City of Yelm
EST. 1924
WASHINGTON

SEPA #: 2021.0054

DETERMINATION OF NON-SIGNIFICANCE

Proponent:	AHBL, Inc
Description of Proposal:	Crystal Springs Plat
Location of the Proposal:	714 Crystal Springs St NW
Section/Township/Range:	Section 19 Township 17 Range 2E Quarter NE NW
Threshold Determination:	The City of Yelm as lead agency for this action has determined that this proposal does not have a probable significant adverse impact on the environment. Therefore, an environmental impact statement (EIS) will not be required under RCW 43.21C.030(2)(c). This decision was made after review of a completed environmental checklist and other information on file with the lead agency. This information is available to the public on request.
Mitigating Measures:	None
Lead agency:	City of Yelm
Responsible Official:	Landon Hawes, Planning & Building Manager
Date of Issue:	November 11, 2021
Comment Deadline:	November 26, 2021
Appeal Deadline:	There is no local administrative appeal of a DNS

Landon Hawes

Landon Hawes, Planning & Building Manager

This Determination of Non-Significance (DNS) is issued pursuant to Washington Administrative Code 197-11-340 (2). Comments must be submitted to Casey Mauck, caseym@yelmwa.gov, at City of Yelm, 106 2nd St SE, Yelm, WA 98597, by November 26, 2021 at 5:00 P.M. The City of Yelm will not act on this proposal prior November 26, 2021 at 5:00 P.M.

DO NOT PUBLISH BELOW THIS LINE

Published: Nisqually Valley News, Thursday, November 18, 2021
Posted in public areas: Thursday, November 11, 2021

Copies to: All agencies/citizens on SEPA mailing list
Dept. of Ecology w/checklist

City of Yelm

Fee	
Date Received	
By	
File No.	

Community Development Department ENVIRONMENTAL CHECKLIST

Instructions:

The State Environmental Policy Act (SEPA) requires all governmental agencies to consider the environmental impacts of a proposal before making decisions. The purpose of this checklist is to provide information to help identify impacts from your proposal, to reduce or avoid impacts from the proposal if it can be done, and to help the City decide whether an EIS is required. An environmental impact statement (EIS) must be prepared for any proposal with probable significant adverse impacts on environmental quality.

This environmental checklist asks you to describe some basic information about your proposal. The City will use this checklist to determine whether the environmental impacts of your proposal are significant and require preparation of an EIS. You must answer each question accurately, carefully and to the best of your knowledge. Answer the questions briefly, but give the best description you can. In most cases, you should be able to answer the questions from your own observations or project plans without the need for experts. If you do not know the answer, or if a question does not apply to your proposal, write "do not know" or "does not apply". Complete answers to the questions now may avoid delays later. If the space provided is too small, feel free to attach additional sheets.

Some questions ask about governmental regulations, such as zoning, shoreline, and landmark designations. Answer these questions if you can. If you have problems, the city staff can assist you.

The checklist questions apply to all parts of your proposal even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal or its environmental effects. You may be asked to explain your answers or provide additional information for determining if there may be significant adverse impacts.

Nonproject Proposals Only:

Complete both the checklist (even though many questions may be answered "does not apply") and the **Supplemental Sheet for Nonproject Actions** (part D). For nonproject actions, the references in the checklist to the words "project," "applicant," and "property or site" should be read as "proposal," "proposer," and "affected geographic area," respectively.

CITY OF YELM
(Update to SEPA Checklist dated 4/28/2006)
ENVIRONMENTAL CHECKLIST

CITY USE ONLY
FEE: $150.00
DATE REC'D
BY:
FILE NO.

A. BACKGROUND

1. Name of proposed project, if any:

Crystal Springs Preliminary Plat

2. Name of applicant:

Sheri Greene, AHBL

3. Address, phone number and email address of applicant and of any other contact person:

Sheri Greene, AHBL
2215 N. 30th Street #300
Tacoma, WA 98403
253-383-2422 sgreene@ahbl.com

Evan Mann, Copper Ridge, LLC.
PO Box 73790
Puyallup, WA 98373
253-820-7835 evan@soundbuilthomes.com

4. Date checklist prepared:

September 3, 2021

5. Agency requesting checklist:

City of Yelm

6. Proposed timing or schedule (including phasing, if applicable):

Construction will commence upon issuance of site development permit. It is anticipated the site development permit will be issued in Winter 2021/2022.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

No.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

SEPA Checklist, Mazama Pocket Gopher Recconnaisance, Geotechnical Report, Traffic Study

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.

No, not to our knowledge

10. List any government approvals or permits that will be needed for your proposal, if known.

SEPA Determination, Preliminary Plat Approval, Site Development Permits, Building Permits, and NPDES Permit

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page.

Project proposes construction of 30-lot residential subdivision and associated roadways. Services will include city water and sewer, and private drainage routed to onsite infiltration facilities.

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. You need not duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The site is located at 714 Crystal Springs in the City of Yelm, Thurston County, parcel number 22719210403.

B. ENVIRONMENTAL ELEMENTS

1. **Earth**

a. General description of the site (circle one):
(flat,) rolling, hilly, steep slopes, mountainous, other _____

b. What is the steepest slope on the site (approximate percent slope)?

Slopes are generally between 0% and 5%.

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.

According to the NRCS Soil Survey, site soils consist primarily of Spanaway gravelly sandy loam.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

Not to our knowledge.

e. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.

The project is in preliminary design and provide for 4,000 cy of cut and 3,000 cy of fill, for a net export of 1,000 cy. Any imported material will be similar to existing and from a clean site. Any exported material will be hauled to an approved location. It is expected that earthwork will balance in the final design.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

Minimal erosion could occur during project construction. All applicable BMPs will be followed to prevent or minimize such impacts.

g. About what percent of the site will be covered with impervious surfaces after project construction such as asphalt or buildings?

Less than 25% of the site will be covered by impervious surfaces from the construction of the roadways and sidewalks. Additional impervious for roofs and driveways at the time of home construction.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

Proposed measures include the use of BMPs to minimize the risk of erosion during construction. A drainage plan will incorporate designs that convey and infiltrate stormwater away from the disturbed areas as much as possible.

2. **Air**

a. What types of emissions to the air would result from the proposal (i.e., dust, automobile exhaust, odors, industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known. **Construction will result in a temporary increase in air pollution, including emissions from equipment and dust from construction activities. Dust controls will include watering soils to prevent blowing of dust. Construction vehicles will be turned off when not in use to help control emissions. Construction activities and equipment will follow the appropriate regulations for controlling emissions to the air. Post-construction emissions would include emissions from vehicle trips associated with the development.**

Subject to ORCAA regulations

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

There are no known off-site sources of emissions or odors observed that might effect this proposal.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

Potential BMPs include using water sprays or other non-toxic dust control methods on unpaved roadways, preventing the tracking out of mud onto public streets, covering soil piles when practical, and minimizing work during periods of high winds. Additionally, to minimize air quality and odor issues caused by tailpipe emissions, BMPs will be used. Such BMPs include maintaining engines of construction equipment while also minimizing the idling of construction equipment.

3. **Water**

a. Surface Water

1) Is there any surface water body or wetland on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds)? If yes, describe type and provide names. State what stream or river it flows into?

No.

Yelm Creek is roughly 315 feet west of western property line

2) Will the project require any work over, in, or adjacent to (within 300 feet) the described waters? If yes, please describe and attach available plans.

Not applicable.

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

There will be no fill or dredge material as a result of construction activities associated with this proposal.

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

The project will not require surface water withdrawals or diversions.

5) Does the proposal lie within a 100-year floodplain? If so, note elevation on the site plan.

The project site does not lie within a 100-year floodplain.

According to 2012 FIRM, west edge of panhandle is in 100-year floodplain. BFE is 332. Subject to Yelm Critical Areas Code 18.21.080

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

No.

b. Groundwater:

1) Will groundwater be withdrawn, or will water be discharged to groundwater? Give general description, purpose, and approximate quantities if known.

Subject to 2019 SWMMWW

Water will not be withdrawn.
All stormwater runoff will be infiltrated onsite. Treatment will be provided where applicable.

2) Describe the underlying aquifer with regard to quality and quantity, sensitivity, protection, recharge areas, etc.

The site is within an extremely sensitive aquifer area so all stormwater runoff from impervious surfaces will be treated prior to infiltrating onsite.

3) Describe waste material that will be discharged into or onto the ground from septic tanks or other sources, if any (such as domestic sewage; industrial byproducts; agricultural chemicals).

No waste material will be discharged to the ground. The homes will be served by the City of Yelm STEP collection system and holding tanks will be maintained by the city.

c. Water Runoff (including storm water):

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

Subject to 2019 SWMMWW

All stormwater from the roadways and driveways will be collected and conveyed to a proprietary treatment device prior to infiltration. The homes will have individual dry wells to infiltrate on lot roof runoff.

2) Could waste materials enter ground or surface waters? If so, generally describe.

No waste materials will enter ground or surface waters as a result of this proposal.

d. Proposed measures to reduce or control surface, ground, and runoff water impacts, if any:

The project will provide source control of pollutants by providing treatment of stormwater using a proprietary treatment device meeting ecology approval. All landscape areas will be stabilized. The HOA will operate under a a maintenance agreement for Best Management Practices to reduce pollutants entering the storm system.

4. **Plants**

a. Check or circle types of vegetation found on the site:

__X__ deciduous tree: alder, maple, oak, aspen, other
__X__ evergreen tree: fir, cedar, pine, other
__X__ shrubs
__X__ grasses
____ pasture
____ crops or grains
____ wet soil plants: cattail, buttercup, bulrush, skunk cabbage, other
____ water plants: water lily, eelgrass, milfoil, other
____ other types of vegetation

b. What kind and amount of vegetation will be removed or altered?

Most of the existing vegetation within the project area will be removed.

1-1 replacement for trees with diameter exceeding 8" required

c. List threatened or endangered species known to be on or near the site.

None to our knowledge.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

Landscape design and buffer will be in accordance with the City of Yelm Municipal Code. Plans will be submitted to the city for approval.

5. **Animals**

a. Circle any birds and animals that have been observed on or near the site or are known to be on or near the site:

birds: hawk, heron, ducks, eagle, ~~songbirds~~,
other: _____
mammals: deer, bear, elk, beaver, other: **rabbits, mice**
fish: bass, salmon, trout, shellfish, other:_____

b. List any priority, threatened or endangered species known to be on or near the site.

None to our knowledge. The area is known to be habitat for the Mazama Pocket Gopher. A Pocket Gopher reconnaissance was performed on June 16, 2021 by EnviroVector. No evidence of Pocket Gophers was mapped within six hundred (600) feet of the subject property or found during the June 16, 2021 site visit..

c. Is the site part of a migration route? If so, explain.

The site is within the Pacific Flyway for Migratory Birds.

d. Proposed measures to preserve or enhance wildlife, if any:

No impacts are anticipated to wildlife, therefore no special measures are proposed.

6. **Energy and Natural Resources**

a. What kinds of energy (electric, natural gas, gasoline, heating oil, wood, solar etc.) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, transportation, etc.

The completed project will utilize electricity to provide for heating, cooling and lighting needs.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

No, this proposal will not have an impact on adjacent property's ability to utilize solar energy.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

Subject to 2018 IRC

The project will meet the 2015 Washington State Energy Code (WSEC). Other conservation features, such as LED lighting and low-flow plumbing fixtures, will be determined upon development.

7. **Environmental Health**

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spills, of hazardous waste, that could occur as a result of this proposal? If so, describe. **There is the potential for construction equipment and personal vehicles to leak fuel, oil or other fluids necessary to operate the equipment/vehicles. This risk is typical of construction activities and vehicle trips associated with the development, and is minimal. The site will provide water quality treatment prior to infiltrating stormwater, further minimizing the risk of impacts.**

Construction BMPs will be followed

1) Describe special emergency services that might be required.

No special emergency services will be required other than those normally provided such as police and fire protection.

2) Proposed measures to reduce or control environmental health hazards, if any:

None are anticipated to be required. Specialized erosion and sediment control measures will be implemented if contaminated soils are detected during the construction process. Standard dust control measures will be implemented to mitigate dust emissions resulting from construction activities. Pursuant to State Law, 811 will be contacted prior to any digging activities to prevent damage to on-site utilities.

b. Noise

1) What types of noise exist in the area which may affect your project (for example: traffic, equipment operation, other)?

There are no off-site sources of noise that will impact this proposal. The primary source of noise in the area is generated from vehicular traffic along Crystal Springs Road and neighboring residential developments.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

Temporary, short-term noise impacts typical of construction projects will occur with operation of equipment during construction. Construction activities will be restricted to the hours permitted under the Yelm Municipal Code. Long term noise will be minimal, and will be typical of residential developments.

3) Proposed measures to reduce or control noise impacts, if any: **To mitigate general noise impacts during the construction phase, measures such as locating stationary equipment away from receiving properties, limiting construction hours to the appropriate Yelm ordinance, turn off idling construction equipment, and train construction crews to avoid unnecessarily loud actions near residential areas will be employed.**

8. **Land and Shoreline Use**

a. What is the current use of the site and adjacent properties?

The site is currently single family residential.

North and west properties are developed residentially, east property is Yelm Public Works, and Southern property is a Yelm Community Schools facility

b. Has the site been used for mineral excavation, agriculture or forestry? If so, describe.

Not to our knowledge.

c. Describe any structures on the site.

There is a single family residence and several outbuildings..

d. Will any structures be demolished? If so, what?

All structures will be demolished.

City of Yelm demolition permit and ORCAA asbestos survey

e. What is the current comprehensive plan designation of the site?

R-6

f. What is the current zoning classification of the site?

R-6 Moderate Density Residential District

g. If applicable, what is the current shoreline master program designation of the site?

Does not apply.

h. Has any part of the site been classified as a "natural resource", "critical" or "environmentally sensitive" area? If so, specify.

The site lies within an extremely sensitive aquifer recharge area.

i. Approximately how many people would reside or work in the completed project?

Based on 2.5 persons per household, approximately 75 people will reside in the completed project.

j. Approximately how many people would the completed project displace?

There would be no displacements. The existing residents are relocating.

k. Proposed measures to avoid or reduce displacement impacts, if any:

Does not apply.

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

The proposed project is permitted outright in the R6 zone. The project requires approval through the Preliminary Plat process to ensure it is compatible with existing and proposed land uses.

9. **Housing**

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

Project proposes 30 units and will likely be middle income.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

The existing residence and outbuildings will be demolished.

c. Proposed measures to reduce or control housing impacts, if any:

No special measures are proposed.

10. **Aesthetics**

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

The height of the structures will not exceed the maximum height allowed in the R6 zone. The exterior building materials will likely be wood.

b. What views in the immediate vicinity would be altered or obstructed?

The site will transition from a single family residence with outbuildings to an attractive residential neighborhood.

c. Proposed measures to reduce or control aesthetic impacts, if any:

Perimeter landscaping and/or sight obscuring fencing will screen the development.

Subject to 18.55 YMC

11. **Light and Glare**

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

Exterior lighting from the houses and street lights will occur after dark, typical of a residential neighborhood.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

No. Lighting will be directed downward so as not to interfere with views or provide glare.

c. What existing off-site sources of light or glare may affect your proposal?

There are no off-site sources of light or glare that will impact the proposal.

d. Proposed measures to reduce or control light and glare impacts, if any:

Lighting fixtures will be shielded and lighting cast downward to reduce light and glare impacts. All lighting fixtures will meet City requirements for light spill.

12. **Recreation**

a. What designated and informal recreational opportunities are in the immediate vicinity? **Brookdale Golf Course is just north of the project site. Ball fields, football field and track are available for public use during non-school hours at Mill Pond Elementary, which abuts the southern boundary of the project.** Not accurate - nearest opportunity is Yelm Middle School

b. Would the proposed project displace any existing recreational uses? If so, describe.

No.

c. Proposed measures to reduce or control impacts or provide recreation opportunities:

5% of the site will be open space with active recreation amenities.

13. **Historic and Cultural Preservation**

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

There are no known buildings, structures, or sites within the immediate vicinity of the project site that are listed on national, state, or local preservation registers.

b. Generally describe any landmarks or evidence of historic, archeological, scientific, or cultural importance known to be on or next to the site.

None to our knowledge.

c. Proposed measures to reduce or control impacts, if any:

If cultural or archeological objects are found during site preparation work, the Washington State Department of Archaeology and Historic Preservation will be notified, and appropriate measures will be taken.

14. **Transportation**

a. Identify sidewalks, trails, public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.

The site will be served by panhandle access road off of Crystal Springs Road and access off of Woodland Court S.E.

b. Is site currently served by public transit? By what means? If not, what plans exist for transit service?

Intercity transmit regional system map indicated the nearest transit route in the area is served by Route 94. The nearest stop is located at the intersection of Edwards Street NW and W Yelm Avenue, approximately 0.56 miles southwest.

c. How many parking spaces would the completed project have? How many would the project eliminate?

Each residence will have a garage and driveway parking.

d. Will the proposal require any new sidewalks, trails, roads or streets, or improvements to existing sidewalks, trails, roads or streets, not including driveways? If so, generally describe (indicate whether public or private).

The project will require new roads and road improvements.

Streets will be dedicated to the City, and have sidewalks/curb/gutter/street trees

e. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

No.

f. How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.

Vehicular trips and peak volumes are noted in the Traffic Impact Analysis Report prepared by Heath and Associates, dated October 2021. Project trip generation is 22 AM Peak-hour trips and 30 PM Peak-hour trips.

g. Proposed measures to reduce or control transportation impacts, if any:

Traffic impact fees will be paid to mitigate transportation impacts.

15. **Public Services**

a. Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe:

Yes, typical public services including fire, police protection, health care, schools, and utility services will be required for this project.

b. Proposed measures to reduce or control direct impacts on public services, if any.

An increased tax base will help mitigate impacts. Fire impact fee and school impact fee required for each dwelling unit

16. **Utilities**

a. Circle utilities currently available at the site: electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other.

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

Electricity - Puget Sound Energy
Water - City of Yelm
Sanitary Sewer - City of Yelm S.T.E.P.
Refuse Service - Rural Refuse
Telephone - Centurylink
Cable/Internet - Comcast

C. SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the City of Yelm is relying on them to make its decision.

Signature: _____
Date Submitted: **September 27, 2021**

Earth Solutions NW LLC

Geotechnical Engineering
Construction Observation/Testing
Environmental Services

GEOTECHNICAL ENGINEERING STUDY
CRYSTAL SPRINGS
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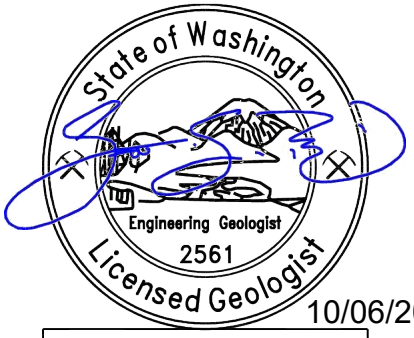
PREPARED FOR

COPPER RIDGE, LLC

October 6, 2021



Scott S. Riegel, L.G., L.E.G.
Senior Project Manager

Kyle R. Campbell, P.E.
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GEOTECHNICAL ENGINEERING STUDY
CRYSTAL SPRINGS
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Important Information about This

Geotechnical-Engineering Report

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

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

Earth Solutions NW LLC

Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

October 6, 2021
ES-8113

Copper Ridge, LLC
P.O. Box 73790
Puyallup, Washington 98373

Attention: Mr. Evan Mann

Dear Mr. Mann:

Earth Solutions NW, LLC (ESNW) is pleased to present this report supporting the planned residential development for Yelm, Washington. In our opinion, the proposed residential development is feasible from a geotechnical standpoint. Based on the conditions observed during our fieldwork, the subject site is underlain primarily by recessional outwash deposits that are suitable for infiltration. The proposed structures can be supported on conventional spread and continuous foundations bearing on competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. In general, competent native soil suitable for support of foundations will likely be encountered at depths of about two to four feet below the existing ground surface (bgs). Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of soils to the specifications of structural fill, or overexcavation and replacement with suitable structural fill, will likely be necessary.

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

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

Sincerely,

EARTH SOLUTIONS NW, LLC

Scott S. Riegel, L.G., L.E.G.
Senior Project Manager

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ES-8113

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Cont'd

ES-8113

GEOTECHNICAL ENGINEERING STUDY
CRYSTAL SPRINGS
714 CRYSTAL SPRINGS STREET NORTHWEST
YELM, WASHINGTON

ES-8113

INTRODUCTION

General

This report was prepared for the proposed residential development to be constructed at 714 Crystal Springs Street Northwest in Yelm, Washington. The purpose of this study was to provide geotechnical recommendations for the proposed development. Our scope of services for completing this geotechnical engineering study included the following:

- Observing, logging, and sampling test pits for purposes of characterizing site soil and groundwater conditions;
- Laboratory testing of soil samples collected at the test pit locations;
- Engineering analyses and recommendations for the proposed development, and;
- Preparation of this report.

The following documents and resources were reviewed as part of our report preparation:

- Geologic Map of the Centralia Quadrangle, Washington, 1987;
- Conceptual Site Plan, undated;
- Web Soil Survey (WSS) online resource, maintained by the Natural Resources Conservation Service under the United States Department of Agriculture, and;
- Yelm Municipal Code Title 18.21: Critical Areas and Resource Lands.

Project Description

Based on review of the referenced plans, the subject site will be redeveloped with up to 30 single-family residences and associated improvements. Grading plans were not available at the time this report was prepared; however, given the low topographic relief on this site, we anticipate grading may include cuts and fills of up to about five feet with deeper excavations required to install underground utilities.

At the time this report was prepared, specific building load values were not available; however, we anticipate the proposed residential structures will consist of relatively lightly loaded wood framing supported on conventional foundations. Based on our experience with similar developments, we estimate wall loads on the order of 1 to 2 kips per linear foot and slab-on-grade loading of 150 pounds per square foot (psf). The feasibility of infiltrating runoff into native soils is being investigated as part of the project plans.

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

SITE CONDITIONS

Surface

The subject site is located east of Crystal Springs Street Northwest in Yelm, Washington, as illustrated on the Vicinity Map (Plate 1). The site consists of a single tax parcel (Thurston County Parcel Number 22719210403) currently developed with a single-family residence, barn, detached garage, and associated improvements. The majority of the subject site is lightly to moderately vegetated with tall grass, and sparse trees and general landscaping around existing buildings. Topography is relatively level, with less than about five feet of total elevation change across the site.

Subsurface

A representative of ESNW observed, logged, and sampled six test pits, excavated at accessible locations within the proposed development area, on August 31, 2021, using a trackhoe and operator provided by the client. The approximate locations of the test pits are depicted on Plate 2 (Test Pit Location Plan). Please refer to the test pit logs provided in Appendix A for a more detailed description of subsurface conditions. Representative soil samples collected at the test pit locations were analyzed in general accordance with Unified Soil Classification System (USCS) and United States Department of Agriculture (USDA) methods and procedures.

Topsoil and Fill

Topsoil was observed extending to depths of approximately 6 to 12 inches below existing grades. The topsoil thickness is variable and vegetation roots often extend below the topsoil zone into the underlying weathered native soil. The topsoil was characterized by dark brown color and fine organic material. Topsoil is not suitable for use as structural fill nor should it be mixed with material to be used as structural fill. Topsoil or otherwise unsuitable material can be used in landscape areas if desired.

Fill was not encountered within the test pits; however, fill is likely present near the existing structures to some degree. If fill is encountered during construction, ESNW should be consulted to verify the suitability for support of the proposed structures and/or reuse as structural fill.

Native Soil

Underlying the topsoil, native soils consisted primarily of medium dense to dense poorly and well-graded gravel with variable sand (USCS: GP and GW respectively). The native soils were generally encountered in a damp to moist condition and extended to the maximum exploration depth of 13 feet below ground surface (bgs). We encountered scattered large cobbles and small boulders at the test pit locations.

Geologic Setting

The referenced geologic map resource identifies recessional outwash, specifically Vashon drift gravel (Qdvg), across the site and surrounding areas. The referenced WSS resource identifies Spanaway gravelly sandy loam (Map Unit Symbols: 110 and 111) across the site and surrounding areas. Spanaway gravelly loam was formed in outwash plains. Based on our field observations, native soils on site are generally consistent with the geologic setting outlined in this section.

Groundwater

Groundwater was not encountered, at the time of our exploration (August 31, 2021). Groundwater seepage rates and elevations fluctuate depending on many factors, including precipitation duration and intensity, the time of year, and soil conditions. In general, groundwater flow rates are higher during the wetter, winter, spring, and early summer months.

Geologically Hazardous Areas

As part of this report, the subject property was evaluated for the presence of geologically hazardous areas in general accordance with the applicable Yelm municipal code. Based on our investigation, the site does not lie within or is immediately adjacent to geologically hazardous areas.

DISCUSSION AND RECOMMENDATIONS

General

In our opinion, the proposed residential structures can be supported on conventional spread and continuous foundations bearing on undisturbed competent native soil, recompacted native soil or new structural fill placed directly on competent native soil. Competent soils suitable for support of foundations are anticipated to be exposed at depths of about two to four feet below existing grades across the majority of the site. Slab-on-grade floors should be supported on competent native soil, re-compacted native soil, or new structural fill. Organic material exposed at subgrade elevations must be removed below design elevation and grades restored with structural fill. Where loose, organic or other unsuitable materials are encountered at or below the footing subgrade elevation, the material should be removed and replaced with structural fill, as necessary.

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

Site Preparation and Earthwork

Site preparation activities will consist of installing temporary erosion control measures and performing clearing and site stripping. Grading activities will likely consist of cuts and fills on the order five feet with the deeper cuts associated with stormwater facilities and utility excavations.

Temporary Erosion Control

Temporary construction entrances and drive lanes, consisting of at least six inches of quarry spalls, should be considered in order to minimize off-site soil tracking and to provide a temporary road surface. Temporary slopes and stockpiles should be covered when not in use. Silt fencing should be installed along the margins of the property. Temporary infiltration swales and galleries can be considered for control of stormwater. Erosion control measures should conform to the applicable Washington State Department of Ecology and City of Yelm/Thurston County standards.

In-Situ Soils

The majority of the soils encountered during our subsurface exploration have a low to moderate sensitivity to moisture and were generally in a damp to moist condition at the time of the exploration on August 2021. Soils encountered during site excavations that are excessively over the optimum moisture content will require aeration or treatment prior to placement and compaction. Conversely, soils that are substantially below the optimum moisture content will require moisture conditioning through the addition of water prior to use as structural fill. An ESNW representative should determine the suitability of in-situ soils for use as structural fill at the time of construction.

Wet Season Grading

If grading takes place during the wet season surface water could collect and degrade site soils if not property controlled. The contractor should establish temporary drainage control measures, such as swales and ponds, prior to extended wet weather. ESNW should be consulted during construction to provide temporary drainage control recommendations.

Structural Fill

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, and roadway areas. Fills placed to construct permanent slopes and throughout retaining wall and utility trench backfill areas are considered structural fill as well. Soils placed in structural areas should be placed in loose lifts of 12 inches or less and compacted to a relative compaction of 95 percent, based on the laboratory maximum dry density as determined by the Modified Proctor Method (ASTM D1557). More stringent compaction specifications may be required for utility trench backfill zones depending on the responsible utility district or jurisdiction.

Excavations and Slopes

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

Based on the soil conditions encountered at the test pit locations, site soils are classified as Type C by OSHA. New fill should also be considered Type C soil. Temporary slopes over four feet in height in Type C soils must be sloped no steeper than (1.5H:1V). Steeper temporary slopes may be feasible and should be evaluated by ESNW during construction. Where encountered, the presence of groundwater seepage may cause caving of temporary slopes. ESNW should observe site excavations to confirm soil types and allowable slope inclinations. If the recommended temporary slope inclinations cannot be achieved, temporary shoring may be necessary to support excavations, particularly utility trench excavations.

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

Foundations

The proposed residential structures can be supported on conventional spread and continuous footings bearing on undisturbed competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. Based on the soil conditions encountered at the test sites, competent soils suitable for support of foundations are anticipated to be exposed at depths of about two to four feet below existing grades across the majority of the site. Where loose or unsuitable soil conditions are observed at foundation subgrade elevations, compaction of the soils to the specifications of structural fill, or overexcavation and replacement with granular structural fill will be necessary. Organic material exposed at foundation subgrade elevations must be removed and grades restored with structural fill.

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

- Allowable soil bearing capacity — 2,500 psf
- Passive earth pressure — 300 pcf (equivalent fluid)
- Coefficient of friction — 0.40

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

With structural loading as expected, total settlement in the range of 1.0 inch is anticipated, with differential settlement of about 0.5 inch. The majority of the settlements should occur during construction, as dead loads are applied.

Seismic Design Considerations

The 2018 International Building Code (2018 IBC) recognizes the most recent edition of the Minimum Design Loads for Buildings and Other Structures manual (ASCE 7-16) for seismic design, specifically with respect to earthquake loads. Based on the soil conditions encountered at the test pit locations, the parameters and values provided below are recommended for seismic design per the 2018 IBC.

Parameter	Value
Site Class	D*
Mapped short period spectral response acceleration, S_S (*g*)	1.291
Mapped 1-second period spectral response acceleration, S_1 (*g*)	0.466
Short period site coefficient, F_a	1
Long period site coefficient, F_v	1.88†
Adjusted short period spectral response acceleration, S_{MS} (*g*)	1.291
Adjusted 1-second period spectral response acceleration, S_{M1} (*g*)	0.876†
Design short period spectral response acceleration, S_{DS} (*g*)	0.861
Design 1-second period spectral response acceleration, S_{D1} (*g*)	0.584†

* *Assumes medium dense native soil conditions, encountered to a maximum depth of 13 feet bgs during the August 2021 field exploration, remain medium dense or better to at least 100 feet bgs.*

† *Values assume F_v may be determined using linear interpolation per Table 11.4-2 in ASCE 7-16.*

As indicated in the table footnote, several of the seismic design values provided above are dependent on the assumption that site-specific ground motion analysis (per Section 11.4.8 of ASCE 7-16) will not be required for the subject project. ESNW recommends the validity of this assumption be confirmed at the earliest available opportunity during the planning and early design stages of the project. Further discussion between the project structural engineer, the project owner, and ESNW may be prudent to determine the possible impacts to the structural design due to increased earthquake load requirements under the 2018 IBC. ESNW can provide additional consulting services to aid with design efforts, including supplementary geotechnical and geophysical investigation, upon request.

Liquefaction is a phenomenon where saturated or loose soil suddenly loses internal strength and behaves as a fluid. This behavior is in response to increased pore water pressures resulting from an earthquake or another intense ground shaking. In our opinion, site susceptibility to liquefaction may be considered low. The depth of the local groundwater table and the gradation and relatively dense characteristics of the native soil were the primary bases for this opinion.

Slab-on-Grade Floors

Slab-on-grade floors for the proposed residential structures should be supported on a firm and unyielding subgrade. Unstable or yielding areas of the subgrade should be recompacted, or overexcavated and replaced with suitable structural fill, prior to construction of the slab.

A capillary break consisting of a minimum of four inches of free-draining crushed rock or gravel should be placed below the slab. The free-draining material should have a fines content of 5 percent or less (percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction). In areas where slab moisture is undesirable, installation of a vapor barrier below the slab should be considered. If a vapor barrier is to be utilized, it should be a material specifically designed for use as a vapor barrier and should be installed in accordance with the specifications of the manufacturer.

Retaining Walls

Retaining walls must be designed to resist earth pressures and applicable surcharge loads. The following parameters can be used for retaining wall design:

- Active earth pressure (unrestrained condition) 35 pcf
- At-rest earth pressure (restrained condition) 55 pcf
- Traffic surcharge (passenger vehicles) 70 psf (rectangular distribution)
- Passive earth pressure 300 pcf
- Coefficient of friction 0.40
- Seismic surcharge 8H*

* *Where H equals the retained height.*

Additional surcharge loading from adjacent foundations, sloped backfill, retaining walls, or other loads should be included in the retaining wall design. Drainage should be provided behind retaining walls such that hydrostatic pressures do not develop. If drainage is not provided, hydrostatic pressures should be included in the wall design.

Retaining walls should be backfilled with at least 18 inches of free-draining material or suitable sheet drainage that extends along the height of the wall. The upper one foot of the wall backfill can consist of a less permeable soil, if desired. A perforated drain pipe should be placed along the base of the wall and connected to an approved discharge location. A typical retaining wall drainage detail is provided on Plate 3.

Drainage

Based on our field observations, the native soils generally consisted of well-drained, poorly to well-graded gravels with slightly variable sand contents. Because of the generally well-drained nature of the native gravels, significant groundwater is not anticipated to be encountered within shallow site excavations. ESNW should be consulted during preliminary grading to identify areas of seepage (if present) and provide recommendations to reduce the potential for instability related to seepage effects.

Finish grades must be designed to direct surface drain water away from structures and slopes. The grade adjacent to buildings should be sloped away from the buildings at a gradient of at least 2 percent for a horizontal distance of at least 10 feet or more as setbacks allow. Water must not be allowed to pond adjacent to structures or slopes. Based on our field observations, it may be feasible to eliminate foundation drains, provided clean, well-drained deposits are exposed at footing subgrade elevation. However, confirmation should be provided by ESNW at the time of construction. A typical foundation drain detail is provided on Plate 4.

Infiltration Evaluation

We conducted in-situ pilot infiltration tests (PITs) at the two areas proposed for infiltration within the overall development. The PITs were completed at test pit locations TP-1 and TP-4 within native soils about 8 to 10 feet below existing grades. As indicated in the *Subsurface* section of this report, native soils encountered during our fieldwork were characterized primarily as Spanaway gravels with variable sand content. Based upon the results of USDA textural analyses performed on representative soil samples, native soils may also be classified chiefly as extremely gravelly coarse sand. Irrespective of gravel content, fines contents within the native gravels were generally less than one percent.

Test Method

The bottom of each PIT area was set at the approximate design facility bottom as recommended in the Method 1 Field Test Methods section of Appendix III-A. Water was metered into each PIT area using a pump fed hose to develop a constant head of about one foot. The hydraulic head was maintained until the water truck was emptied (3,800-gallon capacity), and measurements of flow for each test area was monitored by our field staff. Upon completion of the constant head soaking period, the water source was removed and each test area was allowed to drain. Upon drained conditions, the test pits were advanced to the limits of the excavator to determine soil stratigraphy and check for groundwater.

Test Results

Our testing yielded measured (unfactored) infiltration rates of between 90 and 180 inches per hour (iph). The correction factors below were applied to the measured rates.

Correction Factor	Value
Test Method	0.5
Geometry	0.9*
Plugging	0.9

* *This value is estimated based on typical pond geometry and uses information collected during the testing.*

The total correction factor applied to the measured infiltration rates was 0.4. The resulting long-term (design) infiltration rate is 36 iph. These rates were calculated using the lowest measured infiltration rate.

Soil Types and Site Variability

We conducted USDA textural analyses of representative soil samples collected at the PIT areas. On this basis, the majority of the native soil within the proposed areas consist of extremely gravelly coarse sand. The samples collected at the tested locations indicated consistent soil types across the site, with low variability.

Restrictive Layer

On this site, the restrictive layer is groundwater, as the alluvial sand and gravel persisted to the maximum exploration depth at each location. The groundwater was not identified on this site at the test pit locations during our fieldwork.

Summary and Recommendations

From a geotechnical standpoint, it is our opinion that the native gravels are suitable for infiltration. The low soil variability consisting of a consistent thick layer of sand and gravel and low fines contents within the gravels are the basis of this conclusion. Based on the results of our PIT program, a long-term infiltration rate of 36 iph may be used for the current infiltration trench design that will expose coarse gravel soils. Successful performance of the infiltration systems requires that the base of the facility (receptor soils) exposed sandy soils similar to those encountered at the test depth. The minimum vertical separation and corresponding trench base elevations detailed in the referenced groundwater summary should be incorporated into facility designs. ESNW should review final designs to confirm the recommendations provided in this letter report are incorporated. ESNW should be retained to observe construction of the infiltration facility areas during grading to confirm conditions are as anticipated. This site is identified as a highly susceptible critical aquifer recharge area per YMC section 18.21.070 and will require performance standards within this section to be met as part of the project design.

Utility Support and Trench Backfill

In our opinion, the soils observed at the test pit locations are generally suitable for support of utilities. The native soils observed at the test pit locations are likely suitable for use as structural backfill in the utility trench excavations. Utility trench backfill should be placed and compacted to the specifications of structural fill provided in this report, or to the applicable requirements of presiding jurisdiction. Native sands and gravels used as backfill should be appropriately moisture conditioned through the addition of water to mitigate the settlement potential.

Native soils proposed for use as utility trench backfill should contain aggregate of six inches in diameter or less. Caving of the trench sidewalls should be expected and will require temporary shoring to ensure safety is maintained during utility installation.

Pavement Sections

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

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

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

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

- Three inches of HMA placed over six inches of crushed rock base (CRB), or;
- Three inches of HMA placed over four-and-one-half inches of ATB.

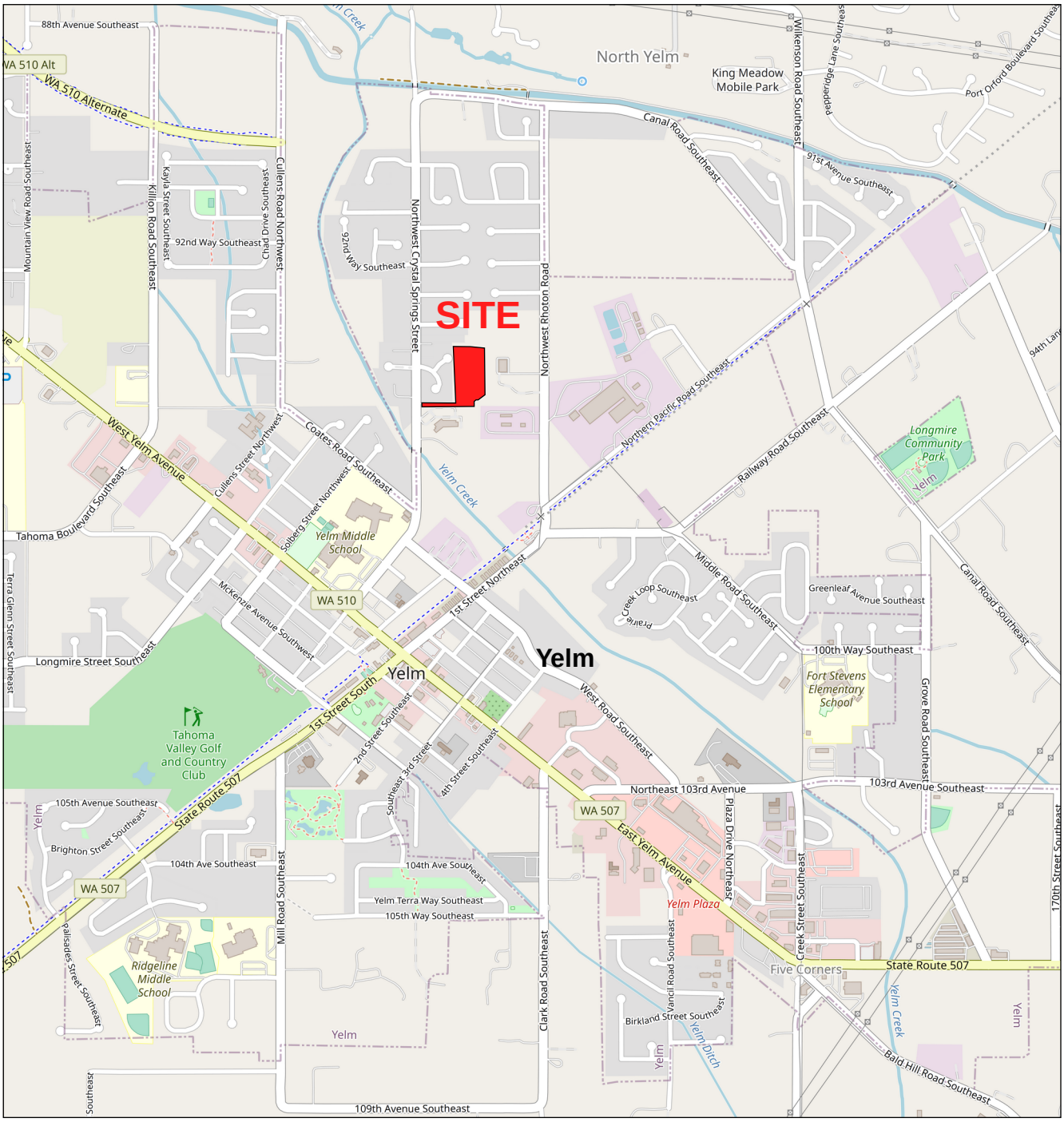
The HMA, CRB and ATB materials should conform to WSDOT specifications. Thurston County/City of Yelm minimum pavement requirements may supersede our recommendations and may require thicker pavement sections.

LIMITATIONS

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

Additional Services

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



Reference:
Thurston County, Washington
OpenStreetMap.org

NORTH

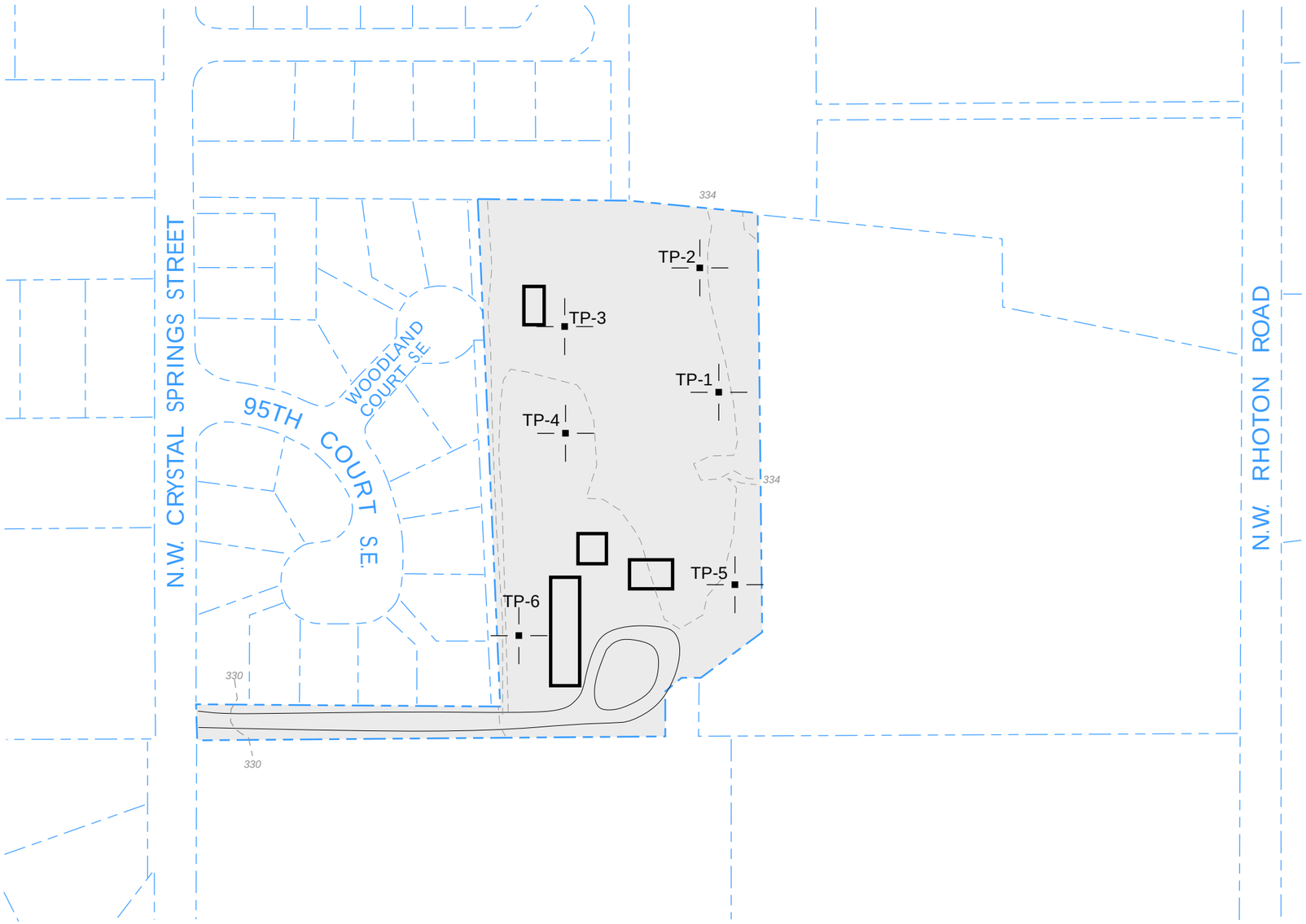
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Vicinity Map
Crystal Springs
Yelm, Washington

Drwn. MRS	Date 09/20/2021	Proj. No. 8113
Checked SKH	Date Sept. 2021	Plate 1



LEGEND

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-8113, Aug. 2021

Subject Site

Existing Building

NORTH

1"=150'

0 75 150

Scale in Feet

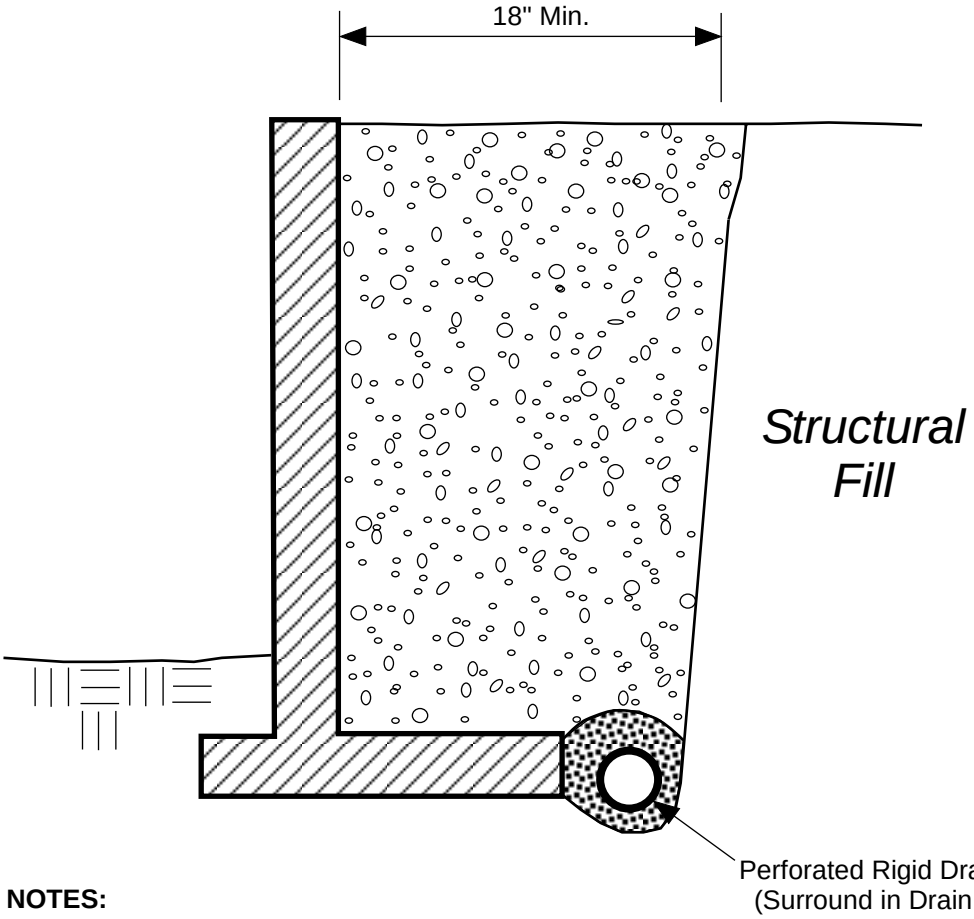
NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided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

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

Test Pit Location Plan
Crystal Springs
Yelm, Washington

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Drwn. By	MRS
Checked By	SKH
Date	09/20/2021
Proj. No.	8113
Plate	2



NOTES:

- Free-draining Backfill should consist of soil having less than 5 percent fines. Percent passing No. 4 sieve should be 25 to 75 percent.
- Sheet Drain may be feasible in lieu of Free-draining Backfill, per ESNW recommendations.
- Drain Pipe should consist of perforated, rigid PVC Pipe surrounded with 1-inch Drain Rock.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

Free-draining Structural Backfill

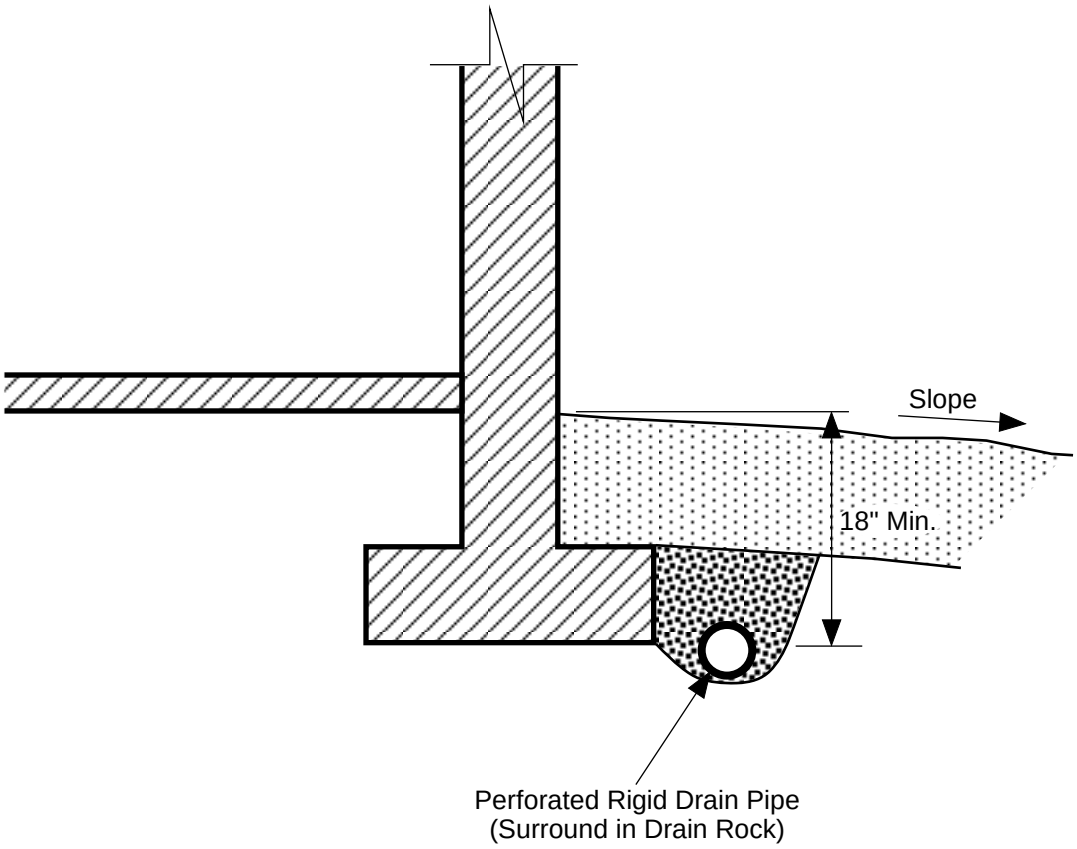
1-inch Drain Rock

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Retaining Wall Drainage Detail
Crystal Springs
Yelm, Washington

Drwn. CAM	Date 10/06/2021	Proj. No. 8113
Checked SSR	Date Oct. 2021	Plate 3



NOTES:

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

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

Surface Seal: native soil or other low-permeability material.

1-inch Drain Rock

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Footing Drain Detail
Crystal Springs
Yelm, Washington

Drwn. CAM	Date 10/06/2021	Proj. No. 8113
Checked SSR	Date Oct. 2021	Plate 4

Appendix A

Subsurface Exploration
Test Pit Logs

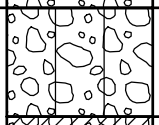
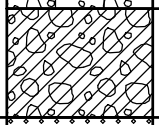
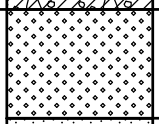
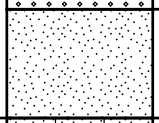
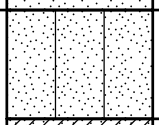
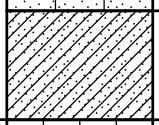
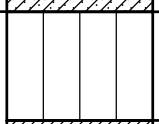
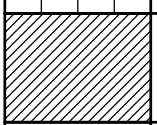
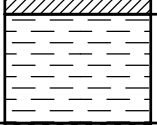
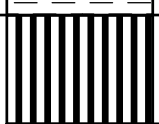
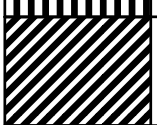
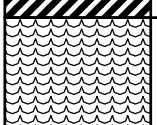
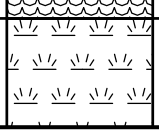
ES-8113

The subsurface conditions at the site were explored by excavating six test pits at the approximate locations illustrated on Plate 2 of this report. The test pit logs are provided in this Appendix. The subsurface exploration was completed on August 31, 2021 to a maximum depth of 13 feet below existing grades.

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

Earth Solutions NW LLC

SOIL CLASSIFICATION CHART

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

DUAL SYMBOLS are used to indicate borderline soil classifications.

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

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-1

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs
DATE STARTED 8/31/21 **COMPLETED** 8/31/21 **GROUND ELEVATION** +-334
EXCAVATION CONTRACTOR Client Provided **LATITUDE** 46.95015 **LONGITUDE** -122.60337
EXCAVATION METHOD **GROUND WATER LEVEL:**
LOGGED BY SKH **CHECKED BY** SSR ▽ **AT TIME OF EXCAVATION**
NOTES Depth of Topsoil & Sod 12": field grass

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, abundant roots
				1.0	
					Brown poorly graded GRAVEL with sand, medium dense, damp
		MC = 2.5%			
					-abundant cobbles and small boulders present throughout
5					
					-minor caving to BOH
			GP		
	GB	MC = 2.3% Fines = 1.2%			[USDA Classification: extremely gravelly coarse SAND]
10					
					-infiltration test
				11.5	
					Brown poorly graded GRAVEL, dense, damp
			GP		
		MC = 3.8% Fines = 0.3%			[USDA Classification: extremely gravelly coarse SAND]
				13.0	
					Test pit terminated at 13.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 5.0 to 13.0 feet.

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TEST PIT NUMBER TP-2

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs
DATE STARTED 8/31/21 **COMPLETED** 8/31/21 **GROUND ELEVATION** +-334
EXCAVATION CONTRACTOR Client Provided **LATITUDE** 46.95049 **LONGITUDE** -122.60344
EXCAVATION METHOD **GROUND WATER LEVEL:**
LOGGED BY SKH **CHECKED BY** SSR ▽ **AT TIME OF EXCAVATION**
NOTES Depth of Topsoil & Sod 12": field grass

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, abundant roots
				1.0	
					Brown poorly graded GRAVEL with sand, medium dense, damp
		MC = 3.6%			-abundant cobbles and small boulders present throughout
					-minor caving from 3.5' to BOH
5			GP		
		MC = 9.3% Fines = 0.9%			-becomes moist [USDA Classification: extremely gravelly coarse SAND]
10					
					-becomes damp
		MC = 3.0% Fines = 0.4%		11.5	[USDA Classification: extremely gravelly coarse SAND]
					Test pit terminated at 11.5 feet below existing grade. No groundwater encountered during excavation. Caving observed from 3.5 feet to BOH.

Earth Solutions NW, LLC
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TEST PIT NUMBER TP-3

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs
DATE STARTED 8/31/21 **COMPLETED** 8/31/21 **GROUND ELEVATION** +-333
EXCAVATION CONTRACTOR Client Provided **LATITUDE** 46.95036 **LONGITUDE** -122.60414
EXCAVATION METHOD **GROUND WATER LEVEL:**
LOGGED BY SKH **CHECKED BY** SSR ▽ **AT TIME OF EXCAVATION**
NOTES Depth of Topsoil & Sod 12": field grass

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, abundant roots
				1.0	Brown well-graded GRAVEL with sand, medium dense, damp
		MC = 1.4% Fines = 0.4%			[USDA Classification: extremely gravelly coarse SAND]
					-abundant cobbles and small boulders present throughout
5			GW		-becomes very dense
					-minor caving from 8' to BOH
				9.0	Brown well-graded GRAVEL, dense, damp
10			GW		
		MC = 1.8% Fines = 0.4%		11.0	[USDA Classification: extremely gravelly coarse SAND]
					Test pit terminated at 11.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 8.0 feet to BOH.

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
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Fax: 425-449-4711

TEST PIT NUMBER TP-4

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs
DATE STARTED 8/31/21 **COMPLETED** 8/31/21 **GROUND ELEVATION** +-331
EXCAVATION CONTRACTOR Client Provided **LATITUDE** 46.95006 **LONGITUDE** -122.60413
EXCAVATION METHOD **GROUND WATER LEVEL:**
LOGGED BY SKH **CHECKED BY** SSR ▽ **AT TIME OF EXCAVATION**
NOTES Depth of Topsoil & Sod 12": field grass

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, abundant roots
				1.0	
			GW		Brown well-graded GRAVEL with sand, medium dense, damp
		MC = 1.8%			-abundant cobbles and small boulders present throughout
					-minor caving from 4' to BOH
5					
		MC = 2.1% Fines = 0.7%			-infiltration test [USDA Classification: extremely gravelly coarse SAND]
				9.5	
10			GP		Brown poorly graded GRAVEL with sand, medium dense, damp
		MC = 3.5% Fines = 0.4%		11.0	[USDA Classification: extremely gravelly coarse SAND]
					Test pit terminated at 11.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 4.0 feet to BOH.

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
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Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-5

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs
DATE STARTED 8/31/21 **COMPLETED** 8/31/21 **GROUND ELEVATION** +-332
EXCAVATION CONTRACTOR Client Provided **LATITUDE** 46.9495 **LONGITUDE** -122.60331
EXCAVATION METHOD **GROUND WATER LEVEL:**
LOGGED BY SKH **CHECKED BY** SSR ▽ **AT TIME OF EXCAVATION**
NOTES Depth of Topsoil & Sod 6": field grass

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, abundant fine roots
				0.5	Brown poorly graded GRAVEL with sand, dense, damp
		MC = 2.4%			-abundant cobbles and small boulders present throughout
					-minor caving from 4' to 6'
5			GP		-minor mottling
					-major caving from 6' to BOH
		MC = 1.7% Fines = 0.1%			[USDA Classification: extremely gravelly coarse SAND]
10					
		MC = 2.8%		10.5	

Test pit terminated at 10.5 feet below existing grade. No groundwater encountered during excavation. Caving observed from 4.0 feet to BOH.

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-6

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs
DATE STARTED 8/31/21 **COMPLETED** 8/31/21 **GROUND ELEVATION** +-331
EXCAVATION CONTRACTOR Client Provided **LATITUDE** 46.94935 **LONGITUDE** -122.60438
EXCAVATION METHOD **GROUND WATER LEVEL:**
LOGGED BY SKH **CHECKED BY** SSR ▽ **AT TIME OF EXCAVATION**
NOTES Depth of Topsoil & Sod 12": field grass

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, abundant fine roots
1.0					Brown poorly graded GRAVEL with sand, medium dense, damp
		MC = 2.1%			-abundant cobbles and small boulders present throughout
5					-minor caving from 4.5' to BOH
	GB	MC = 2.9% Fines = 0.7%	GP		[USDA Classification: extremely gravelly coarse SAND]
					-becomes moist
10					
12.5		MC = 3.8%			Test pit terminated at 12.5 feet below existing grade. No groundwater encountered during excavation. Caving observed from 4.5 feet to BOH.

Appendix B

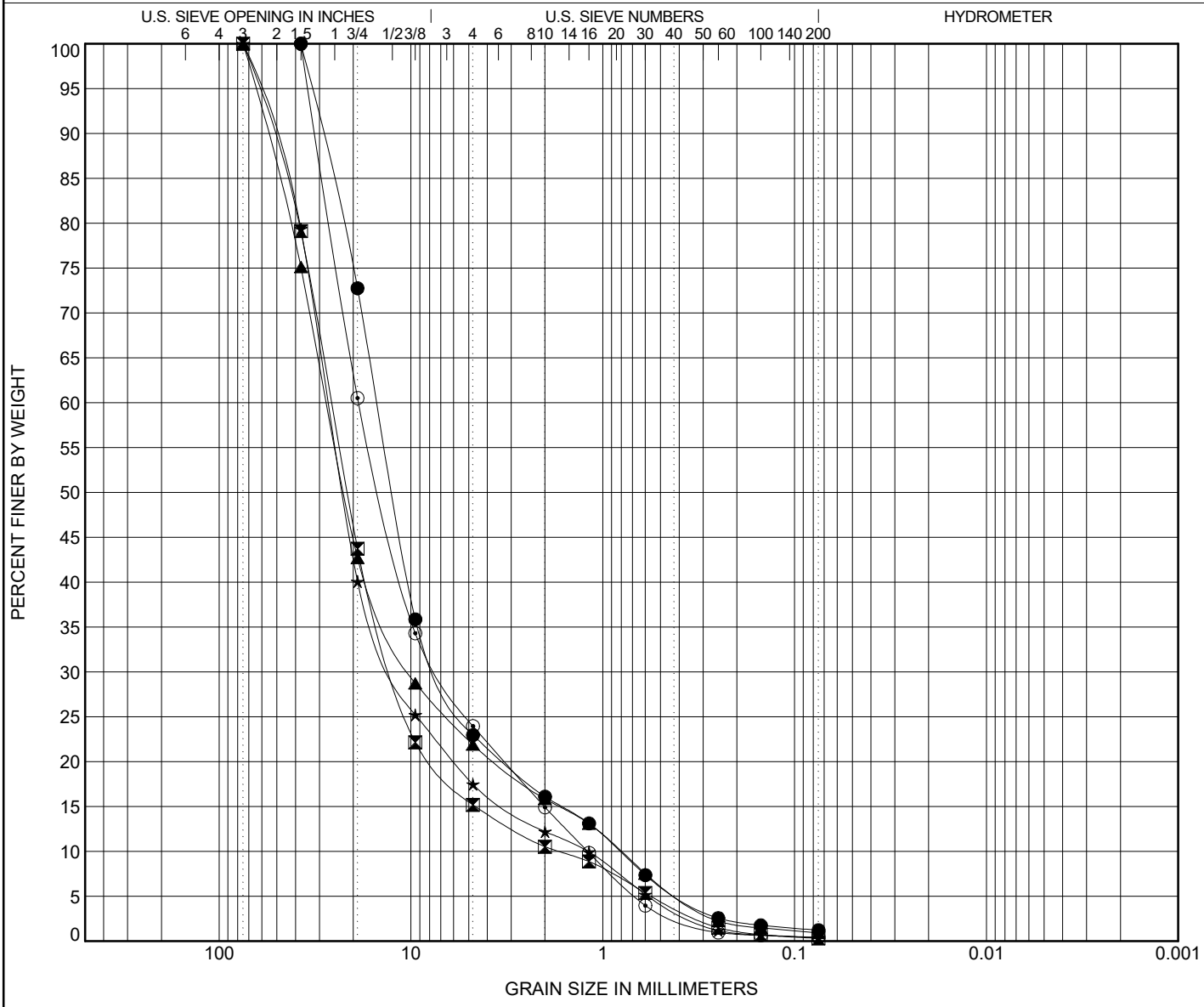
Laboratory Test Results

ES-8113

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	Cc	Cu
●	TP-01	7.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP with Sand.	3.93	18.27
⊠	TP-01	13.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP.	3.40	15.34
▲	TP-02	8.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP with Sand.	4.62	33.69
★	TP-02	11.50ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP with Sand.	4.39	22.41
⊙	TP-03	2.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GW with Sand.	2.25	15.61

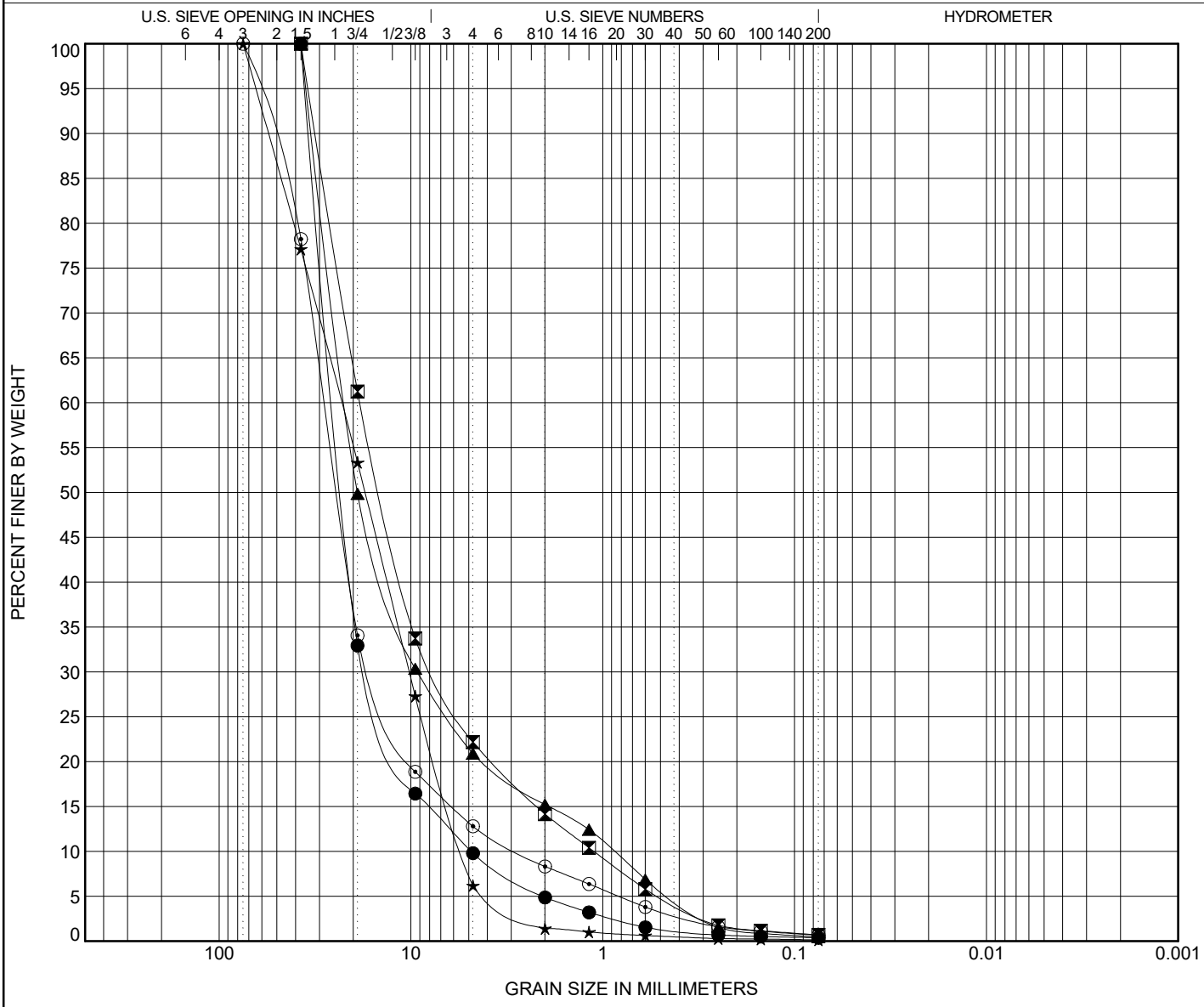
Specimen Identification			D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	TP-01	7.0ft.	37.5	14.952	6.934	0.818				1.2	
⊠	TP-01	13.0ft.	75	25.97	12.226	1.693				0.3	
▲	TP-02	8.0ft.	75	27.313	10.116	0.811				0.9	
★	TP-02	11.5ft.	75	26.824	11.877	1.197				0.4	
⊙	TP-03	2.0ft.	37.5	18.742	7.12	1.2				0.4	

GRAIN SIZE USDA ES-8113 CRYSTAL SPRINGS.GPJ GINT US LAB.GDT 9/9/21

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	Cc	Cu
●	TP-03	11.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GW.	2.33	5.16
⊠	TP-04	8.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GW with Sand.	2.81	16.56
▲	TP-04	11.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP with Sand.	4.47	24.81
★	TP-05	7.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP.	0.84	4.27
⊙	TP-06	7.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP.	3.18	10.23

Specimen Identification			D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	TP-03	11.0ft.	37.5	24.998	16.792	4.849				0.4	
⊠	TP-04	8.0ft.	37.5	18.42	7.591	1.112				0.7	
▲	TP-04	11.0ft.	37.5	21.805	9.26	0.879				0.4	
★	TP-05	7.0ft.	75	22.982	10.206	5.383				0.1	
⊙	TP-06	7.0ft.	75	28.324	15.784	2.768				0.7	

GRAIN SIZE USDA ES-8113 CRYSTAL SPRINGS.GPJ GINT US LAB.GDT 9/9/21

Report Distribution

ES-8113

EMAIL ONLY

Copper Ridge, LLC
P.O. Box 73790
Puyallup, Washington 98373

Attention: Mr. Evan Mann

EnviroVector
1441 West Bay Drive, Suite 301
Olympia, WA 98502

Phone: (360) 790-1559
Email: curtis@envirovector.com

www.envirovector.com

24 August 2021

Evan Mann
Soundbuilt Homes
PO BOX 73790
Puyallup, WA 98373

Reference: 714 Crystal Springs Road
Subject: Mazama Pocket Gopher Screening to Satisfy the City of Yelm Permitting Requirements

Dear, Evan Mann:

At your request, this report has been prepared to satisfy the City of Yelm requirements for Mazama pocket gopher screenings on the subject property (**Table 1; Figure 1**).

Table 1. Parcels Comprising Subject Property

No#	Property Address	Parcel Number	Map Coordinates	Property Size (Acres)
1	714 Crystal Springs Rd SE, Yelm, WA	22719210403	Section 19 Township 17 Range 2E	4.89
1 Parcel	Total Size			4.89 acres

The permitting jurisdiction is the City of Yelm.

1.0 INTRODUCTION

The Mazama pocket gopher is a Federally Threatened species protected under the Endangered Species Act (ESA) and the City of Yelm requirements. Mazama pocket gopher screenings were performed by a qualified biologist certified by the US Fish and Wildlife Service (USFWS) for the purpose of satisfying City of Yelm requirements for a Mazama pocket gopher screening.

The City has determined that a Mazama pocket gopher screening is necessary to comply with the City of Yelm requirements and the ESA.

1.2 Screening Date

The Mazama pocket gopher screening was performed on 16 June 2021.

2.0 METHODOLOGY

The screening was performed within the USFWS prescribed survey window (June 1 through October 31) also in compliance with Thurston County (2021) Site Inspection Protocol and Procedures: Mazama Pocket Gopher.

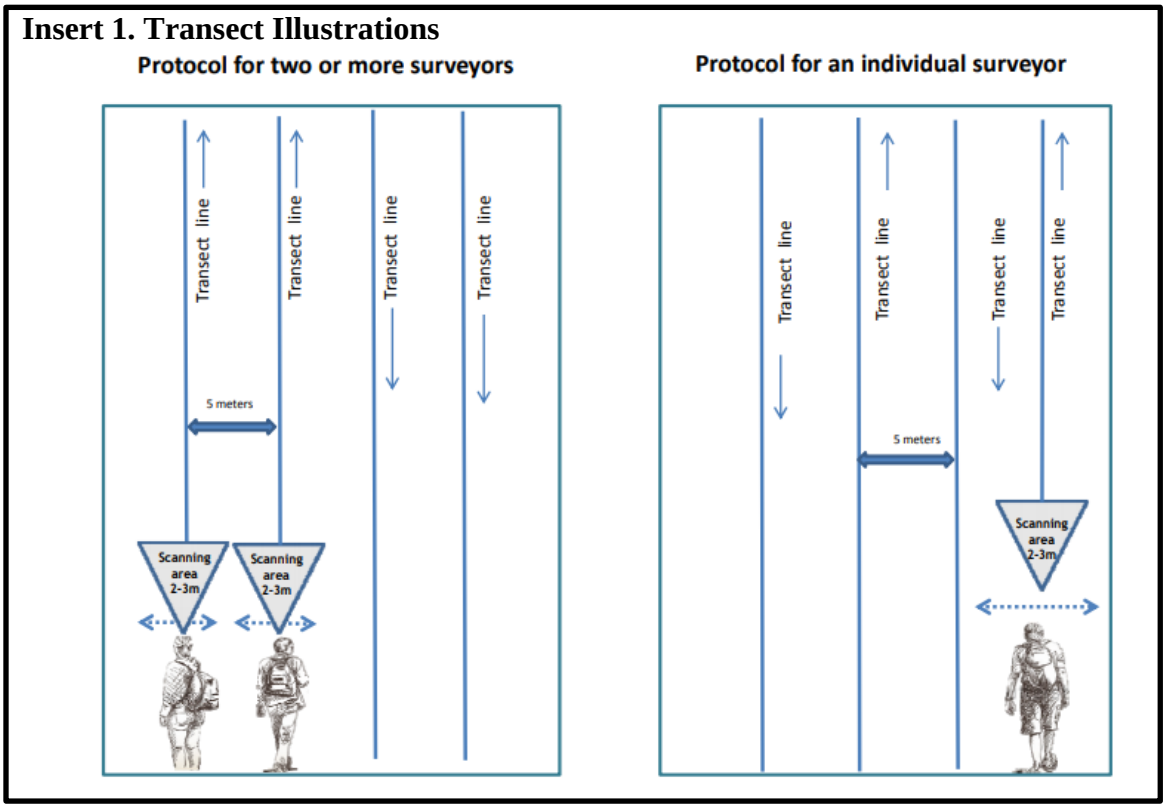
In compliance with the Thurston County (2021) Site Inspection Protocol and Procedures: Mazama Pocket Gopher:

- The study has occurred during the prescribed work window of June 1 to October 31.
- A qualified biologist performed the screenings that has been trained and certified by the USFWS.
- The entire property was evaluated.
- The areas of the property covered under the screening survey is illustrated in **Figure 2**.
- The ground was easily visible.

The site evaluation was performed utilizing USFWS recommended protocol for one (1) surveyor (**Insert 1**). The search pattern had been performed along five (5) meter transects, including brushy and treed areas, examined for any evidence of mounding activity created by the Mazama pocket gopher.

The site evaluation was conducted utilizing USFWS recommended protocol for one (1) surveyor (**Insert 1**). The search pattern had been performed along five (5) meter transects, including brushy and treed areas, examined for any evidence of mounding activity created by the Mazama pocket gopher.

Insert 1. Transect Illustrations



The detailed field methodology follows the Thurston County (2021) Site Inspection Protocol and Procedures: Mazama Pocket Gopher as follows:

1. The survey crew orients themselves with the layout of the property using aerial maps and strategizes their route for walking through the property.
2. Start GPS to record survey route.
3. Walk the survey transects methodically, slowly walking a straight line and scanning an area approximately 2-3 meters to the left and right as you walk, looking for mounds. Transects should be no more than five (5) meters apart when conducted by a single individual.
4. If the survey is performed by a team, walk together in parallel lines approximately five (5) meters apart while you are scanning left to right for mounds.
5. At each mound found, stop and identify it as a MPG or mole mound. If it is a MPG mound, identify it as a singular mound or a group (3 mounds or more) on a data sheet to be submitted to the County.
6. Record all positive MPG mounds, likely MPG mounds, and MPG mound groups in a GPS unit that provides a date, time, georeferenced point, and other required information in County GPS data instruction for each MPG mound. Submit GPS data in a form acceptable to the County.
7. Photograph all MPG mounds or MPG mound groups. At a minimum, photograph MPG mounds or MPG mound groups representative of MPG detections on site.
8. Photos of mounds should include one that has identifiable landscape features for reference. In order to accurately depict the presence of gopher activity on a specific property, the following series of photos should be submitted to the County:
    a. At least one up-close photo to depict mound characteristics
    b. At least one photo depicting groups of mounds as a whole (when groups are encountered).
    c. At least one photo depicting gopher mounds with recognizable landscape features in the background, at each location where mounds are detected on a property
    d. Photos can be taken with the GPS unit or a separate, camera, preferably a camera with locational features (latitude, longitude)
    e. Photo point description or noteworthy landscape or other features to aid in relocation. Additional photos to be considered
    f. The approximate building footprint location from at least two cardinal directions.
    g. Landscape photos to depict habitat type and in some cases to indicate why not all portions of a property require gopher screening.
9. Describe and/or quantify what portion and proportion of the property was screened, and record your survey route and any MPG mounds found on either an aerial or parcel map.
10. If MPG mounds are observed on a site, that day's survey effort should continue until the entire site is screened and all mounds present identified, but additional site visits are not required.

Soils known to be associated with the Mazama pocket gopher are listed in **Insert 2**.

Insert 2. Mazama pocket gopher soils

Table 1. Soils known to be associated with Mazama pocket gopher occupancy.

Mazama Pocket Gopher Preference	Soil Type
More Preferred (formerly High and Medium Preference Soils)	Nisqually loamy fine sand, 0 to 3 percent slopes Nisqually loamy fine sand, 3 to 15 percent slopes Spanaway-Nisqually complex, 2 to 10 percent slopes Cagey loamy sand Indianola loamy sand, 0 to 3 percent slopes Spanaway gravelly sandy loam, 0 to 3 percent slopes Spanaway gravelly sandy loam, 3 to 15% slopes
Less Preferred (formerly Low Preference Soils)	Alderwood gravelly sandy loam, 0 to 3 percent slopes Alderwood gravelly sandy loam, 3 to 15 percent slopes Everett very gravelly sandy loam, 0 to 3 percent slopes Everett very gravelly sandy loam, 3 to 15 percent slopes Indianola loamy sand, 3 to 15 percent slopes Kapowsin silt loam, 3 to 15 percent slopes McKenna gravelly silt loam, 0 to 5 percent slopes Norma fine sandy loam Norma silt loam Spana gravelly loam Spanaway stony sandy loam, 0 to 3 percent slopes Spanaway stony sandy loam, 3 to 15 percent slopes Yelm fine sandy loam, 0 to 3 percent slopes Yelm fine sandy loam, 3 to 15 percent slopes

3.0 BACKGROUND INFORMATION

3.1 Thurston County Geodatabase Soils

Two (2) soil types are mapped on the subject property, Spanaway gravelly sandy loam, 0 to 3% slopes% (More preferred gopher soil) and Spanaway gravelly sandy loam, 3 to 15% (More preferred gopher soil), by the Thurston County Geodatabase (**Appendix B & C, Table 1**).

Table 1. Summary of Soil Preference

Soil Unit	Gopher Soil	Preference	Comments
Spanaway gravelly sandy loam, 0 to 3% slopes	Yes	More preferred	Along on eastern and western portions of the property
Spanaway gravelly sandy loam, 3 to 15% slopes	Yes	More preferred	Located in north-south strip on property

3.2 WDFW PHS Database

No Mazama pocket gopher occurrences are mapped on or within six hundred (600) feet of subject property by the Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) database (**Appendix D**).

Chinook (*Oncorhynchus tshawytscha*), Chum (*Oncorhynchus keta*), Cutthroat (*Oncorhynchus clarki*), Coho (*Oncorhynchus kisutch*), Sockeye (*Oncorhynchus nerka*), Steelhead (*Oncorhynchus mykiss*), and Pink Salmon (*Oncorhynchus gorbuscha*) are mapped in a stream approximately three hundred (300) feet southwest of the subject property.

Big eared bat (*Corynorhinus townsendii*) and Yuma myotis (*Myotis yumanensis*) have been mapped in the Township where the subject property is located.

4.0 FIELD RESULTS

4.1 Mazama Pocket Gopher Site Evaluation

No mounds characteristic of that created by the Mazama pocket gopher have been identified on the subject property during the 16 June 2021 site screening. The entire site consists of a flat, open mowed field of lawn grasses, non-native lawn weeds. The northern portion of the subject property consists of unmaintained sheds and a barn. The southern portion of the subject property includes a gravel driveway, two (2) unmaintained barns, manmade pond, and a single-family residence (**Figure 2**; **Appendix A**).

The subject property is surrounded by high intensity land uses, discouraging Mazama pocket gopher migration onto the property from surrounding land (**Figure 3**). Neighboring properties to the north and west of the subject property consist of high-intensity residential development (**Figure 3; Appendix A, Photos 1, 21, & 22**). High-intensity commercial development occurs south and east of the subject property (**Figure 3; Appendix A, Photos 2, 12, & 19**). Mole mounds were identified on the northern property boundary (**Appendix A, Photos 14-17**).

Mounds created by the Mazama pocket gopher: 1) are crescent or oddly-shaped, 2) contain a plugged tunnel opening that extends diagonally underground from the mound edge, 3) exhibit a fine texture, and are 4) typically in a scattered distribution.

Mole mounds have centrally-located tunnel entrances that extend vertically below the surface, blocky texture, an in-line distribution pattern, and have a conical shape.

Table 2. Summary of Results

Site Visit	Date of Visit	Gopher Occurrence Observed	Comments
1	16 June 2021	No	No mounds characteristic of that created by the Mazama pocket gopher have been identified on the subject property

4.2 Mazama Pocket Gopher Habitat Evaluation

The subject property consists of flat grassy areas dominated by European pasture grasses and "More Preferred" soils, which are mapped throughout the entire subject property. However, the property is isolated by surrounding high intensity land uses. Neighboring properties to the north and west of the subject property consist of high-intensity residential development, and a daily use gravel road extending through the property (**Figure 3; Appendix A, Photos 1, 21, & 22**). High-intensity commercial development occurs south and east of the subject property (**Figure 3; Appendix A, Photos 2, 12, & 19**)

5.0 CONCLUSION

This Mazama pocket gopher summary report was prepared to satisfy the City of Yelm Mazama pocket gopher screening requirements and to comply with the City of Yelm requirements.

The entire subject property was evaluated for the Mazama pocket gopher on 16 June 2021 following the Thurston County (2021) Site Inspection Protocol and Procedures: Mazama Pocket Gopher. The site evaluation was performed within the prescribed survey window (June 1 through October 31).

The subject property is isolated by surrounding high intensity land uses. Neighboring properties to the north and west of the subject property consist of high-intensity residential development, and a daily use gravel road going through the property (**Figure 3; Appendix A, Photos 1, 21, & 22**). High intensity commercial development occurs south and east of the subject property (**Figure 3; Appendix A, Photos 2, 12, & 19**). The subject property contains two (2) soils listed by the Thurston County Geodatabase as "More preferred" by the Mazama pocket gopher;~~,~~ however, no gopher occurrence is mapped within six hundred (600) feet of the subject property or found during the 16 June 2021 site visit (**Appendix D**).

No mounds characteristic of the Mazama pocket gopher have been identified on the subject property. No gopher migration onto the property is likely because of high-intensity land uses surrounding the property.

If you have any questions or require further services, you can contact me at (360) 790-1559.

Sincerely,

Curtis Wambach, M.S.
Senior Biologist and Principal
EnviroVector

Figures

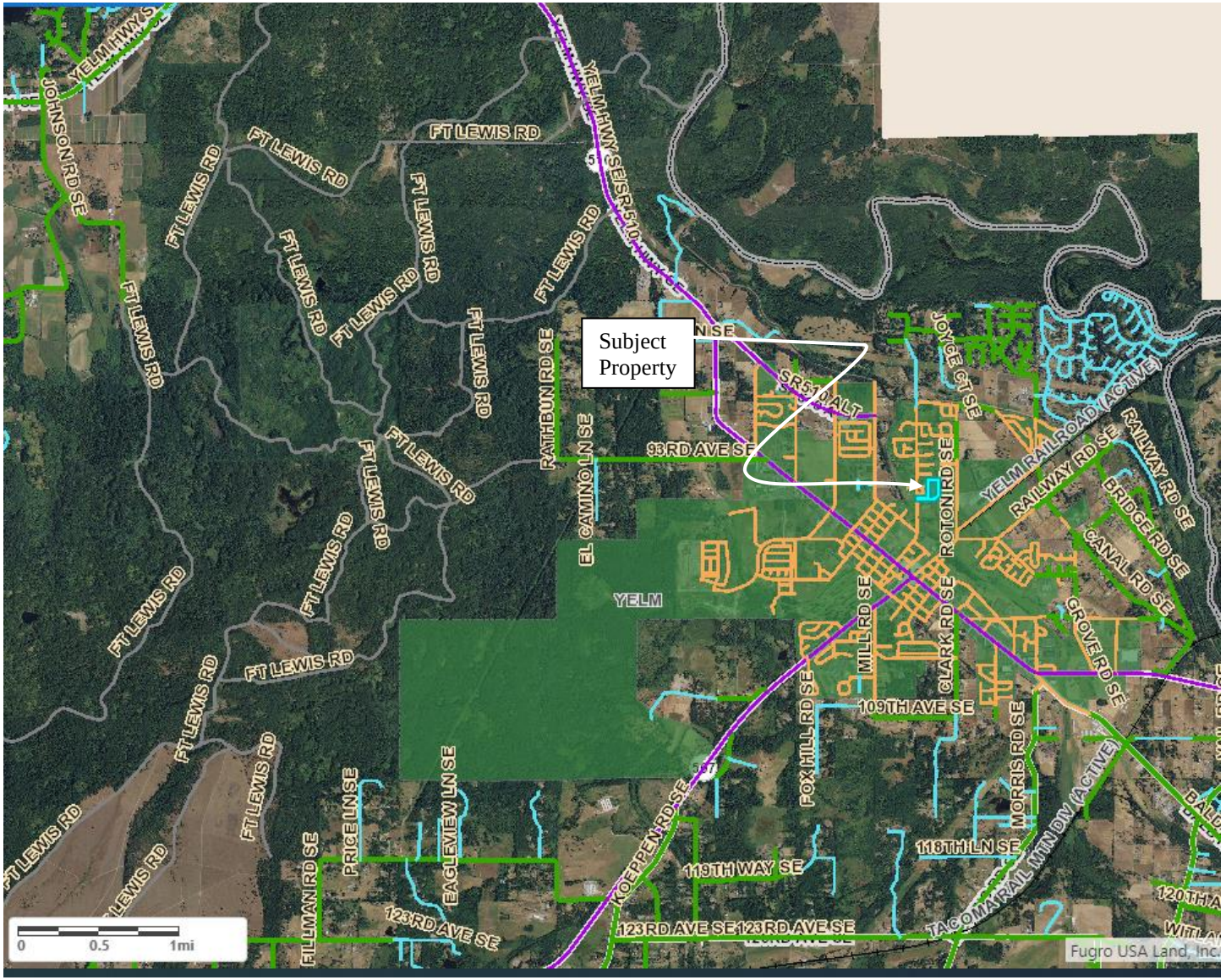


Figure 1 Vicinity Map

Figure 2 Subject Property

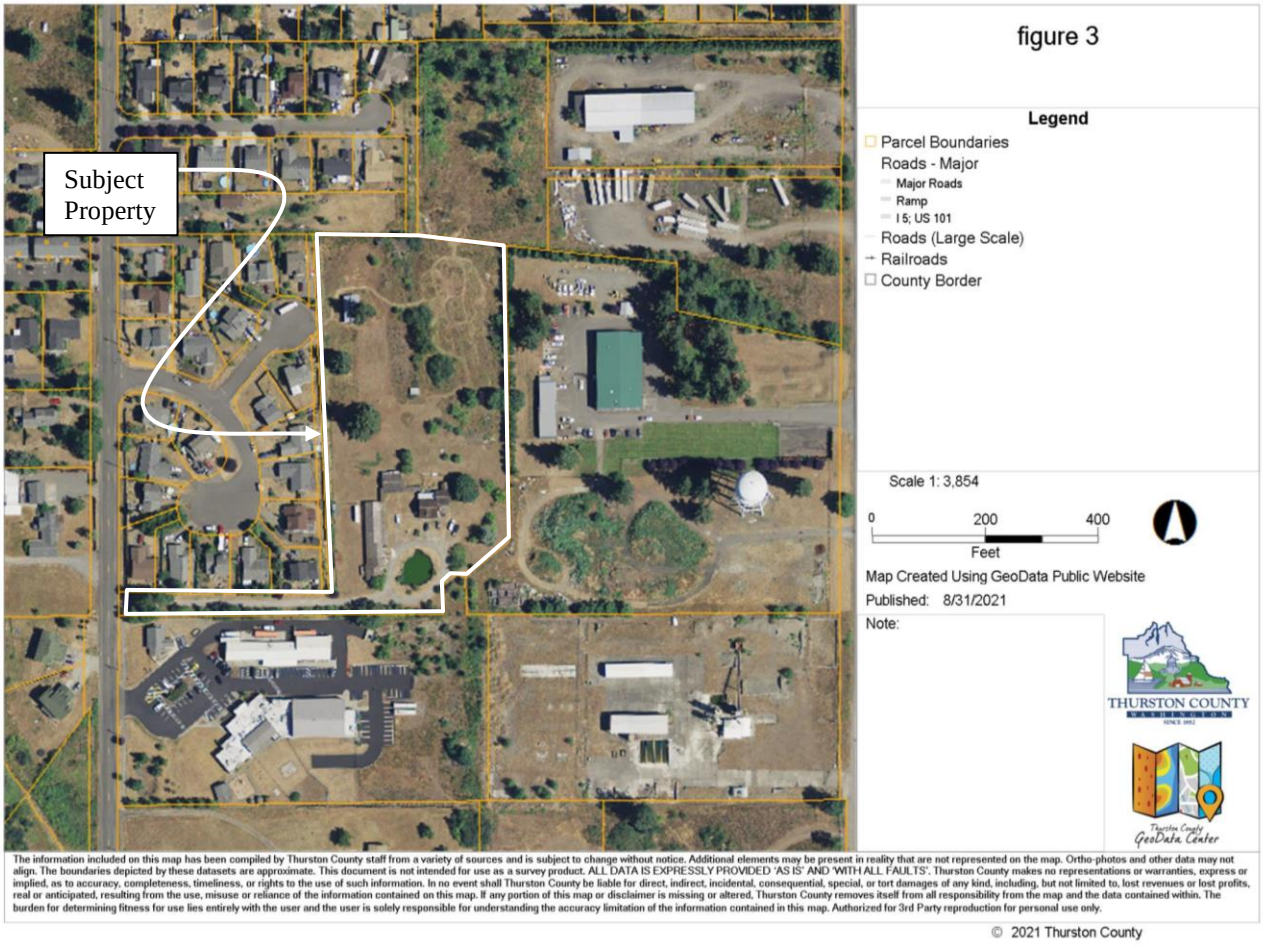


Figure 3 Subject Property

Appendix A

Photo Documentation

Photo 1. Single-family residences surrounding site

Photo 2. Semi-trucks bordering subject property

Photo 3. Single-family residences near subject proerty

Photo 4. Abandoned car on subject property

Photo 5. Old shed on subject property

Photo 6. Old sturctures and maintained lawn on subject property

Photo 7. Single family residence on subject property

Photo 8. Open field on subject property

Photo 9.Maintained lawn on subject property

Photo 10. No mounds present

Photo 11. Gravel and mowed lawn on-the subject property

Photo 12. Fence bordering subject property

Photo 13. Manmade pond on subject property

Photo 14. Old mole mound evidence found on subject property

Photo 15. Mole mound found on subject property

Photo 16. Centrally located tunnel, clear mole indicator

Photo 17. Old mole mound found on subject property

Photo 18. Wildlife found on subject property during site visit

Photo 19. Cluster of scotch broom was found on subject property

Photo 20 Cluster of oxeye daisy located on subject property

Photo 21.Orchard grass found throughout the subject property

Photo 22. Meadow brome found throughout the subject property

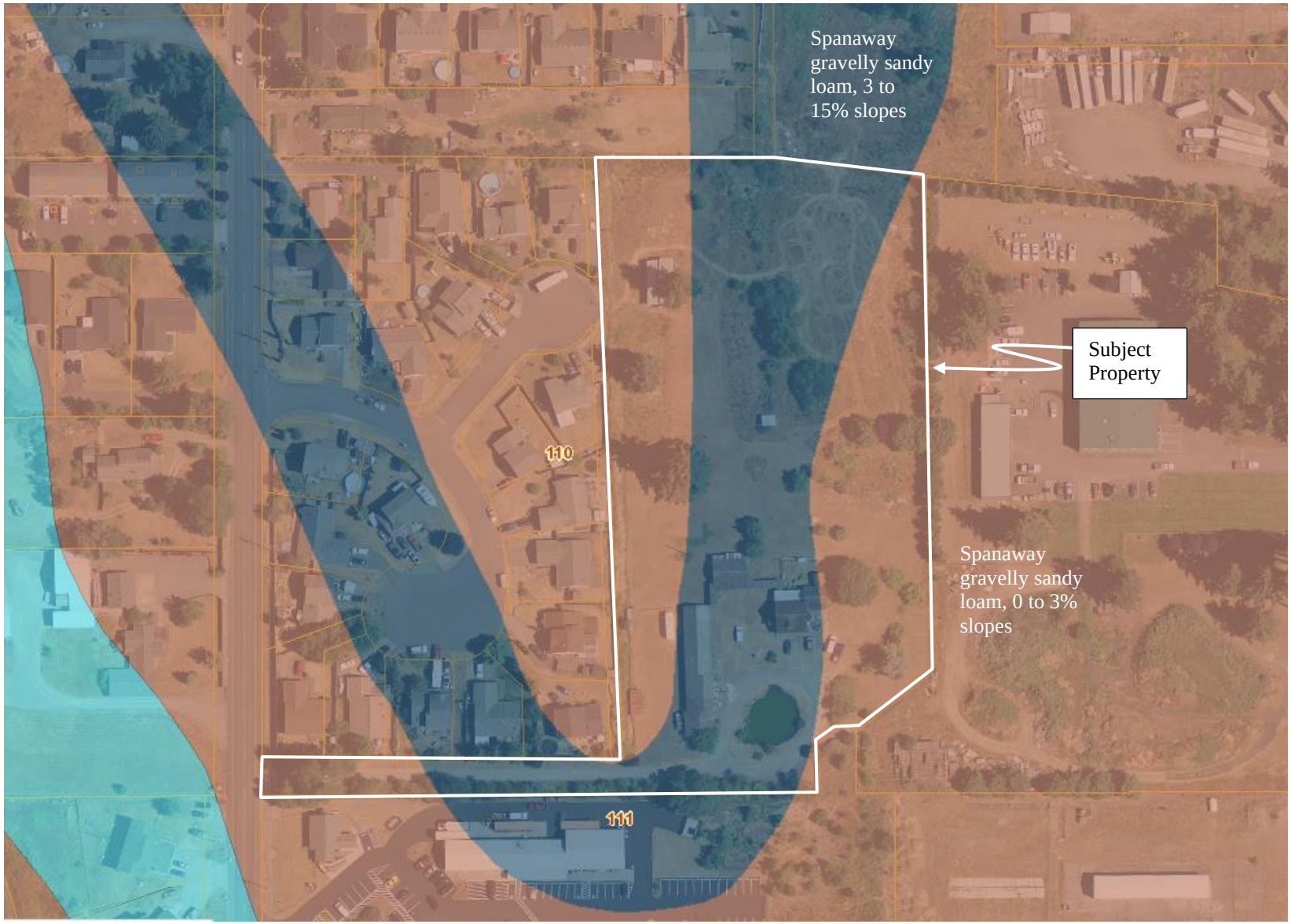
Photo 23. Cluster of tall fescue

Photo 24. Forget me knot throughout the subject property

Appendix B

Thurston County Geodatabase

Soils


Spanaway gravelly sandy loam, 3 to 15% slopes
Subject Property
110
Spanaway gravelly sandy loam, 0 to 3% slopes
111

Appendix C

Thurston County Geodatabase

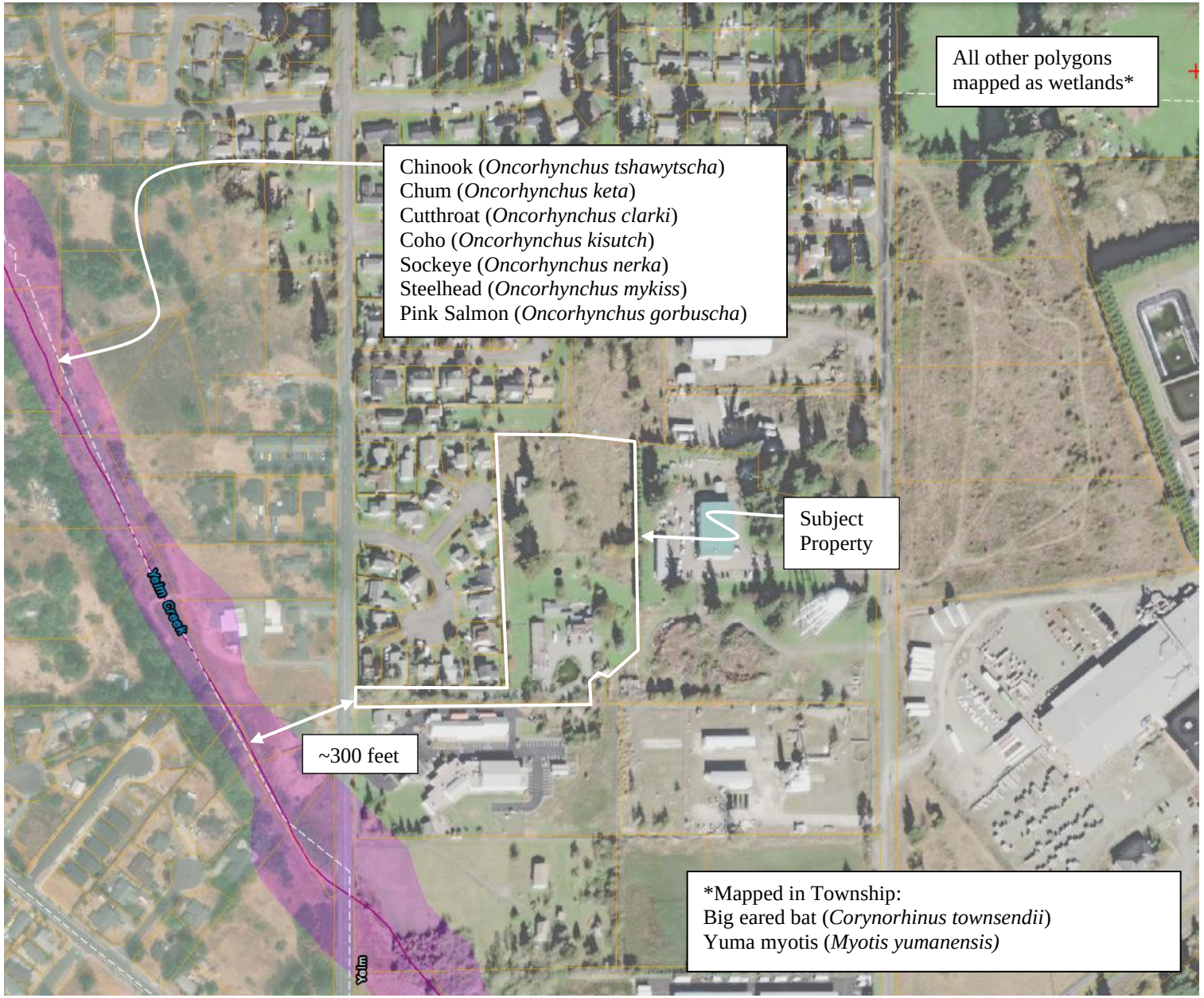
Gopher Indicator Soils


Subject Property
More Preferred

Appendix D

WDFW

Priority Habitat Species (PHS)


All other polygons mapped as wetlands*
Chinook (*Oncorhynchus tshawytscha*)
Chum (*Oncorhynchus keta*)
Cutthroat (*Oncorhynchus clarki*)
Coho (*Oncorhynchus kisutch*)
Sockeye (*Oncorhynchus nerka*)
Steelhead (*Oncorhynchus mykiss*)
Pink Salmon (*Oncorhynchus gorbuscha*)
Subject Property
Yelm Creek
~300 feet
Yelm
*Mapped in Township:
Big eared bat (*Corynorhinus townsendii*)
Yuma myotis (*Myotis yumanensis)*

CRYSTAL SPRINGS
TRAFFIC ASSESSMENT

YELM, WA

10/1/2021

Prepared for: Evan Mann
Soundbuilt Homes

October 2021

Date: October 1, 2021

To: Evan Mann
Soundbuilt Homes
evan@soundbuilthomes.com

From: Aaron Van Aken, PE, PTOE

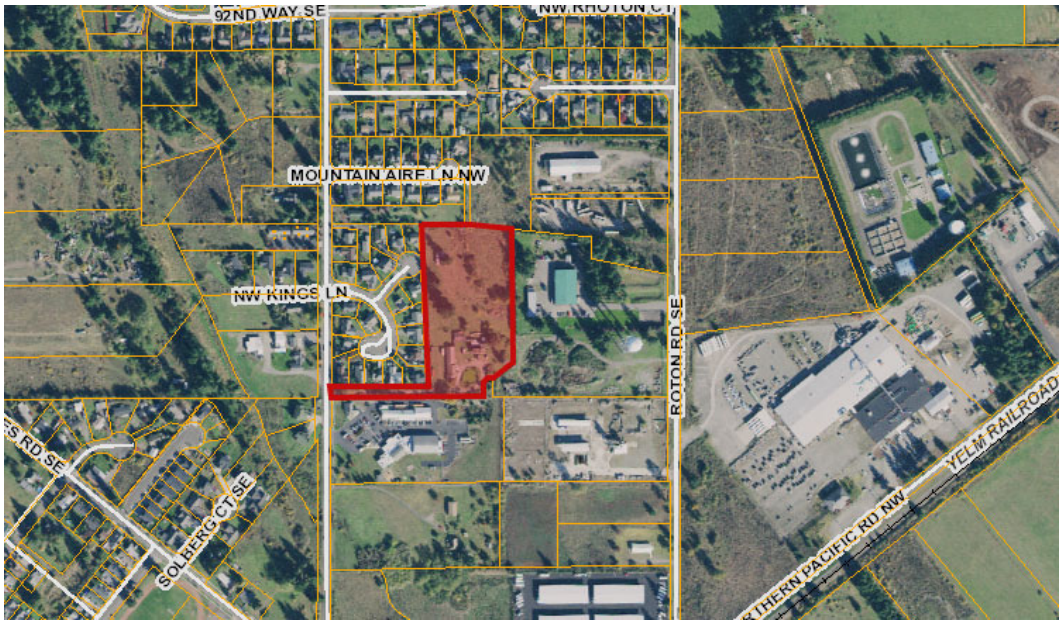
Subject: Crystal Springs – Yelm Traffic Assessment

The intent of this assessment serves to provide trip generation analysis for the proposed development of 30 single-family units in the city of Yelm. The subject site is located on 4.89-acre parcel #: 22719210403. A description of the project summary is provided below.

Proposed Project

Crystal Springs is a proposed residential development consisting of 30 new single-family residential dwelling units. The subject site is located east of Crystal Springs Street NW and north of Yelm Avenue SE. Two points of access would serve the subject property: an access extending east from Crystal Springs Street NE on the southern property limits and a connection into an existing cul-de-sac, Woodland Ct SE. Currently, on-site three structures exist which are to be demolished prior to new construction. Shown below is an aerial image outlining the subject parcel's boundaries. A conceptual site plan illustrating the overall configuration and access is shown in Figure 2.

Figure 1: Aerial Vicinity



HEATH & ASSOCIATES

TRAFFIC AND CIVIL ENGINEERING

CRYSTAL SPRINGS

SITE PLAN
FIGURE 2

PO Box 397 Puyallup, WA 98371 (253) 770 1401 heathtraffic.com

Transit Service

A review of the Intercity Transit regional system map indicates the nearest transit route in the area is served via Route 94. Service is provided from the Olympia Transit Center to the Yelm Walmart from the hours of 5:40 AM to 8:45 PM. The nearest stop with respect to the subject site is located at the intersection of Edwards Street NW and W Yelm Avenue (~0.56 miles southwest walking distance), offering approximately 30-60-minute headways during peak travel times. Weekend service is also provided. Refer to the Intercity Transit route schedule for more detailed information.

Trip Generation

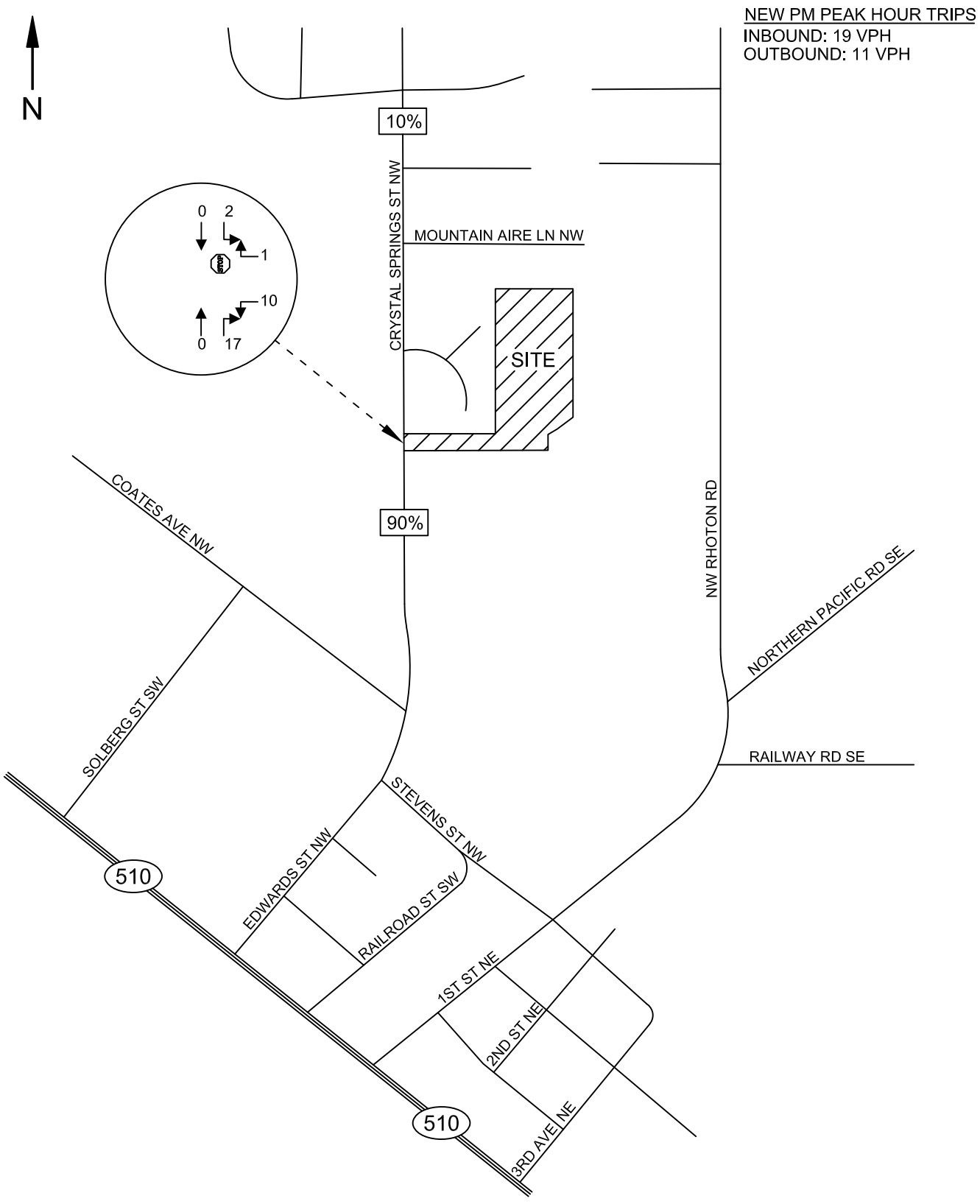
Trip generation is defined by the number of vehicular movements that enter or exit a site during a particular timeframe such as a specific peak hour or an entire day. Trip generation estimates are based on data from the ITE *Trip Generation Manual,* 10th Edition. Crystal Springs Plat is composed of 30 single-family dwelling units. For analysis purposes, the proposed Crystal Springs land use code is *LUC 210 – Single-Family Detached Housing.* Attached to this document are excerpts from the ITE manual for the utilized land use. Table 1 below summarizes the estimated trip volumes using average rates.

Table 1: Project Trip Generation

Land Use	Dwelling Units	AWDT	AM Peak-Hour Trips			PM Peak-Hour Trips		
			In	Out	Total	In	Out	Total
Single-Family	30	283	5	17	**22**	19	11	**30**

The proposed development of 30 single-family units is estimated to generate 22 AM and 30 PM peak hour trips, respectively.

Figure 3 on the following page highlights the project's trip distribution and assignment using project trips. The main access point by way of Crystal Springs Street NW is used to illustrate all PM peak hour trips to and from the site. The majority of traffic is expected to travel to/from the south with access and connection to Yelm Avenue. Trip distribution may change when the SR 510 loop to the north gets extended and completed in its construction.



HEATH & ASSOCIATES

TRAFFIC AND CIVIL ENGINEERING

CRYSTAL SPRINGS

PM PEAK HOUR TRIP DISTRIBUTION & ASSIGNMENT
FIGURE 3

Conclusion

Crystal Springs Plat proposes for the construction of 30 new residential dwelling units in the city of Yelm. The subject property is located on a 4.89-acre site within tax parcel #: 22719210403. Access to and from the site would be provided via two new roadway connections. One driveway, extending east from Crystal Springs Street NW and the second access will be achieved by way of Woodland Ct SE, an existing cul-de-sac. Based on ITE data, the project is estimated to generate 283 average weekday daily trips with 22 trips occurring in the AM peak hour and 30 trips in the PM peak hour.

The project would be subject to City of Yelm Transportation Facilities Charge which are assessed at a cost of $1,497.00 per new PM peak hour trip. An estimated fee is therefore as follows:

30 new PM peak hour trips x $1,497.00/trip = $44,910.00. Credit may be received for the removal of the existing on-site structure(s).

Exact fees and calculations will be determined by the City with current fee schedules at the time of building permit issuance.

Please call if you require anything further.

Sincerely,

Aaron Van Aken, P.E., PTOE

Single-Family Detached Housing
(210)

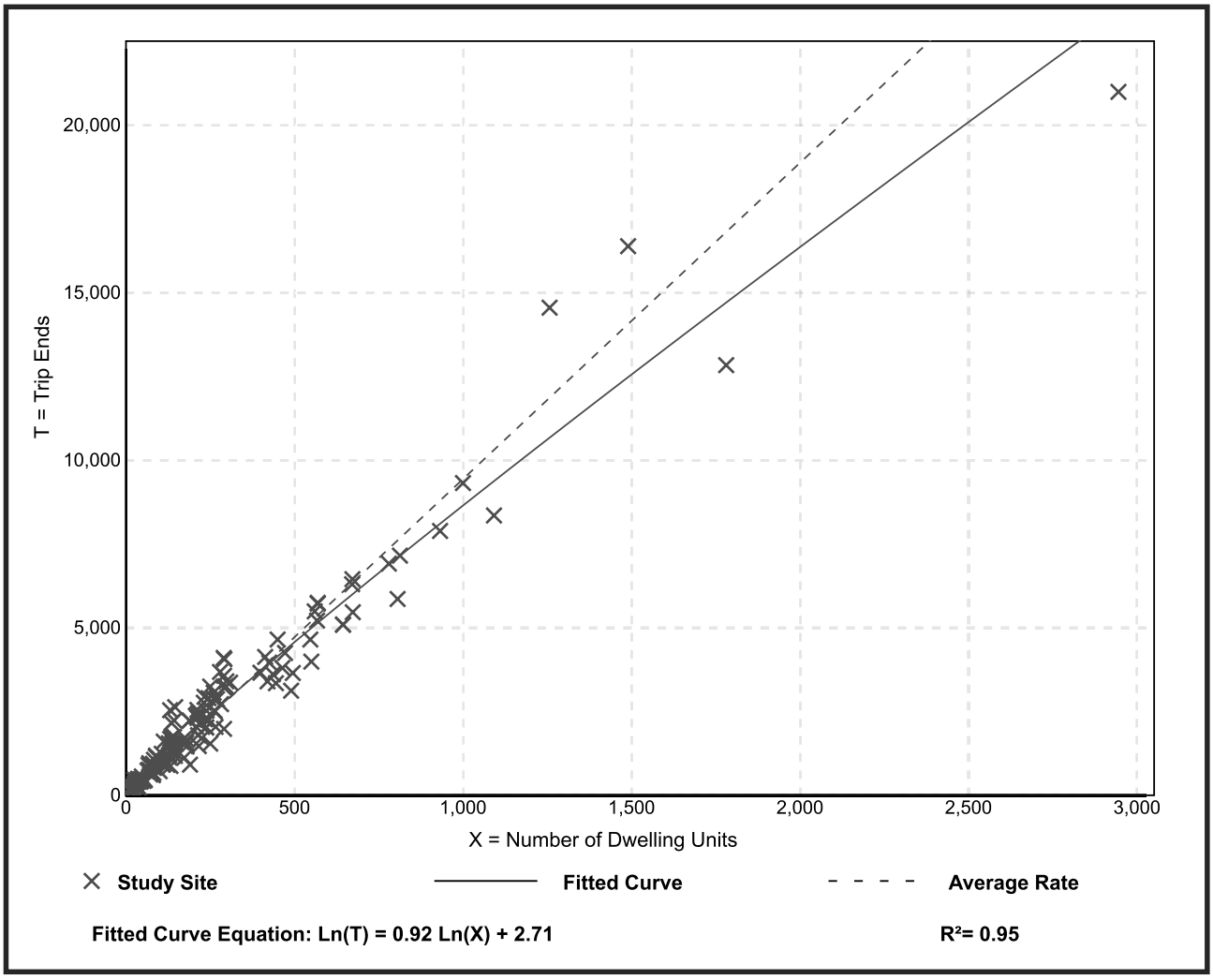
Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday**

Setting/Location: **General Urban/Suburban**
Number of Studies: 159
Avg. Num. of Dwelling Units: 264
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
9.44	4.81 - 19.39	2.10

Data Plot and Equation



Trip Generation Manual, 10th Edition ● Institute of Transportation Engineers

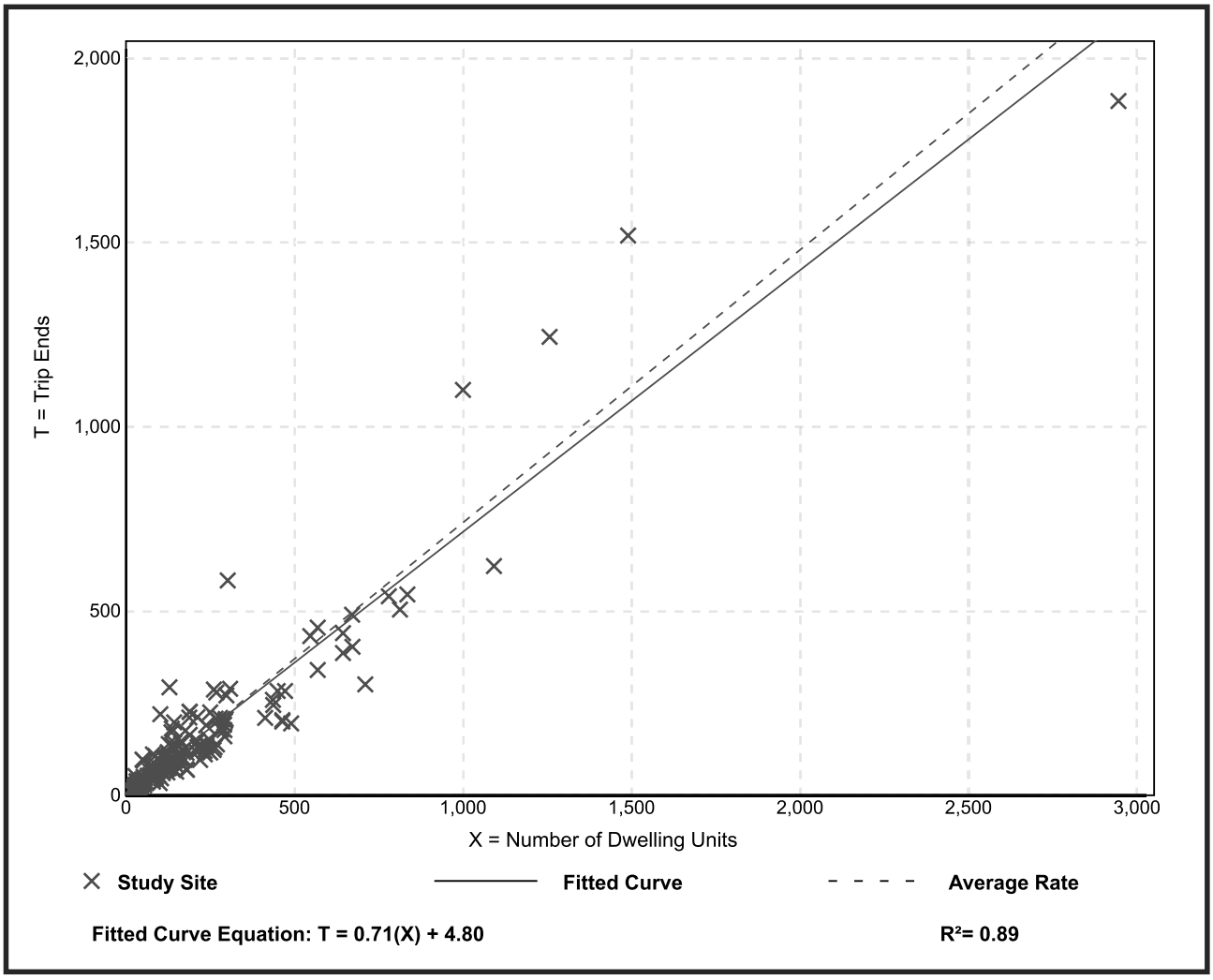
Single-Family Detached Housing
(210)

Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: **General Urban/Suburban**
Number of Studies: 173
Avg. Num. of Dwelling Units: 219
Directional Distribution: 25% entering, 75% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.74	0.33 - 2.27	0.27

Data Plot and Equation



Trip Generation Manual, 10th Edition ● Institute of Transportation Engineers

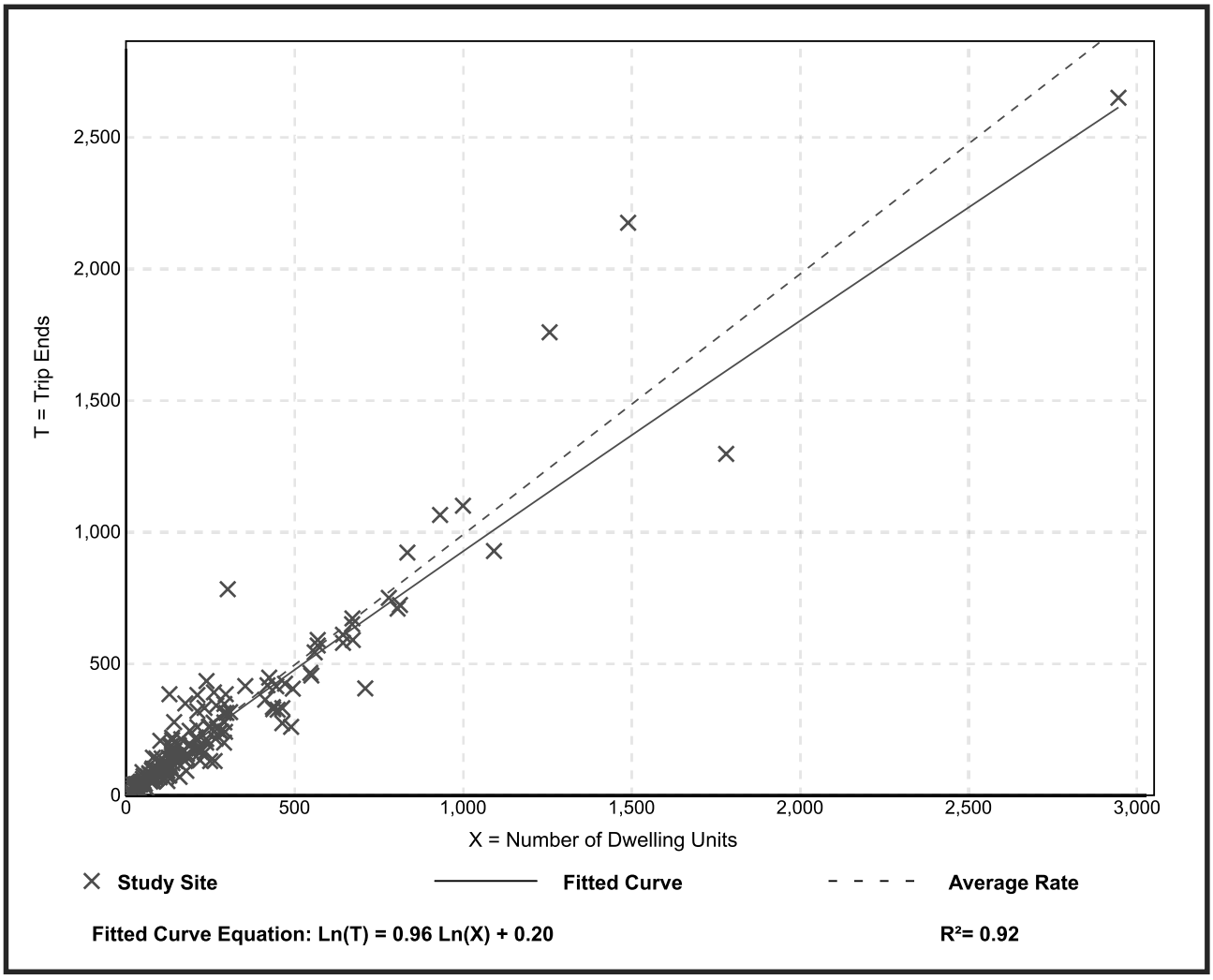
Single-Family Detached Housing
(210)

Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: **General Urban/Suburban**
Number of Studies: 190
Avg. Num. of Dwelling Units: 242
Directional Distribution: 63% entering, 37% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.99	0.44 - 2.98	0.31

Data Plot and Equation



Trip Generation Manual, 10th Edition ● Institute of Transportation Engineers

Stormwater Report

PREPARED FOR:

Mr. Evan Mann
Copper Ridge LLC
PO Box 73790
Puyallup, WA 98373-0790

PROJECT:

Crystal Springs Preliminary Plat
Yelm, Washington
2210633.10

PREPARED BY:

Quinten Foster
Project Engineer

REVIEWED BY:

J. Matthew Weber, PE
Principal

DATE:

October 2021

Stormwater Report

PREPARED FOR:

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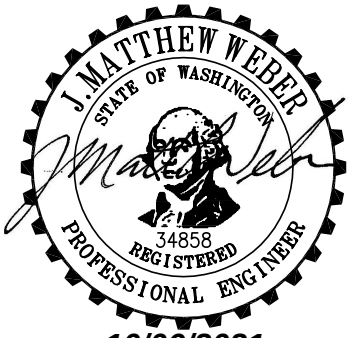


10/06/2021

I hereby state that this Stormwater Report for Crystal Springs Preliminary Plat has been prepared by me or under my supervision and meets the standard of care and expertise that is usual and customary in this community for professional engineers. I understand that City of Yelm does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me.

Table of Contents

Appendices

Appendix A

Exhibits

Appendix B

Conveyance Calculations

Appendix C

Geotechnical Report
Earth Solutions NW, LLC, October 6, 2021

1.0 Project Overview

The following hydrology report summarizes the storm drainage analysis and design for a 30-lot development located at 714 NW Crystal Springs Road in Yelm, Thurston County, Washington. The land is currently a 4.89-acre property. The project includes the addition of 30 residential lots for single-family homes, a new roadway and sidewalks, sewer, water services, and stormwater facilities to treat and dispose of the project's stormwater. The proposed roadway features and utilities will be extended from NW Crystal Springs Road, as well as connecting to Woodland Court SE.

No offsite road improvements will be required, other than frontage improvements along the panhandle at NW Crystal Springs Road.

The 4.89-acre site is located in Section 19, Township 17 North, Range 02 East, W. M.
The Thurston County tax parcel number associated with the project is 22719210403.

The increased stormwater runoff resulting from the addition of impervious area will be treated and retained in accordance with the most recent Washington State Department of Ecology (DOE) *Stormwater Management Manual for Western Washington (SMMWW)*.

2.0 Summary of Minimum Requirements

This project is subject to the *SMMWW* and is a new development that will add more than 10,000 square feet of impervious surfaces; therefore, all Minimum Requirements (MR) apply to this project.

2.1 MR 1 – Preparation of Stormwater Site Plans

This report and the project plans represent the Stormwater Site Plan for this project and satisfy MR 1.

2.2 MR 2 - Construction Stormwater Pollution Prevention

A Construction Stormwater Pollution Prevention Plan will be prepared with final engineering.

2.3 MR 3 – Source Control of Pollution

Pollution source control will be provided for the site by separating roof runoff from pollution generating surfaces. The residential roads should be maintained and cleaned of debris, garbage, and sediment, as required.

The Construction SWPPP, addressing MR 3, will be prepared with final engineering.

2.4 MR 4 – Preservation of Natural Drainage Systems and Outfalls

The project proposes to infiltrate all stormwater runoff, so all runoff will be retained in the developed condition. There are no natural drainage systems or outfalls to preserve.

2.5 MR 5 – Onsite Stormwater Control

This project will meet the Low Impact Development (LID) Performance Standard. The onsite soils have a high infiltration capacity, and all runoff will be retained onsite through treatment systems and infiltration facilities. The LID Performance Standard will be met by infiltrating all stormwater runoff from the site. Refer to Section 10.0 for facility sizing.

2.6 MR 6 – Runoff Treatment

Over 5,000 square feet of pollution generating impervious surface (PGIS) will be added as part of these improvements; therefore, runoff treatment is required for this site. Stormwater from the roadways will be conveyed to stormwater treatment filters before being infiltrated. There are two distinct basins conveying stormwater to separate treatment systems and infiltration trenches. Final treatment system sizing will be completed with final engineering.

2.7 MR 7 – Flow Control

The project exceeds the thresholds for new development projects and must provide flow control. Proposed flow control is achieved with the use of infiltration trenches that will infiltrate 100 percent of runoff. Refer to Section 10.0 for facility sizing.

2.8 MR 8 – Wetlands Protection

To our knowledge, no wetlands are located on or adjacent to the site.

2.9 MR 9 – Basin/Watershed Planning

To our knowledge, no basin plans exist for the site. All of Yelm is within a critical aquifer recharge area. Treatment of stormwater prior to infiltration is proposed via media filter manholes. Final sizing of the treatment system will be done with final engineering.

2.10 MR 10 – Operation and Maintenance

The stormwater system for the roadway improvements will be publicly owned and maintained. The City of Yelm shall be responsible for the operation and maintenance of the public stormwater facilities. An Operation and Maintenance Plan consisting of maintenance checklists for stormwater management will be prepared with final engineering. Operation and maintenance for drainage facilities constructed for each lot shall be the responsibility of the individual owners.

3.0 Existing Conditions

The site is presently covered with grass and a few deciduous trees, along with an existing building on the south end of the site, with slopes ranging from 0 to 5 percent. Presently, it appears the site runs off to the south and down the current access road to NW Crystal Springs Road.

4.0 Soils Reports

Site soils are identified by the Natural Resources Conservation Service (NRCS) Web Soil Survey as Spanaway gravelly sandy loam, a Type A soil. This soil is characterized as very deep, somewhat excessively drained.

Earth Solutions NW conducted a site investigation to confirm subsurface soil conditions and establish a design infiltration rate. Soil test holes were dug in the vicinity of the proposed infiltration basins of the project and observations confirm that the soil types match the SCS soil description. A soil log map showing the location of the test holes is included in the geotechnical report. The report recommends a design infiltration rate of 20 inches per hour. Please see Appendix C for the complete Earth Solutions NW report.

5.0 Wells

An existing well is present at the northern edge of the site. The well will be decommissioned according to City of Yelm and Washington Department of Health standards.

Each lot will be served by the City of Yelm STEP collection system. The holding tank will be maintained by the City and pumped on a regular basis. Domestic water will be provided by the City of Yelm water distribution system.

6.0 Fuel Tanks

No fuel tanks were observed at the project site.

7.0 Sub-Basin Description

Site topography contributes zero acres of offsite storm runoff.

There are two separate basins in the developed conditions. Each basin has an independent treatment and infiltration system. The impervious areas used for determining flow control and water treatment do not include individual lots. On-lot runoff will be collected and infiltrated in individual drywells. Refer to Appendix A-3 for the Developed Basin Map. Drywell sizing will be provided with final engineering.

8.0 Analysis of the 100-Year Flood

Federal Emergency Management Agency (FEMA) mapping does not indicate flooding in the immediate area. Refer to the exhibit in Appendix A-4.

9.0 Aesthetic Considerations for Facilities

The proposed stormwater infiltration facilities will be underground and have minimal impact to the aesthetics of the site.

10.0 Facility Sizing and Downstream Analysis

The stormwater system was sized and analyzed using the latest edition of the Western Washington Hydrology Model (WWHM) continuous modeling software. As previously described, conservative infiltration rates of 20 inches per hour were used for the design calculations.

10.1 Conveyance

Conveyance sizing will be completed with final engineering.

10.2 Treatment

Basic treatment will be provided via media filter cartridge manholes/catch basins. Final sizing will be completed with final engineering

10.3 Flow Control

Flow control will be provided by infiltration trenches. Each basin will have a single trench.

Basin A will have a 4.0-foot deep trench with a bottom area of 1,240 square feet that will be constructed in the open space in Tract A. The trench will be 20 feet wide and 62 feet long.

Basin B will have a 4.0-foot deep trench with a bottom area of 200 square feet that will be constructed on the south side of NW Crystal Springs Road. The trench will be 3 feet wide and 66 feet long.

Infiltration Basin Summary

Basin	Pervious Area (ac)	Impervious Area (ac)	Trench Dimensions (ft x ft)	Percent Infiltrated
A	0.34	1.21	20 x 62	100
B	0.14	0.19	3 x 66	100

The two infiltration basins were sized in accordance with the *SMMWW* and exceed the required storage volumes.

10.4 Roof Runoff

Stormwater for the roof area of the homes will be infiltrated in individual drywells. The drywells will be sized in accordance with *SMMWW* Volume 3, Chapter 3, Section 3.1.1 - BMP T5.10A Downspout Full Infiltration System. Refer to Appendix B-1 for the roof downspout system detail.

11.0 Covenants Dedications, Easements

The storm facilities for the right-of-way improvements shall be publicly owned and maintained. A maintenance agreement should be executed to ensure future maintenance of the facilities. The on-lot systems will be privately owned and maintained and therefore do not require covenants, dedications, or easements.

12.0 Property Owners Association Articles of Incorporation

Not applicable.

13.0 Conclusion

The proposed project involves site improvements associated with a 30-lot development. The project includes clearing, grading, erosion control, utility improvements, and stormwater management facilities. The site, as proposed, will meet the requirements of the most recent Department of Ecology *Stormwater Management Manual for Western Washington (SMMWW)*. This report and associated plans have been prepared within the guidelines established by the City of Yelm for stormwater management.

This analysis is based on data and records either supplied to or obtained by AHBL. These documents are referenced within the text of the analysis. The analysis has been prepared using procedures and practices within the standard accepted practices of the industry.

AHBL, Inc.

Quinten Foster
Project Engineer

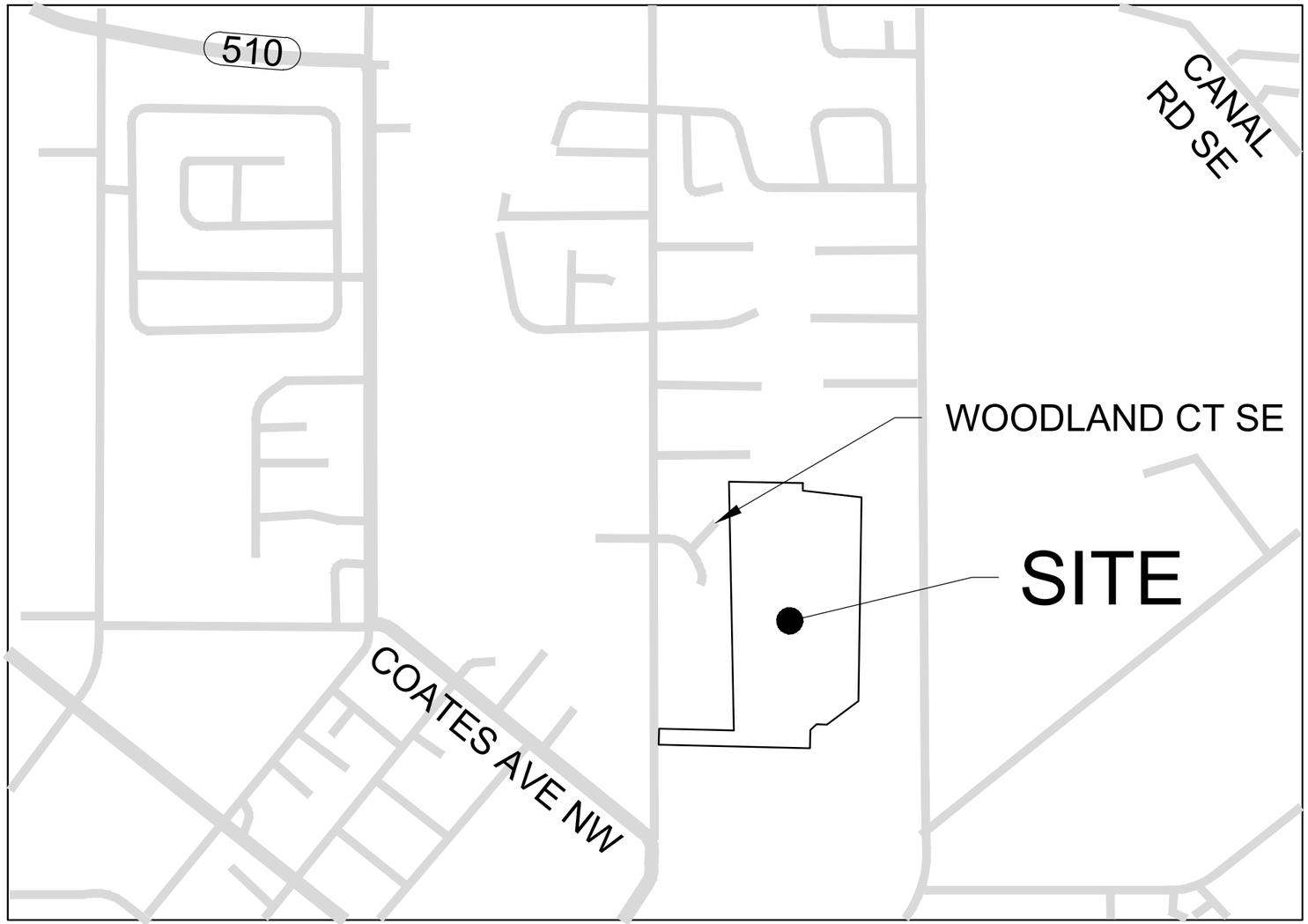
QF/lsk

October 2021

Q:\2021\2210633\WORDPROC\Reports\20211006 Rpt (Storm) 2210633.10.docx

Appendix A

Exhibits



VICINITY MAP

SCALE: 1" = 660' (1/8 MILE)

AHBL
TACOMA·SEATTLE
2215 North 30th Street, Suite 300, Tacoma, WA 98403 253.383.2422 TEL
316 Occidental Avenue South, Suite 320, Seattle, WA 98104 206.267.2425 TEL

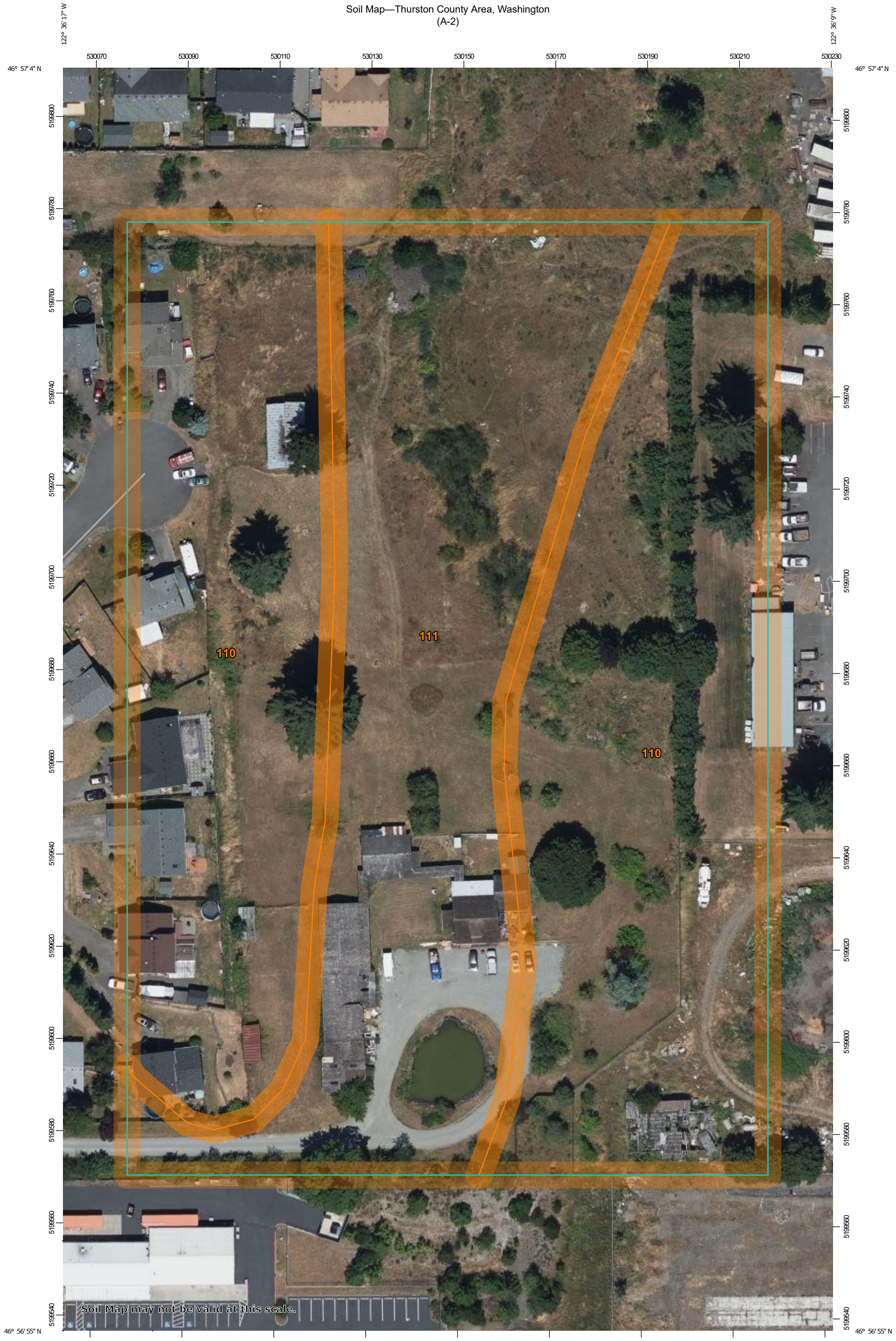
Civil Engineers
Structural Engineers
Landscape Architects
Community Planners
Land Surveyors
Neighbors

CRYSTAL SPRINGS
PRELIMINARY PLAT

VICINITY MAP

A-1

Soil Map—Thurston County Area, Washington
(A-2)



Map Scale: 1:766 if printed on B portrait (11" x 17") sheet.

N

Meters
0 10 20 40 60

Feet
0 35 70 140 210

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Thurston County Area, Washington
Survey Area Data: Version 15, Aug 31, 2021

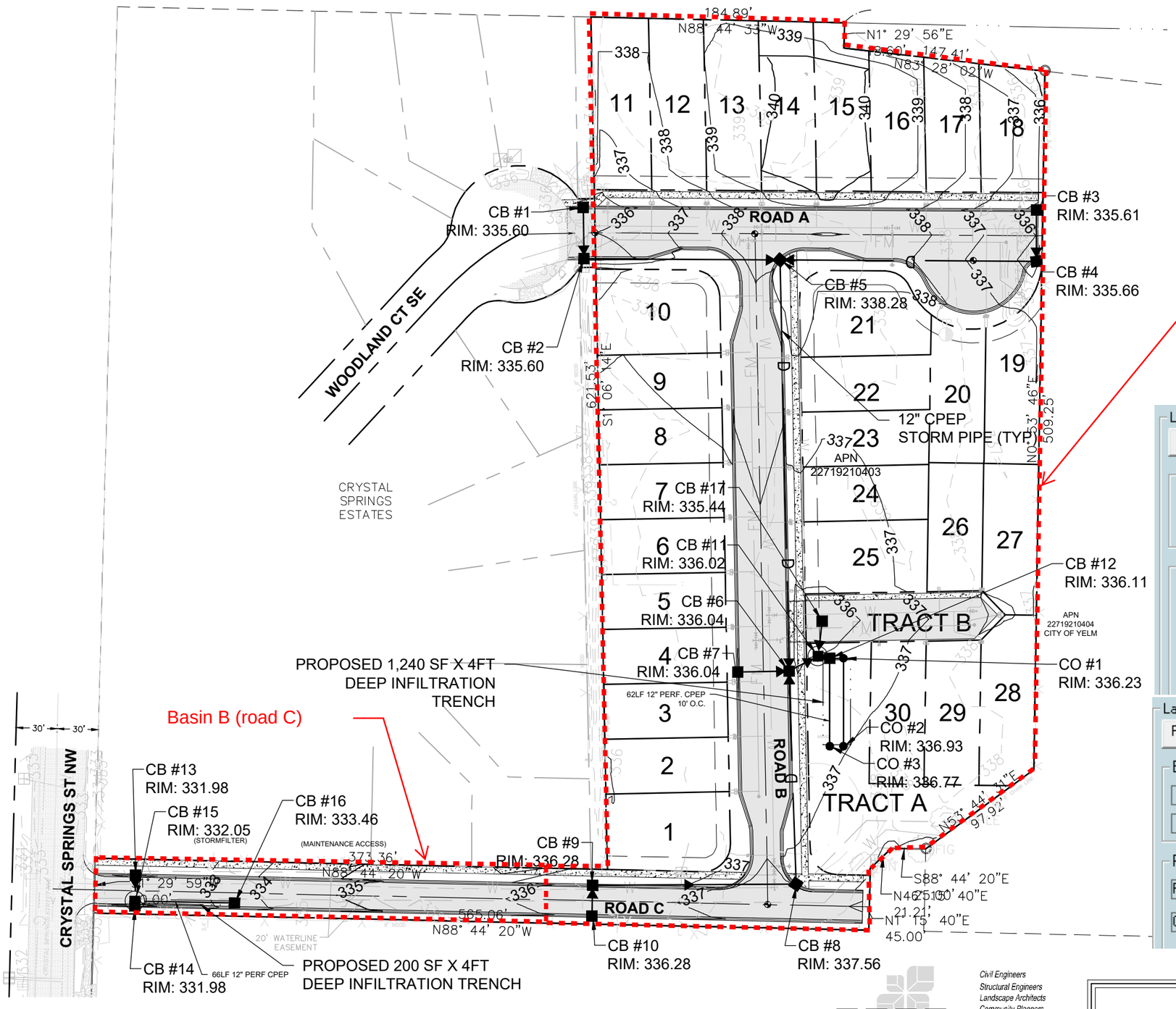
Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 18, 2020—Jul 20, 2020

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
110	Spanaway gravelly sandy loam, 0 to 3 percent slopes	4.5	63.1%
111	Spanaway gravelly sandy loam, 3 to 15 percent slopes	2.6	36.9%
Totals for Area of Interest		**7.1**	**100.0%**



Landuse Basins

onsite

Basin Downstream Connections

Surface Flow	Interflow	Groundwater
onsite	onsite	

Pervious and Impervious Landuse Types and Areas

PERLND Name	Area(ac)	IMPLND Name	Area(ac)
C, Pasture, Flat	0.34171	ROADS/FLAT	0.87734
		DRIVEWAYS/FLAT	0.09642
		SIDEWALKS/FLAT	0.23942

Landuse Basins

ROAD C

Basin Downstream Connections

Surface Flow	Interflow	Groundwater
ROAD C TRENCH	ROAD C TRENCH	

Pervious and Impervious Landuse Types and Areas

PERLND Name	Area(ac)	IMPLND Name	Area(ac)
C, Pasture, Flat	0.14	ROADS/FLAT	0.19

Civil Engineers
Structural Engineers
Landscape Architects
Community Planners
Land Surveyors
Neighbors

AHBL
TACOMA · SEATTLE
2215 North 30th Street, Suite 300, Tacoma, WA 98403 253.383.2422 TEL
316 Occidental Avenue South, Suite 320, Seattle, WA 98104 206.267.2425 TEL

CRYSTAL SPRINGS
PRELIMINARY PLAT

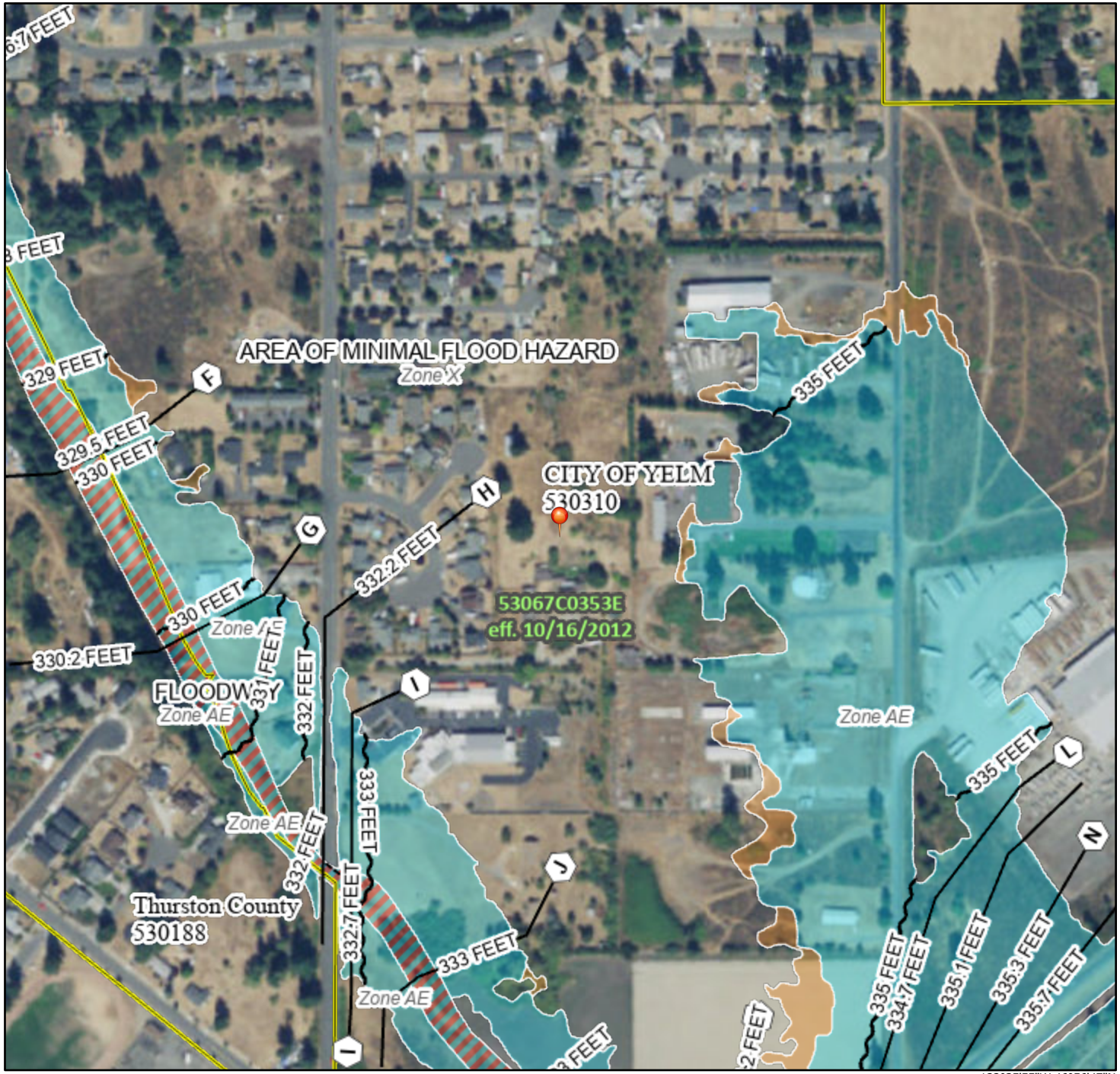
DEVELOPED CONDITIONS MAP

A-3

National Flood Hazard Layer FIRMette

FEMA

122°36'33"W 46°57'12"N



122°35'55"W 46°56'47"N

Feet

0 250 500 1,000 1,500 2,000

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/5/2021 at 6:14 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Appendix B

Conveyance Calculations

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	Infiltration
Site Name:	
Site Address:	
City:	
Report Date:	10/6/2021
Gage:	Lake Lawrence
Data Start:	1955/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	0.857
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

Landuse Basin Data
Predeveloped Land Use

Mitigated Land Use

onsite

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Pasture, Flat	0.34171
Pervious Total	0.34171

Impervious Land Use	acre
ROADS FLAT	0.87734
DRIVEWAYS FLAT	0.09642
SIDEWALKS FLAT	0.23942
Impervious Total	1.21318
Basin Total	1.55489

Element Flows To:

Surface	Interflow	Groundwater
onsite	onsite	

Routing Elements
Predeveloped Routing

Mitigated Routing

onsite

Bottom Length:	62.00 ft.
Bottom Width:	20.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	4
Pour Space of material for first layer:	0.33
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	20
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	236.313
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	236.313
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	4 ft.
Riser Diameter:	12 in.
Element Flows To:	
Outlet 1	Outlet 2

Gravel Trench Bed Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.028	0.000	0.000	0.000
0.0444	0.028	0.000	0.000	0.574
0.0889	0.028	0.000	0.000	0.574
0.1333	0.028	0.001	0.000	0.574
0.1778	0.028	0.001	0.000	0.574
0.2222	0.028	0.002	0.000	0.574
0.2667	0.028	0.002	0.000	0.574
0.3111	0.028	0.002	0.000	0.574
0.3556	0.028	0.003	0.000	0.574
0.4000	0.028	0.003	0.000	0.574
0.4444	0.028	0.004	0.000	0.574
0.4889	0.028	0.004	0.000	0.574
0.5333	0.028	0.005	0.000	0.574
0.5778	0.028	0.005	0.000	0.574
0.6222	0.028	0.005	0.000	0.574
0.6667	0.028	0.006	0.000	0.574
0.7111	0.028	0.006	0.000	0.574
0.7556	0.028	0.007	0.000	0.574
0.8000	0.028	0.007	0.000	0.574
0.8444	0.028	0.007	0.000	0.574
0.8889	0.028	0.008	0.000	0.574
0.9333	0.028	0.008	0.000	0.574
0.9778	0.028	0.009	0.000	0.574
1.0222	0.028	0.009	0.000	0.574

1.0667	0.028	0.010	0.000	0.574
1.1111	0.028	0.010	0.000	0.574
1.1556	0.028	0.010	0.000	0.574
1.2000	0.028	0.011	0.000	0.574
1.2444	0.028	0.011	0.000	0.574
1.2889	0.028	0.012	0.000	0.574
1.3333	0.028	0.012	0.000	0.574
1.3778	0.028	0.012	0.000	0.574
1.4222	0.028	0.013	0.000	0.574
1.4667	0.028	0.013	0.000	0.574
1.5111	0.028	0.014	0.000	0.574
1.5556	0.028	0.014	0.000	0.574
1.6000	0.028	0.015	0.000	0.574
1.6444	0.028	0.015	0.000	0.574
1.6889	0.028	0.015	0.000	0.574
1.7333	0.028	0.016	0.000	0.574
1.7778	0.028	0.016	0.000	0.574
1.8222	0.028	0.017	0.000	0.574
1.8667	0.028	0.017	0.000	0.574
1.9111	0.028	0.018	0.000	0.574
1.9556	0.028	0.018	0.000	0.574
2.0000	0.028	0.018	0.000	0.574
2.0444	0.028	0.019	0.000	0.574
2.0889	0.028	0.019	0.000	0.574
2.1333	0.028	0.020	0.000	0.574
2.1778	0.028	0.020	0.000	0.574
2.2222	0.028	0.020	0.000	0.574
2.2667	0.028	0.021	0.000	0.574
2.3111	0.028	0.021	0.000	0.574
2.3556	0.028	0.022	0.000	0.574
2.4000	0.028	0.022	0.000	0.574
2.4444	0.028	0.023	0.000	0.574
2.4889	0.028	0.023	0.000	0.574
2.5333	0.028	0.023	0.000	0.574
2.5778	0.028	0.024	0.000	0.574
2.6222	0.028	0.024	0.000	0.574
2.6667	0.028	0.025	0.000	0.574
2.7111	0.028	0.025	0.000	0.574
2.7556	0.028	0.025	0.000	0.574
2.8000	0.028	0.026	0.000	0.574
2.8444	0.028	0.026	0.000	0.574
2.8889	0.028	0.027	0.000	0.574
2.9333	0.028	0.027	0.000	0.574
2.9778	0.028	0.028	0.000	0.574
3.0222	0.028	0.028	0.000	0.574
3.0667	0.028	0.028	0.000	0.574
3.1111	0.028	0.029	0.000	0.574
3.1556	0.028	0.029	0.000	0.574
3.2000	0.028	0.030	0.000	0.574
3.2444	0.028	0.030	0.000	0.574
3.2889	0.028	0.030	0.000	0.574
3.3333	0.028	0.031	0.000	0.574
3.3778	0.028	0.031	0.000	0.574
3.4222	0.028	0.032	0.000	0.574
3.4667	0.028	0.032	0.000	0.574
3.5111	0.028	0.033	0.000	0.574
3.5556	0.028	0.033	0.000	0.574
3.6000	0.028	0.033	0.000	0.574

3.6444	0.028	0.034	0.000	0.574
3.6889	0.028	0.034	0.000	0.574
3.7333	0.028	0.035	0.000	0.574
3.7778	0.028	0.035	0.000	0.574
3.8222	0.028	0.035	0.000	0.574
3.8667	0.028	0.036	0.000	0.574
3.9111	0.028	0.036	0.000	0.574
3.9556	0.028	0.037	0.000	0.574
4.0000	0.028	0.037	0.000	0.574

Analysis Results

POC 1

POC #1 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.

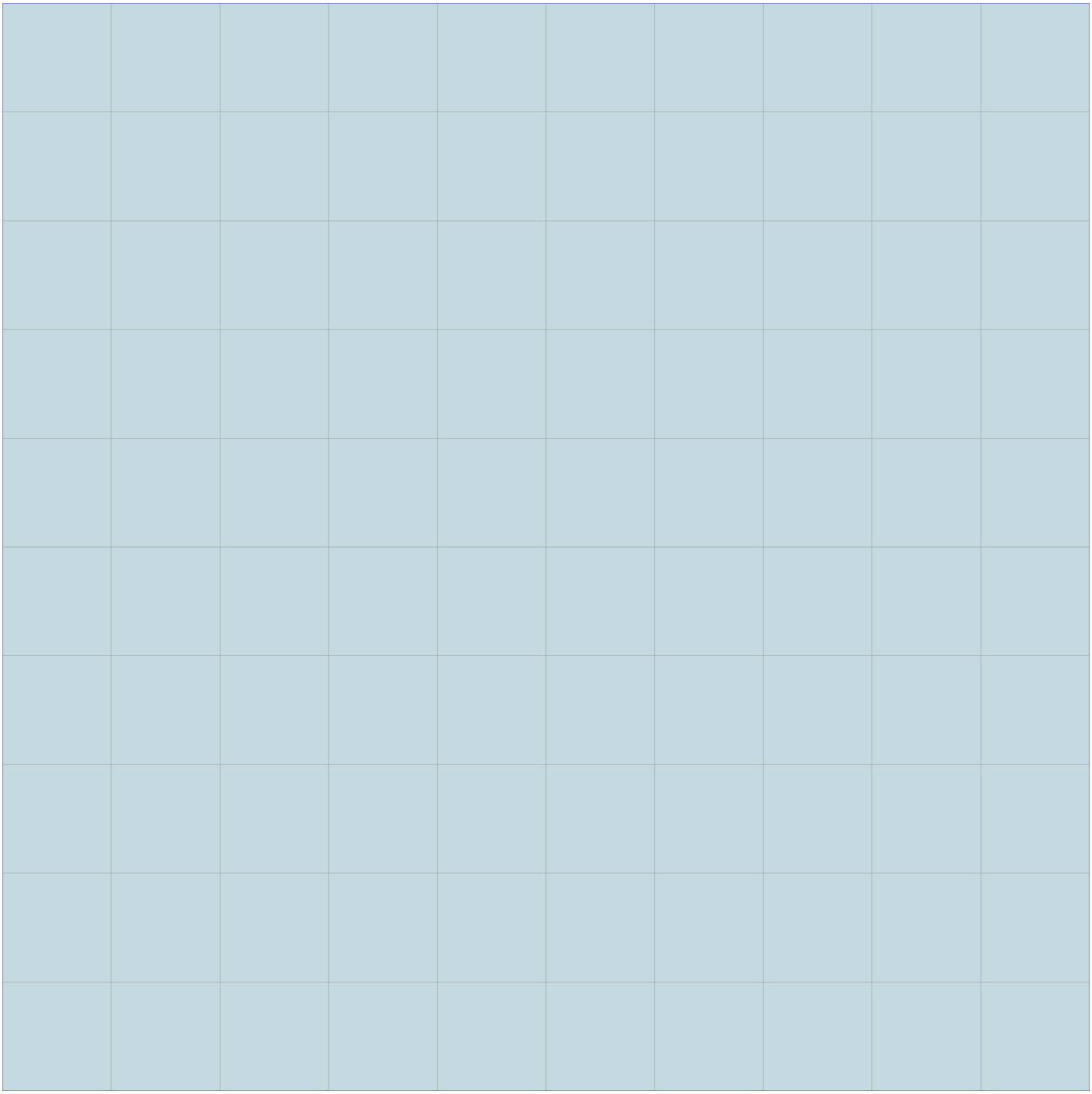
PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic

Predeveloped UCI File

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 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   Infiltration.wdm
MESSU       25   MitInfiltration.MES
            27   MitInfiltration.L61
            28   MitInfiltration.L62
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      13
      IMPLND       1
      IMPLND       5
      IMPLND       8
      RCHRES       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title---------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         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           ***
   13     C, Pasture, Flat        1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   13         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  *********
   13         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 ***
   13         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
   13             0       4.5      0.06       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   13              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   13          0.15       0.4       0.3         6       0.5       0.4
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS       IFWS       LZS       AGWS       GWVS
   13             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           ***
    1      ROADS/FLAT             1    1    1   27    0
    5      DRIVEWAYS/FLAT         1    1    1   27    0
    8      SIDEWALKS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
    5         0    0    1    0    0    0
    8         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
    5         0    0    4    0    0    0    1    9
    8         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     ***
    1         0    0    0    0    0
    5         0    0    0    0    0
    8         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
```

```
    5            400      0.01       0.1       0.1
    8            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
    5              0         0
    8              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
    5              0         0
    8              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
onsite***
PERLND  13                     0.3417     RCHRES   1      2
PERLND  13                     0.3417     RCHRES   1      3
IMPLND   1                     0.8773     RCHRES   1      5
IMPLND   5                     0.0964     RCHRES   1      5
IMPLND   8                     0.2394     RCHRES   1      5

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

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



<-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     onsite                 2    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  5  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  5.0  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
   92    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.028466  0.000000  0.000000  0.000000
  0.044444  0.028466  0.000418  0.000000  0.574074
  0.088889  0.028466  0.000835  0.000000  0.574074
  0.133333  0.028466  0.001253  0.000000  0.574074
  0.177778  0.028466  0.001670  0.000000  0.574074
  0.222222  0.028466  0.002088  0.000000  0.574074
  0.266667  0.028466  0.002505  0.000000  0.574074
  0.311111  0.028466  0.002923  0.000000  0.574074
  0.355556  0.028466  0.003340  0.000000  0.574074
  0.400000  0.028466  0.003758  0.000000  0.574074
  0.444444  0.028466  0.004175  0.000000  0.574074
  0.488889  0.028466  0.004593  0.000000  0.574074
  0.533333  0.028466  0.005010  0.000000  0.574074
  0.577778  0.028466  0.005428  0.000000  0.574074
  0.622222  0.028466  0.005845  0.000000  0.574074
  0.666667  0.028466  0.006263  0.000000  0.574074
  0.711111  0.028466  0.006680  0.000000  0.574074
  0.755556  0.028466  0.007098  0.000000  0.574074
  0.800000  0.028466  0.007515  0.000000  0.574074
  0.844444  0.028466  0.007933  0.000000  0.574074
  0.888889  0.028466  0.008350  0.000000  0.574074
  0.933333  0.028466  0.008768  0.000000  0.574074
  0.977778  0.028466  0.009185  0.000000  0.574074
  1.022222  0.028466  0.009603  0.000000  0.574074
  1.066667  0.028466  0.010020  0.000000  0.574074
  1.111111  0.028466  0.010438  0.000000  0.574074
  1.155556  0.028466  0.010855  0.000000  0.574074
  1.200000  0.028466  0.011273  0.000000  0.574074
  1.244444  0.028466  0.011690  0.000000  0.574074
  1.288889  0.028466  0.012108  0.000000  0.574074
  1.333333  0.028466  0.012525  0.000000  0.574074
  1.377778  0.028466  0.012943  0.000000  0.574074
  1.422222  0.028466  0.013360  0.000000  0.574074
  1.466667  0.028466  0.013778  0.000000  0.574074
  1.511111  0.028466  0.014195  0.000000  0.574074
  1.555556  0.028466  0.014613  0.000000  0.574074
  1.600000  0.028466  0.015030  0.000000  0.574074
  1.644444  0.028466  0.015448  0.000000  0.574074
  1.688889  0.028466  0.015865  0.000000  0.574074
  1.733333  0.028466  0.016283  0.000000  0.574074
  1.777778  0.028466  0.016700  0.000000  0.574074
  1.822222  0.028466  0.017118  0.000000  0.574074
  1.866667  0.028466  0.017535  0.000000  0.574074
  1.911111  0.028466  0.017953  0.000000  0.574074
  1.955556  0.028466  0.018370  0.000000  0.574074
```

```
  2.000000  0.028466  0.018788  0.000000  0.574074
  2.044444  0.028466  0.019205  0.000000  0.574074
  2.088889  0.028466  0.019623  0.000000  0.574074
  2.133333  0.028466  0.020040  0.000000  0.574074
  2.177778  0.028466  0.020458  0.000000  0.574074
  2.222222  0.028466  0.020875  0.000000  0.574074
  2.266667  0.028466  0.021293  0.000000  0.574074
  2.311111  0.028466  0.021710  0.000000  0.574074
  2.355556  0.028466  0.022128  0.000000  0.574074
  2.400000  0.028466  0.022545  0.000000  0.574074
  2.444444  0.028466  0.022963  0.000000  0.574074
  2.488889  0.028466  0.023380  0.000000  0.574074
  2.533333  0.028466  0.023798  0.000000  0.574074
  2.577778  0.028466  0.024215  0.000000  0.574074
  2.622222  0.028466  0.024633  0.000000  0.574074
  2.666667  0.028466  0.025051  0.000000  0.574074
  2.711111  0.028466  0.025468  0.000000  0.574074
  2.755556  0.028466  0.025886  0.000000  0.574074
  2.800000  0.028466  0.026303  0.000000  0.574074
  2.844444  0.028466  0.026721  0.000000  0.574074
  2.888889  0.028466  0.027138  0.000000  0.574074
  2.933333  0.028466  0.027556  0.000000  0.574074
  2.977778  0.028466  0.027973  0.000000  0.574074
  3.022222  0.028466  0.028391  0.000000  0.574074
  3.066667  0.028466  0.028808  0.000000  0.574074
  3.111111  0.028466  0.029226  0.000000  0.574074
  3.155556  0.028466  0.029643  0.000000  0.574074
  3.200000  0.028466  0.030061  0.000000  0.574074
  3.244444  0.028466  0.030478  0.000000  0.574074
  3.288889  0.028466  0.030896  0.000000  0.574074
  3.333333  0.028466  0.031313  0.000000  0.574074
  3.377778  0.028466  0.031731  0.000000  0.574074
  3.422222  0.028466  0.032148  0.000000  0.574074
  3.466667  0.028466  0.032566  0.000000  0.574074
  3.511111  0.028466  0.032983  0.000000  0.574074
  3.555556  0.028466  0.033401  0.000000  0.574074
  3.600000  0.028466  0.033818  0.000000  0.574074
  3.644444  0.028466  0.034236  0.000000  0.574074
  3.688889  0.028466  0.034653  0.000000  0.574074
  3.733333  0.028466  0.035071  0.000000  0.574074
  3.777778  0.028466  0.035488  0.000000  0.574074
  3.822222  0.028466  0.035906  0.000000  0.574074
  3.866667  0.028466  0.036323  0.000000  0.574074
  3.911111  0.028466  0.036741  0.000000  0.574074
  3.955556  0.028466  0.037158  0.000000  0.574074
  4.000000  0.028466  0.037576  0.000000  0.574074
  4.044444  0.028466  0.038841  0.099321  0.574074
  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    0.857          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.857          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           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***
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


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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WWHM2012

PROJECT REPORT

General Model Information

Project Name:	INFILTRATION
Site Name:	
Site Address:	
City:	
Report Date:	10/5/2021
Gage:	Lake Lawrence
Data Start:	1955/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	0.857
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

Landuse Basin Data
Predeveloped Land Use

Mitigated Land Use

ROAD C

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Pasture, Flat	0.14
Pervious Total	0.14

Impervious Land Use	acre
ROADS FLAT	0.19
Impervious Total	0.19
Basin Total	0.33

Element Flows To:

Surface	Interflow	Groundwater
ROAD C TRENCH	ROAD C TRENCH	

Routing Elements
Predeveloped Routing

Mitigated Routing

ROAD C TRENCH

Bottom Length:	66.00 ft.
Bottom Width:	3.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	4
Pour Space of material for first layer:	0.33
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	20
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	42.325
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	42.326
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	4 ft.
Riser Diameter:	12 in.
Element Flows To:	
Outlet 1	Outlet 2

Gravel Trench Bed Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.004	0.000	0.000	0.000
0.0444	0.004	0.000	0.000	0.091
0.0889	0.004	0.000	0.000	0.091
0.1333	0.004	0.000	0.000	0.091
0.1778	0.004	0.000	0.000	0.091
0.2222	0.004	0.000	0.000	0.091
0.2667	0.004	0.000	0.000	0.091
0.3111	0.004	0.000	0.000	0.091
0.3556	0.004	0.000	0.000	0.091
0.4000	0.004	0.000	0.000	0.091
0.4444	0.004	0.000	0.000	0.091
0.4889	0.004	0.000	0.000	0.091
0.5333	0.004	0.000	0.000	0.091
0.5778	0.004	0.000	0.000	0.091
0.6222	0.004	0.000	0.000	0.091
0.6667	0.004	0.001	0.000	0.091
0.7111	0.004	0.001	0.000	0.091
0.7556	0.004	0.001	0.000	0.091
0.8000	0.004	0.001	0.000	0.091
0.8444	0.004	0.001	0.000	0.091
0.8889	0.004	0.001	0.000	0.091
0.9333	0.004	0.001	0.000	0.091
0.9778	0.004	0.001	0.000	0.091
1.0222	0.004	0.001	0.000	0.091

1.0667	0.004	0.001	0.000	0.091
1.1111	0.004	0.001	0.000	0.091
1.1556	0.004	0.001	0.000	0.091
1.2000	0.004	0.001	0.000	0.091
1.2444	0.004	0.001	0.000	0.091
1.2889	0.004	0.001	0.000	0.091
1.3333	0.004	0.002	0.000	0.091
1.3778	0.004	0.002	0.000	0.091
1.4222	0.004	0.002	0.000	0.091
1.4667	0.004	0.002	0.000	0.091
1.5111	0.004	0.002	0.000	0.091
1.5556	0.004	0.002	0.000	0.091
1.6000	0.004	0.002	0.000	0.091
1.6444	0.004	0.002	0.000	0.091
1.6889	0.004	0.002	0.000	0.091
1.7333	0.004	0.002	0.000	0.091
1.7778	0.004	0.002	0.000	0.091
1.8222	0.004	0.002	0.000	0.091
1.8667	0.004	0.002	0.000	0.091
1.9111	0.004	0.002	0.000	0.091
1.9556	0.004	0.002	0.000	0.091
2.0000	0.004	0.003	0.000	0.091
2.0444	0.004	0.003	0.000	0.091
2.0889	0.004	0.003	0.000	0.091
2.1333	0.004	0.003	0.000	0.091
2.1778	0.004	0.003	0.000	0.091
2.2222	0.004	0.003	0.000	0.091
2.2667	0.004	0.003	0.000	0.091
2.3111	0.004	0.003	0.000	0.091
2.3556	0.004	0.003	0.000	0.091
2.4000	0.004	0.003	0.000	0.091
2.4444	0.004	0.003	0.000	0.091
2.4889	0.004	0.003	0.000	0.091
2.5333	0.004	0.003	0.000	0.091
2.5778	0.004	0.003	0.000	0.091
2.6222	0.004	0.003	0.000	0.091
2.6667	0.004	0.004	0.000	0.091
2.7111	0.004	0.004	0.000	0.091
2.7556	0.004	0.004	0.000	0.091
2.8000	0.004	0.004	0.000	0.091
2.8444	0.004	0.004	0.000	0.091
2.8889	0.004	0.004	0.000	0.091
2.9333	0.004	0.004	0.000	0.091
2.9778	0.004	0.004	0.000	0.091
3.0222	0.004	0.004	0.000	0.091
3.0667	0.004	0.004	0.000	0.091
3.1111	0.004	0.004	0.000	0.091
3.1556	0.004	0.004	0.000	0.091
3.2000	0.004	0.004	0.000	0.091
3.2444	0.004	0.004	0.000	0.091
3.2889	0.004	0.004	0.000	0.091
3.3333	0.004	0.005	0.000	0.091
3.3778	0.004	0.005	0.000	0.091
3.4222	0.004	0.005	0.000	0.091
3.4667	0.004	0.005	0.000	0.091
3.5111	0.004	0.005	0.000	0.091
3.5556	0.004	0.005	0.000	0.091
3.6000	0.004	0.005	0.000	0.091

3.6444	0.004	0.005	0.000	0.091
3.6889	0.004	0.005	0.000	0.091
3.7333	0.004	0.005	0.000	0.091
3.7778	0.004	0.005	0.000	0.091
3.8222	0.004	0.005	0.000	0.091
3.8667	0.004	0.005	0.000	0.091
3.9111	0.004	0.005	0.000	0.091
3.9556	0.004	0.005	0.000	0.091
4.0000	0.004	0.006	0.000	0.091

Analysis Results

POC 1

POC #1 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.

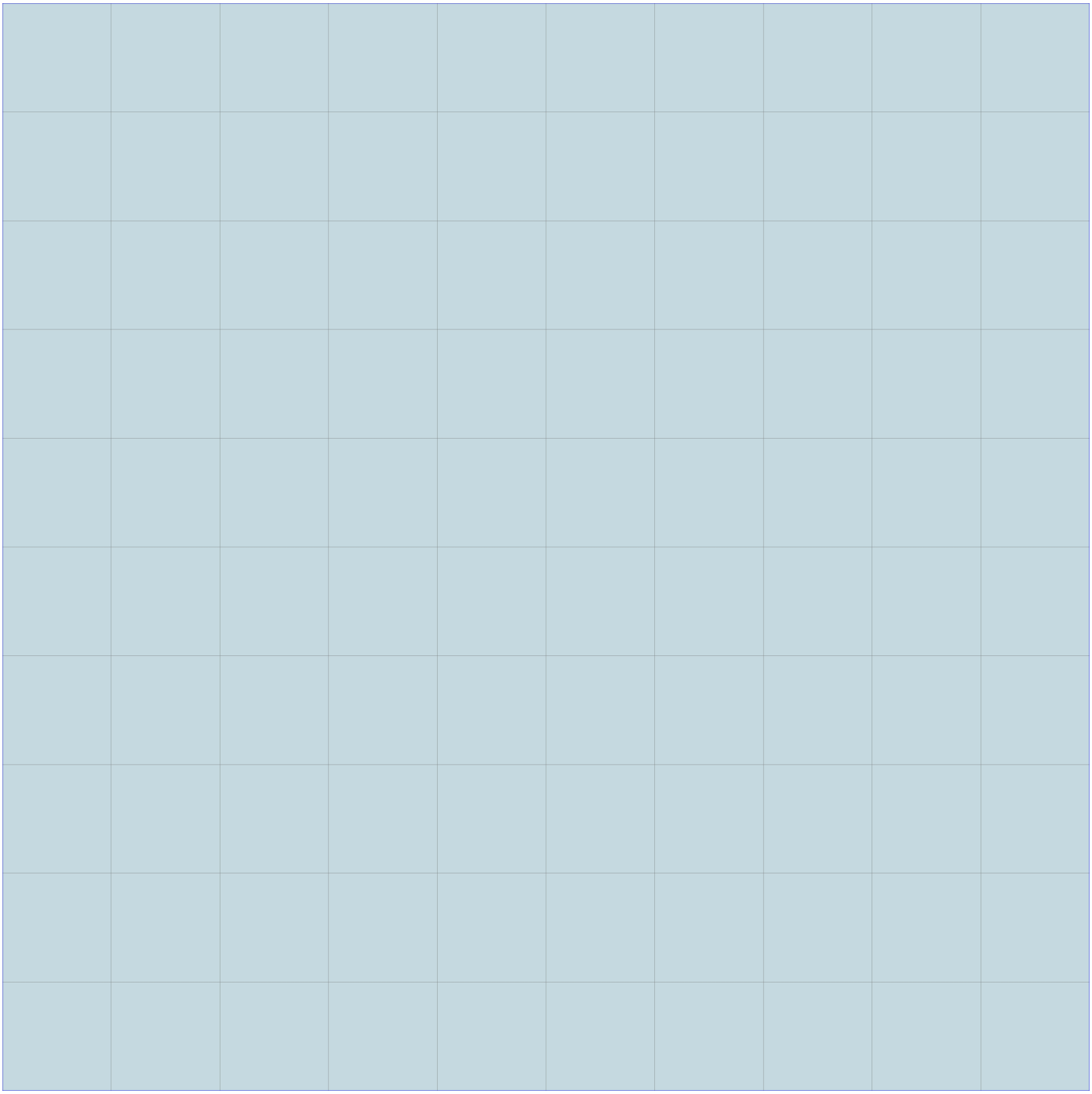
PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic

Predeveloped UCI File

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 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   INFILTRATION.wdm
MESSU       25   MitINFILTRATION.MES
            27   MitINFILTRATION.L61
            28   MitINFILTRATION.L62
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      13
      IMPLND       1
      RCHRES       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title---------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         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           ***
   13     C, Pasture, Flat        1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   13         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  *********
   13         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 ***
```

```
 13         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
   13              0       4.5      0.06       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   13              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   13           0.15       0.4       0.3         6       0.5       0.4
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS       IFWS       LZS       AGWS       GWVS
   13              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           ***
    1      ROADS/FLAT             1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

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

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

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
```

```
    # -  # ***  RETS      SURS
    1             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
ROAD C***
PERLND  13                        0.14     RCHRES   1      2
PERLND  13                        0.14     RCHRES   1      3
IMPLND   1                        0.19     RCHRES   1      5

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

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



<-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     ROAD C TRENCH           2    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  5  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  5.0  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
   92    5
     Depth       Area     Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)    (acres) (acre-ft)   (cfs)      (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.004545  0.000000  0.000000  0.000000
  0.044444  0.004545  0.000067  0.000000  0.091667
  0.088889  0.004545  0.000133  0.000000  0.091667
  0.133333  0.004545  0.000200  0.000000  0.091667
  0.177778  0.004545  0.000267  0.000000  0.091667
  0.222222  0.004545  0.000333  0.000000  0.091667
  0.266667  0.004545  0.000400  0.000000  0.091667
  0.311111  0.004545  0.000467  0.000000  0.091667
  0.355556  0.004545  0.000533  0.000000  0.091667
  0.400000  0.004545  0.000600  0.000000  0.091667
  0.444444  0.004545  0.000667  0.000000  0.091667
  0.488889  0.004545  0.000733  0.000000  0.091667
  0.533333  0.004545  0.000800  0.000000  0.091667
  0.577778  0.004545  0.000867  0.000000  0.091667
  0.622222  0.004545  0.000933  0.000000  0.091667
  0.666667  0.004545  0.001000  0.000000  0.091667
  0.711111  0.004545  0.001067  0.000000  0.091667
  0.755556  0.004545  0.001133  0.000000  0.091667
  0.800000  0.004545  0.001200  0.000000  0.091667
  0.844444  0.004545  0.001267  0.000000  0.091667
  0.888889  0.004545  0.001333  0.000000  0.091667
  0.933333  0.004545  0.001400  0.000000  0.091667
  0.977778  0.004545  0.001467  0.000000  0.091667
  1.022222  0.004545  0.001533  0.000000  0.091667
  1.066667  0.004545  0.001600  0.000000  0.091667
  1.111111  0.004545  0.001667  0.000000  0.091667
  1.155556  0.004545  0.001733  0.000000  0.091667
  1.200000  0.004545  0.001800  0.000000  0.091667
  1.244444  0.004545  0.001867  0.000000  0.091667
  1.288889  0.004545  0.001933  0.000000  0.091667
  1.333333  0.004545  0.002000  0.000000  0.091667
  1.377778  0.004545  0.002067  0.000000  0.091667
  1.422222  0.004545  0.002133  0.000000  0.091667
  1.466667  0.004545  0.002200  0.000000  0.091667
  1.511111  0.004545  0.002267  0.000000  0.091667
  1.555556  0.004545  0.002333  0.000000  0.091667
  1.600000  0.004545  0.002400  0.000000  0.091667
  1.644444  0.004545  0.002467  0.000000  0.091667
  1.688889  0.004545  0.002533  0.000000  0.091667
  1.733333  0.004545  0.002600  0.000000  0.091667
  1.777778  0.004545  0.002667  0.000000  0.091667
  1.822222  0.004545  0.002733  0.000000  0.091667
  1.866667  0.004545  0.002800  0.000000  0.091667
  1.911111  0.004545  0.002867  0.000000  0.091667
  1.955556  0.004545  0.002933  0.000000  0.091667
  2.000000  0.004545  0.003000  0.000000  0.091667
  2.044444  0.004545  0.003067  0.000000  0.091667
  2.088889  0.004545  0.003133  0.000000  0.091667
  2.133333  0.004545  0.003200  0.000000  0.091667
  2.177778  0.004545  0.003267  0.000000  0.091667
  2.222222  0.004545  0.003333  0.000000  0.091667
  2.266667  0.004545  0.003400  0.000000  0.091667
  2.311111  0.004545  0.003467  0.000000  0.091667
  2.355556  0.004545  0.003533  0.000000  0.091667
  2.400000  0.004545  0.003600  0.000000  0.091667
  2.444444  0.004545  0.003667  0.000000  0.091667
  2.488889  0.004545  0.003733  0.000000  0.091667
  2.533333  0.004545  0.003800  0.000000  0.091667
  2.577778  0.004545  0.003867  0.000000  0.091667
  2.622222  0.004545  0.003933  0.000000  0.091667
  2.666667  0.004545  0.004000  0.000000  0.091667
  2.711111  0.004545  0.004067  0.000000  0.091667
  2.755556  0.004545  0.004133  0.000000  0.091667
```

```
  2.800000  0.004545  0.004200  0.000000  0.091667
  2.844444  0.004545  0.004267  0.000000  0.091667
  2.888889  0.004545  0.004333  0.000000  0.091667
  2.933333  0.004545  0.004400  0.000000  0.091667
  2.977778  0.004545  0.004467  0.000000  0.091667
  3.022222  0.004545  0.004533  0.000000  0.091667
  3.066667  0.004545  0.004600  0.000000  0.091667
  3.111111  0.004545  0.004667  0.000000  0.091667
  3.155556  0.004545  0.004733  0.000000  0.091667
  3.200000  0.004545  0.004800  0.000000  0.091667
  3.244444  0.004545  0.004867  0.000000  0.091667
  3.288889  0.004545  0.004933  0.000000  0.091667
  3.333333  0.004545  0.005000  0.000000  0.091667
  3.377778  0.004545  0.005067  0.000000  0.091667
  3.422222  0.004545  0.005133  0.000000  0.091667
  3.466667  0.004545  0.005200  0.000000  0.091667
  3.511111  0.004545  0.005267  0.000000  0.091667
  3.555556  0.004545  0.005333  0.000000  0.091667
  3.600000  0.004545  0.005400  0.000000  0.091667
  3.644444  0.004545  0.005467  0.000000  0.091667
  3.688889  0.004545  0.005533  0.000000  0.091667
  3.733333  0.004545  0.005600  0.000000  0.091667
  3.777778  0.004545  0.005667  0.000000  0.091667
  3.822222  0.004545  0.005733  0.000000  0.091667
  3.866667  0.004545  0.005800  0.000000  0.091667
  3.911111  0.004545  0.005867  0.000000  0.091667
  3.955556  0.004545  0.005933  0.000000  0.091667
  4.000000  0.004545  0.006000  0.000000  0.091667
  4.044444  0.004545  0.006202  0.099321  0.091667
  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    0.857          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.857          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           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***
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


END MASS-LINK

END RUN
```

Disclaimer

Legal Notice

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Local (360)943-0304

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Appendix C

Geotechnical Report
Earth Solutions NW, LLC, October 6, 2021

Earth Solutions NW LLC

Geotechnical Engineering
Construction Observation/Testing
Environmental Services

GEOTECHNICAL ENGINEERING STUDY
CRYSTAL SPRINGS
714 CRYSTAL SPRINGS STREET NORTHWEST
YELM, WASHINGTON

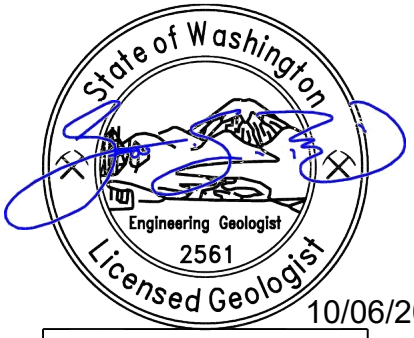
ES-8113

15365 N.E. 90th Street, Suite 100 Redmond, WA 98052
(425) 449-4704 Fax (425) 449-4711
www.earthsolutionsnw.com

PREPARED FOR

COPPER RIDGE, LLC

October 6, 2021



Scott S. Riegel, L.G., L.E.G.
Senior Project Manager

Kyle R. Campbell, P.E.
Principal Engineer

GEOTECHNICAL ENGINEERING STUDY
CRYSTAL SPRINGS
714 CRYSTAL SPRINGS STREET NORTHWEST
YELM, WASHINGTON

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Important Information about This

Geotechnical-Engineering Report

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

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

Earth Solutions NW LLC

Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

October 6, 2021
ES-8113

Copper Ridge, LLC
P.O. Box 73790
Puyallup, Washington 98373

Attention: Mr. Evan Mann

Dear Mr. Mann:

Earth Solutions NW, LLC (ESNW) is pleased to present this report supporting the planned residential development for Yelm, Washington. In our opinion, the proposed residential development is feasible from a geotechnical standpoint. Based on the conditions observed during our fieldwork, the subject site is underlain primarily by recessional outwash deposits that are suitable for infiltration. The proposed structures can be supported on conventional spread and continuous foundations bearing on competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. In general, competent native soil suitable for support of foundations will likely be encountered at depths of about two to four feet below the existing ground surface (bgs). Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of soils to the specifications of structural fill, or overexcavation and replacement with suitable structural fill, will likely be necessary.

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

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

Sincerely,

EARTH SOLUTIONS NW, LLC

Scott S. Riegel, L.G., L.E.G.
Senior Project Manager

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Cont'd

ES-8113

GEOTECHNICAL ENGINEERING STUDY
CRYSTAL SPRINGS
714 CRYSTAL SPRINGS STREET NORTHWEST
YELM, WASHINGTON

ES-8113

INTRODUCTION

General

This report was prepared for the proposed residential development to be constructed at 714 Crystal Springs Street Northwest in Yelm, Washington. The purpose of this study was to provide geotechnical recommendations for the proposed development. Our scope of services for completing this geotechnical engineering study included the following:

- Observing, logging, and sampling test pits for purposes of characterizing site soil and groundwater conditions;
- Laboratory testing of soil samples collected at the test pit locations;
- Engineering analyses and recommendations for the proposed development, and;
- Preparation of this report.

The following documents and resources were reviewed as part of our report preparation:

- Geologic Map of the Centralia Quadrangle, Washington, 1987;
- Conceptual Site Plan, undated;
- Web Soil Survey (WSS) online resource, maintained by the Natural Resources Conservation Service under the United States Department of Agriculture, and;
- Yelm Municipal Code Title 18.21: Critical Areas and Resource Lands.

Project Description

Based on review of the referenced plans, the subject site will be redeveloped with up to 30 single-family residences and associated improvements. Grading plans were not available at the time this report was prepared; however, given the low topographic relief on this site, we anticipate grading may include cuts and fills of up to about five feet with deeper excavations required to install underground utilities.

At the time this report was prepared, specific building load values were not available; however, we anticipate the proposed residential structures will consist of relatively lightly loaded wood framing supported on conventional foundations. Based on our experience with similar developments, we estimate wall loads on the order of 1 to 2 kips per linear foot and slab-on-grade loading of 150 pounds per square foot (psf). The feasibility of infiltrating runoff into native soils is being investigated as part of the project plans.

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

SITE CONDITIONS

Surface

The subject site is located east of Crystal Springs Street Northwest in Yelm, Washington, as illustrated on the Vicinity Map (Plate 1). The site consists of a single tax parcel (Thurston County Parcel Number 22719210403) currently developed with a single-family residence, barn, detached garage, and associated improvements. The majority of the subject site is lightly to moderately vegetated with tall grass, and sparse trees and general landscaping around existing buildings. Topography is relatively level, with less than about five feet of total elevation change across the site.

Subsurface

A representative of ESNW observed, logged, and sampled six test pits, excavated at accessible locations within the proposed development area, on August 31, 2021, using a trackhoe and operator provided by the client. The approximate locations of the test pits are depicted on Plate 2 (Test Pit Location Plan). Please refer to the test pit logs provided in Appendix A for a more detailed description of subsurface conditions. Representative soil samples collected at the test pit locations were analyzed in general accordance with Unified Soil Classification System (USCS) and United States Department of Agriculture (USDA) methods and procedures.

Topsoil and Fill

Topsoil was observed extending to depths of approximately 6 to 12 inches below existing grades. The topsoil thickness is variable and vegetation roots often extend below the topsoil zone into the underlying weathered native soil. The topsoil was characterized by dark brown color and fine organic material. Topsoil is not suitable for use as structural fill nor should it be mixed with material to be used as structural fill. Topsoil or otherwise unsuitable material can be used in landscape areas if desired.

Fill was not encountered within the test pits; however, fill is likely present near the existing structures to some degree. If fill is encountered during construction, ESNW should be consulted to verify the suitability for support of the proposed structures and/or reuse as structural fill.

Native Soil

Underlying the topsoil, native soils consisted primarily of medium dense to dense poorly and well-graded gravel with variable sand (USCS: GP and GW respectively). The native soils were generally encountered in a damp to moist condition and extended to the maximum exploration depth of 13 feet below ground surface (bgs). We encountered scattered large cobbles and small boulders at the test pit locations.

Geologic Setting

The referenced geologic map resource identifies recessional outwash, specifically Vashon drift gravel (Qdvg), across the site and surrounding areas. The referenced WSS resource identifies Spanaway gravelly sandy loam (Map Unit Symbols: 110 and 111) across the site and surrounding areas. Spanaway gravelly loam was formed in outwash plains. Based on our field observations, native soils on site are generally consistent with the geologic setting outlined in this section.

Groundwater

Groundwater was not encountered, at the time of our exploration (August 31, 2021). Groundwater seepage rates and elevations fluctuate depending on many factors, including precipitation duration and intensity, the time of year, and soil conditions. In general, groundwater flow rates are higher during the wetter, winter, spring, and early summer months.

Geologically Hazardous Areas

As part of this report, the subject property was evaluated for the presence of geologically hazardous areas in general accordance with the applicable Yelm municipal code. Based on our investigation, the site does not lie within or is immediately adjacent to geologically hazardous areas.

DISCUSSION AND RECOMMENDATIONS

General

In our opinion, the proposed residential structures can be supported on conventional spread and continuous foundations bearing on undisturbed competent native soil, recompacted native soil or new structural fill placed directly on competent native soil. Competent soils suitable for support of foundations are anticipated to be exposed at depths of about two to four feet below existing grades across the majority of the site. Slab-on-grade floors should be supported on competent native soil, re-compacted native soil, or new structural fill. Organic material exposed at subgrade elevations must be removed below design elevation and grades restored with structural fill. Where loose, organic or other unsuitable materials are encountered at or below the footing subgrade elevation, the material should be removed and replaced with structural fill, as necessary.

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

Site Preparation and Earthwork

Site preparation activities will consist of installing temporary erosion control measures and performing clearing and site stripping. Grading activities will likely consist of cuts and fills on the order five feet with the deeper cuts associated with stormwater facilities and utility excavations.

Temporary Erosion Control

Temporary construction entrances and drive lanes, consisting of at least six inches of quarry spalls, should be considered in order to minimize off-site soil tracking and to provide a temporary road surface. Temporary slopes and stockpiles should be covered when not in use. Silt fencing should be installed along the margins of the property. Temporary infiltration swales and galleries can be considered for control of stormwater. Erosion control measures should conform to the applicable Washington State Department of Ecology and City of Yelm/Thurston County standards.

In-Situ Soils

The majority of the soils encountered during our subsurface exploration have a low to moderate sensitivity to moisture and were generally in a damp to moist condition at the time of the exploration on August 2021. Soils encountered during site excavations that are excessively over the optimum moisture content will require aeration or treatment prior to placement and compaction. Conversely, soils that are substantially below the optimum moisture content will require moisture conditioning through the addition of water prior to use as structural fill. An ESNW representative should determine the suitability of in-situ soils for use as structural fill at the time of construction.

Wet Season Grading

If grading takes place during the wet season surface water could collect and degrade site soils if not property controlled. The contractor should establish temporary drainage control measures, such as swales and ponds, prior to extended wet weather. ESNW should be consulted during construction to provide temporary drainage control recommendations.

Structural Fill

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, and roadway areas. Fills placed to construct permanent slopes and throughout retaining wall and utility trench backfill areas are considered structural fill as well. Soils placed in structural areas should be placed in loose lifts of 12 inches or less and compacted to a relative compaction of 95 percent, based on the laboratory maximum dry density as determined by the Modified Proctor Method (ASTM D1557). More stringent compaction specifications may be required for utility trench backfill zones depending on the responsible utility district or jurisdiction.

Excavations and Slopes

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

Based on the soil conditions encountered at the test pit locations, site soils are classified as Type C by OSHA. New fill should also be considered Type C soil. Temporary slopes over four feet in height in Type C soils must be sloped no steeper than (1.5H:1V). Steeper temporary slopes may be feasible and should be evaluated by ESNW during construction. Where encountered, the presence of groundwater seepage may cause caving of temporary slopes. ESNW should observe site excavations to confirm soil types and allowable slope inclinations. If the recommended temporary slope inclinations cannot be achieved, temporary shoring may be necessary to support excavations, particularly utility trench excavations.

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

Foundations

The proposed residential structures can be supported on conventional spread and continuous footings bearing on undisturbed competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. Based on the soil conditions encountered at the test sites, competent soils suitable for support of foundations are anticipated to be exposed at depths of about two to four feet below existing grades across the majority of the site. Where loose or unsuitable soil conditions are observed at foundation subgrade elevations, compaction of the soils to the specifications of structural fill, or overexcavation and replacement with granular structural fill will be necessary. Organic material exposed at foundation subgrade elevations must be removed and grades restored with structural fill.

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

- Allowable soil bearing capacity — 2,500 psf
- Passive earth pressure — 300 pcf (equivalent fluid)
- Coefficient of friction — 0.40

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

With structural loading as expected, total settlement in the range of 1.0 inch is anticipated, with differential settlement of about 0.5 inch. The majority of the settlements should occur during construction, as dead loads are applied.

Seismic Design Considerations

The 2018 International Building Code (2018 IBC) recognizes the most recent edition of the Minimum Design Loads for Buildings and Other Structures manual (ASCE 7-16) for seismic design, specifically with respect to earthquake loads. Based on the soil conditions encountered at the test pit locations, the parameters and values provided below are recommended for seismic design per the 2018 IBC.

Parameter	Value
Site Class	D*
Mapped short period spectral response acceleration, S_S (*g*)	1.291
Mapped 1-second period spectral response acceleration, S_1 (*g*)	0.466
Short period site coefficient, F_a	1
Long period site coefficient, F_v	1.88†
Adjusted short period spectral response acceleration, S_{MS} (*g*)	1.291
Adjusted 1-second period spectral response acceleration, S_{M1} (*g*)	0.876†
Design short period spectral response acceleration, S_{DS} (*g*)	0.861
Design 1-second period spectral response acceleration, S_{D1} (*g*)	0.584†

* *Assumes medium dense native soil conditions, encountered to a maximum depth of 13 feet bgs during the August 2021 field exploration, remain medium dense or better to at least 100 feet bgs.*

† *Values assume F_v may be determined using linear interpolation per Table 11.4-2 in ASCE 7-16.*

As indicated in the table footnote, several of the seismic design values provided above are dependent on the assumption that site-specific ground motion analysis (per Section 11.4.8 of ASCE 7-16) will not be required for the subject project. ESNW recommends the validity of this assumption be confirmed at the earliest available opportunity during the planning and early design stages of the project. Further discussion between the project structural engineer, the project owner, and ESNW may be prudent to determine the possible impacts to the structural design due to increased earthquake load requirements under the 2018 IBC. ESNW can provide additional consulting services to aid with design efforts, including supplementary geotechnical and geophysical investigation, upon request.

Liquefaction is a phenomenon where saturated or loose soil suddenly loses internal strength and behaves as a fluid. This behavior is in response to increased pore water pressures resulting from an earthquake or another intense ground shaking. In our opinion, site susceptibility to liquefaction may be considered low. The depth of the local groundwater table and the gradation and relatively dense characteristics of the native soil were the primary bases for this opinion.

Slab-on-Grade Floors

Slab-on-grade floors for the proposed residential structures should be supported on a firm and unyielding subgrade. Unstable or yielding areas of the subgrade should be recompacted, or overexcavated and replaced with suitable structural fill, prior to construction of the slab.

A capillary break consisting of a minimum of four inches of free-draining crushed rock or gravel should be placed below the slab. The free-draining material should have a fines content of 5 percent or less (percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction). In areas where slab moisture is undesirable, installation of a vapor barrier below the slab should be considered. If a vapor barrier is to be utilized, it should be a material specifically designed for use as a vapor barrier and should be installed in accordance with the specifications of the manufacturer.

Retaining Walls

Retaining walls must be designed to resist earth pressures and applicable surcharge loads. The following parameters can be used for retaining wall design:

- Active earth pressure (unrestrained condition) 35 pcf
- At-rest earth pressure (restrained condition) 55 pcf
- Traffic surcharge (passenger vehicles) 70 psf (rectangular distribution)
- Passive earth pressure 300 pcf
- Coefficient of friction 0.40
- Seismic surcharge 8H*

* *Where H equals the retained height.*

Additional surcharge loading from adjacent foundations, sloped backfill, retaining walls, or other loads should be included in the retaining wall design. Drainage should be provided behind retaining walls such that hydrostatic pressures do not develop. If drainage is not provided, hydrostatic pressures should be included in the wall design.

Retaining walls should be backfilled with at least 18 inches of free-draining material or suitable sheet drainage that extends along the height of the wall. The upper one foot of the wall backfill can consist of a less permeable soil, if desired. A perforated drain pipe should be placed along the base of the wall and connected to an approved discharge location. A typical retaining wall drainage detail is provided on Plate 3.

Drainage

Based on our field observations, the native soils generally consisted of well-drained, poorly to well-graded gravels with slightly variable sand contents. Because of the generally well-drained nature of the native gravels, significant groundwater is not anticipated to be encountered within shallow site excavations. ESNW should be consulted during preliminary grading to identify areas of seepage (if present) and provide recommendations to reduce the potential for instability related to seepage effects.

Finish grades must be designed to direct surface drain water away from structures and slopes. The grade adjacent to buildings should be sloped away from the buildings at a gradient of at least 2 percent for a horizontal distance of at least 10 feet or more as setbacks allow. Water must not be allowed to pond adjacent to structures or slopes. Based on our field observations, it may be feasible to eliminate foundation drains, provided clean, well-drained deposits are exposed at footing subgrade elevation. However, confirmation should be provided by ESNW at the time of construction. A typical foundation drain detail is provided on Plate 4.

Infiltration Evaluation

We conducted in-situ pilot infiltration tests (PITs) at the two areas proposed for infiltration within the overall development. The PITs were completed at test pit locations TP-1 and TP-4 within native soils about 8 to 10 feet below existing grades. As indicated in the *Subsurface* section of this report, native soils encountered during our fieldwork were characterized primarily as Spanaway gravels with variable sand content. Based upon the results of USDA textural analyses performed on representative soil samples, native soils may also be classified chiefly as extremely gravelly coarse sand. Irrespective of gravel content, fines contents within the native gravels were generally less than one percent.

Test Method

The bottom of each PIT area was set at the approximate design facility bottom as recommended in the Method 1 Field Test Methods section of Appendix III-A. Water was metered into each PIT area using a pump fed hose to develop a constant head of about one foot. The hydraulic head was maintained until the water truck was emptied (3,800-gallon capacity), and measurements of flow for each test area was monitored by our field staff. Upon completion of the constant head soaking period, the water source was removed and each test area was allowed to drain. Upon drained conditions, the test pits were advanced to the limits of the excavator to determine soil stratigraphy and check for groundwater.

Test Results

Our testing yielded measured (unfactored) infiltration rates of between 90 and 180 inches per hour (iph). The correction factors below were applied to the measured rates.

Correction Factor	Value
Test Method	0.5
Geometry	0.9*
Plugging	0.9

* *This value is estimated based on typical pond geometry and uses information collected during the testing.*

The total correction factor applied to the measured infiltration rates was 0.4. The resulting long-term (design) infiltration rate is 36 iph. These rates were calculated using the lowest measured infiltration rate.

Soil Types and Site Variability

We conducted USDA textural analyses of representative soil samples collected at the PIT areas. On this basis, the majority of the native soil within the proposed areas consist of extremely gravelly coarse sand. The samples collected at the tested locations indicated consistent soil types across the site, with low variability.

Restrictive Layer

On this site, the restrictive layer is groundwater, as the alluvial sand and gravel persisted to the maximum exploration depth at each location. The groundwater was not identified on this site at the test pit locations during our fieldwork.

Summary and Recommendations

From a geotechnical standpoint, it is our opinion that the native gravels are suitable for infiltration. The low soil variability consisting of a consistent thick layer of sand and gravel and low fines contents within the gravels are the basis of this conclusion. Based on the results of our PIT program, a long-term infiltration rate of 36 iph may be used for the current infiltration trench design that will expose coarse gravel soils. Successful performance of the infiltration systems requires that the base of the facility (receptor soils) exposed sandy soils similar to those encountered at the test depth. The minimum vertical separation and corresponding trench base elevations detailed in the referenced groundwater summary should be incorporated into facility designs. ESNW should review final designs to confirm the recommendations provided in this letter report are incorporated. ESNW should be retained to observe construction of the infiltration facility areas during grading to confirm conditions are as anticipated. This site is identified as a highly susceptible critical aquifer recharge area per YMC section 18.21.070 and will require performance standards within this section to be met as part of the project design.

Utility Support and Trench Backfill

In our opinion, the soils observed at the test pit locations are generally suitable for support of utilities. The native soils observed at the test pit locations are likely suitable for use as structural backfill in the utility trench excavations. Utility trench backfill should be placed and compacted to the specifications of structural fill provided in this report, or to the applicable requirements of presiding jurisdiction. Native sands and gravels used as backfill should be appropriately moisture conditioned through the addition of water to mitigate the settlement potential.

Native soils proposed for use as utility trench backfill should contain aggregate of six inches in diameter or less. Caving of the trench sidewalls should be expected and will require temporary shoring to ensure safety is maintained during utility installation.

Pavement Sections

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

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

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

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

- Three inches of HMA placed over six inches of crushed rock base (CRB), or;
- Three inches of HMA placed over four-and-one-half inches of ATB.

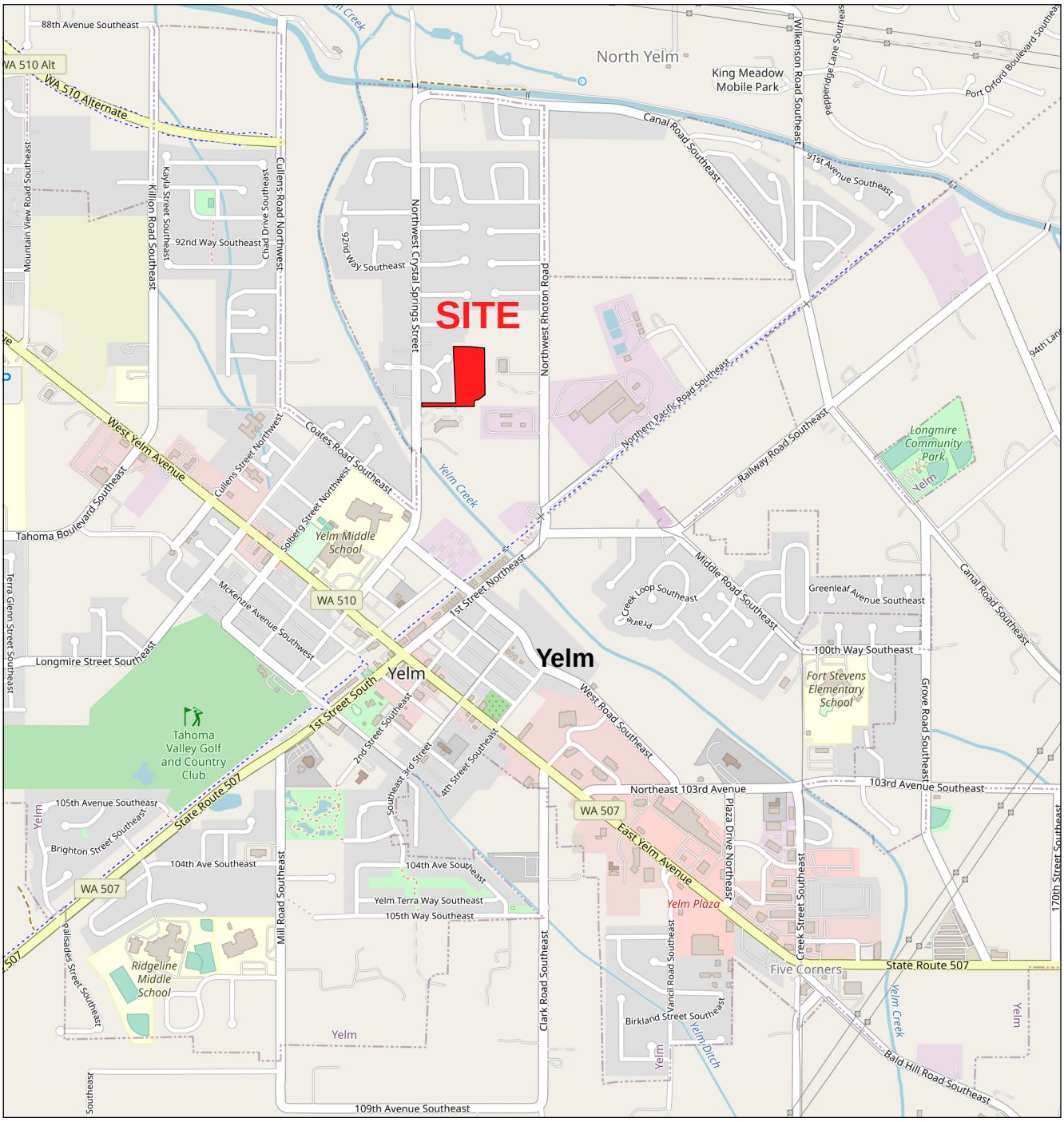
The HMA, CRB and ATB materials should conform to WSDOT specifications. Thurston County/City of Yelm minimum pavement requirements may supersede our recommendations and may require thicker pavement sections.

LIMITATIONS

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

Additional Services

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



Reference:
Thurston County, Washington
OpenStreetMap.org

NORTH

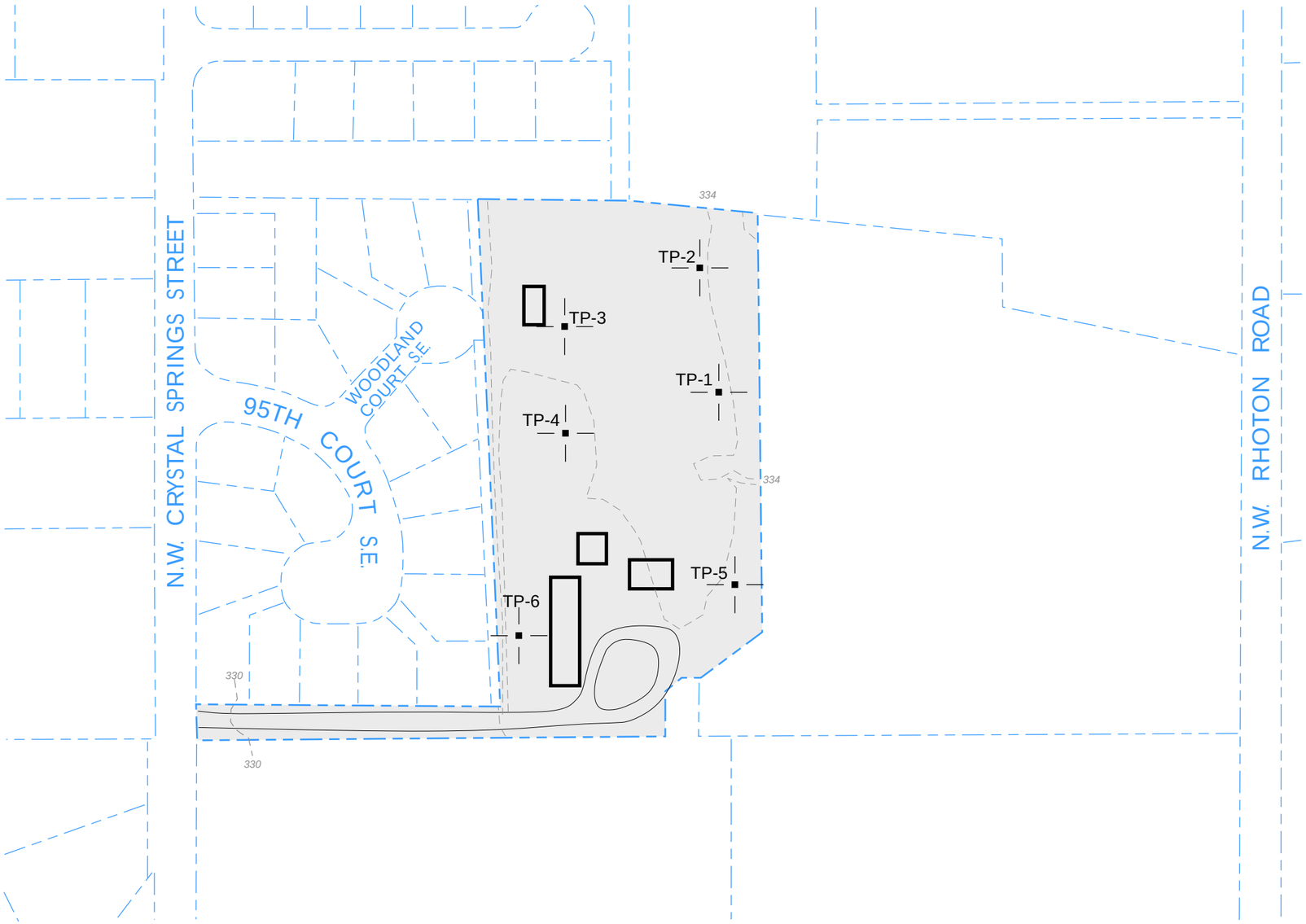
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Vicinity Map
Crystal Springs
Yelm, Washington

Drwn. MRS	Date 09/20/2021	Proj. No. 8113
Checked SKH	Date Sept. 2021	Plate 1



LEGEND

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-8113, Aug. 2021

Subject Site

Existing Building

NORTH

1"=150'

0 75 150

Scale in Feet

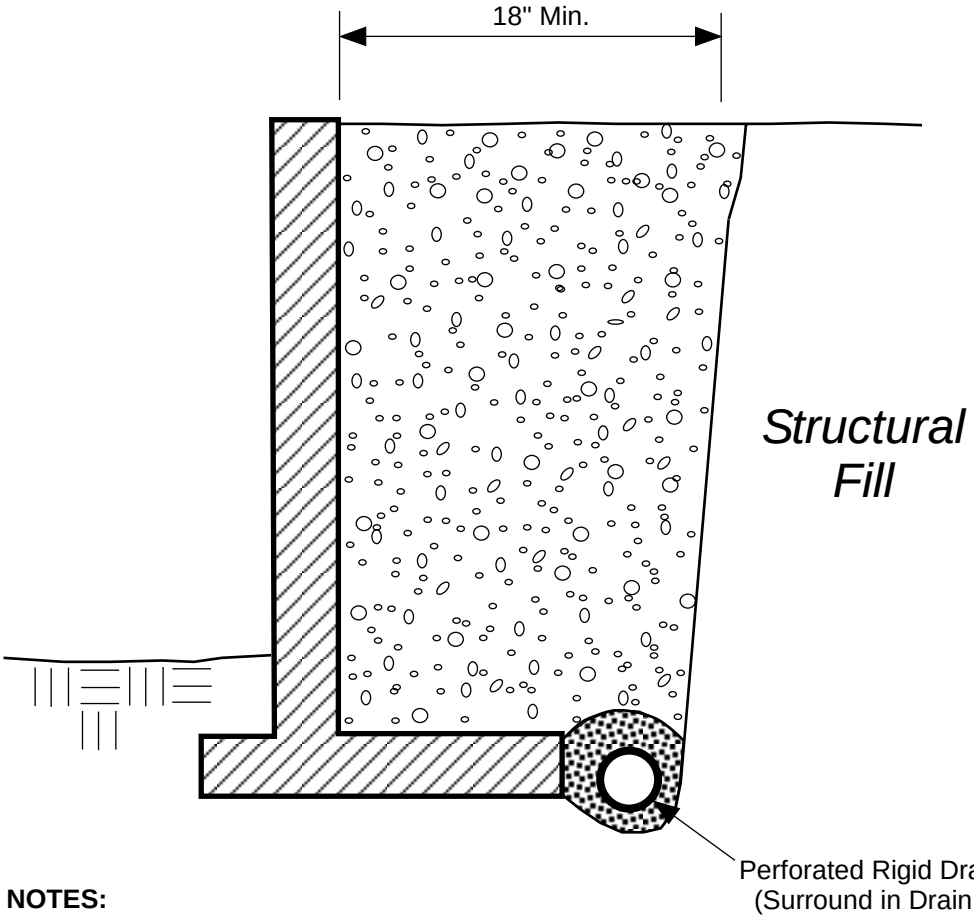
NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided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

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

Test Pit Location Plan
Crystal Springs
Yelm, Washington

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Drwn. By	MRS
Checked By	SKH
Date	09/20/2021
Proj. No.	8113
Plate	2



NOTES:

- Free-draining Backfill should consist of soil having less than 5 percent fines. Percent passing No. 4 sieve should be 25 to 75 percent.
- Sheet Drain may be feasible in lieu of Free-draining Backfill, per ESNW recommendations.
- Drain Pipe should consist of perforated, rigid PVC Pipe surrounded with 1-inch Drain Rock.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

Free-draining Structural Backfill

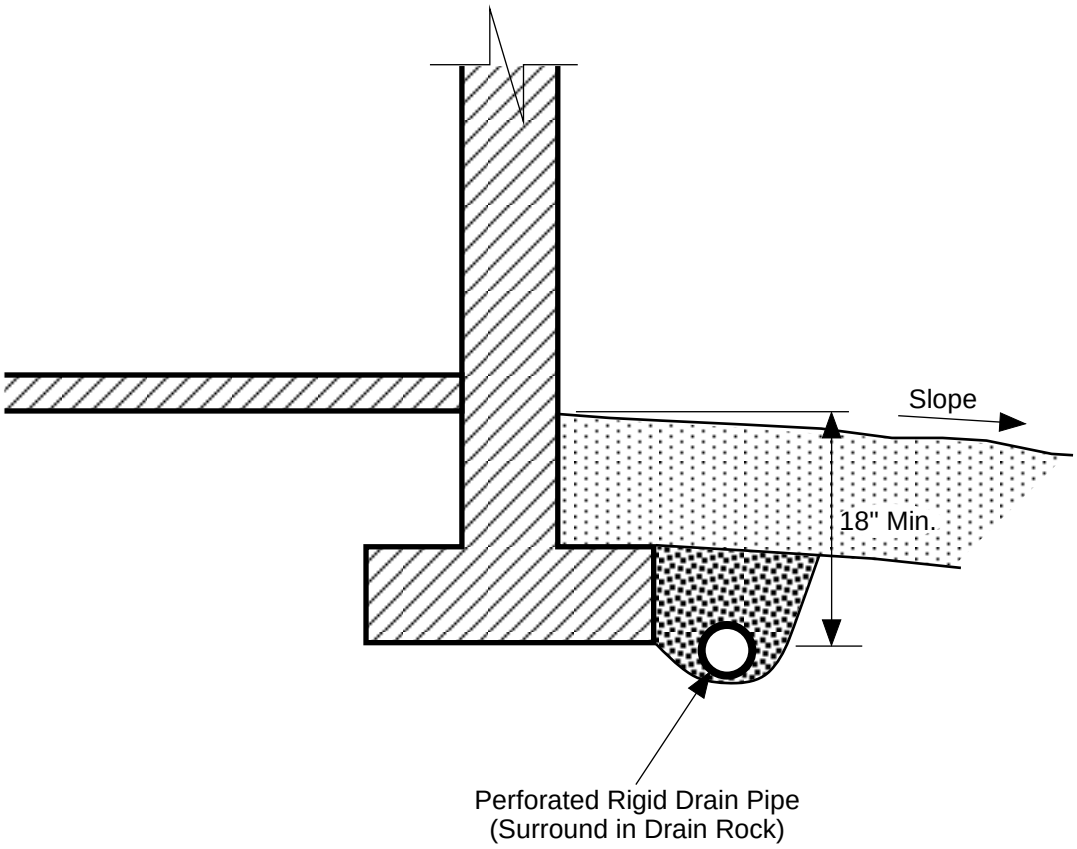
1-inch Drain Rock

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Retaining Wall Drainage Detail
Crystal Springs
Yelm, Washington

Drwn. CAM	Date 10/06/2021	Proj. No. 8113
Checked SSR	Date Oct. 2021	Plate 3



NOTES:

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

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

Surface Seal: native soil or other low-permeability material.

1-inch Drain Rock

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Footing Drain Detail
Crystal Springs
Yelm, Washington

Drwn. CAM	Date 10/06/2021	Proj. No. 8113
Checked SSR	Date Oct. 2021	Plate 4

Appendix A

Subsurface Exploration
Test Pit Logs

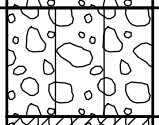
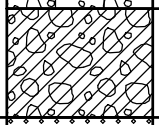
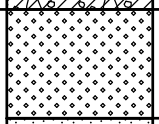
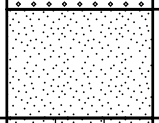
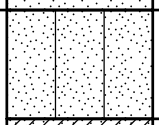
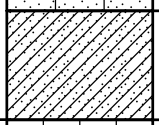
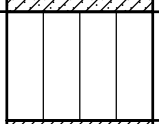
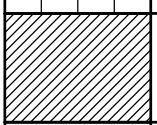
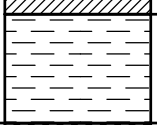
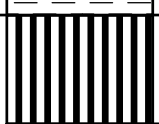
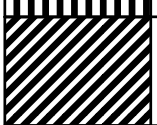
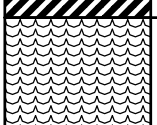
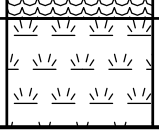
ES-8113

The subsurface conditions at the site were explored by excavating six test pits at the approximate locations illustrated on Plate 2 of this report. The test pit logs are provided in this Appendix. The subsurface exploration was completed on August 31, 2021 to a maximum depth of 13 feet below existing grades.

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

Earth Solutions NW LLC

SOIL CLASSIFICATION CHART

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

DUAL SYMBOLS are used to indicate borderline soil classifications.

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

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-1

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs
DATE STARTED 8/31/21 **COMPLETED** 8/31/21 **GROUND ELEVATION** +-334
EXCAVATION CONTRACTOR Client Provided **LATITUDE** 46.95015 **LONGITUDE** -122.60337
EXCAVATION METHOD **GROUND WATER LEVEL:**
LOGGED BY SKH **CHECKED BY** SSR ▽ **AT TIME OF EXCAVATION**
NOTES Depth of Topsoil & Sod 12": field grass

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, abundant roots
				1.0	
					Brown poorly graded GRAVEL with sand, medium dense, damp
		MC = 2.5%			
					-abundant cobbles and small boulders present throughout
5					
					-minor caving to BOH
			GP		
	GB	MC = 2.3% Fines = 1.2%			[USDA Classification: extremely gravelly coarse SAND]
10					
					-infiltration test
				11.5	
					Brown poorly graded GRAVEL, dense, damp
			GP		
		MC = 3.8% Fines = 0.3%			[USDA Classification: extremely gravelly coarse SAND]
				13.0	
					Test pit terminated at 13.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 5.0 to 13.0 feet.

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TEST PIT NUMBER TP-2

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs
DATE STARTED 8/31/21 **COMPLETED** 8/31/21 **GROUND ELEVATION** +-334
EXCAVATION CONTRACTOR Client Provided **LATITUDE** 46.95049 **LONGITUDE** -122.60344
EXCAVATION METHOD **GROUND WATER LEVEL:**
LOGGED BY SKH **CHECKED BY** SSR ▽ **AT TIME OF EXCAVATION**
NOTES Depth of Topsoil & Sod 12": field grass

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, abundant roots
				1.0	
					Brown poorly graded GRAVEL with sand, medium dense, damp
		MC = 3.6%			-abundant cobbles and small boulders present throughout
					-minor caving from 3.5' to BOH
5			GP		
		MC = 9.3% Fines = 0.9%			-becomes moist [USDA Classification: extremely gravelly coarse SAND]
10					
					-becomes damp
		MC = 3.0% Fines = 0.4%		11.5	[USDA Classification: extremely gravelly coarse SAND]
					Test pit terminated at 11.5 feet below existing grade. No groundwater encountered during excavation. Caving observed from 3.5 feet to BOH.

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TEST PIT NUMBER TP-3

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs
DATE STARTED 8/31/21 **COMPLETED** 8/31/21 **GROUND ELEVATION** +-333
EXCAVATION CONTRACTOR Client Provided **LATITUDE** 46.95036 **LONGITUDE** -122.60414
EXCAVATION METHOD **GROUND WATER LEVEL:**
LOGGED BY SKH **CHECKED BY** SSR ▽ **AT TIME OF EXCAVATION**
NOTES Depth of Topsoil & Sod 12": field grass

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, abundant roots
				1.0	Brown well-graded GRAVEL with sand, medium dense, damp
		MC = 1.4% Fines = 0.4%			[USDA Classification: extremely gravelly coarse SAND]
					-abundant cobbles and small boulders present throughout
5			GW		-becomes very dense
					-minor caving from 8' to BOH
				9.0	Brown well-graded GRAVEL, dense, damp
10			GW		
		MC = 1.8% Fines = 0.4%		11.0	[USDA Classification: extremely gravelly coarse SAND]
					Test pit terminated at 11.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 8.0 feet to BOH.

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TEST PIT NUMBER TP-4

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs
DATE STARTED 8/31/21 **COMPLETED** 8/31/21 **GROUND ELEVATION** +-331
EXCAVATION CONTRACTOR Client Provided **LATITUDE** 46.95006 **LONGITUDE** -122.60413
EXCAVATION METHOD **GROUND WATER LEVEL:**
LOGGED BY SKH **CHECKED BY** SSR ▽ **AT TIME OF EXCAVATION**
NOTES Depth of Topsoil & Sod 12": field grass

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, abundant roots
				1.0	
			GW		Brown well-graded GRAVEL with sand, medium dense, damp
		MC = 1.8%			-abundant cobbles and small boulders present throughout
					-minor caving from 4' to BOH
5					
		MC = 2.1% Fines = 0.7%			-infiltration test [USDA Classification: extremely gravelly coarse SAND]
				9.5	
10			GP		Brown poorly graded GRAVEL with sand, medium dense, damp
		MC = 3.5% Fines = 0.4%		11.0	[USDA Classification: extremely gravelly coarse SAND]
					Test pit terminated at 11.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 4.0 feet to BOH.

Earth Solutions NW, LLC
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TEST PIT NUMBER TP-5

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs
DATE STARTED 8/31/21 **COMPLETED** 8/31/21 **GROUND ELEVATION** +-332
EXCAVATION CONTRACTOR Client Provided **LATITUDE** 46.9495 **LONGITUDE** -122.60331
EXCAVATION METHOD **GROUND WATER LEVEL:**
LOGGED BY SKH **CHECKED BY** SSR ▽ **AT TIME OF EXCAVATION**
NOTES Depth of Topsoil & Sod 6": field grass

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, abundant fine roots
				0.5	Brown poorly graded GRAVEL with sand, dense, damp
		MC = 2.4%			-abundant cobbles and small boulders present throughout
					-minor caving from 4' to 6'
5			GP		-minor mottling
					-major caving from 6' to BOH
		MC = 1.7% Fines = 0.1%			[USDA Classification: extremely gravelly coarse SAND]
10					
		MC = 2.8%		10.5	

Test pit terminated at 10.5 feet below existing grade. No groundwater encountered during excavation. Caving observed from 4.0 feet to BOH.

Earth Solutions NW, LLC
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Fax: 425-449-4711

TEST PIT NUMBER TP-6

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs
DATE STARTED 8/31/21 **COMPLETED** 8/31/21 **GROUND ELEVATION** +-331
EXCAVATION CONTRACTOR Client Provided **LATITUDE** 46.94935 **LONGITUDE** -122.60438
EXCAVATION METHOD **GROUND WATER LEVEL:**
LOGGED BY SKH **CHECKED BY** SSR ▽ **AT TIME OF EXCAVATION**
NOTES Depth of Topsoil & Sod 12": field grass

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, abundant fine roots
1.0					Brown poorly graded GRAVEL with sand, medium dense, damp
		MC = 2.1%			-abundant cobbles and small boulders present throughout
5					-minor caving from 4.5' to BOH
	GB	MC = 2.9% Fines = 0.7%	GP		[USDA Classification: extremely gravelly coarse SAND]
					-becomes moist
10					
12.5		MC = 3.8%			Test pit terminated at 12.5 feet below existing grade. No groundwater encountered during excavation. Caving observed from 4.5 feet to BOH.

Appendix B

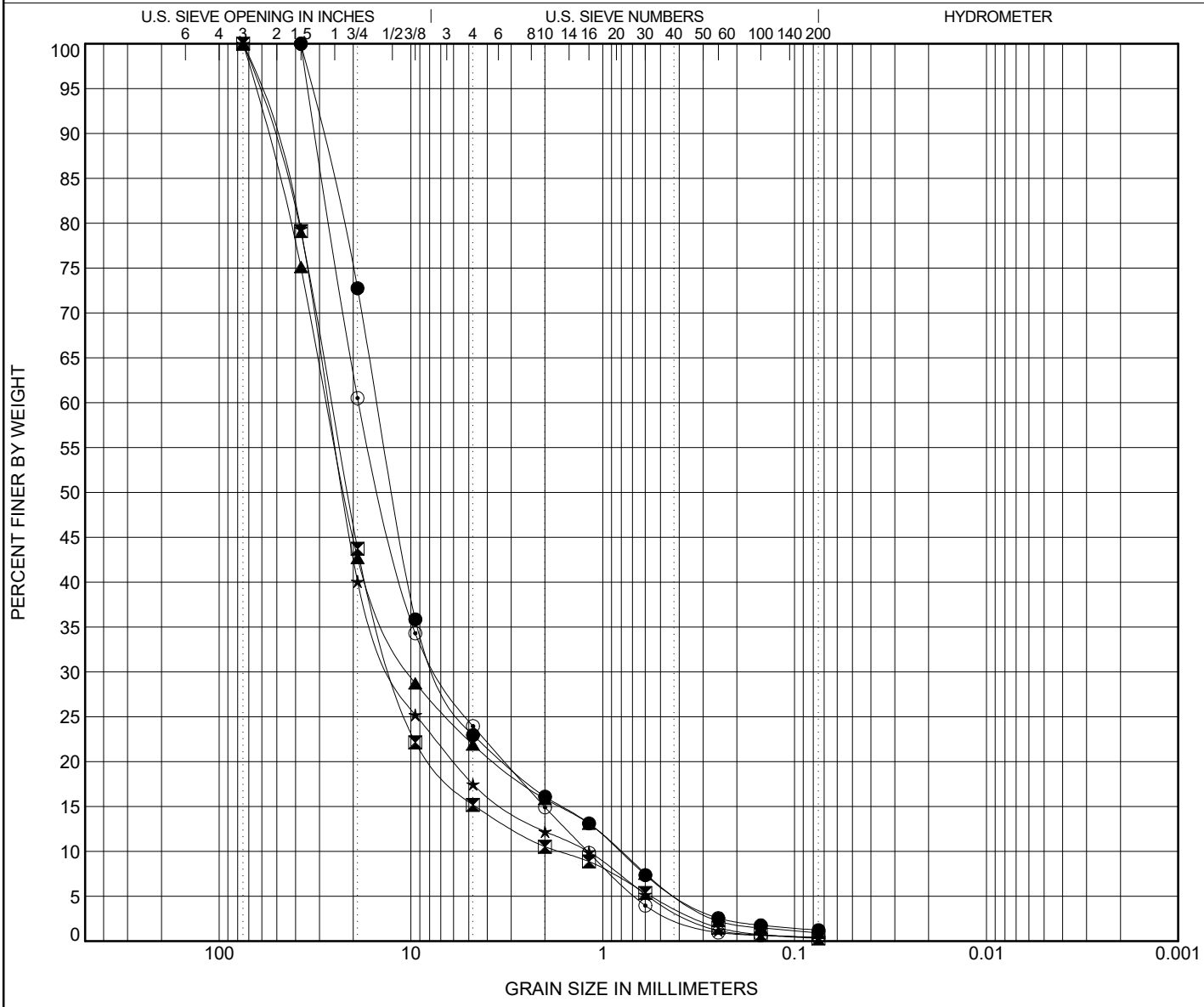
Laboratory Test Results

ES-8113

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	Cc	Cu
●	TP-01	7.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP with Sand.	3.93	18.27
⊠	TP-01	13.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP.	3.40	15.34
▲	TP-02	8.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP with Sand.	4.62	33.69
★	TP-02	11.50ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP with Sand.	4.39	22.41
⊙	TP-03	2.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GW with Sand.	2.25	15.61

Specimen Identification			D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	TP-01	7.0ft.	37.5	14.952	6.934	0.818				1.2	
⊠	TP-01	13.0ft.	75	25.97	12.226	1.693				0.3	
▲	TP-02	8.0ft.	75	27.313	10.116	0.811				0.9	
★	TP-02	11.5ft.	75	26.824	11.877	1.197				0.4	
⊙	TP-03	2.0ft.	37.5	18.742	7.12	1.2				0.4	

GRAIN SIZE USDA ES-8113 CRYSTAL SPRINGS.GPJ GINT US LAB.GDT 9/9/21

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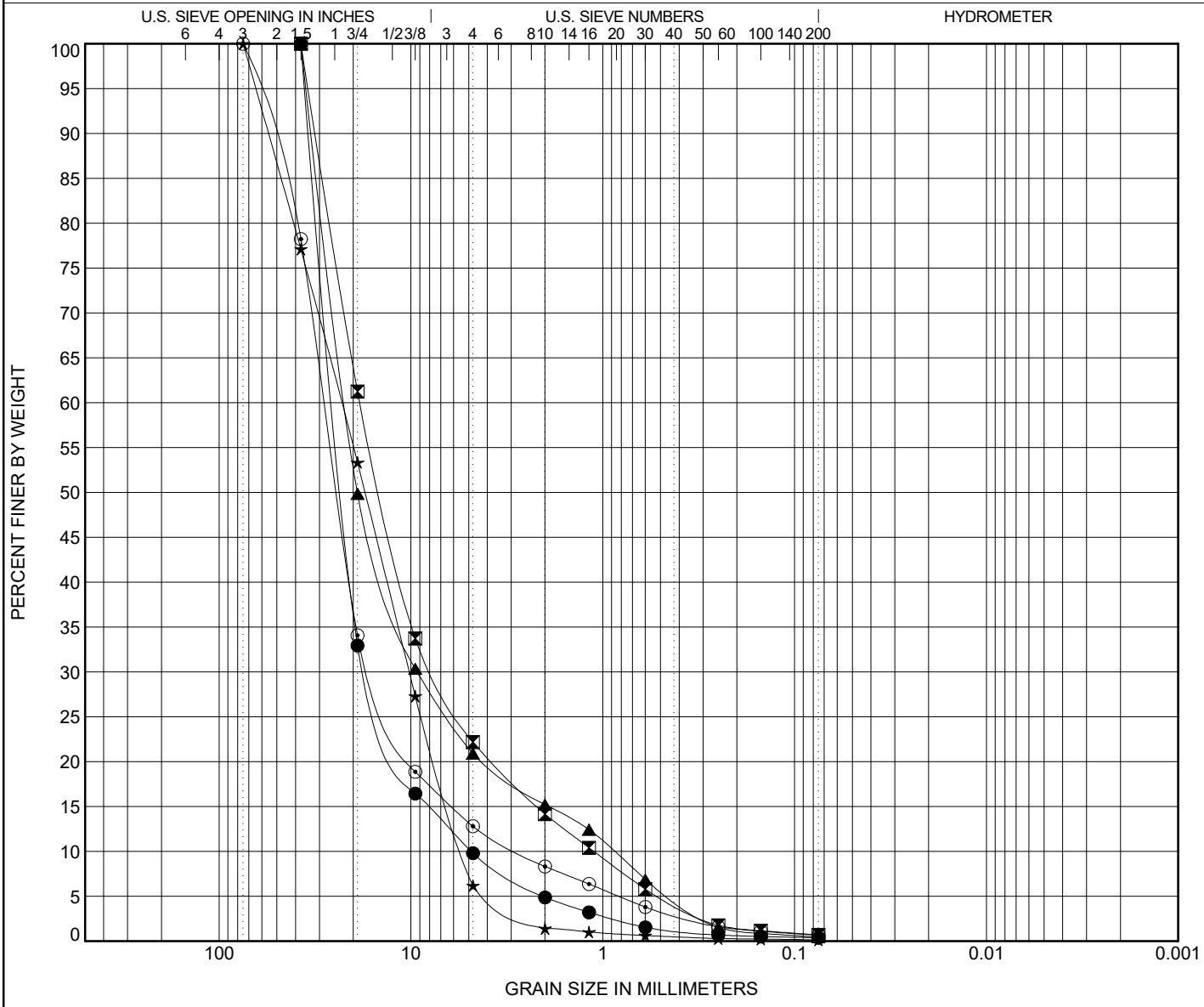
GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-8113 **PROJECT NAME** Crystal Springs



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	Cc	Cu
●	TP-03	11.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GW.	2.33	5.16
⊠	TP-04	8.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GW with Sand.	2.81	16.56
▲	TP-04	11.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP with Sand.	4.47	24.81
★	TP-05	7.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP.	0.84	4.27
⊙	TP-06	7.00ft.	USDA: Brown Extremely Gravelly Coarse Sand. USCS: GP.	3.18	10.23

Specimen Identification			D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	TP-03	11.0ft.	37.5	24.998	16.792	4.849				0.4	
⊠	TP-04	8.0ft.	37.5	18.42	7.591	1.112				0.7	
▲	TP-04	11.0ft.	37.5	21.805	9.26	0.879				0.4	
★	TP-05	7.0ft.	75	22.982	10.206	5.383				0.1	
⊙	TP-06	7.0ft.	75	28.324	15.784	2.768				0.7	

GRAIN SIZE USDA ES-8113 CRYSTAL SPRINGS.GPJ GINT US LAB.GDT 9/9/21

Report Distribution

ES-8113

EMAIL ONLY

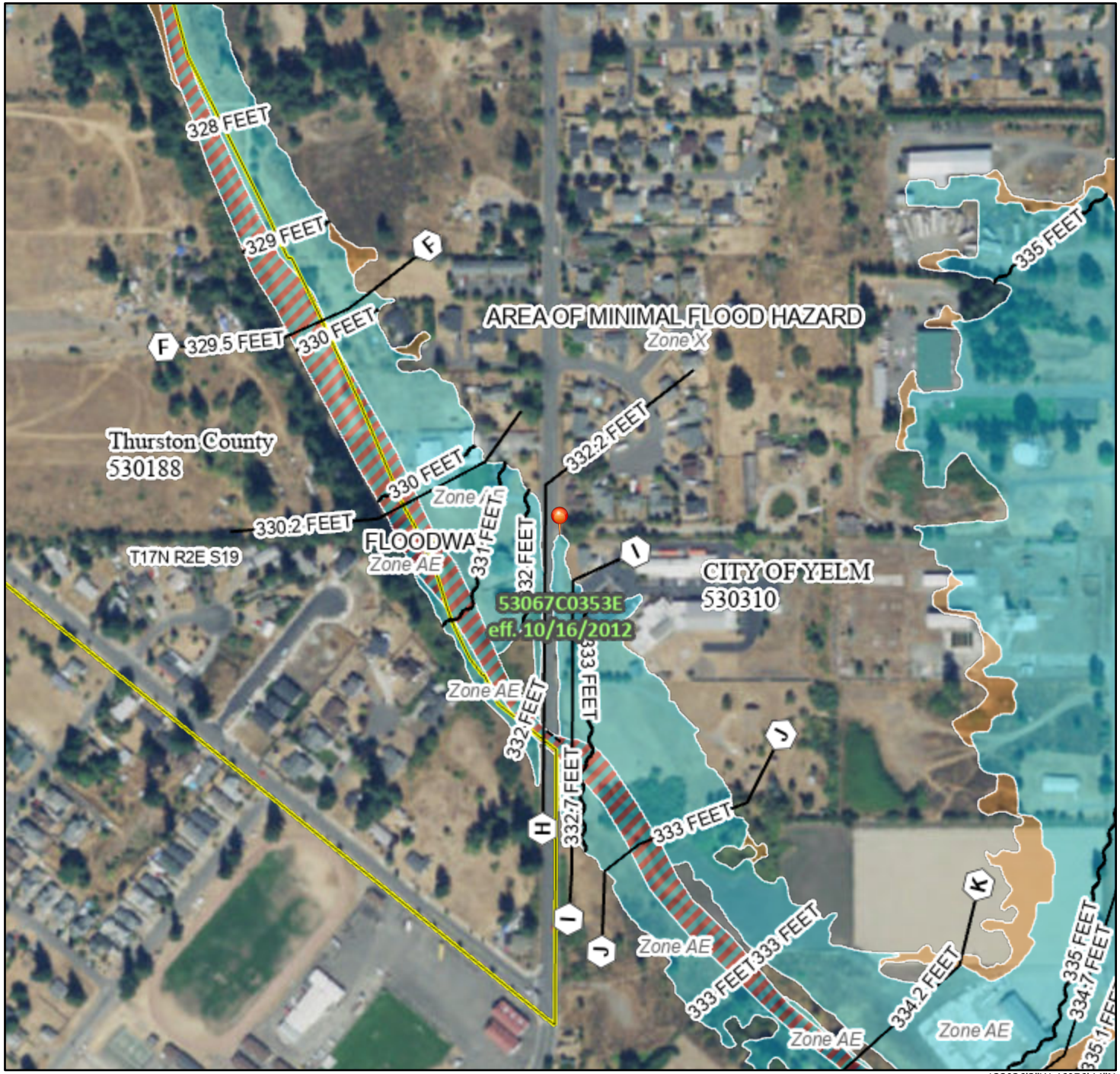
Copper Ridge, LLC
P.O. Box 73790
Puyallup, Washington 98373

Attention: Mr. Evan Mann

National Flood Hazard Layer FIRMette

FEMA

122°36'40"W 46°57'9"N



122°36'3"W 46°56'44"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/21/2021 at 1:46 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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