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FARRIS SHORT PLAT

Lot 2 Improvements

Stormwater Site Plan – Drainage Report

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DATE: December 18, 2022

JOB NO: 2349

ENGINEER: ROBERT TRIVITT, P.E.

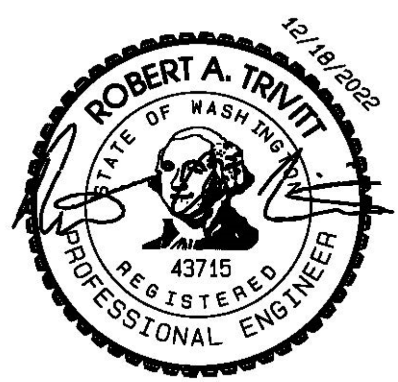


TABLE OF CONTENTS

DRAINAGE REPORT

Section I - Project Overview

Overview:

The project site is located on the north side of West Stewart, between 23rd St and 26th St SW. The overall project consists of the short platting of 2.84 acres into two lots. The current project consists of the construction of a single family residence on Lot 2 of said short plat. Lot 1 is currently developed with a veterinary clinic and residence and outbuildings. Lot 2 includes some outbuildings and the septic system for Lot 1. Lot 1 is landscaped and Lot 2 is primarily pasture. An existing greenhouse and shed will be removed as part of the proposed improvements. Frontage improvements consisting of roadway widening, curb and gutter, and sidewalk have already been installed per short plat conditions.

To address runoff caused by new hard surfaces from this project, permeable pavement will be used for the driveway and a raingarden will be used for the roof.

Project Requirements:

Determination of Applicable Minimum Requirements

The storm drainage requirements for this project are the 2014 Stormwater Management Manual for Western Washington.

This phase of the project consists of Lot 2 improvements for single family residence including building and driveway construction. The project is considered new development. The project consists of 4,873 sf of new driveway, 788 sf of replaced driveway, and 4,274 sf of new roof. This totals 9,147 sf of new hard surface and 788 sf of replaced hard surface for a total of 9,935 sf of new plus replaced hard surface. Approximately 20,852 sf or 0.48 acres will be disturbed. The total area of Lot 2 is 2.37 acres. Since there is greater than 5,000 sf of new plus replaced hard surfaces, all Minimum Requirements apply to the new and replaced hard surfaces and converted vegetation areas, per Figure 2.4.1 below.

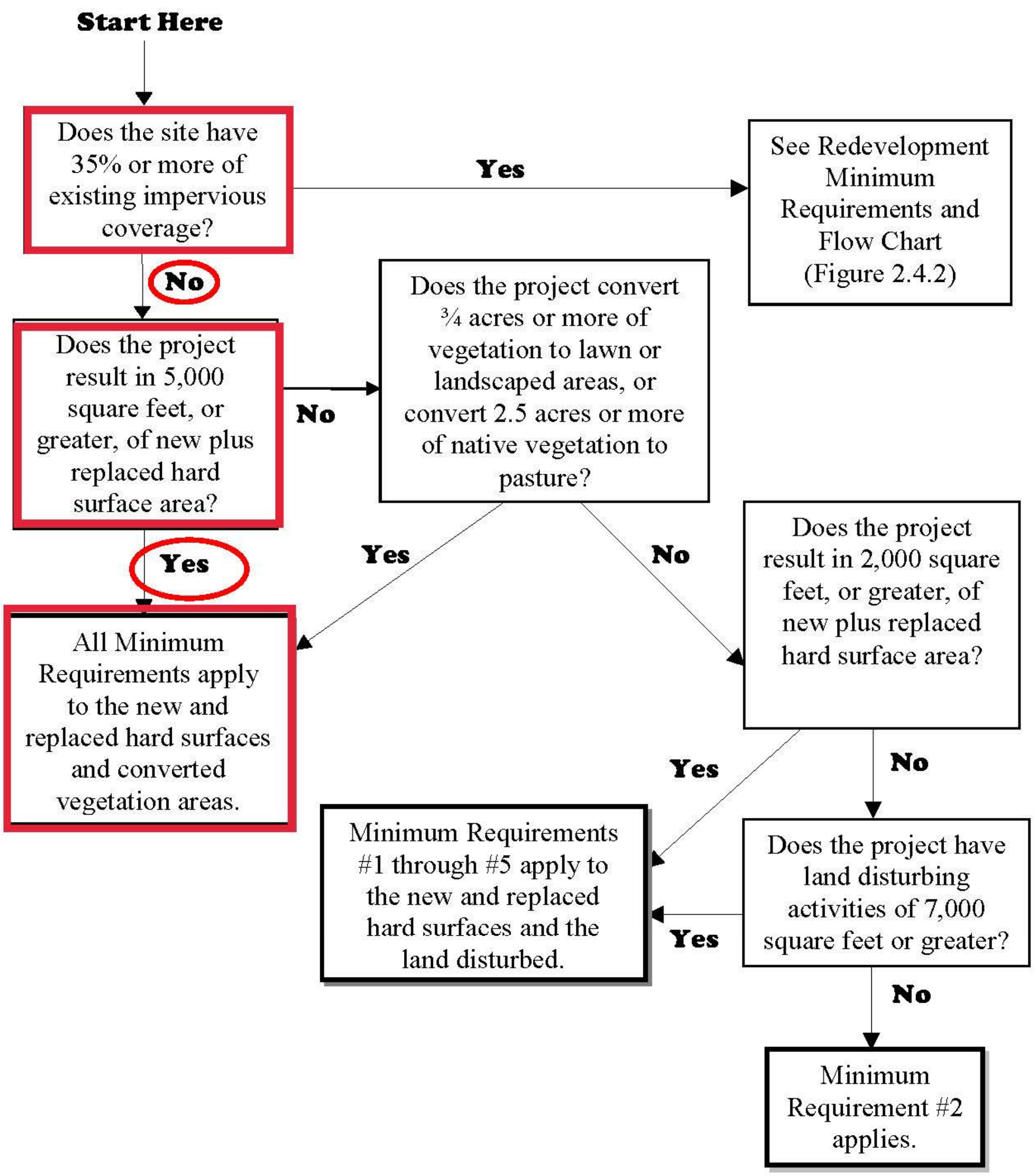


Figure 2.4.1 – Flow Chart for Determining Requirements for New Development

Volume I – Minimum Technical Requirements – December 2014
2-5

Discussion of Minimum Requirements

Minimum Requirement #1: Preparation of Stormwater Site Plans

The Stormwater Site Plan consists of a report and construction plans. This report and the Lot 2 Site Development plans satisfy Minimum Requirement #1.

Minimum Requirement #2: Construction Stormwater Pollution Prevention

An SWPPP has been prepared consisting of Section 5 of this report and the ESC portion of the construction plans to satisfy this requirement.

Minimum Requirement #3: Source Control of Pollution

The proposed used of the site is single family residential. Per Section IV-2.1, implementation of source control BMPs are not required for this use.

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

Currently, drainage from the site generally sheet flows from east to west. The use of sheet flow dispersion and concentrated flow dispersion will preserve the natural drainage system and outfall.

Minimum Requirement #5: On-site Stormwater Management

Because the project site is within the UGA on a parcel less than 5 acres, the project may either meet the Low Impact Development Performance Standard, or use List #2. The applicant chooses to use List #2. BMPs for each surface type are considered and the first feasible BMP in the list is selected.

<u>Lawn and Landscaped Areas</u>:

- All lawn and landscaped areas will meet the requirements of BMP T5.13, Post Construction Soil Quality and Depth with notes on the plans to this effect.

<u>Roofs:</u>

1. BMP T5.30: Full Dispersion is not feasible due to lack of native vegetation on the site. BMP T5.10A: Downspout Full Infiltration – infeasible due to high groundwater and low infiltration rates per the soils analysis found in Appendix B.
2. Bioretention is infeasible due to high groundwater and low infiltration rates per the soils analysis found in Appendix B.
3. BMP T5.10B: Downspout Dispersion is feasible; a dispersion trench and splashblocks will be used for roof runoff.

<u>Other Hard Surfaces:</u>

1. BMP T5.30: Full Dispersion – infeasible due to lace of native vegetation on the site.
2. BMP T5.15: Permeable pavement is infeasible due to high groundwater and low infiltration rates per the soils analysis found in Appendix B.
3. Bioretention is infeasible due to high groundwater and low infiltration rates per the soils analysis found in Appendix B.
4. BMP T5.12: Sheet Flow Dispersion is feasible and will be used for driveway runoff.

Minimum Requirement #6: Runoff Treatment

The project includes 5,661 square feet of driveway of which 4,873 sf is new and 788 sf is replaced. Since the total new pollution generating impervious surface (PGIS) is greater than 5,000 sf, treatment of runoff is required. As a single-family residence development, basic treatment is required. A basic filter strip will be used to provide treatment of runoff from the driveway.

Minimum Requirement #7: Flow Control

The total new plus replaced hard surface area for the project is 9,935 square feet. There are no native vegetation areas being converted. The resulting increase in peak flow for the 100-year event is less than 0.15 cfs, as determined in Section IV of this report. Since the effective impervious area for the project is less than 10,000 square feet, no native vegetation is being converted, and the increase in the 100-year runoff rate is less than 0.15 cfs, flow control is not required.

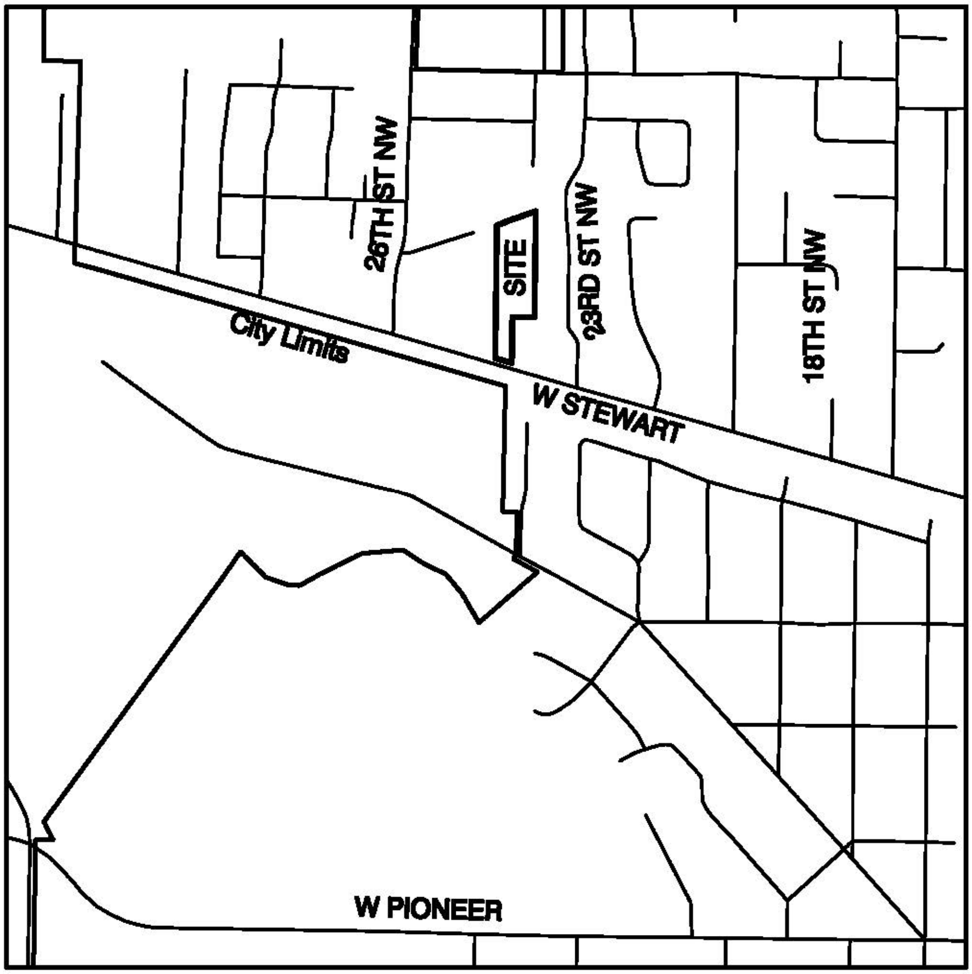
Minimum Requirement #8: Wetlands Protection

There are no known wetlands on or adjacent to the project. The proposed improvements will infiltrate runoff to the maximum extent feasible, and will not alter the natural drainage system, thus meeting this requirement.

Minimum Requirement #9: Operation and Maintenance

The stormwater facilities required for this project that require a maintenance plan are: vegetated filter strip, dispersion trench, and conveyance system. An O&M plan is included with this submittal as required for building permit approval to address this requirement.

Figure 1. Site Location:



Section II - Existing Conditions Summary

Topography:

In existing conditions project area is generally flat. The vicinity generally slopes down to the west, with an average slope of less than 1%.

Ground Cover:

An existing driveway runs along the majority of the proposed driveway route. The reminder of the site is primarily pasture with an existing greenhouse and shed which will be removed/demolished.

Drainage:

Drainage at the project site generally sheet flows to the west per the topography described above.

Soils:

The NRCS Soil Survey of Pierce County indicates the soils along the area of driveway construction are Briscot loam (6A) and in the area of proposed house and raingarden are Sultan silt loam. Briscot soils are classified as hydrologic group D, Sultan soils are classified as hydrologic group C. A geotechnical report was prepared for the site by Migizi Group and can be found in Appendix B. The soils were found to be silty fine sand to sandy silt over mottled silt. Groundwater, or indicators thereof, were found at a depth of 2.5 to 3.5 feet. Groundwater monitoring and infiltration testing was then conducted with results presented in a report by Migizi dated 9/28/21, also in Appendix B. This report found groundwater as shallow as the surface and no measured infiltration occurred. Therefore, infiltration of runoff on the site is deemed infeasible.

Floodplain

The project site is not located within a flood zone per FEMA data. Per Pierce County's flood studies, there is an AH zone approximately 1,500 feet to the northeast with a static flood elevation of 30. The lowest grade in the vicinity of the proposed improvements is 33, well above the closest flood zone.

Section III – Off-Site Analysis

Upstream

Based on the topography of the area, the only upstream area tributary to the site is the approximately 30 feet of back yard areas along the east property line.

Downstream

Any runoff from the site will travel as sheet flow to the west across the west property line and continue as sheet flow for approximately 520 feet across pasture to 26th St NW. There is no defined drainage course at this location, but drainage will run along the grass shoulder or pavement edge t the north for about 100 feet before crossing 10th Ave Ct NW in a 12-inch culvert that discharges into a roadside ditch continuing north. This ditch flows north with a 12-inch culvert driveway crossing at one point, for approximately 525 feet before entering a 12-inch culvert with unknown discharge location. GIS mapping shows this culvert as about 108 feet long. There is an approximately 160 foot gap before another existing closed conveyance system starts, flowing north.

Problems

There are no known drainage problems along this downstream route.

Section IV – Permanent Stormwater Control Plan

Existing Site Hydrology

In existing conditions, any runoff sheet flows offsite to the west as described above. For the hydrologic analysis, the drainage area is the area within grading limits: 20,852 sf and is delineated for existing land cover as follows:

EXISTING	sf	acre
SAT, Pasture, Flat	20064	0.4606
Driveway, Flat	788	0.0181
Total	20852	0.4787

For the WWHM analysis, 15 minute time steps are use and the site is within the 42-inch, east rainfall zone. The basin is connected to POC 1 for flow comparison. A second basin is connected to POC 2 in order to obtain correct treatment flow analysis in developed conditions. This basin is irrelevant in the pre-developed scenario. The resulting peak runoff rates are:

```
 Flow Frequency
Flow(cfs)  0501 15m
2 Year   =    0.0134
5 Year   =    0.0282
10 Year  =    0.0430
25 Year  =    0.0690
50 Year  =    0.0951
100 Year =    0.1281
```

See Appendix A for full WWHM analysis.

Developed Site Hydrology

In developed conditions, a portion of the roof will be routed to a dispersion trench with 25 feet of flowpath, so could be modeled as 50/50 roof/lawn, but, to simplify the analysis, the full roof is modeled as roof. The resulting drainage basin for flow comparison, POC 1 is:

DEVELOPED	sf	acre
SAT, Lawn, Flat	10917	0.2506
Driveway, Flat	5661	0.1300
Roof	4274	0.0981
Total Impervious	9935	0.2281
Total Area	20852	0.4787

The resulting peak runoff rates are:

```
 Flow Frequency
Flow(cfs)  0801 15m
2 Year   =    0.0879
5 Year   =    0.1183
10 Year  =    0.1400
25 Year  =    0.1693
50 Year  =    0.1925
100 Year =    0.2169
```

The increase in peak flow for developed conditions is 0.0888 cfs. Since the increase is less than 0.15 cfs, MR #7 does not apply.

Stormwater Management

To address MR #5, On-Site Stormwater Management BMP's in the form of dispersion trench, splashblocks, and vegetated filter strip will be used.

Include the total roof area on this page in square feet. [drainage report, pg 11]

For the dispersion trench, 3,097 sf of roof area will be routed to it. The required trench length is 10 feet per 700 sf of roof. Therefore, the required trench length is 45 feet. The dispersion trench is setback 25 feet from the property line to provide a minimum 25 foot vegetated flowpath.

For the splashblocks, a maximum of 700 sf of roof area is allowed per splashblocks. The building location is such that the 50 foot vegetated flowpath requirement is easily met onsite.

For the vegetated filter strip, 10 feet of width is required for up to 20 feet of driveway width, with an additional 10 feet of width required for each additional 20 feet of driveway or fraction thereof. The vegetated filter strip width varies, per the plans, based on the tributary driveway width, ranging from 10 to 35 feet wide.

Provide the calculation and parameters for the filter strip sizing such as manning's equation, flow velocity and residence time equations. [drainage report, pg 12]

Runoff Treatment – Basic Filter Strip

To provide treatment of runoff from the driveway, a basic filter strip will be used. This will be the same area as the vegetated filter strip required to meet MR #5. The filter strip is sized for the driveway flow tributary to it. POC 2 is used within the WWHM analysis to size the filter strip. The basin in developed conditions is the 5,661 sf of new plus replaced driveway. The resulting online treatment flow rate is 0.0203 cfs and 100-year peak flow rates is 0.1179 cfs. This flow is distributed across 125 feet of driveway length. The slope of the filter strip is assumed to be 0.5%. Due to the shallow depth of flow relative to vegetation depth, a Manning's n value of 0.35 is used. Manning's Equation shows that the resulting flow depth is 0.17 inches (maximum of 1 allowed), and flow velocity is 0.017 fps. To meet the required 9 minutes of residence time, the required filter strip length is 9.2 feet. This is less than the vegetated filter strip width provided to meet dispersion requirements.

For the 100-year peak flow of 0.1175 cfs, the resulting depth of flow is 0.34 inches, so the 0.35 n value is used for stability analysis as well. The resulting velocity is 0.0331 fps, well below allowable velocity for grass protection.

Therefore, the vegetated flowpath provided to meet MR #5 also meets treatment requirements of a basic filter strip.

Conveyance System Analysis and Design

The only conveyance system for this project is for the 3,097 sf of roof area routed to the dispersion trench. No conveyance system analysis is necessary for this minimal area.

Section V – Construction Stormwater Pollution Prevention Plan

Following are the 12 elements of the SWPPP. Where specific BMP's are prescribed, they are explained as shown on the engineering drawings for the project. Alternate BMP's may be acceptable in lieu of, or as a supplement to the prescribed BMP's. Where identified, alternate BMP's are listed and requirements included. Note that the project is of limited scope and is expected to be completed in one week.

Element #1 – Mark Clearing Limits

The site is already cleared for agricultural and residential use. Therefore no BMPs are necessary for marking of clearing limits.

Element #2 – Establish Construction Access

Construction access or activities occurring on unpaved areas shall be minimized, yet where necessary, access points shall be stabilized to minimize the tracking of sediment onto public roads, and wheel washing, street sweeping, and street cleaning shall be employed to prevent sediment from entering state waters. All wash wastewater shall be controlled on site. The existing paved driveway approach and gravel driveway are adequate to meet construction access requirements. If, during construction, it is determined that additional measures are necessary, the following alternative BMP should be used:

- Stabilized Construction Entrance (C105)

Element #3 – Control Flow Rates

Due to the limited scope of work, no BMPs to control flow rates are required.

Element #4 – Install Sediment Controls

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

- Silt Fence (C233)

Element #5 – Stabilize Soils

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

- Temporary and Permanent Seeding (C120)
- Mulching (C121)

No soils shall remain exposed and unworked for more than 7 days during the dry season (May 1 to September 30) and 2 days during the wet season (October 1 to April 30). Regardless of the time of year, all soils shall be stabilized at the end of the shift before a holiday or weekend if needed based on weather forecasts.

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

Alternate BMP's:

- Plastic Covering (C123)
- Sodding (C124)
- Topsoiling (C125)

Element #6 – Protect Slopes

The slopes within the clearing limits/area to be disturbed are nearly flat. Additional protection is not needed.

Element #7 – Protect Drain Inlets

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

- Storm Drain Inlet Protection (C220)

Element #8 – Stabilize Channels and Outlets

Where site runoff is to be conveyed in channels, or discharged to a stream or some other natural drainage point, efforts will be taken to prevent downstream erosion. No surface channels or outlets are proposed for this project.

Element #9 – Control Pollutants

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

Vehicles, construction equipment, and/or petroleum product storage/dispensing:

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

Specific construction related BMP's to be used include:

- Material Delivery, Storage and Containment (C153)

Element #10 – Control Dewatering

Due to the shallow depth of groundwater, dewatering may be required for the storm pipe installation. The water from all de-watering systems for trenches, vaults and foundations may be disposed of in one of the following manners:

(1) Foundation, vault, and trench de-watering water which have similar characteristics to stormwater runoff at the site shall be discharged into a controlled conveyance system prior to discharge to a sediment trap or sediment pond.

(2) Clean, non-turbid de-watering water, such as well-point ground water, can be discharged to systems tributary to or directly into surface waters of the state, provided the de-watering flow does not cause erosion or flooding of receiving waters. Clean de-watering water should not be routed through stormwater sediment ponds. Other disposal options for clean, non-turbid de-watering water may include:

(a) Infiltration;

(b) Transportation off-site in a vehicle (such as a vacuum flush truck) for legal disposal in a manner that does not pollute state waters;

(c) On-site chemical treatment or other suitable treatment technologies approved by the department and Washington State Department of Ecology;

(d) Sanitary sewer discharge with local sewer district approval, if there is no other option; and

(e) Use of a sedimentation bag with outfall to a ditch or swale for small volumes of localized de-watering water.

Element #11 – Maintain BMPs

All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. Maintenance and repair shall be conducted in accordance with each particular BMP's specifications. Visual monitoring of the BMPs will be conducted at least once every calendar week and within 24 hours of any rainfall event (typically around 0.5" in 24-hour period) that causes a discharge from the site. If the site becomes inactive, and is temporarily stabilized, the inspection frequency may be reduced to once every month, during the dry season

All temporary erosion and sediment control BMPs shall be removed within 30 days after the final site stabilization is achieved or after the temporary BMPs are no longer needed. The need for TESC measures continuance or removal shall be determined by the designated site CESC lead person with concurrence of the City inspector. Trapped sediment shall be removed or stabilized on site. Disturbed soil resulting from removal of BMPs or vegetation shall be permanently stabilized.

Element #12 – Manage the Project

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

- Design the project to fit the existing topography, soils, and drainage patterns.
- Emphasize erosion control rather than sediment control.
- Minimize the extent and duration of the area exposed.
- Keep runoff velocities low.
- Retain sediment on site.
- Thoroughly monitor site and maintain all ESC measures. A Certified Erosion and Sedimentation Control Lead (CESCL) person shall be assigned to the project and will file regular and special inspection reports with the City.
- Schedule major earthwork during the dry season.

In addition, project management will incorporate the key components listed below:
As this project site is located west of the Cascade Mountain Crest, the project will be managed according to the following key project components:

Phasing of Construction

- The construction project is being phased to the extent practicable in order to prevent soil erosion, and, to the maximum extent possible, the transport of sediment from the site during construction.
- Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities during each phase of construction, per the Scheduling BMP (C 162).

Seasonal Work Limitations

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

Coordination with Utilities and Other Jurisdictions

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

Inspection and Monitoring

- All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections shall be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. This person has the necessary skills to:
  - Assess the site conditions and construction activities that could impact the quality of stormwater, and
  - Assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.
- A Certified Erosion and Sediment Control Lead shall be on-site or on-call at all times.
- Whenever inspection and/or monitoring reveals that the BMPs identified in this SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMPs or design changes shall be implemented as soon as possible.

Maintaining an Updated Construction SWPPP

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

Specific management related BMP’s to be used include:

- Certified Erosion and Sediment Control Lead (C160)
- Scheduling (C162)

Section VI – Special Reports and Studies

There are no special reports or studies required for the project.

A Geotechnical Report has been prepared and can be found in Appendix B.

Section VII – Other Permits

A building permit will be required for construction of the residence.

A septic permit from TPCHD will be required.

Section VIII – Operation and Maintenance Manual

An Operations and Maintenance Manual is required for the dispersion trench, vegetated flowpath, and conveyance system. The O&M Manual has been prepared as a separate document.

Section IX – Bond Quantities Worksheet

Any required bond amounts will be calculated when required for permit issuance.

APPENDIX A

WWHM Analysis

pel what this WWHM report is representing. [drainage report, pg 21]

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	Farris SP Lot 2
Site Name:	Farris SP Lot 2
Site Address:	
City:	
Report Date:	12/18/2022
Gage:	42 IN EAST
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year

Landuse Basin Data
Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SAT, Pasture, Flat	0.4606
Pervious Total	0.4606
Impervious Land Use	acre
DRIVEWAYS FLAT	0.0181
Impervious Total	0.0181
Basin Total	0.4787

Element Flows To:

Surface	Interflow	Groundwater

Basin 2

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SAT, Pasture, Flat	0.13
Pervious Total	0.13
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.13

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SAT, Lawn, Flat	0.2506
Pervious Total	0.2506
Impervious Land Use	acre
ROOF TOPS FLAT	0.0981
DRIVEWAYS FLAT	0.13
Impervious Total	0.2281
Basin Total	0.4787

Element Flows To:

Surface	Interflow	Groundwater

Basin 2

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
DRIVEWAYS FLAT	0.13
Impervious Total	0.13
Basin Total	0.13

Element Flows To:

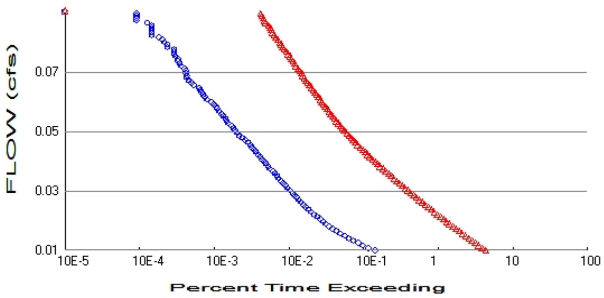
Surface	Interflow	Groundwater

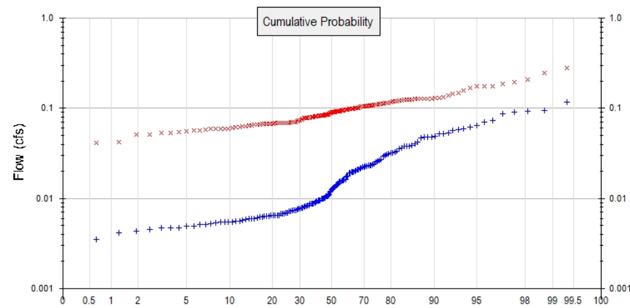
Routing Elements
Predeveloped Routing

Mitigated Routing

Analysis Results

POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.4606
Total Impervious Area: 0.0181

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.2506
Total Impervious Area: 0.2281

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.01342
5 year	0.028202
10 year	0.042959
25 year	0.069021
50 year	0.095092
100 year	0.128082

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.08787
5 year	0.118303
10 year	0.140019
25 year	0.169296
50 year	0.192474
100 year	0.216853

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	0.023	0.099
1903	0.009	0.109
1904	0.010	0.124
1905	0.004	0.056
1906	0.005	0.061
1907	0.009	0.083
1908	0.008	0.069
1909	0.010	0.084
1910	0.058	0.113
1911	0.017	0.091

1912	0.118	0.209
1913	0.033	0.067
1914	0.022	0.278
1915	0.008	0.059
1916	0.011	0.105
1917	0.004	0.043
1918	0.021	0.084
1919	0.005	0.055
1920	0.009	0.071
1921	0.011	0.069
1922	0.015	0.097
1923	0.026	0.080
1924	0.010	0.120
1925	0.004	0.051
1926	0.008	0.098
1927	0.012	0.084
1928	0.006	0.062
1929	0.047	0.119
1930	0.018	0.123
1931	0.011	0.064
1932	0.008	0.066
1933	0.020	0.065
1934	0.092	0.129
1935	0.014	0.057
1936	0.020	0.078
1937	0.016	0.105
1938	0.019	0.057
1939	0.005	0.068
1940	0.010	0.126
1941	0.010	0.127
1942	0.009	0.093
1943	0.007	0.092
1944	0.020	0.133
1945	0.011	0.100
1946	0.013	0.095
1947	0.005	0.061
1948	0.007	0.084
1949	0.022	0.129
1950	0.006	0.075
1951	0.013	0.112
1952	0.057	0.168
1953	0.092	0.127
1954	0.006	0.069
1955	0.005	0.065
1956	0.005	0.059
1957	0.016	0.068
1958	0.095	0.128
1959	0.053	0.114
1960	0.007	0.068
1961	0.029	0.189
1962	0.009	0.081
1963	0.005	0.060
1964	0.016	0.177
1965	0.065	0.108
1966	0.005	0.066
1967	0.007	0.093
1968	0.014	0.077
1969	0.007	0.070

1970	0.038	0.096
1971	0.048	0.105
1972	0.031	0.247
1973	0.048	0.149
1974	0.020	0.108
1975	0.013	0.129
1976	0.038	0.118
1977	0.006	0.051
1978	0.062	0.124
1979	0.008	0.091
1980	0.020	0.089
1981	0.014	0.086
1982	0.005	0.068
1983	0.023	0.092
1984	0.007	0.092
1985	0.008	0.105
1986	0.006	0.054
1987	0.009	0.095
1988	0.019	0.059
1989	0.006	0.060
1990	0.009	0.071
1991	0.025	0.097
1992	0.032	0.097
1993	0.032	0.109
1994	0.038	0.098
1995	0.005	0.058
1996	0.049	0.099
1997	0.015	0.069
1998	0.023	0.083
1999	0.007	0.092
2000	0.006	0.078
2001	0.005	0.066
2002	0.023	0.121
2003	0.006	0.067
2004	0.040	0.100
2005	0.074	0.197
2006	0.022	0.090
2007	0.008	0.101
2008	0.013	0.086
2009	0.006	0.063
2010	0.007	0.081
2011	0.006	0.080
2012	0.006	0.079
2013	0.006	0.074
2014	0.006	0.074
2015	0.021	0.131
2016	0.006	0.071
2017	0.038	0.122
2018	0.087	0.113
2019	0.042	0.110
2020	0.016	0.093
2021	0.033	0.089
2022	0.010	0.126
2023	0.024	0.158
2024	0.059	0.174
2025	0.010	0.082
2026	0.036	0.106
2027	0.008	0.099

2028	0.003	0.040
2029	0.023	0.079
2030	0.054	0.139
2031	0.004	0.041
2032	0.007	0.069
2033	0.007	0.086
2034	0.009	0.067
2035	0.008	0.086
2036	0.030	0.070
2037	0.007	0.091
2038	0.052	0.114
2039	0.014	0.175
2040	0.005	0.068
2041	0.007	0.086
2042	0.027	0.099
2043	0.036	0.112
2044	0.048	0.095
2045	0.031	0.080
2046	0.024	0.078
2047	0.007	0.083
2048	0.005	0.068
2049	0.016	0.102
2050	0.006	0.078
2051	0.022	0.106
2052	0.011	0.081
2053	0.018	0.068
2054	0.026	0.146
2055	0.007	0.081
2056	0.009	0.110
2057	0.012	0.054
2058	0.013	0.103
2059	0.070	0.126

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.1177	0.2776
2	0.0954	0.2473
3	0.0918	0.2092
4	0.0916	0.1971
5	0.0869	0.1890
6	0.0737	0.1772
7	0.0703	0.1752
8	0.0649	0.1742
9	0.0625	0.1683
10	0.0592	0.1576
11	0.0577	0.1485
12	0.0573	0.1455
13	0.0537	0.1386
14	0.0525	0.1330
15	0.0524	0.1305
16	0.0492	0.1290
17	0.0477	0.1289
18	0.0476	0.1287
19	0.0475	0.1276
20	0.0473	0.1273
21	0.0420	0.1267
22	0.0403	0.1263

23	0.0384	0.1261
24	0.0380	0.1256
25	0.0378	0.1243
26	0.0375	0.1236
27	0.0363	0.1235
28	0.0359	0.1221
29	0.0331	0.1209
30	0.0328	0.1196
31	0.0322	0.1192
32	0.0319	0.1183
33	0.0315	0.1144
34	0.0310	0.1140
35	0.0302	0.1135
36	0.0291	0.1131
37	0.0272	0.1116
38	0.0264	0.1116
39	0.0260	0.1099
40	0.0251	0.1095
41	0.0242	0.1092
42	0.0237	0.1087
43	0.0233	0.1082
44	0.0230	0.1080
45	0.0230	0.1065
46	0.0227	0.1063
47	0.0226	0.1055
48	0.0221	0.1051
49	0.0221	0.1049
50	0.0218	0.1047
51	0.0215	0.1035
52	0.0211	0.1017
53	0.0207	0.1010
54	0.0202	0.1003
55	0.0202	0.1002
56	0.0198	0.0994
57	0.0198	0.0992
58	0.0198	0.0991
59	0.0193	0.0989
60	0.0190	0.0981
61	0.0177	0.0976
62	0.0177	0.0974
63	0.0173	0.0970
64	0.0162	0.0968
65	0.0162	0.0959
66	0.0160	0.0951
67	0.0158	0.0950
68	0.0156	0.0948
69	0.0154	0.0931
70	0.0152	0.0927
71	0.0144	0.0926
72	0.0142	0.0920
73	0.0141	0.0920
74	0.0139	0.0917
75	0.0135	0.0916
76	0.0132	0.0914
77	0.0130	0.0909
78	0.0127	0.0907
79	0.0125	0.0902
80	0.0119	0.0892

81	0.0117	0.0889
82	0.0110	0.0861
83	0.0108	0.0859
84	0.0107	0.0859
85	0.0107	0.0858
86	0.0106	0.0857
87	0.0101	0.0844
88	0.0101	0.0841
89	0.0100	0.0839
90	0.0100	0.0838
91	0.0099	0.0833
92	0.0096	0.0831
93	0.0095	0.0826
94	0.0094	0.0823
95	0.0094	0.0814
96	0.0093	0.0813
97	0.0090	0.0811
98	0.0089	0.0808
99	0.0088	0.0802
100	0.0087	0.0797
101	0.0087	0.0796
102	0.0087	0.0794
103	0.0084	0.0789
104	0.0083	0.0785
105	0.0082	0.0784
106	0.0082	0.0783
107	0.0081	0.0780
108	0.0079	0.0772
109	0.0078	0.0753
110	0.0077	0.0741
111	0.0077	0.0739
112	0.0074	0.0715
113	0.0074	0.0709
114	0.0073	0.0708
115	0.0073	0.0703
116	0.0072	0.0699
117	0.0072	0.0694
118	0.0069	0.0693
119	0.0068	0.0693
120	0.0068	0.0692
121	0.0068	0.0691
122	0.0067	0.0685
123	0.0065	0.0684
124	0.0065	0.0683
125	0.0065	0.0681
126	0.0065	0.0679
127	0.0064	0.0675
128	0.0064	0.0675
129	0.0064	0.0674
130	0.0063	0.0669
131	0.0063	0.0667
132	0.0062	0.0662
133	0.0060	0.0658
134	0.0060	0.0655
135	0.0059	0.0651
136	0.0059	0.0646
137	0.0059	0.0635
138	0.0057	0.0632

139	0.0056	0.0619
140	0.0056	0.0613
141	0.0054	0.0610
142	0.0054	0.0597
143	0.0054	0.0597
144	0.0054	0.0590
145	0.0054	0.0588
146	0.0053	0.0587
147	0.0052	0.0581
148	0.0051	0.0573
149	0.0049	0.0571
150	0.0049	0.0559
151	0.0047	0.0547
152	0.0047	0.0537
153	0.0047	0.0536
154	0.0045	0.0512
155	0.0043	0.0510
156	0.0042	0.0426
157	0.0035	0.0409
158	0.0032	0.0398

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0067	7856	239275	3045	Fail
0.0076	6460	214290	3317	Fail
0.0085	5445	192628	3537	Fail
0.0094	4646	173626	3737	Fail
0.0103	4017	156673	3900	Fail
0.0112	3486	141659	4063	Fail
0.0121	3075	128197	4169	Fail
0.0130	2702	116120	4297	Fail
0.0139	2385	105261	4413	Fail
0.0147	2132	95511	4479	Fail
0.0156	1929	86647	4491	Fail
0.0165	1737	78614	4525	Fail
0.0174	1589	71522	4501	Fail
0.0183	1449	64985	4484	Fail
0.0192	1327	59168	4458	Fail
0.0201	1205	53772	4462	Fail
0.0210	1100	48908	4446	Fail
0.0219	1003	44631	4449	Fail
0.0228	926	40753	4400	Fail
0.0237	862	37168	4311	Fail
0.0246	813	33894	4169	Fail
0.0255	752	30930	4113	Fail
0.0264	703	28238	4016	Fail
0.0272	655	25789	3937	Fail
0.0281	620	23617	3809	Fail
0.0290	576	21695	3766	Fail
0.0299	534	19889	3724	Fail
0.0308	500	18182	3636	Fail
0.0317	467	16698	3575	Fail
0.0326	437	15302	3501	Fail
0.0335	401	14039	3500	Fail
0.0344	382	12914	3380	Fail
0.0353	359	11922	3320	Fail
0.0362	336	10897	3243	Fail
0.0371	309	10050	3252	Fail
0.0380	290	9235	3184	Fail
0.0388	270	8554	3168	Fail
0.0397	257	7911	3078	Fail
0.0406	243	7285	2997	Fail
0.0415	227	6764	2979	Fail
0.0424	214	6288	2938	Fail
0.0433	199	5839	2934	Fail
0.0442	188	5390	2867	Fail
0.0451	178	4981	2798	Fail
0.0460	169	4604	2724	Fail
0.0469	157	4283	2728	Fail
0.0478	144	4019	2790	Fail
0.0487	131	3773	2880	Fail
0.0496	118	3526	2988	Fail
0.0505	112	3286	2933	Fail
0.0513	104	3059	2941	Fail
0.0522	100	2869	2869	Fail
0.0531	94	2712	2885	Fail
0.0540	86	2548	2962	Fail

0.0549	81	2392	2953	Fail
0.0558	78	2251	2885	Fail
0.0567	73	2134	2923	Fail
0.0576	69	2013	2917	Fail
0.0585	65	1901	2924	Fail
0.0594	60	1808	3013	Fail
0.0603	58	1696	2924	Fail
0.0612	55	1605	2918	Fail
0.0621	51	1530	3000	Fail
0.0630	44	1454	3304	Fail
0.0638	41	1379	3363	Fail
0.0647	39	1298	3328	Fail
0.0656	37	1237	3343	Fail
0.0665	36	1173	3258	Fail
0.0674	35	1111	3174	Fail
0.0683	29	1040	3586	Fail
0.0692	27	987	3655	Fail
0.0701	25	935	3740	Fail
0.0710	24	886	3691	Fail
0.0719	24	851	3545	Fail
0.0728	23	817	3552	Fail
0.0737	23	774	3365	Fail
0.0746	22	731	3322	Fail
0.0755	20	693	3465	Fail
0.0763	19	660	3473	Fail
0.0772	18	626	3477	Fail
0.0781	18	596	3311	Fail
0.0790	17	571	3358	Fail
0.0799	16	542	3387	Fail
0.0808	16	512	3200	Fail
0.0817	16	477	2981	Fail
0.0826	13	455	3500	Fail
0.0835	13	435	3346	Fail
0.0844	12	415	3458	Fail
0.0853	11	392	3563	Fail
0.0862	10	364	3640	Fail
0.0871	8	349	4362	Fail
0.0880	8	332	4150	Fail
0.0888	8	324	4050	Fail
0.0897	8	312	3900	Fail
0.0906	8	294	3675	Fail
0.0915	7	272	3885	Fail
0.0924	5	260	5200	Fail
0.0933	5	251	5020	Fail
0.0942	5	240	4800	Fail
0.0951	5	231	4620	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

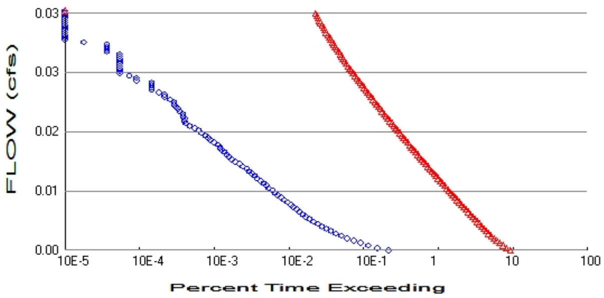
Water Quality BMP Flow and Volume for POC #1

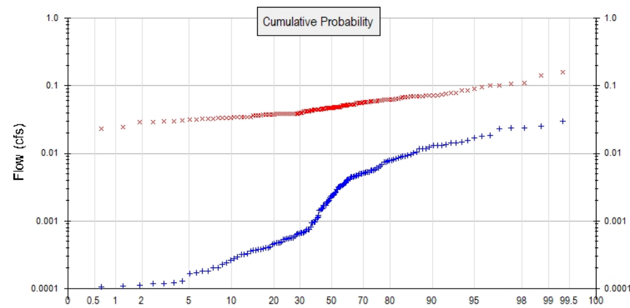
On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

LID Report

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

POC 2





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 0.13
Total Impervious Area: 0

Mitigated Landuse Totals for POC #2
Total Pervious Area: 0
Total Impervious Area: 0.13

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.001959
5 year	0.006601
10 year	0.012117
25 year	0.02269
50 year	0.033652
100 year	0.04762

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.047609
5 year	0.063743
10 year	0.075447
25 year	0.091439
50 year	0.104256
100 year	0.117872

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1902	0.006	0.056
1903	0.000	0.062
1904	0.001	0.071
1905	0.000	0.032
1906	0.000	0.035
1907	0.001	0.047
1908	0.002	0.039
1909	0.001	0.048
1910	0.015	0.046
1911	0.004	0.052
1912	0.030	0.085

1913	0.008	0.037
1914	0.000	0.158
1915	0.001	0.032
1916	0.002	0.060
1917	0.000	0.024
1918	0.005	0.048
1919	0.001	0.030
1920	0.002	0.039
1921	0.002	0.034
1922	0.003	0.052
1923	0.006	0.036
1924	0.000	0.068
1925	0.000	0.029
1926	0.002	0.056
1927	0.003	0.047
1928	0.001	0.034
1929	0.012	0.068
1930	0.004	0.070
1931	0.002	0.035
1932	0.001	0.037
1933	0.005	0.037
1934	0.024	0.060
1935	0.003	0.033
1936	0.005	0.045
1937	0.004	0.060
1938	0.004	0.033
1939	0.000	0.039
1940	0.002	0.072
1941	0.001	0.072
1942	0.002	0.053
1943	0.000	0.052
1944	0.005	0.076
1945	0.002	0.057
1946	0.002	0.045
1947	0.000	0.035
1948	0.001	0.048
1949	0.005	0.074
1950	0.000	0.043
1951	0.003	0.064
1952	0.014	0.070
1953	0.024	0.065
1954	0.001	0.039
1955	0.000	0.037
1956	0.000	0.034
1957	0.004	0.038
1958	0.025	0.048
1959	0.013	0.048
1960	0.001	0.038
1961	0.007	0.108
1962	0.002	0.046
1963	0.000	0.034
1964	0.001	0.100
1965	0.017	0.045
1966	0.000	0.037
1967	0.000	0.053
1968	0.003	0.044
1969	0.001	0.040
1970	0.009	0.045

1971	0.012	0.044
1972	0.008	0.141
1973	0.013	0.085
1974	0.004	0.062
1975	0.002	0.063
1976	0.010	0.067
1977	0.001	0.029
1978	0.016	0.049
1979	0.000	0.052
1980	0.005	0.051
1981	0.003	0.049
1982	0.001	0.039
1983	0.006	0.052
1984	0.001	0.052
1985	0.001	0.059
1986	0.001	0.030
1987	0.002	0.054
1988	0.004	0.032
1989	0.001	0.034
1990	0.001	0.039
1991	0.006	0.055
1992	0.008	0.055
1993	0.008	0.062
1994	0.009	0.042
1995	0.000	0.033
1996	0.013	0.044
1997	0.003	0.039
1998	0.005	0.047
1999	0.000	0.052
2000	0.001	0.045
2001	0.000	0.038
2002	0.005	0.066
2003	0.001	0.038
2004	0.010	0.057
2005	0.018	0.112
2006	0.005	0.051
2007	0.001	0.058
2008	0.002	0.048
2009	0.001	0.036
2010	0.000	0.046
2011	0.000	0.046
2012	0.000	0.045
2013	0.001	0.042
2014	0.000	0.042
2015	0.005	0.070
2016	0.000	0.040
2017	0.009	0.070
2018	0.023	0.041
2019	0.010	0.062
2020	0.003	0.051
2021	0.008	0.043
2022	0.000	0.072
2023	0.006	0.090
2024	0.014	0.095
2025	0.002	0.047
2026	0.009	0.061
2027	0.001	0.057
2028	0.000	0.023

2029	0.005	0.036
2030	0.013	0.078
2031	0.000	0.023
2032	0.000	0.039
2033	0.000	0.049
2034	0.001	0.038
2035	0.001	0.047
2036	0.007	0.039
2037	0.000	0.052
2038	0.013	0.049
2039	0.000	0.100
2040	0.000	0.039
2041	0.000	0.049
2042	0.006	0.056
2043	0.009	0.063
2044	0.012	0.043
2045	0.008	0.035
2046	0.006	0.038
2047	0.001	0.047
2048	0.001	0.039
2049	0.004	0.058
2050	0.000	0.043
2051	0.005	0.061
2052	0.002	0.046
2053	0.004	0.039
2054	0.004	0.078
2055	0.000	0.046
2056	0.000	0.062
2057	0.003	0.031
2058	0.003	0.059
2059	0.019	0.072

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	0.0299	0.1582
2	0.0252	0.1409
3	0.0241	0.1115
4	0.0241	0.1077
5	0.0230	0.0998
6	0.0185	0.0998
7	0.0182	0.0952
8	0.0171	0.0898
9	0.0157	0.0851
10	0.0146	0.0846
11	0.0143	0.0782
12	0.0141	0.0776
13	0.0134	0.0758
14	0.0132	0.0735
15	0.0130	0.0722
16	0.0129	0.0720
17	0.0125	0.0718
18	0.0119	0.0716
19	0.0118	0.0705
20	0.0118	0.0704
21	0.0105	0.0704
22	0.0100	0.0704
23	0.0095	0.0695

24	0.0094	0.0681
25	0.0090	0.0679
26	0.0090	0.0672
27	0.0089	0.0657
28	0.0086	0.0650
29	0.0083	0.0636
30	0.0082	0.0629
31	0.0079	0.0626
32	0.0078	0.0624
33	0.0076	0.0622
34	0.0075	0.0619
35	0.0074	0.0618
36	0.0069	0.0615
37	0.0064	0.0606
38	0.0061	0.0606
39	0.0060	0.0598
40	0.0057	0.0597
41	0.0057	0.0596
42	0.0057	0.0593
43	0.0057	0.0590
44	0.0053	0.0579
45	0.0053	0.0575
46	0.0052	0.0571
47	0.0052	0.0571
48	0.0052	0.0567
49	0.0050	0.0564
50	0.0050	0.0564
51	0.0049	0.0556
52	0.0048	0.0553
53	0.0047	0.0551
54	0.0046	0.0542
55	0.0046	0.0530
56	0.0044	0.0527
57	0.0044	0.0525
58	0.0044	0.0524
59	0.0043	0.0524
60	0.0041	0.0523
61	0.0041	0.0522
62	0.0039	0.0519
63	0.0036	0.0517
64	0.0036	0.0516
65	0.0036	0.0514
66	0.0034	0.0508
67	0.0034	0.0507
68	0.0033	0.0491
69	0.0032	0.0490
70	0.0032	0.0490
71	0.0032	0.0490
72	0.0029	0.0485
73	0.0029	0.0481
74	0.0026	0.0480
75	0.0026	0.0479
76	0.0024	0.0478
77	0.0024	0.0476
78	0.0024	0.0476
79	0.0023	0.0475
80	0.0023	0.0474
81	0.0022	0.0473

82	0.0020	0.0471
83	0.0020	0.0470
84	0.0019	0.0469
85	0.0019	0.0464
86	0.0018	0.0463
87	0.0017	0.0460
88	0.0017	0.0459
89	0.0017	0.0457
90	0.0015	0.0456
91	0.0015	0.0453
92	0.0015	0.0449
93	0.0014	0.0448
94	0.0012	0.0447
95	0.0011	0.0446
96	0.0011	0.0445
97	0.0011	0.0440
98	0.0010	0.0440
99	0.0010	0.0438
100	0.0009	0.0430
101	0.0009	0.0429
102	0.0008	0.0428
103	0.0008	0.0425
104	0.0007	0.0422
105	0.0007	0.0421
106	0.0007	0.0421
107	0.0007	0.0415
108	0.0007	0.0403
109	0.0007	0.0398
110	0.0007	0.0394
111	0.0007	0.0394
112	0.0007	0.0391
113	0.0006	0.0391
114	0.0006	0.0390
115	0.0006	0.0390
116	0.0006	0.0389
117	0.0006	0.0388
118	0.0005	0.0387
119	0.0005	0.0387
120	0.0005	0.0386
121	0.0005	0.0385
122	0.0005	0.0385
123	0.0005	0.0385
124	0.0005	0.0385
125	0.0005	0.0384
126	0.0005	0.0380
127	0.0004	0.0377
128	0.0004	0.0375
129	0.0004	0.0375
130	0.0004	0.0372
131	0.0004	0.0371
132	0.0004	0.0368
133	0.0004	0.0365
134	0.0004	0.0365
135	0.0004	0.0360
136	0.0004	0.0349
137	0.0003	0.0348
138	0.0003	0.0347
139	0.0003	0.0346

140	0.0003	0.0341
141	0.0003	0.0340
142	0.0003	0.0339
143	0.0002	0.0338
144	0.0002	0.0336
145	0.0002	0.0331
146	0.0002	0.0327
147	0.0002	0.0325
148	0.0002	0.0323
149	0.0002	0.0318
150	0.0002	0.0315
151	0.0001	0.0306
152	0.0001	0.0299
153	0.0001	0.0299
154	0.0001	0.0292
155	0.0001	0.0289
156	0.0001	0.0243
157	0.0001	0.0233
158	0.0001	0.0226

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0010	11856	512179	4319	Fail
0.0013	8482	451238	5319	Fail
0.0016	6399	404702	6324	Fail
0.0020	5043	366531	7268	Fail
0.0023	4101	334620	8159	Fail
0.0026	3344	306920	9178	Fail
0.0030	2807	282931	10079	Fail
0.0033	2338	261934	11203	Fail
0.0036	2013	242876	12065	Fail
0.0039	1747	225758	12922	Fail
0.0043	1520	209913	13810	Fail
0.0046	1347	195509	14514	Fail
0.0049	1186	182434	15382	Fail
0.0053	1039	170357	16396	Fail
0.0056	931	159055	17084	Fail
0.0059	847	148529	17535	Fail
0.0063	768	138779	18070	Fail
0.0066	695	129693	18660	Fail
0.0069	630	121327	19258	Fail
0.0072	585	113405	19385	Fail
0.0076	530	106092	20017	Fail
0.0079	479	99278	20726	Fail
0.0082	432	93018	21531	Fail
0.0086	391	87090	22273	Fail
0.0089	357	81494	22827	Fail
0.0092	334	76287	22840	Fail
0.0096	299	71578	23939	Fail
0.0099	275	67146	24416	Fail
0.0102	254	63046	24821	Fail
0.0106	232	59057	25455	Fail
0.0109	207	55284	26707	Fail
0.0112	193	51844	26862	Fail
0.0115	176	48548	27584	Fail
0.0119	162	45573	28131	Fail
0.0122	150	42736	28490	Fail
0.0125	135	40116	29715	Fail
0.0129	120	37656	31379	Fail
0.0132	105	35340	33657	Fail
0.0135	94	33157	35273	Fail
0.0139	87	31163	35819	Fail
0.0142	81	29290	36160	Fail
0.0145	76	27462	36134	Fail
0.0148	69	25789	37375	Fail
0.0152	66	24232	36715	Fail
0.0155	62	22803	36779	Fail
0.0158	55	21457	39012	Fail
0.0162	49	20216	41257	Fail
0.0165	46	19013	41332	Fail
0.0168	42	17917	42659	Fail
0.0172	37	16903	45683	Fail
0.0175	34	15872	46682	Fail
0.0178	30	14958	49860	Fail
0.0181	26	14055	54057	Fail
0.0185	23	13219	57473	Fail

0.0188	22	12460	56636	Fail
0.0191	22	11745	53386	Fail
0.0195	21	11080	52761	Fail
0.0198	21	10454	49780	Fail
0.0201	19	9861	51900	Fail
0.0205	18	9318	51766	Fail
0.0208	17	8787	51688	Fail
0.0211	16	8299	51868	Fail
0.0214	16	7850	49062	Fail
0.0218	14	7390	52785	Fail
0.0221	12	6997	58308	Fail
0.0224	12	6615	55125	Fail
0.0228	10	6260	62600	Fail
0.0231	8	5911	73887	Fail
0.0234	8	5573	69662	Fail
0.0238	8	5266	65825	Fail
0.0241	8	5011	62637	Fail
0.0244	5	4760	95200	Fail
0.0247	5	4482	89640	Fail
0.0251	4	4230	105750	Fail
0.0254	3	3999	133300	Fail
0.0257	3	3810	127000	Fail
0.0261	3	3619	120633	Fail
0.0264	3	3420	114000	Fail
0.0267	3	3238	107933	Fail
0.0271	3	3096	103200	Fail
0.0274	3	2945	98166	Fail
0.0277	3	2813	93766	Fail
0.0280	3	2681	89366	Fail
0.0284	2	2567	128350	Fail
0.0287	2	2429	121450	Fail
0.0290	2	2318	115900	Fail
0.0294	2	2207	110350	Fail
0.0297	1	2104	210400	Fail
0.0300	0	2013	n/a	Fail
0.0304	0	1937	n/a	Fail
0.0307	0	1842	n/a	Fail
0.0310	0	1755	n/a	Fail
0.0313	0	1682	n/a	Fail
0.0317	0	1609	n/a	Fail
0.0320	0	1535	n/a	Fail
0.0323	0	1468	n/a	Fail
0.0327	0	1423	n/a	Fail
0.0330	0	1355	n/a	Fail
0.0333	0	1310	n/a	Fail
0.0337	0	1254	n/a	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume:	0.0144 acre-feet
On-line facility target flow:	0.0203 cfs.
Adjusted for 15 min:	0.0203 cfs.
Off-line facility target flow:	0.0118 cfs.
Adjusted for 15 min:	0.0118 cfs.

LID Report

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

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

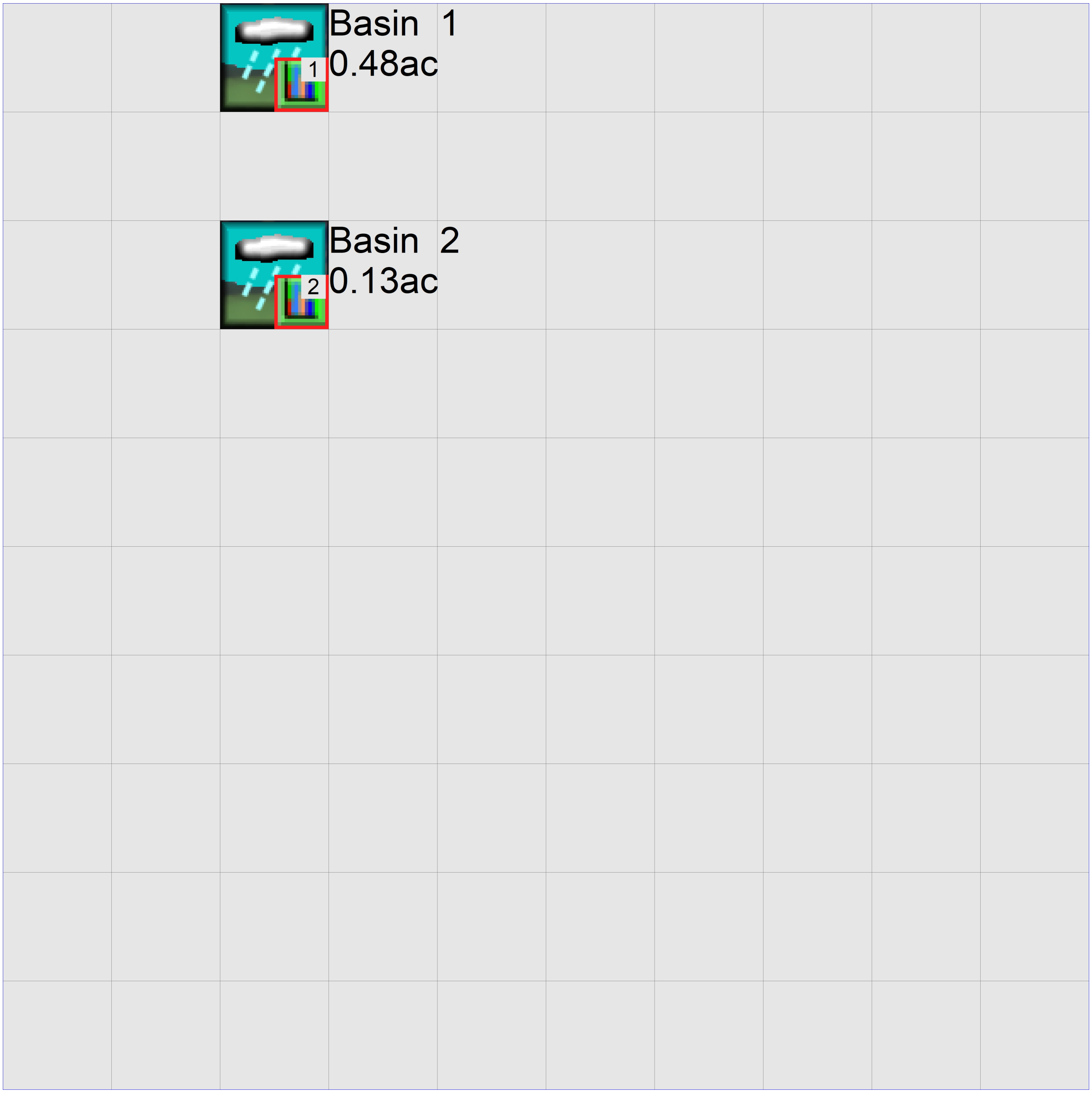
No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   Farris SP Lot 2.wdm
MESSU      25   PreFarris SP Lot 2.MES
           27   PreFarris SP Lot 2.L61
           28   PreFarris SP Lot 2.L62
           30   POCFarris SP Lot 21.dat
           31   POCFarris SP Lot 22.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      22
      IMPLND       5
      COPY       501
      COPY       502
      DISPLY       1
      DISPLY       2
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                    MAX                      1    2   30    9
    2        Basin  2                    MAX                      1    2   31    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1        1    1
  501        1    1
  502        1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   22     SAT, Pasture, Flat      1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   22         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY
```

```
  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   22         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   22         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   22              0         4       1.8       100     0.001       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   22              0         0        10         2         0         0       0.5
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                 ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   22           0.15         3       0.5         1       0.7       0.6
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   22              0         0         0         0       4.2         1         0
  END PWAT-STATE1

END PERLND

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

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    5         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    5         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    5         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    5            400      0.01       0.1       0.1
  END IWAT-PARM2
```

```
  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    5             0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    5             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  22                     0.4606     COPY   501     12
PERLND  22                     0.4606     COPY   501     13
IMPLND   5                     0.0181     COPY   501     15
Basin  2***
PERLND  22                       0.13     COPY   502     12
PERLND  22                       0.13     COPY   502     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1


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

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
  END GEN-INFO
  *** Section RCHRES***

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

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

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

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
```

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    502 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>      <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>               <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY          INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY          INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY          INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Farris SP Lot 2.wdm
MESSU      25   MitFarris SP Lot 2.MES
           27   MitFarris SP Lot 2.L61
           28   MitFarris SP Lot 2.L62
           30   POCFarris SP Lot 21.dat
           31   POCFarris SP Lot 22.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      25
      IMPLND       4
      IMPLND       5
      COPY       501
      COPY       502
      DISPLY       1
      DISPLY       2
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                    MAX                     1    2   30    9
    2        Basin  2                    MAX                     1    2   31    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  502         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out             ***
   25      SAT, Lawn, Flat         1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   25         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY
```

```
  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   25         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   25         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   25              0         4         1       100     0.001       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   25              0         0        10         2         0         0      0.35
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                   ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   25            0.1         3       0.5         1       0.7       0.4
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   25              0         0         0         0       4.2         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name-------->   Unit-systems   Printer ***
    # -  #                      User  t-series Engl Metr ***
                                       in  out           ***
    4      ROOF TOPS/FLAT         1    1    1   27    0
    5      DRIVEWAYS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    4         0    0    1    0    0    0
    5         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    4         0    0    4    0    0    0    1    9
    5         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    4         0    0    0    0    0
    5         0    0    0    0    0
  END IWAT-PARM1
```

```
  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    4            400      0.01       0.1       0.1
    5            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    4             0         0
    5             0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    4             0         0
    5             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                    <--Area-->     <-Target->   MBLK   ***
<Name>   #                    <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  25                        0.2506     COPY   501     12
PERLND  25                        0.2506     COPY   501     13
IMPLND   4                        0.0981     COPY   501     15
IMPLND   5                          0.13     COPY   501     15
Basin  2***
IMPLND   5                          0.13     COPY   502     15

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1


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

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                             in  out                         ***
  END GEN-INFO
  *** Section RCHRES***

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

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

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
```

```
          FG FG FG FG  possible  exit  *** possible  exit      possible  exit
           *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
COPY     2 OUTPUT MEAN   1 1     48.4      WDM    702 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    802 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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APPENDIX B

Geotechnical Reports

Geotechnical Engineering Report

P/N 0420203068

2401 West Stewart
Puyallup, Washington
Short Plat No. P-15-0024

April 21, 2016

prepared for:

Farris Vet Clinic
Attention: Richard Farris
2401 West Stewart
Puyallup, Washington 98371

prepared by:

Migizi Group, Inc.
PO Box 44840
Tacoma, Washington 98448
(253) 537-9400

MGI Project P475-T15

TABLE OF CONTENTS

Page No.

List of Tables

List of Figures

APPENDIX A

APPENDIX B

APPENDIX C

MIGIZI GROUP, INC.

PO Box 44840
Tacoma, Washington 98448

PHONE (253) 537-9400
FAX (253) 537-9401

April 21, 2016

Farris Vet Clinic
2401 West Stewart
Puyallup, WA 98371

Attention: Richard Farris

Subject: **Geotechnical Engineering Report**
Residential Development
2401 West Stewart
Puyallup, WA 98371
P/N 0420203068
Short Plat No. P-15-0024

MGI Project P475-T15

Dear Mr. Farris:

Migizi Group, Inc. (MGI) is pleased to submit this report describing the results of our geotechnical engineering evaluation of the proposed residential development in Puyallup, Washington.

This report has been prepared for the exclusive use of Farris Vet Clinic, and their consultants, for specific application to this project, in accordance with generally accepted geotechnical engineering practice.

1.0 SITE AND PROJECT DESCRIPTION

The project site consists of an irregularly shaped, 2.84 acre parcel located on the north side of West Stewart Street in Puyallup, Washington, as shown on the enclosed Topographic and Location Map (Figure 1). The parcel is orientated lengthwise from north to south, spanning approximately 692 feet along this orientation, and contains a maximum width of ± 185 feet. A short-plat of the property has recently taken place, dividing the parcel into two lots. Lot 1 is roughly rectangular shaped, and encompasses a 67 by 322 foot area towards the southwest corner of the project site. Farris Vet Clinic, associated parking facilities, and the large shed building directly to the north are all contained within Lot 1. The remaining 2.37 acres of the project area, including the long gravel driveway, are incorporated into Lot 2. Outside of the aforementioned gravel driveway, and an existing greenhouse, Lot 2 is largely undeveloped and occupied by an open, grassy field.

Development plans involve the construction of a new single family residence towards the center of the south end of Lot 2, directly north of the west end of the existing greenhouse. The existing gravel driveway will also be improved and expanded to access the proposed residence. Site produced stormwater will be retained on site if feasible, and the improved driveway will be constructed using pervious pavement.

2.0 EXPLORATORY METHODS

We explored surface and subsurface conditions at the project site on March 8, 2016. Our exploration and evaluation program comprised the following elements:

- Surface reconnaissance of the site;
- Four test pit explorations (designated TP-1 through TP-4), advanced on March 8, 2016;
- Two grain-size analyses performed on samples collected from our test pit explorations; and
- A review of published geologic and seismologic maps and literature.

Table 1 summarizes the approximate functional locations and termination depths of our subsurface exploration, and Figure 2 depicts their approximate relative location. The following sections describe the procedures used for excavation of the test pit.

TABLE 1
APPROXIMATE LOCATION AND DEPTH OF EXPLORATION

Exploration	Functional Location	Termination Depth (feet)
TP-1	South of proposed residential site, immediately northwest of existing greenhouse	5
TP-2	West side of proposed residential site	6
TP-3	East side of proposed residential site	6
TP-4	Southwest of existing greenhouse, northeast of existing shed building	6

The specific number and location of our exploration was selected in relation to the existing site features, under the constraints of surface access, underground utility conflicts, and budget considerations.

It should be realized that the exploration performed and utilized for this evaluation reveals subsurface conditions only at discrete locations across the project site and that actual conditions in other areas could vary. Furthermore, the nature and extent of any such variations would not become evident until additional explorations are performed or until construction activities have begun. If significant variations are observed at that time, we may need to modify our conclusions and recommendations contained in this report to reflect the actual site conditions.

2.1 Test Pit Procedures

Our exploratory test pit was excavated with a Deer 310E backhoe operated by the property owner. An engineering geologist from our firm observed the test pit excavation, collected soil samples, and logged the subsurface conditions.

The enclosed test pit logs indicate the vertical sequence of soils and materials encountered in our test pits, based on our field classifications. Where a soil contact was observed to be gradational or undulating, our logs indicate the average contact depth. We estimated the relative density and consistency of the in-situ soils by means of the excavation characteristics and the stability of the test pit sidewalls. Our logs also indicate the approximate depths of any sidewall caving or groundwater seepage observed in the test pits. The soils were classified visually in general accordance with the system described in Figure A-1, which includes a key to the exploration logs. Summary logs of the explorations are included as Figures A-2 through A-5.

3.0 SITE CONDITIONS

The following sections present our observations, measurements, findings, and interpretations regarding, surface, soil, groundwater, and infiltration conditions.

3.1 Surface Conditions

The subject property is located towards the west end of the city limits of Puyallup, Washington. Immediately to the east is more densely populated residential areas, whereas to the west are more sparsely populated agricultural sites. The project area is located between the Puyallup River (to the north) and Clarks Creek (to the south). As previously indicated, the project site consists of a 2.84 acre tax parcel which has recently been short-platted. Lot 1, located towards the southwest corner of the project area, is occupied by the Farris Vet Clinic, associated parking facilities, and a large shed building north of the clinic. Access to the clinic is gained through a gravel driveway which hugs the eastern site boundary, extending north from West Stewart Ave. Lot 2 contains the gravel driveway and portions of the property east and north of the large shed building. The southeast corner of Lot 2 contains an existing greenhouse, and is littered with miscellaneous debris. The remainder of Lot 2 is undeveloped and occupied by an open, grass field. Vegetation on site is largely comprised of tall grasses in the vicinity of Lot 2, and younger cedar along the western, eastern, and northern margins of the site. Scattered brush is encountered throughout the property, and within designated landscaping areas within Lot 1. The subject property is relatively level, with minimal grade change observed over its extent.

No hydrologic features were observed on site, such as seeps, springs, ponds and streams, though scattered ponding was observed within tire ruts along the south side of the Lot 2.

3.2 Soil Conditions

We observed subsurface conditions through the advancement of 4 test pit explorations adjacent to proposed improvements. Test pit explorations TP-1 through TP-3 were performed adjacent to the proposed residential site; south, west, and east of the proposed footprint, respectively. Test pit exploration TP-4 was advanced north of the existing parking facilities, along the proposed alignment of the expanded driveway. In general, our test pit explorations encountered relatively similar subsurface conditions; typically consisting of alluvial deposits associated with the flood plains of the nearby Puyallup River. Underlying a surface mantle of sod and topsoil, we encountered a thin horizon of silty fine sand to sandy silt, typically less than 1 foot in overall thickness. Beneath this stratum, we observed mottled, saturated silt with intermittent lenses or layers of fine sand or silty sand. This stratum was continuous through the termination of all of our subsurface explorations, a maximum depth of 6 feet. Deeper subsurface explorations were not feasible for this project given shallow groundwater and severe caving conditions. An exception to the above described soil sequence was observed in test pit exploration TP-4, with a small fill proponent being encountered towards the top of the exploration, and the upper stratum, free of mottling, was slightly thicker. All soils encountered in our subsurface explorations were in a loose/soft to very loose/soft in situ condition.

The National Cooperative Soil Survey (NCSS) for Pierce County, Washington, classifies soils within the northern half of the property as 42A-Sultan silt loam, and soils within the southern half of the property as 6A-Briscot loam. Each soil group reportedly formed in alluvial flood plain deposits, and is texturally comprised of sand, loam, silt loam and clay loam. Our subsurface explorations generally correspond with the site classification developed by the NCSS.

The enclosed exploration logs (Appendix A) provide a detailed description of the soil strata encountered in our subsurface explorations.

<u>3.3 Groundwater Conditions</u>

We encountered shallow groundwater seepage in all of our test pit explorations, typically observed at a depth of 2½ to 3½ feet below existing grade. Given the fact that our test pit explorations were performed towards the latter end of one of the wettest winters in the recent history of Western Washington, it is our opinion that the observed seepage is representative of seasonally high levels. Given the fact that groundwater was encountered a foot deeper in test pit exploration TP-4, which was the southernmost of our test pit explorations, we anticipate that there will be a general trend of increasing depth to groundwater towards the north to south across the project area. Actual groundwater levels will fluctuate with localized precipitation and geology.

<u>3.4 Infiltration Conditions and Infiltration Rate</u>

Based on our field observations and grain size analyses (presented in Table 2, below), it's evident that native soils consist of slowly permeable silty sand to sandy silt at or near surface elevations, grading to mottled silt with depth, which extended through the termination of our subsurface explorations. Given the relatively shallow depth to groundwater, the only feasible stratum to utilize for infiltration would be the lower of the two soil groups described above, which was found to have a relative fines content (percent silt/clay) that ranges from 79 to 90 percent.

The results of our soil grain size analyses are presented below, and the attached Soil Gradation Graphs (Appendix B) display the grain-size distribution of the samples tested.

TABLE 2 LABORATORY TEST RESULTS FOR NON-ORGANIC ONSITE SOILS							
Soil Sample, Depth	**% Coarse Gravel**	**% Fine Gravel**	**% Coarse Sand**	**% Medium Sand**	**% Fine Sand**	**% Fines**	**D_{10}**
TP-2, S-2, 1.5 feet	0	0	0.2	4.1	5.4	90.2	--
TP-4, S-2, 4 feet	0	0	0	1.7	19.0	79.2	--

Drainage Design Considerations
Given the fine-grained nature of site soils, and the presence of extremely shallow groundwater, it is our opinion that standard retention facilities associated with the full or limited infiltration of stormwater produced by residential construction (i.e. trenches, drywells…) are not feasible for this project. Given such, it is our opinion that roof-runoff produced by the proposed residence should be managed through the introduction of raingardens, a dispersion system, or a combination of the two.

As indicated earlier, the improved driveway will be constructed utilizing pervious pavement. In our opinion, adequate separation from groundwater is present to make this system feasible within the project area.

We determined an infiltration rate for the pervious subgrade by comparing the results of our sieve analyses from test pit explorations TP-2 and TP-4 with Table 3.7, in Volume III of the *2005 DOE Stormwater Management Manual for Western Washington*, located on page 3-76. The alluvial silt stratum, with its intermittent lens and/or layers of silty sand, generally corresponds with a loam U.S.D.A. soil classification. As such, our recommended long-term infiltration rate for the pervious subgrade, using the native fine-grained soils as the infiltrative unit, is 0.13 inches per hour.

Treatment Considerations
As part of our evaluation, we also submitted a sample of native soils for testing to determine the organic content, and cation exchange capacity (CEC) of soils that will underlie proposed pervious pavements. The following table illustrates the results of the laboratory analyses:

TABLE 3 LABORATORY TEST RESULTS FOR TREATMENT CAPACITY OF ONSITE SOILS		
Soil Sample, Depth	**Organic Content (%)**	**Cation Exchange Capacity (CEC)(meq/100g)**
TP-4, S-1, 18 inches	5.4	10.1

The civil engineer in charge should evaluate the above results to determine if native soils are adequate for treatment. Laboratory results prepared by Krazan & Associates, Inc. and AgSource Laboratories are attached as Appendix C.

3.5 Seismic Conditions
Based on our analysis of subsurface exploration logs and our review of published geologic maps, we interpret the onsite soil conditions to generally correspond with site class E, as defined by Table 30.2-1 in *ASCE 7*, per the 2012 *International Building Code (IBC)*.

Using 2012 IBC information on the USGS Design Summary Report website, Risk Category I/II/III seismic parameters for the site are as follows:

S_s = 1.261 g	S_{MS} = 1.135 g	S_{DS} = 0.757 g
S_1 = 0.487 g	S_{M1} = 1.168 g	S_{D1} = 0.778 g

Using the 2012 IBC information, MCE_R Response Spectrum Graph on the USGS Design Summary Report website, Risk Category I/II/III, S_a at a period of 0.2 seconds is 1.135 g and S_a at a period of 1.0 seconds is 1.168 g.

The Design Response Spectrum Graph from the same website, using the same IBC information and Risk Category, S_a at a period of 0.2 seconds is 0.757 g and S_a at a period of 1.0 seconds is 0.778 g.

3.6 Liquefaction Potential

Liquefaction is a sudden increase in pore water pressure and a sudden loss of soil shear strength caused by shear strains, as could result from an earthquake. Research has shown that saturated, loose, fine to medium sands with a fines (silt and clay) content less than about 20 percent are most susceptible to liquefaction. As described in the Soil Conditions section of this report, native soils are comprised of poorly consolidated alluvial deposits. Given the high relative fines content observed in much of the native soils, some measure of resistance to liquefaction is present, but the potential for liquefaction during a large-scale seismic event should still be considered high in the project area. Recommended subgrade preparation techniques highlighted in Section 4.2 of this report will help mitigate some, but not all of the risk for seismically induced post-construction settlement.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Development plans involve the construction of a new single family residence towards the center of the south end of Lot 2, directly north of the west end of the existing greenhouse. The existing gravel driveway will also be improved and expanded to access the proposed residence. Site produced stormwater will be retained on site if feasible, and the improved driveway will be constructed using pervious pavement. We offer these recommendations:

- Feasibility: Based on our field explorations, research and analyses, the proposed structure appears feasible from a geotechnical standpoint.
- Foundation Options: Due to the soft soils underlying the site, over-excavation of spread footing subgrades, to a depth of 3 feet, and the construction of structural fill bearing pads will be necessary for foundation support of the new structure. Given the fact that the over-excavation will likely extend below the water table, we recommend that the bottom 12 inches of the bearing pads consist of 2-4 inch quarry spalls driven into the subgrade using a hoe pack. Recommendations for Spread Footings are provided in Section 4.2.
- Floor Options: Floor sections should bear on medium dense or denser native soils or on properly compacted structural fill that extends down to medium dense or denser native soil. We recommend over-excavation of slab-on-grade floor subgrades to a

minimum depth of 2 feet, then placement of properly compacted structural fill as a floor subbase. If floor construction occurs during wet conditions, it is likely that a geotextile fabric, placed between the structural fill floor subbase and native soils, will be necessary. Recommendations for slab-on-grade floors are included in Section 4.3. Fill underlying floor slabs should be compacted to 95 percent (ASTM:D-1557).

- Infiltration Conditions: Given the fine-grained nature of site soils, and the shallow depth to groundwater, we do not interpret standard full or limited infiltration as being feasible to manage roof-runoff from the proposed residence. Given such, it is our opinion that roof-runoff produced by the proposed residence should be managed through the introduction of raingardens, a dispersion system, or a combination of the two. Pervious pavements utilized in the improved driveway system should be designed utilizing an infiltration rate of **0.13 inches/hour** for native subgrade materials.

The following sections of this report present our specific geotechnical conclusions and recommendations concerning site preparation, spread footings, slab-on-grade floors, asphalt pavement, and structural fill. The Washington State Department of Transportation (WSDOT) Standard Specifications and Standard Plans cited herein refer to WSDOT publications M41-10, *Standard Specifications for Road, Bridge, and Municipal Construction*, and M21-01, *Standard Plans for Road, Bridge, and Municipal Construction*, respectively.

4.1 Site Preparation

Preparation of the project site should involve erosion control, temporary drainage, clearing, stripping, excavations, cutting, subgrade compaction, and filling.

Erosion Control: Before new construction begins, an appropriate erosion control system should be installed. This system should collect and filter all surface water runoff through silt fencing. We anticipate a system of berms and drainage ditches around construction areas will provide an adequate collection system. Silt fencing fabric should meet the requirements of WSDOT Standard Specification 9-33.2 Table 3. In addition, silt fencing should embed a minimum of 6 inches below existing grade. An erosion control system requires occasional observation and maintenance. Specifically, holes in the filter and areas where the filter has shifted above ground surface should be replaced or repaired as soon as they are identified.

Temporary Drainage: We recommend intercepting and diverting any potential sources of surface or near-surface water within the construction zones before stripping begins. Because the selection of an appropriate drainage system will depend on the water quantity, season, weather conditions, construction sequence, and contractor's methods, final decisions regarding drainage systems are best made in the field at the time of construction. Based on our current understanding of the construction plans, surface and subsurface conditions, we anticipate that curbs, berms, or ditches placed around the work areas will adequately intercept surface water runoff.

Clearing and Stripping: After surface and near-surface water sources have been controlled, sod, topsoil, and root-rich soil should be stripped from the site. Our subsurface exploration indicates that the organic horizon can reach thicknesses of up to 8 inches. Stripping is best performed during a period of dry weather.

Site Excavations: Based on our exploration, we expect that site excavations to encountered loose/soft silty alluvial soils, which can be readily excavated using standard excavation equipment.

Dewatering: Our explorations encountered groundwater seepage at a depth of 2½ to 3½ feet below existing grade. For shallow excavations, we anticipate that an internal system of ditches, sump holes, and pumps will be adequate to temporarily dewater excavations. For deeper excavations, those performed well below the water table, we anticipate that well points, or other expensive dewatering techniques will need to be employed to adequately dewater excavations.

Temporary Cut Slopes: All temporary soil slopes associated with site cutting or excavations should be adequately inclined to prevent sloughing and collapse. Temporary cut slopes in site soils should be no steeper than 1½H:1V, and should conform to Washington Industrial Safety and Health Act (WISHA) regulations.

Subgrade Compaction: Exposed subgrades for the foundation of the proposed residence should be compacted to a firm, unyielding state before new concrete or fill soils are placed. Any localized zones of looser granular soils observed within a subgrade should be compacted to a density commensurate with the surrounding soils. In contrast, any organic, soft, or pumping soils observed within a subgrade should be overexcavated and replaced with a suitable structural fill material.

Site Filling: Our conclusions regarding the reuse of onsite soils and our comments regarding wet-weather filling are presented subsequently. Regardless of soil type, all fill should be placed and compacted according to our recommendations presented in the Structural Fill section of this report. Specifically, building pad fill soil should be compacted to a uniform density of at least 95 percent (based on ASTM:D-1557).

Onsite Soils: We offer the following evaluation of these onsite soils in relation to potential use as structural fill:

- *Surficial Organic Soil and Organic-Rich Fill Soils*: Where encountered, surficial organic soils, like duff, topsoil, root-rich soil, and organic-rich fill soils are *not* suitable for use as structural fill under any circumstances, due to high organic content. Consequently, this material can be used only for non-structural purposes, such as in landscaping areas.
- *Alluvial Silt*: Underlying a surface mantle of sod and topsoil, we encountered mottled, silty soils to a depth of 7 feet below existing grade. These soils are extremely moisture sensitive and will be difficult, if not impossible to reuse during wet weather conditions. If reuse is planned, care should be taken while stockpiling in order to avoid saturation/over-saturation of the material, and moisture conditioning should be expected.

- *Alluvial Silty Sand*: Underlying the silt stratum discussed in the above section, we encountered fine silty sand, which was continuous to the termination depth of our subsurface exploration; 12 feet below existing grade. This material type contains a relative fines content (percent silt/clay) of upwards of 38 percent, and is moderately to severely moisture sensitive. This material type will be difficult to reuse in wet weather conditions, particularly given the fact that it was encountered in a saturated in-situ condition.

Permanent Slopes: All permanent cut slopes and fill slopes should be adequately inclined to reduce long-term raveling, sloughing, and erosion. We generally recommend that no permanent slopes be steeper than 2H:1V. For all soil types, the use of flatter slopes (such as 2½H:1V) would further reduce long-term erosion and facilitate revegetation.

Slope Protection: We recommend that a permanent berm, swale, or curb be constructed along the top edge of all permanent slopes to intercept surface flow. Also, a hardy vegetative groundcover should be established as soon as feasible, to further protect the slopes from runoff water erosion. Alternatively, permanent slopes could be armored with quarry spalls or a geosynthetic erosion mat.

4.2 Spread Footings

In our opinion, conventional spread footings will provide adequate support for the residences if the subgrades are properly prepared. Due to the soft soils underlying the site, over-excavation of spread footing subgrades, to a depth of 3 feet, and the construction of structural fill bearing pads will be necessary for foundation support of the new structure.

Footing Depths and Widths: For frost and erosion protection, the bases of all exterior footings should bear at least 18 inches below adjacent outside grades, whereas the bases of interior footings need bear only 12 inches below the surrounding slab surface level. To reduce post-construction settlements, continuous (wall) and isolated (column) footings should be at least 16 and 24 inches wide, respectively.

Bearing Subgrades: Structural fill bearing pads, 3 feet thick and compacted to a density of at least 95 percent (based on ASTM:D-1557), should underlie spread footings on this site. Given the fact that the over-excavation will likely extend below the water table, we recommend that the bottom 12 inches of the bearing pads consist of 2-4 inch quarry spalls driven into the subgrade using a hoe pack.

In general, before footing concrete is placed, any localized zones of loose soils exposed across the footing subgrades should be compacted to a firm, unyielding condition, and any localized zones of soft, organic, or debris-laden soils should be overexcavated and replaced with suitable structural fill.

Lateral Overexcavations: Because foundation stresses are transferred outward as well as downward into the bearing soils, all structural fill placed under footings, should extend horizontally outward from the edge of each footing. This horizontal distance should be equal to the depth of placed fill. Therefore, placed fill that extends 3 feet below the footing base should also extend 3 feet outward from the footing edges.

Subgrade Observation: All footing subgrades should consist of firm, unyielding, native soils, or structural fill materials that have been compacted to a density of at least 95 percent (based on ASTM:D-1557). Footings should never be cast atop loose, soft, or frozen soil, slough, debris, existing uncontrolled fill, or surfaces covered by standing water.

Bearing Pressures: In our opinion, for static loading, footings that bear on properly prepared, structural fill bearing pads 3 feet thick can be designed for a preliminary allowable soil bearing pressure of 1,500 psf. A one-third increase in allowable soil bearing capacity may be used for short-term loads created by seismic or wind related activities.

Footing Settlements: Assuming that structural fill soils are compacted to a medium dense or denser state, we estimate that total post-construction settlements of properly designed footings bearing on properly prepared subgrades will not exceed 1 inch. Differential settlements for comparably loaded elements may approach one-half of the actual total settlement over horizontal distances of approximately 50 feet.

Footing Backfill: To provide erosion protection and lateral load resistance, we recommend that all footing excavations be backfilled on both sides of the footings and stemwalls after the concrete has cured. Either imported structural fill or non-organic onsite soils can be used for this purpose, contingent on suitable moisture content at the time of placement. Regardless of soil type, all footing backfill soil should be compacted to a density of at least 90 percent (based on ASTM:D-1557).

Lateral Resistance: Footings that have been properly backfilled as recommended above will resist lateral movements by means of passive earth pressure and base friction. We recommend using an allowable passive earth pressure of 225 psf and an allowable base friction coefficient of 0.35 for site soils.

4.3 Slab-On-Grade Floors

In our opinion, soil-supported slab-on-grade floors can be used if the subgrades are properly prepared. We offer the following comments and recommendations concerning slab-on-grade floors.

Floor Subbase: We recommend over-excavation of slab-on-grade floor subgrades to a minimum depth of 2 feet, then placement of properly compacted structural fill as a floor subbase. If floor construction occurs during wet conditions, it is likely that a geotextile fabric, placed between the structural fill floor subbase and native soils, will be necessary.

All subbase fill should be compacted to a density of at least 95 percent (based on ASTM:D-1557).

Capillary Break and Vapor Barrier: To retard the upward wicking of moisture beneath the floor slab, we recommend that a capillary break be placed over the subgrade. Ideally, this capillary break would consist of a 4-inch-thick layer of pea gravel or other clean, uniform, well-rounded gravel, such as "Gravel Backfill for Drains" per WSDOT Standard Specification 9-03.12(4), but clean angular gravel can be used if it adequately prevents capillary wicking. In addition, a layer of plastic sheeting (such as Crosstuff, Visqueen, or Moistop) should be placed over the capillary break to serve as a vapor barrier. During subsequent casting of the concrete slab, the contractor should exercise care to avoid puncturing this vapor barrier.

Vertical Deflections: Due to elastic compression of subgrades, soil-supported slab-on-grade floors can deflect downwards when vertical loads are applied. In our opinion, a subgrade reaction modulus of 250 pounds per cubic inch can be used to estimate such deflections.

4.4 Drainage Systems

In our opinion, structures should be provided with permanent drainage systems to reduce the risk of future moisture problems. We offer the following recommendations and comments for drainage design and construction purposes.

Perimeter Drains: We recommend that buildings be encircled with a perimeter drain system to collect seepage water. This drain should consist of a 4-inch-diameter perforated pipe within an envelope of pea gravel or washed rock, extending at least 6 inches on all sides of the pipe, and the gravel envelope should be wrapped with filter fabric to reduce the migration of fines from the surrounding soils. Ideally, the drain invert would be installed no more than 8 inches above the base of the perimeter footings.

Subfloor Drains: We recommend that subfloor drains be included beneath the new building. These subfloor drains should consist of 4-inch-diameter perforated pipes surrounded by at least 6 inches of pea gravel and enveloped with filter fabric. A pattern of parallel pipes spaced no more than 20 feet apart and having inverts located about 12 inches below the capillary break layer would be appropriate, in our opinion.

Discharge Considerations: If possible, all perimeter drains should discharge to a sewer system or other suitable location by gravity flow. Check valves should be installed along any drainpipes that discharge to a sewer system, to prevent sewage backflow into the drain system. If gravity flow is not feasible, a pump system is recommended to discharge any water that enters the drainage system.

Runoff Water: Roof-runoff and surface-runoff water should *not* discharge into the perimeter drain system. Instead, these sources should discharge into separate tightline pipes and be routed away from the building to a storm drain or other appropriate location.

Grading and Capping: Final site grades should slope downward away from the buildings so that runoff water will flow by gravity to suitable collection points, rather than ponding near the building. Ideally, the area surrounding the building would be capped with concrete, asphalt, or low-permeability (silty) soils to minimize or preclude surface-water infiltration.

4.5 Pervious Pavement

We understand that pervious pavement will be utilized in the construction of the improved driveway system. Site grading will consist of removal of sufficient sod and underlying soil to install a thick coarse gravel reservoir along with a slightly finer gravel pavement base course under the area to receive porous paving. The actual thickness of these elements will be determined by the design engineer; however, a minimum of one foot of separation needs to be maintained between from the bottom of the gravel reservoir and seasonally high groundwater levels. We offer the following comments and recommendations for pavement construction.

Subgrade Preparation: The existing subgrade under all pervious pavements must remain in an uncompacted condition to facilitate water infiltration. Traffic from construction equipment and vehicles should be limited to the extent practical prior to placement of the pavement section. Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Any concentrated areas of fines accumulation due to ponding may be removed to a maximum depth of 6 inches. If desired, these areas may be re-leveled using clean sand. Materials meeting the requirements for "Sand Drainage Blanket" in section 9-03.13(1) of the WSDOT Standard Specifications may be used for this purpose.

We recommend placement of a nonwoven filter fabric such as Mirafi 160N or equal over the prepared subgrade prior to construction of the pervious pavement section.

Maintenance Considerations: Do not allow sediment laden runoff onto permeable pavements. Pavements fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures from the local stormwater manual or the manufacturer's procedures.

Construction Observation: We recommend that an MGI representative be retained to observe and document the placement of each course before any overlying layer is placed.

4.6 Structural Fill

The term "structural fill" refers to any material placed under foundations, retaining walls, slab-on-grade floors, sidewalks, pavements, and other structures. Our comments, conclusions, and recommendations concerning structural fill are presented in the following paragraphs.

Materials: Typical structural fill materials include clean sand, gravel, pea gravel, washed rock, crushed rock, well-graded mixtures of sand and gravel (commonly called "gravel borrow" or "pit-run"), and miscellaneous mixtures of silt, sand, and gravel. Recycled asphalt, concrete, and glass, which are derived from pulverizing the parent materials, are also potentially useful as structural fill in certain applications. Soils used for structural fill should not contain any organic matter or debris, nor any individual particles greater than about 6 inches in diameter.

Fill Placement: Clean sand, gravel, crushed rock, soil mixtures, and recycled materials should be placed in horizontal lifts not exceeding 8 inches in loose thickness, and each lift should be thoroughly compacted with a mechanical compactor.

Compaction Criteria: Using the Modified Proctor test (ASTM:D-1557) as a standard, we recommend that structural fill used for various onsite applications be compacted to the following minimum densities:

Fill Application	Minimum Compaction
Footing subgrade and bearing pad	95 percent
Foundation and subgrade wall backfill	90 percent
Slab-on-grade floor subgrade and subbase	95 percent

Subgrade Observation and Compaction Testing: Regardless of material or location, all structural fill should be placed over firm, unyielding subgrades prepared in accordance with the Site Preparation section of this report. The condition of all subgrades should be observed by geotechnical personnel before filling or construction begins. Also, fill soil compaction should be verified by means of in-place density tests performed during fill placement so that adequacy of soil compaction efforts may be evaluated as earthwork progresses.

Soil Moisture Considerations: The suitability of soils used for structural fill depends primarily on their grain-size distribution and moisture content when they are placed. As the "fines" content (that soil fraction passing the U.S. No. 200 Sieve) increases, soils become more sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (by weight) cannot be consistently compacted to a firm, unyielding condition when the moisture content is more than 2 percentage points above or below optimum. For fill placement during wet-weather site work, we recommend using "clean" fill, which refers to soils that have a fines content of 5 percent or less (by weight) based on the soil fraction passing the U.S. No. 4 Sieve.

5.0 RECOMMENDED ADDITIONAL SERVICES

Because the future performance and integrity of the structural elements will depend largely on proper site preparation, drainage, fill placement, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. Subsequently, we recommend that MGI be retained to provide the following post-report services:

- Review all construction plans and specifications to verify that our design criteria presented in this report have been properly integrated into the design;
- Prepare a letter summarizing all review comments (if required);
- Check all completed subgrades for footings and slab-on-grade floors before concrete is poured, in order to verify their bearing capacity; and
- Prepare a post-construction letter summarizing all field observations, inspections, and test results (if required).

6.0 CLOSURE

The conclusions and recommendations presented in this report are based, in part, on the explorations that we observed for this study; therefore, if variations in the subgrade conditions are observed at a later time, we may need to modify this report to reflect those changes. Also, because the future performance and integrity of the project elements depend largely on proper initial site preparation, drainage, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. MGI is available to provide geotechnical monitoring of soils throughout construction.

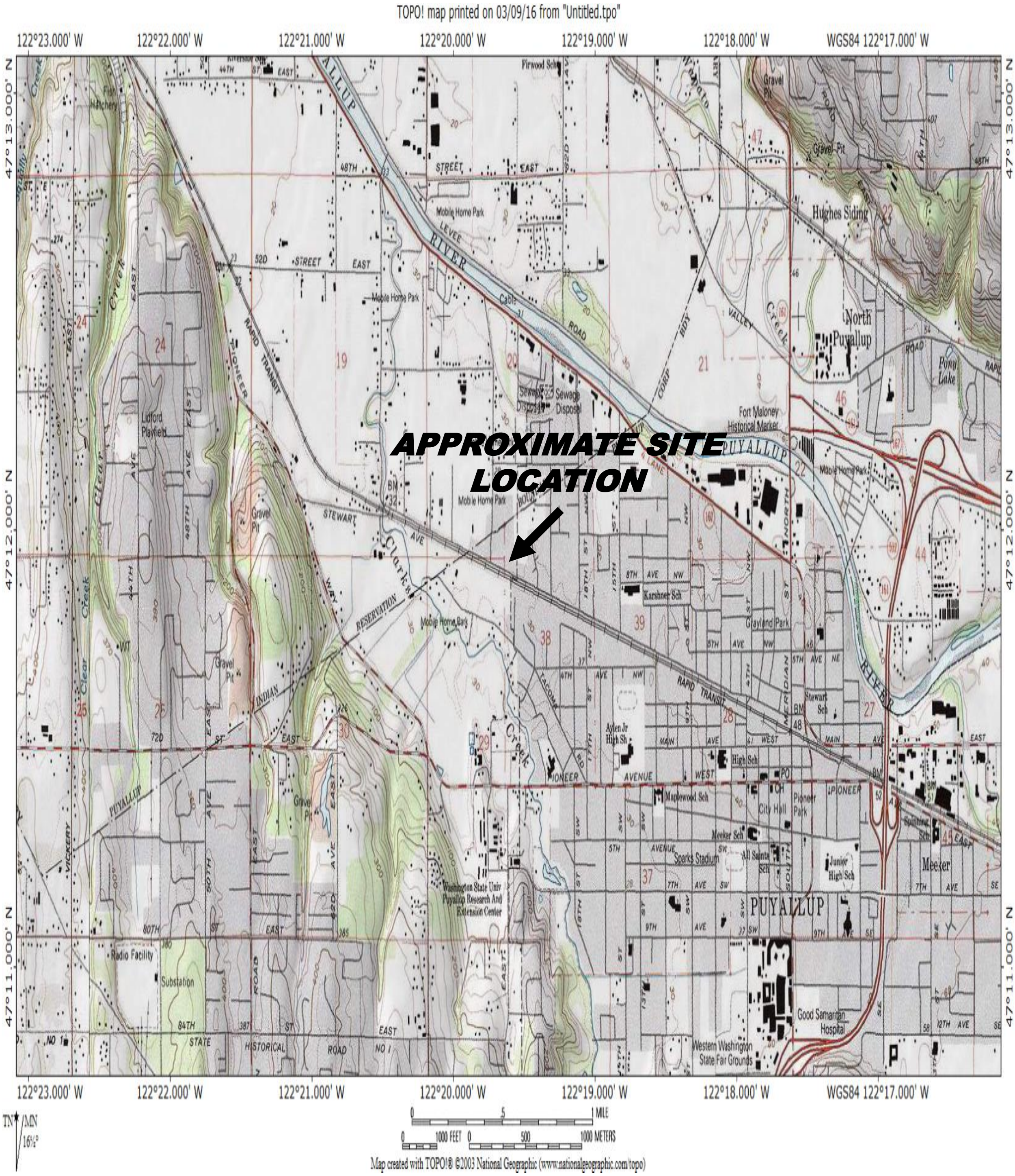
We appreciate the opportunity to be of service on this project. If you have any questions regarding this report or any aspects of the project, please feel free to contact our office.

Respectfully submitted,

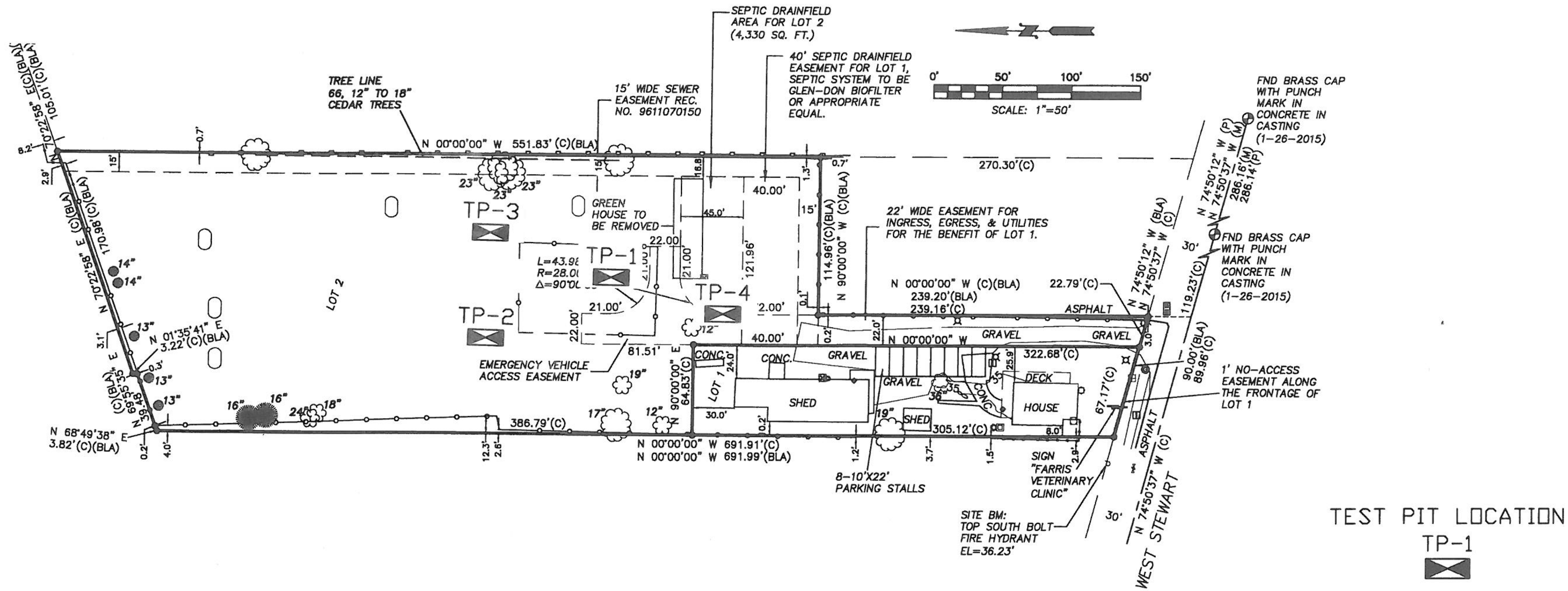
MIGIZI GROUP, INC.

Zach L. Logan
Staff Geologist

James E. Brigham, P.E.
Principal Engineer



Migizi Group, Inc. **P.O. Box 44840** **Tacoma, WA 98448**	2401 West Stewart Avenue Puyallup, Washington 98371 Topographic and Location Map	**FIGURE 1** **P475-T15**



NOTE:
BOUNDARY AND TOPOGRAPHY ARE BASED ON MAPPING PROVIDED TO MIGIZI OBSERVATIONS MADE IN THE FIELD. THE INFORMATION SHOWN DOES NOT CONSTITUTE A FIELD SURVEY BY MIGIZI.

Migizi Group, Inc. PO Box 44840 Tacoma, WA 98448 253-537-9400 253-537-9401 fax www.migizigroup.com	PROJECT: 2401 W Stewart St Puyallup, Washington	
	SHEET TITLE: Site and Exploration Plan	
	DESIGNER: CRL	JOB NO. P475-T15
	DRAWN BY: CRL	SCALE: As Shown
	CHECKED BY: JEB	FIGURE: 2
	DATE: Mar. 29, 2016	FILE: Fig2.dwg

APPENDIX A
SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

LOG OF TEST PIT

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS More than Half > #200 sieve	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 15% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 15% FINES	SM	SILTY SANDS, POOORLY GRADED SAND-SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS More than Half < #200 sieve	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

⧓	Modified California	RV	R-Value
⊠	Split Spoon	SA	Sieve Analysis
■	Pushed Shelby Tube	SW	Swell Test
◧	Auger Cuttings	TC	Cyclic Triaxial
✋	Grab Sample	TX	Unconsolidated Undrained Triaxial
■	Sample Attempt with No Recovery	TV	Torvane Shear
CA	Chemical Analysis	UC	Unconfined Compression
CN	Consolidation	(1.2)	(Shear Strength, ksf)
CP	Compaction	WA	Wash Analysis
DS	Direct Shear	(20)	(with % Passing No. 200 Sieve)
PM	Permeability	▽	Water Level at Time of Drilling
PP	Pocket Penetrometer	▼	Water Level after Drilling(with date measured)

SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

Figure A-1

MIGIZI GROUP

Migizi Group, Inc.
PO Box 44840
Tacoma, WA 98448
Telephone: 253-537-9400
Fax: 253-537-9401

TEST PIT NUMBER TP-1

Figure A-2

CLIENT Farris Vet Clinic
PROJECT NAME 2401 W Stewart Geotech Report
PROJECT NUMBER P475-T15
PROJECT LOCATION Puyallup, Washington
DATE STARTED 3/8/16 **COMPLETED** 3/8/16
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Owner-Operator
GROUND WATER LEVELS:
EXCAVATION METHOD Rubber Tracked Excavator
▽ **AT TIME OF EXCAVATION** 3.00 ft Moderate seepage
LOGGED BY ZLL **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			0.5	Sod and Topsoil
	GB S-1	SM	1.0	(SM) Brown silty fine sand (very loose, moist) (Alluvial Deposits)
2.5	GB S-2	ML	4.0	(ML) Gray mottled silt (very soft, moist) (Alluvial Deposits) Grades to wet at 2 feet ▽
5.0	GB S-3	SM	5.0	(SM) Gray/brown mottled silty fine sand (very loose, wet) (Alluvial Deposits)

Severe caving observed from 0 to 5 feet
Moderate groundwater seepage observed at 3 feet

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Bottom of test pit at 5.0 feet.

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Telephone: 253-537-9400
Fax: 253-537-9401

TEST PIT NUMBER TP-2

CLIENT Farris Vet Clinic
PROJECT NAME 2401 W Stewart Geotech Report
PROJECT NUMBER P475-T15
PROJECT LOCATION Puyallup, Washington
DATE STARTED 3/8/16 **COMPLETED** 3/8/16
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Owner-Operator
GROUND WATER LEVELS:
EXCAVATION METHOD Rubber Tracked Excavator
∇ **AT TIME OF EXCAVATION** 2.50 ft Moderate seepage
LOGGED BY ZLL **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			0.6	Sod and Topsoil
	GB S-1 GB S-2	ML	1.3	(ML) Brown sandy silt (very soft, moist) (Alluvial Deposits)
2.5		ML	4.0	(ML) Gray mottled silt (very soft, wet) (Alluvial Deposits) ∇
5.0		SM	6.0	(SM) Gray/brown mottled silty fine sand (very loose, wet) (Alluvial Deposits) Buried logs encountered at 4 to 5.5 feet

Severe caving observed from 1.5 to 6 feet
Moderate groundwater seepage observed at 2.5 feet

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Bottom of test pit at 6.0 feet.

Migizi Group, Inc.
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Tacoma, WA 98448
Telephone: 253-537-9400
Fax: 253-537-9401

TEST PIT NUMBER TP-3

CLIENT Farris Vet Clinic
PROJECT NAME 2401 W Stewart Geotech Report
PROJECT NUMBER P475-T15
PROJECT LOCATION Puyallup, Washington
DATE STARTED 3/8/16 **COMPLETED** 3/8/16
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Owner-Operator
GROUND WATER LEVELS:
EXCAVATION METHOD Rubber Tracked Excavator
▽ **AT TIME OF EXCAVATION** 2.50 ft Moderate seepage
LOGGED BY ZLL **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
0.0	GB S-1			0.7	Sod and Topsoil
		SM		1.2	(SM) Brown fine silty sand (very loose, moist) (Alluvial Deposits)
2.5		ML		6.0	(ML) Gray/brown mottled silt (very soft, wet) (Alluvial Deposits) ▽ (2.5)
5.0					

Severe caving observed from 3 to 6 feet
Moderate groundwater seepage observed at 2.5 feet

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Bottom of test pit at 6.0 feet.

Migizi Group, Inc.
PO Box 44840
Tacoma, WA 98448
Telephone: 253-537-9400
Fax: 253-537-9401

TEST PIT NUMBER TP-4

Figure A-5

CLIENT Farris Vet Clinic
PROJECT NAME 2401 W Stewart Geotech Report
PROJECT NUMBER P475-T15
PROJECT LOCATION Puyallup, Washington
DATE STARTED 3/8/16 **COMPLETED** 3/8/16
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Owner-Operator
GROUND WATER LEVELS:
EXCAVATION METHOD Rubber Tracked Excavator
▽ **AT TIME OF EXCAVATION** 3.50 ft Slow seepage
LOGGED BY ZLL **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0		SM	1.0	(SM) Brown silty sand with gravel, crushed rock, and brick debris (medium dense, moist) (Fill)
2.5	GB S-1	SM	3.0	(SM) Brown fine silty sand (loose, moist) (Alluvial Deposits)
5.0	GB S-2	ML	6.0	(ML) Gray/brown mottled silt (soft, wet) (Alluvial Deposits) ▽

No caving observed
Slow groundwater seepage observed at 3.5 feet

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Bottom of test pit at 6.0 feet.

APPENDIX B
LABORATORY TESTING RESULTS

Particle Size Analysis Summary Data

Job Name: 2401 W Stewart Ave Puyallup
Job Number: P475-T15
Tested By: ZLL
Date: 3/8/16
Boring #: TP-2
Sample #: 2
Depth: 1.5 feet

Moisture Content (%)	37.8%

Sieve Size	Percent Passing (%)
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	99.8
No. 20 (.850-mm)	98.0
No. 40 (.425-mm)	95.6
No. 60 (.250-mm)	93.9
No. 100 (.150-mm)	92.4
No. 200 (.075-mm)	90.2

Size Fraction	Percent By Weight
Coarse Gravel	
Fine Gravel	
Coarse Sand	0.2
Medium Sand	4.1
Fine Sand	5.4
Fines	90.2
Total	100.0

LL ______
PI ______

D10 ______
D30 ______
D60 ______

Cc ______
Cu ______

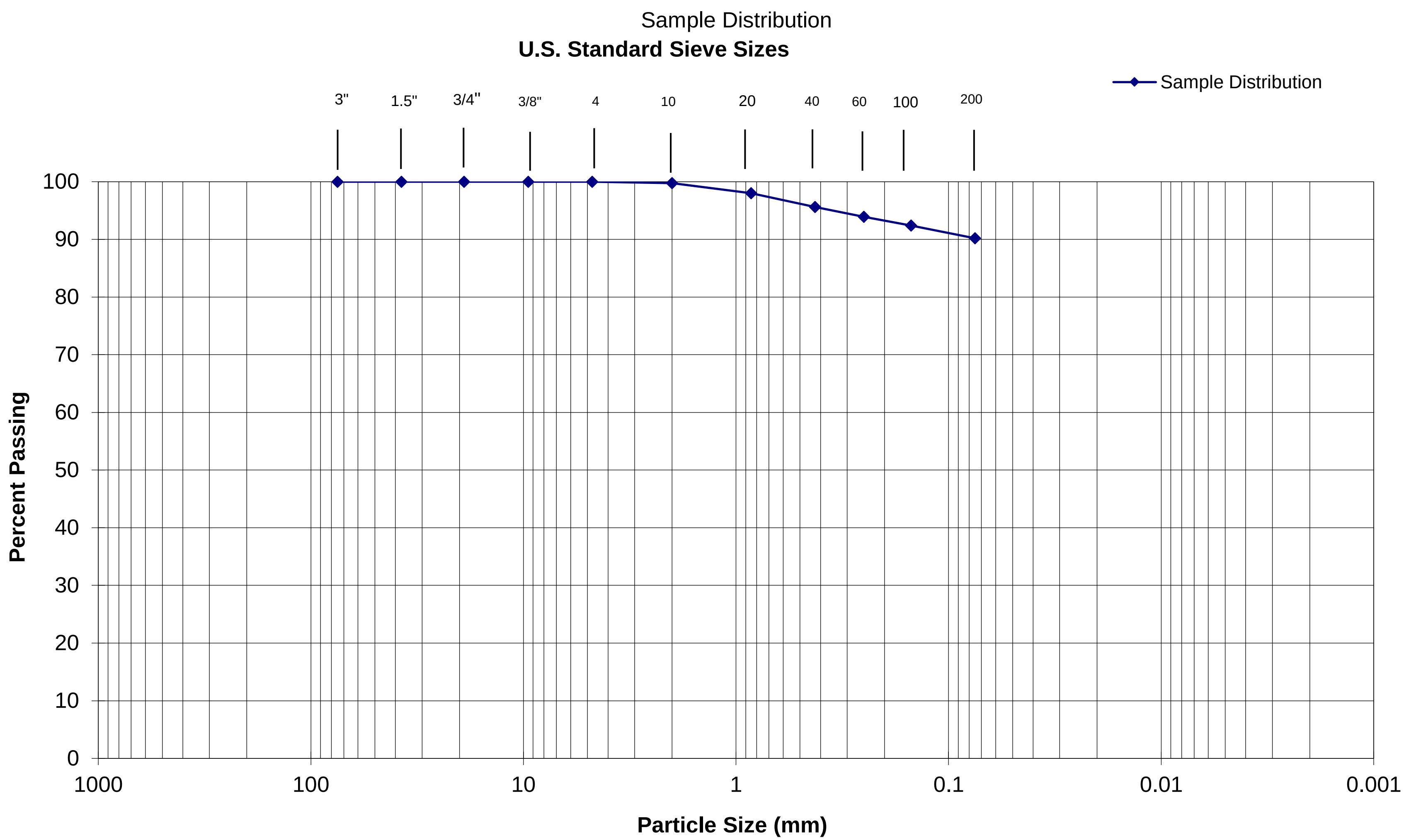
ASTM Classification

Group Name Grayish-brown silt
Symbol (ML) (very soft, wet)

MIGIZI GROUP

Figure B-1

Soil Classification Data Sheet



MIGIZI GROUP	**Sample Distribution**	Job Name: 2401 W Stewart Ave Puyallup	Sample #: 2
		Job Number: P475-T15	Date: 3/8/16
	Figure: B-2	Tested By: ZLL	Depth: 1.5 feet
		Exploration #: TP-2	

Particle Size Analysis Summary Data

Job Name: 2401 W Stewart Ave Puyallup
Job Number: P475-T15
Tested By: ZLL
Date: 3/8/16
Boring #: TP-4
Sample #: 2
Depth: 4 feet

Moisture Content (%)	37.2%

Sieve Size	Percent Passing (%)
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	100.0
No. 20 (.850-mm)	99.3
No. 40 (.425-mm)	98.2
No. 60 (.250-mm)	97.5
No. 100 (.150-mm)	95.7
No. 200 (.075-mm)	79.2

Size Fraction	Percent By Weight
Coarse Gravel	
Fine Gravel	
Coarse Sand	0.0
Medium Sand	1.7
Fine Sand	19.0
Fines	79.2
Total	100.0

LL ____
PI ____

D10 ____
D30 ____
D60 ____

Cc ____
Cu ____

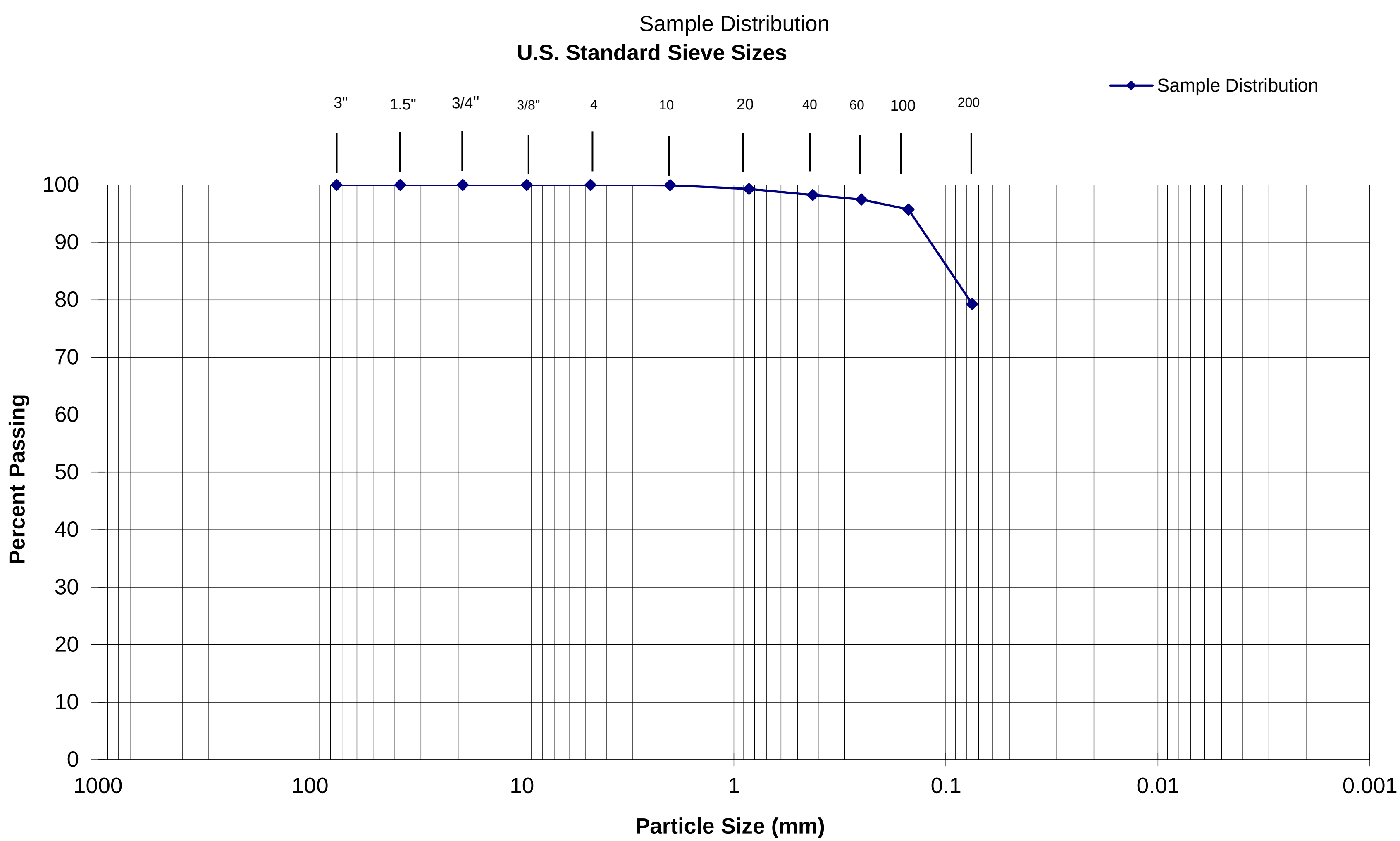
ASTM Classification

Group Name Grayish-brown silt with sand
Symbol (ML) (med. stiff, wet)

MIGIZI GROUP

Figure B-3

Soil Classification Data Sheet



Sample Distribution	Job Name: 2401 W Stewart Ave Puyallup	Sample #: 2
	Job Number: P475-T15	Date: 3/8/16
Figure: B-4	Tested By: ZLL	Depth: 4 feet
	Exploration #: TP-4	

APPENDIX C
KRAZAN & ASSOCIATES, INC. AND AGSOURCE LABORATORIES RESULTS

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

April 1, 2016

Zach Logan
Migizi Group,Inc.
201 160th St. S.
Spanaway WA 98387

RE: Organic Content & Cat-Ion Exchange
Ferris Vet Clinic P475-T15

Dear Mr. Logan,

In accordance with your request and authorization, we have performed laboratory testing and analysis of a silty sand per A.S.T.M. standard D2974. Please the table below for a summary of our test results.

Sample ID	Material Description	Organic Content (ASTM D2974	Cat-Ion Exchance Capacity
16L150	Silty sand	5.4%	10.1 ~~ppm~~ meq/100g

If you have any questions or need any additional information, please do not hesitate to contact our office at (253) 939-2500.

Respectfully submitted,
KRAZAN & ASSOCIATES, INC

mp

Michael Thomas
Laboratory Manager
Krazan and Associates, Inc.
Phone: (253) 939-2500
Email: Mikethomas@krazan.com

Attached:
Agsource Laboratories Soil Analysis of Cat-Ion Exchange Capacity

AgSource Laboratories
A Subsidiary of Cooperative Resources International

323 Sixth Street
Umatilla, OR 97882
Tel:541-922-4894
umatilla@agsource.com

Soil Analysis

Submitted By: **UMK23345**
KRAZAN & ASSOCIATES, INC. - PUYALLUP
922 VALLEY AVENUE NW, SUITE 101
PUYALLUP, WA 98391

Submitted For:
FERRIS VET CLINIC P475-T15

Laboratory Sample #
AU48434

Date Received
24-Mar-2016

Date Reported
25-Mar-2016

Information Sheet #
S9830

REPORT OF ANALYTICAL RESULTS

Client Sample Identification	Analysis	Result
TP-4 SAMPLE 1		
	Actual CEC	10.1 ~~ppm~~ meq/100g

TABLE OF CONTENTS

List of Tables

List of Figures

APPENDIX A

APPENDIX B

MIGIZI GROUP, INC.

PO Box 44840
Tacoma, Washington 98448

PHONE (253) 537-9400
FAX (253) 537-9401

September 28, 2021

Danny Foster
2345 W Stewart St
Puyallup, Washington 98371

Subject: Draft **Infiltration Report**
Residential Development
2345 W Stewart St
Puyallup, Washington 98371
Parcel No. 0420207029

MGI Project P2271-T20

Dear Mr. Foster:

Migizi Group, Inc. (MGI) is pleased to submit this report describing the results of our infiltration evaluation of the development of your residential parcel in Puyallup, Washington. The purpose of this evaluation is to supplement the original *Geotechnical Engineering Report* prepared for this project by the undersigned, dated April 21, 2016.

This report has been prepared for the exclusive use of Danny Foster, and his consultants, for specific application to this project, in accordance with generally accepted geotechnical engineering practice.

1.0 SITE AND PROJECT DESCRIPTION

The parent property of the project site consisted of an irregularly shaped, 2.84-acre parcel located on the north side of West Stewart Street in Puyallup, Washington, as shown on the enclosed Topographic and Location Map (Figure 1). The parcel was orientated lengthwise from north to south, spanning approximately 692 feet along this orientation, and contains a maximum width of ± 185 feet. A short plat of the property has recently taken place, dividing the parcel into two lots. Lot 1 is roughly rectangular shaped and encompasses a 67 by 322-foot area towards the southwest corner of the project site. Farris Vet Clinic, associated parking facilities, and the large, shed building directly to the north are all contained within Lot 1. The remaining 2.37 acres of the project area, including the long gravel driveway, are incorporated into Lot 2. Outside of the aforementioned gravel driveway, and an existing greenhouse, Lot 2 is largely undeveloped and occupied by an open, grassy field.

Development plans involve the construction of a new single-family residence towards the center of the south end of Lot 2, directly north of the west end of the existing greenhouse. The existing gravel driveway will also be improved and expanded to access the proposed residence. Site produced stormwater will be retained on site if feasible, and the improved driveway will be constructed using pervious pavement.

2.0 EXPLORATORY METHODS

We explored surface and subsurface conditions at the project site on December 31, 2020, and performed regular groundwater monitoring visits between December 31, 2020, thru April 30, 2021. Our exploration and evaluation program included the following elements:

- Surface reconnaissance of the site,
- Two test pit explorations (designated TP-1 & TP-2) conducted onsite, advanced on December 31, 2020,
- Two Small-Scale Pilot Infiltration Tests along the alignment of the proposed infiltration trench and pervious pavements,
- Installation of five, 6-foot monitoring wells along the course of the pervious driveway and proposed infiltration trench, with regular groundwater monitoring measurements taken between December 31, 2020, thru April 30, 2021,
- Review of the original *Geotechnical Engineering Report* for this project, prepared by the undersigned, dated April 21, 2016, and
- A review of published geologic and seismologic maps and literature.

Table 1 summarizes the approximate functional locations and termination depths of our subsurface explorations, and Figure 2 depicts their approximate relative locations. The following sections describe the procedures used for excavation of the test pits.

TABLE 1
APPROXIMATE LOCATIONS AND DEPTHS OF EXPLORATIONS

Exploration	Functional Location	Termination Depth (feet)
TP-1	North end of proposed infiltration trench, along north side of existing residence	6½
TP-2	Southwest of the southwest corner of the proposed residential site	9

The specific numbers and locations of our explorations were selected in relation to the existing site features, under the constraints of surface access, underground utility conflicts, and budget considerations.

It should be realized that the explorations performed and used for this evaluation reveal subsurface conditions only at a discrete location across the project site and that actual conditions in other areas could vary. Furthermore, the nature and extent of any such variations would not become evident until additional explorations are performed or until construction activities have begun. If significant variations are observed at that time, we may need to modify our conclusions and recommendations contained in this report to reflect the actual site conditions.

2.1 Test Pit Procedures

Our exploratory test pits were excavated with a rubber-tracked mini-excavator operated by an excavation contractor under subcontract to MGI. An engineering geologist from our firm observed the test pit excavations, collected soil samples, and logged the subsurface conditions.

The enclosed test pit logs indicate the vertical sequence of soils and materials encountered in our test pits, based on our field classifications. Where a soil contact was observed to be gradational or undulating, our logs indicate the average contact depth. We estimated the relative density and consistency of the in-situ soils by means of the excavation characteristics and the stability of the test pit sidewalls. Our logs also indicate the approximate depths of any sidewall caving or groundwater seepage observed in the test pits. The soils were classified visually in general accordance with the system described in Figure A-1, which includes a key to the exploration logs. Summary logs of our explorations are included as Figures A-2 and A-3.

2.2 Infiltration Test Procedures

In-situ field infiltration testing was performed for determination of a Design Infiltration Rate in general accordance with the Small-Scale PIT procedures, as described in Section III-3.3.6 of the *2014 Stormwater Management Manual for Western Washington*, as adopted by the City of Puyallup. The first step of this test procedure was to identify a suitable soil stratum for stormwater retention and once completed, perform an excavation within this soil group with a minimum surface area of 12 square feet (sf). After the excavation was completed, a vertical measuring rod marked in half-inch increments was installed towards the center of the test area. Water was then introduced into the test area, being conveyed through a 4-inch corrugated pipe to a splash block at the bottom of the excavation. After 12 inches of water was developed at the bottom of the excavation, the test surface was saturated prior to testing. After the saturation period was completed, a steady-state flow rate was developed to maintain 12 inches of head at the bottom of the test surface. This steady-state rate was maintained for 1 hour. After completion of the steady-state period, water was no longer introduced into the excavation and infiltration of the existing water was allowed. We recorded the falling head rate for 1 hour for comparison with the steady-state rate.

3.0 SITE CONDITIONS

The following sections present our observations, measurements, findings, and interpretations regarding surface, soil, groundwater, infiltration and seismic conditions and liquefaction potential.

3.1 Surface Conditions

The subject property is located towards the west end of the city limits of Puyallup, Washington. Immediately to the east is more densely populated residential areas, whereas to the west are more sparsely populated agricultural sites. The project area is located between the Puyallup River (to the north) and Clarks Creek (to the south). As previously indicated, the project site consists of a 2.84-acre tax parcel which has recently been short-platted. Lot 1, located towards the southwest corner of the project area, is occupied by the Farris Vet Clinic, associated parking facilities, and a large, shed building north of the clinic. Access to the clinic is gained through a gravel driveway which hugs the eastern site boundary, extending north from West Stewart Ave. Lot 2 contains the gravel driveway and portions of the property east and north of the large, shed building. The southeast corner of Lot 2 contains an existing greenhouse and is littered with miscellaneous debris. The remainder of Lot 2 is undeveloped and occupied by an open, grass field.

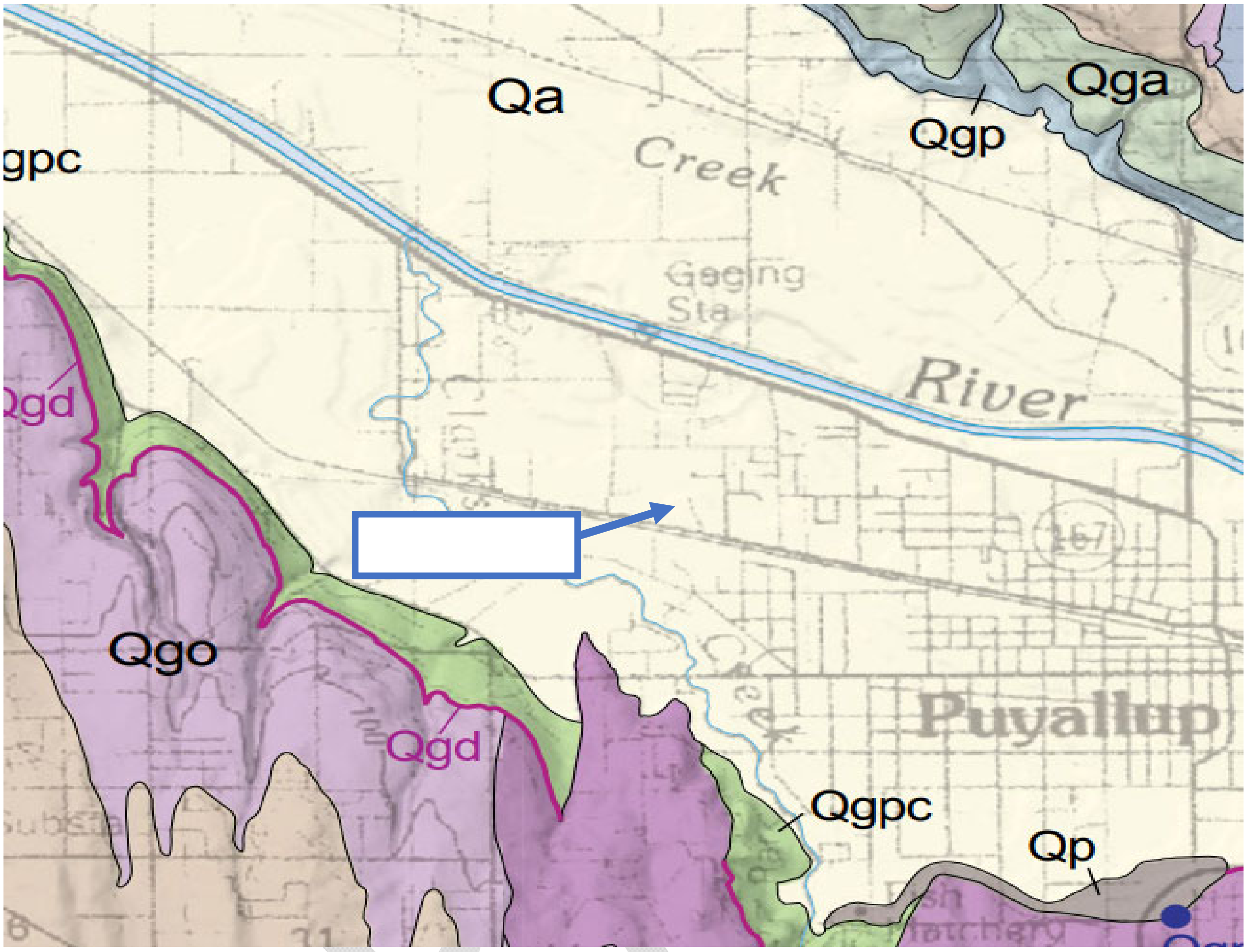
Vegetation on site is largely comprised of tall grasses in the vicinity of Lot 2, and younger cedar along the western, eastern, and northern margins of the site. Scattered brush is encountered throughout the property, and within designated landscaping areas within Lot 1. The subject property is relatively level, with minimal grade change observed over its extent.

No hydrologic features were observed on site, such as seeps, springs, ponds and streams, though scattered ponding had been observed within tire ruts along the south side of the Lot 2.

3.2 Soil Conditions

We observed subgrade conditions through the advancement of two test pit explorations, one in the general vicinity of the proposed infiltration trench for this project, with the second being conducted towards the north end of the proposed pervious driveway alignment. Underlying a surface mantle of sod and topsoil, we encountered poorly consolidated alluvial soils, which ranged in composition from fine silty sand to silt. Given the geographic location of the project area, native soils are associated with the flood plains of the adjacent Puyallup River. Extensive soil mottling was observed throughout the soil column but was highly concentrated within the larger silt lenses. Poorly consolidated alluvial soils were observed through the termination of the explorations conducted for this project, a maximum depth of 9 feet below existing grade.

In the *Geologic Map of the Tacoma 1:100,000-scale Quadrangle, Washington,* as prepared by the Washington State Department of Natural Resources (2015), the project site is mapped as containing Qa, or Quaternary Alluvium. Additionally, the National Cooperative Soil Survey (NCSS) for Pierce County, Washington, classifies soils within the northern half of the property as 42A-Sultan silt loam, and soils within the southern half of the property as 6A-Briscot loam. Each soil group reportedly formed in alluvial flood plain deposits, and is texturally comprised of sand, loam, silt loam and clay loam. Our field observations generally conform with the site classifications prepared by both the USGS and NCSS. An excerpt from the referenced geologic mapping is presented below (page 5).



The enclosed exploration logs (Appendix A) provide a detailed description of the soil strata encountered in our subsurface explorations.

3.3 Groundwater Conditions

During the advancement of our test pit explorations (December 31, 2020), we encountered perched groundwater along a depth of 3½ to 5 feet below existing grade. Given the topographic and geographic setting of the project area, we do not believe that this is indicative of actual groundwater levels, but rather representative of seasonally perched groundwater. Additionally, we installed five, 6-foot monitoring wells along the course of the pervious driveway and proposed infiltration trench, and conducted regular groundwater measurements between December 31, 2020, and April 30, 2021. In total, we conducted 17 weekly groundwater measurements over this timeframe, with maximum groundwater levels being observed as shown in Table 2. Additional monitoring was done after heavy rain events. We anticipate that perched groundwater will be observed along shallow elevations over the "rainy season" (November 1 to March 31), or during periods of extended precipitation. Groundwater levels fluctuate with localized geology and precipitation. Table 2 below shows the depth to water in each monitoring port over this time frame. The Daily field report are attached.

	MW-1	MW-2	MW-3	MW-4	MW-5
1/4/2021	0	9.5	11	4.5	11
1/13/2021	0	8	7.5	5.5	14
1/22/2021	24	31	32	33	27
1/29/2021	28	35	36	37.5	41
2/2/2021	18.5	25	27	28	31.5
2/12/2021	24	31	33	34	36.5
2/19/2021	23	30	31.5	32.5	36.5
2/22/2021	3.5	13.5	16	14.5	11
3/5/2021	29.5	36.5	38	40.5	43
3/12/2021	53.5	60	57.5	53.5	NA
3/19/2021	54.5	60	38	40.5	43
3/26/2021	29.5	36.5	38	40.5	43
4/2/2021	56.5	62.5	61	NA	NA
4/9/2021	62	NA	66.5	NA	NA
4/16/2021	NA	NA	NA	NA	NA
4/23/2021	NA	NA	NA	NA	NA
4/30/2021	NA	NA	NA	NA	NA

Measurement are depth from ground surface to water level in inches.
*NA - No water present

3.4 Infiltration Conditions and Infiltration Rate

As indicated in the *Soil Conditions* section of the report, the site is underlain by slowly permeable alluvial soils, with seepage being encountered at approximately 3 ½ to 5 feet. These hydrogeologic conditions would generally translate into poor infiltration conditions; however, it is our understanding that field infiltration testing is necessary to validate the infeasibility of stormwater retention. As such, we conducted two Small-Scale Pilot Infiltration Tests adjacent to proposed improvements, at the location indicated in the attached Figure 2. After adding the requisite amount of water to achieve 12-inches of head within the test area, no additional water was needed to maintain these levels during the steady-state period, and no drawdown was observed over the falling head period of the test. With a net field infiltration rate of zero for both the steady-state and falling head periods of the test, we interpret infiltration as being infeasible for this project, and site-produced stormwater should be managed through dispersion or collected and diverted to an existing system along Stewart St.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Development plans involve the construction of a new single-family residence towards the center of the south end of Lot 2, directly north of the west end of the existing greenhouse. The existing gravel driveway will also be improved and expanded to access the proposed residence. Site produced stormwater will be retained on site if feasible, and the improved driveway will be constructed using pervious pavement. We offer these recommendations:

- Feasibility: Based on our field explorations, research, and evaluations, the proposed development appears feasible from a geotechnical standpoint.
- Infiltration Conditions: The site is underlain by slowly permeable alluvial soils, with seepage being encountered at approximately 3 ½ to 5 feet. These hydrogeologic conditions generally translate into poor infiltration conditions, which was verified by conducting two Small-Scale Pilot Infiltration Tests adjacent to proposed improvements. With a net field infiltration rate of zero for both the steady-state and falling head periods of the tests, we interpret infiltration as being infeasible for this project, and site-produced stormwater should be managed through dispersion, or collected and diverted to an existing system along Stewart St.

The following sections present our specific geotechnical conclusions and recommendations concerning site preparation, spread footings, slab-on-grade floors, subgrade walls, and structural fill. The Washington State Department of Transportation (WSDOT) Standard Specifications and Standard Plans cited herein refer to WSDOT publications M41-10, *Standard Specifications for Road, Bridge, and Municipal Construction*, and M21-01, *Standard Plans for Road, Bridge, and Municipal Construction*, respectively.

4.1 Site Preparation

Preparation of the project site should involve erosion control, temporary drainage, cutting, filling, excavations, and subgrade compaction.

Erosion Control: Before new construction begins, an appropriate erosion control system should be installed. This system should collect and filter all surface water runoff through silt fencing. We anticipate a system of berms and drainage ditches around construction areas will provide an adequate collection system. Silt fencing fabric should meet the requirements of WSDOT Standard Specification 9-33.2 Table 3. In addition, silt fencing should embed a minimum of 6 inches below existing grade. An erosion control system requires occasional observation and maintenance. Specifically, holes in the filter and areas where the filter has shifted above ground surface should be replaced or repaired as soon as they are identified.

Temporary Drainage: We recommend intercepting and diverting any potential sources of surface or near-surface water within the construction zones before stripping of surficial organic soils begins. Because the selection of an appropriate drainage system will depend on the water quantity, season, weather conditions, construction sequence, and contractor's methods, final decisions regarding drainage systems are best made in the field at the time of construction. Based on our current understanding of the construction plans and surface and subsurface conditions, we anticipate that curbs, berms, or ditches placed around the work areas will adequately intercept surface water runoff.

Clearing and Stripping: After surface and near-surface water sources have been controlled, sod, topsoil, and root-rich soil should be stripped from the site. Stripping has largely been conducted across the project site, although organic-laden soils still extend upwards of 6 inches across the subject lot.

Site Excavations: Based on our explorations, we expect that site excavations will encounter poorly consolidated alluvial soils, which range in composition from fine silty sand to silt, which can be readily excavated using standard excavation equipment.

Dewatering: Perched groundwater was encountered at a depth of 3½ to 5 feet during the advancement of supplemental explorations. Additionally, as evidenced by our groundwater monitoring, stormwaters saturate near surface soils and begin to sheet flow after heavy periods of precipitation. If groundwater is encountered during project excavations, we anticipate that an internal system of ditches, sump holes, and pumps will be adequate to temporarily dewater excavations.

Subgrade Compaction: Exposed subgrades for footings, slabs, and floors should be compacted to a firm, unyielding state before new concrete or fill soils are placed. Any localized zones of looser granular soils observed within a subgrade should be compacted to a density commensurate with the surrounding soils. In contrast, any organic, soft, or pumping soils observed within a subgrade should be over-excavated and replaced with a suitable structural fill material. Surface compaction of all footing and slab subgrades is recommended, although surface compaction could become problematic during wet weather conditions or when in situ site soils become wet.

Site Filling: Our conclusions regarding the reuse of onsite soils and our comments regarding wet-weather filling are presented subsequently. Regardless of soil type, all fill should be placed and compacted according to our recommendations presented in the *Structural Fill* section of this report. Specifically, building pad fill soil should be compacted to a uniform density of at least 95 percent (based on ASTM D-1557).

Onsite Soils: We offer the following evaluation of these onsite soils in relation to potential use as structural fill:

- *Surficial Organic Soils*: Sod, topsoil, and forest duff are *not* suitable for use as structural fill under any circumstances, due to their high organic content. Consequently, these materials can be used only for non-structural purposes, such as in landscaping areas.
- *Alluvial Soils*: As encountered onsite, this material ranges in composition from fine silty sand to silt. Additionally, this material is often encountered in an oversaturated in situ condition and will require substantial moisture conditioning prior to reuse as structural fill. This material should be considered extremely moisture sensitive and will be difficult if not impossible to adequately reuse this material as a structural fill during periods of extended precipitation. If substantial fill soils are required for this project, we recommend importing a manufactured material such as a crushed rock.

Temporary Cut Slopes: All temporary cut slopes in site soils should be no steeper than 1½ H:1V and should conform to Washington Industrial Health and Safety Act (WISHA) regulations.

Permanent Slopes: All permanent cut slopes and fill slopes should be adequately inclined to reduce long-term raveling, sloughing, and erosion. We generally recommend that no permanent slopes be steeper than 2H:1V. For all soil types, the use of flatter slopes (such as 2½H:1V) would further reduce long-term erosion and facilitate revegetation.

Slope Protection: We recommend that a permanent berm, swale, or curb be constructed along the top edge of all permanent slopes to intercept surface flow. Also, a hardy vegetative groundcover should be established as soon as feasible, to further protect the slopes from runoff water erosion. Alternatively, permanent slopes could be armored with quarry spalls or a geosynthetic erosion mat.

5.0 RECOMMENDED ADDITIONAL SERVICES

Because the future performance and integrity of the structural elements will depend largely on proper site preparation, drainage, fill placement, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. Subsequently, we recommend that MGI be retained to provide the following post-report services:

- Review all construction plans and specifications to verify that our design criteria presented in this report have been properly integrated into the design,
- Prepare a letter summarizing all review comments (if required),
- Check all completed subgrades for footings and slab-on-grade floors before concrete is poured to verify their bearing capacity, and
- Prepare a post-construction letter summarizing all field observations, inspections, and test results (if required).

6.0 CLOSURE

The conclusions and recommendations presented in this report are based, in part, on the explorations that we observed for this study; therefore, if variations in the subgrade conditions are observed at a later time, we may need to modify this report to reflect those changes. Also, because the future performance and integrity of the project elements depend largely on proper initial site preparation, drainage, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. MGI is available to provide geotechnical monitoring of soils throughout construction.

We appreciate the opportunity to be of service on this project. If you have any questions regarding this report or any aspects of the project, please feel free to contact our office.

Respectfully submitted,

MIGIZI GROUP, INC.

Zach L. Logan, LG
Project Geologist

Casey R. Lowe, PE
Principal Engineer

APPENDIX A
SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

TEST PIT LOGS

MIGIZI GROUP, INC.

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FAX (253) 537-9401

November 2, 2022

Danny Foster
2345 W Stewart St
Puyallup, WA 98371

Subject: **Response to City Comments**
Farris Short Plat – Lot 2
2345 W Stewart St
Puyallup, WA 98371
Parcel No. 0420207029

MGI Project P2271-T20

Dear Mr. Foster:

Migizi Group, Inc. (MGI) is pleased to submit this response to City of Puyallup comments highlighted in an email chain with the client and the civil engineer of record Azure Green Consultants on April 21, 2022, for the site located at the above-referenced address in Puyallup, WA. The corrections and responses are noted below.

Corrections:
"Fire will require that a Geotech evaluate the existing gravel/soils to ensure it meets the necessary loading requirements of an emergency vehicle per the currently adopted Fire Code. As long as the existing gravel can meet emergency vehicle needs, additional paving beyond the first 50' of the driveway will not be required. Note that the fire truck turnaround is still necessary, and any proposed gravel is considered new pollution generating hard surfaces as outlined by the Ecology manual. Lastly, the Geotech should speak to the trenching that will be done within the driveway for utilities and how the trench shall be compacted/backfilled such that the soil structure is not compromised for an emergency vehicle."

Response:
The existing gravel driveway and the proposed alignment of the fire truck turnaround has been serving the Farris Vet Clinic for access and overflow parking since its founding in the early 1980's. As such, it has seen surcharge vehicle loads that has resulted in extensive subgrade consolidation across these regions. This was verified onsite on September 28, 2022 when MGI personnel observed a proof roll of the driveway/turnaround alignment. The proof roll was conducted with a fully loaded backhoe with rubber tires, which weighs ± 12,500-lbs unloaded, roughly equivalent

to an empty fire truck. The existing subgrade was observed in a firm and unyielding condition, with no deflection and/or rutting being observed. Additionally, conversations with the property owner indicate that a large fire developed onsite in 2008, which resulted in the mobilization of 8 to 9 service vehicles to quell the flames. The service trucks were able to access the property without getting stuck or unduly hindered during operations. Based upon these observations it is our opinion that additional paving beyond the first 50 feet of the driveway is not necessary, and that the existing driveway can support loading requirements of an emergency vehicle per the currently adopted Fire Code. Additionally, it is our understanding that additional trenching along the existing driveway for utility installation is not currently being proposed, with relevant utilities already being in-place.

We appreciate the opportunity to be of service on this project. If you have any questions regarding this report or any aspects of the project, please feel free to contact our office.

Respectfully submitted,

MIGIZI GROUP, INC.

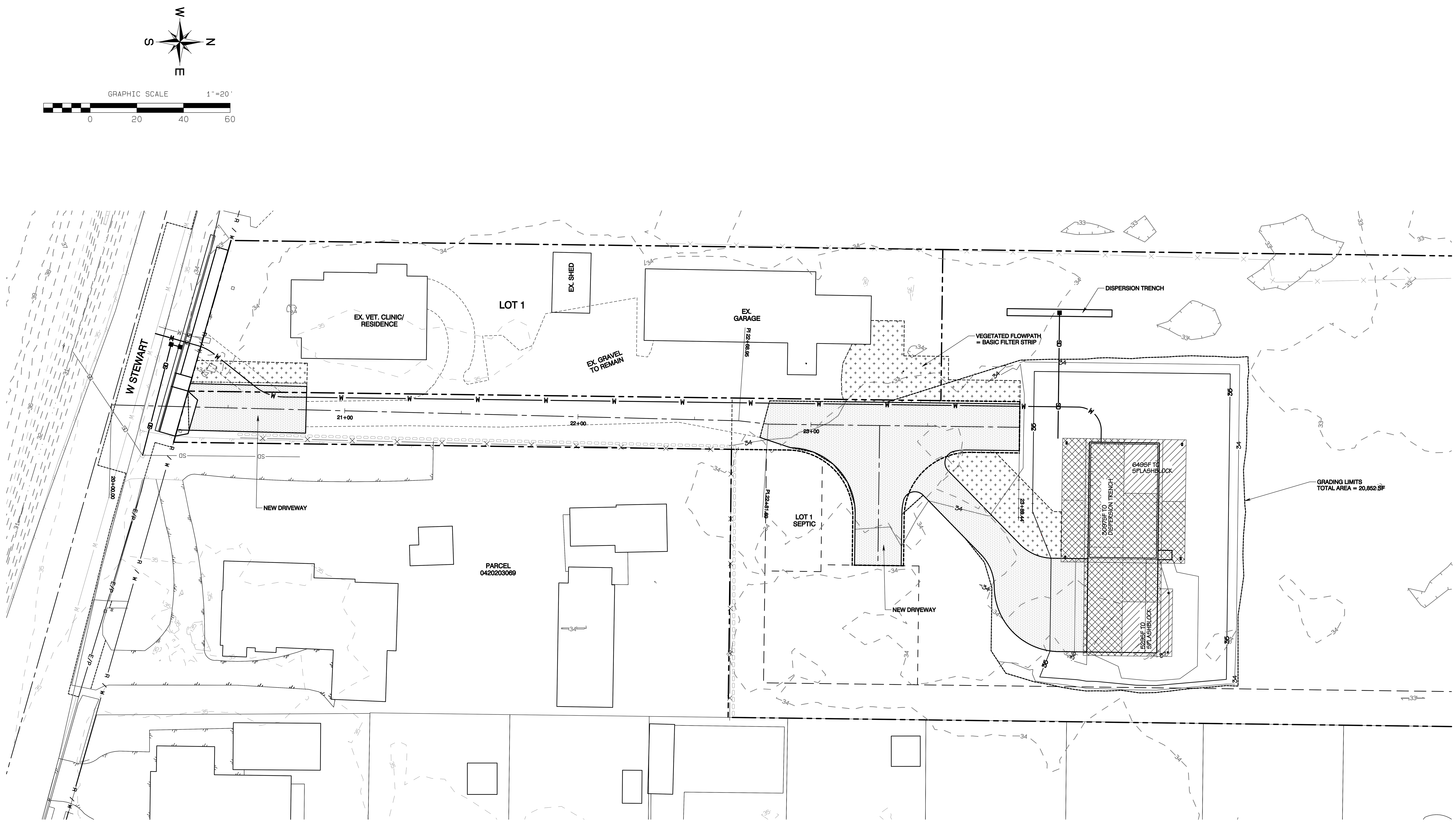
11/02/22

Zach Logan, LG
Project Geologist

James E. Brigham, P.E.
Senior Principal Engineer

Farris Short Plat - Lot 2 Drainage Report

Section 29, Township 20 N, Range 4 E, Willamette Meridian, Pierce County, Washington



Drainage Areas

Farris Short Plat

Richard & Kathy Farris
2401 W Stewart
Puyallup, WA, 98371
Phone 253.255.3413 Fax

AZURE | GREEN CONSULTANTS
+feasibility +planning +engineering +surveying
409 East Pioneer, Suite A - Puyallup, WA 98372 phone: 253.770.3144 fax: 253.770.3142

JOB NO:	2349
DATE:	December 18, 2022
DESIGNED BY:	Rob Trivitt
DRAWN BY:	Rob Trivitt
CHECKED BY:	Jim Job
APPROVED BY:	Paul Green

REVISION	DATE
1	
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DRAWING
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OF 1