STORMWATER DRAINAGE REPORT
LABOSIERRE SHORT PLAT

3035 NE 195th Street
Lake Forest Park, WA 98155
Parcel #: 6152900033

Prepared for:
Plats Financial Group
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4.20.16

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REGISTERED
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Prepared:
March 2016
Revised:

DAVID EVANS
AND ASSOCIATES INC.

1.0 Project Overview

Financial Plats Group is proposing a 4-lot short plat to be constructed on approximately a 4.05 acre parcel (post-boundary line adjustment) within the RS-7.2 (Single-Family Residential, High) zone. The project site is located at 3035 NE 195th St, Lake Forest Park, Washington 98155. Existing single-family residences border the site on all sides of the property with the exception of the north side where it is bounded by NE 195th Street.

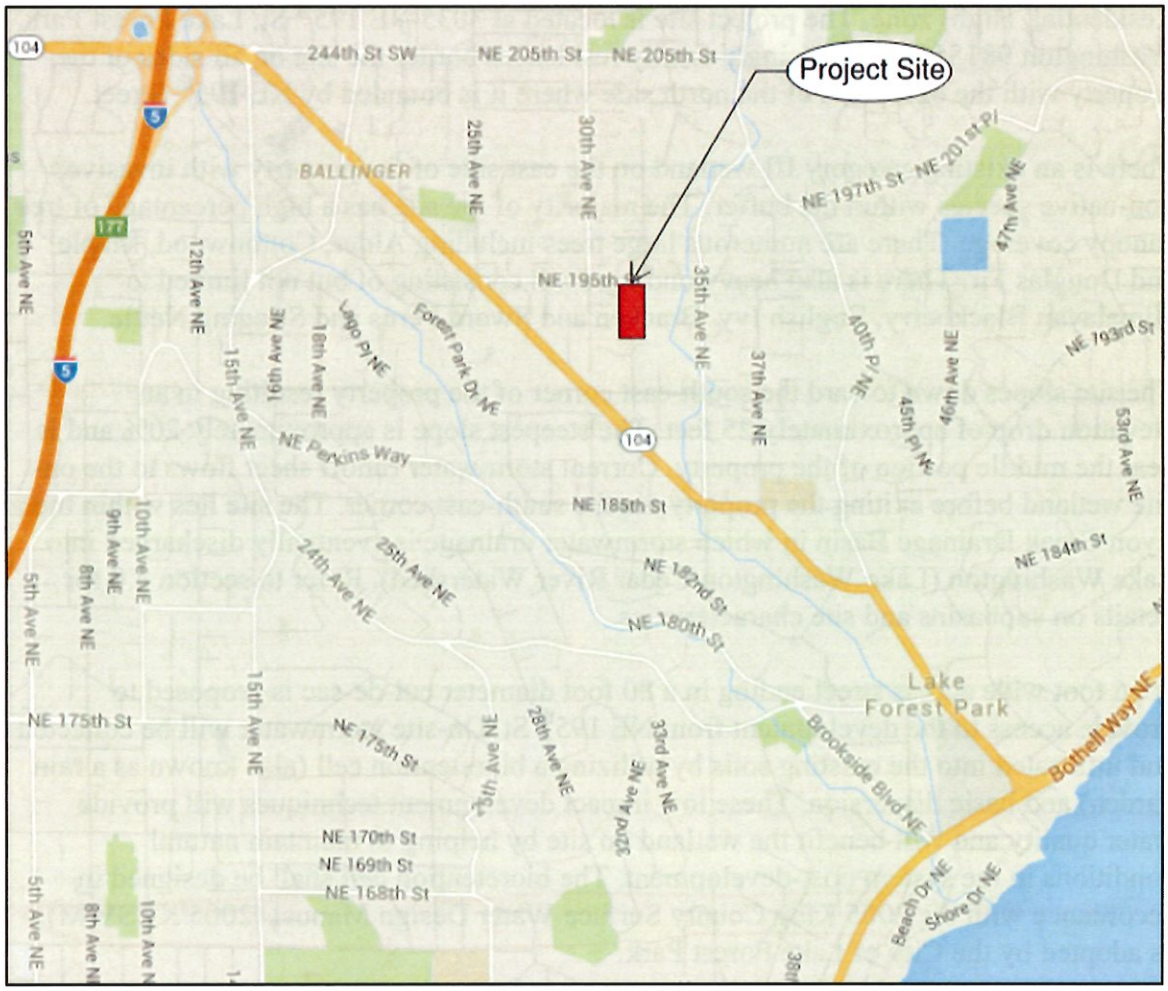
There is an existing category III wetland on the east side of the property with invasive, non-native species within the buffer. The majority of the site has a high percentage of tree canopy coverage. There are numerous large trees including Alder, Cottonwood, Maple and Douglas Fir. There is also heavy undergrowth consisting of but not limited to Himalayan Blackberry, English Ivy, Bracken and Sword Ferns and Stinging Nettle.

The site slopes down toward the south-east corner of the property resulting in an elevation drop of approximately 25 feet. The steepest slope is approximately 20% and is near the middle portion of the property. Current stormwater runoff sheet flows to the on-site wetland before exiting the property via the south-east corner. The site lies within the Lyon Creek Drainage Basin in which stormwater drainage is eventually discharged into Lake Washington (Lake Washington/Cedar River Watershed). Refer to section 3.0 for details on subbasins and site characteristics.

A 16 foot wide access street ending in a 80 foot diameter cul-de-sac is proposed to provide access to the development from NE 195th St. On-site stormwater will be collected and infiltrated into the existing soils by utilizing a bioretention cell (also known as a rain garden) and basic dispersion. These low impact development techniques will provide water quality and will benefit the wetland on site by helping to maintain natural conditions in the system post-development. The bioretention cell shall be designed in accordance with the 2005 King County Surface Water Design Manual (2005 KCSWM), as adopted by the City of Lake Forest Park.

2009 per LFPMC 16.04.030

Figure 1: Vicinity Map (Not To Scale)



2.0 Minimum Requirements

This report provides stormwater requirements for the proposed development. The project will add more than 5,000 square feet of new impervious surfacing and therefore a Full Drainage Review is necessary. The Core Requirements and Special Requirements, as outlined in the King County Surface Water Design Manual (2005), will be met when applicable and are summarized below: 2009

Minimum Requirement #1: Discharge at the Natural Location

Discharging to the natural drainage location helps to prevent adverse impacts to downstream properties caused by diversion of flow from one flow path to another, and to discharge in a manner that does not significantly impact downhill properties or drainage systems.

The proposed discharge from the site will mimic the existing drainage conditions. The runoff will be collected and conveyed to a single bioretention cell which will be utilized to infiltrate the stormwater into the soils. Overflow from the bioretention cell will be routed to the existing wetland in order to maintain its natural hydrology.

Minimum Requirement #2: Offsite Analysis

The intent of the offsite analysis is to identify and evaluate offsite flooding, erosion, and water quality problems that may be created or aggravated by the proposed project, and to ensure appropriate measures are provided for preventing creation or aggravation of those problems. In addition, this requirement is intended to ensure appropriate provisions are made, as needed, to mitigate other identified impacts associated with the quantity and quality of surface and storm water runoff from the project site.

No erosion, flooding, or degradation of the drainage system was identified within ¼ of a mile downstream of the project site. See Section 3.0 for a detailed offsite analysis.

Minimum Requirement #3: Flow Control

Flow control will be provided in order to protect downstream properties and resources from increases in peak, duration and volume of runoff generated by new development.

The bioretention cell will provide flow control for the project site.

Minimum Requirement #4: Conveyance System

All conveyance system elements for the proposed project will be analyzed, designed, and constructed to provide a minimum level of protection against overtopping, flooding, erosion, and structural failure.

The proposed conveyance system consists of a pipe system which will convey stormwater from the impervious areas to the on-site bioretention cell.

Minimum Requirement #5: Erosion & Sediment Control

In order to help minimize the erosion and transport of sediment, several erosion control measures as detailed in the King County Erosion and Sediment Control (ESC) Standards adopted as Appendix D of the 2005 KCSWM will be utilized. See Section 7.0 of this report and the engineering plans for additional information.

Minimum Requirement #6: Maintenance and Operations

All privately maintained drainage facilities shall be maintained as specified in Appendix A of the 2005 KCSWM. A copy of the Operation and Maintenance Manual shall be retained on site and will be transferred with the property to the new owner. A copy of operation and maintenance standards are included in Appendix H of this report.

Minimum Requirement #7: Financial Guarantees and Liability

Drainage facilities will be privately maintained; therefore the financial guarantees and liability are not required for this project.

Minimum Requirement #8: Water Quality

As delineated by the Water Quality Applications Map in the 2005 KCSWM, the project site lies within an incorporated area. Water quality shall be provided by bioretention.

Special Requirement #1: Other Adopted Area-Specific Requirements

No other area-specific requirements apply to this site.

Special Requirement #2: Flood Hazard Area Delineation

The project site is not located in a flood hazard area; therefore no additional special requirements apply to this site.

Special Requirement #3: Flood Protection Facilities

The project site does not rely on any existing or proposed flood protection facilities.

Special Requirement #4: Source Controls

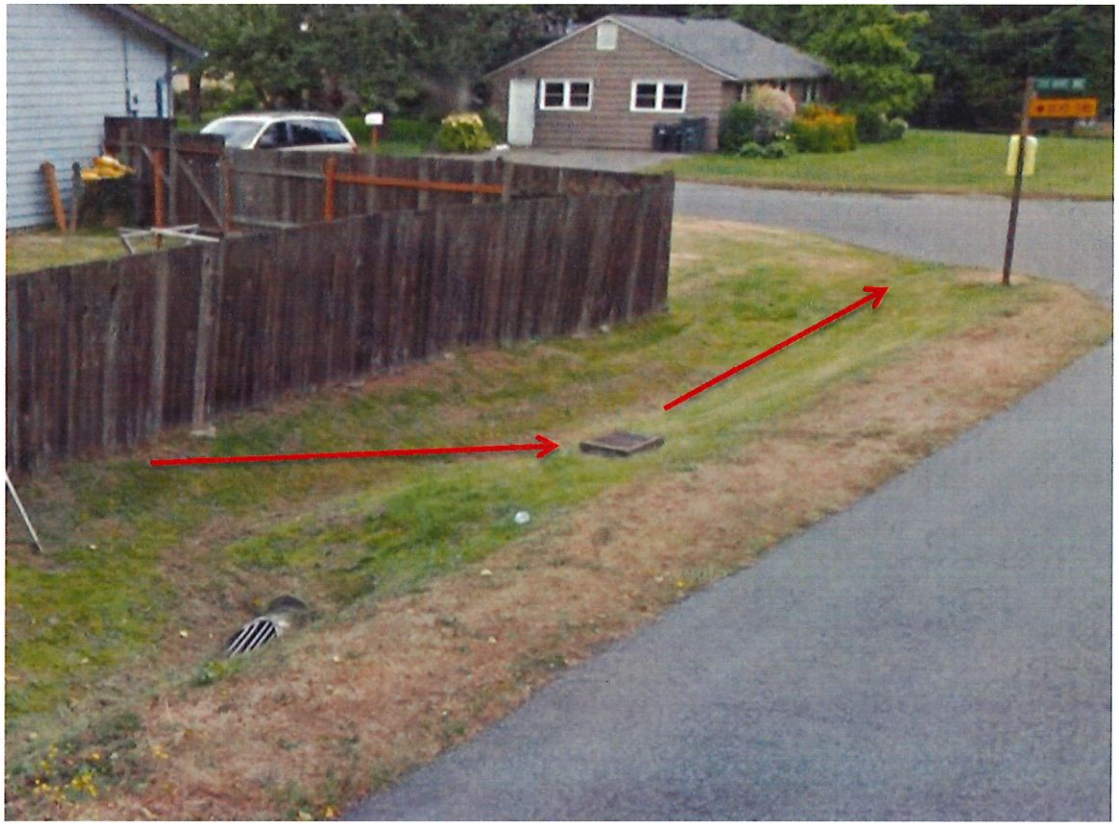
No commercial points of source control are proposed on site.

Special Requirement #5: Oil Control

The site is not classified as a high-use site, therefore no oil control is proposed.

This is a flow control structure? With a riser + orifices?

Figure 3: Control Structure on NE 190th Street near 34th Ave NE

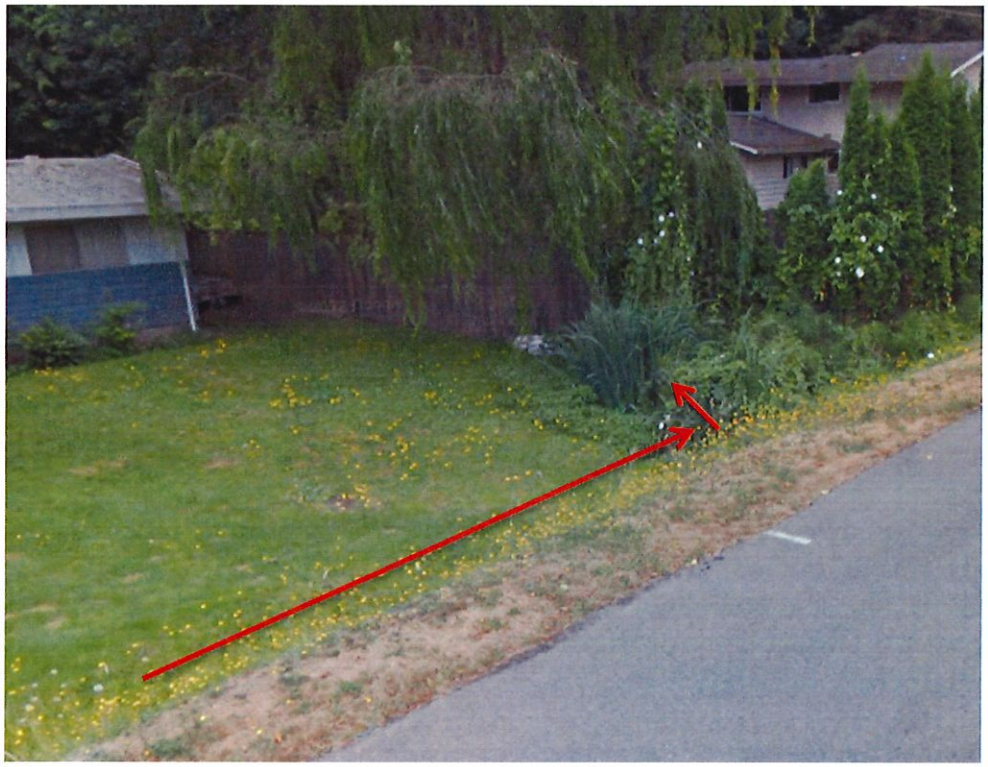


Runoff collected in the open drainage ditch is routed through a pipe and to the control structure. The control structure discharges to a pipe which conveys drainage east under 34th Ave NE.

Figure 4: Drainage on NE 190th Street near 35th Ave NE

The drainage passes through a series of existing ditches and concrete culverts before it is routed under NE 190th Street. It then begins to flow west on the south side of NE 190th Street.

Figure 5: Drainage ditch converging with Lyon Creek east of 33rd Ave NE



The drainage runs to the west through a series of ditches and culverts until it reaches a ditch which flows to the south. This ditch, as shown on the Lake Forest Park Drainage Map (Appendix B), runs directly into Lyon Creek approximately 300 feet downstream. No evidence of flooding, erosion, or degradation was observed within ¼ mile downstream from the project site.

4.0 Flow Control and Water Quality Design

Existing Hydrology

The site is currently forested with no existing structures on the property. On site drainage sheet flows to the existing wetland located near the east side of the site where stormwater is naturally infiltrated into the soil. Any excess drainage flows southerly until it is routed into a series of existing drainage ditches. The drainage system is tributary to the Lyon Creek Basin which drains into the north-west end of Lake Washington.

Developed Hydrology

Drainage from the developed site (1.67 acres) will be infiltrated into the soil via the on-site bioretention cell with overflow dispersing into the wetland. The 2:1 graded areas adjacent to the access road will be vegetated with wetland plantings and runoff generated shall sheet flow into the wetland. This low impact drainage design will assist in maintaining the natural state of the wetland. Any excess drainage unable to be contained within the wetland will continue to drain into the series of ditches near NE 190th Street.

Stormwater Low Impact Development (LID)

As this project site resides within the Lyon Creek Drainage Basin, Low Impact Development is of high importance in order to reduce flooding in the area. As a geotechnical study conducted by Earth Solutions NW confirmed that the soils on site are acceptable for infiltration, the use of a bioretention cell is proposed for this project in order to maintain the hydrology of the existing wetland. This low impact design also allows water quality to be be provided by the hydrophytic plants within the bioretention cell.

Performance Standards

The low impact development drainage design meets the King County flow control BMP requirements as outlined in 5.2.1.1(3) of the 2005 Surface Water Design Manual. 2009
The 6" pipe system which is to convey runoff to the bioretention cell is designed to convey the 25-year peak flow in accordance with section 1.2.4.1(1) of the SWDM.

Flow Control System

Existing site conditions were modeled as forested with type C soil in WWHM 2012. Developed site conditions consist of areas modeled as impervious, flat lawn, and steep lawn. WWHM basin exhibits are included in Appendix D. All runoff generated from the lots and access road will be conveyed to the bioretention cell which has been sized appropriately. Overflow will be conveyed to the wetland on site via basic dispersion. For bioretention sizing please see WWHM report 2 included in Appendix F.

Water Quality System

The Water Quality Applications Map in the 2005 KCSWM shows the project site within an incorporated area. Therefore, it is acceptable for the water quality to be provided by the bioretention facility. The bioretention cell utilizes biological processes of plant uptake and bacterial degradation as well as physical and chemical processes to remove pollutants. This is similar to Basic Water Quality Option 5 in section 6.1.1 of the King County SWDM (2005).

Infiltration System

The on-site bioretention cell will provide stormwater low impact design and flow control for the site. An infiltration rate of 2 inches per hour was provided by Earth Solutions NW for use in preliminary design of the bioretention cell. Please see Appendix G for the Geotechnical Report and the WWHM2012 report.

Rate Not included in geotechnical Report

This is Appendix F

Bioretention Cell Design

The bioretention cell for this project was designed according to the minimum design requirements for a rain garden as specified in section C.2.5.1 of the 2005 King County Surface Water Design Manual. The following are guidelines used in the design process:

- 3:1 side slopes
- 18" amended soil depth
- 12" maximum water depth
- 6" freeboard

Sizing Results per WWHM 2012:

- 3300 SF bottom area for bioretention cell south of cul-de-sac (10150 CF storage volume)
    - See Appendix F, Project Report 2 for details

Flow to Existing Wetland

In order to preserve the existing wetland hydrology on site, some runoff generated from the developed areas will still be allowed to flow into the category III wetland. Overflow from the bioretention cell will be dispersed into the wetland. Additionally, 0.29 acres of 2:1 graded side slopes will be allowed to sheet flow directly into the wetland. Project Report 3 in Appendix F displays the amount of flow which the side slope will contribute to the wetland compared to the pre-developed conditions.

5.0 Conveyance System Analysis and Design

General Design

Conveyance system elements have been analyzed and designed to ensure a minimum level of protection against overtopping, flooding, erosion and or structural failure. The rational method has been used in order to size the proposed conveyance systems. Flows for conveyance were analyzed using the undetained developed conditions shown in Appendix F, Project Report 1.Conveyance and backwater calculations can be found in Appendix E.

8" minimum

Pipe Systems

All pipe material, joints, protective treatment, and construction workmanship shall be in accordance with King County standards. This project proposes the use of 6" PVC gravity pipe with a minimum slope of 3% for storm drainage conveyance. A minimum of 2 feet of cover shall be maintained over the entire project. Type 1 catch basins shall be used throughout project site except where there is more than 5 feet of drop between rim and invert of pipe. When the vertical drop exceeds 5 feet, Type 2 -48" diameter catch basins shall be used.

Conveyance Capacity

Two methods of hydraulic analysis using Manning's equation are used sequentially for the design and analysis of pipe systems (Uniform Flow Analysis method and Backwater Analysis method) in order to verify adequate capacity in proposed pipes. The nomograph shown in Figure 4.2.1.F of the King County Surface Water Design Manual was used in order to show that the proposed 6" storm drain pipe has sufficient capacity to carry the 10-year or 25-year peak flow rate from the site. Refer to Appendix E for calculations showing pipe capacity and backwater calculations.

8"

WWHM2012

PROJECT REPORT #2

Project Name: BIORETENTION CELL
Site Name: PLFG0002
Site Address: 3035 NE 195TH ST
City : LAKE FOREST PARK
Report Date: 3/29/2016 APDC
Gage : Seatac
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 0.83
Version : 2015/09/09

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Forest, Mod	1.378
Pervious Total	1.378
Impervious Land Use	**acre**
Impervious Total	0
Basin Total	1.378

Project site is 1.67 acres as shown on figures in appendix D

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre

C, Lawn, Flat	.574
Pervious Total	0.574
Impervious Land Use	acre
ROADS FLAT	0.804
Impervious Total	0.804
Basin Total	1.378

Element Flows To:

Surface	Interflow	Groundwater
Surface retention 1	Surface retention 1	

Name : Bioretention 1
Bottom Length: 64.00 ft.
Bottom Width: 52.00 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW 12 in/hr
Material thickness of second layer: 0
Material type for second layer: GRAVEL
Material thickness of third layer: 0
Material type for third layer: GRAVEL
Infiltration On
Infiltration rate: 2
Infiltration safety factor: 1
Total Volume Infiltrated (ac-ft.): 138.57
Total Volume Through Riser (ac-ft.): 0
Total Volume Through Facility (ac-ft.): 138.57
Percent Infiltrated: 100
Total Precip Applied to Facility: 12.574
Total Evap From Facility: 6.589
Underdrain not used
Discharge Structure
Riser Height: 1 ft.
Riser Diameter: 12 in.

Element Flows To:

Outlet 1	Outlet 2

Bioretention 1 Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.1022	0.0000	0.0000	0.0000
0.0330	0.1019	0.0006	0.0000	0.0000
0.0659	0.1013	0.0017	0.0000	0.0001
0.0989	0.1007	0.0029	0.0000	0.0003
0.1319	0.1001	0.0041	0.0000	0.0006

The above design parameters are based on a level backfill condition and level grade extending at least 10 feet from the wall toe. Revised design values will be necessary if sloping grades are to be used above or below retaining walls. Additional surcharge loading from adjacent foundations, sloped backfill, or other relevant loads should be included in the retaining wall design.

Retaining walls should be backfilled with free-draining material that extends along the height of the wall and a distance of at least 18 inches behind the wall. The upper 12 inches of the wall backfill can consist of a less permeable soil, if desired. A perforated drain pipe should be placed along the base of the wall and connected to an approved discharge location. A typical retaining wall drainage detail is provided on Plate 3. If drainage is not provided, hydrostatic pressures should be included in the wall design.

Drainage

Perched groundwater should be anticipated in site excavations depending on the time of year grading operations take place, particularly in utility excavations at depth. Temporary measures to control surface water runoff and groundwater during construction would likely involve interceptor trenches and sumps. ESNW should be consulted during preliminary grading to identify areas of seepage and to provide recommendations to reduce the potential for instability related to seepage effects.

During construction surface water must not be allowed to flow over the top and down slopes unless in a controlled manner utilizing swales and rock-lined drainage channels. Finish grades must be designed to direct surface drain water away from structures and slopes. Water must not be allowed to pond adjacent to structures or slopes. In our opinion, foundation drains should be installed along building perimeter footings. A typical foundation drain detail is provided on Plate 4.

Infiltration Feasibility

As indicated in the *Subsurface* section of this report, native soils encountered during our fieldwork were characterized primarily as Vashon advance outwash. Subsequent to USDA textural analyses, the relatively clean Vashon advance outwash was further classified as either gravelly sand or very gravelly sand. The fines contents of the relatively clean Vashon advance outwash were on the order of 0.3 to 5.9 percent.

From a geotechnical standpoint, the Vashon advance outwash is generally suitable for infiltration facility design provided the proposed facility base elevations are advanced through the upper silty sands and into the relatively clean outwash deposits at depth. The 2009 King County Surface Design Manual gives specific outlines for design. Infiltration trenches must be at least 20 feet in length per 1,000 square feet of impervious surface served. The trench must be filled with at least 18 inches of 3/4-inch to 1-1/2-inch washed drain rock. If drywells are to be used for infiltration, drywells must contain a volume of gravel equal to or greater than 60 cubic feet per 1,000 square feet of impervious surface served. The gravel used for drywells must be 1 1/2-inch to 3-inch washed drain rock. In-situ testing can be performed to refine/confirm long-term infiltration rates used for design.

Need this to confirm sizing per WWHM

Excavations and Slopes

The Federal Occupation Safety and Health Administration (OSHA) and the Washington Industrial Safety and Health Act (WISHA) provide soil classification in terms of temporary slope inclinations. Soils that exhibit a high compressive strength are allowed steeper temporary slope inclinations than are soils that exhibit a lower compressive strength.

Based on the soil conditions encountered at the test pit locations, site soils are classified as Type C by OSHA and WISHA. Temporary slopes over four feet in height in Type C soils must be sloped no steeper than one-and-one-half horizontal to one vertical (1.5H:1V). Where encountered, the presence of perched groundwater may cause caving of the temporary slopes due to hydrostatic pressure. ESNW should observe site excavations to confirm soil types and allowable slope inclinations. If the recommended temporary slope inclinations cannot be achieved, temporary shoring may be necessary to support excavations.

Permanent slopes should be planted with vegetation to enhance stability and to minimize erosion and should maintain a gradient of 2H:1V or flatter. An ESNW representative should observe temporary and permanent slopes to confirm the slope inclinations are suitable for the exposed soil conditions. Supplementary recommendations with respect to excavations and slopes may be provided as requested.

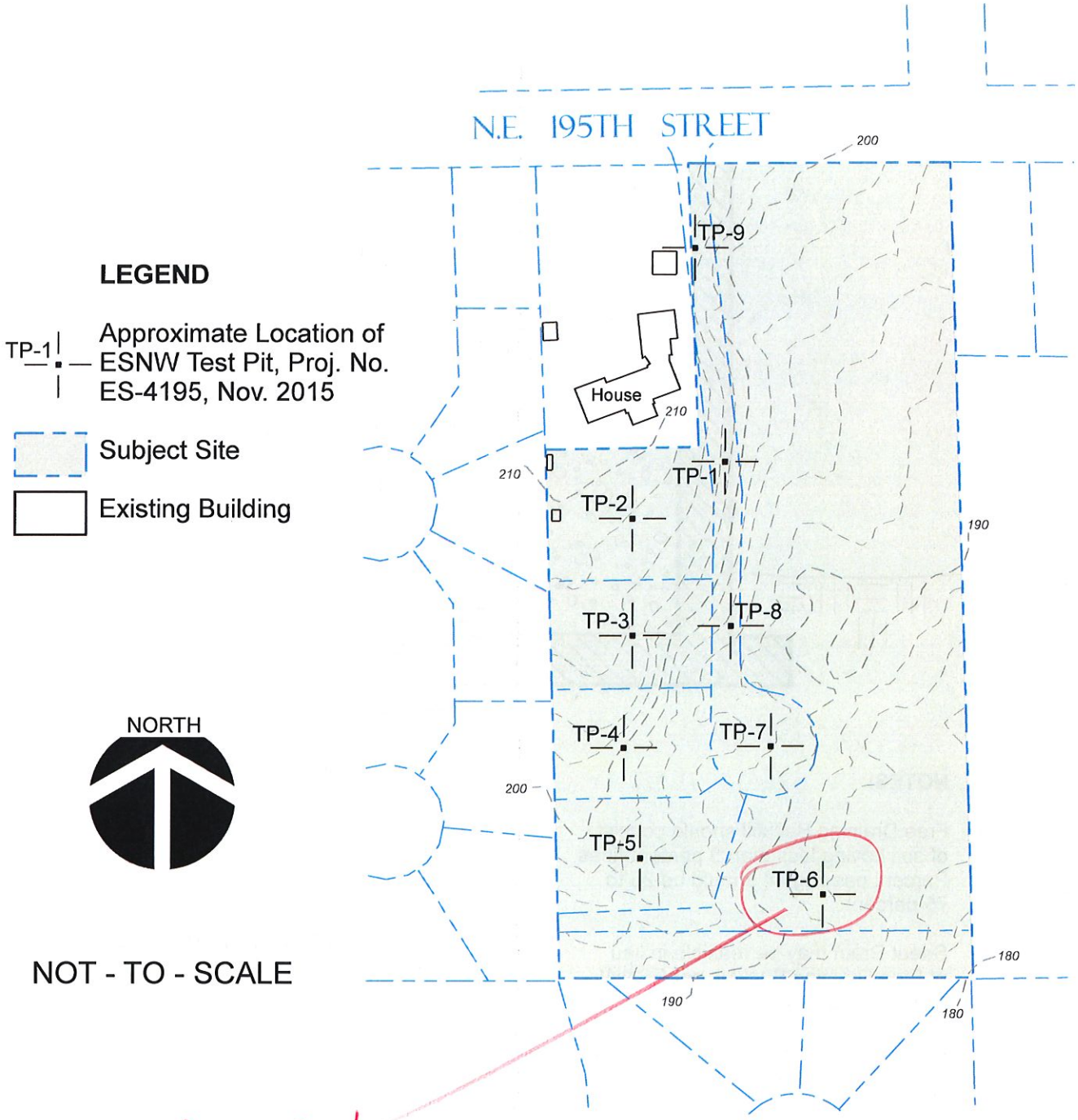
Pavement Sections

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

We anticipate new on-site pavement sections will be subjected primarily to passenger vehicle traffic. For lightly loaded pavement areas subjected primarily to passenger vehicles, the following preliminary pavement sections may be considered:

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

The HMA, ATB and CRB materials should conform to WSDOT specifications. All soil base material should be compacted to a relative compaction of 95 percent, based on the laboratory maximum dry density as determined by ASTM D1557. Final pavement design parameters, including recommendations for heavy traffic areas or access roads, may be provided once final traffic loading has been determined. Road standards utilized by the City of Lake Forest Park may supersede the recommendations provided in this report.



Appears to be in bioretention cell location

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

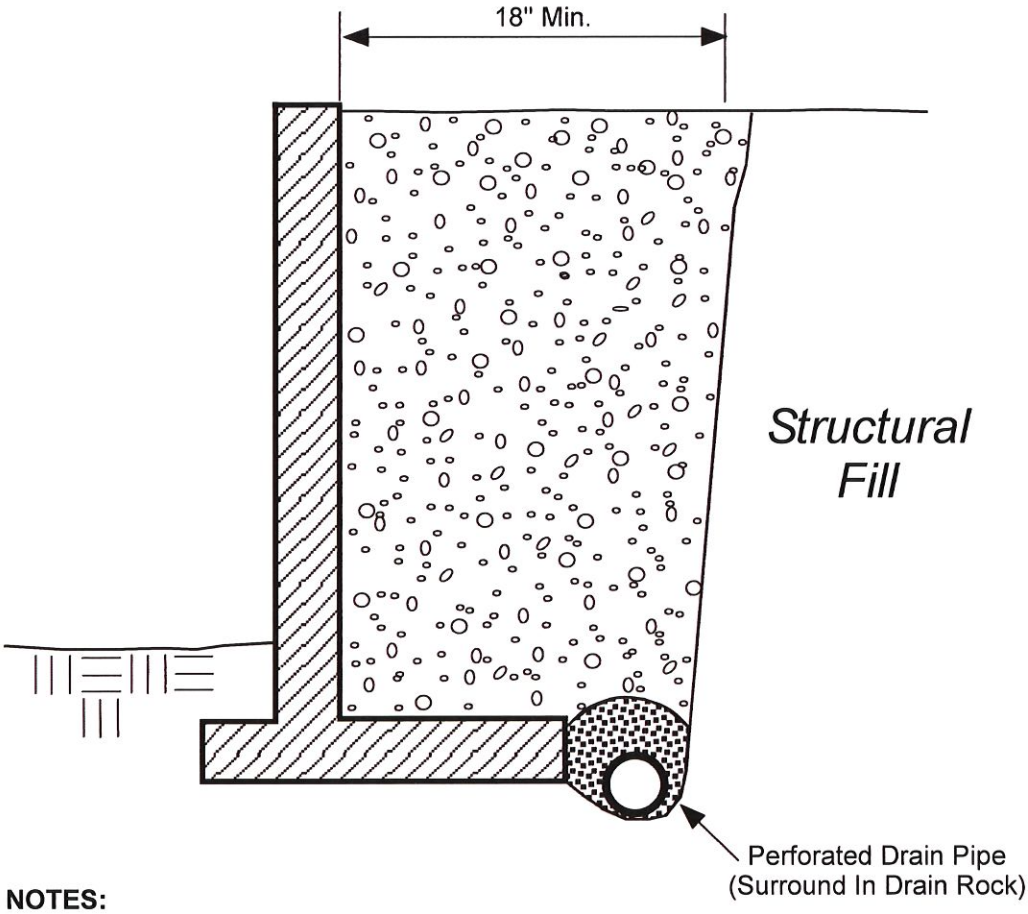
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Monitoring and Environmental Sciences

Test Pit Location Plan
3035 N.E. 195th Street
Lake Forest Park, Washington

Drwn. MRS	Date 12/07/2015	Proj. No. 4195
Checked AZS	Date Dec. 2015	Plate 2



NOTES:

- Free Draining Backfill should consist of soil having less than 5 percent fines. Percent passing #4 should be 25 to 75 percent.
- Sheet Drain may be feasible in lieu of Free Draining Backfill, per ESNW recommendations.
- Drain Pipe should consist of perforated, rigid PVC Pipe surrounded with 1" Drain Rock.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

Free Draining Structural Backfill

1 inch Drain Rock

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

RETAINING WALL DRAINAGE DETAIL
3035 N.E. 195th Street
Lake Forest Park, Washington

Drwn. MRS	Date 12/07/2015	Proj. No. 4195
Checked AZS	Date Dec. 2015	Plate 3

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-6

CLIENT Plats Financial Group, LLC
PROJECT NAME 3035 N.E. 195th Street
PROJECT NUMBER 4195
PROJECT LOCATION Lake Forest Park, Washington
DATE STARTED 11/27/15 **COMPLETED** 11/27/15
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION ---
LOGGED BY AZS **CHECKED BY** AZS
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 12": blackberries
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	1.0	
		MC = 13.60%	SP		Tan poorly-graded SAND, medium dense, moist
					-seepage
5		MC = 20.70%			-oxidation
		MC = 23.90%		7.0	-caving
					Test pit terminated at 7.0 feet below existing grade. Groundwater seepage encountered at 3.0 feet during excavation.
					Bottom of test pit at 7.0 feet.

Per Puget Sound Low Impact Development Technical Guidance Manual, A minimum of 3-feet of separation between groundwater level and bottom of bioretention area if more than 10,000 sf of impervious area is draining to it. With GW found @ 3.0, this is physically impossible

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-7

CLIENT Plats Financial Group, LLC
PROJECT NAME 3035 N.E. 195th Street
PROJECT NUMBER 4195
PROJECT LOCATION Lake Forest Park, Washington
DATE STARTED 11/27/15 **COMPLETED** 11/27/15
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD
AT TIME OF EXCAVATION —
LOGGED BY AZS **CHECKED BY** AZS
AT END OF EXCAVATION —
NOTES Depth of Topsoil & Sod 10": blackberries
AFTER EXCAVATION —

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.9	
		MC = 10.80%	SP-SM	3.5	Brown poorly graded SAND with silt, medium dense, moist -seepage
5		MC = 10.90% Fines = 18.30% MC = 18.30%	SM	7.0	Tan gray silty SAND with gravel, medium dense, wet [USDA Classification: gray gravelly loamy SAND] -oxidation -becomes dense Test pit terminated at 7.0 feet below existing grade. Groundwater seepage encountered at 2.5 feet during excavation. Bottom of test pit at 7.0 feet.