR STOCKPILED MATERIALS. THESE PRESSURES MUST BE PROVIDED BY THE STRUCTURAL ENGINEER.

4. ALLOWABLE PASSIVE PRESSURE INCLUDES FACTOR OF SAFETY OF APPROXIMATELY 1.5.

5. FOR PERMANENT WALLS ADD SEISMIC SURCHARGE. SEE REPORT TEXT.

associated earth sciences incorporated

SOLDIER PILE WALL DESIGN CRITERIA

MAPLEWOOD

REDMOND, WASHINGTON

FIGURE 4

DATE 10/15

PROJ. NO. KE120383B

APPENDIX A

Exploration Logs and Laboratory Test Results

Coarse-Grained Soils - More than 50% (1) Retained on No. 200 Sieve	Gravels - More than 50% (1) of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines (5)	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥12% Fines (5)	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50% (1) or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines (5)	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥12% Fines (5)	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50% (1) or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

Coarse-Grained Soils

Density	SPT(2) blows/foot
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	>50

Fine-Grained Soils

Consistency	SPT(2) blows/foot
Very Soft	0 to 2
Soft	2 to 4
Medium Stiff	4 to 8
Stiff	8 to 15
Very Stiff	15 to 30
Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

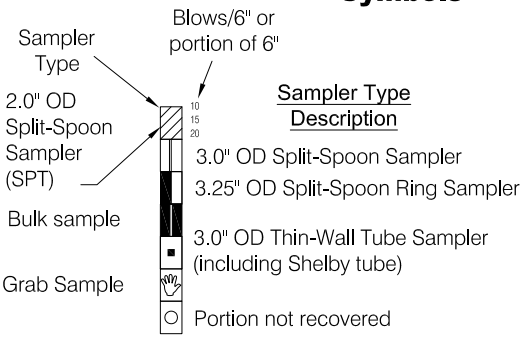
(3) Estimated Percentage

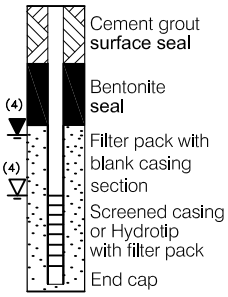
Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols





(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
(4) Depth of ground water
▼ ATD = At time of drilling
▽ Static water level (date)
(5) Combined USCS symbols used for fines between 5% and 12%

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

associated earth sciences incorporated

Exploration Log

Project Number	Exploration Number	Sheet
KE03735C	EB-4	1 of 1

Project Name	Shaughnessy Heights	Ground Surface Elevation (ft)	~88
Location	Redmond, WA	Datum	N/A
Driller/Equipment	Holt/CME 850 Mud Rotary	Date Start/Finish	10/4/06,10/4/06
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	4 inches

Depth (ft)	ST	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
				Lodgement Till					
		S-1		Moist, brown with iron oxide stains, silty SAND with gravel.			8 13 17	30	
5		S-2					13 17 13	30	
		S-3		No recovery - bad blow counts, sampler tip broken bentonite chips in sampler.			5 6 11	17	
10				**Possession Drift?**					
		S-4		Moist, dark blue-gray, SILT with sand, scattered dropstones.			8 22 34		56
		S-5		Wet (perched water), dark blue-gray, fine SAND with trace silt interbedded with silty very fine sand, scattered silt seams.		▼	22 34 22		56
15									
		S-6		Becomes moist, silty fine SAND to sandy SILT with broken rock piece.			50/5"		50/5"
20									
		S-7					50/5"		50/5"
25									
				Moist, blue-gray, clayey SILT, scattered dropstones.					
		S-8					22 38 38		76
30				Bottom of exploration boring at 29 feet Perched ground water observed at approximately 13 feet at time of drilling.					
35									

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample

M - Moisture

- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: EJL

Approved by:

associated earth sciences incorporated

Exploration Log

Project Number	Exploration Number	Sheet
KE120383B	EB-5	1 of 1

Project Name	Maplewood	Ground Surface Elevation (ft)	88
Location	Redmond, WA	Datum	Core Design
Driller/Equipment	Bortec / Track-Mounted	Date Start/Finish	9/24/15,9/24/15
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	4 1/4 inches

Depth (ft)	ST	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
				Grass / Topsoil					
				Recessional Outwash					
		S-1		Very dense, slightly moist, brown, gravelly, fine to coarse SAND, trace silt; blow counts overstated due to rock in drill tip (SP).			23 50/6"	▲	73/12"
5		S-2		Very dense, slightly moist, tan, very gravelly, fine to coarse SAND, some silt; blow counts overstated due to rock in drill tip (SM).			26 32 41	▲	73
		S-3		Very dense, slightly moist, tan, silty, fine to coarse SAND, some gravel; blow counts overstated due to rock in drill tip (SM).			50/4"	▲	50/4"
				Vashon Lodgement Till					
10		S-4		Very dense, slightly moist, gray, very silty, fine SAND, some gravel (SM).			50/2"	▲	50/2"
				Possession (?) Glaciomarine					
15		S-5		Hard, moist, blue gray, sandy SILT, trace gravel; diamict; unsorted; mild reaction with HCl (ML).			11 22 32	▲	54
20		S-6		Hard, moist, blue gray, SILT, trace gravel; diamict; unsorted; mild reaction with HCl (ML).			15 23 34	▲	58
25		S-7		As above.			14 25 37	▲	62

Bottom of exploration boring at 26.5 feet
No ground water encountered.

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample

M - Moisture
Water Level ()
Water Level at time of drilling (ATD)

Logged by: DV
Approved by: JHS

associated earth sciences incorporated

Exploration Log

Project Number	Exploration Number	Sheet
KE120383B	EB-6	1 of 1

Project Name	Maplewood	Ground Surface Elevation (ft)	103
Location	Redmond, WA	Datum	Core Design
Driller/Equipment	Bortec / Track-Mounted	Date Start/Finish	9/24/15,9/24/15
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	4 1/4 inches

Depth (ft)	ST	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
				Topsoil					
				Recessional Outwash					
		S-1		Medium dense, slightly moist, tan, gravelly, fine SAND, trace silt (SP).			4 8 7	▲15	
5		S-2		As above.			9 11 18	▲29	
		S-3		Medium dense, slightly moist, tannish brown, gravelly, fine to coarse SAND (SP).			10 11 10	▲21	
				Possession (?) Glaciomarine					
10		S-4		Very stiff, moist, tan, SILT, trace fine to medium sand, trace gravel; diamict; unsorted; mild reaction with HCl (ML).			5 8 11	▲19	
15		S-5		Very stiff, moist, blue gray, SILT, trace sand; diamict; unsorted; mild reaction with HCl (ML).			6 11 14	▲25	
20		S-6		Hard, slightly moist, blue gray, sandy SILT, trace gravel; diamict; unsorted; mild reaction with HCl (ML).			23 50/5"	▲73/11"	
				Possession (?) Drift					
25		S-7		Very dense, wet, blue gray, silty, fine to coarse SAND, trace gravel (SM).		▼	25 34 30	▲64	

Bottom of exploration boring at 26.5 feet
Unable to measure static water level because hole collapsed up to 12 feet.

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample

M - Moisture
Water Level ()
Water Level at time of drilling (ATD)

Logged by: DV
Approved by: JHS

LOG OF EXPLORATION PIT NO. EP-8

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Duff/Topsoil
1	**Recessional Outwash**
2	Loose, moist, orange-tan, fine SAND with few silt and gravel.
3	Medium dense, moist, tan, fine to medium SAND with some gravel.
4	
5	
6	Becomes interbedded, tan, SILTY very fine SAND and tan fine SAND.
7	
8	
9	**Till**
10	Dense, moist, tan, very fine SAND with few silt and gravel, scattered cobbles.
11	
12	
13	Bottom of exploration pit at depth 12 feet No seepage. No caving.
14	
15	
16	
17	
18	
19	
20	

Shaughnessy Heights
Redmond, WA

Logged by: MM

Approved by:

associated earth sciences incorporated

Project No. KE03735A

January 2004

LOG OF EXPLORATION PIT NO. EP-9

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Duff/Topsoil
1	Loose, moist, tan-orange, fine SAND with few silt and gravel.
2	
3	Medium dense, moist, tan, fine to medium SAND with some gravel.
4	
5	**Till**
6	Becomes dense, moist, tan, fine to medium SAND with some gravel.
7	
8	
9	Dense, moist, slightly oxidized, tan, SILTY very fine SAND with few gravel.
10	
11	Bottom of exploration pit at depth 10 feet No seepage. No caving.
12	
13	
14	
15	
16	
17	
18	
19	
20	

Shaughnessy Heights
Redmond, WA

Logged by: MM

Approved by:

associated earth sciences incorporated

Project No. KE03735A

January 2004

LOG OF EXPLORATION PIT NO. EP-10

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Duff/Topsoil
1	**Recessional Outwash**
2	Loose, moist, tan-orange, fine to medium SAND.
3	Medium dense, moist, tan, fine to medium SAND with some gravel, scattered cobbles.
4	
5	**Till**
6	Becomes dense, moist, tan, fine to medium SAND with some gravel.
7	Dense, moist, tan, SILTY very fine SAND with few gravel and scattered cobbles.
8	
9	Bottom of exploration pit at depth 8 feet No seepage. No caving.
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Shaughnessy Heights
Redmond, WA

Logged by: MM

Approved by:

associated earth sciences incorporated

Project No. KE03735A

January 2004

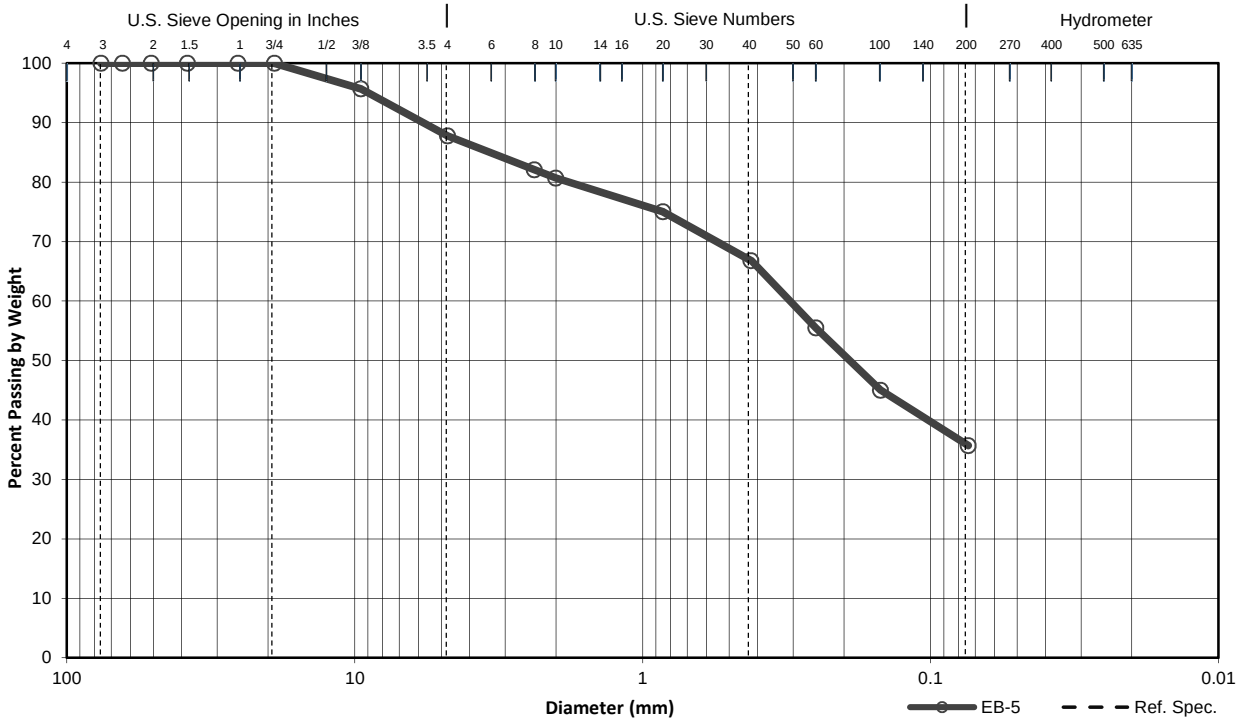
associated earth sciences incorporated

GRAIN SIZE ANALYSIS - MECHANICAL ASTM D422

Project Name	Project Number	Date Sampled	Date Tested	Tested By
Shaughnessy Heights West	**KE120383B**	**9/24/2015**	**9/25/2015**	**MS**

Sample Source	Sample No.	Depth (ft)	Soil Description
Onsite	**EB-5**	**10**	**gravelly, very silty SAND (SM)**

Total Sample Dry Wt. (g)	Moisture Content (%)	D_{10} (mm)	Reference Specification
190.7	**5**	**~0.01**	



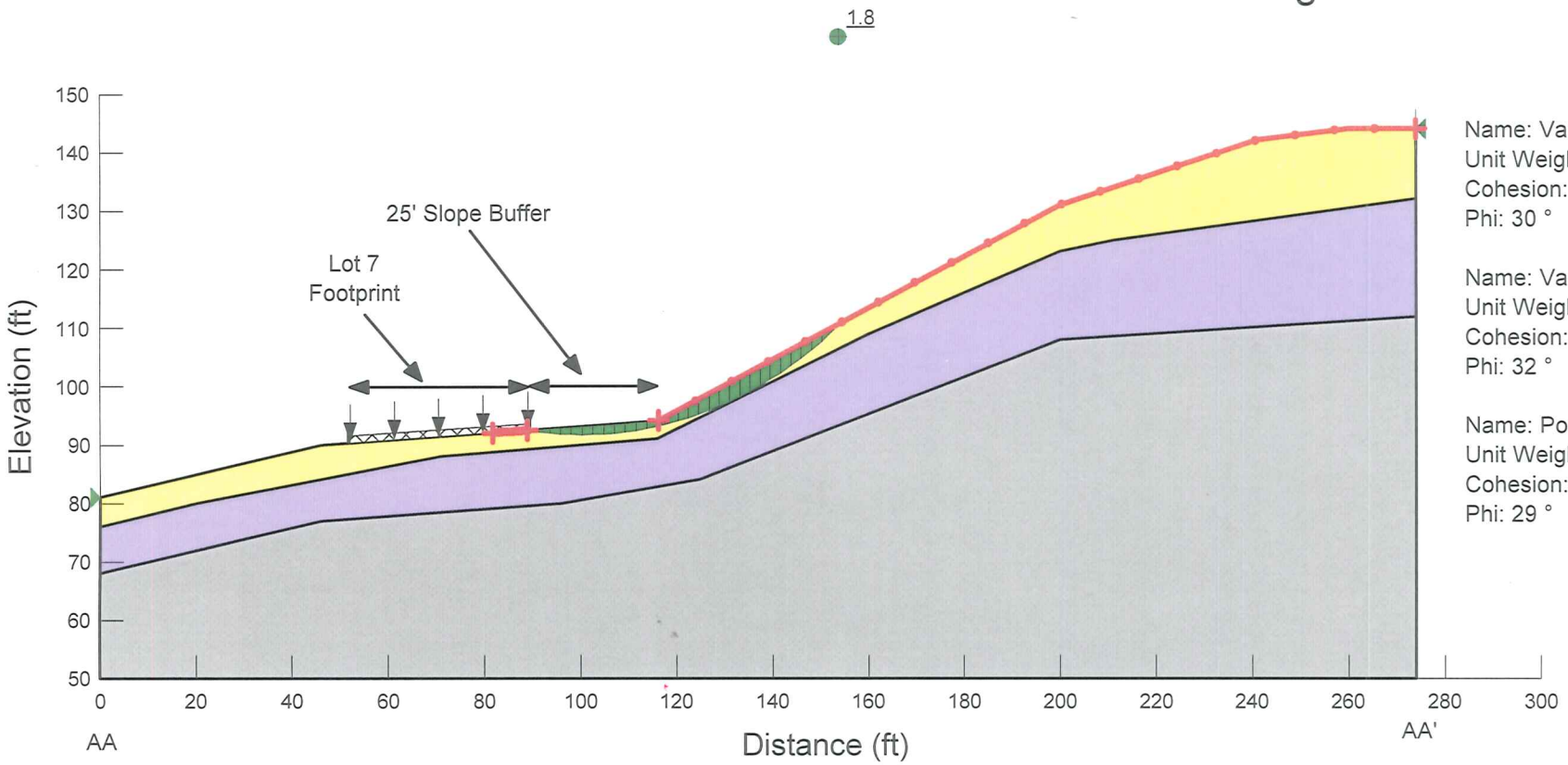
Cobb.	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Sieve No.	Diam. (mm)	Cum. Wt. Ret. (g)	% Ret. by Wt.	% Passing by Wt.	% Specs. Pass. by Wt.	
					Min	Max
3	76.1		0.0	100.0		
2.5	64		0.0	100.0		
2	50.8		0.0	100.0		
1.5	38.1		0.0	100.0		
1	25.4		0.0	100.0		
3/4	19		0.0	100.0		
3/8	9.51	8.2	4.3	95.7		
#4	4.76	23.3	12.2	87.8		
#8	2.38	34.2	17.9	82.1		
#10	2	36.9	19.3	80.7		
#20	0.85	47.6	25.0	75.0		
#40	0.42	63.3	33.2	66.8		
#60	0.25	85.0	44.5	55.5		
#100	0.149	104.9	55.0	45.0		
#200	0.074	122.6	64.3	35.7		

APPENDIX B

Slope Stability Results

Maplewood Development Stability Analysis
Static
10/7/2015
Seismic Load: 0g

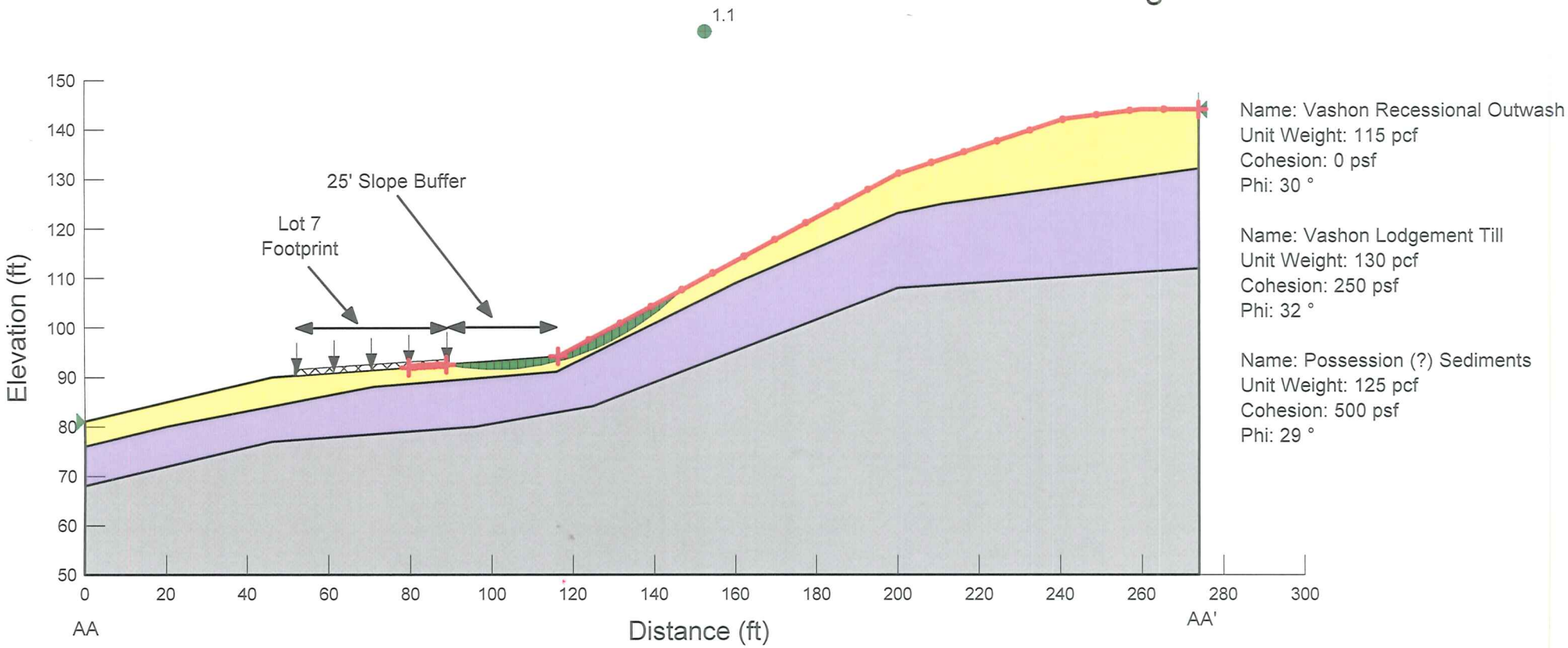


Name: Vashon Recessional Outwash
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 30 °

Name: Vashon Lodgement Till
Unit Weight: 130 pcf
Cohesion: 250 psf
Phi: 32 °

Name: Possession (?) Sediments
Unit Weight: 125 pcf
Cohesion: 500 psf
Phi: 29 °

Maplewood Development Stability Analysis
Pseudo-Static
10/7/2015
Seismic Load: 0.26g



associated earth sciences incorporated

Technical Memorandum

Date:	December 21, 2015	**From:**	Jennifer H. Saltonstall, L.G., L.Hg.
To:	IBBO, LLC and Amalani, LLC	**Project Manager:**	Stephen A. Siebert, P.E.
	105 South Main Street, Suite 230	**Principal in Charge:**	Curtis J. Koger, L.G., L.E.G, L.Hg.
	Seattle, Washington 98104	**Project Name:**	Maplewood (formerly Shaughnessy Heights West)
Attn:	Mr. Barry Margolese	**Project No:**	KE120383B
cc:	Mr. Joshua P. Beard, P.L.A. jpb@coredesigninc.com		
Subject:	Ground water recharge evaluation, Maplewood Project, Redmond, WA		

Associated Earth Sciences, Inc. (AESI) provides this technical memorandum summarizing the results of ground water recharge calculations performed for the Maplewood project in Redmond, Washington. This technical memorandum is based on information presented in previous reports for the project including:

- AESI, February 9, 2004, Subsurface Exploration, Geologic Hazards, and Preliminary Geotechnical Engineering Report, Shaughnessy Heights
- AESI, October 13, 2006, Supplementary Subsurface Explorations and Geotechnical Engineering Study, Shaughnessy Heights
- AESI, September 26, 2012, Geotechnical Findings and Recommendations, Downspout Infiltration Suitability Assessment, Shaughnessy Heights West
- AESI, October 15, 2012, Critical Aquifer Recharge Areas Report, Shaughnessy Heights West
- AESI, October 21, 2015, Critical Aquifer Recharge Areas Report, Maplewood (formerly Shaughnessy Heights West)
- AESI, October 21, 2015, Critical Areas Report (Geotechnical Aspects), Maplewood (formerly Shaughnessy Heights West)
- AESI, October 21, 2015, Subsurface Exploration, Geologic Hazards, and Preliminary Geotechnical Engineering Report, Maplewood (formerly Shaughnessy Heights West)
- Core Design, Inc. (CORE), September 2015, Preliminary Storm Drainage Report for Maplewood Short Plat.

PROJECT DESCRIPTION AND SITE CONDITIONS SUMMARY

The proposed Maplewood project is an 8-unit multi-family residential development located on the southwest margin of a north-south trending upland referred to as Education Hill. The Education Hill upland is bounded to the west by the Sammamish River Valley and to the east by the Bear Creek Valley. The site is

located in a portion of southwest ¼ of Section 1, Township 25 North, Range 5 East, W.M., King County, on the south side of NE 85th Street extended and just east of 167th Avenue NE (see Figure 1, Vicinity Map).

The following is a summary of our understanding of the project and the surrounding area.

- The proposed Maplewood project is a tract from the Shaughnessy Heights development. The tract consists of a single parcel to the northwest of the Shaughnessy Heights development and the project was previously called Shaughnessy Heights West. The subject property is approximately 2.34 acres in size (King County parcel 0125059114). Approximately 1.69 acres of the parcel is located within a Transferable Development Rights easement (Tract "A") and will remain undeveloped. The remainder of the property in which the townhomes are proposed is approximately 0.65 acres (Tract "B").
- The developed site plan includes creation of an 8 unit multi-family development along with associated driveways, sidewalks, utilities, and open space areas and frontage improvements along 167th Avenue NE, as shown as the attached Development Plan (CORE, October 2015). The open space areas are to remain in the existing condition. The townhomes would have partial below grade levels. Based on finished floor elevations of the townhomes provided by CORE we expect cuts from 10 to 15 feet will be required to reach final grades. Retaining walls from 4 t o12 feet in height are proposed on the north and south sides of the tract.
- The existing site is currently an undeveloped forested parcel. On the 0.65-acre tract proposed for townhomes, the ground surface elevation ranges from about 65 feet above mean sea level (amsl) in the southwest corner rising to about 125 feet amsl on the eastern edge. The ground surface generally slopes to the west/southwest across most of the site. A steep slope inclined at greater than 40 percent is present on the eastern portion of the tract. Remnants of a man-made steep slope created as a result of previous grading are present in the southwest portion of the site and south of the site. There is a faint remnant drainage located in the eastern portion of the tract, oriented roughly northeast-southwest, that creates a linear localized depression. Vegetation on the tract consists of both large evergreen and deciduous trees with a moderately dense understory.
- The Preliminary Storm Drainage Report (CORE, 2015) describes that under the existing condition, discharge from the site is to the existing natural discharge location in the southwest corner, and that the proposed condition discharge from the site will be to a new tight line storm drainage system proposed under the adjacent (to the south) project referred to as "The Retreat" project. Drainage is then routed to the south and west as it does in its natural condition through a series of ditches, culverts and pipes. Flow control and water quality treatment will be provided by a public drainage and water quality facility located downstream of the project site. All upstream runoff is collected in the detention facility on the adjacent property.
- Clean roof runoff will be discharged through perforated stub-out drainpipes that connect to the storm system, allowing for minor infiltration through the perforated pipe. Domestic water and sewer service will be provided by the City of Redmond. Irrigation using imported water was not included in the water balance calculations due to the limited landscape/lawn areas.
- As described in our above-referenced reports, the subject site is located at the southwestern base of the Education Hill upland. The upland is mantled by Vashon lodgement till and till sediments were encountered onsite at or within a few feet of ground surface. Areas of Vashon recessional outwash are mapped near the base of the slope and areas of thin outwash were encountered on the slope. Till-like pre-Fraser-age low-permeability deposits are also mapped on the upland margin in the vicinity of the site and were encountered generally less than 10 feet below ground surface.

- As described in our above-referenced reports, ground water was not encountered in any of the on-site explorations, with the exception of an isolated amount of water within the pre-Fraser-age Possession (?) Drift unit observed at a depth 25 feet of in one exploration. Based on the information obtained to date (existing literature and on-site explorations), the principal ground water "regime" in the site vicinity includes the interflow zone and, west of the site, an extensive alluvial aquifer present on the valley floor. The alluvial aquifer has limited hydrogeologic connection to the pre-Fraser ground water we encountered. The depth to ground water in the alluvial aquifer is variable. Based on the static water levels reported on water well logs, the depth to water in the alluvial aquifer ranges from approximately 8.5 to 18 feet west of the site.

GROUND WATER RECHARGE SUMMARY

Water balance analyses were conducted to evaluate the potential hydrologic impacts associated with the proposed development on ground water recharge. The water balance provided estimates of precipitation, evapotranspiration, recharge, and runoff from the site. Water balance analyses for existing and developed condition scenarios were conducted using land use cover types provided by CORE (CORE, 2015) and soil/geologic conditions described in our above-referenced reports. We understand from past communication with City of Redmond Public Works that for SEPA analyses project ground water recharge impacts from the developed condition should be evaluated with respect to the existing condition. Table 1 summarizes existing and developed land use cover types. Table 2 summaries the results of the water balance calculations. The monthly distribution of the difference in recharge is presented in Table 3. It should be noted that the water balance does not account for sources of recharge that are difficult to quantify. The calculated difference in annual recharge between the existing conditions and developed conditions, based on the 0.65-acre townhome tract, is approximately 0.38 acre-feet. This represents a calculated reduction in ground water recharge under the developed conditions.

Table 1
Existing and Developed Condition Land Cover Types

Soil and Land Cover	Outwash	Till*		Impervious	Total (acres)**
	Forest (acres)	Forest (acres)	Grass (acres)	Lot Areas (roof, driveway) (acres)	
Existing areas in acres	0.05	0.60	0	0	0.65
Developed areas in acres	0	0.30	0.08	0.27	0.65

*Areas where Vashon lodgement till or low-permeability pre-Fraser-age Possession deposits were present at about 5 feet or less were considered as Till for ground water recharge/water balance calculations.
**Total acreage is based on Tract "B" acreage and does not include offsite adjacent right-of-way improvements (0.08 acres of road, planter strip and sidewalk) or Tract "A" (1.69 acres of undisturbed forest).

Table 2
Existing and Developed Conditions Monthly Water Balance

		Existing Condition			Developed Condition		
Month	**Rainfall (inches)**	**ET (inches)**	**RCH (inches)**	**RO (inches)**	**ET (inches)**	**RCH (inches)**	**RO (inches)**
Oct	4.45	1.55	1.43	1.47	1.35	0.77	2.33
Nov	6.72	1.07	2.78	2.87	1.04	1.48	4.18
Dec	6.5	0.76	2.83	2.91	0.80	1.51	4.18
Jan	6.2	0.50	2.81	2.89	0.50	1.49	4.19
Feb	4.39	0.43	1.95	2.01	0.41	1.04	2.93
Mar	4.68	0.62	2.00	2.06	0.53	1.07	3.07
Apr	3.68	1.34	1.15	1.19	1.00	0.62	2.06
May	2.83	2.45	0.19	0.19	1.67	0.12	1.04
Jun	2.40	3.16	-	-0.76	2.07	-	0.33
Jul	1.35	4.11	-	-2.77	2.37	-	-1.03
Aug	1.46	3.46	-	-2.01	2.09	-	-0.64
Sep	2.46	2.18	0.14	0.14	1.58	0.09	0.79
TOTAL	**47.1**	**21.63**	**15.27**	**10.22**	**14.40**	**8.58**	**24.07**

Table 3
Comparison of Existing and Developed Condition Monthly Recharge Volumes with Infiltration

Month	Existing Condition Recharge (acre-feet)	Developed Condition Recharge (acre-feet)	Difference (acre-feet)
Oct	0.08	0.04	-0.04
Nov	0.15	0.08	-0.07
Dec	0.15	0.08	-0.07
Jan	0.15	0.08	-0.07
Feb	0.11	0.06	-0.05
Mar	0.11	0.06	-0.05
Apr	0.06	0.03	-0.03
May	0.01	0.01	-
Jun	-	-	-
Jul	-	-	-
Aug	-	-	-
Sep	0.01	-	-
TOTAL	**0.83**	**0.44**	**-0.38**

WATER BALANCE COMPONENTS

The primary components of the water balance for the project site are precipitation (PPT), evapotranspiration (ET), ground water recharge (RCH), and runoff (RO). These components are related by the following equation:

Water Balance: **PPT – RCH – ET – RO = 0**

Where: PPT = Precipitation
RCH = Recharge from rainfall falling on pervious areas
ET = Evapotranspiration
RO = Runoff

Precipitation - PPT

Annual precipitation for the site is based on data recorded at the Redmond Ridge rainfall gauges, 18U and 18V, and at the Carnation rain gauge over the period from October 1949 through December 2004. As shown on Table 2 (attached), the average annual rainfall is approximately 47 inches. The mean monthly rainfall distribution shows that approximately 80 percent of the annual average rainfall occurs between the months of October through May.

Evapotranspiration - ET

Average monthly ET values for forest and grass are based on Hydrological Simulation Program – Fortran (HSPF) simulations conducted by Goldsmith (2004) for the Redmond Ridge and Redmond Ridge East projects and are provided in Table 4. The Redmond Ridge development is located about 3.5 miles east of the site. ET data for the HSPF simulations was estimated from monthly average potential ET data obtained from the Washington State University (WSU) Puyallup station for the period from June 1995 through February 2002 by applying a pan to lake evaporation coefficient of 0.75 to the Puyallup evaporation data.

Table 4
Average Monthly Evapotranspiration Volumes

Month	Forest (in/ac)	Grass (in/ac)	Impervious (in/ac)
Oct	1.55	1.45	1.11
Nov	1.07	1.04	1.02
Dec	0.76	0.76	0.87
Jan	0.50	0.50	0.51
Feb	0.43	0.43	0.40
Mar	0.62	0.61	0.42
Apr	1.34	1.29	0.53
May	2.45	2.12	0.68
Jun	3.16	2.43	0.75
Jul	4.11	2.59	0.38
Aug	3.46	2.16	0.56
Sep	2.18	1.83	0.84
Total	21.63	17.21	8.05

Existing Condition Recharge (RCH) and Runoff (RO)

Recharge under the existing condition is from precipitation falling on pervious areas (RCH). Recharge can vary significantly depending on the near-surface soils. Recharge calculations in this assessment examine flux

of water through the surficial sediments. Ground water recharge through the low-permeability soils (similar in behavior to glacial till for storm water runoff and ground water recharge purposes) was estimated using Equation 1 in combination with the USGS methodology described in Bidlake and Payne (2001). The Bidlake and Payne (2001) study presents predictive equations for annual recharge based on annual precipitation. The equations are derived from an intensive near-surface water balance for four study areas. The equation for till soils provides an estimate of 14.01 inches per year for till soils. The average annual RCH of 14.01 inches per year for till was partitioned monthly by examining the monthly percentage of PPT remaining after ET is subtracted, and multiplying by the total average annual RCH of 14.01 inches.

Thick outwash is interpreted to be present in the southwest corner of the site for purposes of ground water recharge calculations. Ground water recharge through outwash soils was estimated using Equation 1 rearranged as follows: RCH (outwash) = PPT – ET, with RO assumed to be zero for the portion of the site interpreted to be underlain with thicker outwash.

For the purposes of our analysis, the runoff term includes both surface runoff and interflow. Precipitation at this site soaks through the weathered till and thin recessional outwash sediments, and accumulates in the weathered horizon or on underlying low permeability geologic units, creating perched water conditions or an interflow zone during the wetter winter and spring seasons. Ground water flow direction in the interflow zone is largely controlled by the topography of the underlying low-permeability surface, which generally corresponds to surface topography. Based on the topography of this site, the interflow is interpreted to flow offsite to the west. For those summer months where average monthly ET exceeded PPT, the excess ET is interpreted to represent ET from interflow storage. This can result in a calculated negative runoff value during those summer months.

Developed Condition Recharge (RCH)

Recharge under the developed condition has several components. Precipitation falling on pervious areas will continue to provide recharge (RCH) across the site. Under the developed condition, proposed grading will remove much of the weathered till and thin recessional outwash soils. For purposes of ground water recharge calculations, the developed condition soil in pervious areas is assumed to be till.

Additional sources of recharge are available from the proposed stormwater management system including minor infiltration of roof runoff via perforated stub-outs, and also minor infiltration from watering of landscape areas using imported water. Calculations of recharge from perforated stub-out and water of landscape areas were not conducted.

DISCUSSION OF RESULTS

The water balance results indicate that under the developed condition there is a calculated reduction in recharge of about 0.38 acre-feet, or 46 percent, based on a site development of 0.65 acres. For comparison, if the 1.69-acre tract of undisturbed forest is included in the calculation, the reduction of 0.38 acre-feet is about 14 percent. The calculated reduction in recharge does not account for sources of recharge that are difficult to quantify such as the following:

- Some recharge will occur from irrigation using 'imported' water within open space and right-of-way landscaping areas.

- Some recharge will occur from roof perforated stub-out connections.
- Some water will run off the edges of impervious surfaces (roofs, pavement, sidewalks) onto the ground resulting in local recharge through the underlying soil column.
- Paved surfaces and sidewalks are treated as nearly fully impervious surfaces; however, some slow leakage through these surfaces is likely to occur.
- Backfill along utility trenches in low-permeability, parent material typically has a higher permeability than the un-weathered native soil and can provide a pathway for some additional recharge.
- Some water transported offsite will have opportunity to soak into the ground in transit to the City facility.

LIMITATIONS

The conclusions and interpretations presented in this memorandum should not be construed as a warranty of the subsurface conditions. Our conclusions and recommendations are based on information provided by others and our experience in the area. Our experience has shown that soil and ground water conditions can vary significantly over small distances.

Within the limitations of scope, schedule, and budget, AESI attempted to execute these services in accordance with generally accepted professional principles in the fields of engineering geology and hydrogeology at the time this report was prepared. No warranty, express or implied, is made. If you should have any questions, or require further assistance, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

12/21/15
State of Washington
Hydrogeologist
2335
Licensed Geologist
Jennifer H. Saltonstall

-FOR-

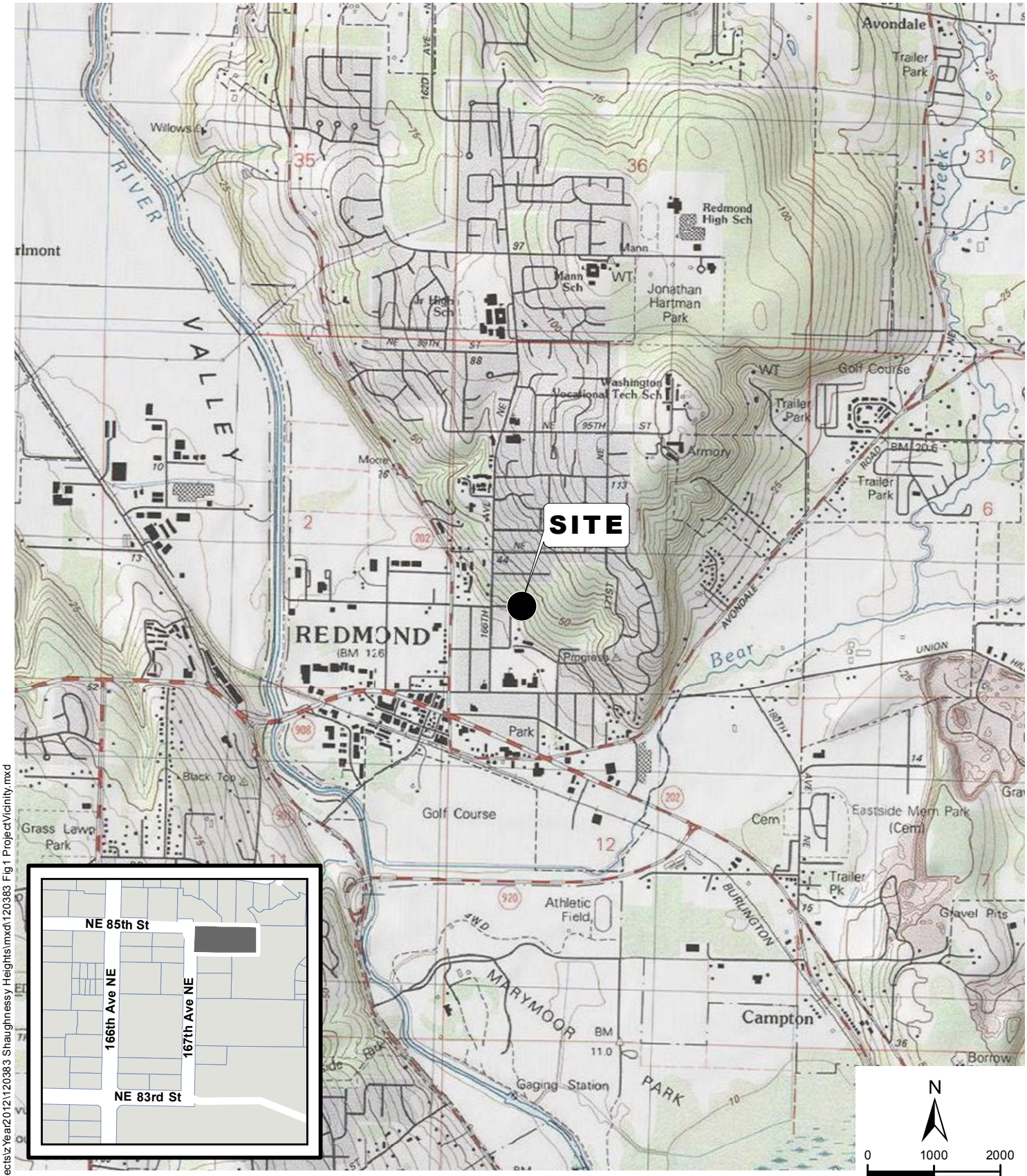
Curtis J. Koger, L.G., L.E.G., L.Hg.
Senior Principal Geologist/Hydrogeologist

Jennifer H. Saltonstall, L.G., L.Hg.
Associate Geologist/Hydrogeologist

ATTACHMENTS

Figure 1 - Vicinity Map
CORE Design, Inc. Development Plan, Sheet P6 of 13, print date October 20, 2015

JHS/KE120383B Projects\20120383\KE\WP



N

0 1000 2000

FEET

REFERENCE: USGS, KING CO

NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

Document Path: H:\GIS_Projects\z Year2012\120383 Shaughnessy Heights\mxd\120383 Fig 1 ProjectVicinity.mxd

associated earth sciences incorporated

VICINITY MAP

MAPLEWOOD
REDMOND, WASHINGTON

FIGURE 1

DATE 10/15

PROJ. NO. KE120383B

associated earth sciences incorporated

Technical Memorandum

Date:	December 21, 2015	**From:**	Jennifer H. Saltonstall, L.G., L.Hg.
To:	IBBO, LLC and Amalani, LLC	**Project Manager:**	Stephen A. Siebert, P.E.
	105 South Main Street, Suite 230	**Principal in Charge:**	Curtis J. Koger, L.G., L.E.G, L.Hg.
	Seattle, Washington 98104	**Project Name:**	Maplewood (formerly Shaughnessy Heights West)
Attn:	Mr. Barry Margolese	**Project No:**	KE120383B
cc:	Mr. Joshua P. Beard, P.L.A. jpb@coredesigninc.com		
Subject:	Ground water recharge evaluation, Maplewood Project, Redmond, WA		

Associated Earth Sciences, Inc. (AESI) provides this technical memorandum summarizing the results of ground water recharge calculations performed for the Maplewood project in Redmond, Washington. This technical memorandum is based on information presented in previous reports for the project including:

- AESI, February 9, 2004, Subsurface Exploration, Geologic Hazards, and Preliminary Geotechnical Engineering Report, Shaughnessy Heights
- AESI, October 13, 2006, Supplementary Subsurface Explorations and Geotechnical Engineering Study, Shaughnessy Heights
- AESI, September 26, 2012, Geotechnical Findings and Recommendations, Downspout Infiltration Suitability Assessment, Shaughnessy Heights West
- AESI, October 15, 2012, Critical Aquifer Recharge Areas Report, Shaughnessy Heights West
- AESI, October 21, 2015, Critical Aquifer Recharge Areas Report, Maplewood (formerly Shaughnessy Heights West)
- AESI, October 21, 2015, Critical Areas Report (Geotechnical Aspects), Maplewood (formerly Shaughnessy Heights West)
- AESI, October 21, 2015, Subsurface Exploration, Geologic Hazards, and Preliminary Geotechnical Engineering Report, Maplewood (formerly Shaughnessy Heights West)
- Core Design, Inc. (CORE), September 2015, Preliminary Storm Drainage Report for Maplewood Short Plat.

PROJECT DESCRIPTION AND SITE CONDITIONS SUMMARY

The proposed Maplewood project is an 8-unit multi-family residential development located on the southwest margin of a north-south trending upland referred to as Education Hill. The Education Hill upland is bounded to the west by the Sammamish River Valley and to the east by the Bear Creek Valley. The site is

located in a portion of southwest ¼ of Section 1, Township 25 North, Range 5 East, W.M., King County, on the south side of NE 85th Street extended and just east of 167th Avenue NE (see Figure 1, Vicinity Map).

The following is a summary of our understanding of the project and the surrounding area.

- The proposed Maplewood project is a tract from the Shaughnessy Heights development. The tract consists of a single parcel to the northwest of the Shaughnessy Heights development and the project was previously called Shaughnessy Heights West. The subject property is approximately 2.34 acres in size (King County parcel 0125059114). Approximately 1.69 acres of the parcel is located within a Transferable Development Rights easement (Tract "A") and will remain undeveloped. The remainder of the property in which the townhomes are proposed is approximately 0.65 acres (Tract "B").
- The developed site plan includes creation of an 8 unit multi-family development along with associated driveways, sidewalks, utilities, and open space areas and frontage improvements along 167th Avenue NE, as shown as the attached Development Plan (CORE, October 2015). The open space areas are to remain in the existing condition. The townhomes would have partial below grade levels. Based on finished floor elevations of the townhomes provided by CORE we expect cuts from 10 to 15 feet will be required to reach final grades. Retaining walls from 4 t o12 feet in height are proposed on the north and south sides of the tract.
- The existing site is currently an undeveloped forested parcel. On the 0.65-acre tract proposed for townhomes, the ground surface elevation ranges from about 65 feet above mean sea level (amsl) in the southwest corner rising to about 125 feet amsl on the eastern edge. The ground surface generally slopes to the west/southwest across most of the site. A steep slope inclined at greater than 40 percent is present on the eastern portion of the tract. Remnants of a man-made steep slope created as a result of previous grading are present in the southwest portion of the site and south of the site. There is a faint remnant drainage located in the eastern portion of the tract, oriented roughly northeast-southwest, that creates a linear localized depression. Vegetation on the tract consists of both large evergreen and deciduous trees with a moderately dense understory.
- The Preliminary Storm Drainage Report (CORE, 2015) describes that under the existing condition, discharge from the site is to the existing natural discharge location in the southwest corner, and that the proposed condition discharge from the site will be to a new tight line storm drainage system proposed under the adjacent (to the south) project referred to as "The Retreat" project. Drainage is then routed to the south and west as it does in its natural condition through a series of ditches, culverts and pipes. Flow control and water quality treatment will be provided by a public drainage and water quality facility located downstream of the project site. All upstream runoff is collected in the detention facility on the adjacent property.
- Clean roof runoff will be discharged through perforated stub-out drainpipes that connect to the storm system, allowing for minor infiltration through the perforated pipe. Domestic water and sewer service will be provided by the City of Redmond. Irrigation using imported water was not included in the water balance calculations due to the limited landscape/lawn areas.
- As described in our above-referenced reports, the subject site is located at the southwestern base of the Education Hill upland. The upland is mantled by Vashon lodgement till and till sediments were encountered onsite at or within a few feet of ground surface. Areas of Vashon recessional outwash are mapped near the base of the slope and areas of thin outwash were encountered on the slope. Till-like pre-Fraser-age low-permeability deposits are also mapped on the upland margin in the vicinity of the site and were encountered generally less than 10 feet below ground surface.

- As described in our above-referenced reports, ground water was not encountered in any of the on-site explorations, with the exception of an isolated amount of water within the pre-Fraser-age Possession (?) Drift unit observed at a depth 25 feet of in one exploration. Based on the information obtained to date (existing literature and on-site explorations), the principal ground water "regime" in the site vicinity includes the interflow zone and, west of the site, an extensive alluvial aquifer present on the valley floor. The alluvial aquifer has limited hydrogeologic connection to the pre-Fraser ground water we encountered. The depth to ground water in the alluvial aquifer is variable. Based on the static water levels reported on water well logs, the depth to water in the alluvial aquifer ranges from approximately 8.5 to 18 feet west of the site.

GROUND WATER RECHARGE SUMMARY

Water balance analyses were conducted to evaluate the potential hydrologic impacts associated with the proposed development on ground water recharge. The water balance provided estimates of precipitation, evapotranspiration, recharge, and runoff from the site. Water balance analyses for existing and developed condition scenarios were conducted using land use cover types provided by CORE (CORE, 2015) and soil/geologic conditions described in our above-referenced reports. We understand from past communication with City of Redmond Public Works that for SEPA analyses project ground water recharge impacts from the developed condition should be evaluated with respect to the existing condition. Table 1 summarizes existing and developed land use cover types. Table 2 summaries the results of the water balance calculations. The monthly distribution of the difference in recharge is presented in Table 3. It should be noted that the water balance does not account for sources of recharge that are difficult to quantify. The calculated difference in annual recharge between the existing conditions and developed conditions, based on the 0.65-acre townhome tract, is approximately 0.38 acre-feet. This represents a calculated reduction in ground water recharge under the developed conditions.

Table 1
Existing and Developed Condition Land Cover Types

Soil and Land Cover	Outwash	Till*		Impervious	Total (acres)**
	Forest (acres)	Forest (acres)	Grass (acres)	Lot Areas (roof, driveway) (acres)	
Existing areas in acres	0.05	0.60	0	0	0.65
Developed areas in acres	0	0.30	0.08	0.27	0.65

*Areas where Vashon lodgement till or low-permeability pre-Fraser-age Possession deposits were present at about 5 feet or less were considered as Till for ground water recharge/water balance calculations.
**Total acreage is based on Tract "B" acreage and does not include offsite adjacent right-of-way improvements (0.08 acres of road, planter strip and sidewalk) or Tract "A" (1.69 acres of undisturbed forest).

Table 2
Existing and Developed Conditions Monthly Water Balance

		Existing Condition			Developed Condition		
Month	**Rainfall (inches)**	**ET (inches)**	**RCH (inches)**	**RO (inches)**	**ET (inches)**	**RCH (inches)**	**RO (inches)**
Oct	4.45	1.55	1.43	1.47	1.35	0.77	2.33
Nov	6.72	1.07	2.78	2.87	1.04	1.48	4.18
Dec	6.5	0.76	2.83	2.91	0.80	1.51	4.18
Jan	6.2	0.50	2.81	2.89	0.50	1.49	4.19
Feb	4.39	0.43	1.95	2.01	0.41	1.04	2.93
Mar	4.68	0.62	2.00	2.06	0.53	1.07	3.07
Apr	3.68	1.34	1.15	1.19	1.00	0.62	2.06
May	2.83	2.45	0.19	0.19	1.67	0.12	1.04
Jun	2.40	3.16	-	-0.76	2.07	-	0.33
Jul	1.35	4.11	-	-2.77	2.37	-	-1.03
Aug	1.46	3.46	-	-2.01	2.09	-	-0.64
Sep	2.46	2.18	0.14	0.14	1.58	0.09	0.79
TOTAL	**47.1**	**21.63**	**15.27**	**10.22**	**14.40**	**8.58**	**24.07**

Table 3
Comparison of Existing and Developed Condition Monthly Recharge Volumes with Infiltration

Month	Existing Condition Recharge (acre-feet)	Developed Condition Recharge (acre-feet)	Difference (acre-feet)
Oct	0.08	0.04	-0.04
Nov	0.15	0.08	-0.07
Dec	0.15	0.08	-0.07
Jan	0.15	0.08	-0.07
Feb	0.11	0.06	-0.05
Mar	0.11	0.06	-0.05
Apr	0.06	0.03	-0.03
May	0.01	0.01	-
Jun	-	-	-
Jul	-	-	-
Aug	-	-	-
Sep	0.01	-	-
TOTAL	**0.83**	**0.44**	**-0.38**

WATER BALANCE COMPONENTS

The primary components of the water balance for the project site are precipitation (PPT), evapotranspiration (ET), ground water recharge (RCH), and runoff (RO). These components are related by the following equation:

Water Balance: **PPT – RCH – ET – RO = 0**

Where: PPT = Precipitation
RCH = Recharge from rainfall falling on pervious areas
ET = Evapotranspiration
RO = Runoff

Precipitation - PPT

Annual precipitation for the site is based on data recorded at the Redmond Ridge rainfall gauges, 18U and 18V, and at the Carnation rain gauge over the period from October 1949 through December 2004. As shown on Table 2 (attached), the average annual rainfall is approximately 47 inches. The mean monthly rainfall distribution shows that approximately 80 percent of the annual average rainfall occurs between the months of October through May.

Evapotranspiration - ET

Average monthly ET values for forest and grass are based on Hydrological Simulation Program – Fortran (HSPF) simulations conducted by Goldsmith (2004) for the Redmond Ridge and Redmond Ridge East projects and are provided in Table 4. The Redmond Ridge development is located about 3.5 miles east of the site. ET data for the HSPF simulations was estimated from monthly average potential ET data obtained from the Washington State University (WSU) Puyallup station for the period from June 1995 through February 2002 by applying a pan to lake evaporation coefficient of 0.75 to the Puyallup evaporation data.

Table 4
Average Monthly Evapotranspiration Volumes

Month	Forest (in/ac)	Grass (in/ac)	Impervious (in/ac)
Oct	1.55	1.45	1.11
Nov	1.07	1.04	1.02
Dec	0.76	0.76	0.87
Jan	0.50	0.50	0.51
Feb	0.43	0.43	0.40
Mar	0.62	0.61	0.42
Apr	1.34	1.29	0.53
May	2.45	2.12	0.68
Jun	3.16	2.43	0.75
Jul	4.11	2.59	0.38
Aug	3.46	2.16	0.56
Sep	2.18	1.83	0.84
Total	21.63	17.21	8.05

Existing Condition Recharge (RCH) and Runoff (RO)

Recharge under the existing condition is from precipitation falling on pervious areas (RCH). Recharge can vary significantly depending on the near-surface soils. Recharge calculations in this assessment examine flux

of water through the surficial sediments. Ground water recharge through the low-permeability soils (similar in behavior to glacial till for storm water runoff and ground water recharge purposes) was estimated using Equation 1 in combination with the USGS methodology described in Bidlake and Payne (2001). The Bidlake and Payne (2001) study presents predictive equations for annual recharge based on annual precipitation. The equations are derived from an intensive near-surface water balance for four study areas. The equation for till soils provides an estimate of 14.01 inches per year for till soils. The average annual RCH of 14.01 inches per year for till was partitioned monthly by examining the monthly percentage of PPT remaining after ET is subtracted, and multiplying by the total average annual RCH of 14.01 inches.

Thick outwash is interpreted to be present in the southwest corner of the site for purposes of ground water recharge calculations. Ground water recharge through outwash soils was estimated using Equation 1 rearranged as follows: RCH (outwash) = PPT – ET, with RO assumed to be zero for the portion of the site interpreted to be underlain with thicker outwash.

For the purposes of our analysis, the runoff term includes both surface runoff and interflow. Precipitation at this site soaks through the weathered till and thin recessional outwash sediments, and accumulates in the weathered horizon or on underlying low permeability geologic units, creating perched water conditions or an interflow zone during the wetter winter and spring seasons. Ground water flow direction in the interflow zone is largely controlled by the topography of the underlying low-permeability surface, which generally corresponds to surface topography. Based on the topography of this site, the interflow is interpreted to flow offsite to the west. For those summer months where average monthly ET exceeded PPT, the excess ET is interpreted to represent ET from interflow storage. This can result in a calculated negative runoff value during those summer months.

Developed Condition Recharge (RCH)

Recharge under the developed condition has several components. Precipitation falling on pervious areas will continue to provide recharge (RCH) across the site. Under the developed condition, proposed grading will remove much of the weathered till and thin recessional outwash soils. For purposes of ground water recharge calculations, the developed condition soil in pervious areas is assumed to be till.

Additional sources of recharge are available from the proposed stormwater management system including minor infiltration of roof runoff via perforated stub-outs, and also minor infiltration from watering of landscape areas using imported water. Calculations of recharge from perforated stub-out and water of landscape areas were not conducted.

DISCUSSION OF RESULTS

The water balance results indicate that under the developed condition there is a calculated reduction in recharge of about 0.38 acre-feet, or 46 percent, based on a site development of 0.65 acres. For comparison, if the 1.69-acre tract of undisturbed forest is included in the calculation, the reduction of 0.38 acre-feet is about 14 percent. The calculated reduction in recharge does not account for sources of recharge that are difficult to quantify such as the following:

- Some recharge will occur from irrigation using 'imported' water within open space and right-of-way landscaping areas.

- Some recharge will occur from roof perforated stub-out connections.
- Some water will run off the edges of impervious surfaces (roofs, pavement, sidewalks) onto the ground resulting in local recharge through the underlying soil column.
- Paved surfaces and sidewalks are treated as nearly fully impervious surfaces; however, some slow leakage through these surfaces is likely to occur.
- Backfill along utility trenches in low-permeability, parent material typically has a higher permeability than the un-weathered native soil and can provide a pathway for some additional recharge.
- Some water transported offsite will have opportunity to soak into the ground in transit to the City facility.

LIMITATIONS

The conclusions and interpretations presented in this memorandum should not be construed as a warranty of the subsurface conditions. Our conclusions and recommendations are based on information provided by others and our experience in the area. Our experience has shown that soil and ground water conditions can vary significantly over small distances.

Within the limitations of scope, schedule, and budget, AESI attempted to execute these services in accordance with generally accepted professional principles in the fields of engineering geology and hydrogeology at the time this report was prepared. No warranty, express or implied, is made. If you should have any questions, or require further assistance, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

12/21/15
State of Washington
Hydrogeologist
2335
Licensed Geologist
Jennifer H. Saltonstall

-FOR-

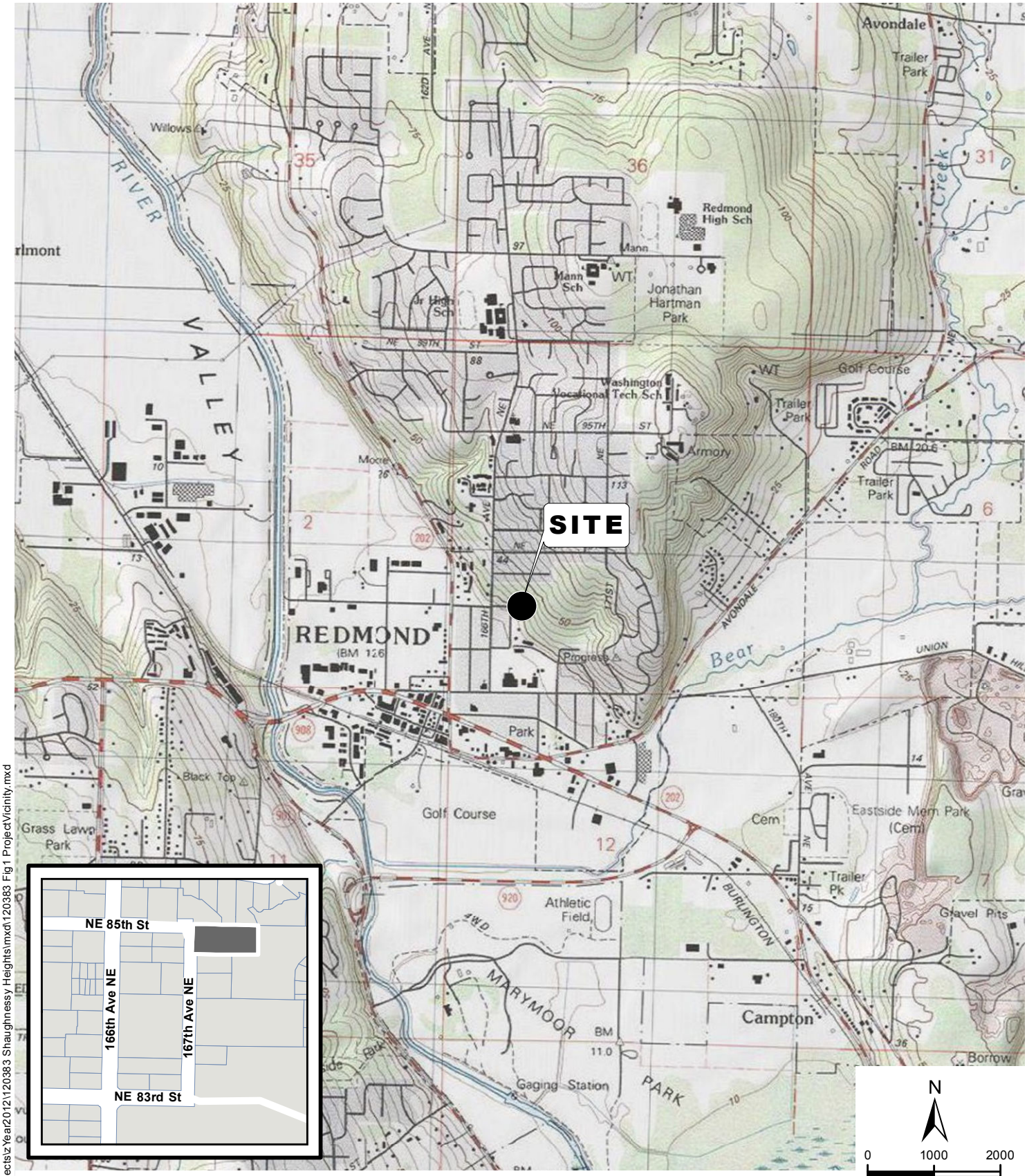
Curtis J. Koger, L.G., L.E.G., L.Hg.
Senior Principal Geologist/Hydrogeologist

Jennifer H. Saltonstall, L.G., L.Hg.
Associate Geologist/Hydrogeologist

ATTACHMENTS

Figure 1 - Vicinity Map
CORE Design, Inc. Development Plan, Sheet P6 of 13, print date October 20, 2015

JHS/KE120383B Projects\20120383\KE\WP



N

0 1000 2000

FEET

REFERENCE: USGS, KING CO

NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

Document Path: H:\GIS_Projects\z Year2012\120383 Shaughnessy Heights\mxd\120383 Fig 1 ProjectVicinity.mxd

associated earth sciences incorporated

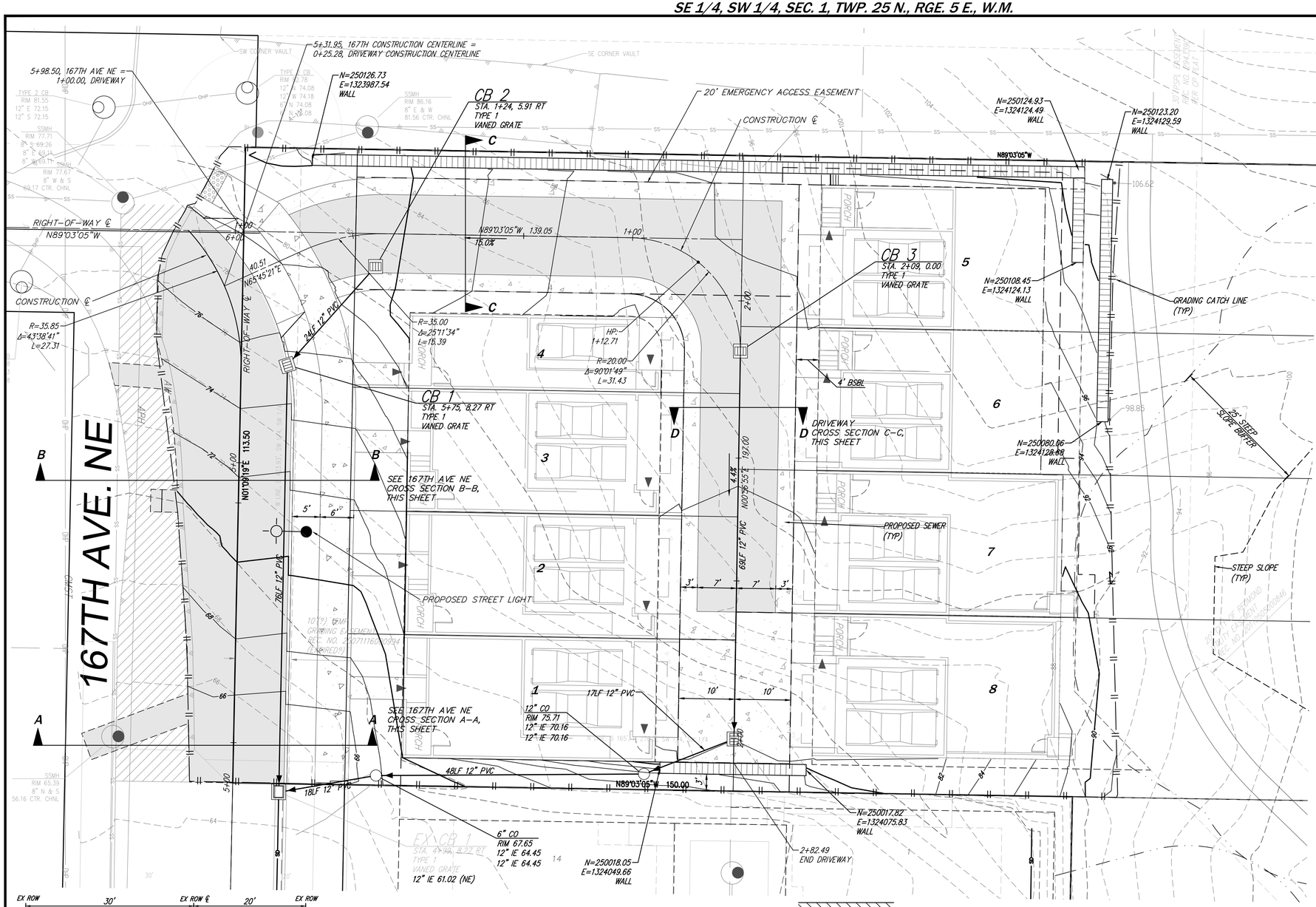
VICINITY MAP

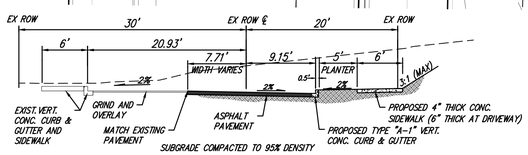
MAPLEWOOD
REDMOND, WASHINGTON

FIGURE 1

DATE 10/15

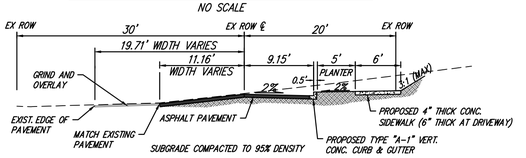
PROJ. NO. KE120383B





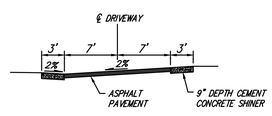
167TH AVE NE - SECTION A-A

NO SCALE



167TH AVE NE - SECTION B-B

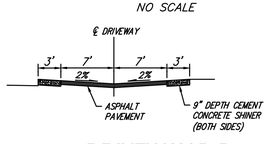
NO SCALE



DRIVEWAY C-C

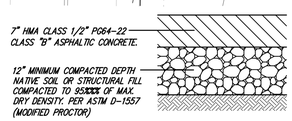
NO SCALE

NO SCALE



DRIVEWAY D-D

NO SCALE



ONSITE SURFACING SECTION NOTE: THE SOILS ENGINEER EMPLOYED BY THE DEVELOPER SHALL VERIFY AND SUBSEQUENTLY ADVISE THE CITY THAT THE INSTALLATION OF THE PAVING SECTION(S) CONFORM TO HIS/HER DESIGN.

ROAD PAVEMENT SURFACING SECTION

LEGEND

- EXISTING CONTOUR — 90 —
- PROPOSED CONTOUR — 90 —
- ROCKERY
- BUILDING SETBACK LINE
- PROPOSED FULL ASPHALT PAVING PER SEC. THIS SHT.T
- 2" GRIND & OVERLAY
- FIRE LANE MARKING TYPE 1 PAINTED CURB

NOTES

1. NEAT CUT EXISTING PAVEMENT FULL DEPTH.
2. STREET TREES TO BE "SUMMIT GREEN ASH" – QTY (2).
3. USE COMPOST AMENDED SOIL PER COR STD PLAN 632.
4. TRANSITION TO EXISTING SIDEWALK.
5. CURB AND SIDEWALK JOINTS PER COR STD PLAN 303
6. ADJUST RIM TO MATCH NEW GRADE.
7. REMOVE EXISTING ASPHALT AND CONCRETE PAVEMENT AND RECONSTRUCT PER ROAD PAVEMENT SURFACING SECTION.

N

SCALE: 1" = 10'

0 5 10 20

GRADING NOTES

1. ALL SITE WORK IMPROVEMENTS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THESE APPROVED PLANS. ANY DEVIATION FROM THESE PLANS WILL REQUIRE PRIOR APPROVAL FROM THE OWNER, ENGINEER AND APPROPRIATE PUBLIC AGENCIES. ALL WORK AND MATERIALS TO BE PER CITY OF REDMOND STANDARDS.

2. THE FACILITIES SHOWN ON THE APPROVED EROSION/SEDIMENTATION CONTROL PLANS SHALL BE CONSTRUCTED, IMPLEMENTED PRIOR TO ANY EXTENSIVE GRADING OR LAND CLEARING IN ACCORDANCE WITH THAT PLAN. THESE FACILITIES MUST BE SATISFACTORILY MAINTAINED UNTIL CONSTRUCTION AND LANDSCAPING IS COMPLETED AND THE POTENTIAL FOR ON-SITE EROSION HAS PASSED.

3. ALL TEMPORARY STOCKPILES AND ANY AREA WHICH HAS BEEN STRIPPED OF VEGETATION AND WHERE NO FURTHER WORK IS ANTICIPATED FOR A PERIOD OF 30 DAYS OR MORE SHALL BE IMMEDIATELY STABILIZED WITH MULCHING, GRASS SEEDING OR OTHER APPROVED EROSION CONTROL TREATMENT APPLICABLE TO THE TIME OF YEAR IN QUESTION. GRASS SEEDING ALONE WILL BE ACCEPTABLE ONLY DURING THE MONTHS OF APRIL THROUGH SEPTEMBER INCLUSIVE. SEEDING MAY PROCEED WHENEVER IT IS IN THE INTEREST OF THE PERMITTEE, BUT MUST BE AUGMENTED WITH MULCHING, NETTING, OR OTHER CITY OF REDMOND-APPROVED TREATMENT. STRAW MULCH SHALL CONSIST OF A MINIMUM THICKNESS OF TWO INCHES SPREAD EVENLY OVER THE SURFACE TO BE PROTECTED. NETTING MAY BE REQUIRED TO HOLD MULCH IN PLACE ON STEEP SLOPES. GRASS SEEDING SHALL BE ACCOMPLISHED THROUGH THE USE OF A CITY OF REDMOND-APPROVED HYDROSEEDER SEED MIXTURE OR THROUGH PLACEMENT OF AN ACCEPTABLE SOD.

4. MAJOR EXPOSED, GRADED SLOPES SHALL BE PROTECTED BY CLEAR PLASTIC SHEETING OR SIMILAR APPROVED METHOD UNTIL SUCH TIME AS THE VEGETATIVE COVER HAS BEEN ESTABLISHED SUFFICIENTLY TO INHIBIT EROSION.

5. SILTATION CONTROL AREAS SHALL BE RETURNED TO ORIGINAL GROUND CONDITIONS OR BROUGHT TO FINISH GRADE AT THE PROJECT'S COMPLETION. ANY PERMANENT STORM DRAINAGE FACILITIES USED FOR EROSION/SEDIMENTATION CONTROL SHALL BE CLEANED PRIOR TO PROJECT ACCEPTANCE.

6. ALL LIMITS OF CLEARING AND AREAS OF VEGETATION PRESERVATION, AS PRESCRIBED ON THESE PLANS, SHALL BE LOCATED BY SURVEY AND OBSERVED DURING CONSTRUCTION. SPECIAL PROTECTIVE FENCING WILL BE REQUIRED. THIS SPECIAL PROTECTIVE FENCING SHALL CONSIST OF 42" HIGH ORANGE SAFETY FENCE. NO DISTURBANCE OR REMOVAL OF ANY GROUND COVER IS TO OCCUR WITHIN THESE PRESERVATION AREAS.

7. GRADES SHOWN ON THIS PLAN REPRESENT THE ENGINEER'S ESTIMATE OF APPROXIMATE OPTIMUM EARTHWORK AND OTHER GRADING/SOIL CONSIDERATIONS. THE CONTRACTOR MAY ALTER THE GRADES SHOWN TO BETTER ACHIEVE THESE RESULTS PROVIDED THAT ANY ALTERATION IS SUBJECT TO THE PRIOR APPROVAL IN WRITING BY THE ENGINEER, OWNER, AND THE APPROPRIATE CITY OF REDMOND DEPARTMENTS.

8. GRADING INTO AREAS OUTSIDE OF THIS PROPERTY IS SUBJECT TO THE WRITTEN CONSENT OF ADJOINING PROPERTY OWNERS. FAILURE TO OBTAIN SUCH CONSENT MAY REQUIRE ADDITIONAL ROCKERY OR OTHER SUITABLE SOIL STABILIZATION SUCH THAT ALL GRADING OCCURS WITHIN THE PROJECT'S BOUNDARIES. THE CONTRACTOR SHALL VERIFY THE STATUS OF THE ADJOINING PROPERTY OWNER'S CONSENT BY CONTACTING THE DEVELOPER PRIOR TO PERFORMING WORK OUTSIDE OF PROJECT BOUNDARIES.

9. ALL SURPLUS OR UNSUITABLE MATERIALS CLEARED OR EXCAVATED AND REMOVED FROM THE SITE SHALL BE DISPOSED OF IN AN APPROVED FILL SITE. IT WILL BE THE PERMITTEE'S RESPONSIBILITY TO LOCATE AN ACCEPTABLE DISPOSAL SITE AND TO ASSURE THAT ALL SURPLUS MATERIAL IS PROPERLY DEPOSITED IN SAME.

10. NO FINAL GRADE CUT OR EMBANKMENT SLOPE SHALL EXCEED 3:1 (HORIZ:VERT) WITHOUT STABILIZATION BY ROCKERY (NOT TO EXCEED 8') OR BY RETAINING WALL, UNLESS SPECIFICALLY AUTHORIZED BY A LICENSED SOILS ENGINEER AND APPROVED BY CITY OF REDMOND. ALL ROCKERIES OVER 4 FEET HIGH AND ALL RETAINING WALLS OUTSIDE OF CITY OF REDMOND RIGHT-OF-WAY WILL REQUIRE A SEPARATE BUILDING PERMIT.

12. ALL EARTHWORK UNDER PAVING TO BE USED BY VEHICULAR TRAFFIC SHALL BE COMPACTED TO AT LEAST 95% OF THE MAXIMUM DRY DENSITY PER MODIFIED PROCTOR ASTM D1557, OR PER SPECIFICATION IN THE SOILS REPORT.

13. UNLESS OTHERWISE NOTED, ALL SPOT ELEVATIONS SHOWN IN PAVED AREAS ARE TOP OF PAVING.

14. ALL PARKING, DRIVEWAY AND LANDSCAPED AREAS SHALL HAVE AT LEAST A 1.0% SLOPE TOWARD THE NEAREST STORM DRAINAGE INTERCEPTION/CONVEYANCE SYSTEM. PLAN DETAILS OR FIELD MODIFICATIONS SHALL NOT SUPERCEDE THIS REQUIREMENT.

15. EXTRUDED CEMENT CONCRETE CURBING, WHERE SPECIFIED, SHALL BE CONSTRUCTED IN ACCORDANCE WITH CITY OF REDMOND STANDARDS AND DETAILS (E.G. CITY OF REDMOND STANDARD PLAN #304A) OR DETAILS SHOWN ON THESE PLANS.

16. ANY OPEN CUTS OF EXISTING PUBLIC ROADWAYS SHALL BE BACKFILLED AND COMPACTED IN ACCORDANCE WITH CITY OF REDMOND STANDARDS. ALL CUTS INTO EXISTING ASPHALT SHALL BE ALONG NEAT, CONTINUOUS, SAWED LINES. A TEMPORARY COLD MIX PATCH SHALL BE PLACED IMMEDIATELY AFTER BACKFILL AND COMPACTION. THE EXISTING SURFACING MUST BE REPLACED IN KIND (OR 4 INCHES OF COMPACTED CLASS "B" ASPHALT CONCRETE, WHICHEVER IS GREATER) WITHIN 30 DAYS OF TEMPORARY PATCHING. THE CONTRACTOR SHALL CLOSELY FOLLOW REQUIREMENTS OF THE RIGHT-OF-WAY PERMIT--SPECIFICALLY; ALLOWABLE WORKING HOURS, DETOUR AND WARNING SIGNS, AND NOTIFICATION OF ROAD ALTERATIONS TO THE POLICE AND/OR OTHER EMERGENCY SERVICES.

17. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ADEQUATE SAFEGUARDS, SAFETY DEVICES, PROTECTIVE EQUIPMENT, FLAGGERS, AND ANY OTHER NEEDED ACTIONS TO PROTECT THE LIFE, HEALTH, AND SAFETY OF THE PUBLIC, AND TO PROTECT PROPERTY IN CONNECTION WITH THE PERFORMANCE OF WORK COVERED BY THE CONTRACT. ANY WORK WITHIN THE TRAVELED RIGHT-OF-WAY THAT MAY INTERRUPT NORMAL TRAFFIC FLOW SHALL REQUIRE AT LEAST ONE FLAGGER FOR EACH LANE OF TRAFFIC AFFECTED. ALL SECTIONS OF THE WSDOT STANDARD SPECIFICATIONS 1-07.23 TRAFFIC CONTROL SHALL APPLY.

18. THE CONTRACTOR SHALL KEEP OFF-SITE STREETS CLEAN AT ALL TIMES BY SWEEPING. FLUSHING OF THESE STREETS WILL NOT BE ALLOWED.

19. IMPERVIOUS SURFACES (ROOFS, STREETS, DRIVEWAYS, ETC.) SHALL BE DIRECTED INTO THE COMPLETED STORM DRAINAGE SYSTEM AS SOON AS POSSIBLE.

20. ANY WORK WITHIN AN EXISTING STREET SHALL NOT COMMENCE UNTIL THE CONTRACTOR PREPARES A TRAFFIC CONTROL PLAN, AND RECIEVES APPROVAL OF THE PLAN FROM THE CITY TRANSPORTATION DIVISION AND CITY CONSTRUCTION INSPECTOR.

NOTE: THIS DEVELOPMENT SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE YEAR 2012 CITY OF REDMOND STANDARD SPECIFICATIONS AND DETAILS.

This approval is for design concept only. These plans appear to be in conformance with City of Redmond design standards for construction. This approval shall not be construed as authorizing construction not in accordance with applicable City standards. The City reserves the right to require revisions to the approved plans to assure conformance with City of Redmond design standards for construction at any time that it is discovered that the proposed construction does not otherwise meet the applicable construction standards. The owner is required to provide designs and plans in accordance with applicable City standards and assure that construction is accomplished in accordance with those standards. The owner and/or design engineer and/or developer, as the case may be, may be required to make necessary approved field revisions to correct any errors or omissions found to exist on the approved plan.

APPROVED FOR CONSTRUCTION

Director of Public Works
City of Redmond

Date

Plan Check Engineer

For Sheet(s)

Storm Drainage Engineer

Utility Engineer

Fire Department

Trans. Engineer

Planning Dept.

NO.	REVISIONS	DATE

3-21-14

CORE DESIGN
14711 NE 29th Place Suite 101
Bellevue, Washington 98007
425.885.7877 Fax 425.885.7963
ENGINEERING · PLANNING · SURVEYING

DEVELOPMENT PLAN
MAPLEWOOD

AMALANI, LLC/IBBO, LLC
105 SOUTH MAIN STREET, SUITE 230
SEATTLE, WA 98104

DATE OCTOBER 2015
DESIGNED MICHAEL A. MOODY, P.E.
DRAWN FLAVIO BAINOTTI
APPROVED MICHAEL A. MOODY, P.E.
JOSH P. BEARD
PROJECT MANAGER

SHEET P6 OF 13

PROJECT NUMBER 15099

```
                                15099_Input.exe
KCRTS Program...File Directory:
C:\KC_SWDM\KC_DATA\
[C] CREATE a new Time Series
ST
       0.43       0.00       0.000000  Till Forest
       0.00       0.00       0.000000  Till Pasture
       0.00       0.00       0.000000  Till Grass
       0.00       0.00       0.000000  Outwash Forest
       0.00       0.00       0.000000  Outwash Pasture
       0.00       0.00       0.000000  Outwash Grass
       0.00       0.00       0.000000  Wetland
       0.00       0.00       0.000000  Impervious
15099_Predev.tsf
 T
    1.00000
 T
[T] Enter the Analysis TOOLS Module
[P] Compute PEAKS and Flow Frequencies
15099_predev.tsf
15099_Predev.pks
[R] RETURN to Previous Menu
[C] CREATE a new Time Series
ST
       0.00       0.00       0.000000  Till Forest
       0.00       0.00       0.000000  Till Pasture
       0.10       0.00       0.000000  Till Grass
       0.00       0.00       0.000000  Outwash Forest
       0.00       0.00       0.000000  Outwash Pasture
       0.00       0.00       0.000000  Outwash Grass
       0.00       0.00       0.000000  Wetland
       0.33       0.00       0.000000  Impervious
15099_Dev.tsf
 T
    1.00000
```