Land Surveying Civil Engineering Land Use Planning Landscape Architecture

CITY OF CAMAS

PRELIMINARY DRAINAGE ANALYSIS

NW 18TH AVE SUBDIVISION

MODERN DWELLINGS, LLC

JOB # 10212.01.02

REVIEWED BY: PETER A. TUCK, P.E.

DESIGNED BY: ALEX KNOPP

Preliminary Drainage Analysis

NW 18th Ave Subdivision

Modern Dwellings, LLC

10212.01.01

April 22, 2022

Designed by: Alex Knopp
Reviewed by: Peter Tuck, P.E.

Olson Engineering Inc.
222 E Evergreen Blvd
Vancouver, WA 98660
360-695-1385

REVISION	BY	DATE	COMMENTS

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General Location

Account: 127439000, 127359000, 127356000
Owner: MODERN DWELLINGS LLC
Address: 8101 NE GLISAN ST
C/S/Z: PORTLAND, OR 97213

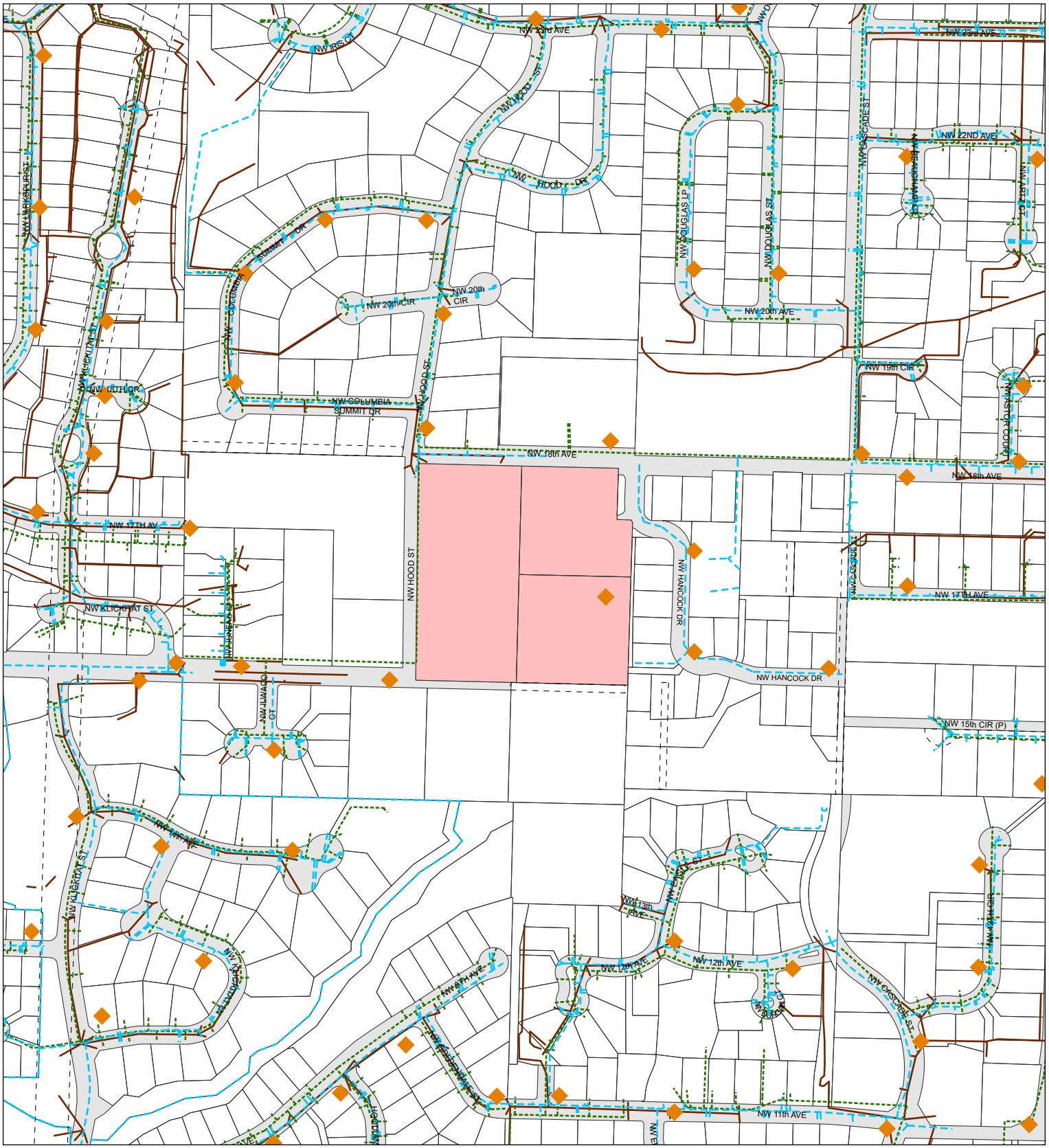
Location of Subject Property(s)

Printed on: April 21, 2022

Geographic Information System

0 1,000 2,000 Feet

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.



Water, Sewer, and Storm Systems

Account: 127439000, 127359000, 127356000
Owner: MODERN DWELLINGS LLC
Address: 8101 NE GLISAN ST
C/S/Z: PORTLAND, OR 97213

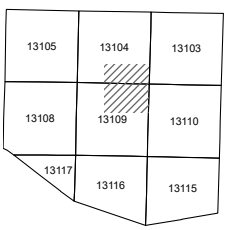
Printed on: April 21, 2022

CLARK COUNTY, WASHINGTON
Geographic Information System

0 200 400 Feet

N

- Subject Property(s)
- Public Road
- Transportation or Major Utility Easement
- 1-Year Wellhead ZOC
- 5-Year Wellhead ZOC
- 10-Year Wellhead ZOC
- Water Lines
- Sewer Lines
- Storm Water Lines
- Hydrants



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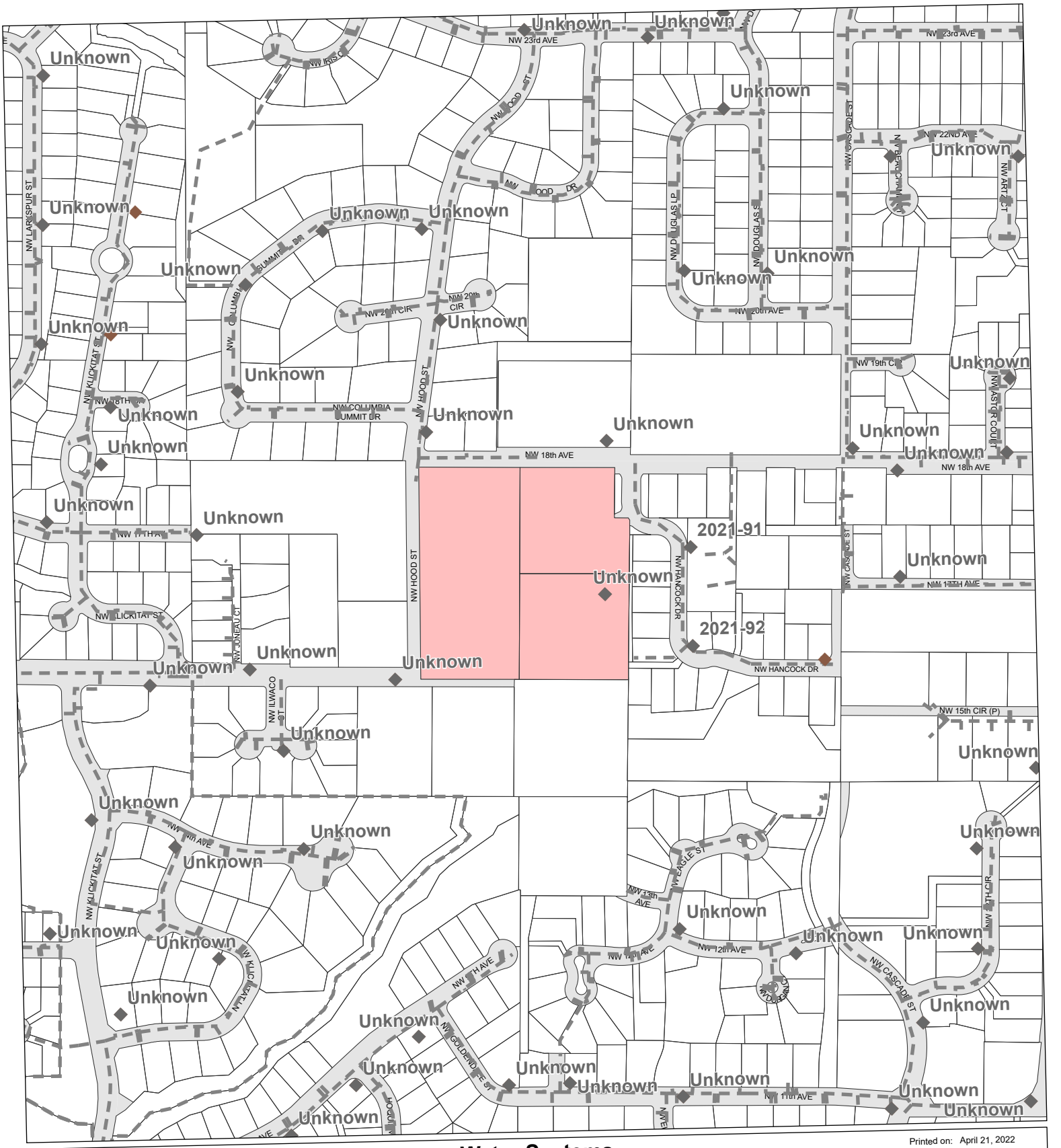

Water Systems

Account: 127439000, 127359000, 127356000
Owner: MODERN DWELLINGS LLC
Address: 8101 NE GLISAN ST
C/S/Z: PORTLAND, OR 97213

Printed on: April 21, 2022

CLARK COUNTY, WASHINGTON
Geographic Information System

0 200 400 Feet

N

- Subject Parcel
- Public Road
- Water District Boundary
- Unknown Size Water Line
- < 10" Water LIne
- 10-20" Water Line
- > 20" Water Line
- No Flow Data Hydrant
- 0 - 499 GPM at 20 PSI
- 500 - 999 GPM at 20 PSI
- > 1000 - 1749 GPM at 20 PSI
- > 1750 GPM at 20 PSI
- Hydrant > 500' from parcel(s)

13105	13104	13103
13108	13109	13110
13117	13116	13115

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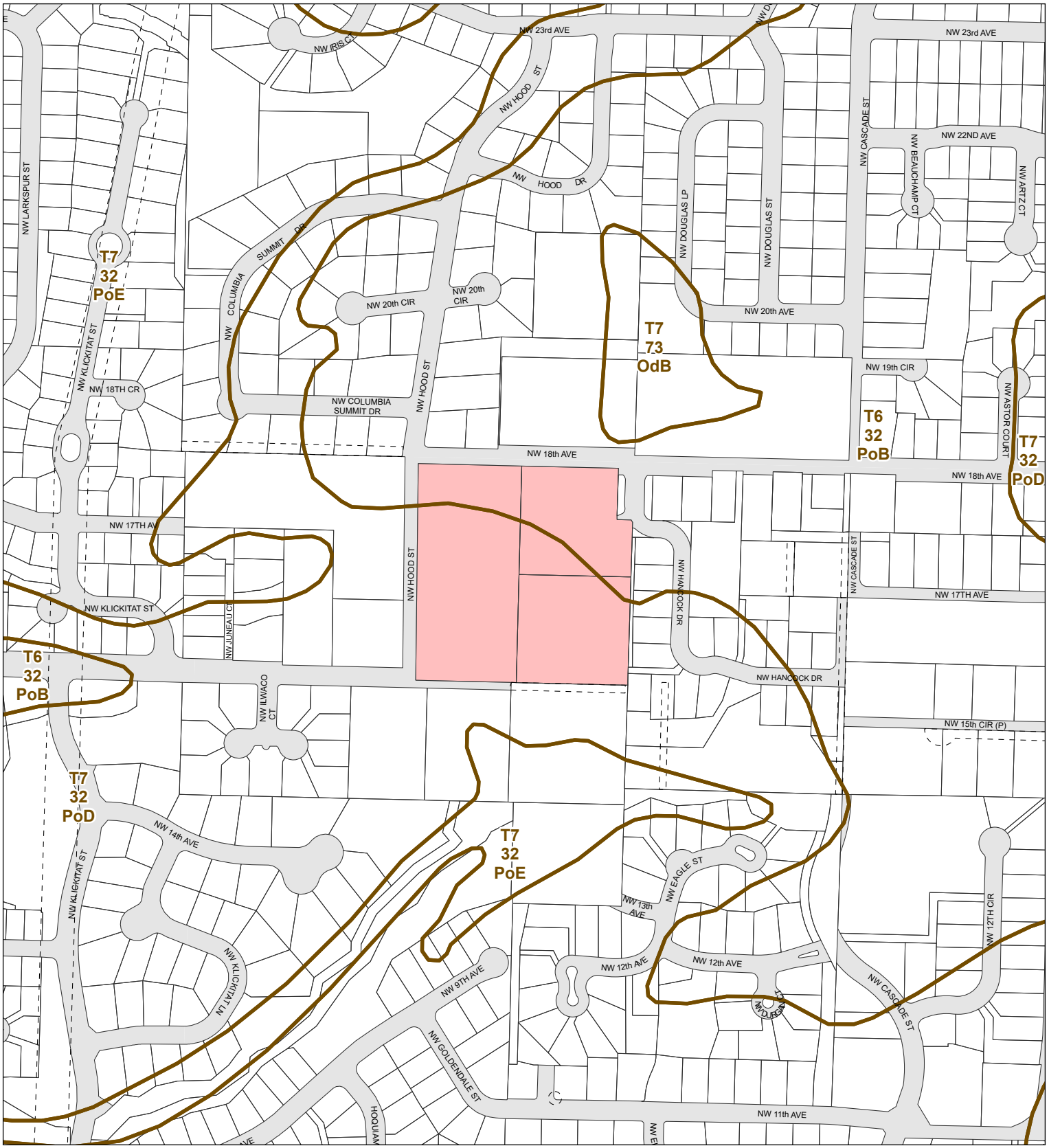

CLARK COUNTY, WASHINGTON
Geographic Information System

0 200 400 Feet

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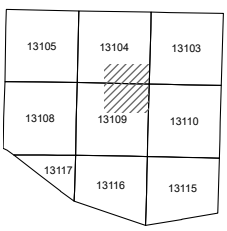
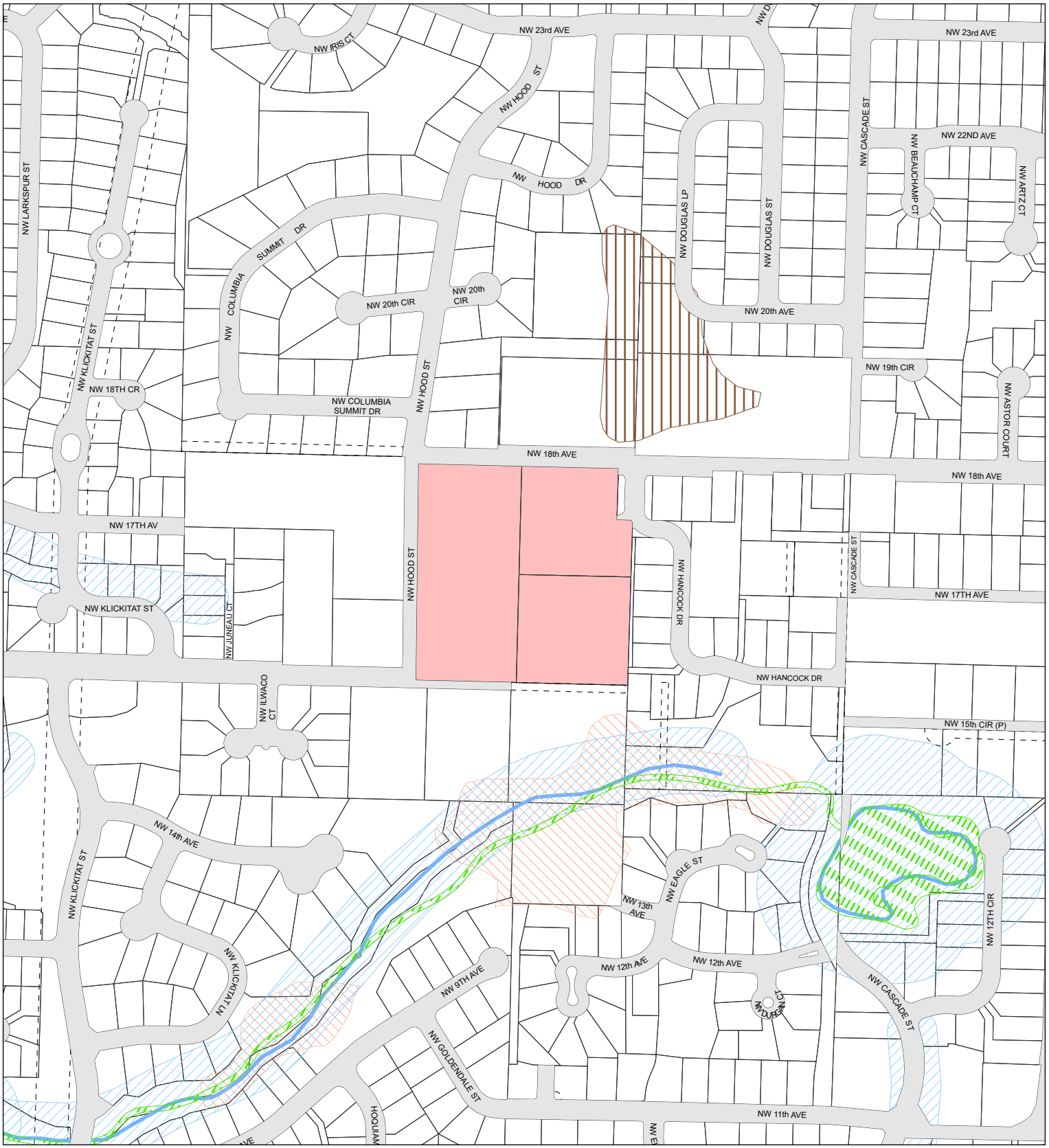
Soil Types

Account: 127439000, 127359000, 127356000
Owner: MODERN DWELLINGS LLC
Address: 8101 NE GLISAN ST
C/S/Z: PORTLAND, OR 97213

Subject Property(s)
Public Road
Transportation or Major Utility Easement
Soil Type Boundary

Printed on: April 21, 2022



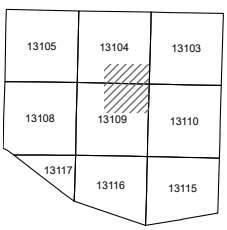


Environmental Constraints I

Printed on: April 21, 2022

Account: 127439000, 127359000, 127356000
Owner: MODERN DWELLINGS LLC
Address: 8101 NE GLISAN ST
C/S/Z: PORTLAND, OR 97213

- Subject Property(s)
- Public Road
- Transportation or Major Utility Easement
- Hydric Soils
- Wetland Inventory
- CARA Category 1
- Riparian Habitat or Species Area
- Non-Riparian Habitat or Species Area
- 100 year Floodplains
- Floodway
- Shorelines
- Stream



CLARK COUNTY, WASHINGTON
Geographic Information System

N

0 200 400 Feet

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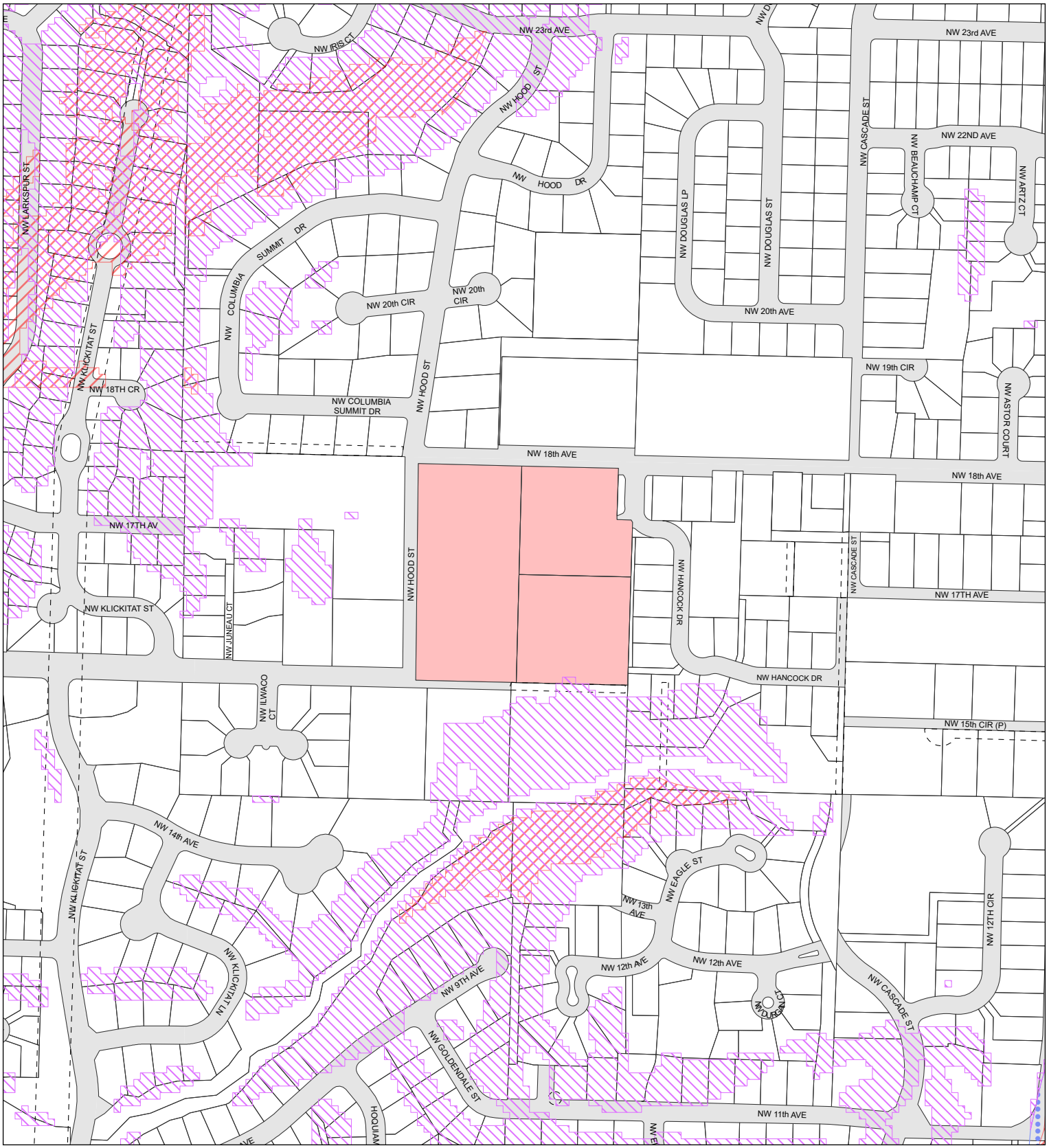
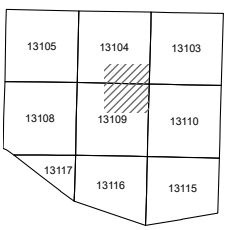


Environmental Constraints II

Account: 127439000, 127359000, 127356000
Owner: MODERN DWELLINGS LLC
Address: 8101 NE GLISAN ST
C/S/Z: PORTLAND, OR 97213

Printed on: April 21, 2022

- Subject Property(s)
- Public Road
- Transportation or Major Utility Easement
- Slopes > 15%
- Potentially Unstable Slope
- Historic or Active Landslide
- Severe Erosion Hazard Area
- Forest Moratorium Area
- CCHR Historic Site
- NRHP Historic Site
- WSHR Historic Site
- WSHR Historic Barn
- INV Historic Site



CLARK COUNTY, WASHINGTON
Geographic Information System

N

0 200 400 Feet

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Section A – Project Overview

1. Describe the site location.

The proposed NW 18th Avenue Subdivision project site is approximately 9.82 acres in size and located on the east side of NW Hood Street and the south of NW 18th Avenue in the city of Camas Washington. The development occupies parcels 127356-000, 127359-000, and 127439-000.

2. Describe the topography, natural drainage patterns, vegetative ground cover, and presence of critical areas (CMC Title 16). Critical areas that receive runoff from the site shall be described to a minimum of ¼ mile away from the site boundary.

The site slopes generally from northeast to southwest with grades ranging from 10% to 15%. The steeper slopes 15% to 25% reside in the south-central portion of the site. The site is predominantly covered with grass with trees and shrubs concentrated around the existing structures. Stormwater runoff from the site drains across the site to the southwest sheet flowing to two different points along the west and south boundary lines. The southern release point drains to a natural channel that is eventually conveyed to Deer Creek located southeast of the site. The west boundary line directs stormwater into a roadside ditch along Hood St. that will discharges stormwater west along NW 16th Ave. There are no critical areas within the site.

3. Identify and discuss existing onsite stormwater systems and their functions

Stormwater is not being controlled onsite for the existing structures and impervious surfaces. Because of the poor soils onsite and large pasture area the impervious areas on the site discharge directly to the pastureland. Whatever stormwater is not infiltrating sheet flows southwest towards the roadside ditches.

4. Identify and discuss site parameters that influence stormwater system design.

According to the Geotechnical Site Investigation completed by Columbia West Engineering, Inc., the soils within the site were moist to damp with no groundwater encountered at depths of 13.5-foot during pit tests. As a result, a closed stormwater cartridge treatment facilities are being proposed combined with an open detention pond. Since the Geotechnical Site Investigation determined the soils onsite as having less than 0.06 inches per hour infiltration rate, all stormwater modeling in WWHM2012 assume saturated soil conditions with Soil Group 4 characteristics. This is described in greater detail in Section C “Soils Evaluation” of this report.

5. Describe drainage to and from adjacent properties.

Stormwater runoff from the site generally drains across the site in the southwest direction to two different points along the west and south boundary line. The southern release point drains to a natural stream that is eventually conveyed SW to the Columbia River. The western release point drains to NW Hood St. roadside ditch which discharges stormwater west to NW 16th Ave. The site receives offsite runoff from portions of parcel #98605219, 986058220, 986058221, 986058222 and 986058223 located east of the lots.

6. Describe adjacent areas, including streams, lakes, wetland areas, residential areas, and roads that might be affected by the construction project.

The site is bordered on the south by existing residential developments and east by a future residential development. It is bordered on the west by NW Hood St and the north is bordered by NW 18th Ave. Frontage improvements to these roads are proposed as part of the development.

7. Generally describe proposed site construction, size of improvements, and proposed methods of mitigating stormwater runoff quantity and quality impacts.

The proposed development is on a 9.82 acres site in size and includes construction of a 34-lot residential subdivision. Site construction includes frontage improvements along NW Hood Street, and NW 18th Avenue for a development of 0.61 acres, in addition to new onsite roads, sidewalks, driveways, homes, and landscape areas. Improvements include roads (1.27 acres onsite and 0.52 acres offsite), roofs (2.27 acres), sidewalks (0.50 acres), personal driveways (0.45 acres), and landscape and open spaces (5.32 acres onsite and 0.09 acres offsite).

Stormwater runoff from the proposed development is to be captured and routed via pipes to an above ground stormwater facility for detention and a corresponding cartridge treatment unit. The stormwater facility will be located in the southwest corner of the site in Tract “B”. The stormwater outlet control structure will direct stormwater through a pipe under NW 16th Avenue to tie into an existing stormwater system. The stormwater facility will have a cartridge treatment unit upstream to meet City of Camas phosphorus control requirements. All the roofs and landscaping areas in lots will be captured via pipe and conveyed directly into the proposed detention pond.

Section B – Minimum Requirements

1. Describe the land-disturbing activity and document the applicable minimum requirements for the project site. Include the following information in table form: a) amount of existing impervious surface, b) new impervious surface, c) replaced impervious surface, d) native vegetation converted to lawn or landscaping, e) native vegetation converted to pasture, and f) total amount of land-disturbing activity in table format.

The site will have one Threshold Discharge Area (TDA1) and discharged to a single point on the southwest corner of the site that get eventually conveyed via pipe to an existing stormwater system west of the site along NW 16th Avenue. New onsite and offsite land-disturbing activity for this proposal is approximately 9.98 acres of the 9.82-acre site and 0.61 acre right of way improvements.

The site is predominantly covered with grass with trees and shrubs concentrated around existing structures. There is one large existing house, garage and shed within the site. The proposed development includes the addition of 2.12 acres of new roof, 1.79 acres of new asphalt pavement, 0.50 acre of new concrete sidewalks, and 0.30 acres of new concrete driveway that are all classified as “New Impervious Surface”. The proposed development also includes 5.42 acres of new landscaping that is classified as “Native Vegetation Converted to Lawn or Landscaping”.

Per Figure 1.1 from the City of Camas Stormwater Design Standards Manual, the development needs to apply the Minimum Requirements as outlined in Figure 1.2. This was determined because the project site will discharge stormwater directly into a Municipal Separate Storm Sewer System owned and operated by the City of Camas and there will be more than 1 acre of disturbance. Per Figure 1.2, since the site has less than 35% of existing impervious surface and the development will add more than 5,000 SF of new impervious surface, Minimum Requirements #1 through #9 will apply to the new impervious surfaces and the converted pervious surfaces.

Refer to Fig. 1.1 and 1.2, included in Appendix C.

The following table summarizes the proposed site changes:

	TDA 1
Existing Impervious Surface (Acres)	1.26
New Impervious Surface (Acres)	4.71
Replaced Impervious Surface (Acres)	0.96
Existing Impervious Surface to Remain (Acres)	0.30
Native vegetation converted to lawn or landscaping (Acres)	5.42
Native vegetation converted to pasture (Acres)	0.00
Total land-disturbing activity (Acres)	9.98

Table B1: Site Improvement Summary

2. **Provide a statement that confirms the minimum requirements that will apply to the development activity. For land-disturbing activities where minimum requirements 1 through 10 must be met include the following: a) Provide the amount of effective impervious area in each TDA, and document through an approved continuous runoff simulation model the increase in the 100-year flood frequency from pre-developed to developed conditions for each TDA, b) list the TDAs that must meet the runoff control requirements listed in Minimum Requirement 6, c) list the TDAs that must meet the flow control requirements listed in Minimum Requirement 7, and d) list the TDAs that must meet the wetlands protection requirements listed in Minimum Requirement 8.**

   The 1.79 acres of new asphalt pavement, 0.50 acre of new sidewalk, and 0.30 acres of new driveways are classified as “Effective Pollution Generating Impervious Surface” (PGIS). The 5.42 acres of landscaping is classified as “Effective Pollution Generating Pervious Surface” (PGPS). The following table summarizes the additional characteristics that determine compliance with Minimum Requirements 6, 7, and 8:

	TDA 1
Effective Pollution Generating Impervious Surface (PGIS) (Acres)	2.59
Effective Pollution Generating Pervious Surface (PGPS) (Acres)	5.42
Does the Large Water Body Exemption apply to this project?	No
Does the 100-year runoff increase by more than 0.1 cfs?	Yes
Does the project discharge directly or indirectly (through a conveyance system) into a wetland?	No

Table B2: Additional Compliance Characteristics

As a result of these surface cover characteristics, the following Minimum Requirements are triggered for this project per the City of Camas Stormwater Design Standards Manual:

	TDA1
Minimum Requirement 2 (Construction Stormwater Pollution Prevention)	Yes
Minimum Requirements 1, 3, 4, and 5 (Stormwater Site Plans, Source Control, Preservation of Natural Drainage Systems & Outfalls, Onsite Stormwater Management)	Yes
Minimum Requirement 6 (Runoff Treatment)	Yes
Minimum Requirement 7 (Flow Control)	Yes
Minimum Requirement 8 (Wetlands Protection)	No

Table B3: Applicable Minimum Requirements

Section C – Soils Evaluation

1. **Describe the site's suitability for stormwater infiltration for flow control, runoff treatment, and low impact development (LID) measures.**

   Columbia West Engineering, Inc. has completed a Geotechnical Site Investigation for this development (see Appendix F). Test pits were excavated on site and it was determined that the soil was moist to damp with no groundwater encountered at depths of 13.5 feet. The report included infiltration testing that showed rates of less than 0.06 inches per hour of infiltration. As a result, infiltration is not being considered as a viable option for flow control or treatment on this project.

2. **Identify water table elevations, flow directions (where available), and data on seasonal water table fluctuations with minimum and maximum water table elevations where these may affect stormwater facilities.**

   Columbia West Engineering, Inc. has completed a Geotechnical Site Investigation for this development (see Appendix F). Six test pits were excavated on site. Soil moisture conditions were moist to damp with no groundwater encountered in any of the test pits. With the proposed open above ground detention system, groundwater elevations shouldn't impact the stormwater facilities.

3. **Identify and describe soil parameters and design methods for use in hydrologic and hydraulic design of proposed facilities.**

   The Soil Survey of Clark County by the Soil Conservation Service shows the soil onsite is primarily Powell Silt Loam (PoD) and (PoB). (See Vicinity Maps Section and Appendix A of this report for the Soils Map). The soil properties are as follows:

   <u>Powell Silt Loam</u> (PoD)(PoB)

   Classification: Hydrologic Group D / SG4

   Permeability: 0-24 in. depth, < 0.06 in/hr

Curve Numbers:	Meadow/Pasture	CN=89
	Grass/Landscape:	CN=90
	Pavement/Sidewalk:	CN=98
	Roof:	CN=98

A detailed list of the runoff curve numbers used in conveyance design is included in Appendix B. According to the Geotechnical Site Investigation by Columbia West Engineering, Inc. (See Appendix F), soil mottling, the presence of clay soils, and the prevalent groundwater seepage indicates that the soils onsite will likely accept little runoff and would be expected to behave more as a Hydrologic Soil Group 4 soil rather than Soil Group 3. As a result, onsite soils have been modeled as a Hydrologic Soil Group 4 for purposes of the stormwater calculations.

Conveyance design for the development is to be completed at time of final design. Runoff for conveyance design is to be estimated using the Santa Barbara Urban Hydrograph (SBUH) methodology. The following design storms are to be used in the hydrologic analysis:

2-year, 24-hour storm	2.8 inches of rainfall
10-year, 24-hour storm	3.8 inches of rainfall
100-year, 24-hour storm	5.0 inches of rainfall
Water Quality Storm (0.70 x 2-year storm)	1.96 inches of rainfall

Isopluvial maps for the 2-year, 10-year, and 100-year storms are included in Appendix B.

4. Report findings of testing and analysis used to determine the infiltration rate.

Due to the soils being damp and poor permeability of the existing soil, infiltration is not being proposed for this development.

5. Where unstable or complex soil conditions exist that may significantly affect the design of stormwater facilities, the responsible official may require a preliminary soils report that addresses stormwater design considerations arising from soil conditions. The preliminary soils report shall be prepared by a registered professional engineer proficient in geotechnical investigation and engineering or a registered soil scientist. The preliminary soils report shall include a soils map developed using the criteria set in the *NRCS National Soil Survey Handbook* (NRCS 2007) and the *SCS Soil Survey Manual* (SCS 1993), at a minimum scale of 1:5,000 (12.7 inch/mile).

A Geotechnical Site Investigation Report has been prepared by Columbia West Engineering, Inc. (see Appendix F). Additional information will be provided, if required.

Section D – Source Control

1. **If the development activity includes any of the activities listed in Section 2.2 of Volume IV of the *Stormwater Management Manual for Western Washington* (SMMWW), identify the source control BMPs to be used with the land-disturbing activity.**

The following Source Control BMPs apply to this project:

- BMPs for Landscaping and Lawn/Vegetation Management
    - Install engineered soil/landscape systems to improve the infiltration and regulation of stormwater in landscaped areas.
    - Do not dispose of collected vegetation into waterways or storm drainage systems.

- BMPs for Maintenance of Stormwater Drainage and Treatment Systems
    - Inspect and clean conveyance system, and catch basins as needed, and determine whether improvements in O & M are needed.
    - Promptly repair any deterioration threatening the structural integrity of the facilities. These include replacement of clean-out gates and catch basin lids.
    - Ensure that storm sewer capacities are not exceeded and that heavy sediment discharges to the sewer system are prevented.
    - Regularly remove debris and sludge from BMPs used for peak-rate control, treatment, etc. and discharge to sanitary sewer if approved by the sewer authority, or truck to a local or state government approved disposal site.
    - Clean catch basins when the depth of deposits reaches 60 percent of the sump depth as measured from the bottom of basin to invert of lowest pipe into or out of the basin. However, in no case should there be less than six inches clearance from the debris surface to the invert of the lowest pipe.
    - Clean woody debris in catch basins as frequently as needed to ensure proper operation of the catch basin.
    - Post warning signs; “Dump No Waste – Drains to Ground Water,” “Streams,” “Lakes,” or emboss on or adjacent to all storm drain inlets where practical.
    - Disposal of sediments and liquids must comply with “Recommendations for Management of Street Wastes” described in Appendix IV-G of Volume IV of the Stormwater Manual.

- BMPs for Urban Streets
    - For maximum Stormwater pollutant reductions on curbed streets and high volume parking lots use efficient vacuum sweepers.
    - For moderate stormwater pollutant reductions on curbed streets use regenerative air sweepers or tandem sweeping operations.
    - For minimal stormwater pollutant reductions on curbed streets use mechanical sweepers.
    - Conduct sweeping at optimal frequencies. Optimal frequencies are those scheduled sweeping intervals that produce the most cost-effective annual reduction of pollutants normally found in stormwater and can vary depending on land use, traffic volume and rainfall patterns.

- Disposal of street sweeping solids must comply with “Recommendations for Management of Street Wastes” described in Appendix IV-G of Volume IV of the Stormwater Manual.
- Inform citizens about eliminating yard debris, oil and other wastes in street gutters to reduce street pollutant sources.
-

Additional recommended BMPs can be found in Section 2.2 of Volume IV of the Stormwater Manual.

Section E – Onsite Stormwater Management BMPs

1. **On the preliminary development plan or other maps, show the site areas where on-site stormwater management BMPs will be effectively implemented. The plan must show the areas of retained native vegetation and required flow lengths and vegetated flow paths, as required for proper implementation of each onsite stormwater BMP. Arrows must show the stormwater flow path to each BMP.**

   All stormwater runoff from the proposed development is to be captured and routed via pipes to a new stormwater facility for treatment and detention. The facility is to be located at the southwest corner of the site on Tract 'B'. The facility is to be comprised of an above ground Detention and Cartridge Treatment System. Contech "Phosphosorb" media filter cartridges are being proposed to meet City of Camas phosphorus control requirements for developments within the LaCamas watershed. The facility in Tract 'B' will discharge via pipe to the stormwater system in NW 16th Avenue to the west of the site. (Refer to Preliminary Development Plan in Appendix I for stormwater facility locations).

2. **Identify and describe geotechnical studies or other information used to complete the analysis and design of each on-site stormwater BMP.**

   Columbia West Engineering, Inc. has completed a Geotechnical Site Investigation for this development (see Appendix F). Test pits were excavated on site and it was determined that the soil was moist to damp with no groundwater seepage encountered. The report included infiltration testing that showed rates of less than 0.06 inches per hour of infiltration. As a result, infiltration is not being considered as a viable option for flow control or treatment on this project.

3. **Identify the criteria (and their source) used to complete analyses for each on-site stormwater BMP.**

   The facility has been designed to provide treatment for the water quality storm (91% of the 24-hour continuous runoff volume) in accordance with City of Camas Stormwater Design Standards Manual Section 5.03 and Volume V of the Stormwater Management Manual for Western Washington (SMMWW) and detention for the continuous storm in accordance with the requirements of the City of Camas Stormwater Design Standards Manual Section 4.02 and Volume III of the SMMWW. WWHM2012 has been used for the continuous simulation model for this development.

4. Describe how design criteria will be met for each proposed on-site stormwater management BMP.

A Detention Pond and a Stormwater Cartridge Treatment Facilities are proposed to meet treatment and flow control requirements. Stormwater treatment will be met with the Manufactured Media Cartridge Filter System and flow-control requirements will be met with the open detention pond and control structure. Since the development is located within the LaCamas watershed, phosphorus control is required per Section 5.04 of the City of Camas Stormwater Design Standards Manual. Contech "Phosphosorb" media filter cartridges were selected to meet these requirements from the Phosphorus Treatment Menu in Section 3.3 of Volume V of the SMMWW. Flow control structures with an orifice and weir will be utilized to control stormwater flows from the facility. (Refer to Appendix I for Preliminary Development Plan).

5. Describe any on-site application of LID measures planned for the project. Provide a plan that shows the proposed location and approximate size of each LID facility.

Due to the saturated soil conditions, infiltration LID measures are not applicable to this project. In addition, due to the onsite slopes and lot sizes, none of the dispersion BMP's are feasible for this site.

6. Identify and describe any assumptions used to complete the analysis.

Groundwater elevation is assumed to be below the detention volume for purposes of designing the stormwater detention facilities. The detention volume in the pond was assumed to be dry at the beginning of the modeled storm event.

7. Describe site suitability, including hydrologic soil groups, slopes, areas of native vegetation, and adequate location of each BMP.

The Soil Survey of Clark County by the Soil Conservation Service shows the soil onsite is primarily Powell Silt Loam (PoB) and (PoD). According to the Geotechnical Site Investigation by Columbia West Engineering, Inc. (See Appendix F), soil mottling, the presence of clay soils indicates that the soils onsite will likely accept little runoff and would be expected to behave more as a Hydrologic Soil Group 4 soil rather than Soil Group 3. As a result, infiltration is not proposed, and onsite soils have been modeled as a Hydrologic Soil Group 4 for purposes of the stormwater calculations.

The proposed stormwater facilities have been located within the relative low areas of the site to provide for the most efficient drainage for the developed site.

Section F – Runoff Treatment Analysis and Design

1. **Document the level of treatment required (basic, enhanced, phosphorus, oil/water separation) based on procedures in Vol. V, Chapter 2 of the SMMWW.**

   Since the development is located within the LaCamas watershed, phosphorus control is required per Section 5.04 of the City of Camas Stormwater Design Standards Manual. According to the procedures outlined in Vol. V, Ch. 2 of the Stormwater Manual, the project requires phosphorus treatment. (See Treatment Facility Selection Flow Chart in Appendix C).

2. **Provide background and description to support the selection of the treatment BMP being proposed. Include an analysis of initial implementation costs and long-term maitenance costs.**

   Due to the saturated soil conditions, it was determined that combined above ground Detention Pond and Media Cartridge Filter Systems would be the most viable treatment option for the site. A cost analysis has not been prepared but could be provided if deemed to be necessary.

3. **Identify geotechnical or soils studies or other information used to complete the analysis and design.**

   Columbia West Engineering, Inc. has completed a Geotechnical Site Investigation for this development (see Appendix F). Test pits were excavated on site and it was determined that the soil was moist to damp and groundwater was never encountered at maximum depths of 13.5 feet. The report included infiltration testing that showed rates of less than 0.06 inches per hour of infiltration. As a result, infiltration is not being considered as a viable option for flow control or treatment on this project.

4. **Identify the BMPs used in the design, and their sources.**

   A Detention and Stormwater Cartridge Treatment Facilities are proposed to meet treatment and flow control requirements. Stormwater treatment will be met with the Manufactured Media Cartridge Filter System and flow-control requirements will be met with the above ground detention pipe and outlet control structure. Since the development is located within the LaCamas watershed, phosphorus control is required per Section 5.04 of the City of Camas Stormwater Design Standards Manual. Contech “Phosphosorb” media filter cartidges were selected to meet these requirements from the Phosphorus Treatment Menu in Section 3.3 of Volume V of the SMMWW. A flow control structure with an orifice will be utilized to control stormwater flow from the facility. (Refer to Appendix I for Preliminary Development Plan).

5. Summarize the results of the runoff treatment design, and describe how the proposed design meets the requirements of CMC Chapter 14.02 and the Stormwater Manual.

Runoff from the new impervious areas (road, curb and sidewalk, and driveways) and some landscape areas will be collected and routed to the Contech Stormfilter vault for treatment. The storm flow will be routed with the required water quality flow to the treatment BMP. A tabulation of water quality treatment flow rates according to the WWHM model is below. These represent the flow rate at or above 91% of the runoff volume (in accordance with City of Camas Stormwater Design Standards Manual Section 5.03 and Volume V of the SMMWW), as estimated by an approved continuous runoff model, required to be treated. Contech "Phosphosorb" media filter cartridges were selected to meet these requirements from the Phosphorus Treatment Menu in Section 3.3 of Volume V of the SMMWW. The cartridge configuration required to treat each flow rate is included in the table below. Each 27" cartridge with "Phosphosorb" treats 18.8 gpm (0.0416 cfs) of flow.

Treatment System	Required WQ Flowrate (Offline)	Contech Stormfilter Sizing	Allowable WQ Flowrate
Tract 'B'	0.498 cfs (Off-Line)	(12) 27" Cartridges	0.502 cfs

Table F1: Water Quality Flow Rate and Cartridge Filter Selection

Refer to Appendix D for screen shots of the WWHM model.

6. Provide a table that lists the amount of Pollution-Generating Pervious Surfaces (PGPS) and Pollution-Generating Impervious Surfaces (PGIS) for each Threshold Discharge Area (TDA).

The following table lists the areas of Pollution-Generating Pervious Surfaces (PGPS) and Pollution-Generating Impervious Surfaces (PGIS) for the Threshold Discharge Area (TDA):

	TDA 1
Effective Pollution Generating Impervious Surface (PGIS) (Acres)	2.59
Effective Pollution Generating Pervious Surface (PGPS) (Acres)	5.42

Table F2: Effective Pollution Generating Surface Summary

Section G – Flow Control Analysis and Design

1. **Identify the site's suitability for stormwater infiltration for flow control, including tested infiltration rates, logs of soil borings, and other information.**

   Columbia West Engineering, Inc. has completed a Geotechnical Site Investigation for this development (see Appendix F). Test pits were excavated on site, and it was determined that the soil was moist to damp with no groundwater seepage encountered at depths of 13.5 feet. The report concluded that soil mottling, the presence of clay soils, and the prevalence of damp soils indicates that the soil will likely accept little runoff. As a result, infiltration is not being considered as a viable option for flow control or treatment on this project.

2. **Identify and describe geotechnical or other studies used to complete the analysis and design.**

   Columbia West Engineering, Inc. has completed a Geotechnical Site Investigation for this development (see Appendix F). Test pit logs in the vicinity of the proposed stormwater facility (TP-5), show infiltration at these sites to be less than 0.06 inches per hour. Due to these infiltration rates and the slope of the ground surface of the site, above ground detention and media cartridge filter system are being proposed for stormwater treatment.

3. **If infiltration cannot be utilized for flow control, provide the following additional information:**

   a. **Identify areas where flow control credits can be obtained for dispersion, LID, or other measures, per the requirements in the Stormwater Manual.**

   Due to the relatively high restrictive layer and saturated soil conditions, infiltration LID measures are not applicable to this project.

   b. **Provide the approximate sizing and location of flow control facilities for each TDA, per Volume III of the Stormwater Manual.**

   All stormwater runoff from the proposed development is to be captured and routed via pipes to a stormwater facility for treatment and detention. The facility is to be located at the southwest corner of the site. The facility is to be comprised of an above ground Detention Pond and Cartridge Treatment System. Contech "Phosphosorb" media filter cartridges are being proposed to meet City of Camas phosphorus control requirements for developments within the LaCamas watershed. The facility will discharge west via pipe to the stormwater system in NW 16th Avenue. The facility will consist of a Contech Stormfilter Vault, Outlet Control Structure and a 37' x 75' detention pond. (Refer to Preliminary Development Plan in Appendix I for stormwater facility locations).

   c. **Identify the criteria (and their sources) used to complete the analysis, including pre-developed and post-developed land use characteristics.**

   The storm facilities have been designed to provide detention for the continuous storm in accordance with the requirements of the City of Camas Stormwater Design Standards

Manual Section 4.02 and Volume III of the SMMWW. WWHM2012 has been used for the continuous simulation model for this development. According to the Geotechnical Site Investigation by Columbia West Engineering, Inc. (See Appendix F), soil mottling, and the presence of clay soils the prevalent indicates that the soils onsite will likely accept little runoff and would be expected to behave more as a Hydrologic Soil Group 4 soil rather than Soil Group 3. As a result, onsite soils have been modeled as a Hydrologic Soil Group 4 for purposes of the stormwater calculations.

The pre-developed TDA 1 and the developed TDA 1 is all being discharged to the Tract 'B' stormwater facility. A summary of the pre-developed and developed catchment data are shown in the tables below:

Pre-developed catchment areas:

Catchment	Storm Facility	Description	Area (acres)
Basin A	Tract 'B'	SG4, Forest, Steep	10.43

Table G1: Hydrologic parameters used in pre-developed catchment analysis

Developed catchment areas:

Catchment	Storm Facility	Description	Area (acres)
Basin A	Tract 'B'	Roads Steep	1.79
		Roof Tops Flat	2.27
		Driveways Steep	0.45
		Sidewalks Steep	0.50
		SG4, Lawn, Steep	5.42

Table G2: Hydrologic parameters used in developed catchment analysis

4. For sites considered to be historical prairie, submit a project site report prepared by a wetland scientist or horticulturist experienced in identifying soils, plans, and other evidence associated with historic prairies to demonstrate the existence of historic prairie on the project site. Areas within Camas that were historically prairie include Fern and Lacamas prairies. Contact City staff for a map showing potential prairie locations.

This section does not apply.

5. Complete a hydrologic analysis for existing and developed site conditions, in accordance with the requirements of Chapter 4 of this manual and Chapter 2, Volume III of the Stormwater Manual, using an approved continuous runoff simulation model. Compute existing and developed flow duration for all subbasins. Provide an output table from the continuous flow model.

Tract 'B' Facility:

A summary of the pre-developed and developed flows for the Tract 'B' Facility from the WWHM2012 calculations is shown in the table below:

Return Period	Pre-developed Flow (cfs)	Developed Flow (cfs)
2-Year	3.32	2.48
10-Year	5.52	4.92
50-Year	6.86	7.75
100-Year	7.30	9.16

Table G3: Pre-developed and developed flows for Tract 'B' Facility.

A summary of the developed flows and stormwater facility storage volumes and stage elevations for the Tract 'B' Facility from the WWHM2012 calculations is shown in the table below:

Return Period	Developed Flow (cfs)	Detention Volume (ac-ft)	Detention Stage Elevation (ft)
2-Year	2.48	0.316	3.40
10-Year	4.92	0.361	3.75
50-Year	7.75	0.395	4.00
100-Year	9.16	0.431	4.25

Table G4: Developed flows and stormwater facility storage volumes / stage elevations for Tract 'B' Facility

From the tables above, the proposed design meets the flow-control requirements, as specified in the City of Camas Stormwater Design Standards Manual Section 4.02 and Volume III of the SMMWW. It can also be seen that the proposed detention volume is sufficient to detain the stormwater from the developed catchment area.

6. Include and reference all hydrologic computations, equations, graphs, and any other aids necessary to clearly show the methodology and results.

Refer to Appendix E for a detailed WWHM2012 hydraulic analysis of the pre-developed and developed site during the 2-, 10-, 50-, and 100-yr. continuous storm events.

7. Include all maps, exhibits, graphics, and references used to determine existing and developed site hydrology.

Refer to the Development Plans in Appendix I for catchment area locations and the specific locations of the stormwater facilities.

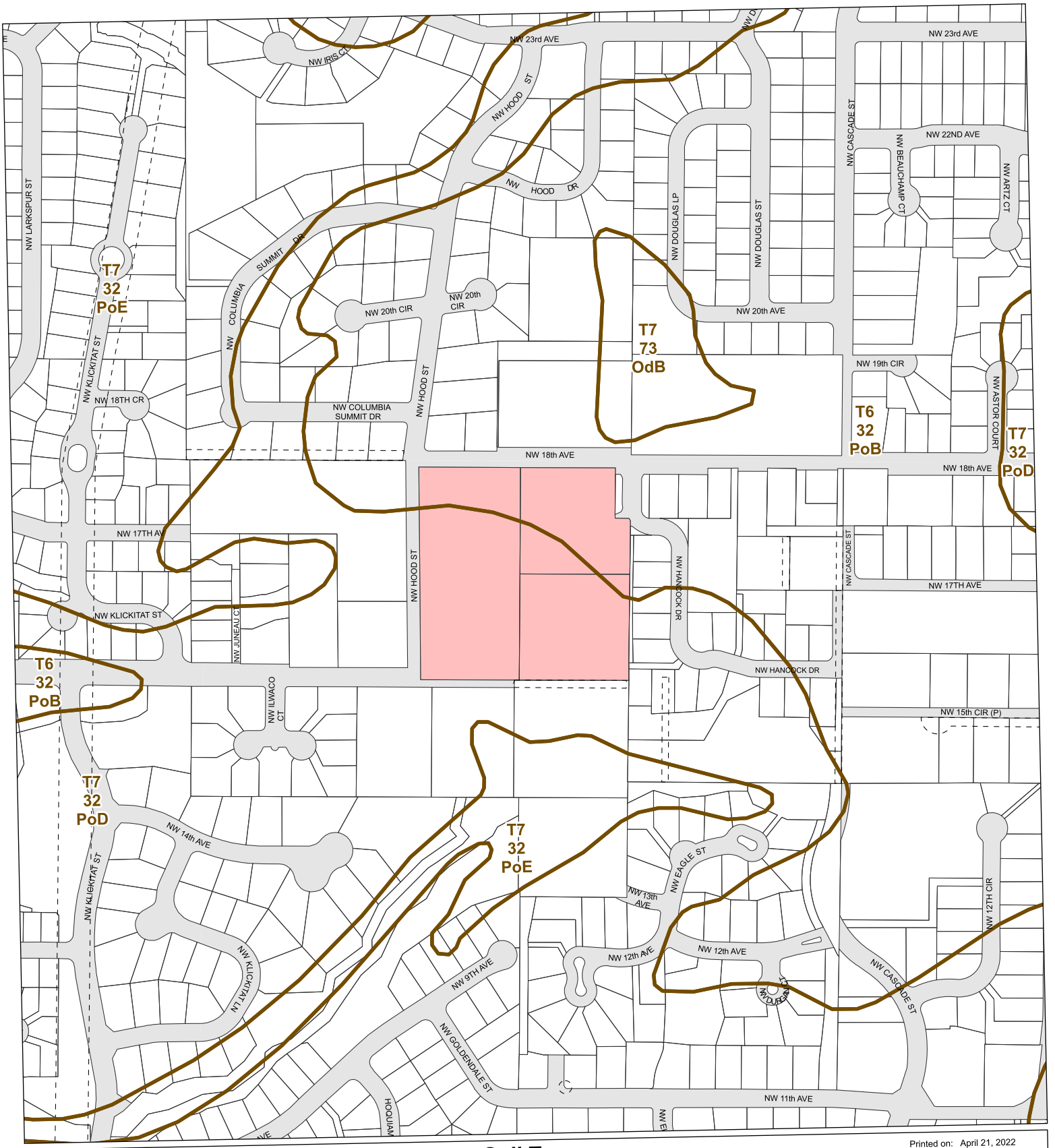
Refer to the Maps section of this report.

Section H – Wetlands Protection

There or no wetlands onsite and the project will not discharge to a wetland off-site making this section not applicable.

Technical Appendices

Map Symbol	Soil Name	Hydrologic Group	Clark County WWHM Soils Group
NbA	NEWBERG	B	2
NbB	NEWBERG	B	2
OdB	ODNE	D	4
OeD	OLEQUA	B	3
OeE	OLEQUA	B	3
OeF	OLEQUA	B	3
OhD	OLEQUA VARIANT	C	4
OhF	OLEQUA VARIANT	C	4
OlB	OLYMPIC	B	3
OlD	OLYMPIC	B	3
OlE	OLYMPIC	B	3
OlF	OLYMPIC	B	3
OmE	OLYMPIC	B	3
OmF	OLYMPIC	B	3
OpC	OLYMPIC VARIANT	C	3
OpE	OLYMPIC VARIANT	C	3
OpG	OLYMPIC VARIANT	C	3
OrC	OLYMPIC VARIANT	C	3
PhB	PILCHUCK	C	2
PoB	POWELL	C	3
PoD	POWELL	C	3
PoE	POWELL	C	3
PuA	PUYALLUP	B	2
Ra	RIVERWASH	D	N/A
Rc	RIVERWASH	D	N/A
Rk	ROCK LAND	D	N/A
Ro	ROUGH BROKEN LAND	A	1
SaC	SALKUM	B	2
SlB	SARA	D	4
SlD	SARA	D	4
SlF	SARA	D	4
SmA	SAUVIE	B	3
SmB	SAUVIE	B	3
SnA	SAUVIE	D	3
SpB	SAUVIE	B	3



Soil Types

Account: 127439000, 127359000, 127356000
Owner: MODERN DWELLINGS LLC
Address: 8101 NE GLISAN ST
C/S/Z: PORTLAND, OR 97213

Subject Property(s)
Public Road
Transportation or Major Utility Easement
Soil Type Boundary

Printed on: April 21, 2022

13105	13104	13103
13108	13109	13110
13117	13116	13115

CLARK COUNTY, WASHINGTON
Geographic Information System

N

0 200 400 Feet

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.

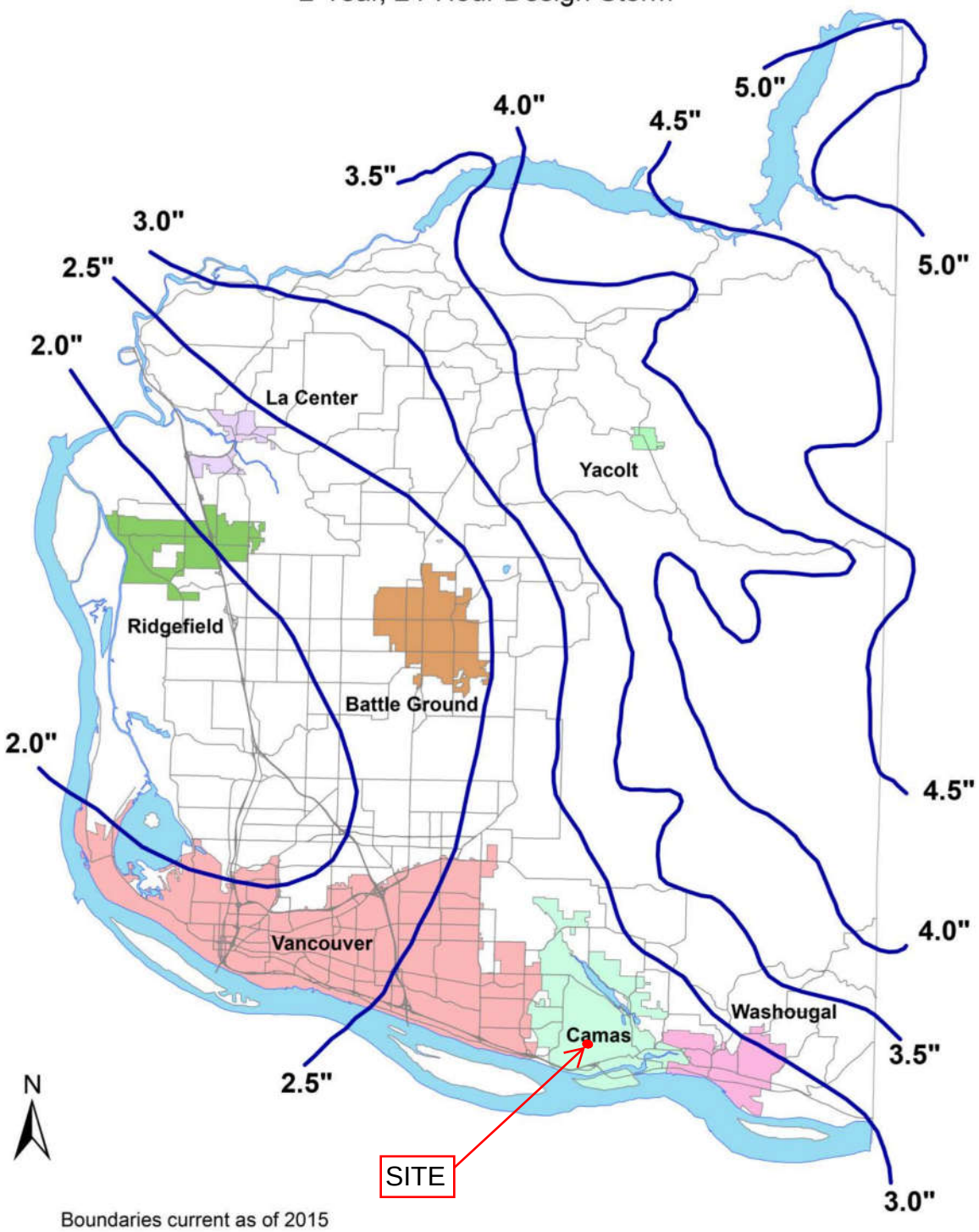
TABLE 7.—*Estimated physical and chemical properties of the soils*—Continued

Soil series and map symbols	Depth from surface	Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction
		Dominant USDA texture	Unified	AASHO	No. 4 (4.76 mm.) [1]	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)			
	Inches							*Inches per hour*	*Inches per inch of soil*	*pH*
Minniece: MnA, MnD.	0–48	Silty clay and clay	CH	A–7	90–95	85–95	65–75	<0.06	0.06–0.08	6.1–7.
	48	Basalt bedrock.								
MoA.	0–12	Silt loam	ML	A–4	100	95–100	65–75	0.63–2.0	0.19–0.21	6.1–6.
	12–22	Silty clay	CH	A–7	95–100	95–100	80–90	0.06–0.2	0.12–0.14	6.1–6.
	22–60	Very gravelly clay loam (weakly cemented).	GC	A–2	35–50	30–50	20–35	<0.06	0.03–0.05	5.6–6.
Mossyrock: MsB.	0–23	Silt loam	OL or OH	A–5	95–100	95–100	50–60	0.63–2.0	0.19–0.21	6.1–6.
	23–60	Silt loam	ML	A–5	100	95–100	55–65	0.63–2.0	0.19–0.21	6.6–7.
	60–74	Loam	ML	A–4	100	95–100	70–80	0.63–2.0	0.16–0.18	6.1–7.
Newberg: NbA, NbB.	0–7	Silt loam	ML	A–4		100	70–80	0.63–2.0	0.19–0.21	5.6–6.
	7–52	Fine sandy loam and sandy loam.	SM or ML	A–4		100	40–55	2.0–6.3	0.13–0.15	6.1–7.
	52–72	Sand	SM	A–1		100	5–15	0.63–20.0	0.05–0.07	6.6–7.
Odne: OdB.	0–50	Silt loam, silty clay loam, clay loam, and loam.	CL	A–4 or A–6		100	75–85	<0.06	0.10–0.12	5.0–6.
Olequa: OeD, OeE, OeF.	0–17	Silt loam	ML	A–7		100	75–85	0.63–2.0	0.19–0.21	6.1–6.
	17–90	Heavy silt loam and silty clay loam.	CL	A–7		100	80–90	0.2–0.63	0.19–0.21	4.5–6.
OhD, OhF.	0–32	Silty clay loam	CL	A–7	95–100	90–95	85–95	0.2–0.63	0.19–0.21	–6.
	32–82	Silty clay and clay	CH	A–7	95–100	90–95	85–95	<0.06	0.06–0.08	5.1–6.
Olympic: OlB, OlD, OlE, OlF, OmE, OmF.	0–44	Clay loam and silty clay loam.	ML or CL	A–7	90–100	90–100	75–85	0.2–0.63	0.19–0.21	5.1–6.
	44–59	Gravelly clay loam.	GC	A–4	75–90	70–85	35–50	0.2–0.63	0.10–0.12	4.5–5.
	59	Fractured basalt.								
OpC, OpE, OpG, OrC.	0–30	Heavy clay loam and heavy silty clay loam.	ML or CL	A–7	90–95	90–95	75–85	0.2–0.63	0.19–0.21	5.1–6.
	30	Fractured basalt.								
Pilchuck: PhB.	0–60	Fine sand	SM	A–3	95–100	90–100	5–10	6.3–20.0	0.05–0.07	6.1–7.
Powell: PoB, PoD, PoE.	0–23	Silt loam	ML	A–4		100	80–90	0.63–0.20	0.18–0.20	5.1–6.
	23–63	Slit loam (fragipan).	ML	A–4		100	80–90	0.06–0.20	0.06–0.08	5.1–6.
Puyallup: PuA.	0–27	Stratified fine sandy loam, loam, and loamy sand.	SM	A–4	100	95–100	35–50	2.0–6.3	0.10–0.12	5.6–6.
	27–60	Gravelly sand	SP or SW	A–1	70–90	65–85	0–5	6.3–20.0	0.04–0.06	6.6–7.
Riverwash, sandy: Ra.	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Riverwash, cobbly: Rc.	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Rock land: Rk.	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Rough broken land: Ro.	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)

See footnotes at end of table.

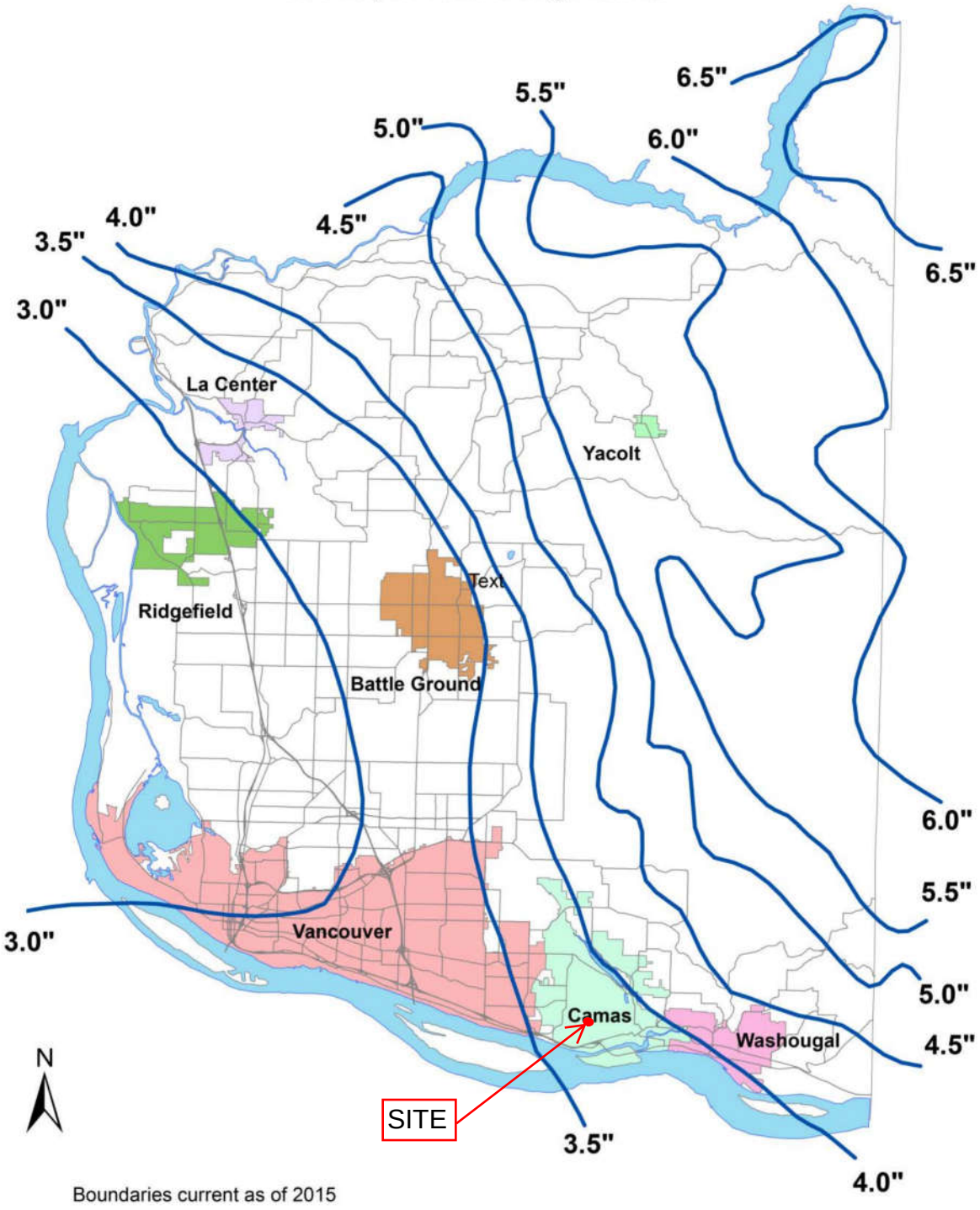
Isopluvial Map for Clark County

2-Year, 24-Hour Design Storm



Isopluvial Map for Clark County

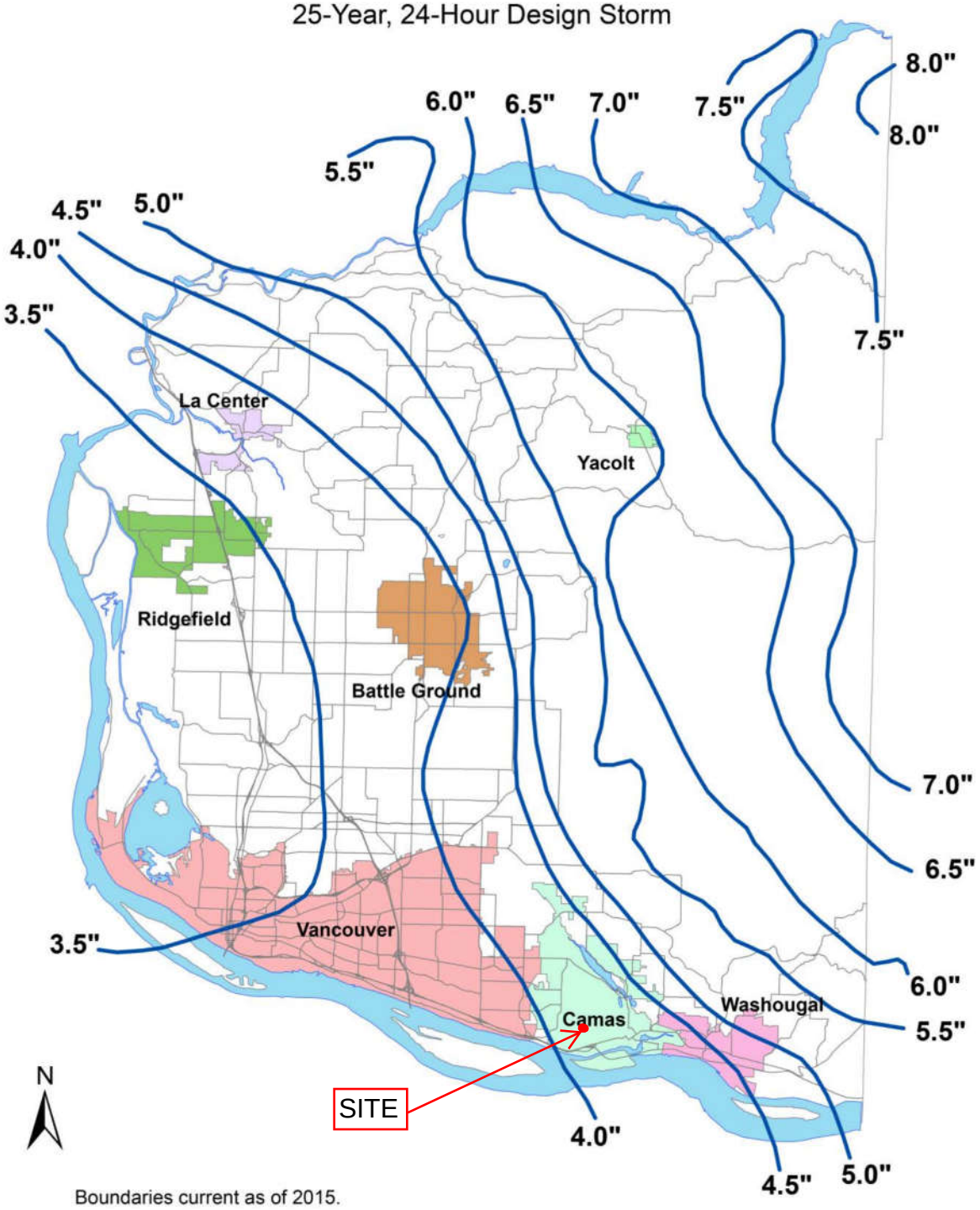
10-Year, 24-Hour Design Storm



Boundaries current as of 2015

Isopluvial Map for Clark County

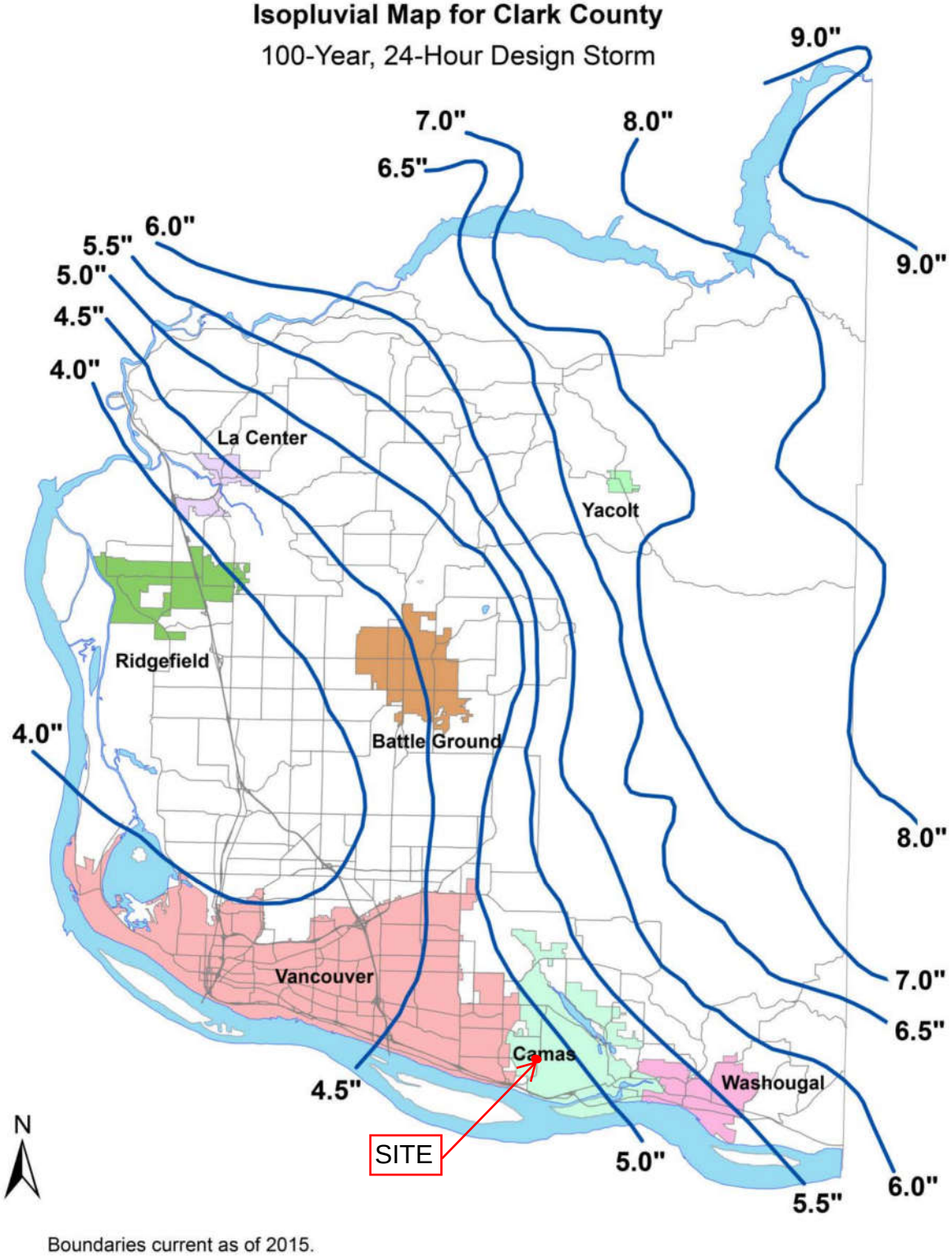
25-Year, 24-Hour Design Storm



Boundaries current as of 2015.

Isopluvial Map for Clark County

100-Year, 24-Hour Design Storm



Boundaries current as of 2015.

Table III-1.3 SCS Western Washington Runoff Curve Numbers
(Published by SCS in 1982) Runoff curve numbers for selected agricultural, suburban and urban land use for Type 1A rainfall distribution, 24-hour storm duration.

LAND USE DESCRIPTION		CURVE NUMBERS BY HYDROLOGIC SOIL GROUP A	B	C	D
Cultivated land(1):	winter condition	86	91	94	95
Mountain open areas:	low growing brush & grasslands	74	82	89	92
Meadow or pasture:		65	78	85	89
Wood or forest land:	undisturbed	42	64	76	81
Wood or forest land:	young second growth or brush	55	72	81	86
Orchard:	with cover crop	81	88	92	94
Open spaces, lawns, parks, golf courses, cemeteries, landscaping.					
Good condition:	grass cover on ≥75% of the area	68	80	86	90
Fair condition:	grass cover on 50-75% of the area	77	85	90	92
Gravel roads & parking lots:		76	85	89	91
Dirt roads & parking lots:		72	82	87	89
Impervious surfaces, pavement, roofs etc.		98	98	98	98
Open water bodies:	lakes, wetlands, ponds etc.	100	100	100	100
Single family residential(2):					
Dwelling Unit/Gross Acre	%Impervious(3)				
1.0 DU/GA	15				
1.5 DU/GA	20				
2.0 DU/GA	25				
2.5 DU/GA	30				
3.0 DU/GA	34				
3.5 DU/GA	38				
4.0 DU/GA	42				
4.5 DU/GA	46				
5.0 DU/GA	48				
5.5 DU/GA	50				
6.0 DU/GA	52				
6.5 DU/GA	54				
7.0 DU/GA	56				
PUD's, condos, apartments, commercial businesses & industrial areas	%impervious must be computed				
		Separate curve number shall be selected for pervious & impervious portions of the site or basin			

(1) For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Sec. 4, Hydrology, Chapter 9, August 1972.
(2) Assumes roof and driveway runoff is directed into street/storm system.
(3) The remaining pervious areas (lawn) are considered to be in good condition for these curve numbers.

Table III-1.4 "n" AND "k" Values Used in Time Calculations for Hydrographs

"n_s" Sheet Flow Equation Manning's Values (for the initial 300 ft. of travel)	n_s
Smooth surfaces (concrete, asphalt, gravel, or bare hand packed soil)	0.011
Fallow fields or loose soil surface (no residue)	0.05
Cultivated soil with residue cover (s≤ 0.20 ft/ft)	0.06
Cultivated soil with residue cover (s> 0.20 ft/ft)	0.17
Short prairie grass and lawns	0.15
Dense grasses	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods or forest with light underbrush	0.40
Woods or forest with dense underbrush	0.80

*Manning values for sheet flow only, from Overton and Meadows 1976 (See TR-55, 1986)

"k" Values Used in Travel Time/Time of Concentration Calculations

Shallow Concentrated Flow (After the initial 300 ft. of sheet flow, R = 0.1)	k_s
1. Forest with heavy ground litter and meadows (n = 0.10)	3
2. Brushy ground with some trees (n = 0.060)	5
3. Fallow or minimum tillage cultivation (n = 0.040)	8
4. High grass (n = 0.035)	9
5. Short grass, pasture and lawns (n = 0.030)	11
6. Nearly bare ground (n = 0.25)	13
7. Paved and gravel areas (n = 0.012)	27

Channel Flow (intermittent) (At the beginning of visible channels R = 0.2)	k_c
1. Forested swale with heavy ground litter (n = 0.10)	5
2. Forested drainage course/ravine with defined channel bed (n = 0.050)	10
3. Rock-lined waterway (n = 0.035)	15
4. Grassed waterway (n = 0.030)	17
5. Earth-lined waterway (n = 0.025)	20
6. CMP pipe (n = 0.024)	21
7. Concrete pipe (0.012)	42
8. Other waterways and pipe 0.508/n	

Channel Flow (Continuous stream, R = 0.4)	k_c
9. Meandering stream with some pools (n = 0.040)	20
10. Rock-lined stream (n = 0.035)	23
11. Grass-lined stream (n = 0.030)	27
12. Other streams, man-made channels and pipe 0.807/n**	

Chapter 1: General Requirements
Continued

Figure 1.1: Flow Chart for Determining Stormwater Requirements

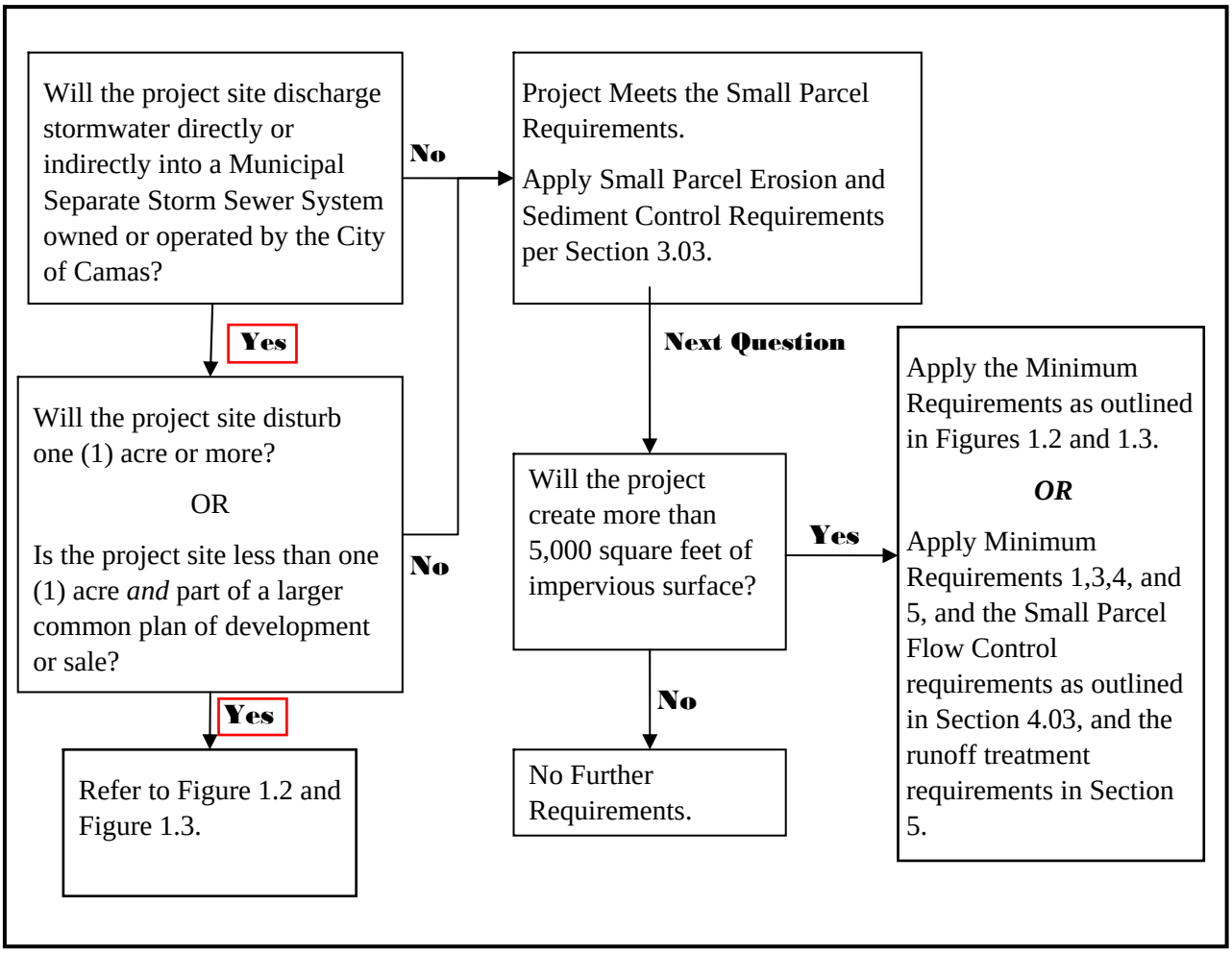
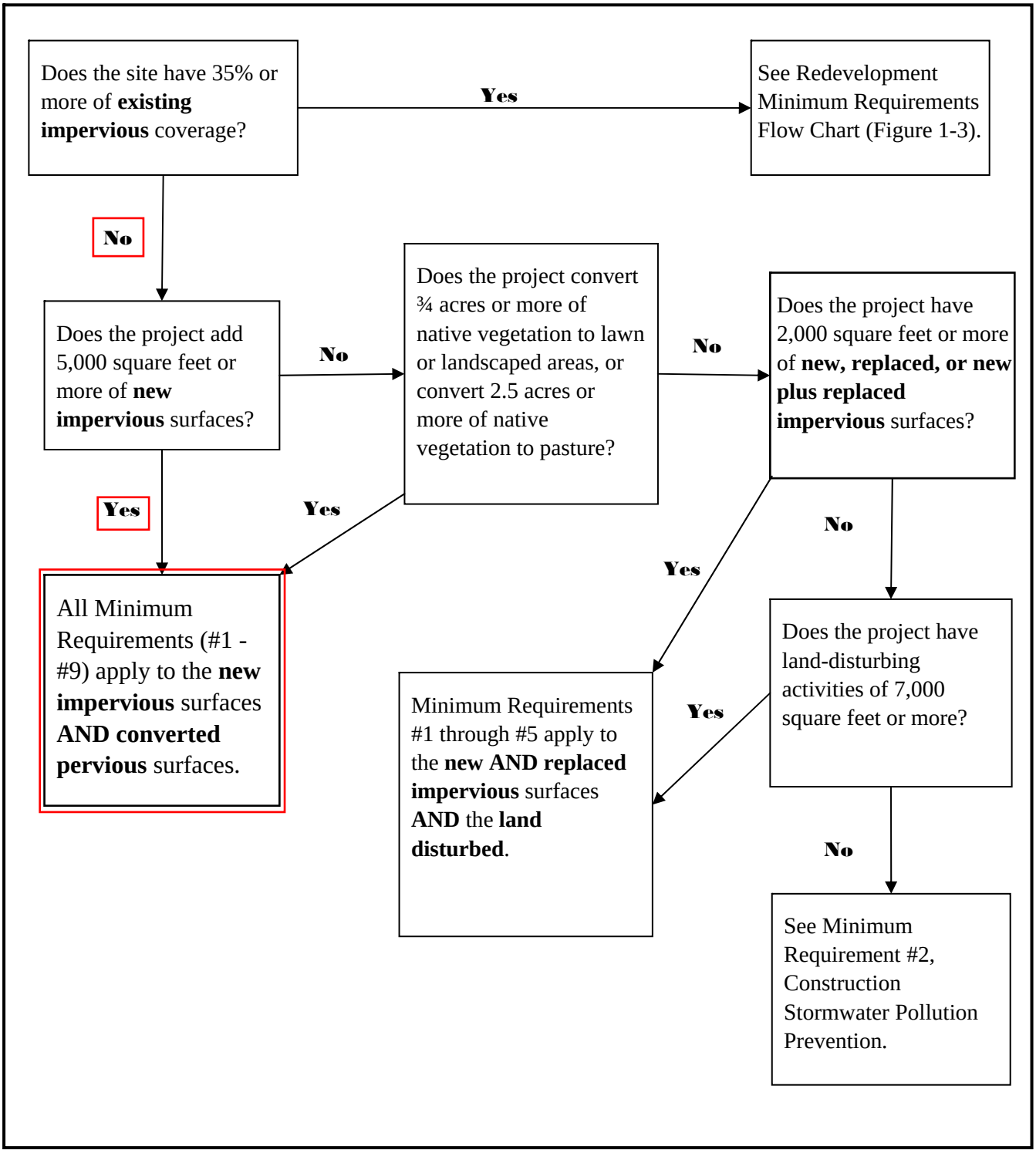


Figure 1.2: New Development Minimum Requirements Flow Chart



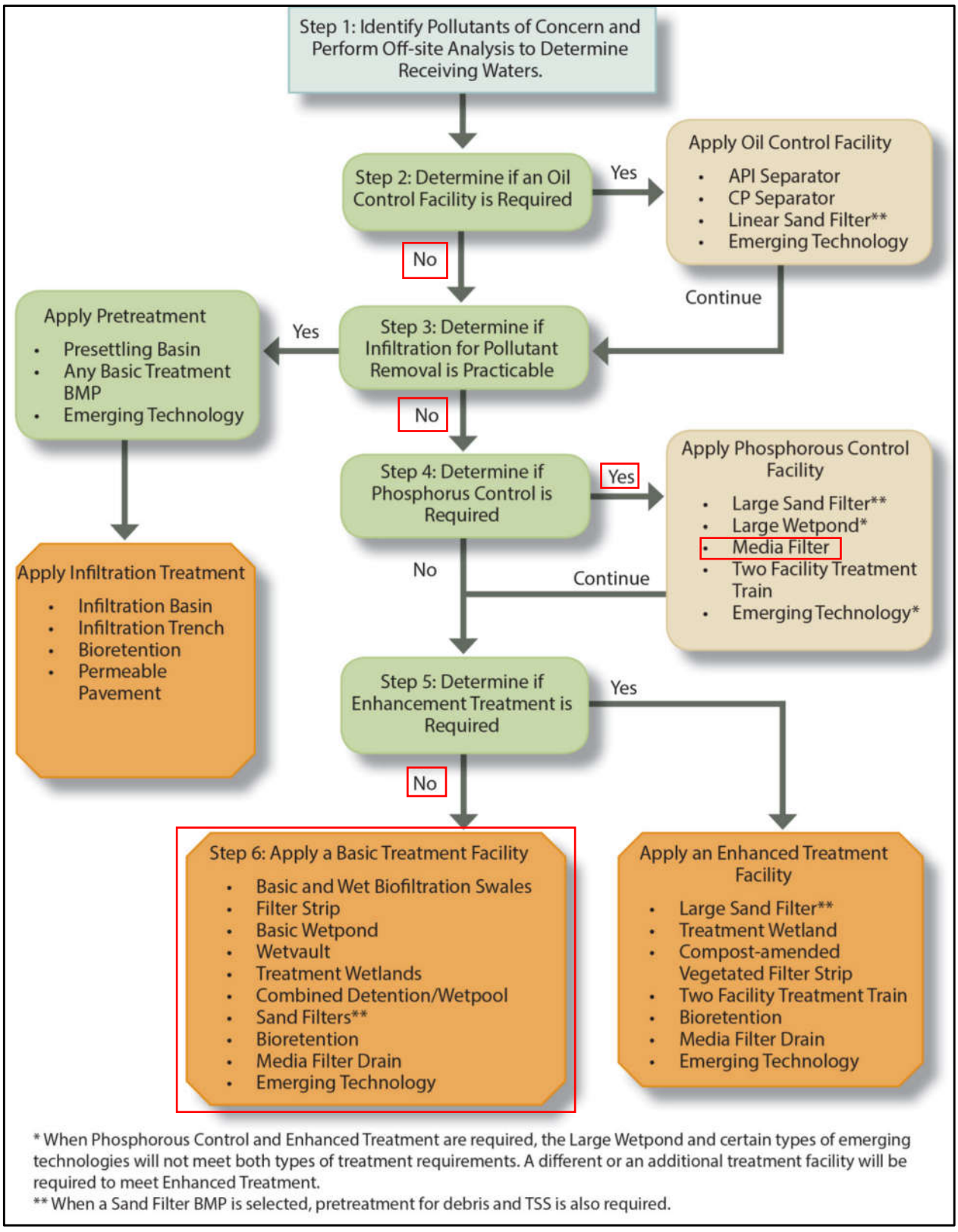


Figure 3.1: Treatment Facility Selection Flow Chart

Schematic

SCENARIOS

Predeveloped

Mitigated

Run Scenario

Basic Elements

Pro Elements

LID Toolbox

Commercial Toolbox

Move Elements

Save x,y | Load x,y

X 40

Y 54

Basin 1 Predeveloped

Subbasin Name: Basin 1

Flows To :	Surface	Interflow	Groundwater

Area in Basin

Show Only Selected

Available Pervious	Acres	Available Impervious	Acres
SG4, Forest, Steep	5.49	ROADS/MOD	0
SG4, Lawn, Mod	0	ROOF TOPS/FLAT	0
SG4, Lawn, Steep	0	SIDEWALKS/FLAT	0

Pervious Total	5.49	Acres
Impervious Total	0	Acres
Basin Total	5.49	Acres

Deselect Zero | Select By: | GO

Schematic

SCENARIOS

Predeveloped

Mitigated

Run Scenario

Basic Elements

Pro Elements

LID Toolbox

Commercial Toolbox

Move Elements

Save x,y | Load x,y

X 40

Y 0

Basin 1 Mitigated

Subbasin Name: Basin 1 — Designate as Bypass for POC:

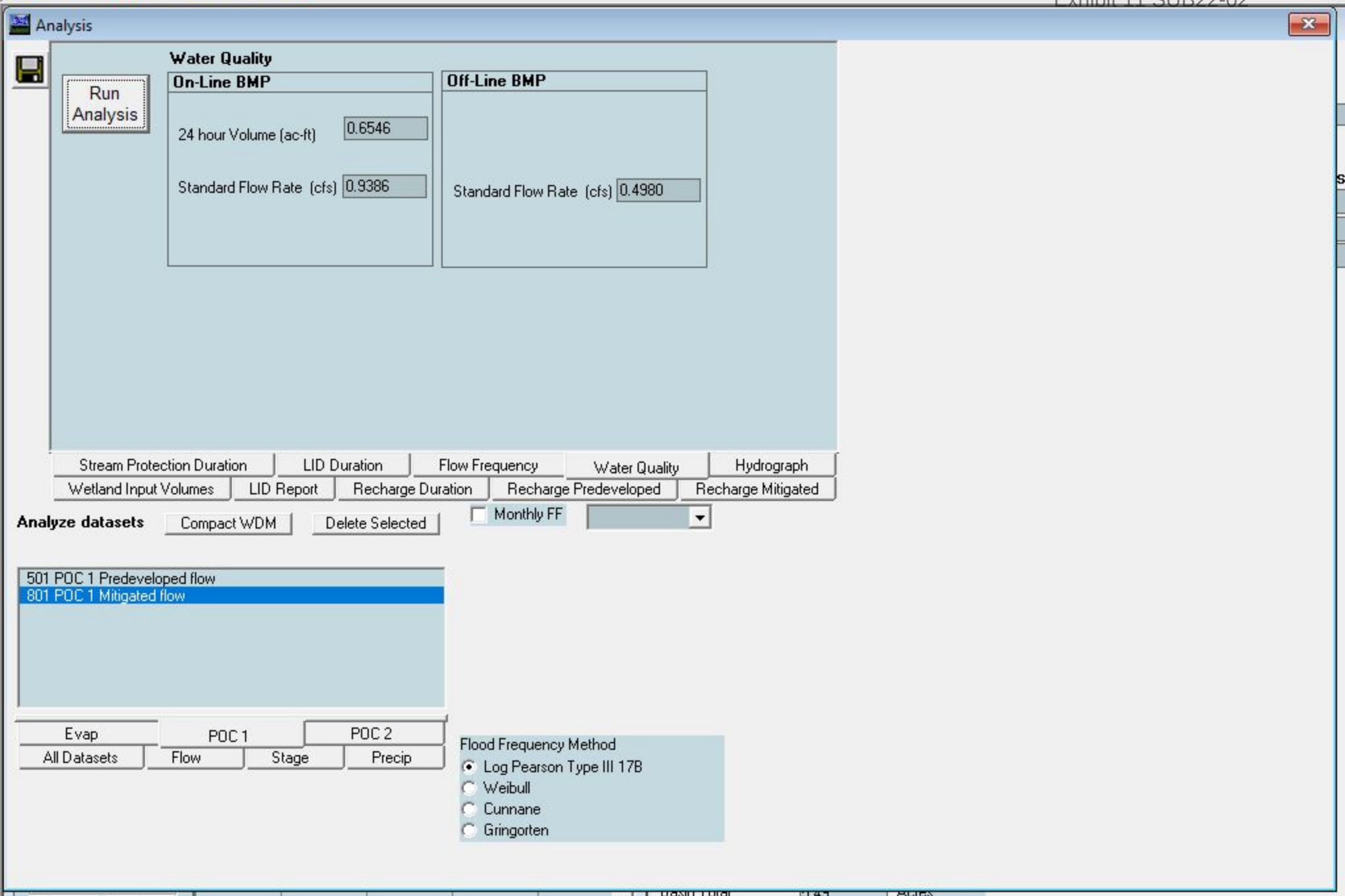
Flows To :	Surface	Interflow	Groundwater

Area in Basin — Show Only Selected

Available Pervious	Acres	Available Impervious	Acres
SG4, Forest, Steep	0	ROADS/MOD	0
SG4, Lawn, Mod	0	ROOF TOPS/FLAT	2.27
SG4, Lawn, Steep	3.22	SIDEWALKS/FLAT	0

Pervious Total	3.22	Acres
Impervious Total	2.27	Acres
Basin Total	5.49	Acres

Deselect Zero | **Select By:** | GO


Analysis
Water Quality
Run Analysis
On-Line BMP
24 hour Volume (ac-ft)
0.6546
Standard Flow Rate (cfs)
0.9386
Off-Line BMP
Standard Flow Rate (cfs)
0.4980
Stream Protection Duration
LID Duration
Flow Frequency
Water Quality
Hydrograph
Wetland Input Volumes
LID Report
Recharge Duration
Recharge Predeveloped
Recharge Mitigated
Analyze datasets
Compact WDM
Delete Selected
Monthly FF
501 POC 1 Predeveloped flow
801 POC 1 Mitigated flow
Evap
POC 1
POC 2
All Datasets
Flow
Stage
Precip
Flood Frequency Method
Log Pearson Type III 17B
Weibull
Cunnane
Gringorten

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Forest, Steep	9.17
Pervious Total	9.17

Impervious Land Use	acre
ROADS STEEP	0.48
ROOF TOPS FLAT	0.78
Impervious Total	1.26
Basin Total	10.43

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Steep	5.42
Pervious Total	5.42

Impervious Land Use	acre
ROADS STEEP	2.24
ROOF TOPS FLAT	2.27
SIDEWALKS STEEP	0.5
Impervious Total	5.01
Basin Total	10.43

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

Bottom Length: 75.00 ft.
Bottom Width: 37.00 ft.
Depth: 4.5 ft.
Volume at riser head: 0.3293 acre-feet.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Discharge Structure
Riser Height: 3.5 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.673 ft.
Notch Height: 0.520 ft.
Orifice 1 Diameter: 5.954 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

Pond Hydraulic Table

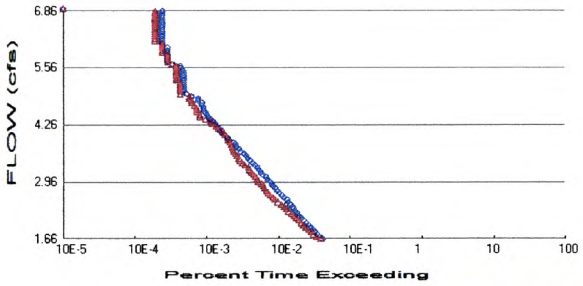
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.063	0.000	0.000	0.000
0.0500	0.064	0.003	0.215	0.000
0.1000	0.065	0.006	0.304	0.000
0.1500	0.066	0.009	0.372	0.000
0.2000	0.066	0.013	0.430	0.000
0.2500	0.067	0.016	0.481	0.000
0.3000	0.068	0.019	0.526	0.000
0.3500	0.069	0.023	0.569	0.000
0.4000	0.070	0.026	0.608	0.000
0.4500	0.070	0.030	0.645	0.000
0.5000	0.071	0.033	0.680	0.000
0.5500	0.072	0.037	0.713	0.000
0.6000	0.073	0.041	0.745	0.000
0.6500	0.074	0.044	0.775	0.000
0.7000	0.074	0.048	0.804	0.000
0.7500	0.075	0.052	0.833	0.000
0.8000	0.076	0.056	0.860	0.000
0.8500	0.077	0.059	0.886	0.000
0.9000	0.078	0.063	0.912	0.000
0.9500	0.079	0.067	0.937	0.000
1.0000	0.080	0.071	0.962	0.000
1.0500	0.080	0.075	0.985	0.000
1.1000	0.081	0.079	1.009	0.000
1.1500	0.082	0.083	1.031	0.000
1.2000	0.083	0.088	1.053	0.000
1.2500	0.084	0.092	1.075	0.000
1.3000	0.085	0.096	1.096	0.000
1.3500	0.086	0.100	1.117	0.000
1.4000	0.086	0.105	1.138	0.000
1.4500	0.087	0.109	1.158	0.000
1.5000	0.088	0.113	1.178	0.000
1.5500	0.089	0.118	1.197	0.000

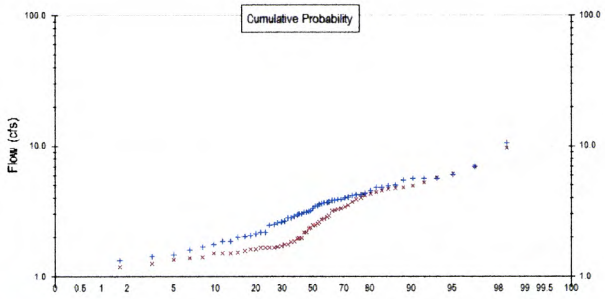
1.6000	0.090	0.122	1.216	0.000	
1.6500	0.091	0.127	1.235	0.000	
1.7000	0.092	0.131	1.254	0.000	
1.7500	0.093	0.136	1.272	0.000	
1.8000	0.094	0.141	1.290	0.000	
1.8500	0.095	0.146	1.308	0.000	
1.9000	0.096	0.150	1.326	0.000	
1.9500	0.096	0.155	1.343	0.000	
2.0000	0.097	0.160	1.360	0.000	
2.0500	0.098	0.165	1.377	0.000	
2.1000	0.099	0.170	1.394	0.000	
2.1500	0.100	0.175	1.410	0.000	
2.2000	0.101	0.180	1.426	0.000	
2.2500	0.102	0.185	1.443	0.000	
2.3000	0.103	0.190	1.458	0.000	
2.3500	0.104	0.195	1.474	0.000	
2.4000	0.105	0.201	1.490	0.000	
2.4500	0.106	0.206	1.505	0.000	
2.5000	0.107	0.211	1.521	0.000	
2.5500	0.108	0.217	1.536	0.000	
2.6000	0.109	0.222	1.551	0.000	
2.6500	0.110	0.228	1.566	0.000	
2.7000	0.111	0.233	1.580	0.000	
2.7500	0.112	0.239	1.595	0.000	
2.8000	0.113	0.244	1.609	0.000	
2.8500	0.114	0.250	1.624	0.000	
2.9000	0.115	0.256	1.638	0.000	
2.9500	0.116	0.262	1.652	0.000	
3.0000	0.117	0.268	1.672	0.000	
3.0500	0.118	0.273	1.721	0.000	
3.1000	0.119	0.279	1.787	0.000	
3.1500	0.120	0.285	1.864	0.000	
3.2000	0.121	0.291	1.952	0.000	
3.2500	0.122	0.298	2.049	0.000	
3.3000	0.123	0.304	2.153	0.000	
3.3500	0.124	0.310	2.265	0.000	
3.4000	0.125	0.316	2.384	0.000	2-year
3.4500	0.126	0.322	2.509	0.000	
3.5000	0.127	0.329	2.640	0.000	
3.5500	0.128	0.335	2.831	0.000	
3.6000	0.130	0.342	3.168	0.000	
3.6500	0.131	0.348	3.598	0.000	
3.7000	0.132	0.355	4.096	0.000	
3.7500	0.133	0.361	4.642	0.000	10-year
3.8000	0.134	0.368	5.217	0.000	
3.8500	0.135	0.375	5.801	0.000	
3.9000	0.136	0.382	6.373	0.000	
3.9500	0.137	0.389	6.913	0.000	
4.0000	0.138	0.395	7.404	0.000	50-year
4.0500	0.139	0.402	7.832	0.000	
4.1000	0.140	0.409	8.190	0.000	
4.1500	0.142	0.416	8.477	0.000	
4.2000	0.143	0.424	8.705	0.000	
4.2500	0.144	0.431	8.896	0.000	100-year
4.3000	0.145	0.438	9.174	0.000	
4.3500	0.146	0.445	9.381	0.000	
4.4000	0.147	0.453	9.582	0.000	
4.4500	0.148	0.460	9.777	0.000	

4.5000	0.149	0.468	9.968	0.000
4.5500	0.151	0.475	10.15	0.000

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 9.17
Total Impervious Area: 1.26

Mitigated Landuse Totals for POC #1
Total Pervious Area: 5.42
Total Impervious Area: 5.01

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	3.322061
5 year	4.743632
10 year	5.524253
25 year	6.344451
50 year	6.860345
100 year	7.301459

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	2.479295
5 year	3.850531
10 year	4.917934
25 year	6.456241
50 year	7.745468
100 year	9.162329

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	2.510	1.937
1950	3.021	2.326
1951	4.251	1.624
1952	2.808	3.893
1953	3.457	1.656
1954	5.614	2.181
1955	2.672	1.533
1956	4.789	4.535
1957	4.555	2.472
1958	3.876	4.969

1959	2.168	1.335
1960	2.033	1.662
1961	4.261	3.316
1962	3.174	2.634
1963	3.488	2.172
1964	3.130	1.843
1965	2.877	2.485
1966	3.864	2.548
1967	3.639	1.673
1968	4.037	5.253
1969	4.354	6.171
1970	10.485	9.630
1971	1.873	1.501
1972	2.805	1.698
1973	3.008	3.182
1974	4.193	4.686
1975	2.486	1.758
1976	3.817	2.918
1977	0.451	1.123
1978	5.614	4.185
1979	3.873	4.740
1980	2.118	1.564
1981	4.941	4.308
1982	3.581	3.532
1983	6.063	4.012
1984	2.069	1.505
1985	1.419	1.859
1986	1.995	1.980
1987	3.121	1.768
1988	1.857	1.501
1989	2.182	1.668
1990	1.585	1.378
1991	3.753	1.970
1992	3.697	1.707
1993	4.790	4.815
1994	3.100	2.840
1995	2.625	3.246
1996	5.498	6.987
1997	6.939	4.424
1998	5.667	3.722
1999	3.656	2.752
2000	2.566	1.253
2001	1.460	1.177
2002	5.014	2.717
2003	3.987	3.271
2004	1.323	1.404
2005	1.676	1.607
2006	2.954	2.377
2007	1.764	3.451
2008	3.337	5.700

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	10.4848	9.6299
2	6.9387	6.9874
3	6.0632	6.1710
4	5.6670	5.6997

5	5.6142	5.2526
6	5.6142	4.9687
7	5.4981	4.8148
8	5.0142	4.7404
9	4.9410	4.6860
10	4.7897	4.5353
11	4.7885	4.4242
12	4.5545	4.3082
13	4.3544	4.1850
14	4.2614	4.0124
15	4.2508	3.8928
16	4.1935	3.7222
17	4.0370	3.5318
18	3.9870	3.4509
19	3.8758	3.3157
20	3.8728	3.2715
21	3.8635	3.2457
22	3.8172	3.1824
23	3.7531	2.9184
24	3.6971	2.8401
25	3.6562	2.7524
26	3.6386	2.7169
27	3.5815	2.6343
28	3.4877	2.5481
29	3.4566	2.4855
30	3.3373	2.4719
31	3.1743	2.3769
32	3.1297	2.3257
33	3.1209	2.1807
34	3.1004	2.1719
35	3.0209	1.9801
36	3.0080	1.9700
37	2.9543	1.9369
38	2.8772	1.8594
39	2.8079	1.8428
40	2.8054	1.7682
41	2.6724	1.7576
42	2.6251	1.7067
43	2.5662	1.6981
44	2.5099	1.6733
45	2.4860	1.6682
46	2.1818	1.6625
47	2.1680	1.6555
48	2.1182	1.6237
49	2.0689	1.6074
50	2.0327	1.5642
51	1.9951	1.5328
52	1.8731	1.5048
53	1.8575	1.5014
54	1.7638	1.5012
55	1.6759	1.4037
56	1.5848	1.3782
57	1.4597	1.3350
58	1.4185	1.2535
59	1.3234	1.1770
60	0.4513	1.1234

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.6610	857	820	95	Pass
1.7135	793	715	90	Pass
1.7661	728	644	88	Pass
1.8186	683	597	87	Pass
1.8711	626	547	87	Pass
1.9236	581	507	87	Pass
1.9761	545	463	84	Pass
2.0287	508	429	84	Pass
2.0812	468	402	85	Pass
2.1337	432	371	85	Pass
2.1862	405	340	83	Pass
2.2387	385	317	82	Pass
2.2913	366	291	79	Pass
2.3438	340	271	79	Pass
2.3963	325	249	76	Pass
2.4488	304	229	75	Pass
2.5013	285	206	72	Pass
2.5538	273	185	67	Pass
2.6064	250	174	69	Pass
2.6589	231	160	69	Pass
2.7114	217	151	69	Pass
2.7639	204	142	69	Pass
2.8164	189	135	71	Pass
2.8690	178	129	72	Pass
2.9215	167	122	73	Pass
2.9740	157	111	70	Pass
3.0265	146	105	71	Pass
3.0790	141	99	70	Pass
3.1315	125	94	75	Pass
3.1841	118	88	74	Pass
3.2366	113	84	74	Pass
3.2891	107	80	74	Pass
3.3416	98	71	72	Pass
3.3941	91	66	72	Pass
3.4467	84	61	72	Pass
3.4992	78	59	75	Pass
3.5517	74	55	74	Pass
3.6042	70	52	74	Pass
3.6567	63	50	79	Pass
3.7092	59	49	83	Pass
3.7618	54	47	87	Pass
3.8143	53	46	86	Pass
3.8668	50	44	88	Pass
3.9193	43	42	97	Pass
3.9718	41	41	100	Pass
4.0244	37	38	102	Pass
4.0769	34	36	105	Pass
4.1294	32	35	109	Pass
4.1819	31	30	96	Pass
4.2344	29	28	96	Pass
4.2869	27	25	92	Pass
4.3395	26	24	92	Pass
4.3920	24	20	83	Pass

4.4445	22	17	77	Pass
4.4970	21	17	80	Pass
4.5495	20	15	75	Pass
4.6021	19	15	78	Pass
4.6546	19	15	78	Pass
4.7071	18	14	77	Pass
4.7596	18	13	72	Pass
4.8121	16	13	81	Pass
4.8646	16	12	75	Pass
4.9172	13	12	92	Pass
4.9697	11	9	81	Pass
5.0222	10	9	90	Pass
5.0747	10	9	90	Pass
5.1272	10	9	90	Pass
5.1798	10	9	90	Pass
5.2323	10	9	90	Pass
5.2848	10	8	80	Pass
5.3373	10	8	80	Pass
5.3898	10	8	80	Pass
5.4424	10	8	80	Pass
5.4949	10	8	80	Pass
5.5474	9	8	88	Pass
5.5999	9	8	88	Pass
5.6524	7	7	100	Pass
5.7049	6	6	100	Pass
5.7575	6	6	100	Pass
5.8100	6	6	100	Pass
5.8625	6	6	100	Pass
5.9150	6	5	83	Pass
5.9675	6	5	83	Pass
6.0201	6	5	83	Pass
6.0726	5	5	100	Pass
6.1251	5	5	100	Pass
6.1776	5	4	80	Pass
6.2301	5	4	80	Pass
6.2826	5	4	80	Pass
6.3352	5	4	80	Pass
6.3877	5	4	80	Pass
6.4402	5	4	80	Pass
6.4927	5	4	80	Pass
6.5452	5	4	80	Pass
6.5978	5	4	80	Pass
6.6503	5	4	80	Pass
6.7028	5	4	80	Pass
6.7553	5	4	80	Pass
6.8078	5	4	80	Pass
6.8603	5	4	80	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.6546 acre-feet
On-line facility target flow:	0.9386 cfs.
Adjusted for 15 min:	0.9386 cfs.
Off-line facility target flow:	0.498 cfs.
Adjusted for 15 min:	0.498 cfs.

Trapezoidal Pond Help

Schematic

SCENARIOS

- [ ] Predeveloped
- [x] Mitigated

Run Scenario

Basic Elements

Pro Elements

LID Toolbox

Commercial Toolbox

Move Elements

Save x,y | Load x,y

X 40

Trapezoidal Pond 1 Mitigated

Facility Name Trapezoidal Pond 1 **Facility Type**

Downstream Connections	Outlet 1	Outlet 2	Outlet 3
	0	0	0

- [ ] Precipitation Applied to Facility
- [ ] Evaporation Applied to Facility

Auto Pond | Quick Pond

Facility Dimension Diagram

Facility Dimensions

Facility Bottom Elevation (ft)	0
Bottom Length (ft)	75
Bottom Width (ft)	37
Effective Depth (ft)	4.5
Left Side Slope (H/V)	3
Bottom Side Slope (H/V)	3
Right Side Slope (H/V)	3
Top Side Slope (H/V)	3
Infiltration	NO

Outlet Structure Data

Riser Height (ft)	3.5
Riser Diameter (in)	18
Riser Type	Notched
Notch Type	Rectangular
Notch Height (ft)	0.52015
Notch Width (ft)	0.67328

Orifice Number	Diameter (in)	Height (ft)
1	5.954	0
2	0	0
3	0	0

Pond Volume at Riser Head (ac-ft) .329

Show Pond Table Open Table

Initial 0

Tide Gate | Time Series | Demand

Determine Outlet With Tide Gate

- [ ] Use Tide Gate

Tide Gate Elevation (ft) 0

Overflow Elevation (ft) 0

Downstream Connection

Iterations 0

Schematic

SCENARIOS

Predeveloped

Mitigated

Run Scenario

Basic Elements

Pro Elements

LID Toolbox

Commercial Toolbox

Move Elements

Save x,y | Load x,y

X 40

Basin 1 Mitigated

Subbasin Name: Basin 1 — Designate as Bypass for POC:

Flows To :	Surface	Interflow	Groundwater
	Trapezoidal Pond 1	Trapezoidal Pond 1	

Show Only Selected

Area in Basin

Available Pervious	Acres
SG4, Forest, Steep	0
SG4, Lawn, Steep	5.42

Available Impervious	Acres
ROADS/STEEP	2.24
ROOF TOPS/FLAT	2.27
SIDEWALKS/STEEP	.5

Pervious Total	5.42	Acres
Impervious Total	5.01	Acres
Basin Total	10.43	Acres

Deselect Zero | **Select By:** | GO

Schematic

SCENARIOS

Predeveloped

Mitigated

Run Scenario

Basic Elements

Pro Elements

LID Toolbox

Commercial Toolbox

Move Elements

Save x,y | Load x,y

X 40

Basin 1 Predeveloped

Subbasin Name: Basin 1

Flows To :	Surface	Interflow	Groundwater

Area in Basin

Show Only Selected

Available Pervious	Acres
SG4, Forest, Steep	9.17
SG4, Lawn, Steep	0

Available Impervious	Acres
ROADS/STEEP	.48
ROOF TOPS/FLAT	.78
SIDEWALKS/STEEP	0

Pervious Total	9.17	Acres
Impervious Total	1.26	Acres
Basin Total	10.43	Acres

Deselect Zero

Select By: GO

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	Detention Pond
Site Name:	
Site Address:	
City:	
Report Date:	4/19/2022
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.300
Version Date:	2021/08/18
Version:	4.2.18

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Forest, Steep	9.17
Pervious Total	9.17

Impervious Land Use	acre
ROADS STEEP	0.48
ROOF TOPS FLAT	0.78
Impervious Total	1.26
Basin Total	10.43

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
SG4, Lawn, Steep	5.42
Pervious Total	5.42

Impervious Land Use	acre
ROADS STEEP	2.24
ROOF TOPS FLAT	2.27
SIDEWALKS STEEP	0.5
Impervious Total	5.01
Basin Total	10.43

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

Bottom Length: 75.00 ft.
Bottom Width: 37.00 ft.
Depth: 4.5 ft.
Volume at riser head: 0.3293 acre-feet.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Discharge Structure
Riser Height: 3.5 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.673 ft.
Notch Height: 0.520 ft.
Orifice 1 Diameter: 5.954 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.063	0.000	0.000	0.000
0.0500	0.064	0.003	0.215	0.000
0.1000	0.065	0.006	0.304	0.000
0.1500	0.066	0.009	0.372	0.000
0.2000	0.066	0.013	0.430	0.000
0.2500	0.067	0.016	0.481	0.000
0.3000	0.068	0.019	0.526	0.000
0.3500	0.069	0.023	0.569	0.000
0.4000	0.070	0.026	0.608	0.000
0.4500	0.070	0.030	0.645	0.000
0.5000	0.071	0.033	0.680	0.000
0.5500	0.072	0.037	0.713	0.000
0.6000	0.073	0.041	0.745	0.000
0.6500	0.074	0.044	0.775	0.000
0.7000	0.074	0.048	0.804	0.000
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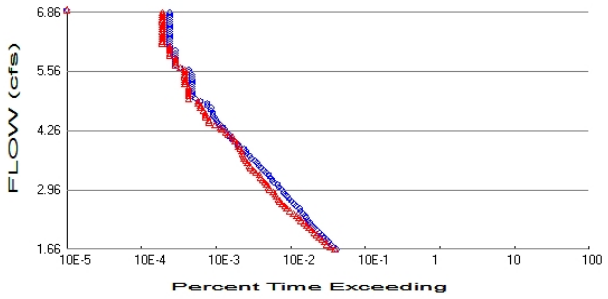
0.9000	0.078	0.063	0.912	0.000
0.9500	0.079	0.067	0.937	0.000
1.0000	0.080	0.071	0.962	0.000
1.0500	0.080	0.075	0.985	0.000
1.1000	0.081	0.079	1.009	0.000
1.1500	0.082	0.083	1.031	0.000
1.2000	0.083	0.088	1.053	0.000
1.2500	0.084	0.092	1.075	0.000
1.3000	0.085	0.096	1.096	0.000
1.3500	0.086	0.100	1.117	0.000
1.4000	0.086	0.105	1.138	0.000
1.4500	0.087	0.109	1.158	0.000
1.5000	0.088	0.113	1.178	0.000
1.5500	0.089	0.118	1.197	0.000

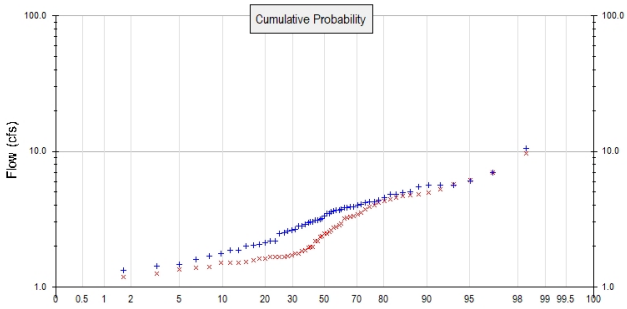
1.6000	0.090	0.122	1.216	0.000	
1.6500	0.091	0.127	1.235	0.000	
1.7000	0.092	0.131	1.254	0.000	
1.7500	0.093	0.136	1.272	0.000	
1.8000	0.094	0.141	1.290	0.000	
1.8500	0.095	0.146	1.308	0.000	
1.9000	0.096	0.150	1.326	0.000	
1.9500	0.096	0.155	1.343	0.000	
2.0000	0.097	0.160	1.360	0.000	
2.0500	0.098	0.165	1.377	0.000	
2.1000	0.099	0.170	1.394	0.000	
2.1500	0.100	0.175	1.410	0.000	
2.2000	0.101	0.180	1.426	0.000	
2.2500	0.102	0.185	1.443	0.000	
2.3000	0.103	0.190	1.458	0.000	
2.3500	0.104	0.195	1.474	0.000	
2.4000	0.105	0.201	1.490	0.000	
2.4500	0.106	0.206	1.505	0.000	
2.5000	0.107	0.211	1.521	0.000	
2.5500	0.108	0.217	1.536	0.000	
2.6000	0.109	0.222	1.551	0.000	
2.6500	0.110	0.228	1.566	0.000	
2.7000	0.111	0.233	1.580	0.000	
2.7500	0.112	0.239	1.595	0.000	
2.8000	0.113	0.244	1.609	0.000	
2.8500	0.114	0.250	1.624	0.000	
2.9000	0.115	0.256	1.638	0.000	
2.9500	0.116	0.262	1.652	0.000	
3.0000	0.117	0.268	1.672	0.000	
3.0500	0.118	0.273	1.721	0.000	
3.1000	0.119	0.279	1.787	0.000	
3.1500	0.120	0.285	1.864	0.000	
3.2000	0.121	0.291	1.952	0.000	
3.2500	0.122	0.298	2.049	0.000	
3.3000	0.123	0.304	2.153	0.000	
3.3500	0.124	0.310	2.265	0.000	
3.4000	0.125	0.316	2.384	0.000	**2-year**
3.4500	0.126	0.322	2.509	0.000	
3.5000	0.127	0.329	2.640	0.000	
3.5500	0.128	0.335	2.831	0.000	
3.6000	0.130	0.342	3.168	0.000	
3.6500	0.131	0.348	3.598	0.000	
3.7000	0.132	0.355	4.096	0.000	
3.7500	0.133	0.361	4.642	0.000	**10-year**
3.8000	0.134	0.368	5.217	0.000	
3.8500	0.135	0.375	5.801	0.000	
3.9000	0.136	0.382	6.373	0.000	
3.9500	0.137	0.389	6.913	0.000	
4.0000	0.138	0.395	7.404	0.000	**50-year**
4.0500	0.139	0.402	7.832	0.000	
4.1000	0.140	0.409	8.190	0.000	
4.1500	0.142	0.416	8.477	0.000	
4.2000	0.143	0.424	8.705	0.000	
4.2500	0.144	0.431	8.896	0.000	**100-year**
4.3000	0.145	0.438	9.174	0.000	
4.3500	0.146	0.445	9.381	0.000	
4.4000	0.147	0.453	9.582	0.000	
4.4500	0.148	0.460	9.777	0.000	

4.5000	0.149	0.468	9.968	0.000
4.5500	0.151	0.475	10.15	0.000

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 9.17
Total Impervious Area: 1.26

Mitigated Landuse Totals for POC #1
Total Pervious Area: 5.42
Total Impervious Area: 5.01

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	3.322061
5 year	4.743632
10 year	5.524253
25 year	6.344451
50 year	6.860345
100 year	7.301459

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	2.479295
5 year	3.850531
10 year	4.917934
25 year	6.456241
50 year	7.745468
100 year	9.162329

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	2.510	1.937
1950	3.021	2.326
1951	4.251	1.624
1952	2.808	3.893
1953	3.457	1.656
1954	5.614	2.181
1955	2.672	1.533
1956	4.789	4.535
1957	4.555	2.472
1958	3.876	4.969

1959	2.168	1.335
1960	2.033	1.662
1961	4.261	3.316
1962	3.174	2.634
1963	3.488	2.172
1964	3.130	1.843
1965	2.877	2.485
1966	3.864	2.548
1967	3.639	1.673
1968	4.037	5.253
1969	4.354	6.171
1970	10.485	9.630
1971	1.873	1.501
1972	2.805	1.698
1973	3.008	3.182
1974	4.193	4.686
1975	2.486	1.758
1976	3.817	2.918
1977	0.451	1.123
1978	5.614	4.185
1979	3.873	4.740
1980	2.118	1.564
1981	4.941	4.308
1982	3.581	3.532
1983	6.063	4.012
1984	2.069	1.505
1985	1.419	1.859
1986	1.995	1.980
1987	3.121	1.768
1988	1.857	1.501
1989	2.182	1.668
1990	1.585	1.378
1991	3.753	1.970
1992	3.697	1.707
1993	4.790	4.815
1994	3.100	2.840
1995	2.625	3.246
1996	5.498	6.987
1997	6.939	4.424
1998	5.667	3.722
1999	3.656	2.752
2000	2.566	1.253
2001	1.460	1.177
2002	5.014	2.717
2003	3.987	3.271
2004	1.323	1.404
2005	1.676	1.607
2006	2.954	2.377
2007	1.764	3.451
2008	3.337	5.700

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	10.4848	9.6299
2	6.9387	6.9874
3	6.0632	6.1710
4	5.6670	5.6997

5	5.6142	5.2526
6	5.6142	4.9687
7	5.4981	4.8148
8	5.0142	4.7404
9	4.9410	4.6860
10	4.7897	4.5353
11	4.7885	4.4242
12	4.5545	4.3082
13	4.3544	4.1850
14	4.2614	4.0124
15	4.2508	3.8928
16	4.1935	3.7222
17	4.0370	3.5318
18	3.9870	3.4509
19	3.8758	3.3157
20	3.8728	3.2715
21	3.8635	3.2457
22	3.8172	3.1824
23	3.7531	2.9184
24	3.6971	2.8401
25	3.6562	2.7524
26	3.6386	2.7169
27	3.5815	2.6343
28	3.4877	2.5481
29	3.4566	2.4855
30	3.3373	2.4719
31	3.1743	2.3769
32	3.1297	2.3257
33	3.1209	2.1807
34	3.1004	2.1719
35	3.0209	1.9801
36	3.0080	1.9700
37	2.9543	1.9369
38	2.8772	1.8594
39	2.8079	1.8428
40	2.8054	1.7682
41	2.6724	1.7576
42	2.6251	1.7067
43	2.5662	1.6981
44	2.5099	1.6733
45	2.4860	1.6682
46	2.1818	1.6625
47	2.1680	1.6555
48	2.1182	1.6237
49	2.0689	1.6074
50	2.0327	1.5642
51	1.9951	1.5328
52	1.8731	1.5048
53	1.8575	1.5014
54	1.7638	1.5012
55	1.6759	1.4037
56	1.5848	1.3782
57	1.4597	1.3350
58	1.4185	1.2535
59	1.3234	1.1770
60	0.4513	1.1234

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.6610	857	820	95	Pass
1.7135	793	715	90	Pass
1.7661	728	644	88	Pass
1.8186	683	597	87	Pass
1.8711	626	547	87	Pass
1.9236	581	507	87	Pass
1.9761	545	463	84	Pass
2.0287	508	429	84	Pass
2.0812	468	402	85	Pass
2.1337	432	371	85	Pass
2.1862	405	340	83	Pass
2.2387	385	317	82	Pass
2.2913	366	291	79	Pass
2.3438	340	271	79	Pass
2.3963	325	249	76	Pass
2.4488	304	229	75	Pass
2.5013	285	206	72	Pass
2.5538	273	185	67	Pass
2.6064	250	174	69	Pass
2.6589	231	160	69	Pass
2.7114	217	151	69	Pass
2.7639	204	142	69	Pass
2.8164	189	135	71	Pass
2.8690	178	129	72	Pass
2.9215	167	122	73	Pass
2.9740	157	111	70	Pass
3.0265	146	105	71	Pass
3.0790	141	99	70	Pass
3.1315	125	94	75	Pass
3.1841	118	88	74	Pass
3.2366	113	84	74	Pass
3.2891	107	80	74	Pass
3.3416	98	71	72	Pass
3.3941	91	66	72	Pass
3.4467	84	61	72	Pass
3.4992	78	59	75	Pass
3.5517	74	55	74	Pass
3.6042	70	52	74	Pass
3.6567	63	50	79	Pass
3.7092	59	49	83	Pass
3.7618	54	47	87	Pass
3.8143	53	46	86	Pass
3.8668	50	44	88	Pass
3.9193	43	42	97	Pass
3.9718	41	41	100	Pass
4.0244	37	38	102	Pass
4.0769	34	36	105	Pass
4.1294	32	35	109	Pass
4.1819	31	30	96	Pass
4.2344	29	28	96	Pass
4.2869	27	25	92	Pass
4.3395	26	24	92	Pass
4.3920	24	20	83	Pass

4.4445	22	17	77	Pass
4.4970	21	17	80	Pass
4.5495	20	15	75	Pass
4.6021	19	15	78	Pass
4.6546	19	15	78	Pass
4.7071	18	14	77	Pass
4.7596	18	13	72	Pass
4.8121	16	13	81	Pass
4.8646	16	12	75	Pass
4.9172	13	12	92	Pass
4.9697	11	9	81	Pass
5.0222	10	9	90	Pass
5.0747	10	9	90	Pass
5.1272	10	9	90	Pass
5.1798	10	9	90	Pass
5.2323	10	9	90	Pass
5.2848	10	8	80	Pass
5.3373	10	8	80	Pass
5.3898	10	8	80	Pass
5.4424	10	8	80	Pass
5.4949	10	8	80	Pass
5.5474	9	8	88	Pass
5.5999	9	8	88	Pass
5.6524	7	7	100	Pass
5.7049	6	6	100	Pass
5.7575	6	6	100	Pass
5.8100	6	6	100	Pass
5.8625	6	6	100	Pass
5.9150	6	5	83	Pass
5.9675	6	5	83	Pass
6.0201	6	5	83	Pass
6.0726	5	5	100	Pass
6.1251	5	5	100	Pass
6.1776	5	4	80	Pass
6.2301	5	4	80	Pass
6.2826	5	4	80	Pass
6.3352	5	4	80	Pass
6.3877	5	4	80	Pass
6.4402	5	4	80	Pass
6.4927	5	4	80	Pass
6.5452	5	4	80	Pass
6.5978	5	4	80	Pass
6.6503	5	4	80	Pass
6.7028	5	4	80	Pass
6.7553	5	4	80	Pass
6.8078	5	4	80	Pass
6.8603	5	4	80	Pass

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
Trapezoidal Pond 1 POC	☐	1480.29			☐	0.00			
Total Volume Infiltrated		1480.29	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

POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run.

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

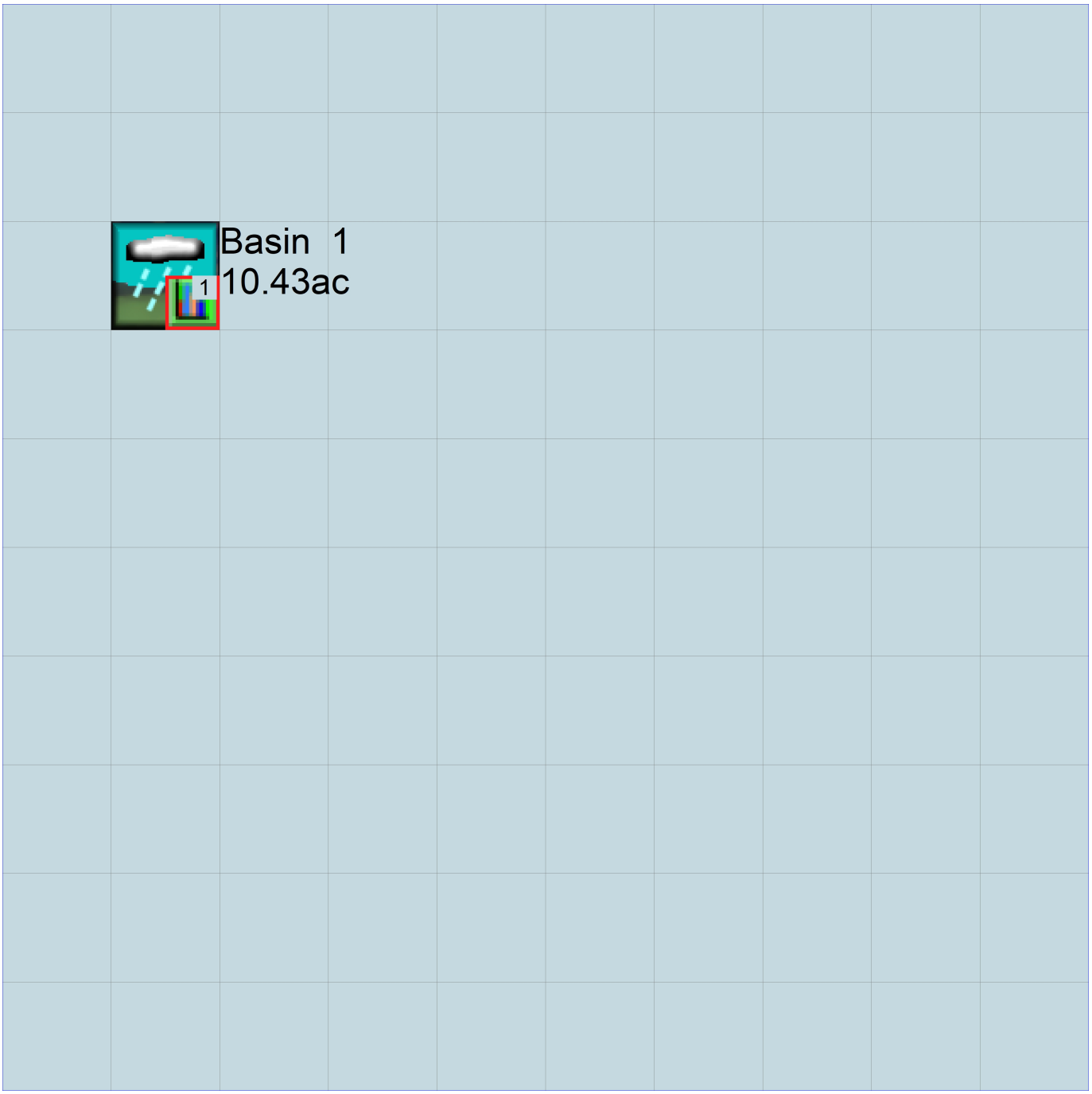
No PERLND changes have been made.

IMPLND Changes

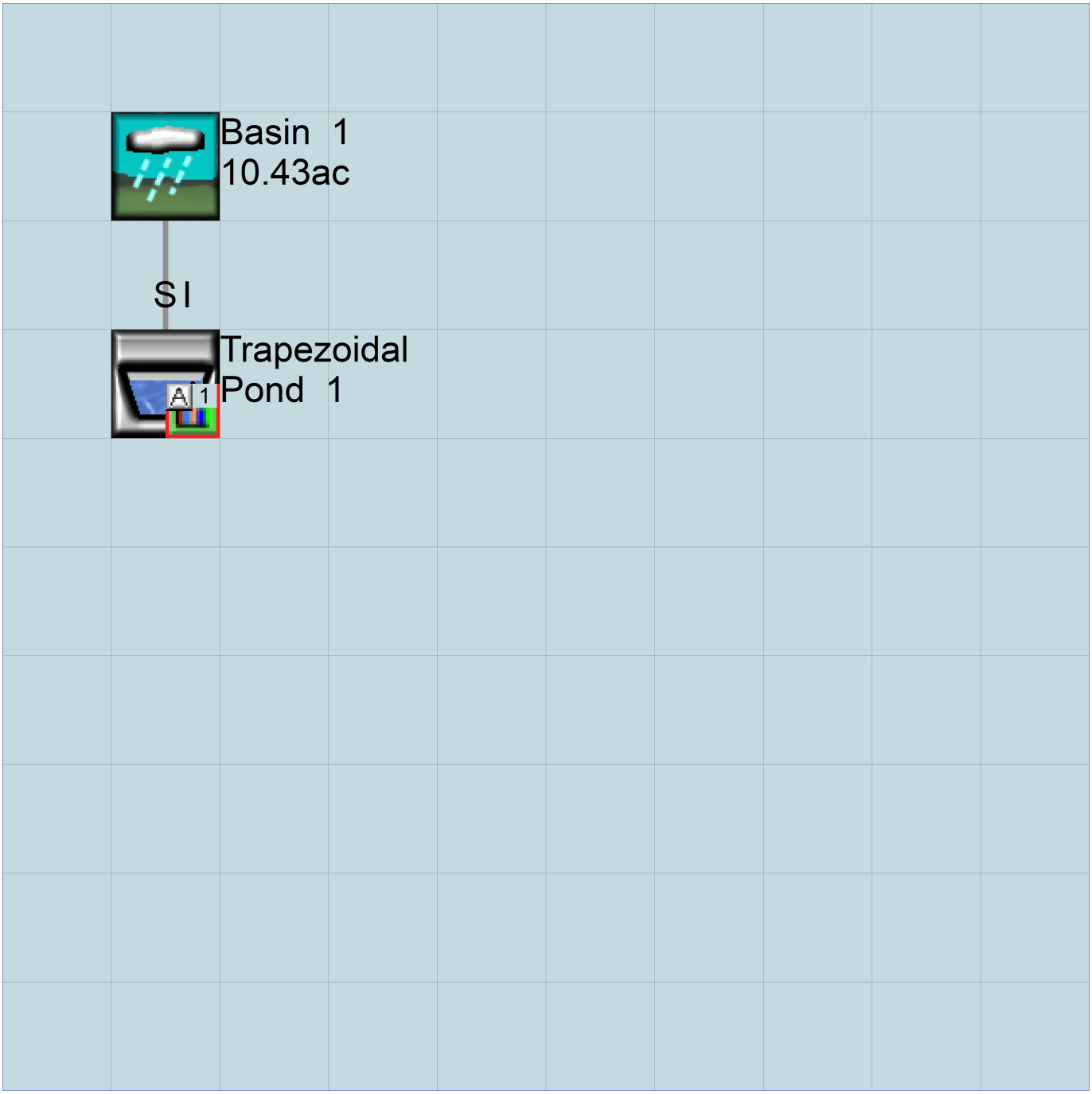
No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 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   Detention Pond.wdm
MESSU       25   PreDetention Pond.MES
            27   PreDetention Pond.L61
            28   PreDetention Pond.L62
            30   POCDetention Pond1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      30
      IMPLND       3
      IMPLND       4
      COPY       501
      DISPLY       1
    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
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                        in  out           ***
   30     SG4, Forest, Steep      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 ***
   30         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  *********
   30         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 ***
   30         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
   30             0         6      0.04       400      0.15         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   30             0         0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   30           0.2       0.4      0.35         2       0.4       0.7
  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
   30             0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

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

  ACTIVITY
    <PLS > ************* Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    3         0    0    1    0    0    0
    4         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    3         0    0    4    0    0    0    1    9
    4         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     ***
    3         0    0    0    0    0
    4         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    3            400       0.1       0.1      0.05
    4            400      0.01       0.1       0.1
```

```
  END IWAT-PARM2

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

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    3              0         0
    4              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  30                       9.17     COPY   501     12
PERLND  30                       9.17     COPY   501     13
IMPLND   3                       0.48     COPY   501     15
IMPLND   4                       0.78     COPY   501     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



<-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    1.3            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.3            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            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
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       1948 10 01        END    2008 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   Detention Pond.wdm
MESSU       25   MitDetention Pond.MES
            27   MitDetention Pond.L61
            28   MitDetention Pond.L62
            30   POCDetention Pond1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      36
      IMPLND       3
      IMPLND       4
      IMPLND      10
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Trapezoidal Pond  1         MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   36     SG4, Lawn, Steep        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 ***
   36         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  *********
   36         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 ***
   36         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
   36              0         6      0.02       400      0.15         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   36              0         0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   36           0.1       0.2      0.25         2       0.4      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
             ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS       IFWS       LZS       AGWS      GWVS
   36              0         0         0         0       2.5          1         0
  END PWAT-STATE1

END PERLND

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

  ACTIVITY
    <PLS > ************ Active Sections ****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    3         0    0    1    0    0    0
    4         0    0    1    0    0    0
   10         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    3         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
   10         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     ***
    3         0    0    0    0    0
    4         0    0    0    0    0
   10         0    0    0    0    0
```

```
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >       IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    3            400       0.1       0.1      0.05
    4            400      0.01       0.1       0.1
   10            400       0.1       0.1      0.05
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >       IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    3              0         0
    4              0         0
   10              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    3              0         0
    4              0         0
   10              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  36                        5.42     RCHRES   1      2
PERLND  36                        5.42     RCHRES   1      3
IMPLND   3                        2.24     RCHRES   1      5
IMPLND   4                        2.27     RCHRES   1      5
IMPLND  10                         0.5     RCHRES   1      5

******Routing******
PERLND  36                        5.42     COPY     1     12
IMPLND   3                        2.24     COPY     1     15
IMPLND   4                        2.27     COPY     1     15
IMPLND  10                         0.5     COPY     1     15
PERLND  36                        5.42     COPY     1     13
RCHRES   1                           1     COPY   501     16
END SCHEMATIC

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



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

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<----------------><---> User T-series  Engl Metr LKFG             ***
                                        in  out                             ***
    1     Trapezoidal Pond-007    1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

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

```
    1         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

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

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

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1               1      0.01       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                       ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
         *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1            0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   91    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.063705  0.000000  0.000000
  0.050000  0.064479  0.003205  0.215110
  0.100000  0.065256  0.006448  0.304212
  0.150000  0.066038  0.009730  0.372582
  0.200000  0.066824  0.013052  0.430221
  0.250000  0.067614  0.016413  0.481001
  0.300000  0.068408  0.019813  0.526911
  0.350000  0.069206  0.023254  0.569129
  0.400000  0.070008  0.026734  0.608424
  0.450000  0.070815  0.030255  0.645331
  0.500000  0.071625  0.033816  0.680239
  0.550000  0.072440  0.037417  0.713440
  0.600000  0.073259  0.041060  0.745164
  0.650000  0.074082  0.044743  0.775592
  0.700000  0.074909  0.048468  0.804869
  0.750000  0.075740  0.052234  0.833119
  0.800000  0.076576  0.056042  0.860442
  0.850000  0.077415  0.059892  0.886923
  0.900000  0.078259  0.063784  0.912636
  0.950000  0.079107  0.067718  0.937644
  1.000000  0.079959  0.071695  0.962003
  1.050000  0.080815  0.075714  0.985760
  1.100000  0.081675  0.079776  1.008957
  1.150000  0.082539  0.083881  1.031633
  1.200000  0.083408  0.088030  1.053821
  1.250000  0.084280  0.092222  1.075552
  1.300000  0.085157  0.096458  1.096852
  1.350000  0.086038  0.100738  1.117746
  1.400000  0.086923  0.105062  1.138257
  1.450000  0.087812  0.109431  1.158405
  1.500000  0.088705  0.113843  1.178208
  1.550000  0.089603  0.118301  1.197684
```

```
  1.600000  0.090504  0.122804  1.216848
  1.650000  0.091410  0.127352  1.235715
  1.700000  0.092320  0.131945  1.254298
  1.750000  0.093233  0.136584  1.272610
  1.800000  0.094152  0.141268  1.290662
  1.850000  0.095074  0.145999  1.308465
  1.900000  0.096000  0.150776  1.326029
  1.950000  0.096930  0.155599  1.343364
  2.000000  0.097865  0.160469  1.360478
  2.050000  0.098804  0.165386  1.377379
  2.100000  0.099747  0.170349  1.394075
  2.150000  0.100694  0.175360  1.410573
  2.200000  0.101645  0.180419  1.426881
  2.250000  0.102600  0.185525  1.443004
  2.300000  0.103559  0.190679  1.458950
  2.350000  0.104523  0.195881  1.474723
  2.400000  0.105490  0.201131  1.490328
  2.450000  0.106462  0.206430  1.505773
  2.500000  0.107438  0.211778  1.521060
  2.550000  0.108418  0.217174  1.536195
  2.600000  0.109402  0.222620  1.551183
  2.650000  0.110390  0.228114  1.566027
  2.700000  0.111383  0.233659  1.580732
  2.750000  0.112379  0.239253  1.595301
  2.800000  0.113380  0.244897  1.609739
  2.850000  0.114385  0.250591  1.624048
  2.900000  0.115394  0.256335  1.638232
  2.950000  0.116407  0.262130  1.652294
  3.000000  0.117424  0.267976  1.672651
  3.050000  0.118446  0.273873  1.721723
  3.100000  0.119471  0.279821  1.787156
  3.150000  0.120501  0.285820  1.864745
  3.200000  0.121534  0.291871  1.952474
  3.250000  0.122572  0.297974  2.049086
  3.300000  0.123614  0.304128  2.153702
  3.350000  0.124660  0.310335  2.265658
  3.400000  0.125711  0.316595  2.384434
  3.450000  0.126765  0.322906  2.509605
  3.500000  0.127824  0.329271  2.640817
  3.550000  0.128886  0.335689  2.831478
  3.600000  0.129953  0.342160  3.168525
  3.650000  0.131024  0.348684  3.598053
  3.700000  0.132099  0.355262  4.095988
  3.750000  0.133178  0.361894  4.642415
  3.800000  0.134262  0.368580  5.217625
  3.850000  0.135349  0.375321  5.801336
  3.900000  0.136441  0.382115  6.373079
  3.950000  0.137537  0.388965  6.913184
  4.000000  0.138636  0.395869  7.404172
  4.050000  0.139740  0.402829  7.832442
  4.100000  0.140848  0.409843  8.190202
  4.150000  0.141961  0.416914  8.477615
  4.200000  0.143077  0.424039  8.705127
  4.250000  0.144198  0.431221  8.895971
  4.300000  0.145322  0.438459  9.174434
  4.350000  0.146451  0.445754  9.381075
  4.400000  0.147584  0.453105  9.581992
  4.450000  0.148721  0.460512  9.777651
  4.500000  0.149862  0.467977  9.968458
  END FTABLE  1
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    1.3            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.3            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            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***
RCHRES   1 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1001 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>             <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  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

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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Geotechnical Site Investigation

NW 18th Avenue Subdivision

Camas, Washington

September 15, 2021

Geotechnical ■ Environmental ■ Special Inspections
Columbia West
Engineering, Inc

11917 NE 95th Street
Vancouver, Washington
98682
Phone: 360-823-2900
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Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

GEOTECHNICAL SITE INVESTIGATION
NW 18th AVENUE SUBDIVISION
CAMAS, WASHINGTON

Prepared For:
Modern Dwellings, LLC.
Attn: Sergey Marandyuk
8101 NE Glisan Street
Portland, Oregon, 97213

Site Location:
3010 NW 18th Avenue
Parcel Nos. 127356000, 127359000, and 127439000
Camas, Washington

Prepared By:
Columbia West Engineering, Inc.
11917 NE 95th Street
Vancouver, Washington 98682
Phone: 360-823-2900
W.O. No. 21184

Date Prepared:
September 15, 2021

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GEOTECHNICAL SITE INVESTIGATION
NW 18th AVENUE SUBDIVISION
CAMAS, WASHINGTON

1.0 INTRODUCTION

Columbia West Engineering, Inc. (Columbia West) was retained by Modern Dwellings, LLC to conduct a geotechnical site investigation for the proposed NW 18th Avenue Subdivision project located in Camas, Washington. The purpose of the investigation was to observe and assess subsurface soil conditions at specific locations and provide geotechnical engineering analyses, planning, and design recommendations for proposed development. The specific scope of services was outlined in a proposal contract dated June 21, 2021. This report summarizes the investigation and provides field assessment documentation and laboratory analytical test reports. This report is subject to the limitations expressed in Section 7.0, *Conclusion and Limitations*, and Appendix E.

1.1 General Site Information

As indicated on Figures 1 and 2, the subject site is located at 3010 NW 18th Avenue in Camas, Washington. The site is comprised of tax parcels 127356000, 127359000, and 127439000 totaling approximately 9.82 acres. The approximate latitude and longitude are N 45° 35' 27" and W 122° 26' 25", and the legal description is a portion of the NE ¼ of Section 09, T1N, R3E, Willamette Meridian. The regulatory jurisdictional agency is City of Camas, Washington.

1.2 Proposed Development

Correspondence with the design team and review of the proposed development plan shown on Figure 2A indicates that proposed development at the NW 18th Avenue Subdivision includes the development of the above-referenced tax parcels into 35 new single-family residential lots, private asphalt access drives, public asphalt roadways, underground utilities, and stormwater facilities. Columbia West has not reviewed preliminary grading plans but understands that cut and fill may be proposed at the subject site. This report is based upon proposed development as described above and may not be applicable if modified.

2.0 REGIONAL GEOLOGY AND SOIL CONDITIONS

The subject site lies within the Willamette Valley/Puget Sound Lowland, a wide physiographic depression flanked by the mountainous Coast Range on the west and the Cascade Range on the east. Inclined or uplifted structural zones within the Willamette Valley/Puget Sound Lowland constitute highland areas and depressed structural zones form sediment-filled basins. The site is located in the northern portion of the Portland/Vancouver Basin, an open, somewhat elliptical, northwest-trending syncline approximately 60 miles wide.

According to the *Geologic Map of the Camas Quadrangle, Clark County, Washington, and Multnomah County, Oregon* (Russell C. Evarts, USGS Geological Survey, 2008),

near-surface soils at subject site are expected to consist of Holocene-aged, unconsolidated loess deposits of silt and fine sand (Qlo). Mapped QTc exposures on the western portion of the property indicate that loess deposits may be underlain by Pleistocene- to Pliocene-aged, unconsolidated to cemented, pebble- to boulder-sized sedimentary conglomerate.

The *Web Soil Survey* (United States Department of Agriculture, Natural Resource Conservation Service [USDA NRCS], 2021 Website) identifies surface soils as Powell silt loam. Although soil conditions may vary from the broad USDA descriptions, Powell soils are generally fine-textured silts and clays with low permeability, moderate water capacity, moderate shrink-swell potential, and moderate shear strength. They exhibit a slight erosion hazard based primarily on slope grade.

3.0 REGIONAL SEISMOLOGY

Recent research and subsurface mapping investigations within the Pacific Northwest appear to suggest the historic potential risk for a large earthquake event with strong localized ground movement may be underestimated. Past earthquakes in the Pacific Northwest appear to have caused landslides and ground subsidence, in addition to severe flooding near coastal areas. Earthquakes may also induce soil liquefaction, which occurs when elevated horizontal ground acceleration and velocity cause soil particles to interact as a fluid as opposed to a solid. Liquefaction of soil can result in lateral spreading and temporary loss of bearing capacity and shear strength. Liquefaction is discussed later in Section 5.3.1, *Soil Liquefaction and Dynamic Settlement*.

There are at least four major known fault zones in the vicinity of the site that may be capable of generating potentially destructive horizontal accelerations. These fault zones are described briefly in the following text.

Portland Hills Fault Zone

The Portland Hills Fault Zone consists of several northwest-trending faults located along the northeastern margin of the Tualatin Mountains, also known as the Portland Hills, and the southwest margin of the Portland Basin. The fault zone is approximately 25 to 30 miles in length and is located approximately 18 miles west of the site. According to *Seismic Design Mapping, State of Oregon* (Geomatrix Consultants, 1995), there is no definitive consensus among geologists as to the zone fault type. Several alternate interpretations have been suggested.

According to the *USGS Earthquake Hazards Program*, the fault was originally mapped as a down-to-the-northeast normal fault but has also been mapped as part of a regional-scale zone of right-lateral, oblique slip faults, and as a steep escarpment caused by asymmetrical folding above a south-west dipping, blind thrust fault. The Portland Hills fault offsets Miocene Columbia River Basalts, and Miocene to Pliocene sedimentary rocks of the Troutdale Formation. No fault scarps on surficial Quaternary deposits have been described along the fault trace, and the fault is mapped as buried by the Pleistocene-aged Missoula flood deposits.

However, evidence suggests that fault movement has impacted shallow Holocene deposits and deeper Pleistocene sediments. Seismologists recorded a M3.2 earthquake thought to

be associated with the fault zone near Kelly Point Park in November 2012, a M3.9 earthquake thought to be associated with the fault zone near Kelly Point Park in April 2003, and a M3.5 earthquake possibly associated with the fault zone approximately 1.3 miles east of the fault in 1991. Therefore, the Portland Hills Fault Zone is generally thought to be potentially active and capable of producing possible damaging earthquakes.

Gales Creek-Newberg-Mt. Angel Fault Zone

Located approximately 32 miles southwest of the site, the northwest-striking, approximately 50-mile long Gales Creek-Newberg-Mt. Angel Structural Zone forms the northwestern boundary between the Oregon Coast Range and the Willamette Valley, and consists of a series of discontinuous northwest-trending faults. The southern end of the fault zone forms the southwest margin of the Tualatin basin. Possible late-Quaternary geomorphic surface deformation may exist along the structural zone (Geomatrix Consultants, 1995).

According to the *USGS Earthquake Hazards Program*, the Mount Angel fault is mapped as a high-angle, reverse-oblique fault, which offsets Miocene rocks of the Columbia River Basalts, and Miocene and Pliocene sedimentary rocks. The fault appears to have controlled emplacement of the Frenchman Spring Member of the Wanapum Basalts, and thus must have a history that predates the Miocene age of these rocks. No unequivocal evidence of deformation of Quaternary deposits has been described as a thick sequence of sediments deposited by the Missoula floods covers much of the southern part of the fault trace.

Although no definitive evidence of impacts to Holocene sediments have clearly been identified, the Mount Angel fault appears to have been the location of minor earthquake swarms in 1990 near Woodburn, Oregon, and a M5.6 earthquake in March 1993 near Scotts Mills, approximately four miles south of the mapped extent of the Mt. Angel fault. It is unclear if the earthquake occurred along the fault zone or a parallel structure. Therefore, the Gales Creek-Newberg-Mt. Angel Structural Zone is considered potentially active.

Lacamas Lake-Sandy River Fault Zone

The northwest-trending Lacamas Lake Fault and northeast-trending Sandy River Fault intersect north of Camas, Washington approximately 2 miles east of the site, and form part of the northeastern margin of the Portland basin. According to *Geology and Groundwater Conditions of Clark County Washington* (USGS Water Supply Paper 1600, Mundorff, 1964) and the *Geologic Map of the Lake Oswego Quadrangle* (Oregon DOGAMI Series GMS-59, 1989), the Lacamas Lake fault zone consists of shear contact between the Troutdale Formation and underlying Oligocene andesite-basalt bedrock. Secondary shear contact associated with the fault zone may have produced a series of prominent northwest-southeast geomorphic lineaments in proximity to the site.

According to the *USGS Earthquake Hazards Program* the fault has been mapped as a normal fault with down-to-the-southwest displacement and has also been described as a steeply northeast or southwest-dipping, oblique, right-lateral, slip-fault. The trace of the Lacamas Lake fault is marked by the very linear lower reach of Lacamas Creek. No fault scarps on Quaternary surficial deposits have been described. The Lacamas Lake fault offsets Pliocene-aged sedimentary conglomerates generally identified as the Troutdale

formation, and Pliocene- to Pleistocene-aged basalts generally identified as the Boring Lava formation.

Recent seismic reflection data across the probable trace of the fault under the Columbia River yielded no unequivocal evidence of displacement underlying the Missoula flood deposits, however, recorded mild seismic activity during the recent past indicates this area may be potentially seismogenic.

Cascadia Subduction Zone

The Cascadia Subduction Zone has recently been recognized as a potential source of strong earthquake activity in the Portland/Vancouver Basin. This phenomenon is the result of the earth's large tectonic plate movement. Geologic evidence indicates that volcanic ocean floor activity along the Juan de Fuca ridge in the Pacific Ocean causes the Juan de Fuca Plate to perpetually move east and subduct under the North American Continental Plate. The subduction zone results in historic volcanic and potential earthquake activity in proximity to the plate interface, believed to lie approximately 20 to 50 miles west of the general location of the Oregon and Washington coast (Geomatrix Consultants, 1995).

4.0 GEOTECHNICAL AND GEOLOGIC FIELD INVESTIGATION

A geotechnical field investigation consisting of visual reconnaissance, six test pits (TP-1 through TP-6) and five infiltration tests (IT-1.1 to IT-5.2) occurred on August 5, 2021. The test pits were explored with a track-mounted excavator. Subsurface soil profiles were logged in accordance with Unified Soil Classification System (USCS) specifications. Disturbed soil samples were collected from relevant soil horizons and submitted for laboratory analysis. Analytical laboratory test results are presented in Appendix A. Exploration locations are indicated on Figure 2. Subsurface exploration logs are presented in Appendix B. Soil descriptions and classification information are provided in Appendix C. A photo log is presented in Appendix D.

4.1 Surface Investigation and Site Description

The approximate 9.82-acre subject site consists of three tax parcels located at 3010 NE 18th Avenue in Camas, Washington. The site is bounded by NW 18th Avenue to the north, NW Hood Street to the west, residential acreage to the south, and newly developed Haven Heights subdivision to the east. The site currently has a multi-story residence, two multi-story garage structures, and an agricultural structure located on the east half of the site. The area on the west is undeveloped grassy field. Site vegetation primarily consisted of grass in open areas with trees and shrubs concentrated around existing structures.

Field reconnaissance and review of site topographic mapping indicate rolling to gently sloped terrain with grades of 10 to 15 percent characterizing the site. Site elevations range from approximately 692 feet above mean sea level (amsl) in the southwest corner of the parcel to approximately 754 feet amsl in the northeast corner. Slope grades exceed 15 percent in localized areas and are identified as potential landslide hazards according to *Clark County Maps Online*. Discussion related to slope geometry, geomorphic features, and stability are discussed later in Section 5.0, *Geologic Hazards*.

4.2 Subsurface Exploration and Investigation

The test pits were explored to a maximum depth of 13.5 feet below ground surface (bgs). Exploration locations were selected to observe subsurface soil characteristics in proximity to proposed development areas and are indicated on Figure 2.

4.2.1 Soil Type Description

The field investigation indicated the presence of approximately 8 to 14 inches of sod and topsoil in the observed locations. Underlying the topsoil layer subsurface soils resembling native USDA Powell soil series description were encountered. Subsurface lithology may generally be described by soil types identified in the following text. Field logs and observed stratigraphy for the encountered materials are presented in Appendix B, *Subsurface Exploration Logs*.

Soil Type 1 – Lean CLAY / CLAY with Sand

Soil Type 1 was observed to primarily consist of light brown to brown, brown, gray to light brown, dry, moist, lean CLAY and CLAY with sand. Occasional sub-rounded cobbles were observed. Soil Type 1 was observed below topsoil layer in all test pits and extended to the maximum depth of exploration in all test pits.

4.2.2 Groundwater

Groundwater was not encountered within the test pit explorations to maximum explored depth of 13.5 feet bgs. Groundwater levels are often subject to seasonal variance and may rise during extended periods of increased precipitation or flooding. Review of nearby well logs obtained from the State of Washington Department of Ecology indicates that static groundwater levels in the area may vary significantly. Variations in ground water elevations likely reflect the screened interval depth of these wells, changes in ground surface elevation, and the presence of multiple aquifers and confining units.

Seeps and springs may become evident during site grading, primarily along slopes or in areas cut below existing grade. Structures, roads, and drainage design should be planned accordingly. Piezometer installation and long-term monitoring, beyond the scope of this investigation, would be necessary to provide more detailed groundwater information.

5.0 GEOLOGIC HAZARDS

Camas Municipal Code, Section 16.59 defines geologic hazard requirements for proposed development in areas subject to City of Camas jurisdiction. Three potential geologic hazards are identified: (1) erosion hazard areas, (2) landslide hazard areas, and (3) seismic hazard areas. As previously indicated, hazard mapping obtained from *Clark County Maps Online* indicates potential landslide hazard areas (slopes greater than 15 percent) within portions of the property.

Columbia West conducted a geologic hazard review to assess whether these hazards are present at the subject property proposed for development, and if so, to provide mitigation recommendations. The geologic hazard review was based upon physical and visual reconnaissance, subsurface exploration, laboratory analysis of collected soil samples, and

review of maps and other published technical literature. The results of the geologic hazard review are discussed in the following sections.

5.1 Erosion Hazards

Camas Municipal Code, Section 16.59.020.A defines an erosion hazard as areas where slope grades meet or exceed 40 percent. Based upon review of slope grade mapping published by *Clark County Maps Online,* maximum slope grades of 15 to 25 percent are mapped in the south central portion of the site. Therefore, site slopes do not meet the definition of an erosion hazard according to *Camas Municipal Code*.

5.2 Landslide Hazards

Columbia West conducted a review of available mapping, *Clark County GIS* data, and site reconnaissance to evaluate the potential presence of a landslide hazard on or near the subject site.

5.2.1 Geologic Literature Review

Columbia West reviewed *Slope Stability, Clark County, Washington* (Fiksdal, 1975) to assess site slope characteristics. The Fiksdal report identifies four levels of potential instability within Clark County: (1) stable areas – no slides or unstable slopes, (2) areas of potential instability because of underlying geologic conditions and physical characteristics associated with steepness, (3) areas of historical or still active landslides, and (4) older landslide debris. The site is mapped as (1) stable – no slides or unstable slopes.

Columbia West also reviewed the *Geologic Map of the Camas Quadrangle, Clark County, Washington, and Multnomah County, Oregon* (Russell C. Evarts, USGS Geological Survey, 2008) and the *Landslide Inventory Map of the Northwest Quarter of the Camas Quadrangle, Multnomah County, Oregon, and Clark County, Washington* (William Burns, et al., 2012) which indicates that no active landslides or historic landslide deposits are mapped at the subject site or in the surrounding vicinity.

5.2.2 Slope Reconnaissance and Slope Stability Assessment

To observe geomorphic conditions, Columbia West personnel conducted visual and physical reconnaissance of slopes on the property. Test pits TP-1 through TP-6 were explored in sloped areas. Subsurface native soils at the locations tested generally consisted of lean CLAY and CLAY with sand with trace to some gravels and cobbles. Soil horizons appeared firm and well developed.

Review of topographic mapping published by *Clark County Maps Online* indicates that the subject site is located in an area that slopes regionally downgradient from east to west with no apparent toe or crest observed on the property or adjacent parcels. The maximum grade change between the east and west property boundaries is approximately 62 feet. Slope grades of 10 to 15 percent characterize the property with localized areas approaching 15 to 25 percent. Slopes appear planar with no observed evidence of instability. There was no observed direct evidence of large-scale, mass slope movements or historic landslides. No landslide debris was observed within explored site soils and groundwater seeps or springs within the face of the slopes were not observed.

Camas Municipal Code defines a landslide hazard as slopes mapped by Fiksdal as 'areas of potential instability' or areas meeting all three of the following characteristics: 1) slopes steeper than 15 percent; 2) hillsides intersecting geologic contacts with permeable sediment overlying low permeability sediment or bedrock, and; 3) any springs or groundwater seepage. The above-mentioned criteria were not observed during our field investigation or site research. Based upon the results of slope reconnaissance, subsurface exploration, and site research, in Columbia West's opinion slopes on the subject site do not meet the definition of a landslide hazard according to *Camas Municipal Code.*

5.3 Seismic Hazard Areas

Seismic hazards include areas subject to severe risk of earthquake-induced damage. Damage may occur due to soil liquefaction, dynamic settlement, ground shaking amplification, or surface faulting rupture. These seismic hazards are discussed below.

5.3.1 Soil Liquefaction and Dynamic Settlement

According to *the Liquefaction Susceptibility Map of Clark County, Washington* (Washington State Department of Natural Resources, 2004), the site is mapped as very low susceptibility for liquefaction. Liquefaction, defined as the transformation of the behavior of a granular material from a solid to a liquid due to increased pore-water pressure and reduced effective stress, may occur when granular materials quickly compact under cyclic stresses caused by a seismic event. The effects of liquefaction may include immediate ground settlement, lateral spreading, and differential compaction.

Soils most susceptible to liquefaction are recent geologic deposits, such as river and floodplain sediments. These soils are generally saturated, cohesionless, loose to medium dense sands within 50 feet of ground surface. Potentially liquefiable soils located above the existing, historic, or expected ground water levels do not generally pose a liquefaction hazard. It is important to note that changes in perched ground water elevation may occur due to project development or other factors not observed at the time of investigation.

Based upon the results of subsurface exploration, literature review, and laboratory analysis, the above-mentioned criteria were not observed during the geotechnical site investigation. Therefore, the potential for soil liquefaction is considered to be very low.

5.3.2 Ground Shaking Amplification

Review of the *Site Class Map of Clark County, Washington* (Washington State Department of Natural Resources, 2004), indicates that site soils may be represented by Site Class C as defined in *2015 IBC Section 1613.3.2*. A designation of Site Class C indicates that minor amplification of seismic energy may occur during a seismic event due to subsurface conditions. However, this is typical for many areas within Clark County, does not represent a geologic hazard in Columbia West's opinion, and will not prohibit development if properly accounted for during the design process. Additional seismic information is presented in Section 6.9, *Seismic Design Considerations*.

5.3.3 Fault Rupture

Because there are no known geologic seismic faults within the site boundaries, fault rupture is unlikely.

6.0 DESIGN RECOMMENDATIONS

The geotechnical site investigation suggests the proposed development is generally compatible with surface and subsurface soils, provided the recommendations presented in this report are utilized and incorporated into the design and construction processes. The primary geotechnical concerns associated with the site are fine-textured soils. Design recommendations are presented in the following text sections.

6.1 Site Preparation and Grading

Vegetation, organic material, unsuitable fill, and deleterious material that may be encountered should be cleared from areas identified for structures and site grading. Vegetation, other organic material, and debris should be removed from the site. Stripped topsoil should also be removed or used only as landscape fill in nonstructural areas with slopes less than 25 percent. The stripping depth for sod and highly organic topsoil is anticipated to vary between approximately 8 and 14 inches. The required stripping depth may increase in areas of existing fill, heavy organics, or previously existing structures. Actual stripping depths should be determined based upon visual observations made during construction when soil conditions are exposed. The post-construction maximum depth of landscape fill placed or spread at any location onsite should not exceed one foot.

Previously disturbed soil, debris, or unconsolidated fill encountered during grading or construction activities should be removed completely and thoroughly from structural areas. This includes old remnant foundations, basement walls, utilities, associated soft soils, and debris. These materials and associated disturbed soils should also be completely removed from structural areas. Excavation areas should be backfilled with engineered structural fill.

The test pits excavated during site exploration were backfilled loosely with onsite soils. These test pits should be located and properly backfilled with structural fill during site improvements construction. Trees, stumps, and associated roots should also be removed from structural areas, individually and carefully. Resulting cavities and excavation areas should be backfilled with engineered structural fill.

Site grading activities should be performed in accordance with requirements specified in the *2018 International Building Code* (IBC), Chapter 18 and Appendix J, with exceptions noted in the text herein. Site preparation, soil stripping, and grading activities should be observed and documented by Columbia West.

6.2 Engineered Structural Fill

Areas proposed for fill placement should be appropriately prepared as described in the preceding text. Surface soils should be scarified and compacted prior to additional fill placement. Engineered structural fill should be placed in loose lifts not exceeding 12 inches in depth and compacted using standard conventional compaction equipment. The soil moisture content should be within two percentage points of optimum conditions. A field density at least equal to 95 percent of the maximum dry density, obtained from the modified Proctor moisture-density relationship test *(ASTM 1557)*, is recommended for structural fill placement and scarified and recompacted subgrade.

Compaction of engineered structural fill should be verified by nuclear gauge field compaction testing performed in accordance with *ASTM D6938*. Field compaction testing should be performed for each vertical foot of engineered fill placed. Engineered fill placement should be observed by Columbia West.

Engineered structural fill placement activities should be performed during dry summer months if possible. Most clean native soils may be suitable for use as structural fill if adequately dried or moisture-conditioned to achieve recommended compaction specifications. Native soils may require addition of moisture during periods of dry weather. Compacted fill soils should be covered shortly after placement.

Because they are moisture-sensitive, fine-textured soils are often difficult to excavate and compact during wet weather conditions. If adequate compaction is not achievable with clean native soils, import structural fill consisting of granular fill meeting WSDOT specifications for *Gravel Borrow 9-03.14(1)* is recommended.

Representative samples of proposed engineered structural fill should be submitted for laboratory analysis and approval by Columbia West prior to placement. Laboratory analyses should include particle-size gradation and standard Proctor moisture-density analysis.

6.3 Cut and Fill Slopes

Fill placed on existing grades steeper than 5H:1V should be horizontally benched at least 10 feet into the slope. Fill slopes greater than six feet in height should be vertically keyed into existing subsurface soil. A typical fill slope cross-section is shown in Figure 3. Drainage implementations, including subdrains or perforated drainpipe trenches, may also be necessary in proximity to cut and fill slopes if seeps or springs are encountered. Drainage design may be performed on a case-by-case basis. Extent, depth, and location of drainage may be determined in the field by Columbia West during construction when soil conditions are exposed. Failure to provide adequate drainage may result in soil sloughing, settlement, or erosion.

Final cut or fill slopes at the site should not exceed 2H:1V or 10 feet in height without individual slope stability analysis. The values above assume a minimum horizontal setback for loads of 10 feet from top of cut or fill slope face or overall slope height divided by three (H/3), whichever is greater. A minimum slope setback detail for structures is presented in Figure 4.

Concentrated drainage or water flow over the face of slopes should be prohibited, and adequate protection against erosion is required. Fill slopes should be constructed by placing fill material in maximum 12-inch level lifts, compacting as described in Section 6.2, *Engineered Structural Fill* and horizontally benching where appropriate. Fill slopes should be overbuilt, compacted, and trimmed at least two feet horizontally to provide adequate compaction of the outer slope face. Proper cut and fill slope construction is critical to overall project stability and should be observed and documented by Columbia West.

6.4 Foundations

Foundations for proposed structures are anticipated to consist of shallow continuous perimeter or column spread footings. Footings should be designed by a licensed structural

engineer and conform to the recommendations below. Typical building loads are not expected to exceed approximately 3 kips per foot for perimeter footings or 10 kips per column. If actual loading exceeds anticipated loading, additional analysis should be conducted for the specific load conditions and proposed footing dimensions.

The existing ground surface should be prepared as described in Section 6.1, *Site Preparation and Grading*, and Section 6.2, *Engineered Structural Fill*. Foundations should bear upon firm native soil or engineered structural fill.

To evaluate bearing capacity for proposed structures, serviceability and reliability of shear resistance for subsurface soils was considered. Allowable bearing capacity is typically a function of footing dimension and subsurface soil properties, including settlement and shear resistance. Based upon in situ field testing and laboratory analysis, the estimated allowable bearing capacity for well-drained foundations prepared as described above is 1,500 psf. Bearing capacity may be increased by one-third for transient lateral forces such as seismic or wind. The estimated coefficient of friction between in situ compacted native soil or engineered structural fill and in-place poured concrete is 0.35. Lateral forces may also be resisted by an assumed passive soil equivalent fluid pressure of 250 psf/f against embedded footings. The upper six inches of soil should be neglected in passive pressure calculations.

Footings should extend to a depth at least 18 inches below lowest adjacent grade to provide adequate bearing capacity and protection against frost heave. Foundations constructed during wet weather conditions will require over-excavation of saturated subgrade soils and granular structural backfill prior to concrete placement. Over-excavation recommendations should be provided by Columbia West during foundation excavation and construction. Excavations adjacent to foundations should not extend within a 2H:1V angle projected down from the outside bottom footing edge without additional geotechnical analysis.

Foundations should not be permitted to bear upon undocumented fill or disturbed soil. Columbia West should observe foundation excavations prior to placing forms or reinforcing bar to verify subgrade support conditions are as anticipated in this report.

6.5 Slabs on Grade

Proposed structures may have slab-on-grade floors. Slabs should be supported on firm, competent, in situ soil or engineered structural fill. Disturbed soils and unsuitable fills in proposed slab locations should be removed and replaced with structural fill.

Preparation beneath slabs should be performed in accordance with the recommendations presented in Section 6.1, *Site Preparation and Grading* and Section 6.2, *Engineered Structural Fill*. Slabs should be underlain by at least 6 inches of 1 ¼”-0 crushed aggregate meeting *WSDOT 9-03.9(3).* Geotextile filter fabric conforming to *WSDOT 2010 Standard Specification M 41-10, 9-33.2(1), Geotextile Properties, Table 3: Geotextile for Separation or Soil Stabilization* may be used below the crushed aggregate to increase subgrade support. Base aggregate should be compacted to at least 95 percent of maximum dry density determined by the modified Proctor moisture-density relationship test *(ASTM D1557)*.

For lightly loaded slabs not exceeding 200 psf, the modulus of subgrade reaction is estimated to be 100 psi/inch. Columbia West should be contacted for additional analysis if slab loading exceeds 200 psf. If desired, a moisture barrier may be constructed beneath the slabs. Slabs should be appropriately waterproofed in accordance with the desired type of finished flooring. Slab thickness and reinforcement should be designed by an experienced structural engineer in accordance with anticipated loads.

6.6 Static Settlement

Total long-term static footing displacement for shallow foundations constructed as described in this report is not anticipated to exceed approximately 1 inch. Differential settlement between comparably loaded footing elements is not expected to exceed approximately ½ inch over a span of 50 feet. The resulting vertical displacement after loading may be due to elastic distortion, dissipation of excess pore pressure, or soil creep.

6.7 Excavation

Soils at the site were explored to a maximum depth of 13.5 feet using a track-mounted excavator. Bedrock was not encountered and blasting or specialized rock-excavation techniques are not anticipated. Groundwater was not encountered within the test pit explorations. However, perched groundwater layers may exist at shallower depths depending on seasonal fluctuations in the water table.

Based upon laboratory analysis and field testing, near-surface soils may be Washington State Industrial Safety and Health Administration (WISHA) Type C. For temporary open-cut excavations deeper than four feet, but less than 20 feet in soils of these types, the maximum allowable slope is 1.5H:1V. WISHA soil type should be confirmed during field construction activities by the contractor. Soil is often anisotropic and heterogeneous, and it is possible that WISHA soil types determined in the field may differ from those described above.

Site-specific shoring design may be required if open-cut excavations are infeasible or if excavations are proposed adjacent to existing infrastructure. Typical methods for stabilizing excavations consist of soldier piles and timber lagging, sheet pile walls, tiebacks and shotcrete, or pre-fabricated hydraulic shoring. Because lateral earth pressure distributions acting on below-grade structures are dependent upon the type of shoring system used, Columbia West should be contacted to conduct additional analysis when shoring type, excavation depths, and locations are known.

The contractor should be held responsible for site safety, sloping, and shoring. Columbia West is not responsible for contractor activities and excavation should be conducted in accordance with all applicable local, state, and federal laws.

6.8 Lateral Earth Pressure

Lateral earth pressures should be considered during design of retaining walls and below grade structures. Hydrostatic pressure and additional surcharge loading should also be considered. Wall foundation construction and bearing capacity should adhere to specifications provided previously in Section 6.4, *Foundations*. Retained material may include engineered structural backfill or undisturbed native soil. Structural wall backfill should consist of imported granular material meeting *Section 9-03.12(2)* of *WSDOT*

Standard Specifications. Backfill should be prepared and compacted to at least 95 percent of maximum dry density as determined by the modified Proctor test *(ASTM D1557).* Recommended parameters for lateral earth pressures for retained soils and engineered structural backfill consisting of imported granular fill meeting WSDOT specifications for *Gravel Backfill for Walls 9-03.12(2)* are presented in Table 1.

The design parameters presented in Table 1 are valid for static loading cases only and are based upon in situ undisturbed native soils or compacted granular fill. The recommended earth pressures do not include surcharge loads, dynamic loading, hydrostatic pressure, or seismic design. If sloped backfill conditions are proposed, Columbia West should be contacted for additional analysis and associated recommendations.

If seismic design is required for unrestrained walls, seismic forces may be calculated by superimposing a uniform lateral force of $10H^2$ pounds per lineal foot of wall, where H is the total wall height in feet. If seismic design is required for restrained walls, seismic forces may be calculated by superimposing a uniform lateral force of $25H^2$ pounds per lineal foot of wall. The resultant force should be applied at 0.6H from the base of the wall.

Table 1. Recommended Lateral Earth Pressure Parameters for Level Backfill

Retained Soil	Equivalent Fluid Pressure for Level Backfill			Wet Density	Drained Internal Angle of Friction
	At-rest	Active	Passive		
Undisturbed native Lean CLAY and CLAY with Sand (Soil Type 1)	61 pcf	42 pcf	319 pcf	115 pcf	28°
Approved Structural Backfill Material	52 pcf	32 pcf	568 pcf	135 pcf	38°
WSDOT 9-03.12(2) compacted aggregate backfill					

**The upper 6 inches of soil should be neglected in passive pressure calculations. If exterior grade from top or toe of retaining wall is sloped, Columbia West should be contacted to provide location-specific lateral earth pressures.*

A continuous one-foot-thick zone of free-draining, washed, open-graded 1-inch by 2-inch drain rock and a 4-inch perforated gravity drainpipe is assumed behind retaining walls. Geotextile filter fabric should be placed between the drain rock and backfill soil. Specifications for drainpipe design are presented in Section 6.11, *Drainage*. If walls cannot be gravity drained, saturated base conditions and/or applicable hydrostatic pressures should be assumed.

Final retaining wall design should be reviewed and approved by Columbia West. Retaining wall subgrade and backfill activities should also be observed and tested for compliance with recommended specifications by Columbia West during construction.

6.9 Seismic Design Considerations

According to the *ASCE 7 Hazard Tool,* the anticipated peak ground and maximum considered earthquake spectral response accelerations resulting from seismic activity for the subject site are summarized in Table 2.

Table 2. Approximate Probabilistic Ground Motion Values for 'firm rock' sites based on subject property longitude and latitude

	2% Probability of Exceedance in 50 yrs
Peak Ground Acceleration	0.375 g
0.2 sec Spectral Acceleration	0.832 g
1.0 sec Spectral Acceleration	0.358 g

The listed probabilistic ground motion values are based upon "firm rock" sites with an assumed shear wave velocity of 2,500 ft/s in the upper 100 feet of soil profile. These values should be adjusted for site class effects by applying site coefficients F_a, F_v, and F_{PGA} as defined in *ASCE 7-16* and associated *ASCE 7-16 Supplement 1* dated December 12, 2018, *Tables 11.4-1, 11.4-2, and 11.8.1*. The site coefficients are intended to more accurately characterize estimated peak ground and respective earthquake spectral response accelerations by considering site-specific soil characteristics and index properties. As mentioned previously in Section 5.3.2 *Ground Shaking Amplification*, the Site Class Map of Clark County indicates site soils may be represented by Site Class C.

Localized peak ground accelerations exceeding the adjusted values may occur in some areas in direct proximity to an earthquake's origin. This may be a result of amplification of seismic energy due to depth to competent bedrock, compression and shear wave velocity of bedrock, presence and thickness of loose, unconsolidated alluvial deposits, soil plasticity, grain size, and other factors.

Identification of specific seismic response spectra is beyond the scope of this investigation. If site structures are designed in accordance with recommendations specified in the *2018 IBC*, the potential for peak ground accelerations in excess of the adjusted and amplified values should be understood.

6.10 Infiltration Testing Results

To investigate the feasibility of subsurface disposal of stormwater, Columbia West conducted in situ infiltration testing at various locations within the project area on August 5, 2021. Results of in situ infiltration testing are presented in Table 3. The soil classification presented in Table 3 is based upon laboratory analysis and visual classification. The infiltration rate is presented as a recommended coefficient of permeability (k) and has been reported without application of a factor of safety.

As indicated in Table 3, the test was conducted in test pit TP-2, TP-4, and TP-5 at depths of 2 to 5 feet bgs. Soils in the tested location were observed and sampled to adequately characterize the subsurface profile. Tested native soils are classified as lean CLAY (CL) and CLAY with sand (CL) according to USCS specifications. Soil laboratory analytical test reports are provided in Appendix A.

Single-ring, falling head infiltration testing was performed by inserting a three-inch diameter pipe into the soil at the noted depth. The test was conducted by filling the apparatus with water and measuring time relative to changes in hydraulic head at regular intervals. Using

Darcy's Law for saturated flow in homogenous media, the coefficient of permeability (k) was then calculated.

Table 3. Infiltration Test Results

Test Number	Location	Test Depth (feet bgs)	Groundwater Depth on 08/05/21 (feet bgs)	USCS Soil Type (* Indicates Visual Classification)	Clark County WWHM Soil Group**	Passing No. 200 Sieve (%)	Infiltration Rate (Coefficient of Permeability, k) (inches/hour)
IT-2.1	TP-2	2.0	Not Observed to 13 bgs	CL, Lean CLAY	4	88.1	< 0.06
IT-2.2		5.0		CL, Lean CLAY*	4	-	< 0.06
IT-4.1	TP-4	4.0	Not Observed to 12.5 bgs	CL, Lean CLAY*	4	-	< 0.06
IT-5.1	TP-5	2.0	Not Observed to 13 bgs	CL, CLAY with Sand*	4	-	< 0.06
IT-5.2		5.0		CL, CLAY with Sand	4	82.9	< 0.06

* WWHM Classifications are Based Upon Subsurface Investigation and Infiltration Testing Conducted at the Locations Shown.

Columbia West also classified tested near-surface soils into a representative soil group based upon site-specific infiltration test results and review of published literature. As indicated in Table 3, observed near-surface infiltration rates were less than 0.06 inches per hour in the tested locations. Based upon review of USDA hydrologic soil group criteria (USDA, 2007), Appendix 2-A of the *2021 Clark County Stormwater Manual,* and the *Clark County WWHM Soil Groupings Memorandum* (Otak, 2010), measured infiltration rates generally meet the criteria for WWHM Soil Group 4. Therefore, based upon site-specific infiltration testing and review of published literature, tested near-surface soils may be appropriately classified as presented in Table 3.

Due to the presence of shallow groundwater and fine-textured, low permeability soils at the site, subsurface disposal of concentrated stormwater via infiltration is likely infeasible and is not recommended without further study.

6.11 Drainage

At a minimum, site drainage should include surface water collection and conveyance to properly designed stormwater management structures and facilities. Drainage design in general should conform to City of Camas regulations. Finished site grading should be conducted with positive drainage away from structures. Depressions or shallow areas that may retain ponding water should be avoided. Roof drains, low-point drains, and perimeter foundation drains are recommended for structures. Drains should consist of separate systems and gravity flow with a minimum two-percent slope away from foundations into an approved discharge location.

Perimeter foundation drains should consist of 3-inch perforated PVC pipe surrounded by a minimum of 1 ft^3 of clean, washed drain rock per linear foot of pipe and wrapped with geotextile filter fabric. Open-graded drain rock with a maximum particle size of 3 inches and less than 2 percent passing the No. 200 sieve is recommended. Geotextile filter fabric should consist of Mirafi 140N or approved equivalent, with AOS between No. 70 and No. 100 sieve. The water permittivity should be greater than 1.5/sec. Figure 5 presents a typical foundation

drain. Perimeter drains may limit increased hydrostatic pressure beneath footings and assist in reducing potential perched moisture areas.

Subdrains should also be considered if portions of the site are cut below surrounding grades. Shallow groundwater, springs, or seeps should be conveyed via drainage channel or perforated pipe into an approved discharge. Recommendations for design and installation of perforated drainage pipe may be performed on a case-by-case basis by Columbia West during construction. Failure to provide adequate surface and sub-surface drainage may result in soil slumping or unanticipated settlement of structures exceeding tolerable limits. A typical perforated drainpipe trench detail is presented in Figure 6.

Drains should be closely monitored after construction to assess their effectiveness. If additional surface or shallow subsurface seeps become evident, the drainage provisions may require modification or additional drains. Columbia West should be consulted to provide appropriate recommendations.

6.12 Bituminous Asphalt and Portland Cement Concrete

Review of Figure 2A indicates that proposed development will include new asphalt-paved public roadways. Unless a site-specific pavement design is conducted, Columbia West recommends adherence to City of Camas paving guidelines for roadway improvements in the public right-of-way.

For dry weather construction, pavement surface sections should bear upon competent subgrade consisting of scarified and compacted native soil or engineered structural fill. Wet weather pavement construction is discussed in Section 6.13, *Wet Weather Construction Methods and Techniques*. Subgrade conditions should be evaluated and tested by Columbia West prior to placement of crushed aggregate base. Subgrade evaluation should include nuclear gauge density testing and wheel proof-roll observations conducted with a loaded 12-cubic yard, double-axle dump truck or equivalent. Nuclear gauge density testing should be conducted at 150-foot intervals or as determined by the onsite geotechnical engineer. Subgrade soil should be compacted to at least 95 percent of the modified Proctor dry density, as determined by ASTM D1557. Areas of observed deflection or rutting during proof-roll evaluation should be excavated to a firm surface and replaced with compacted crushed aggregate.

Crushed aggregate base should be compacted and tested in accordance with the specifications outlined above. Asphalt concrete pavement should be compacted to at least 91 percent of maximum Rice density. Nuclear gauge density testing should be conducted to verify adherence to recommended specifications. Testing frequency should be in accordance with Washington Department of Transportation and City of Camas specifications.

Portland cement concrete curbs and sidewalks should be installed in accordance with City of Camas specifications. Curb and sidewalk aggregate base should be observed and proof-rolled by Columbia West. Soft areas that deflect or rut should be stabilized prior to pouring concrete. Concrete should be tested during installation in accordance with ASTM C171, C138, C231, C143, C1064, and C31. This includes casting of cylinder

specimen at a frequency of four cylinders per 100 cubic yards of poured concrete. Recommended field concrete testing includes slump, air entrainment, temperature, and unit weight.

6.13 Wet Weather Construction Methods and Techniques

Wet weather construction often results in significant shear strength reduction and soft areas that may rut or deflect. Installation of granular working layers may be necessary to provide a firm support base and sustain construction equipment. Granular layers should consist of all-weather gravel, 2x4-inch gabion, or other similar material (six-inch maximum size with less than five percent passing the No. 200 sieve).

Construction equipment traffic across exposed soil should be minimized. Equipment traffic induces dynamic loading, which may result in weak areas and significant reduction in shear strength for wet soils. Wet weather construction may also result in generation of significant excess quantities of soft wet soil. This material should be removed from the site or stockpiled in a designated area.

Construction during wet weather conditions may require increased base thickness. Over-excavation of subgrade soils or subgrade amendment with lime and/or cement may be necessary to provide a firm base upon which to place crushed aggregate. Geotextile filter fabric is also recommended. If soil amendment with lime or cement is considered, Columbia West should be contacted to provide appropriate recommendations based upon observed field conditions and desired performance criteria.

Crushed aggregate base should be installed in a single lift with trucks end-dumping from an advancing pad of granular fill. During extended wet periods, stripping activities may also need to be conducted from an advancing pad of granular fill. Once installed, the crushed aggregate base should be compacted with several passes from a static drum roller. A vibratory compactor is not recommended because it may further disturb the subgrade. Subdrains may also be necessary to provide subgrade drainage and maintain structural integrity.

Aggregate base should consist of 1 ¼”-0 crushed aggregate meeting *WSDOT 9-03.9(3)* and be compacted to at least 95 percent of maximum dry density according to the modified Proctor density test *(ASTM D1557).* Compaction should be verified by nuclear gauge density testing, conducted at 150-foot intervals or as determined by the onsite geotechnical engineer. Observation of a proof-roll with a loaded dump truck is also recommended as an indication of the compacted aggregate’s performance.

It should be understood that wet weather construction is risky and costly. Columbia West should observe and document wet weather construction activities. Proper construction methods and techniques are critical to overall project integrity.

6.14 Erosion Control Measures

As indicated previously in Section 5.1, *Erosion Hazards*, the erosion hazard for site soils in flat to shallow-gradient portions of the property is likely to be low. The potential for erosion generally increases in sloped areas. Therefore, disturbance to vegetation in sloped areas should be minimized during construction activities. Soil is also prone to erosion if

unprotected and unvegetated during periods of increases precipitation. Erosion can be minimized by performing construction activities during dry summer months.

Site-specific erosion control measures should be implemented to address the maintenance of exposed areas. This may include silt fence, biofilter bags, straw wattles, or other suitable methods. During construction activities, exposed areas should be well-compacted and protected from erosion with visqueen, surface tackifier, or other means, as appropriate. Temporary slopes or exposed areas may be covered with straw, crushed aggregate, or riprap in localized areas to minimize erosion. Erosion and water runoff during wet weather conditions may be controlled by application of strategically placed channels and small detention depressions with overflow pipes.

After grading, exposed surfaces should be vegetated as soon as possible with erosion-resistant native vegetation. Jute mesh or straw may be applied to enhance vegetation. Once established, vegetation should be properly maintained. Disturbance to existing native vegetation and surrounding organic soil should also be minimized during construction activities.

6.15 Utility Installation

Utility installation may require subsurface excavation and trenching. Excavation, trenching and shoring should conform to federal (Occupational Safety and Health Administration) (OSHA) (29 CFR, Part 1926) and WISHA (WAC, Chapter 296-155) regulations. Site soils may slough when cut vertically and sudden precipitation events or perched groundwater may result in accumulation of water within excavation zones and trenches.

Utilities should be installed in general accordance with manufacturer's recommendations. Utility trench backfill should consist of *WSDOT 9-03.19 Bank Run Gravel for Trench Backfill* or *WSDOT 9-03.14(2) Select Borrow* with a maximum particle size of 2 ½-inches. Trench backfill material within 18 inches of the top of utility pipes should be hand compacted (i.e., no heavy compaction equipment). The remaining backfill should be compacted to at least 95 percent of maximum dry density as determined by the standard Proctor moisture-density test *(ASTM D698).* Clean, free-draining, fine bedding sand is recommended for use in the pipe zone. With exception of the pipe zone, backfill should be placed in loose lifts not exceeding 12 inches in thickness.

Compaction of utility trench backfill material should be verified by nuclear gauge field compaction testing performed in accordance with *ASTM D6938*. Field compaction testing should be performed at 200-foot intervals along the utility trench centerline at the surface and midpoint depth of the trench. Compaction frequency and specifications may be modified for non-structural areas in accordance with recommendations of the site geotechnical engineer.

7.0 CONCLUSION AND LIMITATIONS

This geotechnical site investigation report was prepared in accordance with accepted standard conventional principles and practices of geotechnical engineering. This investigation pertains only to material tested and observed as of the date of this report and is based upon proposed site development as described in the text herein. This report is a

professional opinion containing recommendations established by engineering interpretations of subsurface soils based upon conditions observed during site exploration. Soil conditions may differ between tested locations or over time. Slight variations may produce impacts to the performance of structural facilities if not adequately addressed. This underscores the importance of diligent QA/QC construction observation and testing to verify soil conditions are as anticipated in this report.

Therefore, this report contains several recommendations for field observation and testing by Columbia West personnel during construction activities. Columbia West cannot accept responsibility for deviations from recommendations described in this report. Future performance of structural facilities is often related to the degree of construction observation by qualified personnel. These services should be performed to the full extent recommended.

This report is not an environmental assessment and should not be construed as a representative warranty of site subsurface conditions. The discovery of adverse environmental conditions, or subsurface soils that deviate from those described in this report, should immediately prompt further investigation. The above statements are in lieu of all other statements expressed or implied.

This report was prepared solely for the client and is not to be reproduced without prior authorization from Columbia West. Final engineering plans and specifications for the project should be reviewed and approved by Columbia West as they relate to geotechnical and grading issues prior to final design approval. Columbia West is not responsible for independent conclusions or recommendations made by other parties based upon information presented in this report. Unless a particular service was expressly included in the scope, it was not performed and there should be no assumptions based upon services not provided. Additional report limitations and important information about this document are presented in Appendix E. This information should be carefully read and understood by the client and other parties reviewing this document.

Sincerely,

COLUMBIA WEST ENGINEERING, Inc.

Lance V. Lehto, PE, GE
President

LANCE V. LEHTO
STATE OF WASHINGTON
36301
REGISTERED
PROFESSIONAL ENGINEER

9-15-2021

REFERENCES

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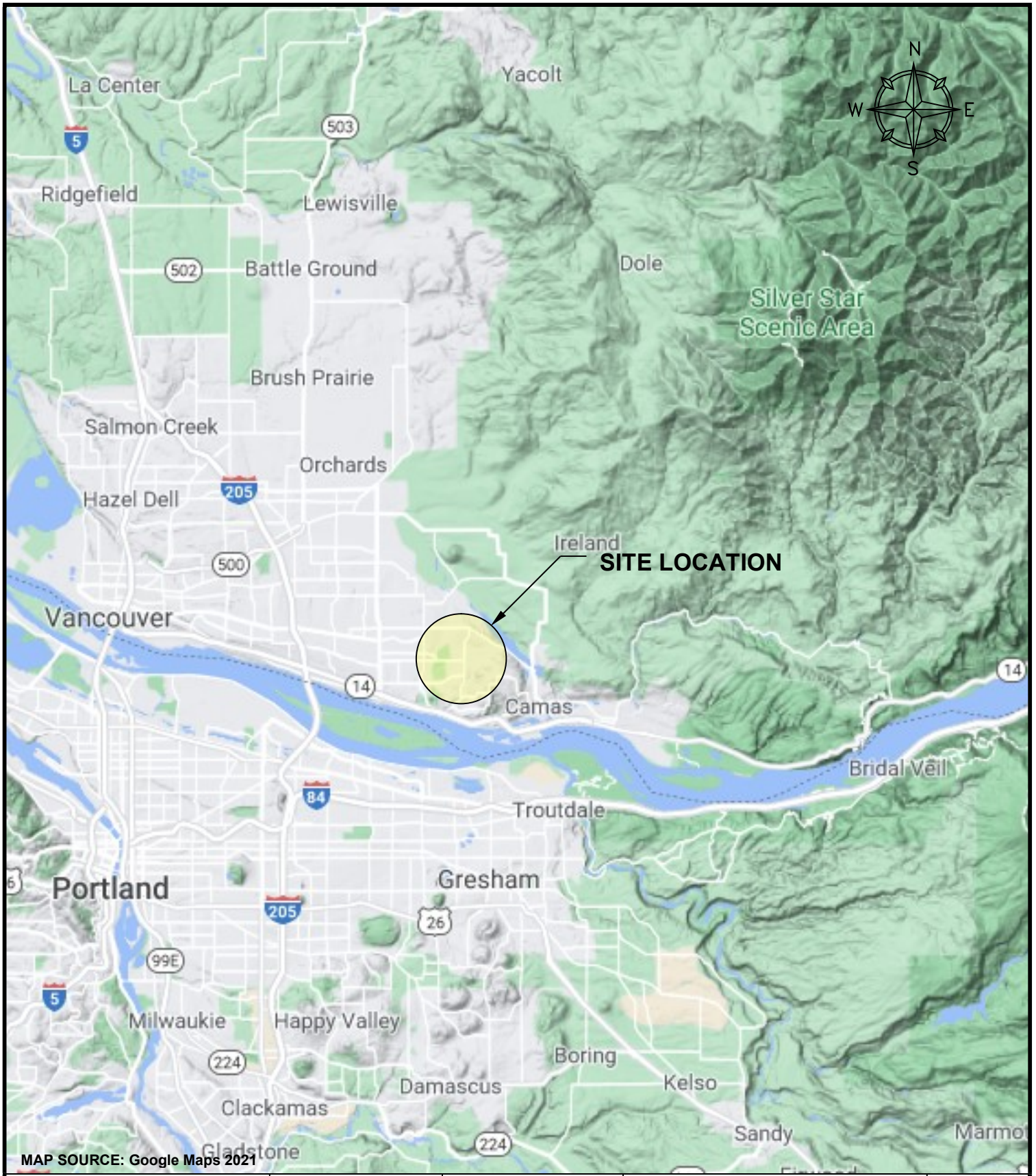
FIGURES



MAP SOURCE: Google Maps 2021

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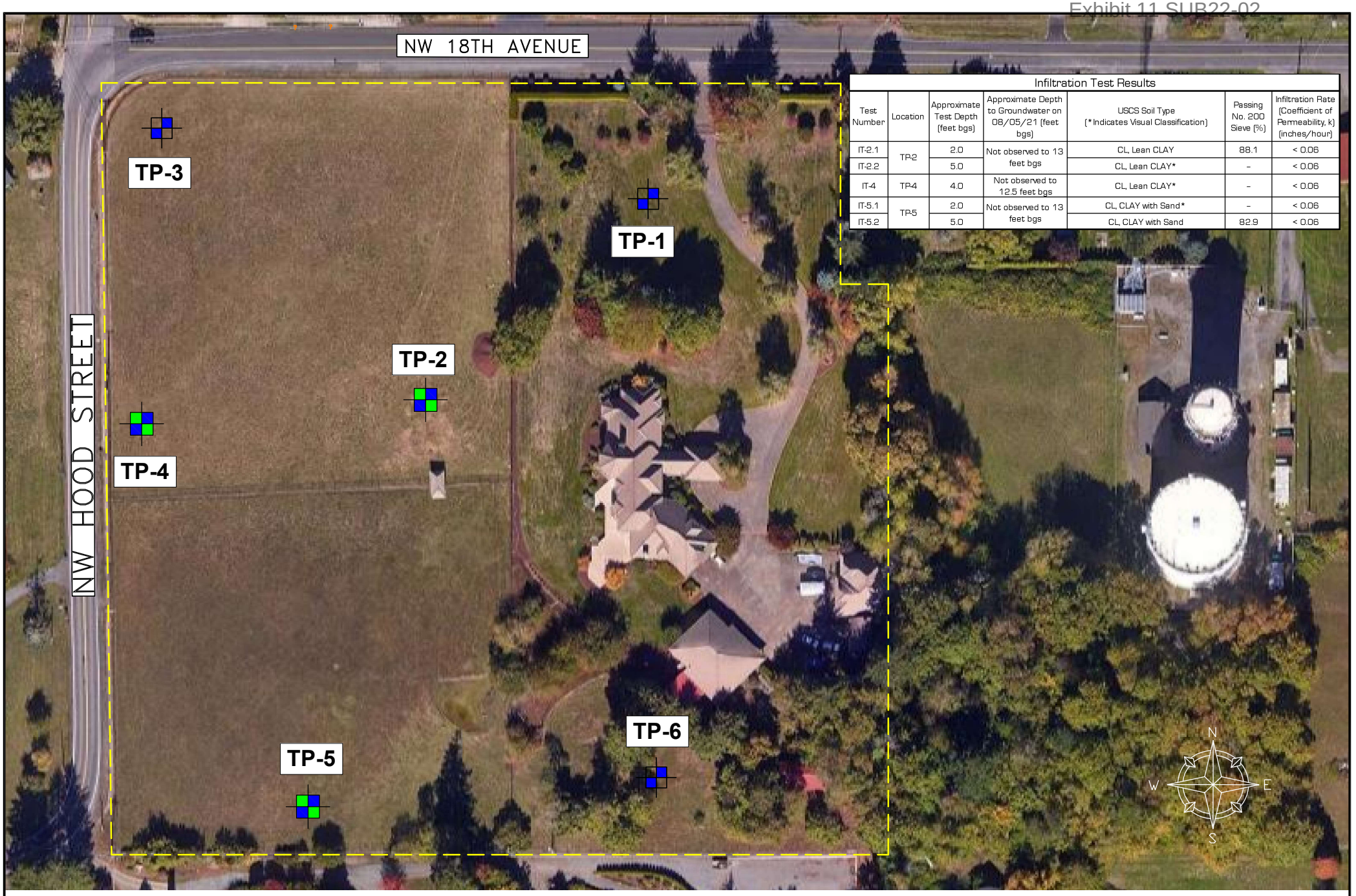
Design	Drawn: EMU		
Checked: ASR	Date: 08/11/2021		
Client: Mod Dwellings	Rev	By	Date
Job No.: 21184			
CAD File: FIGURE 1			
Scale: NONE			

SITE LOCATION MAP

NW 18TH AVENUE SUBDIVISION
CAMAS, WASHINGTON

FIGURE 1



Infiltration Test Results

Test Number	Location	Approximate Test Depth (feet bgs)	Approximate Depth to Groundwater on 08/05/21 (feet bgs)	USCS Soil Type (*Indicates Visual Classification)	Passing No. 200 Sieve (%)	Infiltration Rate (Coefficient of Permeability, k) (inches/hour)
IT-2.1	TP-2	2.0	Not observed to 13 feet bgs	CL, Lean CLAY	88.1	< 0.06
IT-2.2		5.0		CL, Lean CLAY*	-	< 0.06
IT-4	TP-4	4.0	Not observed to 12.5 feet bgs	CL, Lean CLAY*	-	< 0.06
IT-5.1	TP-5	2.0	Not observed to 13 feet bgs	CL, CLAY with Sand*	-	< 0.06
IT-5.2		5.0		CL, CLAY with Sand	82.9	< 0.06

APPROXIMATE SITE BOUNDARY APPROXIMATE LOCATION OF INFILTRATION TEST APPROXIMATE LOCATION OF TEST PIT

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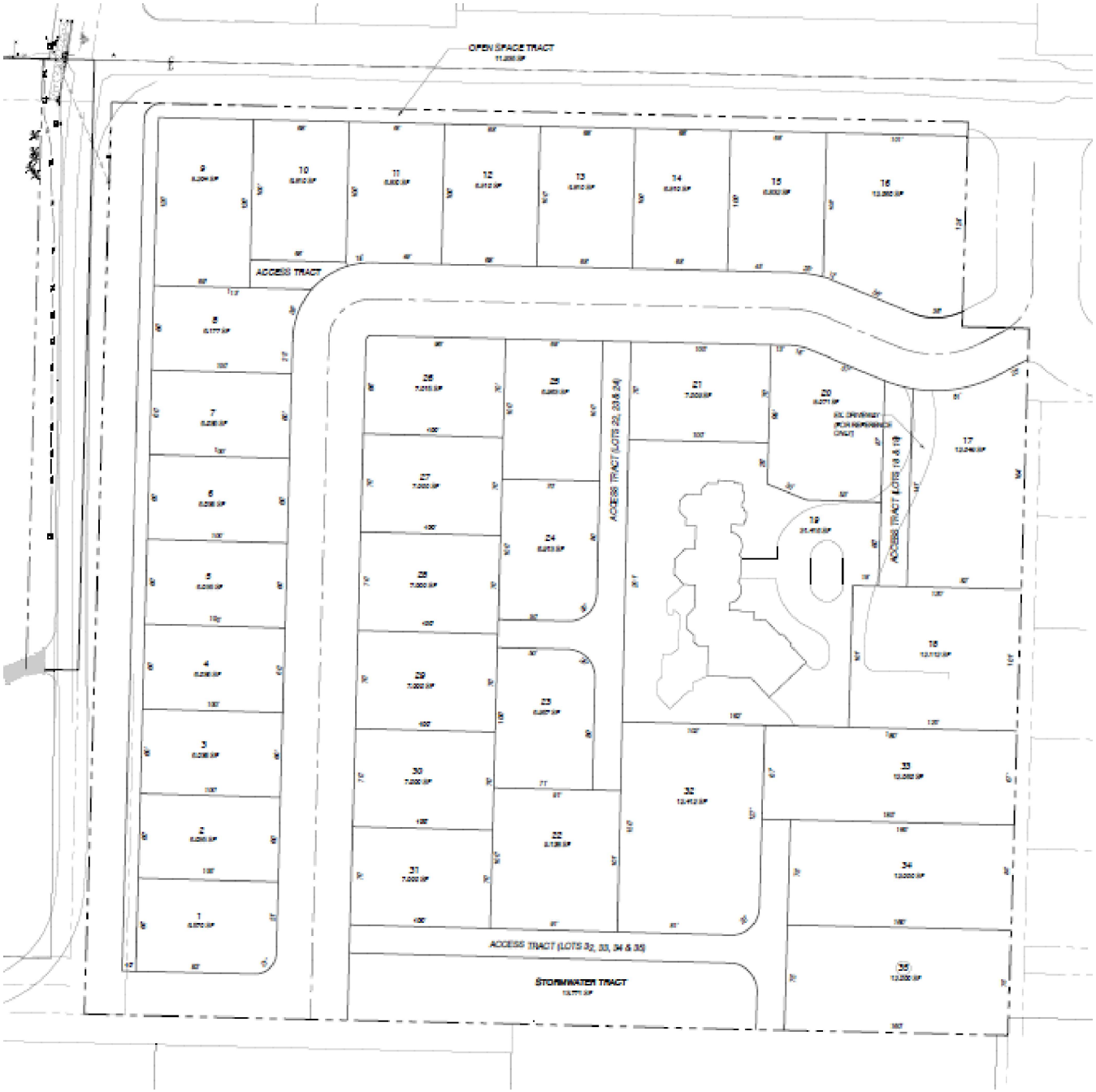
EXPLORATION LOCATION MAP
NW 18TH AVENUE SUBDIVISION

NOTES:
1. SITE LOCATION: 3010 NW 18TH AVENUE IN CAMAS, WASHINGTON.
2. SITE CONSISTS OF TAX PARCELS 127439000, 127359000 AND 127356000, TOTALING APPROXIMATELY 9.82 ACRES.
3. AERIAL PHOTO SOURCED FROM GOOGLE EARTH.
4. EXPLORATION LOCATIONS ARE APPROXIMATE AND NOT SURVEYED.
5. TEST PITS BACKFILLED LOOSELY WITH ONSITE SOILS ON AUGUST 5, 2021.

FIGURE
2



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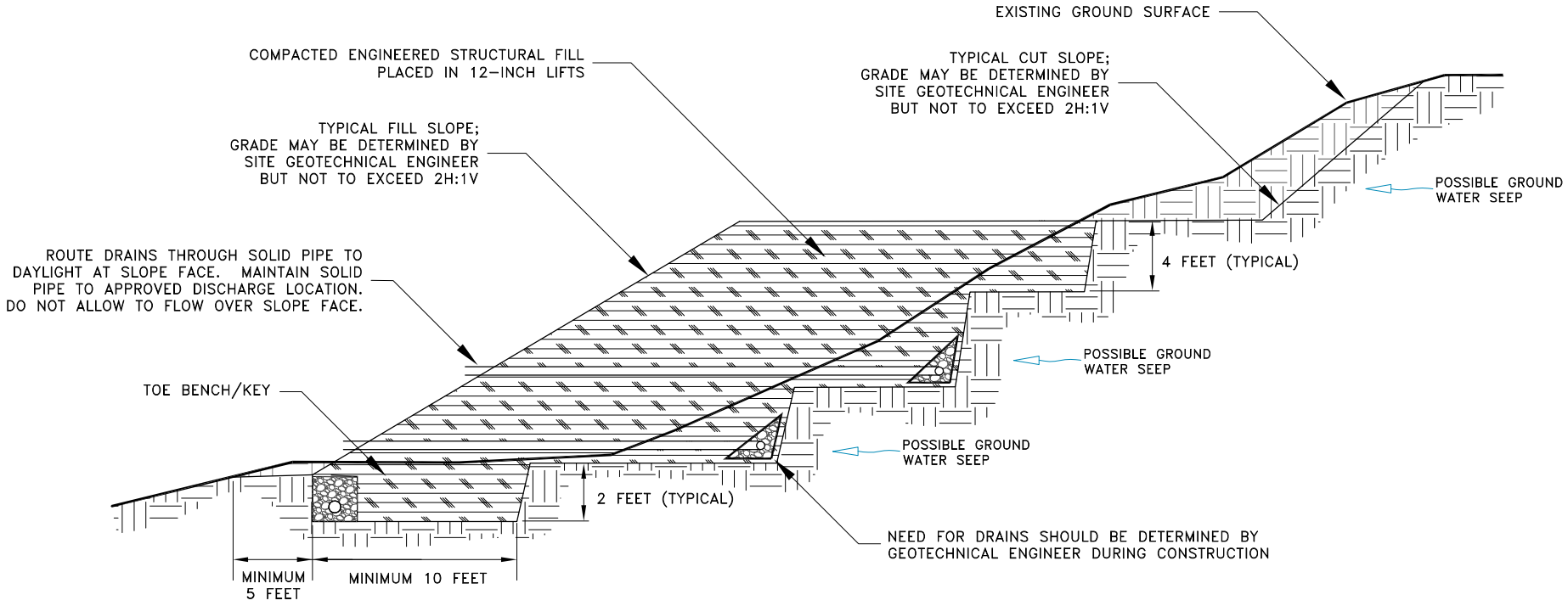
Job No: 21184
Date: 08/30/21
Drawn: EMU
Checked: ASR

PRELIMINARY SITE PLAN
NW 18TH AVENUE SUBDIVISION

NOTES:
1. PRELIMINARY SITE PLAN PROVIDED BY OLSON ENGINEERS.
2. SITE PLAN APPLIES TO PARCEL NOS. 127356000, 127359000 AND 127439000.

FIGURE
2A

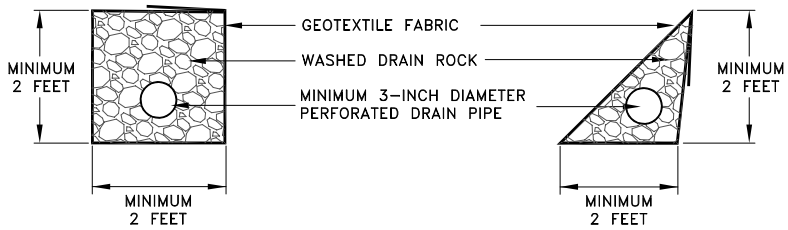


DRAIN SPECIFICATIONS

GEOTEXTILE FABRIC SHALL CONSIST OF MIRAFI 140N OR APPROVED EQUIVALENT WITH AOS BETWEEN No. 70 AND No. 100 SIEVE.

WASHED DRAIN ROCK SHALL BE OPEN–GRADED ANGULAR DRAIN ROCK WITH LESS THAN 2 PERCENT PASSING THE No. 200 SIEVE AND A MAXIMUM PARTICLE SIZE OF 3 INCHES.

TYPICAL DRAIN SECTION DETAIL



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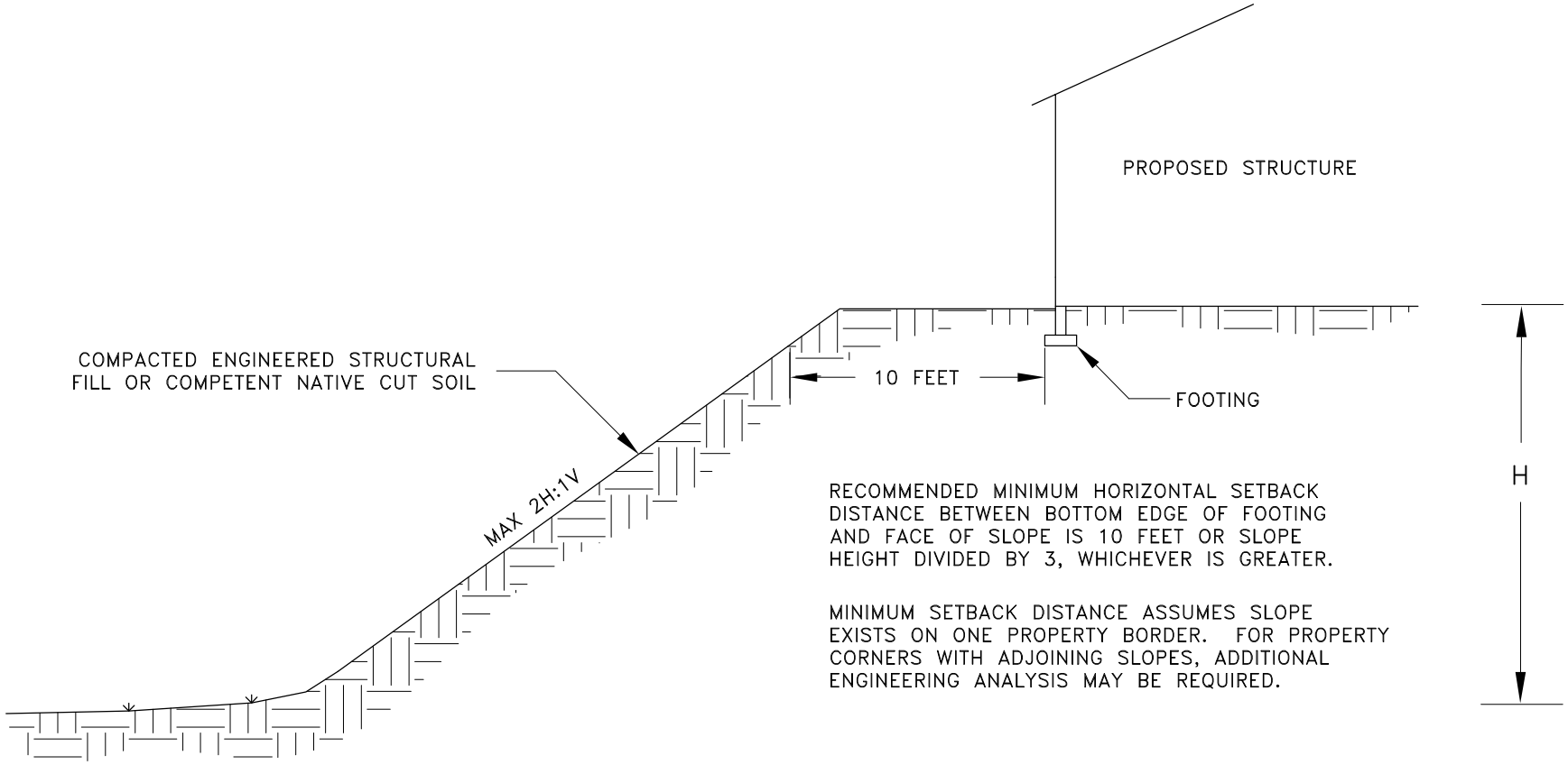
TYPICAL CUT AND FILL SLOPE CROSS SECTION

NOTES:
1. DRAWING IS NOT TO SCALE.
2. DRAWING REPRESENTS TYPICAL CUT AND FILL SLOPE CROSS SECTION AND MAY NOT BE SITE–SPECIFIC.

FIGURE 3



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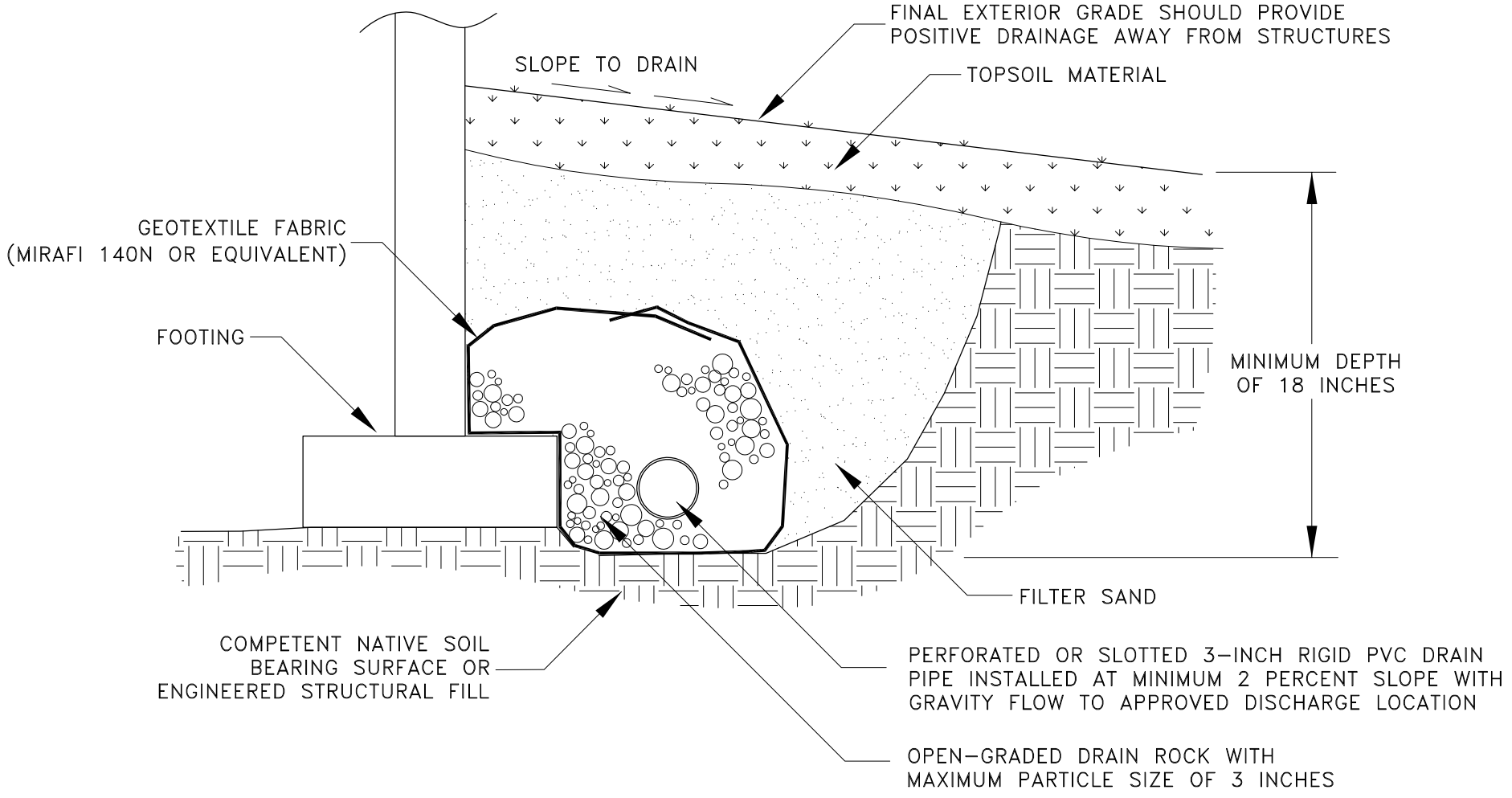
TYPICAL MINIMUM FOUNDATION SLOPE SETBACK DETAIL

NOTES:
1. DRAWING IS NOT TO SCALE.
2. SLOPES AND PROFILES SHOWN ARE APPROXIMATE.
3. DRAWING REPRESENTS TYPICAL FOUNDATION SETBACK DETAIL AND MAY NOT BE SITE-SPECIFIC.

FIGURE 4



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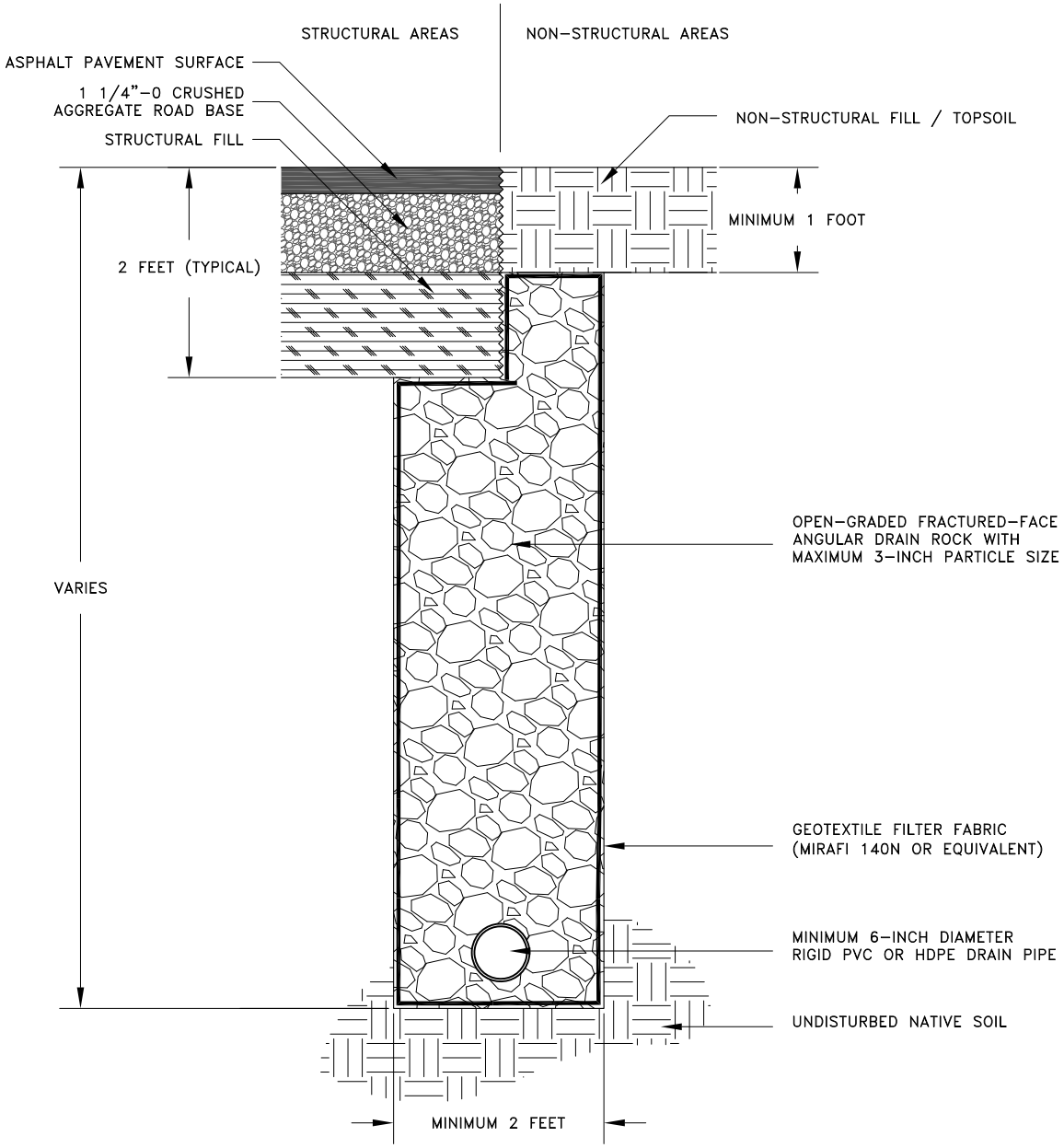
TYPICAL PERIMETER FOOTING DRAIN DETAIL

NOTES:
1. DRAWING IS NOT TO SCALE.
2. DRAWING REPRESENTS TYPICAL PERIMETER FOOTING DRAIN DETAIL AND MAY NOT BE SITE–SPECIFIC.

FIGURE
5



NOTE: LOCATION, INVERT ELEVATION, DEPTH OF TRENCH, AND EXTENT OF PERFORATED PIPE REQUIRED MAY BE MODIFIED BY THE GEOTECHNICAL ENGINEER DURING CONSTRUCTION BASED UPON FIELD OBSERVATION AND SITE–SPECIFIC SOIL CONDITIONS.

Geotechnical ▪ Environmental ▪ Special Inspections Columbia West Engineering, Inc	TYPICAL PERFORATED DRAINPIPE TRENCH DETAIL	NOTES: 1. DRAWING IS NOT TO SCALE. 2. DRAWING REPRESENTS TYPICAL PERFORATED DRAIN PIPE TRENCH DETAIL AND MAY NOT BE SITE–SPECIFIC.	FIGURE 6

APPENDIX A
LABORATORY TEST RESULTS

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PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
NW 18th Avenue Subdivision Camas, Washington	Modern Dwellings, LLC 8101 NE Glisan Street Portland, Oregon 97213	21184	S21-0708
		REPORT DATE 08/27/21	FIELD ID TP2.1
		DATE SAMPLED 08/05/21	SAMPLED BY EMU

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY	Test Pit, TP-02 depth = 2 feet	CL, Lean Clay
SPECIFICATIONS none		**AASHTO CLASSIFICATION** A-6(16)

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Rainhart "Mary Ann" Sifter, moist prep, hand washed, 12" single sieve-set	ASTM D6913, Method A

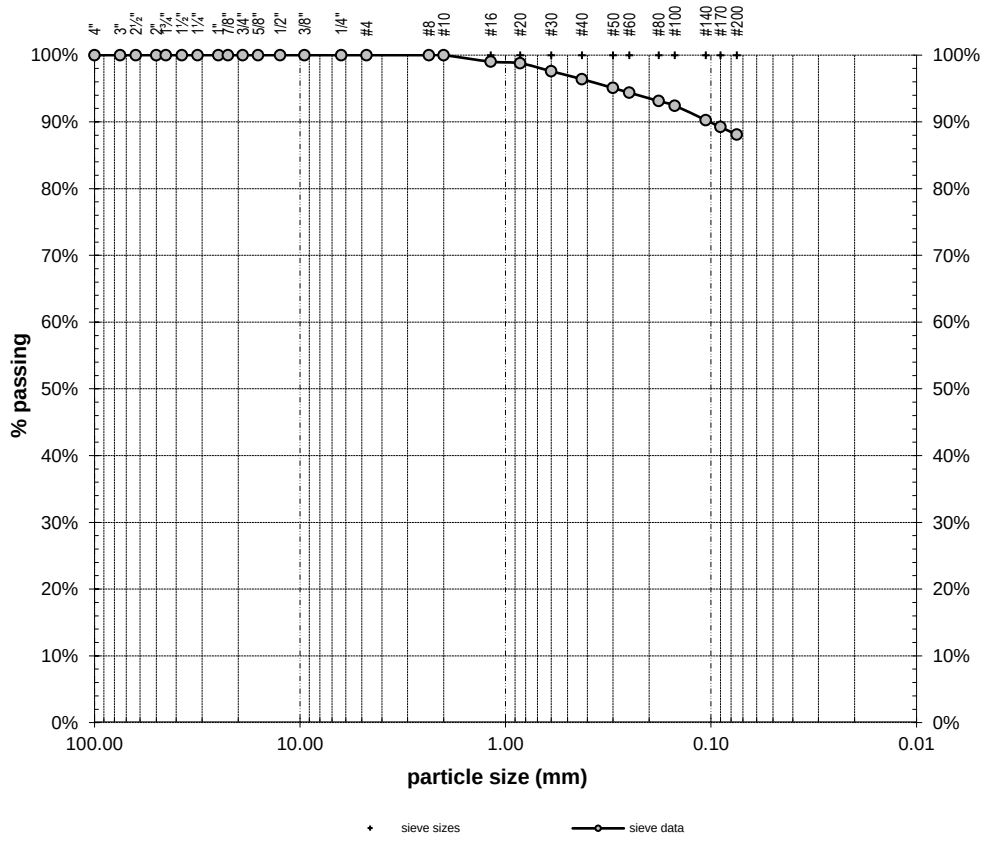
ADDITIONAL DATA

initial dry mass (g) =	140.36		
as-received moisture content =	22.7%	coefficient of curvature, C_C =	n/a
liquid limit =	37	coefficient of uniformity, C_U =	n/a
plastic limit =	18	effective size, $D_{(10)}$ =	n/a
plasticity index =	19	$D_{(30)}$ =	n/a
fineness modulus =	n/a	$D_{(60)}$ =	n/a

SIEVE DATA

% gravel = 0.0%
% sand = 11.9%
% silt and clay = 88.1%

GRAIN SIZE DISTRIBUTION



	SIEVE SIZE US	SIEVE SIZE mm	PERCENT PASSING SIEVE act.	PERCENT PASSING SIEVE interp.	SPECS max	SPECS min
GRAVEL	6.00"	150.0		100%		
	4.00"	100.0		100%		
	3.00"	75.0		100%		
	2.50"	63.0		100%		
	2.00"	50.0		100%		
	1.75"	45.0		100%		
	1.50"	37.5		100%		
	1.25"	31.5		100%		
	1.00"	25.0		100%		
	7/8"	22.4		100%		
	3/4"	19.0		100%		
	5/8"	16.0		100%		
	1/2"	12.5		100%		
	3/8"	9.50		100%		
	1/4"	6.30		100%		
	#4	4.75	100%			
SAND	#8	2.36		100%		
	#10	2.00	100%			
	#16	1.18		99%		
	#20	0.850	99%			
	#30	0.600		98%		
	#40	0.425	96%			
	#50	0.300		95%		
	#60	0.250	94%			
	#80	0.180		93%		
	#100	0.150	92%			
	#140	0.106		90%		
	#170	0.090		89%		
	#200	0.075	88%			

DATE TESTED	TESTED BY
08/24/21	KMS

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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
NW 18th Avenue Subdivision Camas, Washington	Modern Dwellings, LLC 8101 NE Glisan Street Portland, Oregon 97213	21184	S21-0708
		REPORT DATE: 08/27/21	FIELD ID: TP2.1
		DATE SAMPLED: 08/05/21	SAMPLED BY: EMU

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY	Test Pit, TP-02 depth = 2 feet	CL, Lean Clay

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Liquid Limit Machine, Hand Rolled

TEST PROCEDURE: ASTM D4318

ATTERBERG LIMITS

liquid limit =	37
plastic limit =	18
plasticity index =	19

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	34.72	35.69	34.85	
dry soil + pan weight, g =	31.02	31.71	30.90	
pan weight, g =	20.71	20.79	20.47	
N (blows) =	32	24	17	
moisture, % =	35.9 %	36.5 %	37.9 %	

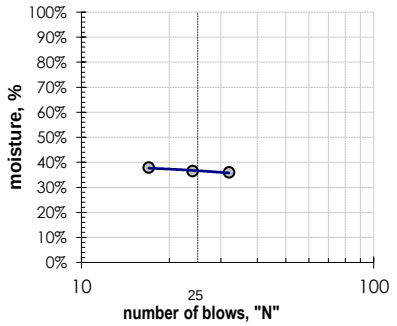
SHRINKAGE

shrinkage limit =	n/a
shrinkage ratio =	n/a

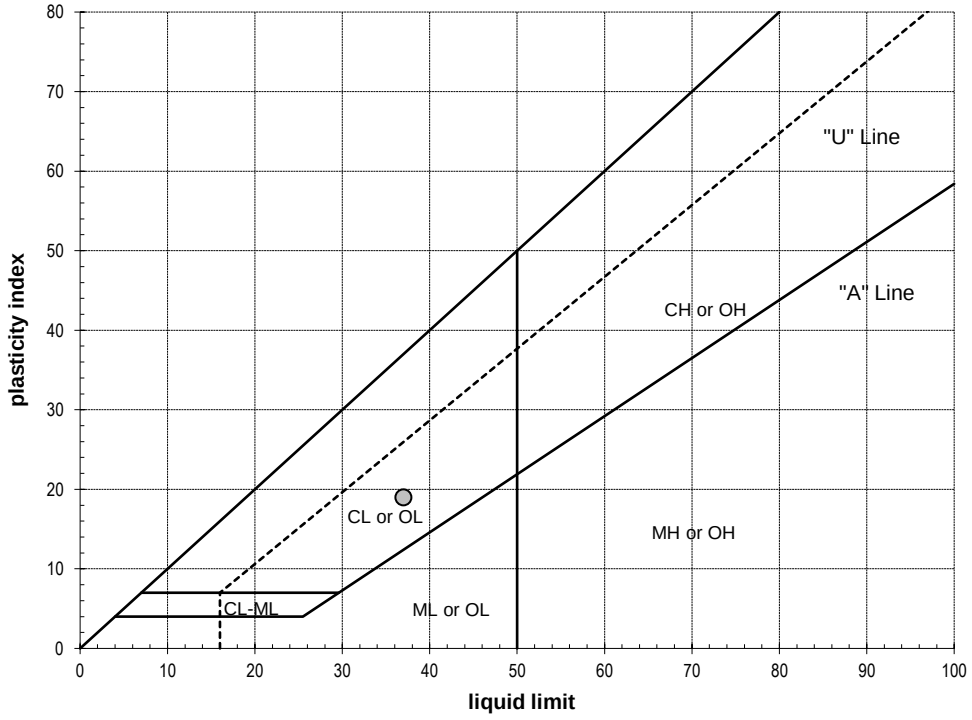
PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.78	28.22		
dry soil + pan weight, g =	26.71	27.04		
pan weight, g =	20.80	20.60		
moisture, % =	18.1 %	18.3 %		

LIQUID LIMIT



PLASTICITY CHART



ADDITIONAL DATA

% gravel =	0.0%
% sand =	11.9%
% silt and clay =	88.1%
% silt =	n/a
% clay =	n/a
moisture content =	22.7%

DATE TESTED	TESTED BY
08/26/21	KMS

COLUMBIA WEST ENGINEERING, INC. authorized signature

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PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
NW 18th Avenue Subdivision Camas, Washington	Modern Dwellings, LLC 8101 NE Glisan Street Portland, Oregon 97213	21184	S21-0709
		REPORT DATE 08/27/21	FIELD ID TP5.2
		DATE SAMPLED 08/05/21	SAMPLED BY EMU

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY with Sand	Test Pit, TP-05 depth = 5 feet	CL, Lean Clay with Sand
SPECIFICATIONS none		AASHTO CLASSIFICATION A-6(15)

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Rainhart "Mary Ann" Sifter, moist prep, hand washed, 12" single sieve-set

TEST PROCEDURE: ASTM D6913, Method A

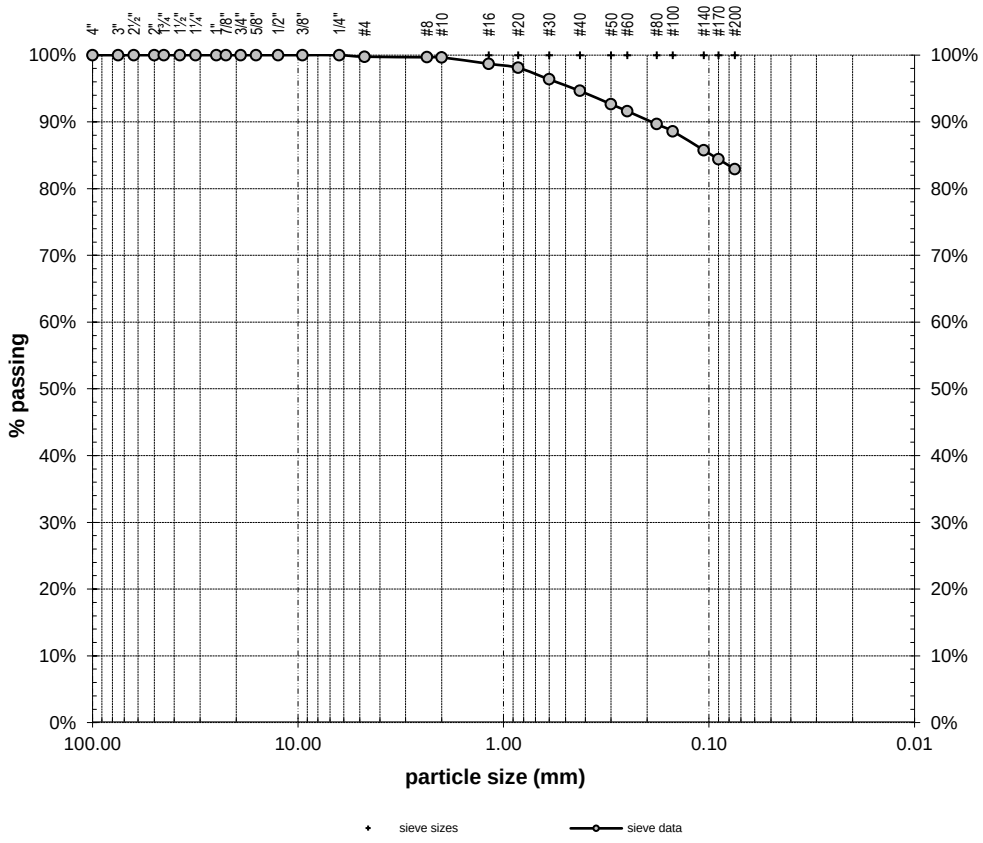
ADDITIONAL DATA

initial dry mass (g) =	143.71		
as-received moisture content =	22.8%	coefficient of curvature, C_C =	n/a
liquid limit =	38	coefficient of uniformity, C_U =	n/a
plastic limit =	19	effective size, $D_{(10)}$ =	n/a
plasticity index =	19	$D_{(30)}$ =	n/a
fineness modulus =	n/a	$D_{(60)}$ =	n/a

SIEVE DATA

% gravel = 0.2%
% sand = 16.8%
% silt and clay = 82.9%

GRAIN SIZE DISTRIBUTION



	SIEVE SIZE US	SIEVE SIZE mm	PERCENT PASSING SIEVE act.	PERCENT PASSING SIEVE interp.	SPECS max	SPECS min
GRAVEL	6.00"	150.0		100%		
	4.00"	100.0		100%		
	3.00"	75.0		100%		
	2.50"	63.0		100%		
	2.00"	50.0		100%		
	1.75"	45.0		100%		
	1.50"	37.5		100%		
	1.25"	31.5		100%		
	1.00"	25.0		100%		
	7/8"	22.4		100%		
	3/4"	19.0		100%		
	5/8"	16.0		100%		
	1/2"	12.5		100%		
	3/8"	9.50		100%		
	1/4"	6.30	100%			
	#4	4.75	100%			
SAND	#8	2.36		100%		
	#10	2.00	100%			
	#16	1.18		99%		
	#20	0.850	98%			
	#30	0.600		96%		
	#40	0.425	95%			
	#50	0.300		93%		
	#60	0.250	92%			
	#80	0.180		90%		
	#100	0.150	89%			
	#140	0.106		86%		
	#170	0.090		84%		
	#200	0.075	83%			

DATE TESTED: 08/24/21
TESTED BY: KMS

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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
NW 18th Avenue Subdivision Camas, Washington	Modern Dwellings, LLC 8101 NE Glisan Street Portland, Oregon 97213	21184	S21-0709
		REPORT DATE: 08/27/21	FIELD ID: TP5.2
		DATE SAMPLED: 08/05/21	SAMPLED BY: EMU

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY with Sand	Test Pit, TP-05 depth = 5 feet	CL, Lean Clay with Sand

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Liquid Limit Machine, Hand Rolled

TEST PROCEDURE: ASTM D4318

ATTERBERG LIMITS

liquid limit = 38
plastic limit = 19
plasticity index = 19

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	33.66	33.95	33.56	
dry soil + pan weight, g =	30.27	30.38	29.87	
pan weight, g =	20.84	20.93	20.58	
N (blows) =	34	25	19	
moisture, % =	36.0 %	37.8 %	39.7 %	

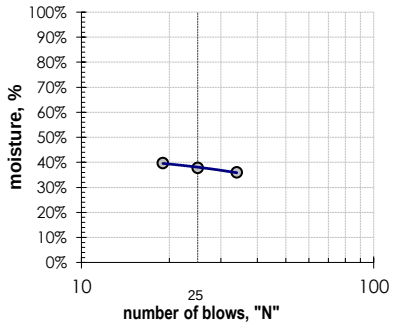
SHRINKAGE

shrinkage limit = n/a
shrinkage ratio = n/a

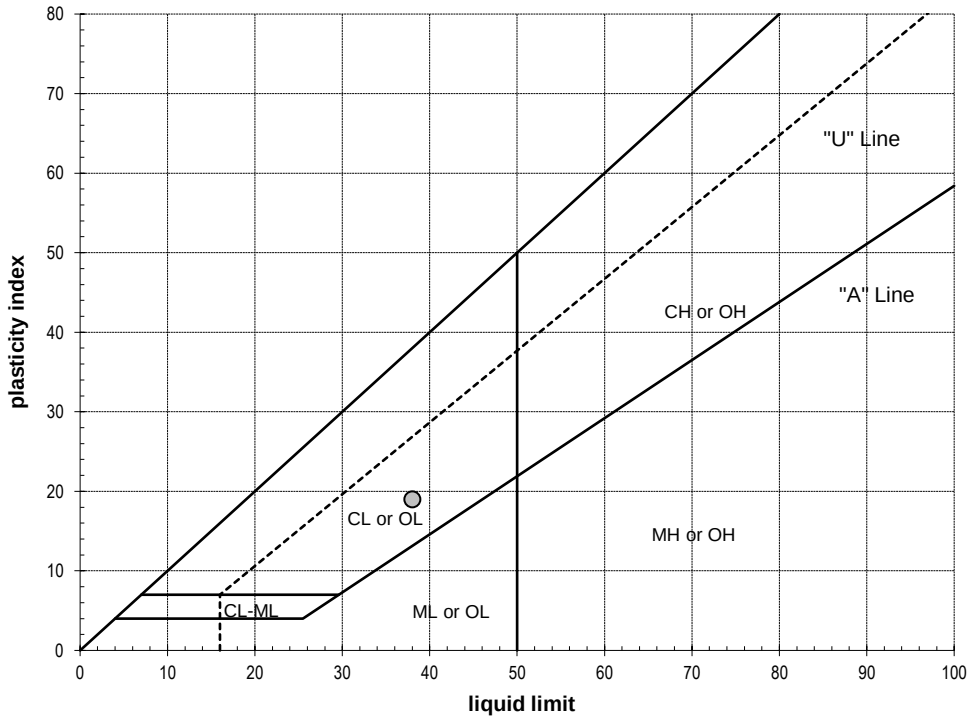
PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.47	28.62		
dry soil + pan weight, g =	26.37	27.36		
pan weight, g =	20.52	20.77		
moisture, % =	18.8 %	19.1 %		

LIQUID LIMIT



PLASTICITY CHART



ADDITIONAL DATA

% gravel =	0.2%
% sand =	16.8%
% silt and clay =	82.9%
% silt =	n/a
% clay =	n/a
moisture content =	22.8%

DATE TESTED	TESTED BY
08/26/21	KMS

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PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
NW 18th Avenue Subdivision Camas, Washington	Modern Dwellings, LLC 8101 NE Glisan Street Portland, Oregon 97213	21184	S21-0710
		REPORT DATE 08/27/21	FIELD ID TP6.1
		DATE SAMPLED 08/05/21	SAMPLED BY EMU

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY with Sand	Test Pit, TP-06 depth = 11 feet	CL, Lean Clay with Sand
SPECIFICATIONS none		AASHTO CLASSIFICATION A-6(17)

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Rainhart "Mary Ann" Sifter, moist prep, hand washed, 12" single sieve-set

TEST PROCEDURE: ASTM D6913, Method A

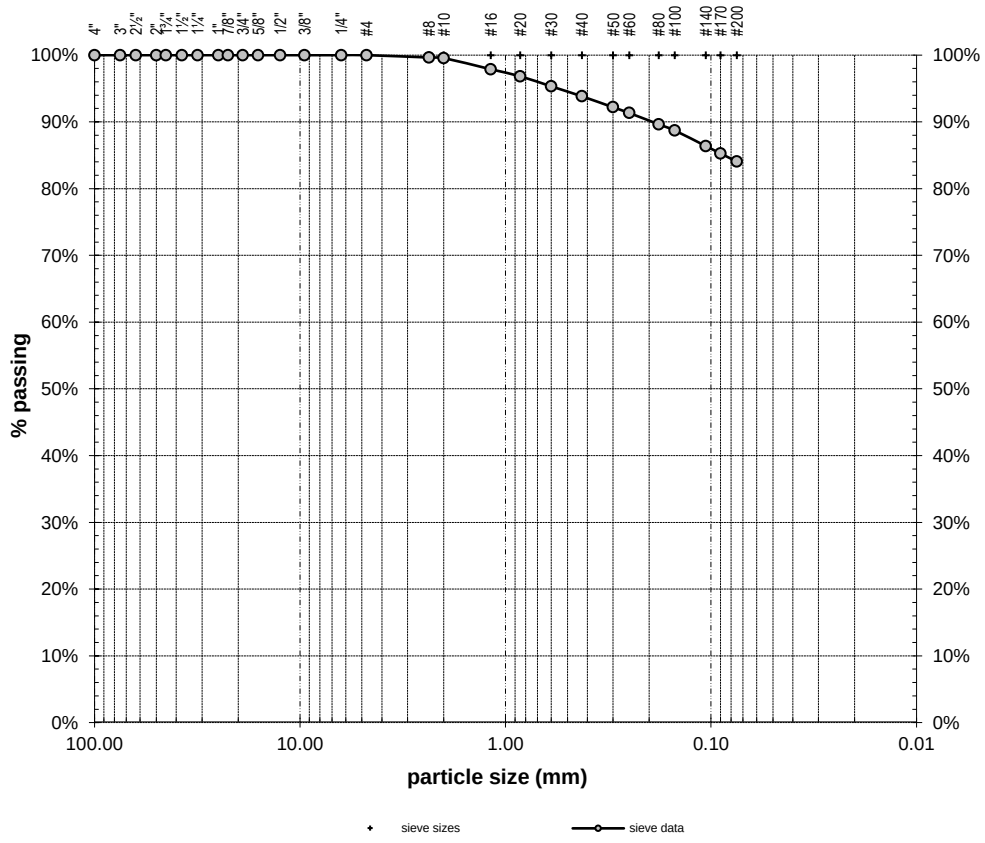
ADDITIONAL DATA

initial dry mass (g) =	153.53		
as-received moisture content =	20.8%	coefficient of curvature, C_C =	n/a
liquid limit =	40	coefficient of uniformity, C_U =	n/a
plastic limit =	19	effective size, $D_{(10)}$ =	n/a
plasticity index =	21	$D_{(30)}$ =	n/a
fineness modulus =	n/a	$D_{(60)}$ =	n/a

SIEVE DATA

% gravel =	0.0%
% sand =	15.9%
% silt and clay =	84.1%

GRAIN SIZE DISTRIBUTION



	SIEVE SIZE US	SIEVE SIZE mm	PERCENT PASSING SIEVE act.	PERCENT PASSING SIEVE interp.	SPECS max	SPECS min
GRAVEL	6.00"	150.0		100%		
	4.00"	100.0		100%		
	3.00"	75.0		100%		
	2.50"	63.0		100%		
	2.00"	50.0		100%		
	1.75"	45.0		100%		
	1.50"	37.5		100%		
	1.25"	31.5		100%		
	1.00"	25.0		100%		
	7/8"	22.4		100%		
	3/4"	19.0		100%		
	5/8"	16.0		100%		
	1/2"	12.5		100%		
	3/8"	9.50		100%		
	1/4"	6.30		100%		
	#4	4.75	100%			
SAND	#8	2.36		100%		
	#10	2.00	100%			
	#16	1.18		98%		
	#20	0.850	97%			
	#30	0.600		95%		
	#40	0.425	94%			
	#50	0.300		92%		
	#60	0.250	91%			
	#80	0.180		90%		
	#100	0.150	89%			
	#140	0.106		86%		
	#170	0.090		85%		
	#200	0.075	84%			

DATE TESTED	TESTED BY
08/24/21	KMS

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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
NW 18th Avenue Subdivision Camas, Washington	Modern Dwellings, LLC 8101 NE Glisan Street Portland, Oregon 97213	21184	S21-0710
		REPORT DATE: 08/27/21	FIELD ID: TP6.1
		DATE SAMPLED: 08/05/21	SAMPLED BY: EMU

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY with Sand	Test Pit, TP-06 depth = 11 feet	CL, Lean Clay with Sand

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Liquid Limit Machine, Hand Rolled

TEST PROCEDURE: ASTM D4318

ATTERBERG LIMITS

liquid limit =	40
plastic limit =	19
plasticity index =	21

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	33.84	33.42	33.81	
dry soil + pan weight, g =	30.35	29.87	29.99	
pan weight, g =	20.93	20.95	20.93	
N (blows) =	35	24	18	
moisture, % =	37.1 %	39.8 %	42.2 %	

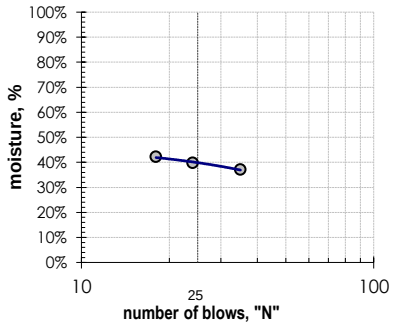
SHRINKAGE

shrinkage limit =	n/a
shrinkage ratio =	n/a

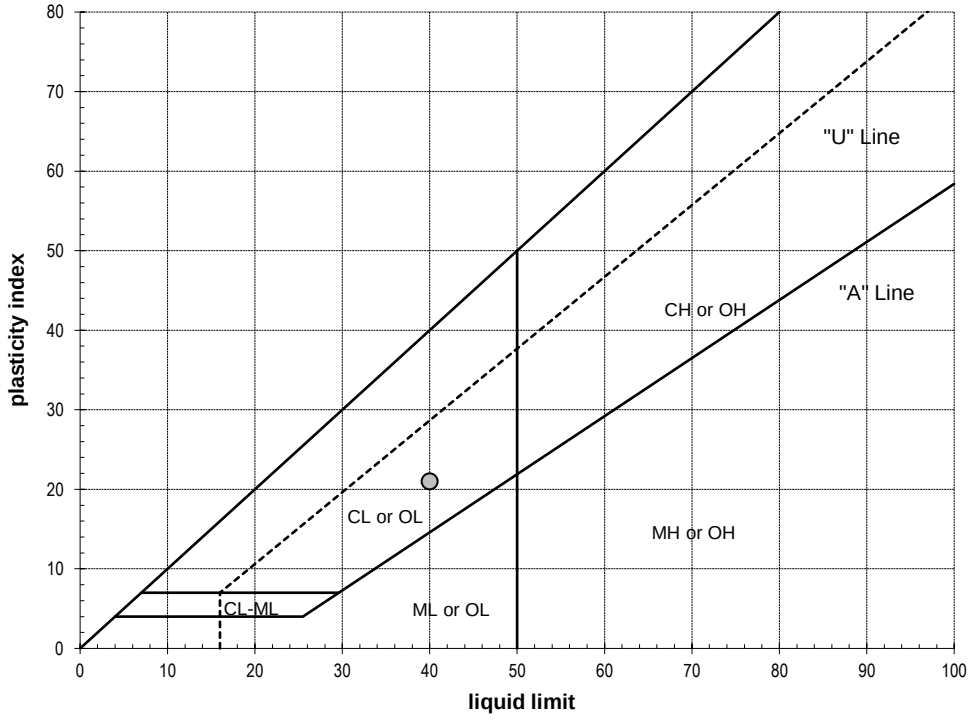
PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.71	27.12		
dry soil + pan weight, g =	26.61	26.08		
pan weight, g =	20.77	20.61		
moisture, % =	18.8 %	19.0 %		

LIQUID LIMIT



PLASTICITY CHART



ADDITIONAL DATA

% gravel =	0.0%
% sand =	15.9%
% silt and clay =	84.1%
% silt =	n/a
% clay =	n/a
moisture content =	20.8%

DATE TESTED	TESTED BY
08/26/21	KMS

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APPENDIX B
SUBSURFACE EXPLORATION LOGS

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
NW 18th Avenue Subdivision	Modern Dwellings, LLC		21184	TP-1
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**TECHNICIAN**	**DATE**
Camas, Washington	L&S Contractors	Excavator	EMU / BJB	08/05/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	744 ft amsl	Not Encountered	0807	0833

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 8 to 10 inches of grass and topsoil.					
		Powell Silt Loam		CL		Brown, damp to moist, lean CLAY [Soil Type 1].					
5											
10						Sub-rounded cobbles.					
						Bottom of test pit at 13.5 feet bgs. Groundwater not observed on 08/05/21.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
NW 18th Avenue Subdivision	Modern Dwellings, LLC		21184	TP-2
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**TECHNICIAN**	**DATE**
Camas, Washington	L&S Contractors	Excavator	EMU / BJB	08/05/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	728 ft amsl	Not Encountered	0845	1135

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 10 to 14 inches of grass and topsoil.					
		Powell Silt Loam		CL		Light brown to brown, dry to damp, lean CLAY [Soil Type 1].					IT2.1
	TP2.1		A-6(16)			Slow digging at 2 feet.	22.7	88.1	37	19	D = 2.0-ft k < 0.06 in/hr
5						Slow digging at 5 feet.					IT2.2 D = 5.0-ft k < 0.06 in/hr
10											
						Bottom of test pit at 13 feet bgs. Groundwater not observed on 08/05/21.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
NW 18th Avenue Subdivision	Modern Dwellings, LLC		21184	TP-3
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**TECHNICIAN**	**DATE**
Camas, Washington	L&S Contractors	Excavator	EMU / BJB	08/05/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	732 ft amsl	Not Encountered	0915	0940

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 8 to 12 inches of grass and topsoil.					
		Powell Silt Loam		CL		Brown, damp to moist, lean CLAY [Soil Type 1].					
5											
10						Fractured cobbles.					
						Bottom of test pit at 12 feet bgs. Groundwater not observed on 08/05/21.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
NW 18th Avenue Subdivision	Modern Dwellings, LLC		21184	TP-4
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**TECHNICIAN**	**DATE**
Camas, Washington	L&S Contractors	Excavator	EMU / BJB	08/05/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	706 ft amsl	Not Encountered	0942	1123

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 10 to 14 inches of grass and topsoil.					
		Powell Silt Loam		CL		Light brown to brown, damp to moist, lean CLAY [Soil Type 1].					
						Slow digging at 4 feet.					IT4.1 D = 4.0-ft k < 0.06 in/hr
5											
						Sub-rounded cobbles, round 4-12" cobbles					
10											
						Bottom of test pit at 12.5 feet bgs. Groundwater not observed on 08/05/21.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
NW 18th Avenue Subdivision	Modern Dwellings, LLC		21184	TP-5
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**TECHNICIAN**	**DATE**
Camas, Washington	L&S Contractors	Excavator	EMU / BJB	08/05/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	694 ft amsl	Not Encountered	1015	1215

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 10 to 14 inches of grass and topsoil.					
		Powell Silt Loam		CL		Gray to light brown, dry to damp, CLAY with sand [Soil Type 1].					IT5.1 D = 2.0-ft k < 0.06 in/hr
						Slow digging at 2 feet.					
5	TP5.2		A-6(15)			Slow digging at 5 feet.	22.8	82.9	38	19	IT5.2 D = 5.0-ft k < 0.06 in/hr
						Sub-rounded cobbles.					
10											
						Bottom of test pit at 13 feet bgs. Groundwater not observed on 08/05/21.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
NW 18th Avenue Subdivision	Modern Dwellings, LLC		21184	TP-6
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**TECHNICIAN**	**DATE**
Camas, Washington	L&S Contractors	Excavator	EMU / BJB	08/05/21
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	724 ft amsl	Not Encountered	1045	1112

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 8 to 14 inches of grass and topsoil.					
		Powell Silt Loam		CL		Light brown to brown, dry to damp, lean CLAY with sand [Soil Type 1].					
5											
						Becomes orange, brown and damp to moist					
10						Sub-rounded cobbles.					
	TP6.1		A-6(17)				20.8	84.1	40	21	
						Bottom of test pit at 12 feet bgs. Groundwater not observed on 08/05/21.					
15											

APPENDIX C
SOIL CLASSIFICATION INFORMATION

SOIL DESCRIPTION AND CLASSIFICATION GUIDELINES

Particle-Size Classification

COMPONENT	ASTM/USCS		AASHTO	
	size range	sieve size range	size range	sieve size range
Cobbles	> 75 mm	greater than 3 inches	> 75 mm	greater than 3 inches
Gravel	75 mm – 4.75 mm	3 inches to No. 4 sieve	75 mm – 2.00 mm	3 inches to No. 10 sieve
Coarse	75 mm – 19.0 mm	3 inches to 3/4-inch sieve	-	-
Fine	19.0 mm – 4.75 mm	3/4-inch to No. 4 sieve	-	-
Sand	4.75 mm – 0.075 mm	No. 4 to No. 200 sieve	2.00 mm – 0.075 mm	No. 10 to No. 200 sieve
Coarse	4.75 mm – 2.00 mm	No. 4 to No. 10 sieve	2.00 mm – 0.425 mm	No. 10 to No. 40 sieve
Medium	2.00 mm – 0.425 mm	No. 10 to No. 40 sieve	-	-
Fine	0.425 mm – 0.075 mm	No. 40 to No. 200 sieve	0.425 mm – 0.075 mm	No. 40 to No. 200 sieve
Fines (Silt and Clay)	< 0.075 mm	Passing No. 200 sieve	< 0.075 mm	Passing No. 200 sieve

Consistency for Cohesive Soil

CONSISTENCY	SPT N-VALUE (BLOWS PER FOOT)	POCKET PENETROMETER (UNCONFINED COMPRESSIVE STRENGTH, tsf)
Very Soft	2	less than 0.25
Soft	2 to 4	0.25 to 0.50
Medium Stiff	4 to 8	0.50 to 1.0
Stiff	8 to 15	1.0 to 2.0
Very Stiff	15 to 30	2.0 to 4.0
Hard	30 to 60	greater than 4.0
Very Hard	greater than 60	-

Relative Density for Granular Soil

RELATIVE DENSITY	SPT N-VALUE (BLOWS PER FOOT)
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	more than 50

Moisture Designations

TERM	FIELD IDENTIFICATION
Dry	No moisture. Dusty or dry.
Damp	Some moisture. Cohesive soils are usually below plastic limit and are moldable.
Moist	Grains appear darkened, but no visible water is present. Cohesive soils will clump. Sand will bulk. Soils are often at or near plastic limit.
Wet	Visible water on larger grains. Sand and silt exhibit dilatancy. Cohesive soil can be readily remolded. Soil leaves wetness on the hand when squeezed. Soil is much wetter than optimum moisture content and is above plastic limit.

AASHTO SOIL CLASSIFICATION SYSTEM

TABLE 1. Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35 Percent or Less Passing .075 mm)				Silt-Clay Materials (More than 35 Percent Passing 0.075)		
Group Classification	A-1	A-3	A-2	A-4	A-5	A-6	A-7
Sieve analysis, percent passing:							
2.00 mm (No. 10)	-	-	-				
0.425 mm (No. 40)	50 max	51 min	-	-	-	-	-
0.075 mm (No. 200)	25 max	10 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)							
Liquid limit				40 max	41 min	40 max	41 min
Plasticity index	6 max	N.P.		10 max	10 max	11 min	11 min
General rating as subgrade	Excellent to good			Fair to poor			

Note: The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate superiority of A-3 over A-2.

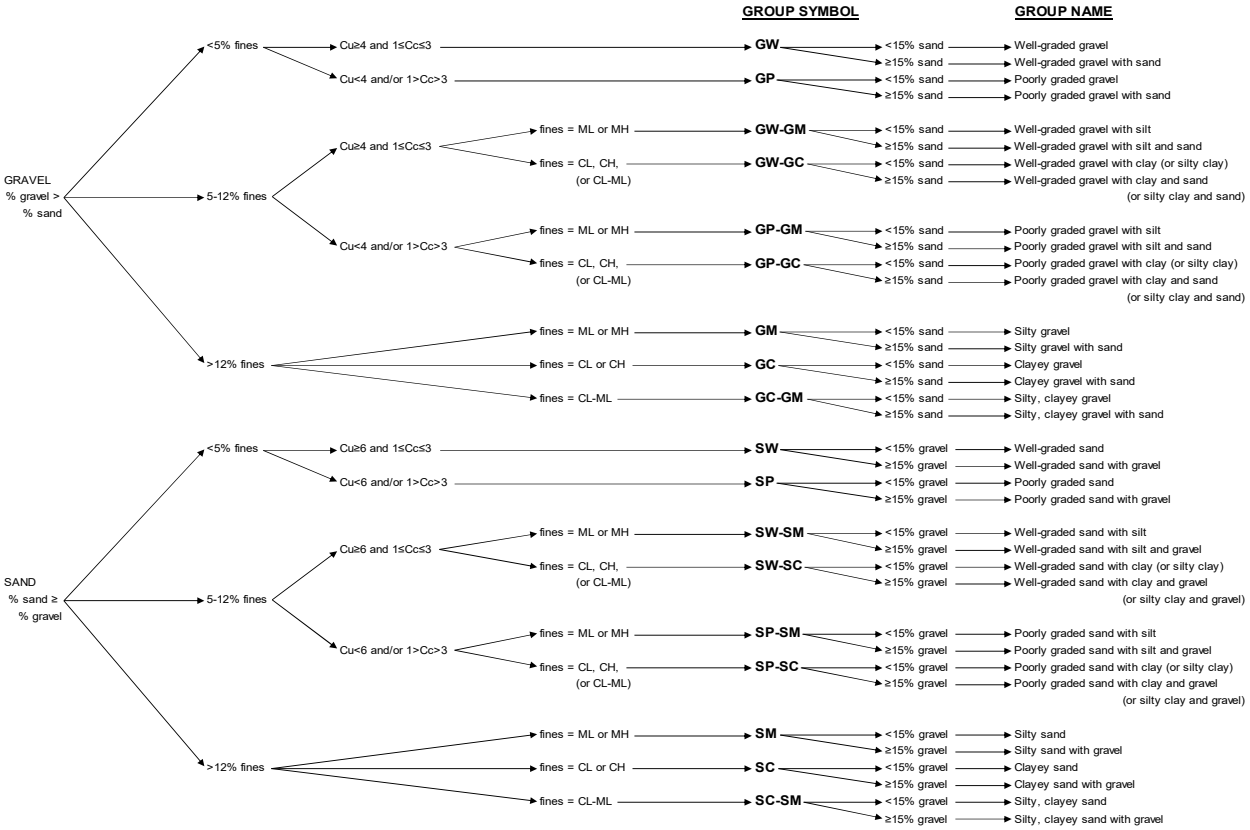
TABLE 2. Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35 Percent or Less Passing 0.075 mm)							Silt-Clay Materials (More than 35 Percent Passing 0.075 mm)			
	A-1			A-2							A-7
Group Classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5, A-7-6
Sieve analysis, percent passing:											
2.00 mm (No. 10)	50 max	-	-	-	-	-	-	-	-	-	-
0.425 mm (No. 40)	30 max	50 max	51 min	-	-	-	-	-	-	-	-
0.075 mm (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)											
Liquid limit				40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11min
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General ratings as subgrade	Excellent to Good							Fair to poor			

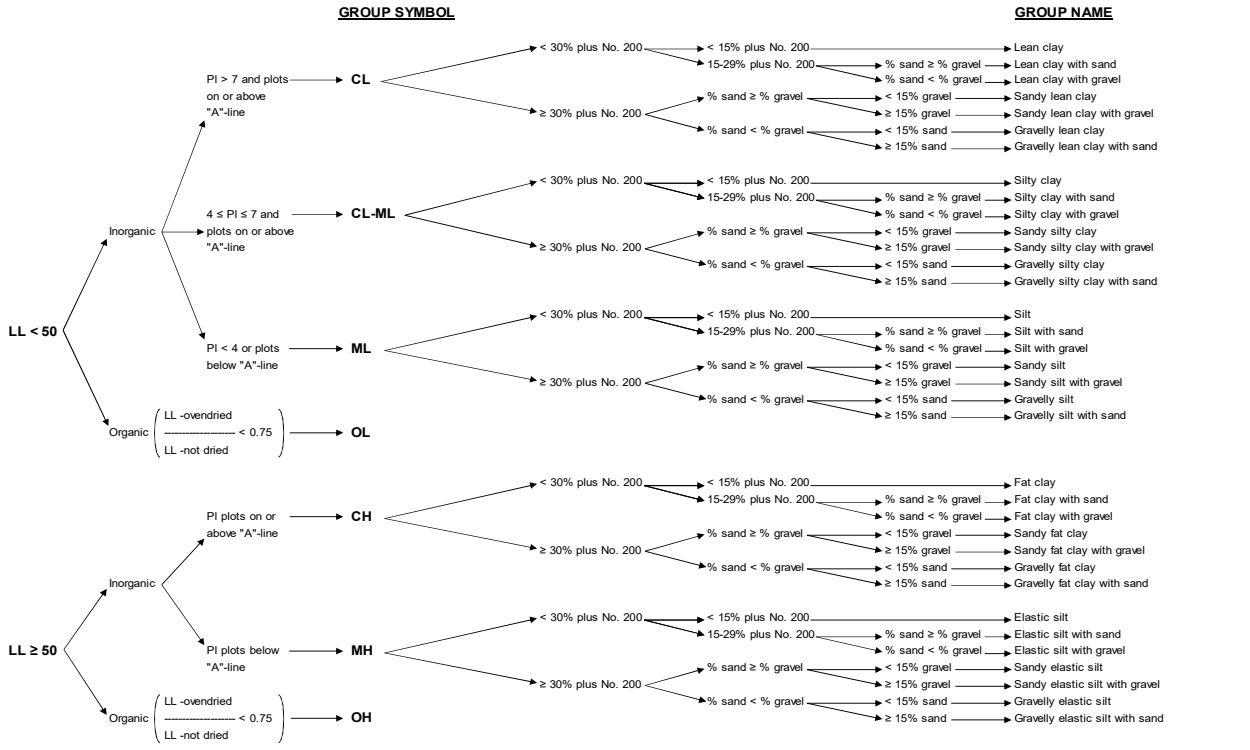
Note: Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30 (see Figure 2).

AASHTO = American Association of State Highway and Transportation Officials

USCS SOIL CLASSIFICATION SYSTEM



Flow Chart for Classifying Coarse-Grained Soils (More Than 50% Retained on No. 200 Sieve)



Flow Chart for Classifying Fine-Grained Soil (50% or More Passes No. 200 Sieve)

APPENDIX D
PHOTO LOG

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

NW 18th Avenue Subdivision

August, 2021

Camas, Washington

Test Pit Profile, TP-1

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

NW 18th Avenue Subdivision

August, 2021

Camas, Washington

Test Pit Profile, TP-3

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

NW 18th Avenue Subdivision

August, 2021

Camas, Washington

Test Pit Profile, TP-5

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

NW 18th Avenue Subdivision

August, 2021

Camas, Washington

TP-2 Site Area, Facing Southeast

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

NW 18th Avenue Subdivision

August, 2021

Camas, Washington

Central Site Area, Facing West

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

NW 18th Avenue Subdivision

August, 2021

Camas, Washington

Southwest Site Area, Facing Northeast

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

NW 18th Avenue Subdivision

August, 2021

Camas, Washington

Eastern Site Area, Facing South

APPENDIX E
REPORT LIMITATIONS AND IMPORTANT INFORMATION

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

Date: September 15, 2021
Project: NW 18th Avenue Subdivision
Camas, Washington

Geotechnical and Environmental Report Limitations and Important Information

Report Purpose, Use, and Standard of Care

This report has been prepared in accordance with standard fundamental principles and practices of geotechnical engineering and/or environmental consulting, and in a manner consistent with the level of care and skill typical of currently practicing local engineers and consultants. This report has been prepared to meet the specific needs of specific individuals for the indicated site. It may not be adequate for use by other consultants, contractors, or engineers, or if change in project ownership has occurred. It should not be used for any other reason than its stated purpose without prior consultation with Columbia West Engineering, Inc. (Columbia West). It is a unique report and not applicable for any other site or project. If site conditions are altered, or if modifications to the project description or proposed plans are made after the date of this report, it may not be valid. Columbia West cannot accept responsibility for use of this report by other individuals for unauthorized purposes, or if problems occur resulting from changes in site conditions for which Columbia West was not aware or informed.

Report Conclusions and Preliminary Nature

This geotechnical or environmental report should be considered preliminary and summary in nature. The recommendations contained herein have been established by engineering interpretations of subsurface soils based upon conditions observed during site exploration. The exploration and associated laboratory analysis of collected representative samples identifies soil conditions at specific discreet locations. It is assumed that these conditions are indicative of actual conditions throughout the subject property. However, soil conditions may differ between tested locations at different seasonal times of the year, either by natural causes or human activity. Distinction between soil types may be more abrupt or gradual than indicated on the soil logs. This report is not intended to stand alone without understanding of concomitant instructions, correspondence, communication, or potential supplemental reports that may have been provided to the client.

Because this report is based upon observations obtained at the time of exploration, its adequacy may be compromised with time. This is particularly relevant in the case of natural disasters, earthquakes, floods, or other significant events. Report conclusions or interpretations may also be subject to revision if significant development or other manmade impacts occur within or in proximity to the subject property. Groundwater conditions, if presented in this report, reflect observed conditions at the time of investigation. These conditions may change annually, seasonally or as a result of adjacent development.

Additional Investigation and Construction QA/QC

Columbia West should be consulted prior to construction to assess whether additional investigation above and beyond that presented in this report is necessary. Even slight variations in soil or site conditions may produce impacts to the performance of structural facilities if not adequately addressed. This underscores the importance of diligent QA/QC construction observation and testing to verify soil conditions do not differ materially or significantly from the interpreted conditions utilized for preparation of this report.

Therefore, this report contains several recommendations for field observation and testing by Columbia West personnel during construction activities. Actual subsurface conditions are more readily observed and discerned during the earthwork phase of construction when soils are exposed. Columbia West cannot accept responsibility for deviations from recommendations described in this report or future

performance of structural facilities if another consultant is retained during the construction phase or Columbia West is not engaged to provide construction observation to the full extent recommended.

Collected Samples

Uncontaminated samples of soil or rock collected in connection with this report will be retained for thirty days. Retention of such samples beyond thirty days will occur only at client's request and in return for payment of storage charges incurred. All contaminated or environmentally impacted materials or samples are the sole property of the client. Client maintains responsibility for proper disposal.

Report Contents

This geotechnical or environmental report should not be copied or duplicated unless in full, and even then only under prior written consent by Columbia West, as indicated in further detail in the following text section entitled *Report Ownership*. The recommendations, interpretations, and suggestions presented in this report are only understandable in context of reference to the whole report. Under no circumstances should the soil boring or test pit excavation logs, monitor well logs, or laboratory analytical reports be separated from the remainder of the report. The logs or reports should not be redrawn or summarized by other entities for inclusion in architectural or civil drawings, or other relevant applications.

Report Limitations for Contractors

Geotechnical or environmental reports, unless otherwise specifically noted, are not prepared for the purpose of developing cost estimates or bids by contractors. The extent of exploration or investigation conducted as part of this report is usually less than that necessary for contractor's needs. Contractors should be advised of these report limitations, particularly as they relate to development of cost estimates. Contractors may gain valuable information from this report, but should rely upon their own interpretations as to how subsurface conditions may affect cost, feasibility, accessibility and other components of the project work. If believed necessary or relevant, contractors should conduct additional exploratory investigation to obtain satisfactory data for the purposes of developing adequate cost estimates. Clients or developers cannot insulate themselves from attendant liability by disclaiming accuracy for subsurface ground conditions without advising contractors appropriately and providing the best information possible to limit potential for cost overruns, construction problems, or misunderstandings.

Report Ownership

Columbia West retains the ownership and copyright property rights to this entire report and its contents, which may include, but may not be limited to, figures, text, logs, electronic media, drawings, laboratory reports, and appendices. This report was prepared solely for the client, and other relevant approved users or parties, and its distribution must be contingent upon prior express written consent by Columbia West. Furthermore, client or approved users may not use, lend, sell, copy, or distribute this document without express written consent by Columbia West. Client does not own nor have rights to electronic media files that constitute this report, and under no circumstances should said electronic files be distributed or copied. Electronic media is susceptible to unauthorized manipulation or modification, and may not be reliable.

Consultant Responsibility

Geotechnical and environmental engineering and consulting is much less exact than other scientific or engineering disciplines, and relies heavily upon experience, judgment, interpretation, and opinion often based upon media (soils) that are variable, anisotropic, and non-homogenous. This often results in unrealistic expectations, unwarranted claims, and uninformed disputes against a geotechnical or environmental consultant. To reduce potential for these problems and assist relevant parties in better understanding of risk, liability, and responsibility, geotechnical and environmental reports often provide definitive statements or clauses defining and outlining consultant responsibility. The client is encouraged to read these statements carefully and request additional information from Columbia West if necessary.

City of Camas

Storm Sewer Systems

Operation & Maintenance Manual

Public & Private Systems

September 2009

City of Camas

Storm Sewer Systems

Operation & Maintenance Manual

Public & Private Systems

September 2009

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TABLE OF CONTENTS

Operation & Maintenance Manual

Introduction

Public & Private Systems

September 2009

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Background
Everything, whether it be public or privately owned, roads, parking lots, residential developments, commercial or industrial developments, or school facilities have various components that make up a storm sewer system. These components consist of conveyance pipes, catch basins, manholes, roadside ditches, stormwater facilities (such as drywells, bioswales, detention ponds, wet ponds, oil/water separators), landscaping (both hardscape and softscape), and any other structure that collects, conveys, controls, and/or treats stormwater. Regardless of the component, all storm sewer systems eventually discharge into 'waters of the state' which are our streams, rivers, lakes, wetlands, and groundwater.

Under the Federal Clean Water Act (FCWA) and in compliance with the Department of Ecology's NPDES Phase II Permit 'waters of the state' are to be protected from contamination. This in turn protects threatened and endangered species under the Federal Endangered Species Act (FESA).

One way to protect 'waters of the state' is to provide the proper maintenance of all storm sewer system components. It is the responsibility of the City of Camas to ensure that all components of the storm sewer system are properly maintained and operated. The City is responsible for those components that are located within the City's right-of-way, such as the conveyance pipes, manholes, catch basins, and roadside ditches. There are also a few specific stormwater ponds that are the responsibility of the City. However, the majority of the storm facilities are owned and maintained by the property owners as private facilities. These property owners include, but are not limited to, Homeowners Associations (HOA's), property manager companies, school districts, and commercial/industrial site owners.

Purpose of the Manual
This manual is intended to help, both public and private operators, meet the requirements for proper maintenance and operation of the various storm sewer system components. Proper maintenance will help to assure that:

- Storm sewer facilities operate as they were designed;
- Storm sewer systems are cleaned of the pollutants that they trap, such as sediment and oils, so that storm sewer systems are not overwhelmed and in so doing become pollutant sources;
- Pollutant sources are removed, or minimized, prior to entering the storm sewer system.

Along with keeping a site from flooding, properly maintained storm sewers can help reduce surface water and groundwater pollution. Most sites have some type of stormwater control component designed to limit the environmental and flooding damage caused by stormwater runoff. These components require more labor intensive maintenance than a system of pipes and catch basins.

It is the intent of the City to conduct yearly inspections of storm sewer facilities, preferably late spring/early summer to allow maintenance to occur late summer, prior to the fall rainy season. See Appendix A for an example of a *Storm Sewer System Maintenance Notification* form.

Manual Layout
The manual breaks out the various storm sewer system components and the general maintenance activities required for said component. For each component or activity this manual will:

- Briefly describe the component type, e.g. facility or activity.
- List the water quality and non-water quality result of each facility or activity.
- List the *Best Management Practices (BMP's)* needed to meet the water quality and general maintenance requirements.

Additional information may be found in other manuals, such as the Washington Department of Ecology's *2005 Stormwater Management Manual for Western Washington, Vols. IV and V*, or site specific Operation and Maintenance (O&M) Manuals.

Maintenance is performed as a means to obtain specific results. The maintenance results, as listed below, are specified for each drainage feature or activity. They include maintaining performance and appearance of the facility, and the need to prevent maintenance work itself from becoming a pollutant source or damaging habitat.

Maintenance Results (R1-R10)
Water Quality Results:
R1 Avoid or minimize sediment and pollutant discharges from the work area.
R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
R3 Avoid or minimize vegetation removal.
R4 Preserve native vegetation.

Infrastructure Maintenance Results:
R5 Protect public safety and health.
R6 Prevent catastrophique infrastructure failures.
R7 Maintain and/or restore the intended infrastructure function.
R8 Prevent and/or reduce flooding.
R9 Protect infrastructure.
R10 Meet public expectations for aesthetics.

Storm sewer facility refers to specific drainage features, such as catch basins, pipes, ditches, ponds, biofiltration swales, and infiltration systems. Activities refer to maintenance tasks associated with operating and maintaining stormwater facilities such as vegetation management and small repair projects. Depending on the extent of the maintenance, some property owners may be able to handle storm sewer maintenance themselves. Often, however, depending on the type of maintenance, the property owners will contract out the work. Landscapers are often employed to maintain vegetated facilities, such as swales and pond areas.

Heavier work, like cleaning catch basins, ditch inlets, outlet structures, or drywells often requires special equipment, such as trucks that can vacuum out sediment. When located within the city right-of-way, maintenance is typically the responsibility of the City. For those located on private

property a contractor would need to be contacted to perform this work. Check phone book listings, such as sewer and cleaning contractors, tank cleaning, and environmental and ecological services. Check with the contractor to ensure that all materials are disposed of according to solid waste and hazardous materials regulations. *Ultimately, the generator of the waste or hazardous material is responsible for proper disposal.*

Special Facilities:
Manufactured storm sewer facilities, such as leaf compost filters and oil/water separators often have maintenance requirements and manuals specified or written by the manufacturer. Also, larger or more complex storm sewer facilities may include specifications for maintenance and vegetation management that provide specific detail above and beyond this manual. Where the *Public Works Director* determines that these manuals or plans provide an equal or greater level of maintenance and water quality protection, then these procedures shall be followed by the owner. The Public Works Director must approve these individual maintenance plans, specifications, or manuals.

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Operation & Maintenance Procedures

Vegetated Facilities

Public & Private Systems

September 2009

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Biofiltration Swales

Biofiltration swales use grass or other dense vegetation to filter sediment and oily materials out of stormwater. Usually they look like flat-bottomed channels with grass growing in them. Swales are stormwater treatment devices that must be properly maintained to sustain pollutant removal capacity.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the surrounding area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

Swales are easy to inspect and need to be well maintained to treat stormwater. Make frequent visual inspections, at least once every 6 months and after storm events of >0.50 inch rainfall/24 hours, for problems such as channeling flow, rills, bare ground, sediment accumulation, oily material, and debris. Maintain adequate grass growth and eliminate bare spots.

Identify and remove pollutant sources that are discharging to the swale.

Maintain access to inlet and outlet structures for pollutant removal, and to grass swale for mowing and noxious weed removal.

Cleaning

Remove leaves, litter, sediment, oily materials, and grass cuttings when mowing or at any time that it is observed in the swale as this can cause blockage of inlets and outlets.

Clear inlets, outlets, curb cuts, and level spreaders of debris to prevent blockage of stormwater flow.

Use a rake and shovel to remove, by hand, sediment accumulations greater than 2-inches thick that cover grass areas; avoid vegetation removal. Reseed bare areas.

Vegetation Management

Mow to keep grass at the maximum height (9-inches). Mow to no less then 4-inches in height and a minimum of four cuttings per year. Remove clippings from the swale.

If a swale has an underdrain system, vehicular traffic (other then grass mowing equipment) on the swale bottom is to be avoided to prevent damage to the underdrain pipes.

Preserve healthy vegetation or reestablish vegetation where needed. Seed bare spots.

Blackberry removal is required and should be done 2-3 times a year. Pesticide use is **not** allowed. After cutting down of blackberries, vines are to be bagged and removed from the area.

Use appropriate BMP's to cover bare soils. BMP's include hydroseeding or mulches.

Trees and shrubbery are not allowed to grow within the biofiltration swale as they interfere with the facility's function and maintenance activities. Any cut trees should be salvaged for habitat enhancement or converted to mulch or firewood.

Storm sewer facilities are, in effect, water body buffers where pesticides and fertilizers are not to be used. See Vegetation Management in Storm Sewer Systems for more information.

Repairs

Often swales have problems due to flooding or erosion. Where possible, correct the underlying problem before trying to repair the symptom.

Level spreaders must be in proper working order for swales to function properly. Where level spreaders are damaged, sunken, or bypassed by erosion, repair them to design standards.

If there is a problem with grass dying due to the swale being flooded during the wet season, there are two options: convert the swale vegetation to a plant variety that can stand being flooded or find a way to fix the swale so it drains better.

Call the Public Works Department at 817-7231 for information on approved plants. **Design modifications to any storm sewer facility cannot be made without prior approval from the City of Camas.**

Filter Strips

Filter strips are linear strips of grass that remove sediment and oils from stormwater by filtering it. Stormwater is treated as it runs across the filter. Usually, filter strips are placed along the edge of linear paved areas, such as parking lots and roads. Where designed filter strips are installed; road shoulders should only be graded to maintain level flow off the road.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

Filter strips are easy to inspect and need to be well maintained to treat stormwater. Make frequent visual inspections for problems such as channeling flow, rills, bare ground, oily material, and debris.

Identify and remove pollutant sources.

Cleaning

Clear inlets and outlets to prevent blockage.

Remove litter when mowing or litter accumulates.

Use a rake and/or shovel to remove sediment and debris accumulations greater than 2-inches thick that cover grass areas; avoid vegetation removal. Remove sediment and re-level the slope to an even surface so that water spreads and does not form channels. Reseed bare areas.

Vegetation Management

Mow to keep grass at the optimum height (6-inches). Mow to no less then 4-inches in height and a minimum of four cutting per year.

Remove clippings from the treatment area. They may be spread elsewhere on site where they will not reenter the stormwater facility.

Preserve healthy vegetation or reestablish vegetation where needed. Seed bare spots.

Use appropriate BMP's to cover bare soils. BMP's include hydroseeding or mulches.

Storm sewer facilities are, in effect, water body buffers where pesticides and fertilizers are not to be used. See Vegetation Management in Storm Sewer Systems for more information.

Repairs
Where possible, correct the underlying problem before trying to repair the symptom.

The flow spreader must be level and spread flow evenly across the filter strip. Immediately repair any defects in the flow spreader.

If ruts develop, fill them with coarse soil, level the surface and reseed.

Detention Ponds/Facility

Detention pond facilities are designed to hold and slowly release stormwater by use of a pond and a specially designed control structure. Styles vary greatly from well manicured to natural appearing. Generally, native vegetation is preferred for reduced maintenance and enhance wildlife habitat. Some facilities are designed to appear as natural water bodies or are in a park-like setting.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R3 Avoid or minimize vegetation removal.
- R7 Maintain or restore the intended infrastructure function.
- R8 Prevent or reduce flooding.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

Facilities should be inspected, at a minimum, once a year. Inspect the facility for litter, dead vegetation, invasion of trees and noxious weeds, accumulated sediment, oil and other pollutants. Identify pollutant sources to the facility.

Cleaning

Remove litter when litter accumulates.

Remove any pollutants greater in volume then a surface sheen.

Remove trees and noxious weeds that are growing within the pond, on side slopes/berms, or within the emergency overflow area.

Remove sediment when it accumulates to 10 percent of the designed pond depth (plans can be obtained for Public Works Department). Sediment removal should be undertaken during the summer months (drier time of the year). Ponds are not to be altered from the original approved design without prior permission from the City of Camas.

Material Handling

Disposal of waste, e.g. sediment or standing water, from the maintenance of these facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Vegetation Management

Where a facility has a natural area (open space/buffer/wetlands), vegetation management should be timed to avoid or minimize impacts on wildlife. An example is a facility used by breeding birds such as red-winged black birds.

Mow, or rotary weed trim, vegetation to match surrounding area or sustain any other intended use of the facility, such as wildlife habitat or recreation area.

Use mechanical methods to control weeds. Pesticides, herbicides and fertilizers are not to be used in stormwater control facilities. See Vegetation Management in Storm Sewer Systems for more information.

If plants need replacing, please contact the City for a list of native plants.

Trees are not allowed to grow in the pond, on emergency overflows, or on berms. Trees can block flows and roots can lead to berm failure.

Trees and shrubbery may be allowed to grow around the perimeter of the pond unless growth interferes with the facility function or maintenance activities.

Blackberry removal is required and should be done 2-3 times a year. Pesticide use is **not** allowed around water. After cutting down of blackberries, vines are to be bagged and removed from the area.

Repairs

Repair and seed bare areas. Repair eroded slopes when rills form. Use cover BMP's on exposed soils.

Rodent holes in a dam or berm can serve as a means of piping water out of the pond. Remove the rodents, preferably by trapping, and repair the dam or berm. Check with the Washington Department of Fish and Wildlife before removing a game animal or fur-bearer, for example muskrat, beaver, and nutria.

Where applicable, repair the pond liner if it is visible and repair or replace where there are more than three holes greater than ¼-inch diameter.

If berms or dams show signs of settlement or sinkholes, serious problems may be occurring. Consult a licensed professional engineer to determine the cause of the settlement or sinkhole. Spillway areas should be completely covered by minimum of 12-inches of rock. **Design modifications to any storm sewer facility cannot be made without prior approval from the City of Camas.**

Infiltration Facilities (Basins/Ponds/Trenches)

Infiltration facilities dispose of water by holding it in an area where it can soak into the ground. These are open facilities that may either drain rapidly and have grass bases, or have perpetual ponds where water levels rise and fall with stormwater flows. Infiltration facilities may be designed to handle all of the runoff from an area or they may overflow and bypass larger storms.

Since the facility is designed to pass water into the ground, generally after passing through a sediment trap/manhole, anything that can cause the base to clog will reduce the performance and is a large concern. Generally, infiltration basins are managed like detention ponds, but with greater emphasis on maintaining the capacity to infiltrate stormwater.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R3 Avoid or minimize vegetation removal.
- R7 Maintain or restore the intended infrastructure function.
- R8 Prevent or reduce flooding.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

During the first year after construction, the sediment trap shall be monitored after every large storm (>1-inch per 24 hours) and monthly from October 1 through May 31 to ensure the facility is draining as intended.

Check once per year after a rainstorm to see if the facility is draining as intended. Inspect all features of the facility annually.

A thorough inspection of the observation points should be made if there is a decrease in retention basin capacity. Inspection points can include monitoring ports built into the base of the facility and water table depth monitoring wells. Water levels in these inspection points can provide information about the performance of the facility. It will probably require a licensed professional engineer or other professional trained in hydraulics to interpret the information.

Identify and remove pollutant sources to the facility. Inspect the facility for oil and other pollutants and remove any pollutants greater in volume than a surface sheen.

Cleaning

Trash is to be removed as it accumulates.

Remove sediment when it accumulates to 2-inches or if the facility does not drain between storms or meet 90 percent of design capabilities.

If the facility has a sediment trap/manhole, clean out the sediment when one-half foot accumulates.

Materials Handling
Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Vegetation Management
Where a facility has a natural area (open space/buffer/wetlands), vegetation management should be timed to avoid or minimize impacts on wildlife. An example is a facility used by breeding birds such as red-winged black birds.

Mow, or rotary weed trim, vegetation to match surrounding area or sustain any other intended use of the facility, such as wildlife habitat or recreation area.

Use mechanical methods to control weeds. Pesticides, herbicides and fertilizers are not to be used in stormwater control facilities. See Vegetation Management in Storm Sewer Systems for more information.

If plants need replacing, please contact the City for a list of native plants.

Trees should not be allowed to grow in the pond, over the trench, on emergency overflows, or on berms that are greater than 4-feet in height. Trees can block flows and roots can lead to berm failure. Remove any trees growing on emergency overflows, berms greater than 4-feet in height, or within the pond.

Trees and shrubbery should be allowed to grow around the perimeter of the facility unless growth interferes with the facility function or maintenance activities. Any cut trees should be salvaged for habitat enhancement or converted to mulch or firewood.

Repairs
If the facility is overflowing for a storm that is it was designed to infiltrate, it needs to be repaired. This may require removing accumulated sediment and cleaning or rebuilding the system so that it works according to design.

Repair and seed bare areas. Repair eroded slopes when rills form. Use cover BMP's on exposed soils.

Rodent holes on a dam or berm can serve as a means of piping water out of the pond. Remove the rodents, preferably by trapping, and repair the dam or berm. Check with the Washington Department of Fish and Wildlife before removing a game animal or fur-bearer, for example muskrat, beaver, and nutria.

Spillway areas should be completely covered with more a minimum of 12-inches of rock.

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Wet Biofiltration Ponds, Swales, and Treatment Wetlands

Wet biofiltration swales and treatment wetlands use dense wetland vegetation and settling to filter sediment and oily materials out of stormwater. These stormwater treatment devices must be properly maintained to sustain pollutant removal capacity. In some cases, biofiltration swales that were designed to drain between storms remain wet and need to be rebuilt or converted to wetland swales. A designed wet biofiltration swale uses wetland plants instead of grass.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

Swales are easy to inspect and need to be well maintained to treat stormwater. Make frequent visual inspections for problems such as bare ground, sediment and oily material.

Identify and remove sources of pollutants to the swale.

Cleaning

Clear inlets and outlets of debris in order to prevent blockage.

Remove litter and trash when it collects.

Where possible, use a rake and/or shovel to remove sediment accumulations greater than 2-inches thick in 10 percent of the treatment area.

Vegetation Management

Sparse vegetation or dense clumps of cattail do not properly treat stormwater. Try to find the cause of the problem and fix it to ensure dense vegetation. Cut back excessive cattail shoots. Normally, wetland vegetation does not need to be harvested unless there is an excessive die back that causes water quality problems.

If there is a problem with grass dying due to the swale being flooded during the wet season, there are two options: plant varieties that can stand being flooded or find a way to fix the swale so it drains better. Call the Public Works Department at 817-7231 for information on plants and possible swale modifications.

Outside of the treatment area, preserve healthy vegetation or reestablish vegetation where needed. Seed bare spots. Use cover BMP's on bare soils.

Trees and shrubbery should be allowed to grow unless they interfere with facility function or maintenance activities. Any cut trees should be salvaged for habitat enhancement or converted to mulch or firewood.

Stormwater control facilities are, in effect, water body buffers in which pesticides and fertilizer are not used. See Vegetation Management in Stormwater Control Facilities for more information.

Repairs

Often swales have problems due to flooding or erosion. Where possible, correct the underlying problem before trying to repair the symptom.

Repair any defect that causes the wet swale to dry out during the wet season.

Replace stormwater facility signs that are broken, damaged, or stolen.

Drainage Ditches

Ditches are often manmade open-channels that carry only stormwater. These ditches are maintained to prevent localized flooding by draining stormwater. Maintenance includes removing sediment, debris, litter, and overgrown vegetation.

Many manmade drainage ditches carry water when it is not raining. This water comes from groundwater seepage and wetlands. These ditches can be recognized by the presence of wetland plants, such as cattails. Any work that disturbs these channels is probably subject to a variety of environmental regulations and may require an HPA permit from the Washington Department of Fish and Wildlife. Contact the Washington Department of Fish and Wildlife and the City of Camas Public Words Department before beginning any work.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R3 Avoid or minimize vegetation removal.
- R4 Preserve natives plants.
- R7 Maintain or restore the intended infrastructure function.
- R8 Prevent or reduce flooding.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect ditches during routine site maintenance or at least once per year.

Cleaning

Land disturbing activities that remove vegetation or disturb soil are subject to erosion/sediment control requirements per CMC 15.32. A good time to clean drainage ditches is during the growing season, when it's easiest to reestablish vegetation.

Cleaning or excavating within seasonally dry or ditched watercourses may require an HPA from WDFW. Consult the official state DNR water type maps or contact the City of Camas for assistance in determining whether watercourses are typed streams (e.g. type 1, 2, 3, 4 or 5) that are regulated by WDFW. *Contact VTDFW Region Five office for additional information on whether specific watercourses are regulated under the State Hydraulic Code, or if unmapped streams are encountered.*

If feasible, remove small amounts of sediment by hand when performing routine site maintenance.

Vegetation should only be removed when it reduces free movement of water through the ditch. Never remove more vegetation than is absolutely needed.

Only remove sediment when it reaches 20 percent of the ditch depth or affects the historic or designed hydraulic capacity.

Alternate cleaning areas with undisturbed areas, leaving undisturbed sections to act as sediment trapping filters between worked areas.

Trap sediment that is generated by ditch maintenance to keep it from entering water bodies. Use sediment-trapping BMP's such as bio-filter bags at the lower end of each excavated area.

Prevent sediment from eroding when ditch work is performed. Perform work during dry weather unless there is an emergency, such as property or road flooding.

Vegetate bare soils by hydroseeding or cover bare soils with an approved BMP. Hand seed for smaller areas.

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Operation & Maintenance Procedures

Stormwater Structures

Public & Private Systems

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Catch Basins and Curb Inlets

Catch basins and curb inlets trap sediment and some oils that are washed off the road surface during a storm event. This sediment and the oils if not removed from the basins and inlets have the potential to pollute water bodies. They need to be inspected and cleaned at a minimum annually, more often if necessary; to remove accumulated sediment, fluids, and trash.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, facilities, and property from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function
- R8 Prevent or reduce flooding.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect catch basins and curb inlets at least once per year, more often if necessary.

Periodically inspect the catch basin or curb inlets and surrounding areas for pollutants, such as leaks from dumpsters, minor spills, and oil dumping. Act to have the pollutant source removed. Ensure that grass clippings and leave debris is not being blown into the streets.

Cleaning

Clean catch basins and curb inlets when they become one third full in order to maintain sediment-trapping capacity. Catch basin, curb inlet, and manhole cleaning should be performed in a manner that keeps removed sediment and contaminated water from being discharged back into the storm sewer.

Clean putrid materials from the catch basins and curb inlets when discovered or reported.

Keep the inlet grates cleared of debris and litter.

Safety

Work inside underground structures (e.g. manholes) requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor for this work.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs

Repair any damages that prevent the catch basin or curb inlet from functioning as designed. An example is a broken or missing outlet elbow.

Follow the Procedures described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

Debris Barriers/Trash Racks

Debris barriers and trash racks are barred covers to pipe openings. They prevent large objects from entering pipes and keeps pets and people out of the pipes as well. In cases where there is fish migration, maintaining unblocked trash racks allows fish passage.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R5 Protect public safety and health.
- R6 Prevent catastrophique infrastructure failures.
- R7 Maintain or restore the intended infrastructure function.
- R8 Prevent or reduce flooding.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect debris barriers and trash racks at least once per year in the fall.

Cleaning

Clean debris barriers and trash racks when debris is plugging more then 20 percent of the openings or when obstruction to fish passages are created. Consult the Washington Department of Wildlife is in a fish-bearing waterway.

Repairs

Immediately replace missing racks and bars.

Replace bars that are deteriorated to the point where they may be easily removed.

Straighten bent bars back into position.

Follow the Procedures described in the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

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Energy Dissipaters

Energy dissipaters are critical for preventing erosion at storm drain outfalls. There are a variety of designs, including wire gabion baskets, rock splash pads, trenches, and specially designed pools or manholes.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R8 Prevent or reduce flooding.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect at least once per year.

Cleaning

Remove any accumulated litter.

Dispersion trenches: remove sediment from pipe when it reaches 20 percent of the pipe diameter.

Repairs

Rock splash pads: replace missing or moved rocks to cover exposed soil and meet design standards.

Dispersion trenches: repair conditions that cause concentrated flow along the trench. Clean pipe perforations when one-half of them are plugged or if flows bypass or overflow the trench.

Manhole/Chamber: when the structure deteriorates to one-half its original size or it becomes structurally unsound, replace it to the design standards.

Follow the practice described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

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Manholes

Manholes are large cylindrical vaults usually set at storm sewer pipe connections. Unless you have OSHA approved training and equipment, never enter a manhole. There is a considerable risk of poisonous gas and injury.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R8 Prevent or reduce flooding.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect the manhole once per year. Check frame and lid for cracks and wear, such as rocking lids or lids move by traffic.

Periodically inspect the manhole and surrounding areas for pollutants such as leaks from dumpsters, minor spills, and oil dumping. Take action to have the pollutant source removed.

Cleaning

Clean manholes when there is a blockage of the stormwater channel. Cleaning should be performed in a way that ensures removed sediment and water is not discharged back into the storm sewer.

Safety

Never enter a confined space without proper training and safety gear. Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs

Repair all security and access features so they are fully functional. This includes locking lids, cover, and ladder rungs.

Replace broken parts or lids that rock or are moved by traffic.

Follow the practice described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

Oil/Water Separators and Buried Wet Vaults

An oil/water separator is an underground vault that treats stormwater by mechanically separating oil from water. The oil rises to the surface and floats on the water and sediment settles to the bottom. Buried wet vaults are similar to oil/water separators in that they are sub-surface vaults that separate sediment and floating materials from stormwater.

These facilities have special problems for maintenance and should be serviced by contractors. The main issues are working in confined spaces and properly handling any sludge and oil cleaned from vaults or oil/water separators. Manufacturer's recommendations for maintenance should be followed at a minimum.

Maintenance Results

R1 Avoid or minimize sediment and pollutant discharges from the work area.
R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
R7 Maintain or restore the intended infrastructure function.
R9 Protect infrastructure.

Procedures

Inspection

Periodically check stormwater flow out of the facility. It should be clear and not have a thick visible oil sheen.

Annually check for cracks large enough to let soil enter the vault, broken or defective plates and baffles, and crushed or damaged pipes.

Periodically inspect the surrounding areas for pollutants, such as leaks from dumpsters, minor spills, and oil dumping. Take action to the pollutant source removed.

Cleaning

Remove trash and litter from the vault, inlet, and piping.

Remove oil when it reaches one-inch thickness.

Remove sediment when it accumulates to 6-inches in depth.

Safety

Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid

Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs

Repair any cracked or defective plates or baffles. Cracks are repaired so that no cracks greater than ¼-inch are present. Repair any leaks that allow water levels to drop and cause oil to be washed from the unit.

Repair all security and access features so they are fully functional. This includes locking lids, covers, and ladder rungs.

Follow the practice described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

Flow Control Structures/Flow Restrictors

Flow control structures and flow restrictors direct or restrict flow in or out of a facility. Outflow controls on detention facilities are a common example where flow control structures slowly release stormwater at a specific rate. If these flow controls are damaged, plugged, bypassed, or not working properly, the facility could overtop or be releasing water at too high of a rate. This would likely damage streams habitat and property. Site plans should have detailed drawings showing how the flow control structures should appear. Consult a licensed professional engineer or the City of Camas Public Works Department for assistance.

Maintenance Results

R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
R7 Maintain or restore the intended infrastructure function.
R9 Protect infrastructure.

Procedures

Inspection

Inspect at least once per year for all features listed under Cleaning and Repairs, or when a facility does not drain properly or other problems occur.

Cleaning

Remove sediment within 18-inches of the bottom of an orifice plate.

Remove trash and debris that may block the orifice plate.

Remove any trash or debris that may bloc an overflow pipe.

Safety

Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs

Repair or replace to original design specification any outlet orifice that is enlarged, bypassed, or damaged.

Make certain that overflow outlets are not blocked.

Structures should be securely in place and within 10 percent of vertical.

Repair outlet pipe structures that have leaking connections or holes not specified by the design.

Repair or replace a non-functional or damaged cleanout gate.

Repair or replace damaged orifice plates to original design specification.

No outflow controls can be modified with approval of the City of Camas Public Works Department engineer.

Follow the practice described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

Storm Sewer/Drain Pipe

Storm sewer pipes convey stormwater. Storm pipes are constructed of many different types of materials and are sometimes perforated to allow groundwater to be collected by the storm system. Storm pipes are cleaned to remove sediment or blockages when problems are identified. Storm pipes must be clear of obstructions and breaks to prevent localized flooding.

Maintenance Results

- O1 Avoid or minimize sediment and pollutant discharges from the work area.
- O2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- O7 Maintain or restore the intended infrastructure function.
- O8 Prevent or reduce flooding.
- O9 Protect infrastructure.

Procedures

Inspection

Pipes are difficult to inspect requiring special equipment and training. Usually, if a problem occurs the owner needs to call a sewer of plumbing contractor to inspect, repair, or clean pipelines.

Cleaning

Clean pipes when sediment depth is greater than 20 percent of pipe diameter. When cleaning a pipe, minimize sediment and debris discharges from pipes to the storm sewer. Install downstream debris traps (where applicable) before cleaning and then remove material.

Generally, use mechanical methods to remove root obstructions from inside storm sewer pipes. Do not put root-dissolving chemicals in storm sewer pipes. If there is a problem, remove the vegetation over the line.

Safety

Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Sediment and debris from pipes should be disposed in the garbage as solid waste. Pick out any rocks first.

Repairs

Repair or replace pipes when a dent or break closes more than 20 percent of the pipe diameter.

Repair or replace pipes damaged by rust or deterioration.

Follow the practice described under the Activity: Installation, Repair, and Replacement of Enclosed Drainage Systems.

Underground Detention Systems

Some detention systems consist of underground tanks or vaults that are usually placed under paved areas. They hold and slowly release stormwater runoff from roofs and pavement.

Tanks and vaults are confined spaces where work requires special OSHA-required training and equipment.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect annually for the features listed under Cleaning and Repairs.

Periodically inspect the manhole and surrounding areas for pollutants such as leaks from dumpsters, minor spills, and oil dumping. Take action to have the pollutant source removed.

Cleaning

Remove trash and litter from the vault, inlet, and piping.

Clean air vents that have one-half of their area plugged.

Remove sediment when it accumulates to $1/10^{th}$ the depth of a rectangular vault or $1/10^{th}$ the diameter of a round tank or pipe.

Safety

Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs

Repair any cracked or defective plates or baffles. Cracks are repaired so that no cracks greater than ¼-inch are present.

Any part of a tank or pipe that is bent out of shape more than 10 percent of its design shape must be replaced or repaired.

Repair any joints that are cracked and allow soil into the facility.

Repair all security and access features so they are fully functional. This includes locking lids, covers, and ladder rungs.

Follow the practice described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

Operation & Maintenance Procedures

Special Facilities

Public & Private Systems

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Drywells

Drywells are perforated, open-bottomed manholes used to infiltrate stormwater into the ground. While not the intended use, drywells trap sediment and some of the oil pollutants in stormwater runoff. Drywells are more likely to fill with oily sediment in areas that lack swales or other treatment facilities. Fine oil sediment can clog drywells and lead to localized street flooding. Also, pollutants discharged into drywells can migrate into groundwater. Drywells were often installed in closed topographic depressions, areas with will-drained soils, or areas having inadequate storm sewers. Often, drywells contain groundwater.

Maintenance Results

R1 Avoid or minimize sediment and pollutant discharges from the work area.
R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
R7 Maintain or restore the intended infrastructure function.
R8 Prevent or reduce flooding.
R9 Protect infrastructure.

Procedures

Inspection

Drywells should be inspected at least once a year and no less than once every five years.

Periodically inspect the manhole and surrounding areas for pollutants such as leaks from dumpsters, minor spills, and oil dumping. Take action to have the pollutant source removed.

If a problem with flooding or slow drainage occurs, observe or inspect the drywell for infiltration rate and observe water level depths if monitoring wells are installed.

Cleaning

Clean out drywells when sediment depth is greater than 1/3 of the distance between the vase and inlet pipe.

Drywell cleaning should be performed in a way that makes certain removed sediment and water is not discharged back into the storm sewer.

Safety

Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs
If the drywell does not dissipate stormwater, it should be replaced or repaired.

It is possible to restore some drywell capacity by water-jetting clogged openings.

Another option is installing a new drywell or drainage trench, and converting the clogged drywell into a sediment trap. This has the advantage of providing a sediment trap and some amount of spill trapping. The sediment trap conversion requires grouting the holes, covering the base with concrete, and adding piping. Alterations to any storm facility **cannot** be done without approval from the City of Camas.

If there is standing water in a drywell, it probably is into the water table. Drywells in the water table should be rebuilt to prevent stormwater from going directly into groundwater.

Repair all security and access features so they are fully functional. This includes locking lids, covers, and ladder rungs.

Follow the practice described under the Activity: Installation, Repair, and Replacement of Enclosed Drainage Systems.

StormFilter™ (Leaf Compost Filter)

The StormFilter is a patented system for treating stormwater. The systems have evolved during the last 10 years from very simple above ground filter beds to a variety of vault devices containing cylindrical filters filled with leaf compost pellets. StormFilter facilities consist of cartridges filled with one or a combination of media. Media can be selected to target pollutants specific to a particular site. The cartridges are housed in pre-cast or cast in-place concrete vaults or in a steel catch basin configuration. Each configuration uses baffles to promote settling of solids and separation of oils and other floatable materials. The majority of pollutants are captured by the media and held in the cartridges. Some additional settling will occur in the inlet and cartridge bays of each vault.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect the StormFilter every six months. The inspection should determine sediment depth and the specific maintenance and repairs needed.

Inspect annually for cracks large enough to let soil enter the vault, broken or defective plates and baffles, and crushed or damaged pipes.

Periodically inspect the manhole and surrounding areas for pollutants such as leaks from dumpsters, minor spills, and oil dumping. Take action to have the pollutant source removed.

Cleaning

Remove trash and litter from the vault, inlet, and piping.

Remove sediment when it accumulates to 6-inches in depth in settling chambers.

Remove sediment when it accumulates on filter media.

Replace media cartridges per manufacture's recommendation.

Safety

Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid

Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs

Repair any cracked or defective plates or baffles. Cracks are repaired so that no cracks greater than ¼-inch are found.

Replace media cartridges if it takes longer than an hour for water to empty through media or if water frequently overflows the treatment chamber. Replace defective cartridges.

Repair all security and access features so they are fully functional. This includes locking lids, covers, and ladder rungs.

Follow the practice described under the Activity: Installation, Repair, and Replacement of Enclosed Drainage Systems.

Infiltration Systems (work in-progress)

Due to the dominance of clay soils within the City of Camas, infiltrations systems are not allowed, except on a case-by-case basis.

Maintenance Results

R1 Avoid or minimize sediment and pollutant discharges from the work area.
R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
R7 Maintain or restore the intended infrastructure function.
R10 Meet public expectations for aesthetics

Procedures

Inspection

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Operation & Maintenance Procedures

Miscellaneous Activities

Public & Private Systems

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Fences, Gates, and Water Quality Signs

Fences are installed around the perimeter of storm sewer facilities as a means of protecting the public, as they restrict entrance to the facility. Gates are installed to allow for maintenance access. Gates will be secured shut, typically with a double lock system that allows access to the City and to the property owner's maintenance crew.

Water Quality Signs are installed on the fences, or on sign poles, within public view as a means of educating the public as to the presence of a storm sewer facility. These signs also have a number located in the upper right hand corner that is cross referenced, at the City, to an address and maintenance responsibility.

Maintenance Results

R5 Protect public safety and health.
R7 Maintain or restore the intended infrastructure function.
R9 Protect infrastructure.

Procedures

Inspection

Inspect fences, gates, and water quality signs during facility maintenance.

Repairs

Repair any opening that allows entry into the facility, including access beneath the fence.

Replace any missing gates.

Repair broken gate hinges or gates which do not close and lock properly.

Replace any missing signs or signs that have more than a 20 percent unreadable surface.

Repair sign posts that lean more than 8-inches off vertical.

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Access Roads and Easements

Most stormwater facilities have access roads to bring in heavy equipment for facility maintenance. These roads should be maintained for inspection access and ease of equipment access.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

Inspect once a year or when facilities are maintained.

Cleaning

Remove litter when mowing or when there is any accumulation.

Remove any debris that blocks roads or may damage tires.

Vegetation Management

Manage vegetation as for the rest of the facility. Trees and shrubs may be removed from access roads and easements if they block access for necessary maintenance or will prevent or harm intended stormwater facility function. Use of pesticides is prohibited unless prior approval is received from the City.

Repairs

Correct any bare or eroded soils by seeding or a cover BMP.

Repair road surfaces when they may lead to erosion or limit equipment access.

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Pavement Sweeping

Pavement sweeping is performed as a means of removing sand, dirt, and litter from streets and curb gutters. Sweeping also reduces dust during dry weather. Pavement sweeping is also part of storm sewer maintenance procedure because it limits the amount of sediment washed into the storm sewer facilities. The water quality procedure for street sweeping focuses on sediment removal and disposal. Reducing the amount of sediment washed into catch basins, curb inlets, detention facilities, drywells, and other facilities can save money because sweeping is generally cheaper that removing sediment from facilities. Sweeping also helps protect facilities from clogging with sediment.

Maintenance Results

- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R5 Protect public safety and health.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

Inspect on a weekly basis, depending on traffic volumes.

Cleaning

Sweep the site to help keep sediment from entering storm sewer systems and water bodies.

Sweeping is especially useful for cleaning up work areas.

Sweeping can be as easy as using a couple of push brooms or as involved as using mechanical methods.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Sweepings should be disposed of as solid waste or under a program permitted by the Southwest Washington Health District.

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Operation & Maintenance Procedures

Enclosed Storm Sewers System

Public & Private Systems

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Installation, Repair, and Replacement of Enclosed Drainage Systems

This chapter includes tasks such as repair and replacement of pipe, catch basins, drywells, and manholes. It also includes drainage projects that add new pipes, catch basins, or infiltration structures. New drainage projects are subject to regulations under CMC 15.36 Erosion/Sediment Control Plans.

Maintenance Results

R1 Avoid or minimize sediment and pollutant discharges from the work area.
R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
R7 Maintain or restore the intended infrastructure function.
R8 Prevent or reduce flooding.

Procedures

Cleaning

Avoid or minimize vegetation removal. If work is near a stream or wetland, there are regulatory requirements to must be met.

Prevent debris, oils, cleaning agents, and sediment from entering waterways.

Avoid or minimize work in wet weather. This will reduce the problems of containing sediment.

Carry spill control kit on-site to contain and clean up possible small spills in the work area, e.g. oil spills.

Protect our storm systems:

- Install sediment traps around curb inlets and catch basins, e.g. biobags or gravel filled pillows.
- Install catch basin inserts.
- Sweep or vacuum dust and debris from the repair job. Do not wash materials into storm sewers.
- Place stockpiles away from drainage ways, wetlands, and natural wetland and habitat buffers. Cover stockpiles or contain them with berms or other containment devices.
- At stream crossings, trap material using screens or another approved form of containment. Use containment BMP's to protect roadside ditches during wet weather.

Ensure that along with the approved erosion/sediment control measures that are in-place prior to construction, that there is an emergency sediment control kit for unexpected problems; e.g. trench dewatering. This should include:

- Sediment bag,
- Additional biobags and catch basin inserts,
- Push brooms and flat edge shovels.

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Minor Culvert Repair (not in a natural stream)

This activity is for the replacement or repair of culverts and inlets. It applies only to structures that are in ditches that are specifically for storm drainage. These are ditches that do not carry water during dry weather. If there is any question about whether the ditch is a storm drain or a stream, consult with the Washington Department of Fish and Wildlife and the City of Camas Public Works Department.

Maintenance Results

R1 Avoid or minimize sediment and pollutant discharges from the work area.
R3 Avoid or minimize vegetation removal.
R7 Maintain or restore the intended infrastructure function.
R8 Prevent or reduce flooding.
R9 Protect infrastructure.

Procedures

Comply with erosion/sediment control requirements in CMC 15.32.

Avoid or minimize vegetation removal. If work is near a stream or wetland, there are likely to be regulatory requirements.

Other than to address a threat to public safety or property due to flooding, perform work during the dry season.

Minimize soil disturbance.

Use sediment controls to trap any sediment and prevent sediment from entering the storm sewer and water bodies. Sediment trapping BMP's are to be used to the extent practical during emergencies. An emergency sediment control kit is highly recommended.

Use cover BMP's to prevent erosion of bare soil. Vegetate bare soils.

Major Culvert Repair (at a Stream Crossing)

This activity is the replacement or repair of culverts and inlets bridging a stream or ditch with flowing water during dry weather. If there is any question about whether the ditch is a storm drain or a stream, consult the Washington Department of Fish and Wildlife and the City of Camas Public Works Department.

These projects must meet all regulatory requirements.

- SEPA
- Shoreline
- HPA Permit
- Flood Plain

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Operation & Maintenance Procedures

Vegetation Management

Public & Private Systems

April 2009

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General Goals and Philosophy

The City of Camas recognizes the special importance of the rivers, streams, wetlands, ponds, and stormwater control and treatment facilities. The sensitive nature of such habitat, their plant and animal communities, and their direct link with other waterways require that we establish specific policies to ensure their health. All landscape management decisions for controlling unwanted vegetation, diseases, and pests should follow Integrated Pest Management (IPM) principles and decision-making rationale. These are as follows:

- Proper planning and management decisions begin the IPM process.
- Cultural methods of vegetation and pest control are preferred and are first employed.
- Mechanical means of vegetation and pest control are next in line of preference, and are utilized where feasible.
- Biological methods of vegetation and pest control are considered before chemical means, where they are feasible.
- Botanical and synthetic pesticides are used only when no other feasible methods exist.

General Procedures

Use Only Appropriate Plants

The City of Camas has adopted a list of approved plants for use in development projects, and to assist homeowners in choosing appropriate plantings. The list also has prohibited undesirable plants. Only plants approved for use on the City of Camas Plant List are allowed for use within the City's right-of-way, storm sewer facilities, and wetland buffers.

Mulching

Mulches and other ground coverings are useful during the installation and restoration of landscapes as well as their ongoing maintenance. Mulches meet a variety of needs. They suppress weeds, help to retain moisture around plants, reduce possible erosion, and provide visual enhancement.

Always consider the possible impacts when using mulches, which may include:

- Inadvertent introduction of non-native plants and diseases to the site.
- Leaching of substances such as tannins from the mulch into nearby waterways.
- Migration of mulch material in waterways.
- Nutrient leaching into waterways.

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Vegetation and Pest Management in Storm Sewer Facilities

Storm sewer facilities include biofiltration treatment swales, treatment wetlands, treatment ponds, detention ponds, open channels, and infiltration basins. Stormwater control facilities discharge to surface water or groundwater directly or through pipes or ditches. Facilities are built to remove pollutants and to control the discharge rate of stormwater.

Generally, vegetation should be maintained to blend into surrounding areas. Storm sewer facilities can also provide habitat for birds, amphibians, and other aquatic life. Promoting native vegetation, where feasible, improves habitat. Swales often blend into intensively managed landscapes. Pond perimeters can include native vegetation.

The use of pesticides, and in most cases fertilizer, is not compatible with the task of pollutant removal or where there is a direct discharge of stormwater to streams and groundwater.

Features of Storm Sewer Facilities:

- There is a mix of native and non-native plants.
- Generally not used by the public.
- Include areas managed to promote design function, such as turf in swales.
- Managed landscapes may be nearby.
- May be used by fish and wildlife.

Objectives for Storm Sewer Facilities:

- Maintain healthy plant communities.
- Avoid or minimize need for chemical intervention.
- Control invasive plants where feasible.
- No bare soil areas are allowed.
- Tolerance for natural appearance and weeds.

Procedures

The vegetation management focus is in establishing and maintaining healthy low-maintenance native plantings and sustaining the design function of vegetated filters, such as biofiltration swales. This includes controlling invasive plants where feasible, and planting cover on bare soils.

Only use plants on the City of Camas approved plant list.

In some cases, the original plantings may not be appropriate for the actual conditions at a facility. One example is a frequently flooded swale that cannot support normal turf. In cases like this, replace turf with appropriate wetland plants if the underlying drainage problem cannot be fixed.

Consider the use of soil amendments, such as compost before using fertilizer.

Limit mulch use to covering bare soil while establishing plantings.

Chemical use should be avoided within 25 feet of any area that holds or conveys surface water or stormwater. This includes the base of a biofiltration swale.

Trees or shrubs that hinder accessibility to access roads may be trimmed (or removed if within the access road) when access is required for maintenance by heavy equipment.

Trees that pose a risk to stormwater structures due to root growth should be removed and replaced by smaller shrubs.

Vegetation and Pest Management in Wetland Areas

Constructed wetlands are built to treat stormwater. As water bodies, treatment wetlands connect to streams and groundwater. Constructed wetlands also play host to insects, fish, amphibian, and birds that are sensitive to horticultural chemicals. Because of this, chemical use should be avoided or minimized in wetland buffers. Wetland management has a low tolerance for invasive or non-native plants.

Procedures listed here apply only to those parts of a constructed wetland that are not subject to inundation or saturation during the growing season.

Features of Constructed Wetlands:

- Limited public access.
- Plants may or may not be well established, depending on age and condition.
- May provide fish and wildlife habitat.

Objectives for Constructed Wetlands:

- Maintain health plant communities.
- Avoid or minimize need for chemical intervention.
- Low tolerance of invasive and non-native plants.
- Bare soil areas are not allowed.

Procedures

There should be a plan for establishing and maintaining vegetation in a newly constructed wetland facility. If there is a plan, follow it. If there is not a plan, follow these Procedures. Maintenance focuses on establishing and sustaining healthy native plantings. This includes more vigorously controlling invasive plants. It also includes covering for bare soil.

Only use plants on the City of Camas approved plant list.

Consider the use of soil amendments such as compost before using fertilizer.

Limit mulch use to covering bare soil while establishing plantings.

Chemical intervention is to be minimized and is to be avoided, whenever possible, within 25 feet of areas subject to inundation during the growing season.

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Operation & Maintenance Procedures

Example "Storm Sewer System Maintenance Notification"

Public & Private Systems

April 2009

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CITY OF CAMAS
STORM SEWER SYSTEM MAINTENANCE NOTIFICATION

Date Inspected: _____
Facility Name (subdivision/commercial/industrial): _____
Address or Location: _____
Contact Information: _____
Complete Maintenance by: _____ Re-inspected on: _____

TYPE OF FACILITY:

Detention Pond: Wet _____ Extended Dry _____ Other _____

Water Quality Swale: Yes No Wetlands in Vicinity: Yes No Possible

Other Comments: _____

GENERAL LOCATION SKETCH: Show approximate dimensions, north arrow, structure locations, access location, name of nearest road, etc. As-Builts Available: Yes No

Facility Check List:

Item	Yes	No
Located Access		
Located Inlet		
Located Outlet		
Located Orifice		
Slopes (Note Excess)		
Fenced / Gated		
Needs a Lock		
1-3 Photos Taken		
Outlet Type: Standpipe, Grated, Pipe, Open Channel, Other		
Other Comments:		

GENERAL MAINTENANCE NEEDS:

Mowing Ability: _____% Weed Eater Ability (due to fence/steep slopes): _____%

Remove the following: Blackberries Scotch broom Thistle Trees in Pond/Swale Cattails

Silt Removal Needed: Yes No If Yes, From: Inlet / Outlet Structure Pond / Swale

Inlet Protection: Adequate / Inadequate Outlet Protection: Adequate / Inadequate

Overflow Protection: Adequate / Inadequate Protection Needs: additional rock / vegetation removal

Trash Debris and/or Vegetation Removal Needed: Yes No

Erosion Damage: Severe Minor None Recommended Repairs: _____

_____

Vegetation: Dense Average Sparse Needs: Replacement Additional Seeding

Additional Work Needed After Initial Vegetation Removal: yes / no

Description: _____

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PRE-APPLICATION MEETING NOTES
18th Avenue Subdivision
PA22-03

Thursday, January 6, 2022
3:30pm, City Hall (meeting via zoom)
616 NE 4th Ave. Camas, WA. 98607

Applicant:	Gayle Gerke Olson Engineering, Inc.
City of Camas:	Lauren Hollenbeck, Senior Planner Robert Maul, Interim Community Development Director Anita Ashton, Engineering Project Manager Brian Smith, Building Official Randy Miller, Fire Marshall
Location:	3010 NW 18th Avenue Camas, WA 98607 Parcel Numbers: 127356000, 127359000, 127439000
Zoning:	R-7.5 (Single-Family Residential)
Description:	The applicant is proposing to subdivide 9.69-acres into 33 single-family residential lots.

NOTICE: Notwithstanding any representation by City staff at a pre-application conference, staff is not authorized to waive any requirement of the City Code. Any omission or failure by staff to recite to an applicant all relevant applicable code requirements shall not constitute a waiver by the City of any standard or requirement. [CMC 18.55.060 (C)] This pre-application conference shall be valid for a period of 180 days from the date it is held. If no application is filed within 180 days of the conference or meeting, the applicant must schedule and attend another conference before the City will accept a permit application. [CMC 18.55.060 (D)] Any changes to the code or other applicable laws, which take effect between the pre-application conference and submittal of an application, shall be applicable. [CMC 18.55.060 (D)]. A link to the Camas Municipal Code (CMC) can be found on the City of Camas website, http://www.cityofcamas.us/ on the main page under "Business and Development".

PLANNING DIVISION **LAUREN HOLLENBECK (360) 817-7253**

An application for a subdivision is considered a Type III permit. Applicable codes for this proposal include Title 16 Environment, Title 17 Land Development and Title 18 Zoning of the Camas Municipal Code (CMC), which can be found on the city website. Please note it remains the **applicant's responsibility** to review the CMC and address all applicable provisions. The following pre-application notes are based on application materials and site plan submitted to the City on December 14, 2021:

Application Requirements

Your proposal will need to comply with the general application requirements per **CMC Section 18.55.110** in addition to the specific applicable application requirements outlined in **CMC Section 17.11.030.B** for a preliminary subdivision plat. The following is an excerpt from the requirements of CMC Section17.11.030.B (see code section for full text):

1. A completed city application form and required fee(s);

Fees will be based on the adopted fees at the time of land use application submittal. The current fees include the following:	
1. Preliminary Plat	$7,175 + $250 per lot
2. SEPA	$810.00
3. Critical Areas Review *(for each type)*	$775.00
4. Archaeological Review	$137.00
5. Fire Department Review	$354.00
Fees for building permit are collected at the time of the building permit submittal. Fees for engineering are collected at time of engineering plan approval.	
6. Building Permit and Plan Review	based on the valuation of the project
7. Engineering Review	3% of estimated construction costs

2. A completed and signed SEPA checklist;
3. Complete applications for other required land use proposals applicable to the proposal;
4. A vicinity map showing location of the site;
5. A survey of existing significant trees as required under CMC Section 18.13.045;
6. All existing conditions shall be delineated on the site plan per CMC Section 17.11.030.B.6(a-p);
7. A preliminary grading plan as slopes are greater than ten percent;
8. Preliminary stormwater plan and report;
9. A geotechnical report consistent with CMC Chapter 16.59 if development is proposed on slopes greater than ten percent
10. A copy of the Clark County assessor's map which show the location of each property within 300 feet of the subdivision;
11. One set of mailing labels for all property owners as provided in CMC Section 18.55.110;
12. A traffic study
13. A narrative addressing ownership and maintenance of open spaces, stormwater facilities, public trails and critical areas, and the applicable approval criteria (CMC Section 17.11.030.D) and standards of the Camas Municipal Code. It should also address any proposed building conditions or restrictions.
14. A development sign must be posted on site per CMC Section 18.55.110.H (1-5).
15. Necessary drawings and reports- three sets and an electronic copy (send as a PDF by email or on a disc). All documents and reports must be submitted as separate pdf copies.

Preliminary Plat

The following comments are based on the site plan materials submitted with this Pre Application:

1. The preliminary plat drawings must meet the density and dimensional standards for lots in a Single-Family Residential (R-7.5) zone, and infrastructure improvements (i.e. roads, easements, etc.).
    a. "Front lot line" means the lot line separating the lot from a street. "Front Yard" means an open space between side lot lines and measured horizontally, from the front lot line at right angles to the front lot line, to the nearest point of the building. The front yard setback shall be measured from NW 17th Avenue for Lot 19.

2. There is a one-time exception for division of land, which does not conform to the City's density standards. Per CMC 18.09.040 Table 1 (Note 3), "*For parcels with an existing dwelling, a one-time exception may be allowed to partition from the parent parcel a lot that exceeds the maximum lot size permitted in the underlying zone. Any further partitioning of the parent parcel or the oversized lot must comply with the lot size requirements of the underlying zone*." This criterion can be used to create the proposed lot size for the existing residential home.
3. Per CMC 18.09.080.B, the lots along the eastern boundary line shall be the maximum lot size of 12,000 square feet, as the property abuts a lower density residential zone to the east. In applying this section, where a land division is required to increase the size of lots, the land division may utilize the density transfer provisions in CMC 18.09.040.B Table 1 (i.e. min. lot size 5,250 sq.ft. and max. lot size is 9,000 sq.ft., 60-ft wide, 80-ft. depth).
4. Density calculation is based on development/net acreage which is defined as the total land use development exclusive of open space and critical areas.
5. Building setback requirements are found at CMC 18.09.040-Table 2, which includes the requirement for setbacks to be drawn on the plat. Per Note 2, *"Garage setback is five feet behind the front of the dwelling."*
6. The side lot lines of lots 7-11, 28, 31 and Tract C shall be radial to curved streets per CMC 17.19.030.D.2.
7. Building envelopes (setbacks) shall be shown on the preliminary and final plats. Per CMC Section 17.19.030.D.3.a, a 40ft. by 40ft. square dwelling should be able to fit within the building envelope.
8. Each dwelling unit within a new development shall be landscaped with at least one tree per CMC 17.19.030.F.
9. Per CMC 17.19.040.B.1.c, if the average lot size is less than 7,500 square feet, one additional off-street parking space is required for every 5 units and shall be located within a common tract.
10. Per CMC 17.19.040.B.10.a, a Circulation plan is required at application that includes the subject site and properties within six hundred feet showing topography, critical areas and existing and proposed streets, trails, etc. Streets shall extend to and connect with neighboring properties per CMC 17.19.040.B.6.a.
11. The storm drainage facility shall include a 10-foot L2 landscape buffer per CMC 17.19.030.F.6.
12. The location and height of any retaining walls shall be shown on the grading plan. Retaining wall height requirements are found in CMC 18.17.060.

Landscaping Regulations and Tree Retention

Landscaping standards shall apply to all new land divisions per CMC 18.13.020.B.1. A Landscape, Tree and Vegetation plan must be submitted pursuant to CMC 18.13.040.A. If trees are proposed for removal, a Tree Survey is required per CMC 18.13.040.B and must be prepared by a certified arborist or professional forester pursuant to the requirements outlined in CMC 18.13.045. A minimum 20-unit tree density per net acre is required and needs to be incorporated in the overall landscape plan per CMC 18.13.051.A.

Critical Areas Review

Clark County GIS mapping identifies geologically hazardous areas (i.e. steep slopes) have been identified on the subject property. As such, per CMC Section 16.51.130, a critical areas report prepared by a qualified professional is required if a proposed development is within or adjacent to a critical area. The general requirements for a critical areas report are found in CMC Section 16.51.140. The City's code contains additional requirements for each type of critical area.

- The critical areas report requirements for Geologically Hazardous Areas are found in CMC 16.59.060 and 16.59.070.

SEPA

The proposed development is not categorically exempt from the requirements of the State Environmental Policy Act (SEPA) per CMC Section 16.07.020.A as the proposed is more than ten residential units and contains environmentally sensitive areas per CMC 16.07.025.C. The current SEPA environmental checklist is on the website.

Archaeological Review

The site is located in an area of high probability for the presence of archaeological objects. As such, an archaeological predetermination report is required consistent with the requirements of CMC 16.31.070.A. Submit proof of mailing or emailing the tribes per CMC 16.31.160.

ENGINEERING DIVISION ANITA ASHTON (360) 817-7231 aashton@cityofcamas.us

General Requirements:

1. Civil site construction plans shall be prepared by a licensed Washington State Engineer in accordance with the *Camas Design Standards Manual (CDSM)* and CMC 17.19.040.
2. Per CMC 17.19.040.C.1 all utilities designed to serve the development shall be placed underground. This includes the dry utilities, such as power, fiber optics, cable, etc.
3. *Engineering civil site improvements plans are not to be submitted until after land-use decision is issued.*
4. Engineering civil site improvement plans are to be submitted to Community Development (CDev) Engineering Dept. for review and approval.
5. CDev engineering is responsible for plan review (PR) and construction inspection (CI).
6. A 3% PR&CI fee is collected by CDev engineering for all infrastructure improvements.
    a. A stamped preliminary engineer's estimate shall be submitted to the CDEV Engineering Dept prior to or with submittal of plans for first review.
        i. The first review submittal shall consist of three (3) full size sets and one (1) half size set of the engineering plans, and one (1) hard copy of the preliminary TIR.
    b. Payment of the 1% plan review (PR) fee shall be due prior to start of first review.
    c. Payment of the 2% construction inspection (CI) fee shall be due prior to construction plan approval and release of approved plans to the applicant's consultant.
    d. Under no circumstances will the applicant be allowed to begin construction prior to construction plan approval.
7. *Final acceptance is issued by the Community Development Engineering department.*
8. *Per CMC 17.21.060.H Except for one sales office or one model home, building applications will not be accepted until after Final Acceptance has been issued for all infrastructure improvements.*
9. Any existing wells, septic tanks, and septic drain fields shall be decommissioned in accordance with State and County guidelines per CMC 17.19.020 (A3).
10. The applicant will be required to purchase all permanent traffic control signs, street name signs, street lighting, and traffic control markings for the proposed development.
11. Regulations for installation of public improvements, improvement agreements, bonding, final platting, and final acceptance can be found at CMC 17.21.
12. The applicant will be responsible for ensuring that private utilities; underground power, telephone, gas, CATV, interior street/parking lighting, and associated appurtenances are installed.

Traffic/Transportation:

1. A full transportation impact study (TIA) is required as the proposed development will result in an excess of 200 vehicle trips per day (VPD).
2. Current ITE manual is the 11th Edition.
3. The Applicant will be required to have a traffic engineer analyze the following:
   a. Site distance access(es) at:
      i. NW 17th Avenue and NW Hancock Drive.
      ii. NW 16th Avenue and NW Hood Street.
   b. A traffic circulation plan showing ingress and egress, per CMC 17.19.040 (B.10.a).
   c. Address movement conflicts with nearby intersections, left-turn pocket analysis at NW 16th Avenue & NW Hood Street, NW 18th Avenue & NW Hancock Drive, and applicable private driveways.
   d. Provide trip AM and PM Peak trip distribution to and from the site. Offsite intersections to be analyzed, if any, will be based on the trip distribution out to a threshold of 20 new trips per intersection.

Streets:

1. The proposed development fronts NW 18th Avenue, NW Hood Street, and NW 16th Avenue. All three roads are identified as a 2 or 3 lane arterials per the City's 2016 Comp Plan. Except that NW 16th Avenue, east of NW Hood Street, is classified as a local roadway.
   a. Answer to consultant question regarding how is it determined when an arterial/collector is 2 or 3 lanes: In general, arterials and collectors, once fully improved, are required to be three lanes based on the need for left turn pockets and two-way turn lanes.
2. Per CMC 17.19.040.B.5, the applicant will be required to dedicate up to 37-feet of right-of-way from the centerline of each road for frontage improvements along NW 18th Avenue and NW Hood Street.
   a. Dedication of additional right-of-way on NW 16th Avenue, east of NW Hood Street, will be based on Table 17.19.040-2 Minimum Public Street Standard 'A'.
3. Per CMC 17.19.040.B.1, the applicant will be required to construct half-width street improvements along the three frontages, NW 18th Avenue, NW Hood Street, and portion of NW 16th Avenue.

[NW 16th Avenue – east of NW Hood Street]:

4. There is an existing driveway that extends from the intersection with NW Hood Street to the easternmost end of the proposed improvements, which provides access to the following parcels:
   a. PIN 92233002, 3220 NW 16th Avenue
   b. PIN 92233004, 3102 NW 16th Avenue
   c. PIN 127429000, 3018 NW 16th Avenue
5. Per CMC 17.19.040.B.5 the applicant is to provide ample right-of-way dedication to the east to allow access for future development of parcel 127429000. The existing driveway for said parcel is located within the applicant's proposed Tract F Open Space.
   a. Half-width street improvements, east of NW Hood Street, are to be extended to the westernmost property line of parcel no. 127429000.
   b. The applicant will be required to provide continuous access to the parcel located to the south of proposed Tract F, as the existing driveway is located within proposed Tract F.

[Proposed Private Road Tract 'B']:

6. Per CMC Table 17.19.040-1 Minimum Private Street Standards 'C' for access to five or more dwelling units, greater that 100-feet and less than 300-feet in length requires a 42-foot wide tract, 28-foot paved surface, and planter strip and sidewalk on the north side and cul-de-sac only.
   a. As shown, proposed Tract 'B' meets CMC Table 17.19.040-1 Minimum Private Street Standards 'C' .

b. The applicant will be required to provide for signage for towing services and noted on the plat and in the CC&R's.

[Proposed NW 17th Avenue]:

7. Per CDSM Table 3 Access Spacing Standards the minimum access spacing allowed on a local roadway from a collector is 110-feet.
    a. NW 16th Avenue, east of NW Hood Street, is classified as a local roadway.
    b. The proposed access off NW 16th Avenue is approximately 200-feet east of the intersection of NW 16th Avenue and NW Hood St. This meets the minimum access spacing standards.
    c. Proposed NW 17th Avenue is proposed at a public roadway in accordance with Table 17.19.040-2 Minimum Public Street Standards.
8. Private access roads/driveways in excess of 150-feet, as measured from the centerline of the adjacent road will provide a dead-end turnaround. Applicant to work with staff to provide a turnaround that meets the requirements of the Fire Marshal Office (FMO).
9. Private access roads/driveways are to install FMO approved address monuments at the right-of-way adjacent to the private road/driveway.
10. The applicant will be required to improve the intersection of NW Hood Street and NW 16th Avenue, as follows:
    a. NW 16th Avenue, from the east, is to be 90-degrees, or perpendicular, to the curve.
    b. The centerline radius is to meet the minimum radius for a 3-lane arterial, per Table 2 – General Guidelines for Geometry of a Public Roadway.
    c. The curb radii for both corners at NW 16th Avenue and NW Hood Street are to meet the collector standard.
11. Street tree planting is required in accordance with CMC 17.19.030 (F).
12. LED street lighting is to be installed along all street frontages within and adjacent to the proposed development, in accordance with CDSM.
13. Private streets, with street lighting, are to have separate meters and the maintenance of all lights and power will be the responsibility of the Owner/Homeowner's Association.

<u>Stormwater:</u>

1. The site of the proposed development is approximately 8.96 acres after boundary line adjustment.
2. A preliminary stormwater report (TIR), in accordance with the latest edition of Ecology's *Stormwater Management Manual for Western Washington (current edition 2019 SWMMWW*), is required at time of application.
3. Per CMC 14.02 Stormwater Control, stormwater treatment and detention shall be designed in accordance with the latest edition of Ecology's *SWMMWW*.
4. Refer to Ecology's Figure I-3.*2 Flow Chart for Determining Requirements for Re-Development (Vol. I, Chapter 3)* and the Camas Stormwater Design Standards.
    a. All redevelopment projects shall comply with Minimum Requirement (MR) #2 – Submittal of a Stormwater Pollution Prevent Plan (SWPPP).
    b. As the project results in 5,000 sf, or greater, of new plus replaced hard surface area; than Minimum Requirements (MR) #1- #9 will apply.
5. Ownership and maintenance of onsite stormwater facilities will be the responsibility of the property Owner/HOA, per CMC 17.19.040 (C3).
6. The City shall have right-of-entry for inspection purposes.
7. Onsite private storm easements are to be shown on the construction drawings.
8. A designated concrete washout area (BMP C154, Vol. II, Chap. 3, pgs. 320-326) is to be shown on the site plans. The concrete washout area is to be removed prior to issuance of occupancy for the last residence constructed.

Erosion Control

1. The size of the proposed development is approximately 8.96 acres after boundary line adjustment.
2. Per CMC 17.21.030.B an erosion and sediment control (ESC) bond, in the amount 200% of the engineer's estimate for ESC measures, is to be submitted prior to any land-disturbing activities.
3. As the land-disturbing activities are greater than one acre, the applicant will be required to obtain an NPDES Construction Stormwater General Permit from Ecology, which includes the Stormwater Pollution Prevention Plan (SWPPP). Copies of both are to be submitted to engineering prior to any land-disturbing activities.
4. The applicant will be responsible for all erosion and sediment control measures to ensure that sediment laden water does not leave the site or impact adjacent parcels.
5. Mud tracking onto the road surface is discouraged and any mud tracking is to be cleaned up immediately.

Water

1. There is an existing 12-inch ductile iron water main located in NW 16th Avenue and NW 18th Avenue.
2. The City's Water System Plan Extension identifies the extension of the 12-inch water main from the intersection of NW 16th Ave. & NW Hood St. east to the Haven Heights aka Hancock Springs subdivision.
    a. A 12-inch main connection from NW Hood Street to the 1600 block in the Haven Heights subdivision will be required.
    b. Staff will coordinate with the applicant regarding upsizing the proposed waterline.
    c. The 12-inch waterline is SDC creditable.
3. The applicant will be required to design and construct a minimum 8-inch diameter water main connection thru the proposed development from NW 16th Avenue northeast to the 8-inch diameter water main to be located at the intersection of the future NW 17th Avenue & NW Hancock Drive.
4. The Applicant shall provide a separate service and water meter to each of the lots located within this development.
5. A water sampling station will be required.
6. Applicant shall demonstrate that there are adequate fire flows available for the development.
7. A 10-foot separation shall be maintained between water and sanitary sewer lines within the right-of-way and within the private roadway.
    a. A utility access and maintenance easement shall be provided over and under said utility to the city when located within the private roadway.
8. The tap on the existing waterline is to be performed by a tapping Contractor approved by the City's Water/Sewer Dept. Approved list provided below.

Sanitary Sewer:

1. There is an existing 4-inch pressurized sewer main located in NW 16th Avenue, NW Hood Street, and NW 18th Avenue.
2. The applicant will be required to design and construct a new STEP sewer main to serve the proposed development with 1-inch laterals provided to each lot.
3. The applicant will be required to provide and record a utility access and maintenance easement, to the city, across the new private roads.
4. At the time of single-family residential construction, each lot will be required to provide and install STEP tanks.
    a. The STEP tank is to be per CDSM STEP Tank Details.
    b. The STEP tank is to be installed by a certified Roth tank installer.
5. The applicant will be required to provide a right-of-entry to the City for maintenance of the STEP tank and the STEP tank is to be located such that the City has access for maintenance and pumping.

6. A 10-foot separation shall be maintained between water and sanitary sewer lines within the right-of-way and within the private roadway.
    a. The applicant will be required to provide a utility access and maintenance easement over and under said utility to the city when located within the private roadway.
7. The tap on the existing STEP main is to be performed by a tapping Contractor approved by the City's Water/Sewer Dept. Approved list provided below.

City Approved Tapping Contractors:

1. A&A Drilling Services, Inc (water & pressure sewer):
   16734 SE Kens Ct. #B, Milwaukie, OR 97267, 800-548-3827,
   http://www.aadrilling.com
2. Ferguson Waterworks (water only):
   14103 NW 3rd Court, Vancouver, WA 98685, 360-896-8708, https://www.ferguson.com/branch/nw-3rd-ct-vancouver-wa-waterworks

Parks/Trails:

1. Not applicable

Impact Fees & System Development Charges (SDCs):

1. The proposed development is in the South District.
2. Impact Fees and SDCs are collected at time of building permit issuance.
3. The impact fees and SDCs noted below are for informational purposes only.
4. Impact fees and SDCs are adjusted on January 1st of each year.

Impact Fees for 2022:

1. Single Family Detached:
    a. Traffic Impact Fees - $3,657.00
    b. School Impact Fees (SIF) (Camas) – 5,371.00
    c. Park/Open Space Impact Fees (PIF) – 5,217.00
    d. Fire Impact Fees (FIF) - $0.20 sf

System Development Charges (SDCs) for 2022:

1. Water
    a. 3/4" meter - $8,071.00 + $401.00 connection fee
2. Sewer
    a. Residential - $2,493.00 + $177.00 STEP/STEF Inspection

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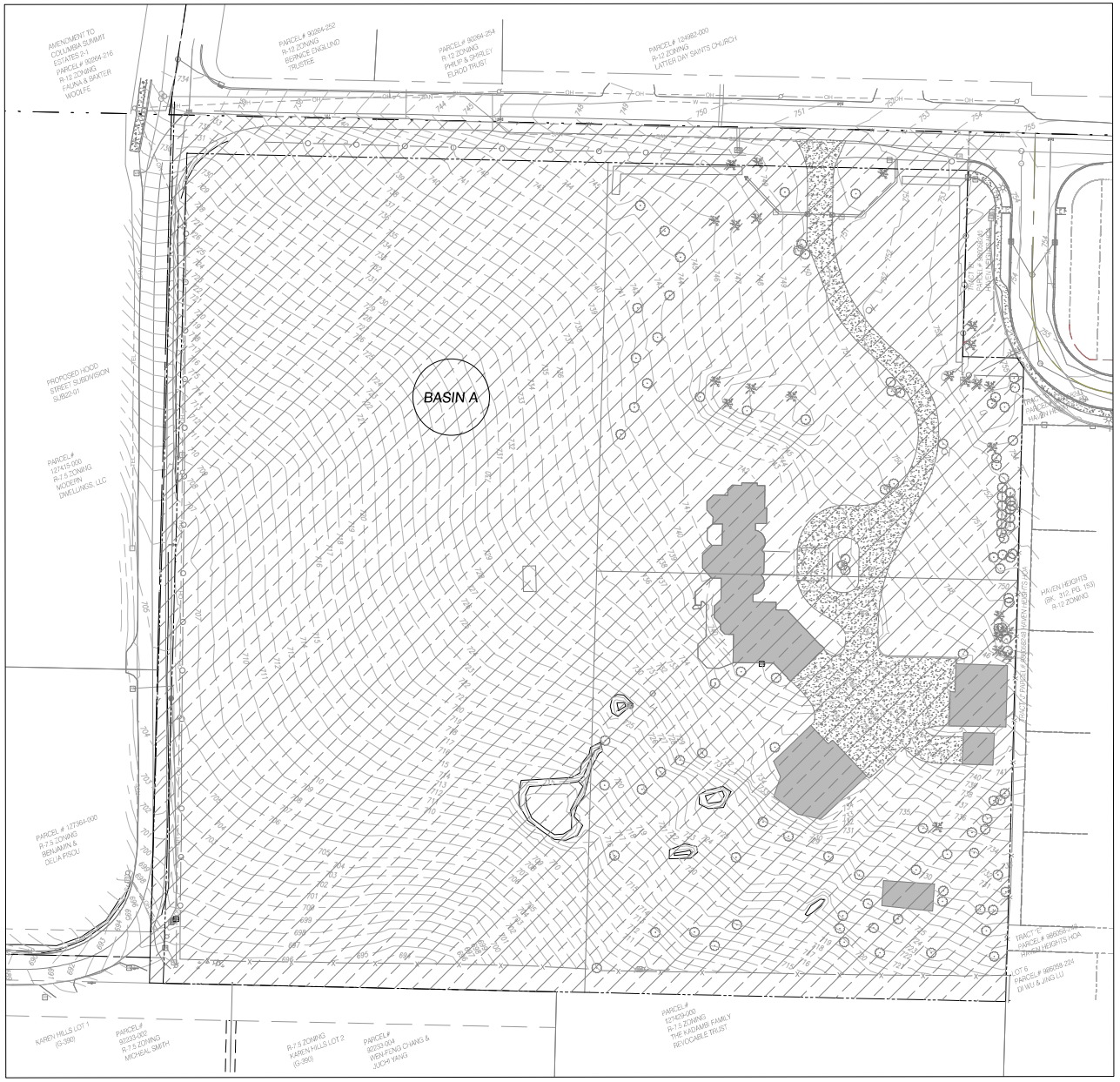
BUILDING DIVISION **BRIAN SMITH (360) 817-7243**

1. The address for the existing home at 3010 NW 18th Ave may need to be updated and addressed off of 17th Ave as currently proposed.
2. Existing structures need an asbestos survey and demolition permit.
3. Decommissioning of septic tanks and drain fields through Clark County Department of Health
4. The structures will be reviewed under the most current building codes as adopted by The State of Washington.
5. The structural drawings and calculations shall be prepared and stamped by a Professional Engineer licensed by the State of Washington.
6. The placement of buildings and structures on or adjacent to slopes steeper than one unit vertical in three units horizontal shall conform to Sections R403.1.7.1 through R403.1.7.4.
7. Geotechnical engineer's report may be required
8. The required fire distance between buildings and property line shall be in accordance with the International Building Codes.

9. The required fire suppression system shall be in accordance with IBC and other applicable codes standards and shall be reviewed by the Camas Fire Marshal's office.
10. Storm sewer disposal and connections shall be identified on the approved plans.
11. All lots shall be provided a storm drain lateral at the lowest practical location.
12. Developer shall provide a designated concrete wash out area.
13. Storm water from adjacent properties and existing developments should be taken into consideration.
14. System Development Charges and Impact fees shall be assessed prior to permits
15. An approved monument sign for posting addresses shall be provided at all Flag lots. The monument sign, location and design shall be noted on the Plat.
16. Any development located within a special flood hazard area shall be in accordance with CMC 16.57
17. Impact fees and System Development charges shall be applicable.

FIRE DEPARTMENT **RANDY MILLER (360) 834-6191**

1. Any existing structures scheduled for demolition may be considered for use as a fire department training burn. Contact DFM Randy Miller at the FMO for further information. 360-834-6191
2. NFPA 13D Residential Fire Sprinklers required in all new dwellings. Additionally it is recommended to install fire sprinklers in the garage in consultation with the fire sprinkler contractor. Contact the FMO for further information.
3. If a larger water meter is required to meet fire flow and the larger meter is not required for reasons of the international residential code from the building department, the SDC up-charges are waived and the minimal cost difference in the actual meter shall be paid.
4. A flow switch is optional but recommended to tie into the homes security system along with an outside bell.
5. If a PRV is needed for pressures over 80 PSI on the domestic supply, it shall be installed after the fire line supply. If the pressure is over 80 PSI a PRV may be needed on the toilet supply line supplied from the fire sprinkler system.
6. An inside bell or horn strobe is recommended (If system is not tied into a security system) Contact Randy Miller in the FMO for more information.
7. Water supply line from the meter into the structure shall be sized per the fire sprinkler contractors design calculations or a 2- inch line shall be installed.
8. Providing fire sprinklers in garages are optional but strongly encouraged. Please contact the FMO for further details.
9. A fire hydrant is required at the Northeast corner of lot 16 and between lots 5 & 6.
10. Witnessed hydrant flushing required with the FMO on any new fire hydrant installation.
11. Access roads or flag lots to be a minimum 12-foot wide paved with a 20-foot wide clearance and a minimum 13.6-foot vertical clearance. These minimums may be greater per city of Camas engineering department.
12. Approved Fire Department turnaround required for dead end streets or access driveway over 150 ft to residential structures, Tract "D".
13. Provide radiuses to access roads/driveways for tracts "C", "D" and lot 9.
14. Obstructed access plan required for all private roads, flag lots serving more than one home or access tracts. Towing signs are the recommended plan unless an alternate method is provided and approved.



Catchment	Storm Facility	Description	Area (acres)
Basin A	Tract 'B'	SG4, Forest, Steep	10.43

Table G1: Hydrologic parameters used in pre-developed catchment analysis

SCALE: 1"=40'

-40 0 40 80

CLIENT:
MODERN NW INC.
810 NE GLISAN ST.
PORTLAND OR, 97213
PH: (971) 322-3318
FX:
CONTACT: SERGY MARANDYUK
EMAIL: sergey@modernnw.com

PRE-DEVELOPED CATCHMENT PLAN FOR:
18TH AVENUE SUBDIVISION

OLSON ENGINEERING, INC.
LAND SURVEYORS
ENGINEERS
222 E. EVERGREEN, VANCOUVER, WA 98660
360-695-1385

PETER A. KUCK
EXPIRES: 3/4/23
REGISTERED PROFESSIONAL ENGINEER

04.27.2022

CHANGES / REVISIONS

DESCRIPTION:	DATE:

DESIGNED: AAK
DRAWN: AAK
CHECKED: PAT
DATE: APRIL 2022
SCALE: H: 1"= 40'
V: N/A

18TH AVENUE SUBDIVISION
JOB NO.:A10212.01.01

SHEET
1-2

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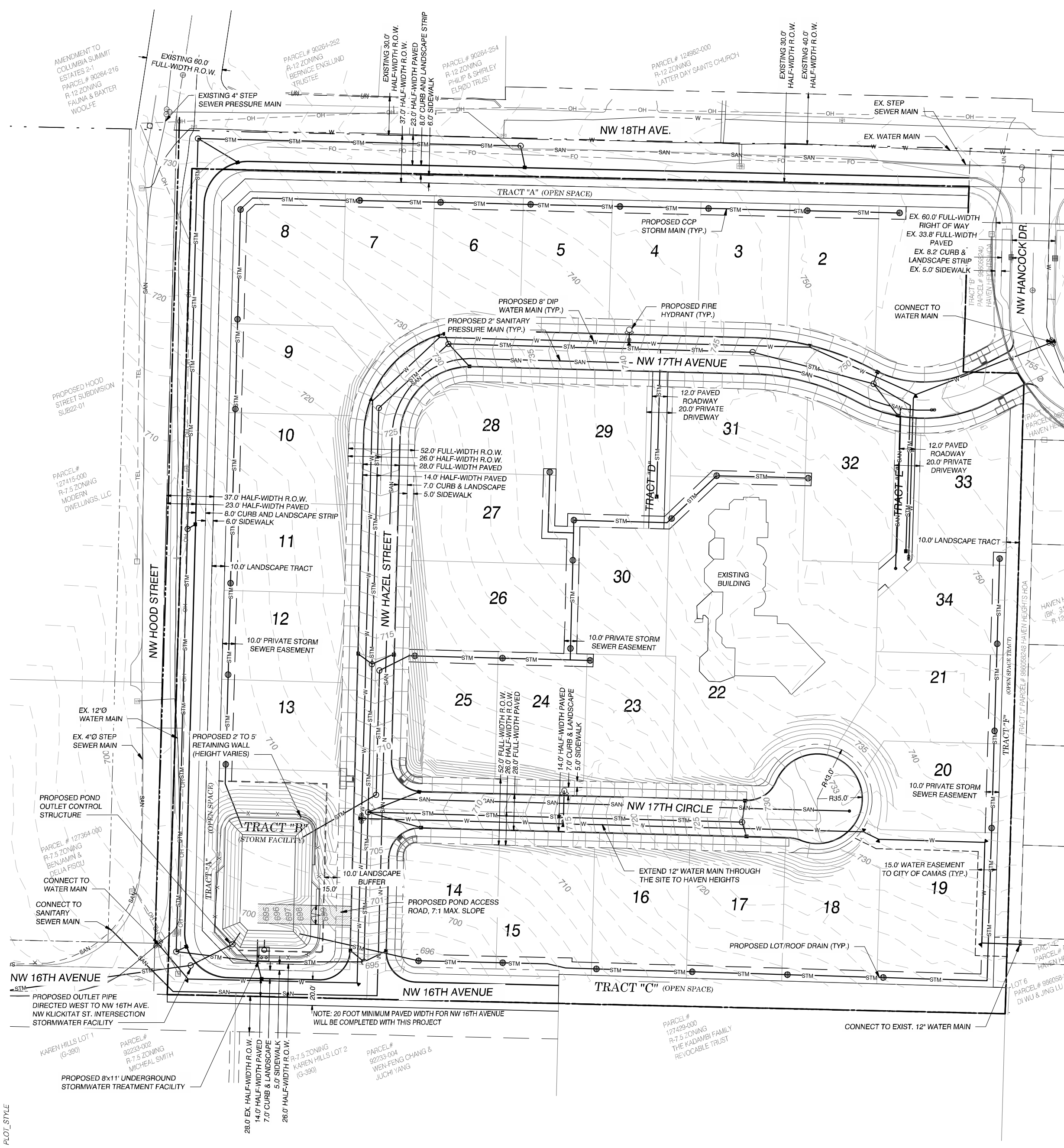
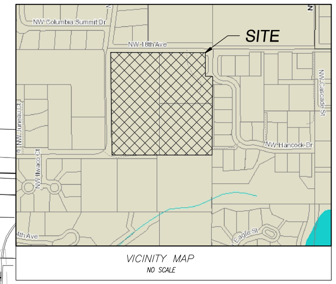
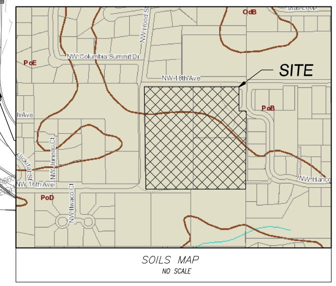
PLOT STYLE

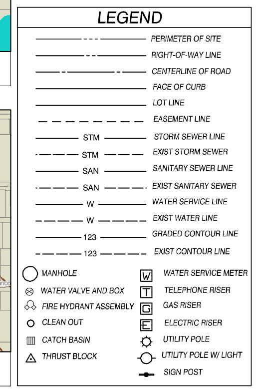




VICINITY MAP
NO SCALE



SOILS MAP
NO SCALE



GENERAL NOTES

WATER

1) THERE IS AN EXISTING 12" WATER MAIN IN NW 16TH AVE AND NW HOOD ST.

2) A NEW 8" WATER MAIN WILL BE CONSTRUCTED THAT WILL LOOP THROUGH THE SUBDIVISION TO THE EXISTING MAIN FROM NW 18TH AVE. TO NW HOOD STREET. A 12" WATER MAIN IS TO BE EXTENDED THROUGH THE SITE FROM THE NW 16TH AVE./HOOD STREET INTERSECTION TO THE EXISTING STUB LOCATED IN TRACT "E" OF HAVEN HEIGHTS.

3) ALL PROPOSED LOTS WILL INCLUDE AN INDIVIDUAL WATER METER.

4) PROPOSED FIRE HYDRANTS WILL BE ADDED THROUGH THE SITE TO MEET FIRE CONTROL REQUIREMENTS AND WILL BE LOCATED AS REQUIRED BY THE FIRE MARSHALL.

5) WATER EASEMENTS WILL BE DEDICATED TO CITY OF CAMAS AS REQUIRED.

SANITARY

1. THERE IS AN EXISTING 4" SANITARY PRESSURE (STEP) MAIN IN NW 18TH AVE.

2. A NEW PRESSURE MAIN WILL BE EXTENDED INTO THE DEVELOPMENT TO SERVE ALL PROPOSED LOTS AND WILL RECONNECT WITH NW HOOD STREET.

3. 4" SANITARY SEWER LATERALS WILL BE INSTALLED TO SERVE EACH LOT PER CITY OF CAMAS REQUIREMENTS.

SANITARY SEWER EASEMENTS WILL BE DEDICATED TO CITY OF CAMAS AS REQUIRED.

STORMWATER

1) ALL STORMWATER TREATMENT AND DETENTION WAS DESIGNED TO BE IN ACCORDANCE WITH THE CITY OF CAMAS STANDARDS AND THE STORMWATER MANAGEMENT MANUAL FOR WESTERN WASHINGTON.

2) ALL STORMWATER FACILITIES WILL BE PRIVATELY OWNED AND MAINTAINED BY THE HOA WITH RIGHT-OF-ENTRY TO THE CITY OF CAMAS FOR INSPECTION PROPOSES.

3) NATIVE SOILS ON THE SITE ARE CONSIDERED POWELL SILT LOAM AND ARE TO BE CLASSIFIED IN WWHM AS GROUP 4 (USDA GROUP C).

4) STORMWATER RUNOFF FROM THE ON SITE PAVEMENT, SIDEWALKS, DRIVEWAYS AND LANDSCAPE AREAS WILL BE COLLECTED IN CATCH BASINS AND ROUTED TO A FILTER CARTRIDGES (CONTECH STORMFILTER OR SIMILAR) FOR TREATMENT. STORMWATER WILL BE DETAINED IN A DETENTION POND AND THEN RELEASED AT RATES BELOW PREDEVELOPED CONDITIONS.

5) STORM SEWER ACCESS AND INSPECTION EASEMENTS WILL BE DEDICATED TO CITY OF CAMAS AS REQUIRED.

EROSION CONTROL

1) EROSION CONTROL MEASURES WILL BE DESIGNED IN CONFORMANCE WITH THE CITY OF CAMAS EROSION CONTROL ORDINANCE DURING FINAL DESIGN.

TRANSPORTATION

1) NW 18TH AVE AND NW HOOD ST. ARE CLASSIFIED AS 2 OR 3 LANE ARTERIAL ROADS BY THE CITY OF CAMAS. HALF-WIDTH FRONTAGE IMPROVEMENTS WILL BE COMPLETE ADJACENT TO THE SITE ALONG NW 18TH AVE, NEW HOOD ST. AND NW 16TH AVE.

2) NW HAZEL STREET, NW 17TH AVENUE AND NW 17TH CIRCLE ARE CLASSIFIED AS A 2 LANE LOCAL ROADWAYS BY THE CITY OF CAMAS.

APPROXIMATE GRADING VOLUMES

CUT	6,100 CY
FILL	1,600 CY

NOTE: CUT AND FILL AREAS AND VOLUMES ARE CALCULATED FROM EXISTING GROUND TO FINISHED GRADE AND ARE NOT ADJUSTED FOR STRIPPINGS, TRENCH EXCAVATION, STRUCTURAL EXCAVATION OR SHRINK/SWELL. CONTRACTORS ARE SOLELY RESPONSIBLE FOR QUANTITY ESTIMATES FOR BIDDING PURPOSES.

SCALE: 1"=40'

-40 0 40 80

CLIENT:
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8101 NE GLISAN ST.
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PRELIMINARY DEVELOPMENT PLAN FOR:

18TH AVENUE SUBDIVISION

OLSON ENGINEERING INC.
LAND SURVEYORS
ENGINEERS
222 E. EVERGREEN, VANCOUVER, WA 98660
360-695-1385
503-289-9936

PETER A. TUCK, STATE OF WASHINGTON, REGISTERED PROFESSIONAL ENGINEER
4/27/22

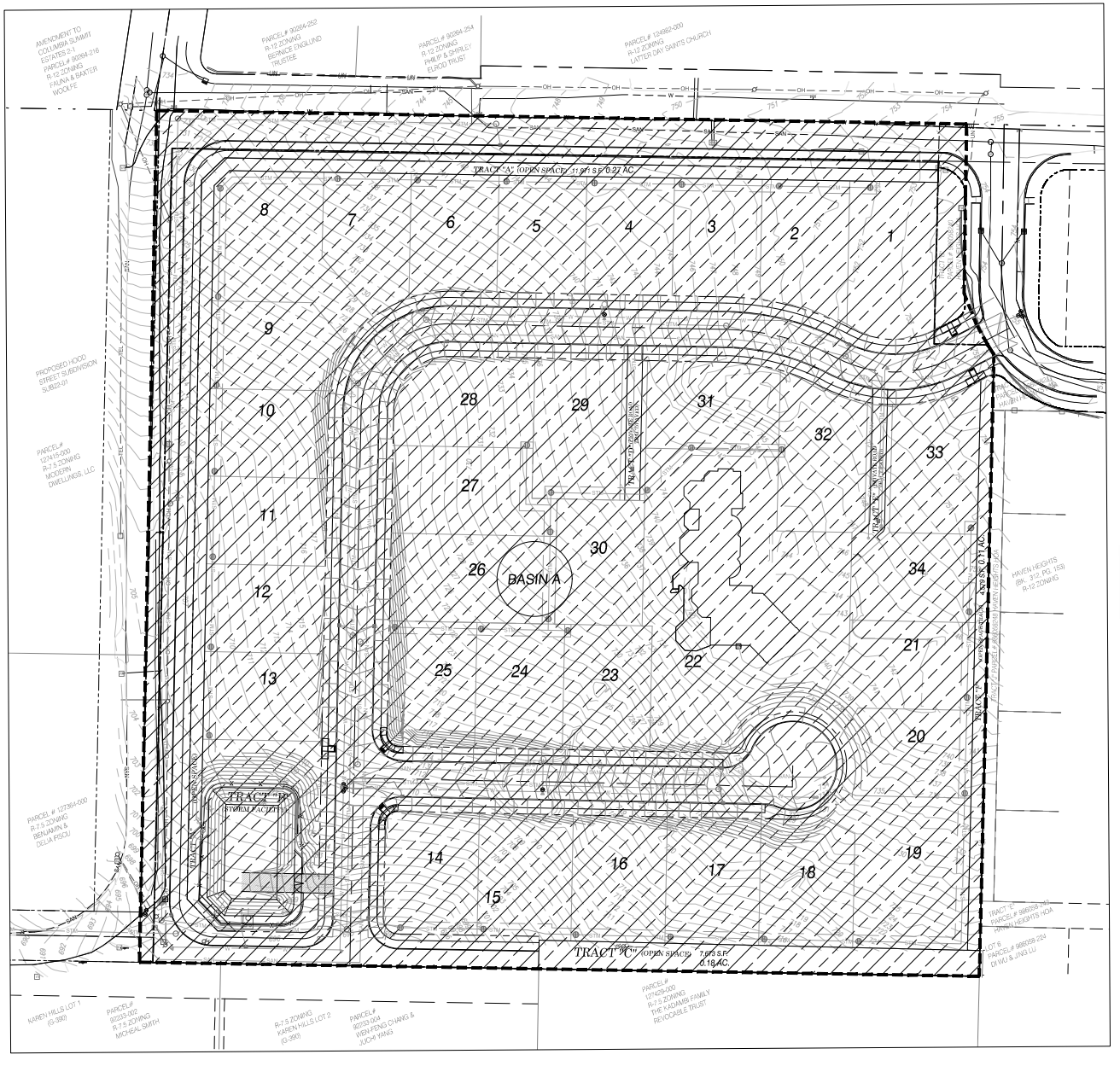
CHANGES / REVISIONS

DESCRIPTION:	DATE:

DESIGNED: AAK
DRAWN: AAK
CHECKED: RWP
DATE: APRIL 2022
SCALE: H: 1"= 40' V: N/A

18TH AVENUE SUBDIVISION
JOB NO.: A10212.01.01

SHEET
1 OF 1



Catchment	Storm Facility	Description	Area (acres)
Basin A	Tract 'B'	Roads Steep	1.79
		Roof Tops Flat	2.27
		Driveways Steep	0.45
		Sidewalks Steep	0.50
		SG4, Lawn, Steep	5.42

Table G2: Hydrologic parameters used in developed catchment analysis

SCALE: 1"=40'

-40 0 40 80

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810 NE GLUSAN ST.
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DEVELOPED CATCHMENT PLAN FOR:
18TH AVENUE SUBDIVISION

OLSON LAND SURVEYORS ENGINEERS
ENGINEERING INC.
222 E. EVERGREEN, VANCOUVER, WA. 98660
360-695-1385

04/27/2022

CHANGES / REVISIONS

DESCRIPTION:	DATE:

DESIGNED: AAK
DRAWN: AAK
CHECKED: PAT
DATE: APRIL 2022
SCALE: H: 1"= 40'
V: N/A

18TH AVENUE SUBDIVISION

JOB NO.: A10212.01.01

SHEET
2-2