ENVIRONMENTAL CHECKLIST

for the proposed

Electrical Engineering and Computer Science Project – Building

prepared for

Western Washington University Capital, Planning and Development

April 18, 2022

EA Engineering, Science, and Technology, Inc., PBC
Perkins&Will
Associated Earth Sciences
Larry Steele & Associates

PREFACE

The purpose of this Environmental Checklist is to identify and evaluate the probable environmental impacts that could result from the ***Electrical Engineering and Computer Science (EECS) Project – Building*** and to identify measures to mitigate those impacts. The ***EECS – Building*** would include the development of a new 53,000 sq. ft. building on the site. The project would also feature a skybridge connecting the proposed building to the Communications Facility building, as well as some modification to the Communications Facility building.

The State Environmental Policy Act (SEPA)[1] requires that all governmental agencies consider the environmental impacts of a proposal before the proposal is decided upon. This Environmental Checklist has been prepared in compliance with the State Environmental Policy Act; and the SEPA Rules, effective April 4, 1984, as amended (Chapter 197-11, Washington Administrative Code), which implements SEPA.

This document is intended to serve as SEPA review for site preparation work, construction, and operation of the ***EECS – Building***. Analysis associated with the proposed project contained in this Environmental Checklist is based on conceptual plans for the project. While not construction-level detail, the conceptual plans accurately represent the eventual size, location, and configuration of the proposed project and is considered adequate for analysis and disclosure of environmental impacts.

This Environmental Checklist is organized into three major sections. *Section A* of the Checklist (beginning on page 1) provides background information concerning the *Proposed Action* (e.g., purpose, proponent/contact person, project description, project location, etc.). *Section B* (beginning on page 9) contains the analysis of environmental impacts that could result from implementation of the proposed project, based on review of major environmental parameters. This section also identifies proposed mitigation measures. *Section C* (page 20) contains the signature of the preparer, confirming the completeness of this Environmental Checklist.

Project-relevant analyses that served as a basis for this Environmental Checklist include: *Geotechnical Report* (AESI, 2021); *Greenhouse Gas Emissions Worksheet* (EA, 2022); Tree Survey (Larry Steele & Associates, 2021) and, *Shadow Study* (Perkins&Will, 2022).

[1] Chapter 43.21C. RCW

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ENVIRONMENTAL CHECKLIST

A. BACKGROUND

1. Name of proposed project, if applicable: ***Electrical Engineering and Computer Science (EECS) Project – Building***
2. Name, address, and phone number of Owner / Decision maker:

   Rick Benner, Director

   Capital Planning and Development, MS 9122

   Western Washington University

   Bellingham, WA 98225

   (360) 650-3550
3. Name, address, and phone number of contact person:

   Mark Nicasio, Project Manager/Architect

   Capital Planning and Development, MS 9122

   Western Washington University

   Bellingham, WA 98225

   (360) 650-6296
4. Date checklist prepared: April 18, 2022
5. Department requesting checklist: WWU Capital Planning and Development
6. Proposed timing or schedule (including phasing, if applicable): Construction is anticipated to start in January 2023 and be completed in May 2024.
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: The following environmental analyses were prepared in support of this Environmental Checklist:
   - Geotechnical Report (AESI, 2021), see **Appendix A**;
   - Greenhouse Gas Emissions Worksheet (EA, 2022), see **Appendix B**;
   - Tree Survey (Larry Steele & Associates, 2021), see **Appendix C**; and
   - Shadow Studies (Perkins&Will, 2022), see **Appendix D**.

   The following environmental review was also referenced in preparing this Environmental Checklist:
   - Electrical Engineering and Computer Science – Displaced Parking SEPA Checklist (EA, Perkins&Will, 2022).
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: Permits for the EECS Project – Displaced Parking are pending.

10. List any government approvals or permits that will be needed for your proposal, if known: The following permits will be required for the proposed building:

    City of Bellingham

    - Building, Mechanical, Structural, Stormwater, Plumbing, and Fire Protection Permit;
    - Clearing/Site Demolition/Early Works Permit;
    - Electrical Permit; and
    - Temporary and Permanent Stormwater Management Plan Approvals.

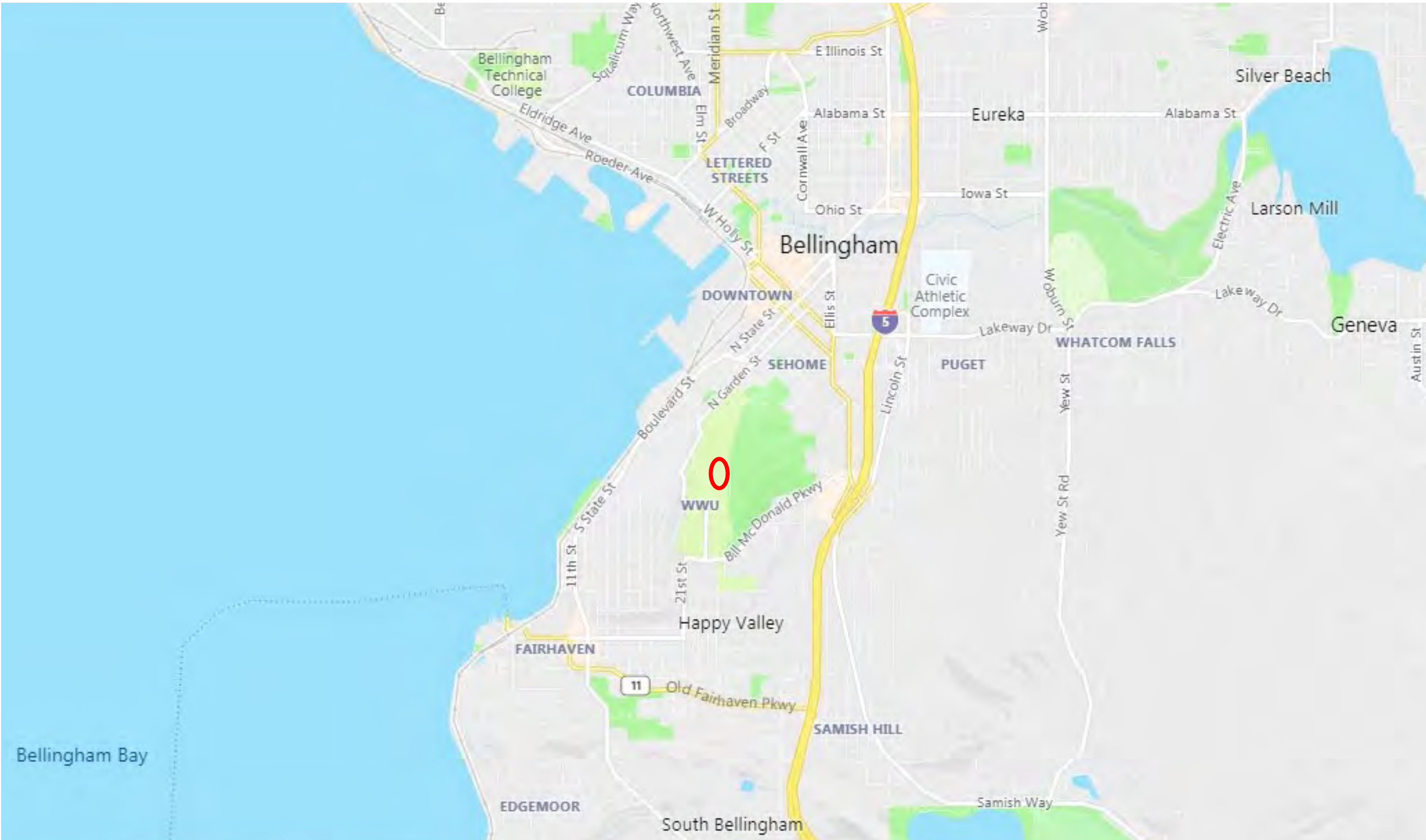
    Department of Ecology

    - Washington State Department of Ecology's Construction Stormwater NPDES and State Waste Discharge General Permit

11. Give a brief and 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: The approximately 49,676-sq. ft. (1.14 ac.) ***EECS Building*** site is located in the WWU neighborhood in Bellingham, Washington (see **Figure 1**, Vicinity Map). The site is situated in the core of the WWU campus, between the Communications Facility (CF) building to the west and E College Way to the east, at 172 E College Way (see **Figure 2**, Aerial Map). The site is currently occupied by existing parking lots (Lot AIC and part of Lot 17G, the latter the parking lot that would be displaced by this project that was the subject of the Electrical Engineering and Computer Science – Displaced Parking SEPA Checklist) and landscaping.

    The proposed ***EECS Building*** is a four-story, 53,000-sq. ft. mass timber building that would provide for growth in the STEM disciplines of Computer Science and Electrical & Computer Engineering at WWU (see **Figure 3**, Site Plan; **Figure 4**, Building Axonometrics; **Figure 5**, Building Elevations – South and East; and **Figure 6** Building Elevations – North and West). The new facility would consist primarily of teaching labs, learning research labs, and active learning classrooms, along with academic administrative and collaborative spaces. The project would also include a minor renovation of the existing CF building at Level 4 to connect the two buildings with a skybridge, as well as some modification to existing Computer Science space in the CF building. Approximately 3,000-sq. ft. of renovation would occur in the CF building existing atrium to connect the fourth floor to the proposed ***EECS Building***, as well as provide an accessible route through the first level atrium space.

WWU Electrical Engineering and Computer Science Project—Building Environmental Checklist



Project Site

Note: This figure is not to scale

North

Source: Bing Maps and EA Engineering, 2022.

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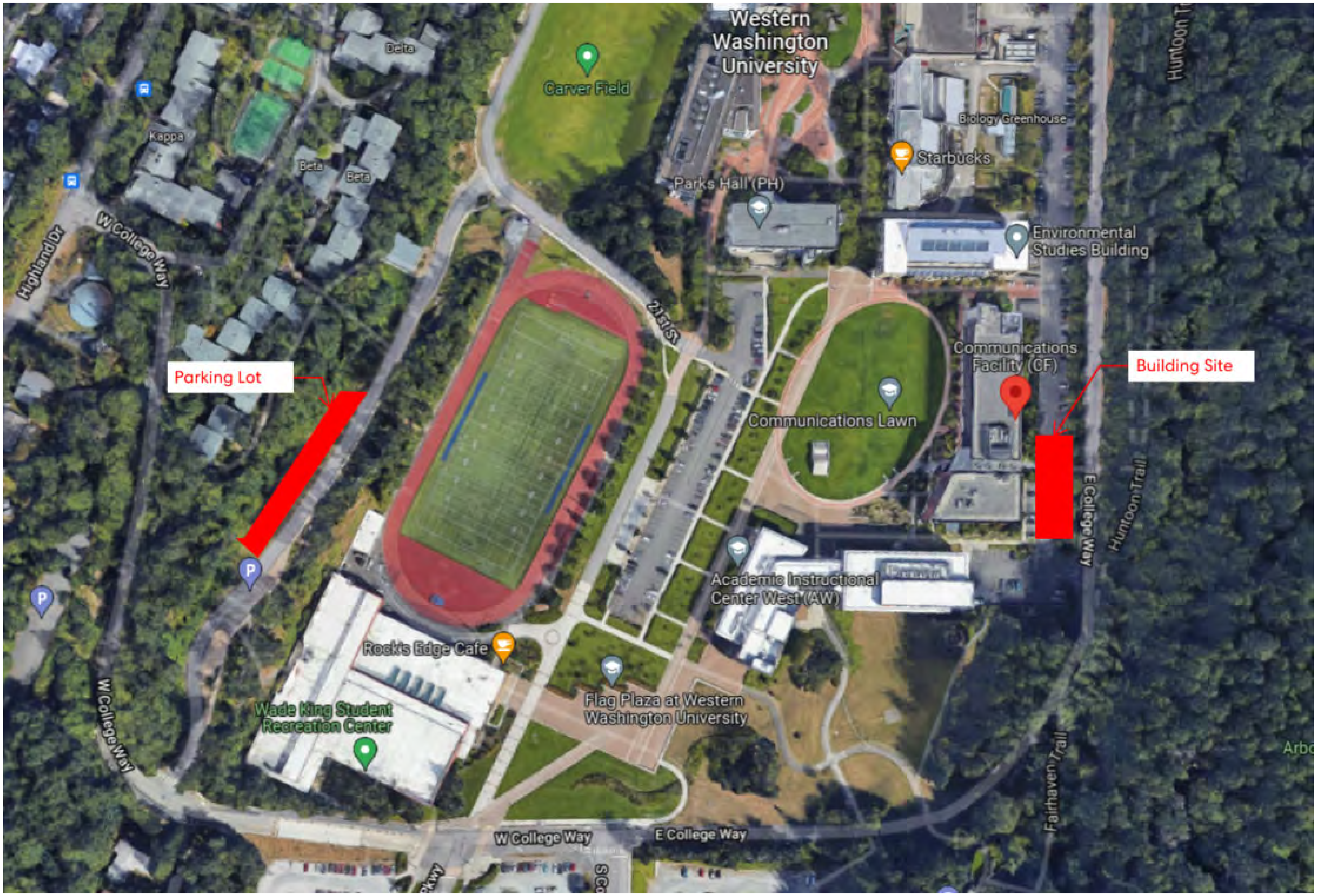
Figure 1

Vicinity Map

WWU Electrical Engineering and Computer Science Project—Building Environmental Checklist



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Source: Perkins & Will, 2021.

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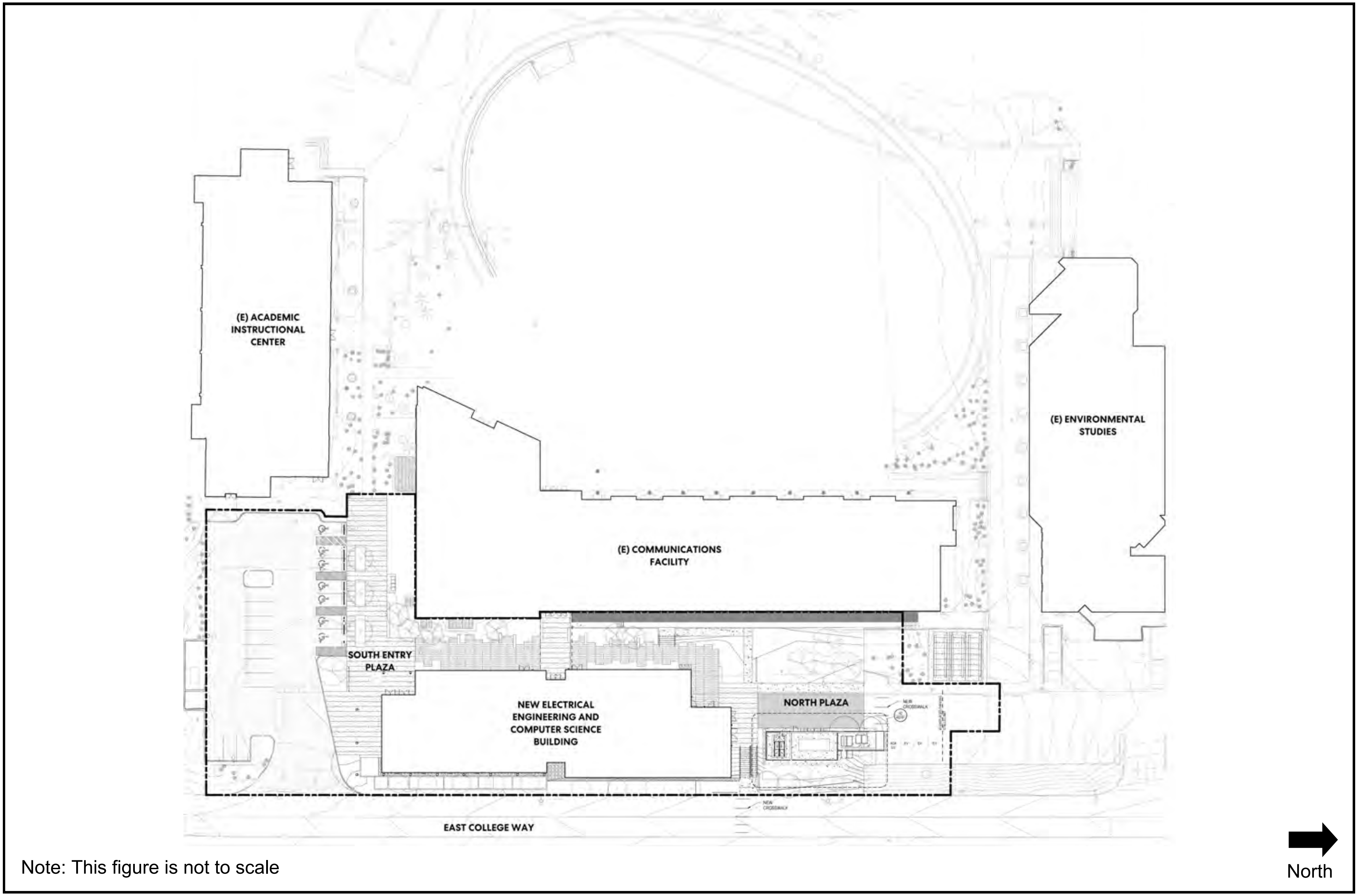
Figure 2

Aerial Map

WWU Electrical Engineering and Computer Science Project—Building Environmental Checklist



Source: Perkins & Will, 2022.

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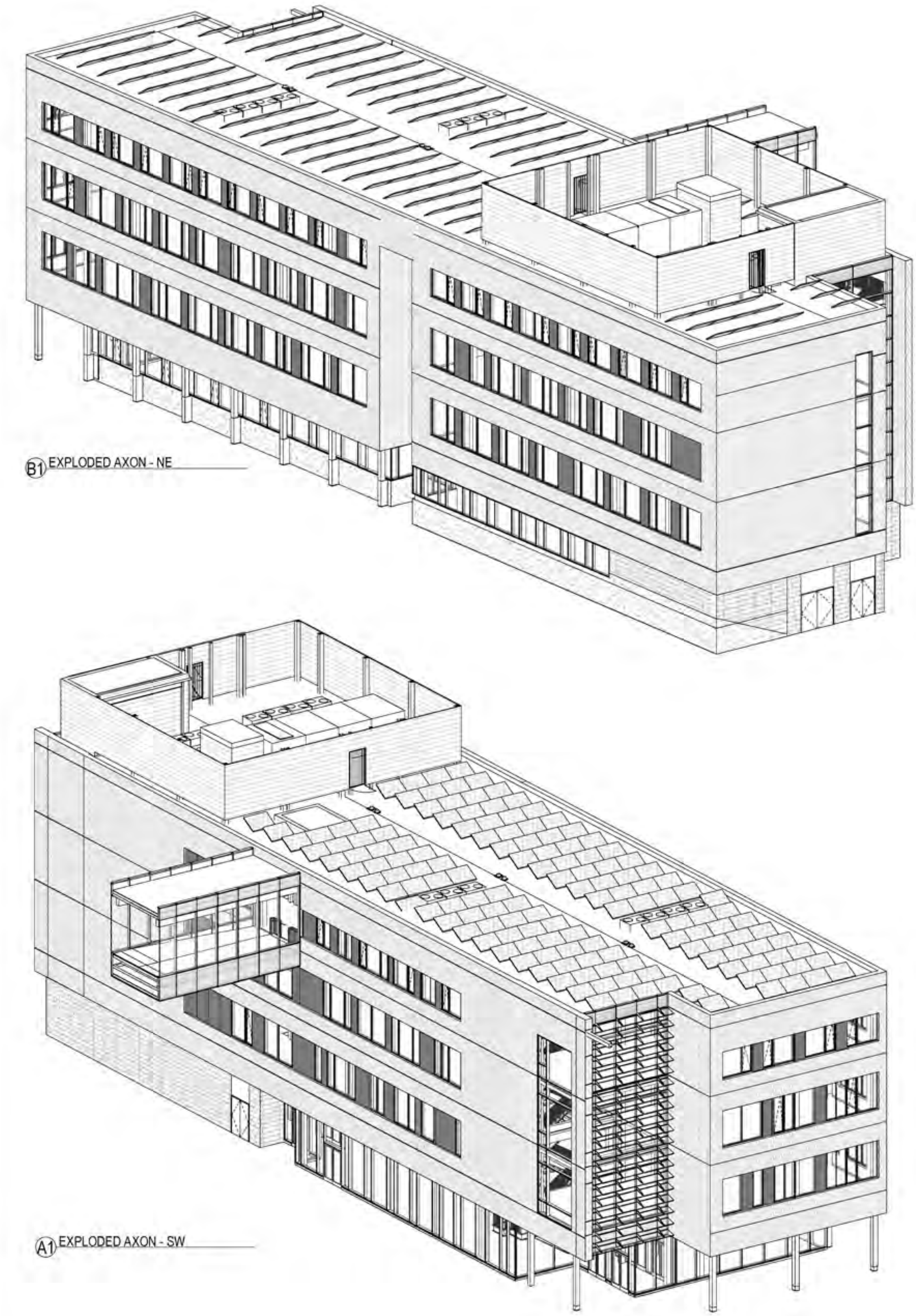
Figure 3

Site Plan

WWU Electrical Engineering and Computer Science Project—Building Environmental Checklist



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North

Source: Perkins & Will, 2022.

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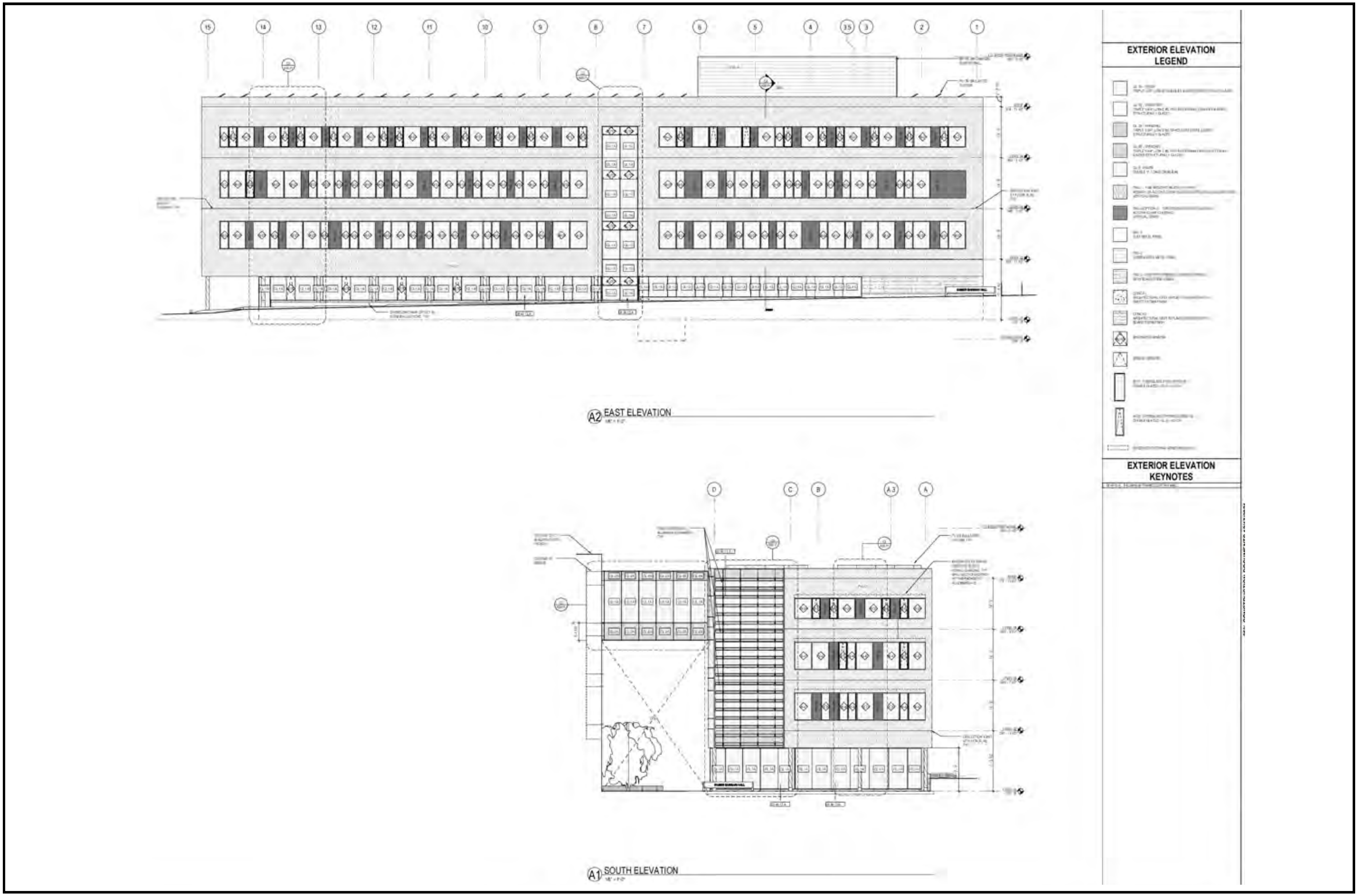
Figure 4

Building Axonometrics

WWU Electrical Engineering and Computer Science Project—Building Environmental Checklist



Source: Perkins & Will, 2022.

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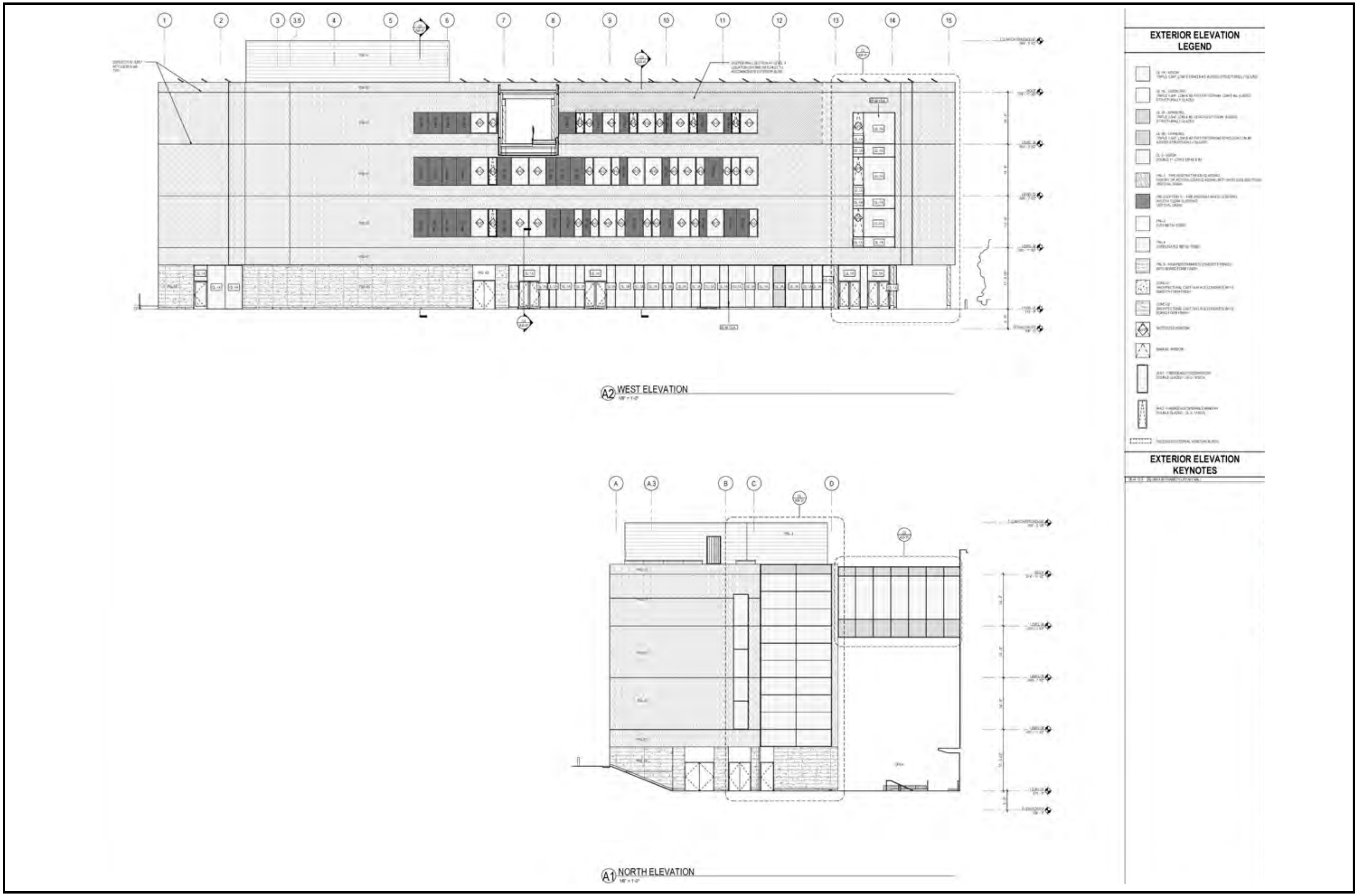
Figure 5

Building Elevations—South & East



Source: Perkins & Will, 2022.

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Figure 6

Building Elevations—North & West

A. ENVIRONMENTAL ELEMENTS

B. EARTH

The following responses are based on the Geotechnical Report prepared by AESI in June 2021 (see **Appendix A**).

1. General description of the site (Choose one):

   a. ☒ Flat
   b. ☐ Rolling
   c. ☐ Hilly
   d. ☐ Steep Slopes
   e. ☐ Mountainous
   f. ☐ Other: ______

2. What is the steepest slope on the site (approximate percent slope): The steepest slope onsite is approximately 12%.

3. 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: Based on eight exploration borings conducted at the site, it was determined that subsurface conditions consist of Chuckanut Formation bedrock, typically covered by 5 to 15 feet of existing fill. Recent alluvium and Quaternary glacial drift are located between the existing fill and bedrock in some site areas. None of the on-site soils are considered agricultural soils and no prime farmland is present.

4. Are there surface indications or a history of unstable soils in the immediate vicinity? If so describe: There are no visible surface indications or history of unstable soils onsite or in the site vicinity. The City of Bellingham Environmental Critical Areas (ECA) maps show no existing ECAs (e.g., geotechnical hazards) on the project site. However, all of western Washington is at risk of a strong seismic event.

5. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill: Approximately 775 cubic yards of excavation would be required for the proposed building and associated utilities.

6. Could erosion occur as a result of clearing, construction, or use? If so, generally describe: Construction of the ***EECS Building*** would result in the temporary exposure of soils on the site, and erosion is possible in conjunction with any construction activity. Minimal erosion is anticipated to occur for this project because the site is generally flat and appropriate Temporary Erosion and Sedimentation Control (TESC) measures and Best Management Practices (BMPs) would be implemented, in accordance with City of Bellingham and the *Stormwater Management Manual for Western Washington* requirements.

7. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)? The existing site contains a surface parking lot that is generally comprised of impervious surfaces. Following construction, approximately 80% of the site would be covered in impervious surfaces (e.g., building roof area, surface parking, and walkways).

8. Proposed measures to reduce or control erosion, or other impacts to the earth, if any: The following measures are proposed to reduce or control erosion, or other earth-related impacts:

- Erosion and sedimentation control would be implemented, in accordance with City of Bellingham and the *Stormwater Management Manual for Western Washington* requirements, including:
  - Limit earthwork to seasonally drier periods, if possible;
  - Use perimeter silt fences, stabilized entrances, and straw bales in exposed areas;
  - Limit vegetation removal to those areas required to construct the project;
  - Establish new landscaping as soon as practical after grading is complete;
  - Collect surface water as close to the source as possible; and
  - Implement permanent drainage control as soon as possible.
- Additional subsurface data could be collected for the shoring system and building.
- Some amount of remedial subgrade preparation could be warranted.
- Care would be taken during site preparation and excavation operations of moisture-sensitive soils and during wet weather conditions.
- New building foundations and floor slabs and any other substantial structures could be constructed using a conventional shallow foundation system underlain by ground improvement consisting of the installation of aggregate piers.
- The building would be designed in accordance with the 2018 IBC to resist seismic events.
- The geotechnical consultant could perform geotechnical review of plans prior to final design.
- The geotechnical consultant could be retained to provide geotechnical observation and special inspections during construction.

C. AIR

The following responses are based, in part, on the Greenhouse Gas (GHG) Emissions Worksheet prepared by EA in March 2022 (see **Appendix B**).

1. What types of emission to the air would result from the proposal (i.e., dust, automobile, odors, and industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known: During construction, in the dry months that coincide with early excavation and sitework activities, dust could be generated. Other emissions from project construction would be created by heavy equipment exhaust during excavation/utility and foundation work, as well as from lifts and forklifts used onsite. The project is targeting ILFI's Zero Energy and Zero Carbon and would be tracking contractor's emission levels for transportation.

   Motor vehicles are often the primary source of air emissions during operation of a project. After the proposed project is completed, operation of the building would not generate any new vehicular trips to WWU campus as a whole. Therefore, the project is not anticipated to cause significant increases in CO levels and no significant air quality impacts are expected.

   The scale of global climate change is so large that a project's GHG impacts can only be evaluated on a cumulative scale, and it is not anticipated that a single development project would cause an individually discernible impact on global climate change. However, to evaluate the climate change impacts of the ***EECS Building***, a GHG Emissions Worksheet was prepared to estimate the emissions footprint for the lifecycle of the proposed project on a gross-level basis (see **Appendix B**). The emissions estimate is based on the combined emissions from the following sources:

- **Embodied Emissions** – extraction, processing, transportation, construction, and disposal of materials, and landscape disturbance;
- **Energy-related Emissions** – energy demands created by the development after it is completed; and,
- **Transportation-related Emissions** – transportation demands created by the development after it is completed.

The Worksheet estimate is based on building use and size. It is estimated that lifespan emissions from the proposed project would total approximately 55,410 $MTCO_2e$[2] (see **Appendix B** for details).

2. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe: Vehicle traffic in the vicinity of the site is the primary existing source of emissions and odors, including traffic on: E College Way, S College Drive, Bill McDonald Parkway, W College Way, and Highland Drive. Off-site emissions and odors are not anticipated to affect the proposed project.

3. Proposed measures to reduce or control emissions or other impacts to air, if any: Although no significant construction or operational air quality impacts are anticipated with the proposed project, the following measures are proposed to help reduce or control emissions:
    - Construction contractors would be required to comply with all applicable federal, state, and local air quality regulations, and would be required to prepare a plan to minimize dust and odors during construction. Examples of measures that would be implemented include: construction work areas would be covered in crushed rock, and the site would be watered from a hydrant or water truck to minimize or eliminate dust.
    - Depending on the sensitivity of the adjacent buildings, and any nearby fresh air intakes, the exhaust odors (from heavy equipment, lifts, and forklifts) could be addressed with scrubbers on the equipment.
    - The HVAC system in the proposed building would be as efficient as possible, minimizing central plant heating demand and electric energy usage for cooling. The lighting and installed equipment would be as efficient as possible with associated controls to limit unnecessary electricity consumption.

D. WATER – SURFACE

1. Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into: No surface water body exists onsite or in the vicinity of the site

2. Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attached available plans: No, as no surface water body exists within 200 feet of the site.

[2] $MTCO_2e$ is defined as Metric Ton Carbon Dioxide Equivalent; it equates to 2,204.62 pounds of CO_2. This is a standard measure of the amount of CO_2 emission reduced or sequestered. Carbon is not the same as CO_2. Sequestering 3.67 tons of CO_2 is equivalent to sequestering one ton of carbon.

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: No fill/dredge material would be placed in/removed from surface waters onsite or in the vicinity of the site.

4. Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known: No surface water withdrawals or diversions would occur from waters onsite or in the vicinity of the site.

5. Does the proposal lie within a 100-year floodplain? If so, note the location on the site plan: No, the site is not located in a 100-year floodplain

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 waste materials would be discharged to surface waters onsite or in the vicinity of the site.

E. WATER – GROUND

1. Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known: No. Per the geotechnical report, groundwater was not encountered in any of the exploration borings at the site. The static groundwater elevation is estimated to be well below the anticipated bottom of excavation for the project.

2. Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: domestic sewage; industrial - containing chemicals; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve: No waste materials would be discharged into the ground from septic tanks or other sources.

F. WATER – RUNOFF (Including storm water)

1. Describe the source of runoff (including storm water) and method of collection and flow disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other water? If so, describe: Under the proposal, a permanent stormwater management system would be installed that would comply with City of Bellingham and the *Stormwater Management Manual for Western Washington* requirements. Infiltration into existing fill is not permitted by code and is not proposed. Stormwater from the site would be collected in a series of catch basins and routed, via gravity flow, to a below grade regional stormwater detention system owned by WWU for flow control. Stormwater quality treatment would be provided prior to discharging to Taylor Creek to the south of the site.

2. Could waste materials enter ground or surface waters? If so, generally describe: Waste materials are not expected to enter ground or surface waters because stormwater quality treatment measures would be installed as part of the stormwater management system per City of Bellingham and the *Stormwater Management Manual for Western Washington* requirements.

3. Proposed measures to reduce or control surface, ground, and runoff water impacts, if any: The proposed project would comply with applicable City and the *Stormwater Management Manual for Western Washington* requirements relating to surface water runoff control and water quality. TESC and BMPs would be implemented during construction and the site would be stabilized following construction to minimize erosion and sedimentation. A permanent stormwater management system would also be installed. Therefore, no significant impacts on surface or groundwater are expected.

G. PLANTS

The following responses are based, in part, on the Tree Survey prepared by Larry Steele & Associates in September 2021 (see **Appendix C**).

1. Check types of vegetation found on the site:
   a. ☒ Grass
   b. ☒ Shrubs
   c. ☐ Pasture
   d. ☐ Crop or Grain
   e. ☒ Deciduous Tree: Alder, Maple, Aspen, or Other
   f. ☒ Evergreen Tree: Fir, Cedar, Pine, or Other
   g. ☐ Wet Soil Plants: Cattail, Buttercup, Bullrush, Skunk Cabbage, or Other
   h. ☐ Water Plants: Water Lily, Eelgrass, Milfoil, or Other
   i. ☐ Other Types of Vegetation: ______________________________

2. What kind and amount of vegetation will be removed or altered? The surveyor located, measured, and documented tree diameters of all the significant trees -- greater than 6 inches in diameter at standard height (DSH) -- that could be impacted by development of the proposed building. A total of 38 trees were identified onsite that meet this criterion. Of these, it is expected that up to (21) significant trees greater than 6 inches DBH would be removed: (1) Katsura, (1) Douglas Fir, and (19) Maples species (see **Appendix C** for details).

   Some shrubs and groundcover would also be disturbed for the proposed project.

3. List threatened or endangered species known to be on or near the site: No known threatened or endangered plant species are located on or near the site.

4. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any: Proposed landscaping would include:
   - Trees planted to replace the trees that would be removed with construction of the proposed building are intended to be at a 1:1 replacement ratio. Nine (9) Stewartia trees are intended to be salvaged and transplanted onsite. A total of 21 trees are planned to be replaced onsite for the 21 removed, consisting of Douglas Fir, Maples, and Hornbeams.
   - New shrubs or groundcover would also be planted in areas disturbed by construction.

H. ANIMALS

1. Check any birds and animals which have been observed on or near the site or are known to be on or near the site:

   a. **Birds:** ☐ Hawk ☐ Heron ☐ Eagle ☒ Songbirds
   b. **Mammals:** ☒ Deer ☐ Bear ☐ Elk ☐ Beaver
   c. **Fish:** ☐ Bass ☐ Trout ☐ Salmon ☐ Herring ☐ Shellfish
   d. **Other:**________________

   Birds- A variety of native birds are present or migrate across campus. ***Mammals***- squirrels, rats, and racoons inhabit the campus; deer wander through campus; other mammals come down to the WWU campus from the surrounding Sehome Hill Arboretum and neighborhoods on occasion. ***Fish***- No surface waters and associated fish are present onsite or near the site.

2. List any threatened or endangered species known to be on or near the site: No threatened or endangered animal species are known to be on or near the site.

3. Is the site part of a migration route? If so, explain: Yes. The entire Puget Sound area is within the Pacific Flyway, a major north-south flyway for migratory birds in America, extending from Alaska to Patagonia. Every year, migratory birds travel some or all this distance -- in spring and in fall -- following food sources, heading to breeding grounds, or travelling to overwintering sites.

4. Proposed measure to preserve or enhance wildlife, if any: Proposed measures to preserve or enhance wildlife include:

   - Some of the proposed native shrub and groundcover plantings would be edible and could be foraged by local wildlife and would enhance the plant palette for pollinator insects.
   - The proposal would comply with applicable City and the *Stormwater Management Manual for Western Washington* requirements related to surface water management, which would protect aquatic species downstream of the site.

I. ENERGY AND NATURAL RESOURCES

The following responses are based, in part, on the Shadow Study prepared by Perkins&Will in March 2022 (see **Appendix D**).

1. What kinds of energy (electric, natural gas, oil, wood-stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.: The proposed building's electricity demand for lighting, laboratory equipment, exhaust fans, etc. would be provided by Puget Sound Energy. As the project is pursuing ILFI Zero Energy and Zero Carbon Certification, no combustion source would be allowed. The proposed Variable Refrigerant Flow (VRF) system would include air-source VRF condensers located on the roof to provide heat pump heating and cooling. The Dedicated Outdoor Air System (DOAS), also located on the roof, would have an air-to-air energy recovery device (ERV or run-around loop) The project would have an exterior back-up generator to the north of the building in case of emergency, as well as infrastructure for a future battery storage for resiliency.

2. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe: No, the proposed building is not expected to block the potential use of solar energy by any adjacent buildings or properties. Due to the proximity of buildings in this portion of the WWU campus, a shadow study was conducted for the project. The shadows generated from 10:00 AM to noon on the Winter Solstice (December 21st) were analyzed. Prior to 10:00 AM on Winter Solstice, the site is shaded by Sehome Arboretum to the east. By noon, the sun has moved far enough west for the arboretum and proposed building together to shade the CF building's east façade. Approximately 1,785 sq. ft. of the shading on the CF building would be from the proposed building (see **Appendix D** for details on the shadow study).

3. 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: The following energy conservation features would be included in the project:

    - The project is pursuing ILFI Zero Energy Certification and would be offsetting 100% of the building's operational power usage with photovoltaics located on the roof as well as off-site purchase through PSE's Green Direct program.
    - The proposed building would be all energy powered, a deviation from the standard campus that has buildings connected to the steam combustion source.
    - The building has been designed to meet or exceed the current Washington State Energy Code (WSEC) requirements, including, a high-performance envelope to help reduce the internal mechanical loads and energy-efficient lighting and controls.

J. ENVIRONMENTAL HEALTH

1. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, which could occur as a result of this proposal? If so, describe:
    a. Describe special emergency services that might be required: During construction, there would be a few soldering stations in the building that would have their own dedicated exhaust system. The VRF condensing units would have a limited amount of refrigerant in the system, with the project providing access doors at piping joints to help minimize/identify leaks. It is possible that normal fire, medical, and/or other emergency services may, on occasion, be needed from the City of Bellingham during construction and operation of the project.
    b. Proposed measures to reduce or control environmental health hazards, if any: Periodic maintenance on the condensing units and any fan coils would be scheduled and the system pressure in the refrigerant loop would be checked for any leaks.

2. Noise

    a. What types of noise exist in the area which may affect your project (for example, traffic, equipment, operation, other): The predominant source of existing noise in the vicinity of the project site is from vehicular traffic on adjacent streets (e.g., E College Way). Existing traffic noise is not anticipated to affect the proposed project.
    b. 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: Construction noise would be created from the following activities: back-up alarms on trucks, forklifts, aerial lifts, and earthwork

equipment; and general heavy equipment engine noise during earthwork and underground utility work. An overall increase in traffic to the campus is not anticipated because the proposed project would reduce the amount of parking stalls in this area and offset those stalls in the Displaced Parking lot to the west of Wade King Service Road (see **Figure 2**). Roof-top air handling units and condensing units, as well as the at grade generator would generate fan noise.

c. Proposed measures to reduce or control noise impacts, if any: The project would comply with the City of Bellingham's noise regulations, including hours of construction. To further control noise impacts from construction, the project would coordinate with WWU on the appropriate timing for construction activities to happen. Sound attenuators would be provided on the Air Handling Units (AHUs) per the City of Bellingham code and the University acoustical requirements.

K. LAND AND SHORELINE USE

1. What is the current use of the site and adjacent properties: The site is currently asphalt parking lots (Lot AIC and part of Lot 17G) and landscaping. Surrounding uses include: ***North***- a continuation of Lot 17G onsite; ***East***- E College Way, and farther east the Sehome Hill Arboretum; ***South***- a wooded open space area, and to the southwest the Academic Instructional Center (AIC; ***West-*** the Communications Facility (CF) building, and farther northwest the Environmental Studies (ES) building.
2. Has the site been used for agriculture? If so, describe: No, the project site is located in an urban area and has not been used as a working farmland for over 100 years.
3. Describe any structures on the site: There are no existing structures onsite.
4. Will any structures be demolished? If so, describe: No structures would be demolished.
5. What is the current comprehensive plan designation of the site: The Comprehensive Plan designation of the ***EECS Building*** site is WWU Neighborhood, Area 1, and its zoning classification is Institutional. The site is located in District 14 of the WWU Institutional Master Plan (IMP).
6. If applicable, what is the current shoreline master program designation of the site? The site is not located within a designated shoreline area.
7. Has any part of the site been classified as an "Environmentally Sensitive" area? If so, specify: According to the City of Bellingham Environmental Critical Areas (ECA) maps, there are no existing ECA's on the project site.
8. Approximately how many people would reside / work in the completed project? No people would reside in the proposed academic building There would be (2) 16-seat Energy Course Labs, (1) 10-seat robotics lab, (1) 30-seat ECE ALC, (2) 16-seat ECE Active Learning Classroom (ALC), (2) 29-seat Project Course Labs, (3) 5-seat R&D Labs, (1) 8-seat R&D Lab, (1) 12-seat R&D lab, (2) 36-seat CS ALC, (1) 18-seat Senior Project Room, (1) 12-seat CS R&D lab located in the existing CF building, 49 offices (private offices, shared private offices, and open workstations) and (1) Tech work room with 5 offices located in the existing CF building. With the event space, conference rooms, and lounges, peak occupant total would be 632. There would be approximately 164 Full Time Equivalent (FTE) employees and 468 transient employees associated with the project.

9. Approximately how many people would the completed project displace? No people would be displaced by the project.

10. Proposed measures to avoid or reduce displacement impacts, if any: None required.

11. Proposed measures to avoid or reduce displacement impacts, if any: None required.

12. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any: Use of the site would be compatible with the Comprehensive Plan, zoning, and IMP. IMP District 14 in which the site is located allows classrooms, laboratories, computer labs, faculty offices, food services, and parking. Currently, the WWU has used 3,470,100 gross sq. ft. of the 4 million gross sq. ft. threshold in the IMP. With the ***EECS Building***, WWU would use 3,523,100 gross sq. ft., still within the IMP threshold.

L. HOUSING

1. Approximately how many units would be provided, if any? Indicate whether high, middle, or low income housing: No housing units would be provided.

2. Approximately how many units, if any would be eliminated? Indicate whether high, middle, or low income housing: No housing units would be eliminated.

3. Proposed measures to reduce or control housing impacts, if any: None required.

M. AESTHETICS

1. What is the tallest height of any proposed structure(s), not including antennas? What is the principle exterior building material(s) proposed: The overall height of the building would be 64 ft.-3 in., with an 11 ft.-5 in. mechanical roof screen enclosure for the rooftop AHU. The principle exterior building material would be a Shou Sugi Ban Wood Cladding Rain Screen System with fiberglass windows. The first floor would mainly consist of a curtain wall aluminum system with some glass fiber reinforced concrete panels on a rainscreen system. The mechanical enclosure would be comprised of metal panels.

2. What views in the immediate vicinity would be altered or obstructed: Views of the arboretum from the CF building would be obstructed by the proposed ***EECS Building***. However, the proposed building would provide new views of the arboretum.

3. Proposed measures to reduce or control aesthetics impacts, if any: The proposed building would maximize glazing and transparency to what is allowed by code at the main spine of CF Building and ***EECS Building***.

N. LIGHT AND GLARE

1. What type of light or glare will the proposal produce? What time of day would it mainly occur: The proposed project is not expected to result in significant light or glare-related impacts from stationary or mobile sources (e.g., from vehicles). At times during the construction process, area lighting of the job site at night (to meet safety requirements) may be necessary, which would be noticeable proximate to the site. In general, however, light and glare from construction of the proposed project is not anticipated to adversely affect adjacent uses.

Once operational, interior and exterior lighting, and pedestrian and parking lot lighting onsite could at times be visible at night from adjacent land uses and streets. Reflected solar glare could also potentially be noticeable at times during the day adjacent to the site. While noticeable, no significant long-term light/glare impacts are expected due to the types of proposed building materials and lighting fixtures, and the fact that reflected glare, if it occurs, would be limited in duration and affected by weather conditions.

As described above under *Aesthetics*, the primary building materials would include: Shou Sugi Ban Wood Cladding, fiberglass windows, curtainwall, and glass fiber reinforced concrete panels. Low glare fixtures with controlled optics would be utilized on the project. Exterior fixtures would be full cut off fixtures. Up-lighting would not be used in exterior applications. Low lumen fixtures would be used in those applications to reduce glare.

2. Could light or glare from the finished project be a safety hazard or interfere with views: Lighting from the proposed building is not expected to create safety hazards or interfere with views. Glare would be controlled by the lighting fixtures chosen for interior and exterior luminaires. The project would minimize light trespass from the building and site, reduce sky-glow to increase night sky access, improve nighttime visibility through glare reduction, and reduce development impacts from lighting on nocturnal environments. Also, existing lights on E College Way are being replaced with LED heads by WWU as part of a separate project.
3. What existing off-site sources of light or glare may affect your proposal: There are existing metal halide streetlamps located on E College Way, around the AIC parking lot to the south, as well as the remaining portion of parking lot 17G to the north.
4. Proposed measures to reduce or control light or glare impacts, if any: Proposed lighting fixtures would include honeycomb louvers, lensing, or parabolic louvers that would aid in reducing any potential glare produced by the fixtures. Other measures would include indirect lighting where possible, diffusing lenses, and analyzing light source location and adjacent reflectance.

O. RECREATION

1. What designated and informal recreational opportunities are in the immediate vicinity: The WWU campus has many open green spaces and fields. A wooded area with a number of paths is located to the south, the arboretum to the east, and the Communications Lawn to the west of the site. There are several art pieces located in the vicinity as well.
2. Would the proposed project displace any existing recreational uses? If so, describe: No, the proposed project would not displace any recreational uses or pieces of art.
3. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any: The project would create plazas at the south entrance and north end of the proposed building. Between the CF building and the EECS building, landscaping elements such as a walkway with scattered concrete seats would be provided.

P. HISTORIC AND CULTURAL PRESERVATION

1. Are there any places (or objects) listed on / proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe: There are no places or objects proposed or listed on an historic register on or next to the site.

2. Generally describe any landmarks or evidence of historic, archeological, scientific, or cultural importance known to be on or next to the site: No historic or cultural landmarks or evidence are known on or next to the site.

3. Proposed measures to reduce or control impacts, if any: Significant impacts to historic or cultural resources are not expected. However, in the unlikely event that cultural resources are inadvertently discovered during construction, all work would be halted and WWU, Washington State Department of Archaeology and Historic Preservation (DAHP), the City of Bellingham, and potentially affected tribes would be notified.

Q. TRANSPORTATION

1. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on the site plans, if any: Vehicular access to the proposed project would be from E College Way via Bill McDonald Parkway.

2. Is the site currently served by public transit? If not, what is the approximate distance to the nearest transit stop: WWU campus as a whole is served by public transit. The closest transit stop is located within a 5-minute walk, on Bill McDonald Parkway.

3. How many parking spaces would the completed project have? How many would the project eliminate: The proposed ***EECS Building*** will displace 43 parking stalls. 43 new parking stalls are being created by the EECS Displaced Parking project to the west of Wade King Service Road (see **Figure 2**). The EECS project would reconfigure the AIC parking lot to the south to provide additional ADA and non-ADA stalls. Currently, there are (3) ADA stalls and (14) non-ADA stalls in the AIC lot. The project would provide (7) ADA stalls and (13) non-ADA stalls. Within the site boundary, the project would provide (4) Electrical Vehicle (EV) parking stalls and (1) Electrical Vehicle Van ADA stall to the north of the building.

4. Will the proposal require any new roads or streets, or any improvements to existing roads or streets not including driveways? If so, generally describe (indicate whether public or private): The project would not require any new roads, streets, or improvements to existing roads.

5. Will the project use (or occur in the immediate vicinity of) water, rail or air transportation? If so, generally describe: No, the project would not use or occur near water, rail, or air transportation.

6. How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur: The proposed project would not generate any new trips to WWU campus as a whole.

7. Proposed measures to reduce or control transportation impacts, if any: None required.

R. PUBLIC SERVICES

1. Would the project result in an increased need for public services (for example – fire or police protection, healthcare, schools, other)? If so, generally describe: The proposed project could generate the need for public services to the site due to the proposed building; however, this is not expected to represent a significant increase in the need for public services on the campus. To the extent that emergency service providers have planned for increasing service demands from WWU, no significant impacts are expected.

2. Proposed measures to reduce or control direct impacts on public services, if any: While the uses in the proposed building could generate demand for emergency services to the site, it is anticipated that adequate service capacity is available to preclude the need for additional public facilities/services. The building would also be fully sprinklered which would help reduce the need for fire service.

S. UTILITIES

1. Choose which utilities are currently available at the site:
   a. ☒ Electricity
   b. ☒ Natural Gas
   c. ☒ Water
   d. ☒ Refuse Service
   e. ☒ Telephone
   f. ☒ Sanitary Service
   g. ☐ Septic System
   h. ☐ Other ____________________

1. Describe the utilities that are proposed for the project, the utility providing the service and the construction activates on the site or in the immediate vicinity which might be needed: Water (Private - WWU); Sewer (Private – WWU); Gas (Cascade Natural Gas); Power (PSE); Storm (Private - WWU).

T. SIGNATURE

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

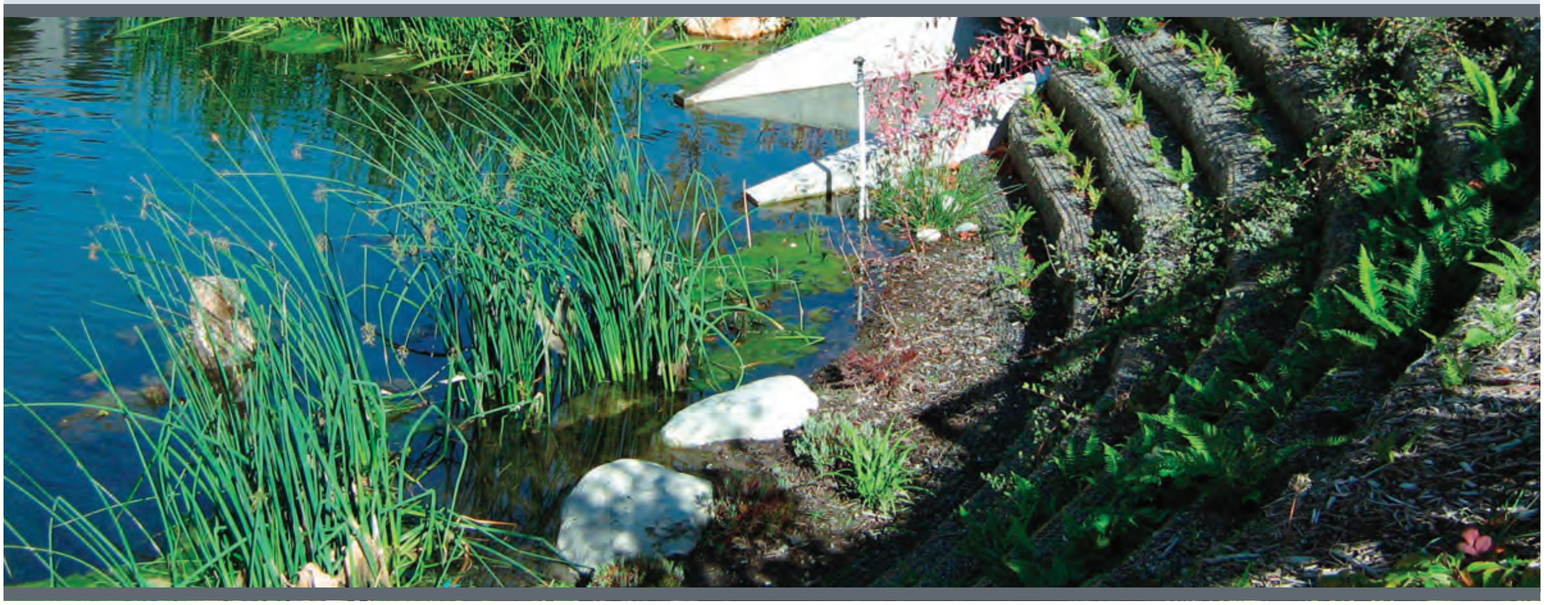
Signature: [signature] Gretchen Brunner, Senior Planner
EA Engineering, Science, and Technology, Inc. PBC

Date Submitted: April 18, 2022

APPENDIX A

Geotechnical Report

associated earth sciences incorporated



Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report

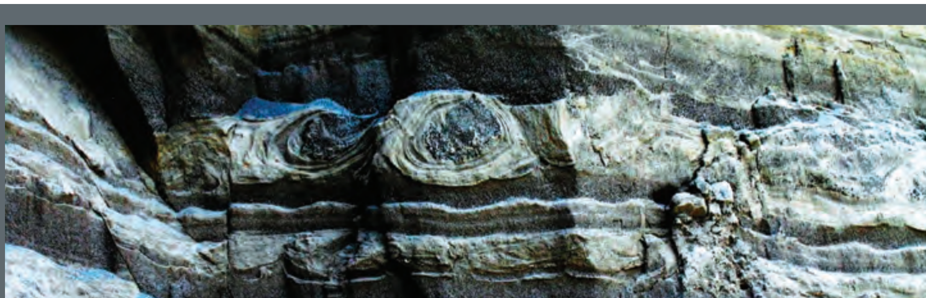
WWU ELECTRICAL ENGINEERING AND COMPUTER SCIENCE BUILDING

Bellingham, Washington

Prepared For:

PERKINS & WILL

Project No. 20200298E001
June 2, 2021



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

June 2, 2021
Project No. 20200298E001

Perkins & Will
1301 Fifth Avenue
Seattle, Washington 98101

Attention: Mr. Anthony Gianopoulos

Subject: Subsurface Exploration, Geologic Hazard,
and Geotechnical Engineering Report
WWU Electrical Engineering and Computer Science Building
Bellingham, Washington

Dear Mr. Gianopoulos:

We are pleased to present the enclosed copy of the referenced report. This report summarizes the results of tasks including subsurface exploration, geologic hazard analysis, laboratory testing, and geotechnical engineering, and offers recommendations for design of the project. This report is based on a schematic design plan set dated March 5, 2021. We should be allowed to review our report and update it as needed as project plans reach completion.

We have enjoyed working with you on this study and are confident that the recommendations presented in this report will aid in the successful completion of your project. Please contact me if you have any questions or if we can be of additional help to you.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Kurt D. Merriman, P.E.
Senior Principal Engineer

KDM/ld - 20200298E001-004

SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, AND GEOTECHNICAL ENGINEERING REPORT

WWU ELECTRICAL ENGINEERING AND COMPUTER SCIENCE BUILDING

Bellingham, Washington

Prepared for:
Perkins & Will
1301 Fifth Avenue
Seattle, Washington 98101

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

June 2, 2021
Project No. 20200298E001

I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of Associated Earth Sciences, Inc.'s (AESI's) subsurface exploration, geologic hazard analysis, and geotechnical engineering study for the proposed WWU Electrical Engineering and Computer Science (EECS) building in Bellingham, Washington. The site location is shown on the "Vicinity Map," Figure 1. The approximate locations of explorations completed for this study are shown on the "Site and Exploration Plan," Figures 2 and 3. Logs of our subsurface explorations are included in Appendix A. Laboratory testing is included in Appendix B.

1.1 Purpose and Scope

The purpose of this study is to provide subsurface soil and groundwater data to be utilized in the design of the WWU EECS building project. Our study included advancing eleven exploration borings (EB-1 through EB-11) and performing a geologic study of subsurface sediment and groundwater conditions. Geotechnical engineering studies were completed to formulate recommendations for the type of suitable foundations, allowable foundation soil bearing pressures, anticipated foundation settlements, erosion considerations, excavation shoring considerations, and general site drainage. This report summarizes our current fieldwork and offers design recommendations based on our present understanding of the project.

1.2 Authorization

Authorization to proceed with this study was given to AESI by means of a consultant agreement dated November 18, 2020. Our study was accomplished in general accordance with our proposal dated November 18, 2020. This report has been prepared for the exclusive use of Perkins & Will and its agents, for specific application to this project. Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

2.0 PROJECT AND SITE DESCRIPTION

The new EECS building will consist of a partial basement level topped by four levels at ground level and above. Gross floor area will be 58,275 square feet. The basement will be constructed in an excavation supported by a top-down shoring system that will be bidder-designed and is expected to consist of a cantilevered soldier pile wall. The building will be constructed with a ground level close to existing grade, at an elevation that matches the adjacent Communications Facility building. A new parking area is planned as part of the project at a separate location nearby to the west near the Student Recreation Center. The parking area will be constructed close to existing grades, and will be underlain by a stormwater detention system.

2.1 Historical Geotechnical Work

AESI previously completed geotechnical engineering for design and construction of the Academic Instruction Center (AIC) building nearby to the southwest of the future EECS building. The AIC building was underlain by existing fill and soft, compressible sediments, which were in turn underlain by sandstone bedrock. The depth to bedrock was highly variable. The AIC building was constructed with a conventional shallow foundation design underlain by an aggregate pier ground improvement system. A similar foundation support approach is planned for the EECS building.

3.0 SITE EXPLORATION

Our field investigation for the current study was conducted in January 2021 and included advancing eleven exploration borings. The existing site conditions, and the approximate locations of subsurface explorations referenced in this study, are presented on the "Site and Exploration Plan" (Figures 2 and 3). The various types of sediments, as well as the depths where the characteristics of the sediments changed, are indicated on the exploration logs, which are included in Appendix A. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types. If changes occurred between sample intervals in our exploration borings, they were interpreted. Our explorations were approximately located in the field by measuring from known site features depicted on existing plans used to create Figures 2 and 3.

The conclusions and recommendations presented in this report are based, in part, on the explorations completed for this study. The number, locations, and depths of the explorations were completed within site and budgetary constraints. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. It should be noted that differing subsurface conditions may be present due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of variations between the field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.

3.1 Exploration Borings

Explorations completed for this study were advanced using a track-mounted drill. During the drilling process, samples were generally obtained at 2½- to 5-foot-depth intervals. The borings were continuously observed and logged by a geologist from our firm. The exploration logs presented in Appendix A are based on the field logs, drilling action, visual observation of the samples collected, and laboratory grain-size testing data included in this report.

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

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

4.0 SUBSURFACE CONDITIONS

4.1 Regional Geologic Map

Published geologic mapping for the site and immediate vicinity were reviewed on the United States Geological Survey National Geologic Map Database. We retrieved a copy of the geologic map of the Bellingham 1:100,000 quadrangle, Washington, Thomas J. Lapen, Washington Division of Geology and Earth Resources, Open File Report 2000-5, 2000. This map indicates that the site is expected to be underlain at shallow depth by Chuckanut Formation bedrock.

4.2 Site Stratigraphy

As shown on the exploration logs, subsurface conditions encountered at the site consisted of Chuckanut Formation bedrock, typically covered by 5 to 15 feet of existing fill. Between existing fill and bedrock, three borings encountered recent alluvium and six encountered Quaternary glacial drift. The following sections present more detailed subsurface information on the sediment types encountered at the site.

Surfacing

Most of the exploration borings were completed in locations with existing asphalt paving or existing crushed rock parking area surfacing. Notes on surface conditions are included on the exploration logs in Appendix A.

Fill

Fill soils (those not naturally placed), were encountered in all of our exploration borings to depths ranging from 5 to 15 feet below the existing ground surface. Existing fill was typically medium dense, and consisted of silty sand with variable content of organic material, gravel, and sandstone clasts likely derived from previous on-site grading. Existing fill is not recommended for support of building foundations or floor slabs, and warrants remedial preparation below ancillary structures and paving. Existing fill is not suitable to be used as a stormwater infiltration receptor. Excavated existing fill is expected to be wetter than optimum for compaction purposes and is expected to contain areas of bedrock clasts, organic content, and minor construction debris that would need to be removed prior to reuse in structural fill applications. Reuse of excavated existing fill in structural fill applications is only allowed if explicitly permitted by project specifications.

Alluvium

Stratigraphically underlying the fill, three borings in the planned building area encountered natural sediments interpreted as alluvium. Alluvium was observed to consist of very loose to medium dense silt and sand with varying organic content. The alluvium at boring EB-3 was notably organic and was described to contain woody debris. Alluvial sediments are unlikely to provide direct structural support due to the depth below grade where they were observed. Alluvial sediments are not suitable as a stormwater infiltration receptor due to their fine texture and limited lateral and vertical stratigraphic distribution. Alluvial sediments are not expected to be excavated in substantial quantities and therefore are unlikely to be used in structural fill applications.

Quaternary Glacial Drift

Stratigraphically underlying the fill six borings encountered Quaternary glacial drift. Glacial drift was observed to consist of typically medium dense silt and silty sand, with variable but generally low organic content. Quaternary glacial drift is unlikely to provide direct structural support, or to be handled in substantial quantity during site grading due to the depth below existing grade where it was encountered. Quaternary glacial drift is not suitable as a stormwater infiltration receptor due its fine texture.

Bedrock

Each boring with the exceptions of EB-7 and EB-11 encountered sandstone bedrock of the Chuckanut Formation. The bedrock varied in consistency, in some cases leading to drilling refusal nearly as soon as it was encountered in a boring, an in other locations allowing drill penetration of up to 9 feet even with the lightweight limited-access exploration drill rig. Highly variable strength and excavation resistance of the Chuckanut Formation bedrock is common, and was experienced during construction of the WWU AIC building a short distance from the current project. Chuckanut Formation bedrock is suitable for structural support as recommended in this report. Chuckanut Formation bedrock is not suitable as an infiltration receptor and is not expected to be handled in substantial quantity during site grading.

4.3 Hydrology

Groundwater was not encountered in any of the exploration borings for this study at the time they were completed (January 2021). Perched groundwater was not observed, but is possible during the wetter winter months.

4.4 Laboratory Testing

Grain-Size Analysis

AESI performed three grain-size analyses (sieves) on representative samples retrieved from the exploration borings. The laboratory test results are included in Appendix B.

II. GEOLOGIC HAZARDS AND MITIGATIONS

The following sections present data, conclusions, and recommendations related to geologic hazards. We reviewed the *City of Bellingham Geologic Hazards Map* (April 2018). No geologic hazards are mapped at the project.

5.0 LANDSLIDE HAZARDS AND MITIGATIONS

The project area is relatively flat. Quantitative slope stability analysis was not completed and is not warranted, in our opinion.

6.0 SEISMIC HAZARDS AND MITIGATIONS

The site does not include areas designated as Seismic Hazard Areas on the previously-referenced *City of Bellingham Geologic Hazards Map*. The following discussion is a more general assessment of seismic hazards that is intended to be useful to the project design team in terms of understanding seismic issues, and to the structural engineer for structural design.

All of Western Washington is at risk of strong seismic events resulting from movement of the tectonic plates associated with the Cascadia Subduction Zone (CSZ), where the offshore Juan de Fuca plate subducts beneath the continental North American plate. The site lies within a zone of strong potential shaking from subduction zone earthquakes associated with the CSZ. The CSZ can produce earthquakes up to magnitude 9.0, and the recurrence interval is estimated to be on the order of 500 years. Geologists infer the most recent subduction zone earthquake occurred in 1700 (Goldfinger et al., 2012[1]). Three main types of earthquakes are typically associated with subduction zone environments: crustal, intraplate, and interplate earthquakes. Seismic records in the Puget Sound region document a distinct zone of shallow crustal seismicity (e.g., the Seattle Fault Zone). These shallow fault zones may include surficial expressions of previous seismic events, such as fault scarps, displaced shorelines, and shallow bedrock exposures. The shallow fault zones typically extend from the surface to depths ranging from 16 to 19 miles. A deeper zone of seismicity is associated with the subducting Juan de Fuca plate. Subduction zone seismic events produce intraplate earthquakes at depths ranging from 25 to 45 miles beneath the Puget Lowland including the 1949, 7.2-magnitude event; the 1965, 6.5-magnitude event; and the 2001,

[1] 1 Goldfinger, C., Nelson, C.H., Morey, A.E., Johnson, J.E., Patton, J.R., Karabanov, E., Gutierrez-Pastor, J., Eriksson, A.T., Gracia, E., Dunhill, G., Enkin, R.J, Dallimore, A., and Vallier, T., 2012, Turbidite Event History—Methods and Implications for Holocene Paleoseismicity of the Cascadia Subduction Zone: U.S. Geological Survey Professional Paper 1661–F, 170.

6.8-magnitude event) and interplate earthquakes at shallow depths near the Washington coast including the 1700 earthquake, which had a magnitude of approximately 9.0. The 1949 earthquake appears to have been the largest in this region during recorded history and was centered in the Olympia area. Evaluation of earthquake return rates indicates that an earthquake of the magnitude between 5.5 and 6.0 is likely within a given 20-year period.

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

6.1 Surficial Ground Rupture

We reviewed published geologic maps of inferred faults on the United States Geological Survey Quaternary Fault and Fold Database of the United States[2]. The site is not underlain or in close proximity to mapped faults, and therefore the potential for surface rupture at the project site is anticipated to be low.

6.2 Liquefaction

Liquefaction is a temporary loss in soil shear strength that can occur when loose granular soils below the groundwater table are exposed to cyclic accelerations, such as those that occur during earthquakes. The observed site sediments were observed to be unsaturated and are not expected to be prone to liquefaction due to their generally high density and absence of shallow groundwater. A detailed liquefaction hazard analysis was not performed as part of this study, and none is warranted, in our opinion.

6.3 Ground Motion/Seismic Site Class (2018 *International Building Code*)

Structural design of the new building should follow 2018 *International Building Code* (IBC) standards. We recommend that the project be designed in accordance with Site Class “C” in accordance with the 2018 IBC, and the publication *American Society of Civil Engineers* (ASCE) 7 referenced therein, the most recent version of which is ASCE 7-16.

[2] https://www.usgs.gov/natural-hazards/earthquake-hazards/faults?qt-science_support_page_related_con=4#qt-science_support_page_related_con.

7.0 EROSION CONTROL

Project plans should include implementation of temporary erosion controls in accordance with local standards of practice. Control methods should include limiting earthwork to seasonally drier periods if possible, use of perimeter silt fences, stabilized construction entrances, and straw mulch in exposed areas. Removal of existing vegetation should be limited to those areas that are required to construct the project, and new landscaping and vegetation with equivalent erosion mitigation potential should be established as soon as practical after grading is complete. During construction, surface water should be collected as close as possible to the source to minimize silt entrainment that could require treatment or detention prior to discharge. Timely implementation of permanent drainage control measures should also be a part of the project plans, and will help reduce erosion and generation of silty surface water onsite.

III. DESIGN RECOMMENDATIONS

8.0 INTRODUCTION

Our explorations indicate that, from a geotechnical engineering standpoint, the proposed project is feasible provided the recommendations in this report are incorporated into design and construction of the project. Surficial fill soils and native sediments below the new building are soft, and an aggregate pier ground improvement system is recommended below foundations and floor slabs.

- We recommend that the new building foundations and floor slabs and any other substantial structures be constructed using a conventional shallow foundation system underlain by ground improvement consisting of the installation of aggregate piers. Other foundation support alternatives are possible, including removing and replacing existing fill or installing foundation piles. We are available to discuss other foundation support approaches on request.

- The project will include a shoring wall around the perimeter of the basement. The subsurface conditions in that portion of the site vary substantially and additional subsurface data will be needed to design the shoring system. A bidder-designed soldier pile shoring wall is expected, and should be designed based on supplementary subsurface explorations that have not been completed at the time this report was written.

- Areas of new paving and other similar ancillary structures should be assessed, and some level of remedial preparation of existing fill may be warranted as outlined in the "Site Preparation" section of this report.

- Stormwater infiltration for the project is not recommended.

9.0 SITE PREPARATION

Erosion and surface water control should be established around the perimeter of the excavation to satisfy City of Bellingham requirements.

9.1 Building Pad Area

Site preparation should include removal of all existing pavement, structures, buried utilities, and any other deleterious material from below the new building. The subgrade for the building pad, or for structural fill placement below the building pad, is expected to consist of existing fill. The subgrade should be proof-rolled and compacted. Any areas that are soft, yielding, organic, or otherwise unsuitable should be repaired as needed based on site observations during construction. Structural fill should then be placed to reach planned grades. The building pad should be capped with a working surface of at least 8 inches of crushed rock to facilitate construction of aggregate piers.

9.2 Paving Areas

Areas of planned paving should be prepared by stripping existing vegetation and topsoil, removing structures and utilities to be demolished, and excavating to planned paving subgrade elevation. The resulting subgrade should then be evaluated visually, compacted, and proof-rolled. Exposed soils are expected to consist of existing fill. Areas with organic or deleterious material, or areas that yield during proof-rolling should receive additional preparation tailored to proof-rolling results and field conditions at the time of construction.

9.3 Allowance Recommendations

Because building and paving subgrades will consist of existing fill, some amount of remedial subgrade preparation will likely be needed. We recommend establishing a unit cost in bid documents for removal and export of unsuitable soils, and import of suitable granular fill. The unit prices should be based on in situ bank cubic yards as the unit of measurement. An allowance should be included to encourage competitive unit pricing during bidding. The allowance language should establish that earthwork allowances are to be used only at the owner’s direction, and in accordance with unit prices. For planning purposes we recommend including 500 cubic yards of export/import in bid documents. This is an arbitrary number intended to encourage competitive pricing, and to allow the owner to budget for anticipated remedial preparation. The actual amount used may be more or less based on field conditions during construction.

9.4 Temporary Cut Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction based on the conditions encountered at that time. For estimating purposes, however, we anticipate that temporary, unsupported cut slopes in existing fill be planned at a maximum slope of 1.5H:1V (Horizontal:Vertical). Temporary cut slopes may need to be adjusted in the field at the time of construction based on the presence of surface water or perched seepage zones. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. In addition, WISHA/OSHA regulations should be followed at all times.

9.5 Site Disturbance

Some of the on-site soils contain a high percentage of fine-grained material, which makes them moisture-sensitive and subject to disturbance when wet. The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened, particularly during wet weather conditions. If disturbance occurs in areas of conventional footings, the softened soils should be removed and the area brought to grade with clean crushed rock fill. Because of the moisture-sensitive nature of the soils, we anticipate that wet weather construction would significantly increase the earthwork costs over dry weather construction.

9.6 Winter Construction

The existing fill material contains substantial silt and is considered highly moisture-sensitive. Soils excavated onsite will likely require drying during favorable dry weather conditions to allow their reuse in structural fill applications. During winter conditions use of excavated on-site soils in compacted fill applications may not be possible, and the use of imported fill or cement treatment of on-site soils may be needed if sitework will be completed during the winter. Care should be taken to seal all earthwork areas during mass grading at the end of each workday by grading all surfaces to drain and sealing them with a smooth-drum roller. Stockpiled soils that will be reused in structural fill applications should be covered whenever rain is possible.

If winter construction is expected, crushed rock fill should be used to provide construction staging areas where exposed soil is present. The stripped subgrade should be observed by the geotechnical engineer, and should then be covered with a geotextile fabric, such as Mirafi 500X or equivalent. Once the fabric is placed, we recommend using a crushed rock fill layer at least 10 inches thick in areas where construction equipment will be used. Soil-cement treatment is another approach to providing a workable site during the winter. We are available to provide more detailed cement-treatment recommendations on request and if allowed by the governing jurisdiction.

9.7 Frozen Subgrades

If earthwork takes place during freezing conditions, all exposed subgrades should be allowed to thaw, and then be recompacted prior to placing subsequent lifts of structural fill. Alternatively, the frozen material could be stripped from the subgrade to reveal unfrozen soil prior to placing subsequent lifts of fill. The frozen soil should not be reused as structural fill until allowed to thaw and adjusted to the proper moisture content, which may not be possible during winter months.

10.0 STRUCTURAL FILL

Structural fill should be placed and compacted according to the recommendations presented in this section and requirements included in project specifications. All references to structural fill in this report refer to subgrade preparation, fill type, placement, and compaction of materials, as discussed in this section. If a percentage of compaction is specified under another section of this report, the value given in that section should be used.

Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts, with each lift being compacted to at least 95 percent of the modified Proctor maximum dry density using ASTM D-1557 as the standard. In the case of roadway and utility trench filling, the backfill should be placed and compacted in accordance with City of Bellingham standards. At this time we are not aware of any planned right-of-way work associated with the project. For planning purposes, we recommend the use of a well-graded sand and gravel for on-site road and utility trench backfill.

The contractor should note that AESI should evaluate any proposed fill soils prior to their use in fills. This would require that we have a sample of the material at least 3 business days in advance of filling activities to perform a Proctor test and determine its field compaction standard. Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. Use of moisture-sensitive soil in structural fills is not recommended during the winter months or under wet site and weather conditions. Most of the on-site soils are moisture-sensitive and have natural moisture contents over optimum for compaction and will likely require moisture-conditioning before use as structural fill. In addition, construction equipment traversing the site when the soils are wet can cause considerable disturbance. If import soil is required, a select import material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction and at least 30 percent retained on the No. 4 sieve.

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

11.0 FOUNDATIONS

Conventional shallow footings may be used for building support when founded on existing fill soils improved by placement of aggregate piers, as previously discussed. Building foundations should be designed for an allowable foundation soil bearing pressure of 5,000 pounds per square foot (psf). This allowable foundation soil bearing pressure may be increased by one-third to accommodate transient wind and seismic loads.

Perimeter footings should be buried at least 18 inches into the surrounding soil for frost protection. However, all footings must penetrate to the prescribed bearing stratum, and no footing should be founded in or above organic or loose soils. All footings should have a minimum width of 18 inches.

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

Foundation settlement parameters are established as part of the aggregate pier design process and are summarized in the following report section. Disturbed soil not removed from footing excavations prior to footing placement could result in increased settlements. All footing areas should be inspected by AESI prior to placing concrete to verify that the design bearing capacity of the soils has been attained and that construction conforms to the recommendations contained in this report. Such inspections may be required by the governing municipality. Perimeter footing drains should be provided, as discussed under the “Drainage Considerations” section of this report.

11.1 Aggregate Piers

Aggregate piers are recommended below the new building and any other substantial structures. Aggregate piers are vertical columns of compacted stone that are constructed on the building pad before new foundations are constructed. The purpose of aggregate piers is to both improve existing fill soils and to transmit loads to more competent native bearing soils at depth. Aggregate piers are formed by drilling or displacing the existing soil column to a pre-determined depth with an auger or vibratory mandrel. Crushed rock is fed from the surface and compacted in thin lifts resulting in a column of compacted aggregate and compaction of soils surrounding the pier.

Aggregate piers are proprietary systems and are designed by the contractor who installs them. The contractor will determine the depth and diameter of the pier holes and the appropriate spacing. Aggregate pier designs are specifically tailored to a foundation plan, and the locations and depths of foundations should be determined prior to aggregate pier design. Conventional shallow foundations are then constructed above the subgrade after piers have been installed. The aggregate pier contractor should review exploration logs contained in this report carefully. Existing fill soils, such as those observed in our explorations, may contain drilling obstacles. Where drilling obstacles are encountered, the contractor should be prepared to relocate planned piers or remove obstacles, as needed, as part of the base bid work.

The aggregate pier design should be based on the following parameters:

<u>Footings:</u>

Maximum Allowable Bearing Pressure for Footings Supported by Aggregate Piers:	5,000 psf
Maximum Total Long-Term Settlement for Footings:	≤ 1 inch
Maximum Long-Term Differential Settlement of Adjacent Footings:	≤ ½ inch over 30 feet ≤1 inch over 200 feet
Maximum Aggregate Pier Spacing Under Foundations:	8 feet

<u>Floor Slabs:</u>

Subgrade Modulus (Minimum):	50 lb/in^3
Maximum Long-Term Total Settlement for Slabs:	≤ 1 inch
Maximum Long-Term Differential Settlement for Slabs:	≤ ½ inch over 30 feet

We recommend full-time construction observation by AESI during pier installation to verify that the piers extend to native bearing soils. Air or water jetting are not acceptable practices during the installation of aggregate piers.

12.0 DRAINAGE CONSIDERATIONS

Traffic across the on-site soils when they are damp or wet will result in disturbance of the otherwise firm stratum. Therefore, during sitework and construction, the contractor should provide surface drainage and subgrade protection, as necessary.

Any retaining walls, basement walls, and all perimeter foundation walls should be provided with a drain at the footing elevation. Drains should consist of rigid, perforated, PVC pipe surrounded by washed gravel. The level of the perforations in the pipe should be set at the bottom of the footing, and the drains should be constructed with sufficient gradient to allow gravity discharge away from the building. The perforations should be located on the lower portion of the pipe. In addition, any retaining or subgrade walls should be lined with a minimum, 12-inch-thick, washed gravel blanket, backfilled completely with free-draining material over the full height of the wall (excluding the first 1 foot below the surface). Composite drainage mats such as Mira Drain 6000 installed in accordance with the manufacturer's recommendations may be used in lieu of the free-draining aggregate blanket for walls such as stormwater detention vaults that will not be completed as finished habitable space on the interior. The drainage aggregate or composite drain mats should tie into and freely communicate with the footing drains. Roof and surface runoff should not discharge into the footing drain system, but should be handled by a separate, rigid, tightline drain.

To minimize erosion, stormwater discharge or concentrated runoff should not be allowed to flow down any steep slopes. In planning, exterior grades adjacent to walls should be sloped downward away from the structures at an inclination of at least 3 percent to achieve surface drainage. Runoff water from impervious surfaces should be collected by a storm drain system that discharges into the site stormwater system.

13.0 FLOOR SLABS

Floor slabs are expected to be underlain by aggregate piers. The slabs should be cast atop a minimum of 4 inches of washed pea gravel or washed crushed rock to act as a capillary break where moisture migration through the slabs is to be controlled. The capillary break material should be overlain by a 10-mil-thick vapor barrier material prior to concrete placement. American Concrete Institute (ACI) recommendations should be followed for all concrete placement.

14.0 FOUNDATION WALLS

The following recommendations may be applied to conventional walls up to 8 feet tall. We should be allowed to offer situation-specific input if any taller walls are planned. All backfill behind foundation walls or around foundation units should be placed in accordance with our recommendations for structural fill and as described in this report. Horizontally backfilled walls, which are free to yield laterally at least 0.1 percent of their height, may be designed to resist lateral earth pressure represented by an equivalent fluid equal to 35 pounds per cubic foot (pcf). Fully restrained, horizontally backfilled, rigid walls that cannot yield should be designed for an equivalent fluid of 50 pcf. Walls with sloping backfill up to a maximum gradient of 2H:1V should be designed using an equivalent fluid of 55 pcf for yielding conditions or 75 pcf for fully restrained conditions. If parking areas are adjacent to walls, a surcharge equivalent to 2 feet of soil should be added to the wall height in determining lateral design forces.

As required by the 2018 IBC, retaining wall design should include a seismic surcharge pressure in addition to the equivalent fluid pressures presented above. Considering the site soils and the recommended wall backfill materials, we recommend a seismic surcharge pressure of 5H and 10H psf, where H is the wall height in feet for the “active” and “at-rest” loading conditions, respectively. The seismic surcharge should be modeled as a rectangular distribution with the resultant applied at the midpoint of the walls

The lateral pressures presented above are based on the conditions of a uniform backfill consisting of excavated on-site soils or imported structural fill compacted to 90 percent of ASTM D-1557 within about 3 feet of the wall. A higher degree of compaction is not recommended, as this will increase the pressure acting on the walls. A lower compaction may result in settlement of the slab-on-grade or other structures supported above the walls. Thus, the compaction level is critical and must be tested by our firm during placement. Surcharges from adjacent footings or heavy construction equipment must be added to the above values. Perimeter footing drains should be provided for all retaining walls, as discussed under the “Drainage Considerations” section of this report.

It is imperative that proper drainage be provided so that hydrostatic pressures do not develop against the walls. Wall drainage recommendations are presented in Section 14.0 of this report.

14.1 Passive Resistance and Friction Factors

Lateral loads can be resisted by friction between the foundation and the natural soils or supporting structural fill soils, and by passive earth pressure acting on the buried portions of the foundations. The foundations must be backfilled with structural fill and compacted to at least 95 percent of the maximum dry density to achieve the passive resistance provided below. We recommend the following allowable design parameters which include a factor of safety of 1.5:

- Passive equivalent fluid = 250 pcf
- Coefficient of friction = 0.35

15.0 EXCAVATION SHORING

The project will include excavation shoring in an area that is rectangular in plan view and located around the perimeter of the partial basement of the new building. The shoring is expected to extend one building level below grade, and a maximum exposed shoring wall height of up to 10 feet is anticipated. The shoring wall has not yet been designed, and is expected to be bidder-designed. The shoring wall is expected to consist of cantilevered soldier piles and wood lagging. No tiebacks are anticipated.

The shoring wall may be temporary and structurally superseded by the building basement wall when it is constructed or may be incorporated into the permanent structural design of the building. If the wall is temporary, the design would not typically include seismic loading conditions and no corrosion protection is typically provided. Permanent shoring walls are required to satisfy seismic loading conditions and metal parts of the system are usually encapsulated, epoxy-coated, or painted to provide long-term corrosion protection.

The area of the proposed shoring is characterized by several different subsurface materials with different engineering properties. In general, the surficial fill soils consist of fill, alluvium, and glacial drift soils which are weak and provide less support for shoring systems. These surficial weak soils are underlain by bedrock which provides good support for shoring systems but can be difficult to excavate to install shoring components. The depth/elevation at which the change from weak to strong materials occurs varies widely, ranging from about 5 to 20 feet below existing grade at the locations of borings included in this report. We recommend that the shoring be designed based on supplementary exploration borings specifically completed to provide shoring design information.

AESI contacted two local shoring contractors with design-build experience on projects similar to this one. Based on those conversations, cantilevered soldier pile shoring is expected to be feasible. It should be noted that shoring systems are not perfectly rigid, and correctly-designed cantilevered soldier pile walls allow some lateral deflection at the wall face and some lateral and vertical displacements in the retained soil zone. If settlement-sensitive structures are located within a horizontal distance of the shoring system equal to twice the shoring height, consideration should be given as to the sensitivity of the adjacent structure(s) to settlement. If small amounts of settlement are unacceptable additional settlement mitigations methods (such as underpinning) or alternate shoring designs (such as tieback walls with pre-tensioned anchors) could be considered.

16.0 STORMWATER INFILTRATION

Our subsurface explorations encountered existing fill, alluvial sediments, glacial drift, and sandstone. Infiltration into existing fill is not permissible by code and is not recommended. None of the native sediments we observed were texturally well suited and laterally extensive enough to serve as a stormwater infiltration receptor. Stormwater infiltration at this site is not feasible in our opinion and is not recommended.

17.0 PAVEMENT AND SIDEWALK RECOMMENDATIONS

The pavement sections included in this report section are for driveway and parking areas onsite, and are not applicable to right-of-way improvements. At this time, we are not aware of any planned right-of-way improvements; however, if any new paving of public streets is required, we should be allowed to offer situation-specific recommendations.

Pavement and sidewalk areas should be prepared in accordance with the "Site Preparation" section of this report. Soft or yielding areas should be overexcavated to provide a suitable subgrade and backfilled with structural fill.

New paving may include areas subject only to light traffic loads from passenger vehicles driving and parking, and may also include areas subject to heavier loading from vehicles that may include buses, fire trucks, food service trucks, and garbage trucks. In light traffic areas, we recommend a pavement section consisting of 3 inches of hot-mix asphalt (HMA) underlain by 4 inches of crushed surfacing base course. In heavy traffic areas, we recommend a minimum pavement section consisting of 4 inches of HMA underlain by 2 inches of crushed surfacing top course and 4 inches of crushed surfacing base course. The crushed rock courses must be compacted to 95 percent of the maximum density, as determined by ASTM D-1557. All paving materials should meet gradation criteria contained in the current Washington State Department of Transportation (WSDOT) Standard Specifications.

Depending on construction staging and desired performance, the crushed base course material may be substituted with ATB beneath the final asphalt surfacing if desired. The substitution of ATB should be as follows: 4 inches of crushed rock can be substituted with 3 inches of ATB, and 6 inches of crushed rock may be substituted with 4 inches of ATB. ATB should be placed over a native or structural fill subgrade compacted to a minimum of 95 percent relative density, and a 1½- to 2-inch thickness of crushed rock to act as a working surface. If ATB is used for construction access and staging areas, some rutting and disturbance of the ATB surface should be expected to result from construction traffic. The general contractor should remove affected areas and replace them with properly compacted ATB prior to final surfacing.

18.0 RECOMMENDATIONS FOR FUTURE WORK

- Additional exploration borings are recommended to delineate subsurface conditions at the location of the planned shoring walls. Shoring walls should be bidder-designed based on the supplementary subsurface explorations.

- We recommend that we be allowed to work with the design team to prepare project specifications for aggregate piers. It may be valuable to complete additional subsurface explorations in the building footprint to determine the depth of existing fill and depth to bedrock at additional locations. The additional subsurface data would allow for better owner cost estimating, better aggregate pier design by the contractor, and would make construction change orders due to varying subsurface conditions less likely. We are available to discuss additional subsurface explorations on request.

The two items listed above are recommended but are not included in our currently-approved scope of services for the project. We are available to provide scope of work and cost recommendations for these items on request.

19.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

We recommend that AESI perform a geotechnical review of the plans prior to final design completion. In this way, we can confirm that our recommendations have been correctly interpreted and implemented in the design. The City of Bellingham may require a plan review by the geotechnical engineer as a condition of permitting.

We recommend that AESI be retained to provide geotechnical special inspections during construction, and preparation of a letter summarizing our construction phase work when construction is complete. The City of Bellingham may require such geotechnical special inspections. The integrity of the earthwork and foundations depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent.

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

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

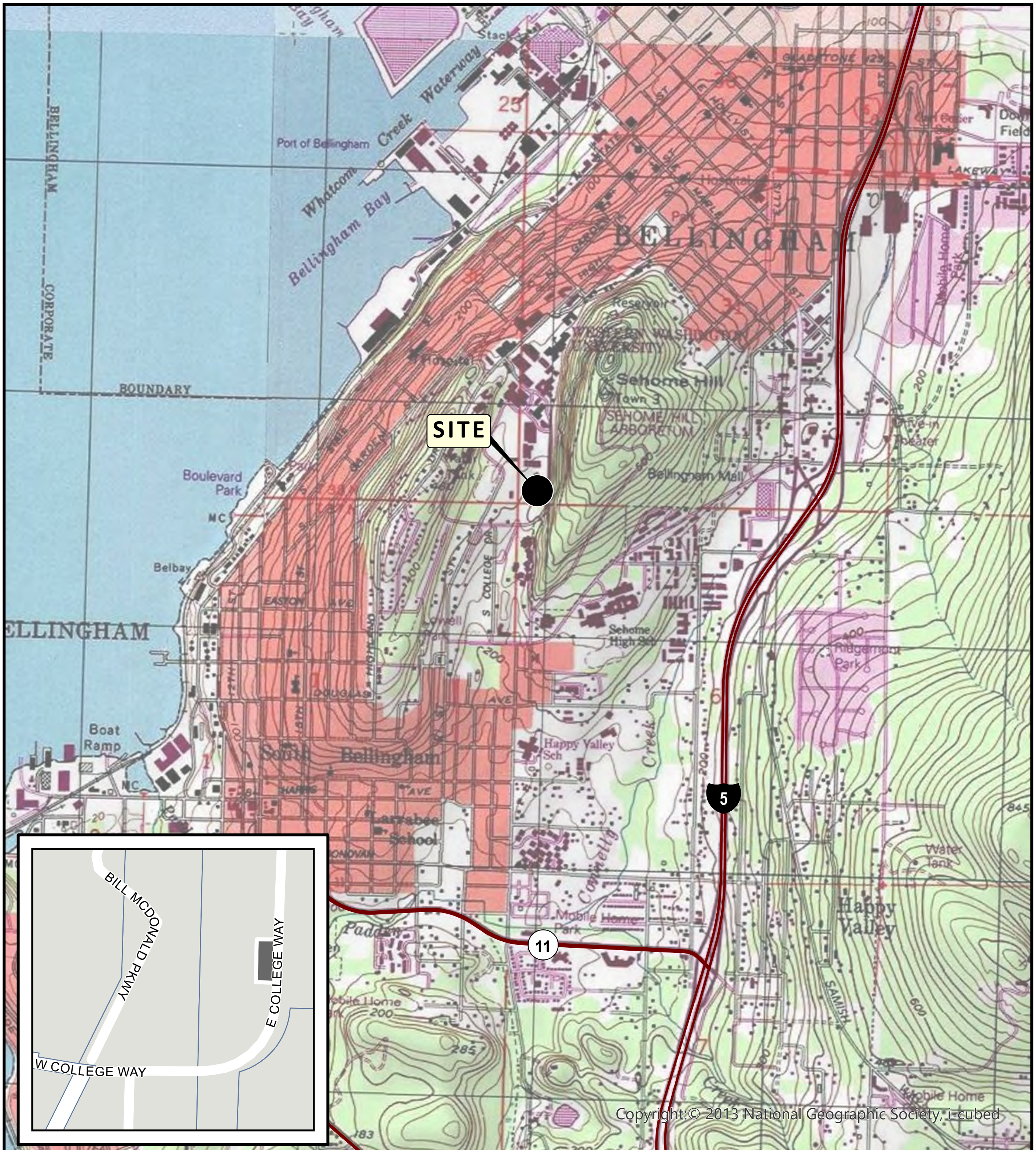
06/02/2021

Bruce Guenzler

Bruce W. Guenzler, L.E.G.
Senior Associate Geologist

Kurt D. Merriman, P.E.
Senior Principal Engineer

Attachments:
Figure 1. Vicinity Map
Figure 2. Site and Exploration Plan
Figure 3. Site and Exploration Plan
Appendix A. Exploration Logs
Appendix B. Laboratory Testing Results



DATA SOURCES / REFERENCES:
USGS: 7.5' SERIES TOPOGRAPHIC MAPS, ESRI/I-CUBED/NATIONAL GEOGRAPHIC SOCIETY 2013
WHATCOM CO: STREETS 03/17, CITY LIMITS, PARCELS, 07/20
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N

0 1000 2000
FEET

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

associated earth sciences incorporated

VICINITY MAP

WWU ELECTRICAL ENGINEERING AND COMPUTER SCIENCE BLD
BELLINGHAM, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20200298E001	9/20	1

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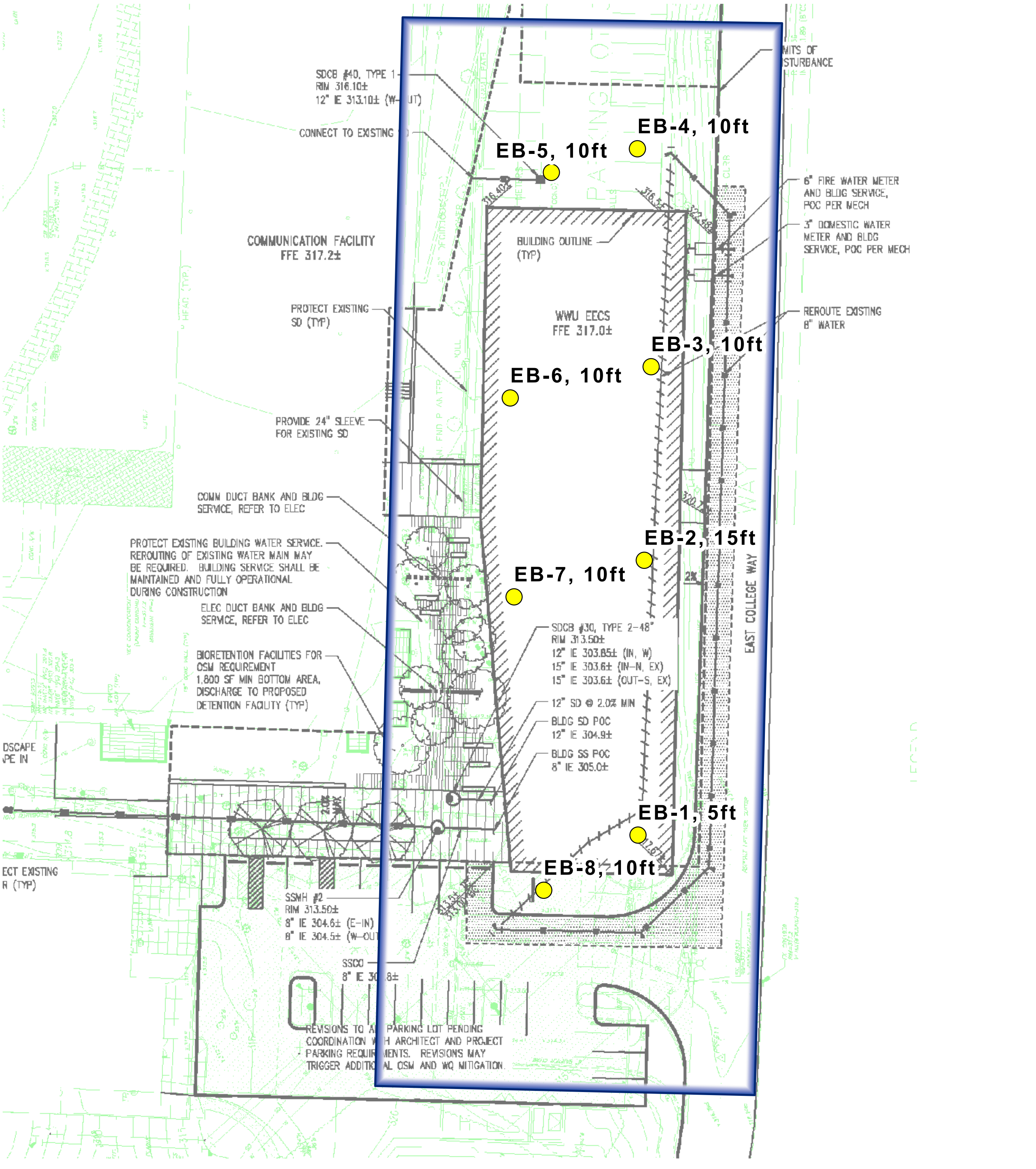

LEGEND

SITE

EXPLORATION BORING, DEPTH OF FILL

DATA SOURCES / REFERENCES:
PERKINS & WILL, WWU ELECTRICAL ENGINEERING AND COMPUTER SCIENCE BUILDING, CIVIL SITE PLAN AT BUILDING, C110, 6/22/20
GEOREFERENCED USING WHATCOM CO: AERIAL PICTOMETRY INT. 2016
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N

0 50
Feet

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

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SITE AND EXPLORATION PLAN

WWU EE AND CS BLDG
BELLINGHAM, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20200298E001	2/21	2

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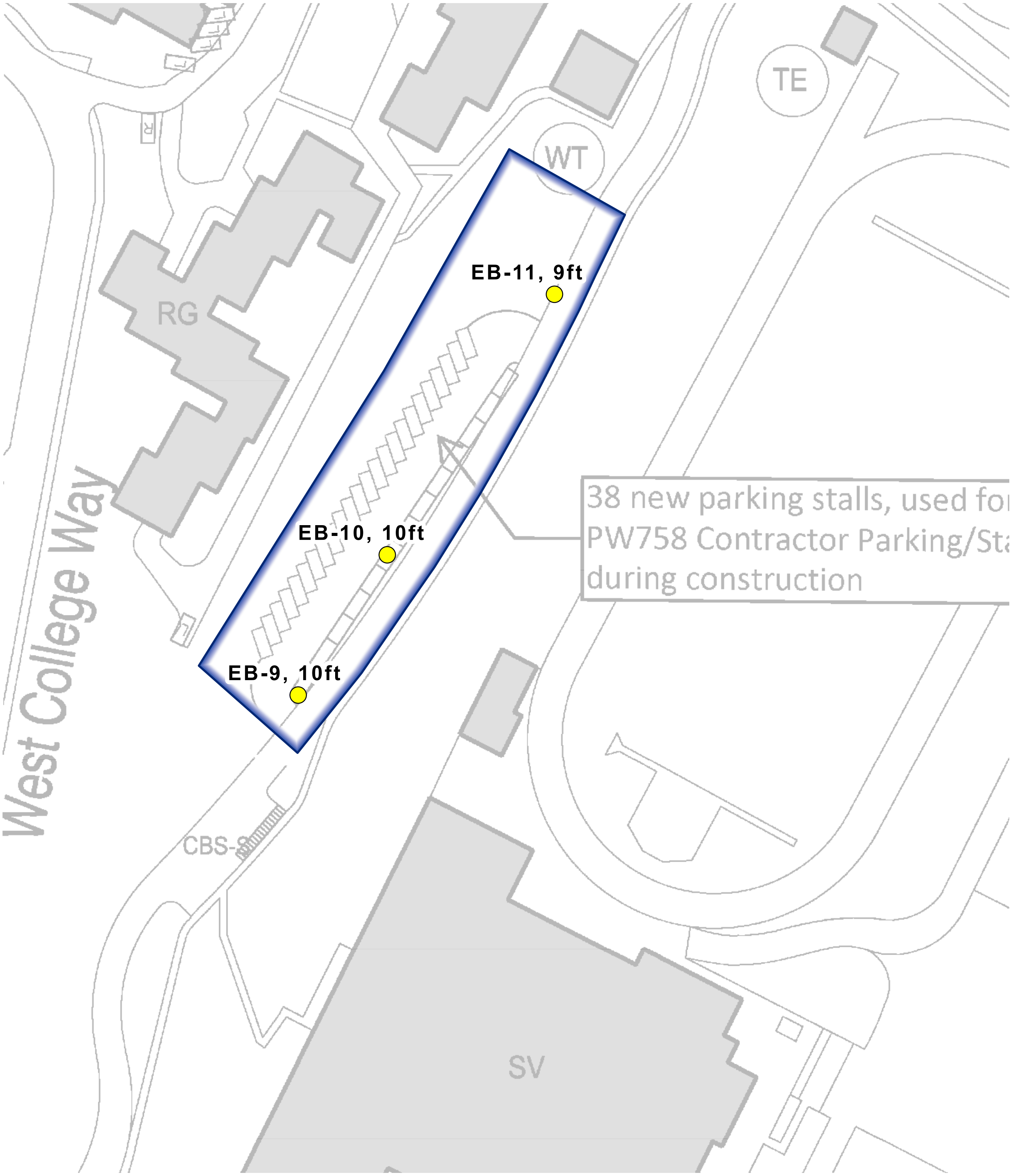

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LEGEND

SITE

EXPLORATION BORING, DEPTH OF FILL

DATA SOURCES / REFERENCES:
BASEMAPE RECEIVED FROM PERKINS & WILL VIA EMAIL
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

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

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SITE AND EXPLORATION PLAN

WWU EE AND CS BLDG - PARKING IMPROVEMENTS
BELLINGHAM, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20200298E001	2/21	3

APPENDIX A

Exploration Logs

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

Terms Describing Relative Density and Consistency

	Density	SPT[2] blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

	Consistency	SPT[2] blows/foot
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

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

Component Definitions

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

(3) Estimated Percentage

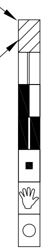
Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

Moisture Content

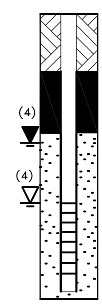
Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols

Sampler Type
Blows/6" or portion of 6"
2.0" OD Split-Spoon Sampler (SPT)
Bulk sample
Grab Sample



Sampler Type Description
3.0" OD Split-Spoon Sampler
3.25" OD Split-Spoon Ring Sampler
3.0" OD Thin-Wall Tube Sampler (including Shelby tube)
Portion not recovered



Cement grout surface seal
Bentonite seal
Filter pack with blank casing section
Screened casing or Hydrotip with filter pack
End cap

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

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

blocks \ dwg \ log_key.dwg LAYOUT: Layout 4 -2014 Qty Chng

Exploration Boring

associated earth sciences incorporated

Project Number	Exploration Number	Sheet
20200298E001	EB-1	1 of 1

Project Name: WWU Electrical Engineering & Computer Science Building
Location: Bellingham, WA
Driller/Equipment: Geologic Drill / Mini Track Rig
Hammer Weight/Drop: 140# / 30

Ground Surface Elevation (ft): 310 +/-
Datum: NAVD 88
Date Start/Finish: 1/20/21,1/20/21
Hole Diameter (in): 4

Depth (ft)	ST	Samples	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
			Asphalt - 3 inches					
			Fill					
		S-1	Moist, tannish brown, silty, fine SAND, trace gravel; contains pieces of weathered sandstone (SM).			36 45 43	88	
5			**Weathered Chuckanut Formation**					
		S-2	Moist, gayish brown, silty, SAND, trace organics (SM).			19 19 40	59	
		S-3	As above; becomes tannish brown SANDSTONE; poor recovery.			50/5"	50/5"	
			Bottom of exploration boring at 8 feet No groundwater encountered.					
10								

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

associated earth sciences incorporated

Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-2	1 of 2

Project Name	WWU Electrical Engineering & Computer Science Building	Ground Surface Elevation (ft)	311 +/-
Location	Bellingham, WA	Datum	NAVD 88
Driller/Equipment	Geologic Drill / Mini Track Rig	Date Start/Finish	1/20/21,1/20/21
Hammer Weight/Drop	140# / 30	Hole Diameter (in)	4

Depth (ft)	S T	Samples	DESCRIPTION	Blows/6"	Blows/Foot
			Asphalt - 3 inches		
			Fill		
	SPT	S-1	Moist, brown to gray, silty, GRAVEL (GM).	16, 13, 12	25
5	SPT	S-2	Moist, mottled grayish brown, sandy, SILT, trace gravel; unsorted (ML).	6, 5, 10	15
10	SPT	S-3	As above; blowcounts likely overstated due to gravel.	5, 10, 8	18

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-2	2 of 2

Project Name	WWU Electrical Engineering & Computer Science Building	Ground Surface Elevation (ft)	311 +/-
Location	Bellingham, WA	Datum	NAVD 88
Driller/Equipment	Geologic Drill / Mini Track Rig	Date Start/Finish	1/20/21,1/20/21
Hammer Weight/Drop	140# / 30	Hole Diameter (in)	4

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
15		S-4		**Weathered Chuckanut Formation** Gray, SANDSTONE; poor recovery.			50/5"	▲50/5"	
				Bottom of exploration boring at 15.4 feet No groundwater encountered.					
20									

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

Exploration Boring

associated earth sciences incorporated

Project Number	Exploration Number	Sheet
20200298E001	EB-3	1 of 2

Project Name: WWU Electrical Engineering & Computer Science Building
Location: Bellingham, WA
Driller/Equipment: Geologic Drill / Mini Track Rig
Hammer Weight/Drop: 140# / 30
Ground Surface Elevation (ft): 313 +/-
Datum: NAVD 88
Date Start/Finish: 1/20/21,1/20/21
Hole Diameter (in): 4

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
				Asphalt - 4 inches					
				Fill					
				Moist, grayish brown, silty, SAND, trace gravel, trace organics (SM).					
		S-1					4 8 6	▲14	
5				As above; contains chunks of weathered sandstone (SM).					
		S-2					4 6 6	▲12	
10				**Alluvium**					
		S-3		Moist, bluish gray, sandy, SILT; few organics (woody debris) (ML).			3 6 6	▲12	

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

Exploration Boring

associated earth sciences incorporated

Project Number	Exploration Number	Sheet
20200298E001	EB-3	2 of 2

Project Name: WWU Electrical Engineering & Computer Science Building
Location: Bellingham, WA
Driller/Equipment: Geologic Drill / Mini Track Rig
Hammer Weight/Drop: 140# / 30

Ground Surface Elevation (ft): 313 +/-
Datum: NAVD 88
Date Start/Finish: 1/20/21,1/20/21
Hole Diameter (in): 4

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
15		S-4		**Chuckanut Formation** Brown, SANDSTONE; poor recovery.			50/5"	▲50/5"	
				Bottom of exploration boring at 15.4 feet No groundwater encountered.					
20									

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-4	1 of 2

Project Name	WWU Electrical Engineering & Computer Science Building	Ground Surface Elevation (ft)	314 +/-
Location	Bellingham, WA	Datum	NAVD 88
Driller/Equipment	Geologic Drill / Mini Track Rig	Date Start/Finish	1/20/21,1/20/21
Hammer Weight/Drop	140# / 30	Hole Diameter (in)	4

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
0		**Asphalt - 4 inches**		
		Fill		
	S-1	Moist, brownish gray, silty, SAND; few gravels; contains chunks of weathered sandstone (SM).	9 8 5	13
5	S-2	As above; becomes bluish gray.	2 3 4	7
10		**Alluvium**		
	S-3	Moist to very moist, greenish gray, silty, SAND, trace organics (SM).	2 2 1	3

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-4	2 of 2

Project Name	WWU Electrical Engineering & Computer Science Building	Ground Surface Elevation (ft)	314 +/-
Location	Bellingham, WA	Datum	NAVD 88
Driller/Equipment	Geologic Drill / Mini Track Rig	Date Start/Finish	1/20/21,1/20/21
Hammer Weight/Drop	140# / 30	Hole Diameter (in)	4

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
		S-4		**Weathered Chuckanut Formation** No recovery. Driller notes rocky drill action and refusal at 13 feet. Bottom of exploration boring at 13.3 feet No groundwater encountered.			50/3"	▲50/3"	
15									
20									

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

Exploration Boring

associated earth sciences incorporated

Project Number	Exploration Number	Sheet
20200298E001	EB-5	1 of 3

Project Name: WWU Electrical Engineering & Computer Science Building
Location: Bellingham, WA
Driller/Equipment: Geologic Drill / Mini Track Rig
Hammer Weight/Drop: 140# / 30

Ground Surface Elevation (ft): 314 +/-
Datum: NAVD 88
Date Start/Finish: 1/20/21,1/20/21
Hole Diameter (in): 4

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
		Asphalt - 6 inches		
		Fill		
		Moist, bluish gray, silty, SAND; few gravels and woody debris (SM).		
	S-1		8 9 12	21
5		As above; becomes grayish brown; trace brick debris (SM).		
	S-2		4 6 6	12
10		**Alluvium**		
	S-3	Moist, dark grayish brown, sandy, SILT, trace organics; few fine gravels (ML).	6 5 4	9

Columns also include: ST, Graphic Symbol, Well Completion, Water Level, Other Tests. Blows/Foot scale: 10, 20, 30, 40.

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

associated earth sciences incorporated

Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-5	2 of 3

Project Name: WWU Electrical Engineering & Computer Science Building
Location: Bellingham, WA
Driller/Equipment: Geologic Drill / Mini Track Rig
Hammer Weight/Drop: 140# / 30

Ground Surface Elevation (ft): 314 +/-
Datum: NAVD 88
Date Start/Finish: 1/20/21,1/20/21
Hole Diameter (in): 4

Depth (ft)	ST	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
15				**Quaternary Glacial Drift**					
		S-4		Moist, mottled grayish brown, fine sandy, SILT, trace organics (ML/CL).			6 10 12	▲22	
20		S-5		**Weathered Chuckanut Formation**			50/6"	▲50/6"	
				Moist, gray to dark gray, silty, SAND (SM/SC).					

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-5	3 of 3

Project Name: WWU Electrical Engineering & Computer Science Building
Location: Bellingham, WA
Driller/Equipment: Geologic Drill / Mini Track Rig
Hammer Weight/Drop: 140# / 30

Ground Surface Elevation (ft): 314 +/-
Datum: NAVD 88
Date Start/Finish: 1/20/21,1/20/21
Hole Diameter (in): 4

Depth (ft)	ST	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
25				Moist, brownish gray, fine sandy, SILT (ML/CL).					
		S-6					23 38 34	▲72	
				As above; few coal seams.					
		S-7					43 35 36	▲71	
				Bottom of exploration boring at 29 feet No groundwater encountered.					
30									
35									

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- ∇ Water Level ()
- ▼ Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

associated earth sciences incorporated

Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-6	1 of 2

Project Name	WWU Electrical Engineering & Computer Science Building	Ground Surface Elevation (ft)	313 +/-
Location	Bellingham, WA	Datum	NAVD 88
Driller/Equipment	Geologic Drill / Mini Track Rig	Date Start/Finish	1/20/21,1/20/21
Hammer Weight/Drop	140# / 30	Hole Diameter (in)	4

Depth (ft)	ST	Samples	DESCRIPTION	Blows/6"	Blows/Foot
			Asphalt - 4 inches		
			Fill		
		S-1	Moist, gray, to dark gray, silty, SAND; few gravels (SM).	6 8 8	16
5		S-2	As above.	3 7 7	14
10			**Quaternary Glacial Drift**		
		S-3	Moist, grayish brown, silty, SAND, some gravel, trace organics (SM).	9 11 13	24

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

AESIBOR 20200298E001.GPJ February 9, 2021

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Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-6	2 of 2

Project Name: WWU Electrical Engineering & Computer Science Building
Location: Bellingham, WA
Driller/Equipment: Geologic Drill / Mini Track Rig
Hammer Weight/Drop: 140# / 30

Ground Surface Elevation (ft): 313 +/-
Datum: NAVD 88
Date Start/Finish: 1/20/21,1/20/21
Hole Diameter (in): 4

Depth (ft)	ST	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
15		S-4		As above.			8 39 50/4"	▲50/4"	
				Weathered Chuckanut Formation Gray, SILT/MUDSTONE.					
				Bottom of exploration boring at 16.5 feet No groundwater encountered.					
20									

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

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Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-7	1 of 1

Project Name	WWU Electrical Engineering & Computer Science Building	Ground Surface Elevation (ft)	311 +/-
Location	Bellingham, WA	Datum	NAVD 88
Driller/Equipment	Geologic Drill / Mini Track Rig	Date Start/Finish	1/21/21,1/21/21
Hammer Weight/Drop	140# / 30	Hole Diameter (in)	4

Depth (ft)	S T	Samples	DESCRIPTION	Blows/6"	Blows/Foot
0			**Asphalt - 4 inches**		
			Fill		
		S-1	Moist, grayish brown, silty, SAND, trace organics; few gravels (SM).	28 15 11	26
5		S-2	As above; dark brown (SM).	7 13 12	25
10			**Quaternary Glacial Drift**		
		S-3	Moist, bluish gray, silty, SAND, some gravel (SM).	12 25 30	55
			Bottom of exploration boring at 11.5 feet No groundwater encountered.		

Columns also printed: Graphic Symbol, Well Completion, Water Level, Other Tests. Blows/Foot scale: 10, 20, 30, 40

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

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Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-8	1 of 1

Project Name: WWU Electrical Engineering & Computer Science Building
Location: Bellingham, WA
Driller/Equipment: Geologic Drill / Mini Track Rig
Hammer Weight/Drop: 140# / 30

Ground Surface Elevation (ft): 310 +/-
Datum: NAVD 88
Date Start/Finish: 1/21/21,1/21/21
Hole Diameter (in): 4

Depth (ft)	ST	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
				Asphalt - 4 inches					
				Fill					
5		S-1		Moist, brown to grayish brown, silty, SAND; few gravels (SM).			31 9 8	▲17	
10		S-2		**Weathered Chuckanut Formation** Poor recovery. Driller notes rocky drill action.			50/5"	▲50/5"	
				Bottom of exploration boring at 10.4 feet No groundwater encountered.					

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-9	1 of 3

Project Name	WWU Electrical Engineering & Computer Science Building	Ground Surface Elevation (ft)	
Location	Bellingham, WA	Datum	
Driller/Equipment	Geologic Drill / Mini Track Rig	Date Start/Finish	1/21/21,1/21/21
Hammer Weight/Drop	140# / 30	Hole Diameter (in)	4

Depth (ft)	ST	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
				Crushed Rock - 4 inches					
				Fill					
		S-1					8 8 9	▲17	
5				Moist to very moist, mottled grayish brown, sandy, SILT; few gravels (ML).					
		S-2					3 4 5	▲9	
10				**Quaternary Glacial Drift**					
		S-3		Very moist, gray, sandy, SILT; few to trace fine gravel; poor recovery (ML).			9 11 17	▲28	

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

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Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-9	2 of 3

Project Name: WWU Electrical Engineering & Computer Science Building
Location: Bellingham, WA
Driller/Equipment: Geologic Drill / Mini Track Rig
Hammer Weight/Drop: 140# / 30
Ground Surface Elevation (ft):
Datum:
Date Start/Finish: 1/21/21,1/21/21
Hole Diameter (in): 4

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
15		S-4		As above; poor recovery.			7 12 12	▲24	
20		S-5		As above; moist to very moist; interbed of sand; stratified (ML).			6 5 6	▲11	

Sampler Type (ST):

2" OD Split Spoon Sampler (SPT)
3" OD Split Spoon Sampler (D & M)
Grab Sample
No Recovery
Ring Sample
Shelby Tube Sample
M - Moisture
Water Level ()
Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-9	3 of 3

Project Name: WWU Electrical Engineering & Computer Science Building
Location: Bellingham, WA
Driller/Equipment: Geologic Drill / Mini Track Rig
Hammer Weight/Drop: 140# / 30
Ground Surface Elevation (ft):
Datum:
Date Start/Finish: 1/21/21,1/21/21
Hole Diameter (in): 4

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
25		S-6		**Weathered Chuckanut Formation** No recovery. Driller notes rocky drill action. Bottom of exploration boring at 25.3 feet No groundwater encountered.			50/3"	▲50/3"	
30									
35									

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

Exploration Boring

associated earth sciences incorporated

Project Number	Exploration Number	Sheet
20200298E001	EB-10	1 of 2

Project Name	WWU Electrical Engineering & Computer Science Building	Ground Surface Elevation (ft)	
Location	Bellingham, WA	Datum	
Driller/Equipment	Geologic Drill / Mini Track Rig	Date Start/Finish	1/21/21,1/21/21
Hammer Weight/Drop	140# / 30	Hole Diameter (in)	4

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
				Fill					
		S-1		Moist to very moist, grayish brown, silty, SAND; few gravels and organics (SM).			8 7 3	▲10	
5		S-2		Moist, mottled brown to grayish brown, silty, SAND; few gravels and organics (SM).			3 5 6	▲11	
10				**Quaternary Glacial Drift**					
		S-3		Moist, grayish brown, sandy, SILT; few gravels and weathered bedrock fragments; unsorted (ML).			8 15 25	▲40	

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

Exploration Boring

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Project Number	Exploration Number	Sheet
20200298E001	EB-10	2 of 2

Project Name: WWU Electrical Engineering & Computer Science Building
Location: Bellingham, WA
Driller/Equipment: Geologic Drill / Mini Track Rig
Hammer Weight/Drop: 140# / 30
Ground Surface Elevation (ft):
Datum:
Date Start/Finish: 1/21/21,1/21/21
Hole Diameter (in): 4

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
		S-4		**Weathered Chuckanut Formation** Moist, grayish brown, silty, SAND; few pieces of bedrock; poor recovery (SM).			50/6"	▲50/6"	
				Bottom of exploration boring at 12.5 feet No groundwater encountered.					
15									
20									

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

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Exploration Boring

Project Number	Exploration Number	Sheet
20200298E001	EB-11	1 of 1

Project Name	WWU Electrical Engineering & Computer Science Building	Ground Surface Elevation (ft)	
Location	Bellingham, WA	Datum	
Driller/Equipment	Geologic Drill / Mini Track Rig	Date Start/Finish	1/21/21,1/21/21
Hammer Weight/Drop	140# / 30	Hole Diameter (in)	4

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
		Fill		
		Poor recovery.		
	S-1	Cuttings appear moist, brown, silty, SAND, with some bedrock pieces and trace organic debris.	12 14 7	21
5	S-2	Moist to very moist, silty, SAND, trace gravel, trace organics (SM).	3 3 4	7
		Driller notes potential cobbles at 8 feet.		
		Quaternary Glacial Drift		
	S-3	Moist, mottled grayish brown, silty, SAND, trace cobbles; few gravels; unsorted (SM). Driller notes initial refusal likely on cobble at 9 feet.	50/6"	50/6"
10	S-4	Moist, bluish gray, silty, gravelly, SAND (SM/SP).	17 31 50/3"	50/3"
		Bottom of exploration boring at 11.3 feet No groundwater encountered.		

Sampler Type (ST):

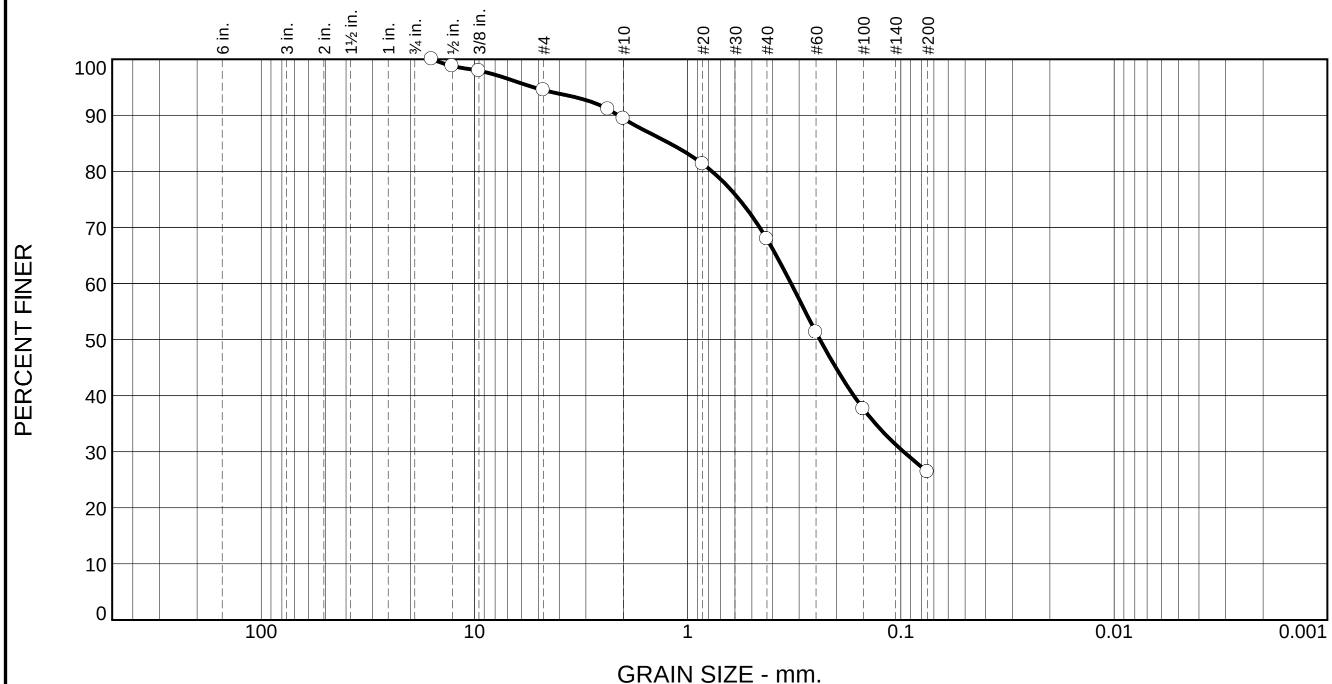
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDH
Approved by: JHS

APPENDIX B

Laboratory Testing Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.5	5.1	21.5	41.5	26.4	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
5/8"	100.0		
1/2"	98.8		
3/8"	97.9		
#4	94.5		
#8	91.1		
#10	89.4		
#20	81.3		
#40	67.9		
#60	51.3		
#100	37.6		
#200	26.4		

* (no specification provided)

Material Description

silty SAND, some gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 2.1190 D_{85}= 1.2142 D_{60}= 0.3276
D_{50}= 0.2398 D_{30}= 0.0972 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 01/26/2021 **Date Tested:** 02/05/2021

Tested By: NAS

Checked By: JH/BG

Title:

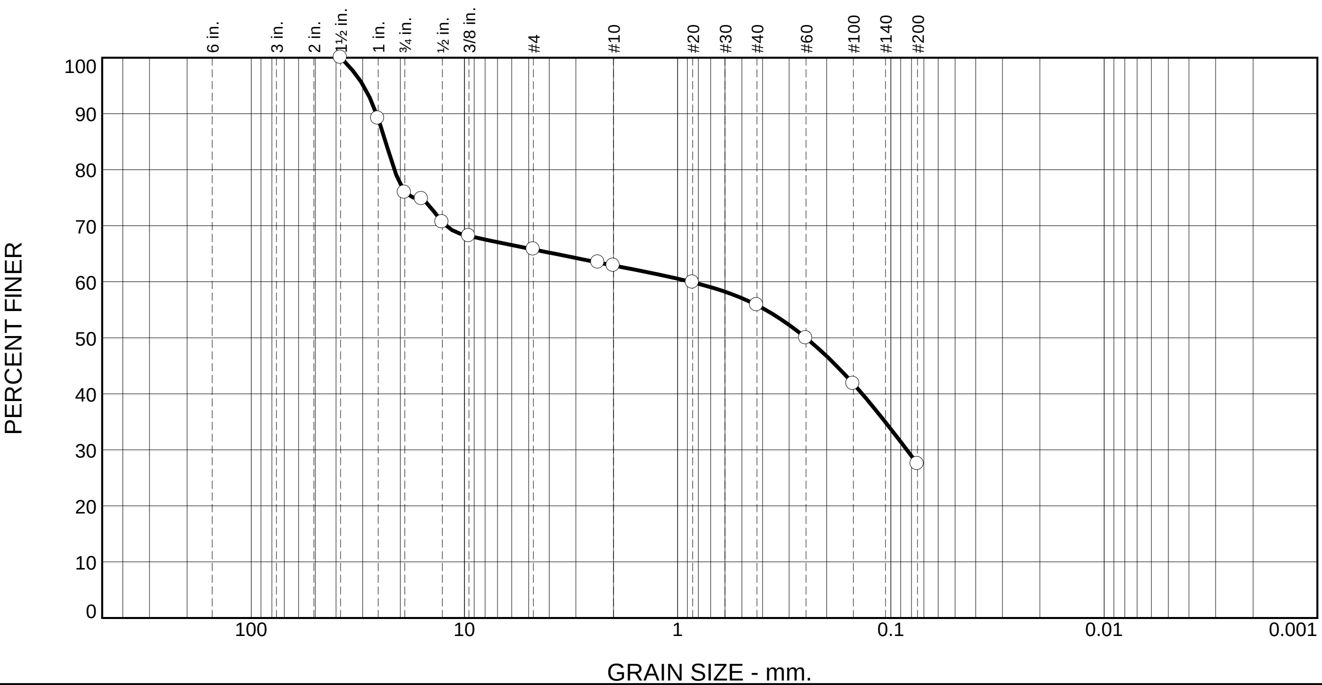
Location: Onsite
Sample Number: EB-6 **Depth:** 5'
Date Sampled: 01/21/2021

associated earth sciences incorporated

Client: Western Washington University
Project: WWU Electrical Engineering and Computer Science BLDG

Project No: 20200298 E001 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	24.1	10.1	2.9	7.1	28.3	27.5	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5"	100.0		
1"	89.2		
3/4"	75.9		
5/8"	74.8		
1/2"	70.7		
3/8"	68.2		
#4	65.8		
#8	63.4		
#10	62.9		
#20	59.9		
#40	55.8		
#60	50.0		
#100	41.8		
#200	27.5		

* (no specification provided)

Material Description

gravelly, silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 25.8728 D_{85}= 23.4424 D_{60}= 0.8705
D_{50}= 0.2507 D_{30}= 0.0841 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 01/26/2021 **Date Tested:** 02/05/2021

Tested By: NAS

Checked By: JH/BG

Title:

Location: Onsite
Sample Number: EB-10 **Depth:** 10'
Date Sampled: 01/21/2021

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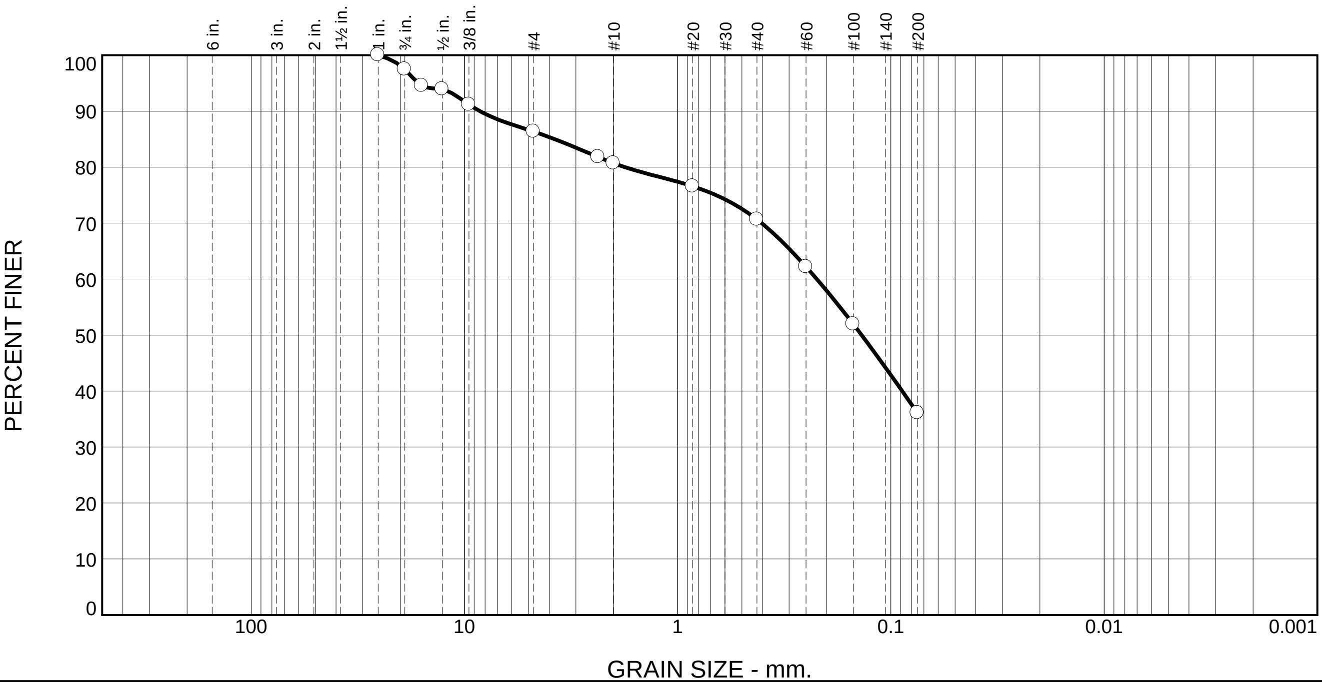
Client: Western Washington University
Project: WWU Electrical Engineering and Computer Science BLDG
Project No: 20200298 E001 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	2.5	11.1	5.7	10.0	34.6	36.1	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
3/4"	97.5		
5/8"	94.6		
1/2"	93.9		
3/8"	91.2		
#4	86.4		
#8	81.8		
#10	80.7		
#20	76.6		
#40	70.7		
#60	62.2		
#100	51.9		
#200	36.1		

* (no specification provided)

Material Description

silty SAND, some gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 8.4715 D_{85}= 3.7836 D_{60}= 0.2227
D_{50}= 0.1372 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 01/26/2021 **Date Tested:** 02/05/2021

Tested By: NAS

Checked By: JH/BG

Title:

Location: Onsite
Sample Number: EB-11 **Depth:** 9'
Date Sampled: 01/21/2021

associated earth sciences incorporated

Client: Western Washington University
Project: WWU Electrical Engineering and Computer Science BLDG

Project No: 20200298 E001 **Figure**

APPENDIX B

GHG Emissions Worksheet

City of Seattle Department of Planning and Development
SEPA GHG Emissions Worksheet
Version 1.7 12/26/07

Introduction
The Washington State Environmental Policy Act (SEPA) requires environmental review of development proposals that may have a significant adverse impact on the environment. If a proposed development is subject to SEPA, the project proponent is required to complete the SEPA Checklist. The Checklist includes questions relating to the development's air emissions. The emissions that have traditionally been considered cover smoke, dust, and industrial and automobile emissions. With our understanding of the climate change impacts of GHG emissions, the City of Seattle requires the applicant to also estimate these emissions.

Emissions created by Development
GHG emissions associated with development come from multiple sources:

- The extraction, processing, transportation, construction and disposal of materials and landscape disturbance (Embodied Emissions)
- Energy demands created by the development after it is completed (Energy Emissions)
- Transportation demands created by the development after it is completed (Transportation Emissions)

GHG Emissions Worksheet
This GHG Emissions Worksheet has been developed to assist applicants in answering the SEPA Checklist question relating to GHG emissions. The worksheet was originally developed by King County, but the City of Seattle and King County are working together on future updates to maintain consistency of methodologies across jurisdictions.

The SEPA GHG Emissions worksheet estimates all GHG emissions that will be created over the life span of a project. This includes emissions associated with obtaining construction materials, fuel used during construction, energy consumed during a buildings operation, and transportation by building occupants.

Using the Worksheet
1. Descriptions of the different residential and commercial building types can be found on the second tabbed worksheet ("Definition of Building Types"). If a development proposal consists of multiple projects, e.g. both single family and multi-family residential structures or a commercial development that consists of more than on type of commercial activity, the appropriate information should be estimated for each type of building or activity.

2. For paving, estimate the total amount of paving (in thousands of square feet) of the project.

3. The Worksheet will calculate the amount of GHG emissions associated with the project and display the amount in the "Total Emissions" column on the worksheet. The applicant should use this information when completing the SEPA checklist.

4. The last three worksheets in the Excel file provide the background information that is used to calculate the total GHG emissions.

5. The methodology of creating the estimates is transparent; if there is reason to believe that a better estimate can be obtained by changing specific values, this can and should be done. Changes to the values should be documented with an explanation of why and the sources relied upon.

6. Print out the “Total Emissions” worksheet and attach it to the SEPA checklist. If the applicant has made changes to the calculations or the values, the documentation supporting those changes should also be attached to the SEPA checklist.

WWU Electrical Engineering and Computer Science Project - Building

Section I: Buildings

Type (Residential) or Principal Activity (Commercial)	# Units	Square Feet (in thousands of square feet)	Emissions Per Unit or Per Thousand Square Feet (MTCO2e) Embodied	Energy	Transportation	Lifespan Emissions (MTCO2e)
Single-Family Home............................	0		98	672	792	**0**
Multi-Family Unit in Large Building	0		33	357	766	**0**
Multi-Family Unit in Small Building	0		54	681	766	**0**
Mobile Home.......................................	0		41	475	709	**0**
Education		53.0	39	646	361	**55410**
Food Sales		0.0	39	1,541	282	**0**
Food Service		0.0	39	1,994	561	**0**
Health Care Inpatient		0.0	39	1,938	582	**0**
Health Care Outpatient		0.0	39	737	571	**0**
Lodging		0.0	39	777	117	**0**
Retail (Other Than Mall).......................		0.0	39	577	247	**0**
Office		0.0	39	723	588	**0**
Public Assembly		0.0	39	733	150	**0**
Public Order and Safety		0.0	39	899	374	**0**
Religious Worship		0.0	39	339	129	**0**
Service		0.0	39	599	266	**0**
Warehouse and Storage		0.0	39	352	181	**0**
Other		0.0	39	1,278	257	**0**
Vacant		0.0	39	162	47	**0**

Section II: Pavement..........................

Pavement..		0.00				**0**

Total Project Emissions: **55410**

Version 1.7 12/26/07

Definition of Building Types

Type (Residential) or Principal Activity (Commercial)	**Description**
Single-Family Home..................................	Unless otherwise specified, this includes both attached and detached buildings
Multi-Family Unit in Large Building	Apartments in buildings with more than 5 units
Multi-Family Unit in Small Building	Apartments in building with 2-4 units
Mobile Home...	
Education	Buildings used for academic or technical classroom instruction, such as elementary, middle, or high schools, and classroom buildings on college or university campuses. Buildings on education campuses for which the main use is not classroom are included in the category relating to their use. For example, administration buildings are part of "Office," dormitories are "Lodging," and libraries are "Public Assembly."
Food Sales	Buildings used for retail or wholesale of food.
Food Service	Buildings used for preparation and sale of food and beverages for consumption.
Health Care Inpatient	Buildings used as diagnostic and treatment facilities for inpatient care.
Health Care Outpatient	Buildings used as diagnostic and treatment facilities for outpatient care. Doctor's or dentist's office are included here if they use any type of diagnostic medical equipment (if they do not, they are categorized as an office building).
Lodging	Buildings used to offer multiple accommodations for short-term or long-term residents, including skilled nursing and other residential care buildings.
Retail (Other Than Mall)............................	Buildings used for the sale and display of goods other than food.
Office	Buildings used for general office space, professional office, or administrative offices. Doctor's or dentist's office are included here if they do not use any type of diagnostic medical equipment (if they do, they are categorized as an outpatient health care building).
Public Assembly	Buildings in which people gather for social or recreational activities, whether in private or non-private meeting halls.
Public Order and Safety	Buildings used for the preservation of law and order or public safety.
Religious Worship	Buildings in which people gather for religious activities, (such as chapels, churches, mosques, synagogues, and temples).
Service	Buildings in which some type of service is provided, other than food service or retail sales of goods
Warehouse and Storage	Buildings used to store goods, manufactured products, merchandise, raw materials, or personal belongings (such as self-storage).
Other	Buildings that are industrial or agricultural with some retail space; buildings having several different commercial activities that, together, comprise 50 percent or more of the floorspace, but whose largest single activity is agricultural, industrial/ manufacturing, or residential; and all other miscellaneous buildings that do not fit into any other category.
Vacant	Buildings in which more floorspace was vacant than was used for any single commercial activity at the time of interview. Therefore, a vacant building may have some occupied floorspace.

Sources: ....

Residential — 2001 Residential Energy Consumption Survey
Square footage measurements and comparisons
http://www.eia.doe.gov/emeu/recs/sqft-measure.html

Commercial — Commercial Buildings Energy Consumption Survey (CBECS),
Description of CBECS Building Types
http://www.eia.doe.gov/emeu/cbecs/pba99/bldgtypes.html

Embodied Emissions Worksheet

Section I: Buildings

Type (Residential) or Principal Activity (Commercial)	# thousand sq feet/ unit or building	Life span related embodied GHG missions (MTCO2e/ unit)	Life span related embodied GHG missions (MTCO2e/ thousand square feet) - See calculations in table below
Single-Family Home................................	2.53	98	39
Multi-Family Unit in Large Building	0.85	33	39
Multi-Family Unit in Small Building	1.39	54	39
Mobile Home...	1.06	41	39
Education	25.6	991	39
Food Sales	5.6	217	39
Food Service	5.6	217	39
Health Care Inpatient	241.4	9,346	39
Health Care Outpatient	10.4	403	39
Lodging	35.8	1,386	39
Retail (Other Than Mall)..........................	9.7	376	39
Office	14.8	573	39
Public Assembly	14.2	550	39
Public Order and Safety	15.5	600	39
Religious Worship	10.1	391	39
Service	6.5	252	39
Warehouse and Storage	16.9	654	39
Other	21.9	848	39
Vacant	14.1	546	39

Section II: Pavement.............................

All Types of Pavement............................			50

	Columns and Beams	Intermediate Floors	Exterior Walls	Windows	Interior Walls	Roofs	Total Embodied Emissions (MTCO2e)	Total Embodied Emissions (MTCO2e/ thousand sq feet)
Average GWP (lbs CO2e/sq ft): Vancouver, Low Rise Building	5.3	7.8	19.1	51.2	5.7	21.3		
Average Materials in a 2,272-square foot single family home	0.0	2269.0	3206.0	285.0	6050.0	3103.0		
MTCO2e	0.0	8.0	27.8	6.6	15.6	30.0	88.0	38.7

Sources

All data in black text — King County, DNRP. Contact: Matt Kuharic, matt.kuharic@kingcounty.gov

Residential floorspace per unit — 2001 Residential Energy Consumption Survey (National Average, 2001)
Square footage measurements and comparisons
http://www.eia.doe.gov/emeu/recs/sqft-measure.html

Floorspace per building — EIA, 2003 Commercial Buildings Energy Consumption Survey (National Average, 2003)
Table C3. Consumption and Gross Energy Intensity for Sum of Major Fuels for Non-Mall Buildings, 2003
http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set9/2003excel/c3.xls

Average GWP (lbs CO2e/sq ft): Vancouver, Low Rise Building — Athena EcoCalculator
Athena Assembly Evaluation Tool v2.3- Vancouver Low Rise Building
Assembly Average GWP (kg) per square meter
http://www.athenasmi.ca/tools/ecoCalculator/index.html

Lbs per kg	2.20
Square feet per square meter	10.76

Average Materials in a 2,272-square foot single family home — Buildings Energy Data Book: 7.3 Typical/Average Household
Materials Used in the Construction of a 2,272-Square-Foot Single-Family Home, 2000
http://buildingsdatabook.eren.doe.gov/?id=view_book_table&TableID=2036&t=xls
See also: NAHB, 2004 Housing Facts, Figures and Trends, Feb. 2004, p. 7.

Average window size — Energy Information Administration/Housing Characteristics 1993
Appendix B, Quality of the Data. Pg. 5.
ftp://ftp.eia.doe.gov/pub/consumption/residential/rx93hcf.pdf

Pavement Emissions Factors
MTCO2e/thousand square feet of asphalt or concrete pavement 50 (see below)

Embodied GHG Emissions……………………Worksheet Background Information

Buildings
Embodied GHG emissions are emissions that are created through the extraction, processing, transportation, construction and disposal of building materials as well as emissions created through landscape disturbance (by both soil disturbance and changes in above ground biomass).

Estimating embodied GHG emissions is new field of analysis; the estimates are rapidly improving and becoming more inclusive of all elements of construction and development.

The estimate included in this worksheet is calculated using average values for the main construction materials that are used to create a typical family home. In 2004, the National Association of Home Builders calculated the average materials that are used in a typical 2,272 square foot single-family household. The quantity of materials used is then multiplied by the average GHG emissions associated with the life-cycle GHG emissions for each material.

This estimate is a rough and conservative estimate; the actual embodied emissions for a project are likely to be higher. For example, at this stage, due to a lack of comprehensive data, the estimate does not include important factors such as landscape disturbance or the emissions associated with the interior components of a building (such as furniture).

King County realizes that the calculations for embodied emissions in this worksheet are rough. For example, the emissions associated with building 1,000 square feet of a residential building will not be the same as 1,000 square feet of a commercial building. However, discussions with the construction community indicate that while there are significant differences between the different types of structures, this method of estimation is reasonable; it will be improved as more data become available.

Additionally, if more specific information about the project is known, King County recommends two online embodied emissions calculators that can be used to obtain a more tailored estimate for embodied emissions: www.buildcarbonneutral.org and www.athenasmi.ca/tools/ecoCalculator/.

Pavement
Four recent life cycle assessments of the environmental impacts of roads form the basis for the per unit embodied emissions of pavement. Each study is constructed in slightly different ways; however, the aggregate results of the reports represent a reasonable estimate of the GHG emissions that are created from the manufacture of paving materials, construction related emissions, and maintenance of the pavement over its expected life cycle. For specifics, see the worksheet.

Special Section: Estimating the Embodied Emissions for Pavement

Four recent life cycle assessments of the environmental impacts of roads form the basis for the per unit embodied emissions of pavement. Each study is constructed in slightly different ways; however, the aggregate results of the reports represent a reasonable estimate of the GHG emissions that are created from the manufacture of paving materials, construction related emissions, and maintenance of the pavement over its expected life cycle.

The results of the studies are presented in different units and measures; considerable effort was undertaken to be able to compare the results of the studies in a reasonable way. For more details about the below methodology, contact matt.kuharic@kingcounty.gov.

The four studies, Meil (2001), Park (2003), Stripple (2001) and Treolar (2001) produced total GHG emissions of 4-34 MTCO2e per thousand square feet of finished paving (for similar asphalt and concrete based pavements). This estimate does not including downstream maintenance and repair of the highway. The average (for all concrete and asphalt pavements in the studies, assuming each study gets one data point) is ~17 MTCO2e/thousand square feet.

Three of the studies attempted to thoroughly account for the emissions associated with long term maintenance (40 years) of the roads. Stripple (2001), Park et al. (2003) and Treolar (2001) report 17, 81, and 68 MTCO2e/thousand square feet, respectively, after accounting for maintenance of the roads.

Based on the above discussion, King County makes the conservative estimate that 50 MTCO2e/thousand square feet of pavement (over the development's life cycle) will be used as the embodied emission factor for pavement until better estimates can be obtained. This is roughly equivalent to 3,500 MTCO2e per lane mile of road (assuming the lane is 13 feet wide).

It is important to note that these studies estimate the embodied emissions for roads. Paving that does not need to stand up to the rigors of heavy use (such as parking lots or driveways) would likely use less materials and hence have lower embodied emissions.

Sources:

Meil, J. A Life Cycle Perspective on Concrete and Asphalt Roadways: Embodied Primary Energy and Global Warming Potential. 2006. Available: http://www.cement.ca/cement.nsf/eee9ec7bbd630126852566c40052107b/6ec79dc8ae03a782852572b90061b914/$FILE/ATTK0WE3/athena%20report%20Feb.%202%202007.pdf

Park, K, Hwang, Y., Seo, S., M.ASCE, and Seo, H. , "Quantitative Assessment of Environmental Impacts on Life Cycle of Highways," Journal of Construction Engineering and Management , Vol 129, January/February 2003, pp 25-31, (DOI: 10.1061/(ASCE)0733-9364(2003)129:1(25)).

Stripple, H. Life Cycle Assessment of Road. A Pilot Study for Inventory Analysis. Second Revised Edition. IVL Swedish Environmental Research Institute Ltd. 2001. Available: http://www.ivl.se/rapporter/pdf/B1210E.pdf

Treloar, G., Love, P.E.D., and Crawford, R.H. Hybrid Life-Cycle Inventory for Road Construction and Use. Journal of Construction Engineering and Management. P. 43-49. January/February 2004.

Energy Emissions Worksheet

Type (Residential) or Principal Activity (Commercial)	Energy consumption per building per year (million Btu)	Carbon Coefficient for Buildings	MTCO2e per building per year	Floorspace per Building (thousand square feet)	MTCE per thousand square feet per year	MTCO2e per thousand square feet per year	Average Building Life Span	Lifespan Energy Related MTCO2e emissions per unit	Lifespan Energy Related MTCO2e emissions per thousand square feet
Single-Family Home............................	107.3	0.108	11.61	2.53	4.6	16.8	57.9	672	266
Multi-Family Unit in Large Building	41.0	0.108	4.44	0.85	5.2	19.2	80.5	357	422
Multi-Family Unit in Small Building	78.1	0.108	8.45	1.39	6.1	22.2	80.5	681	489
Mobile Home..	75.9	0.108	8.21	1.06	7.7	28.4	57.9	475	448
Education	2,125.0	0.124	264.2	25.6	10.3	37.8	62.5	16,526	646
Food Sales	1,110.0	0.124	138.0	5.6	24.6	90.4	62.5	8,632	1,541
Food Service	1,436.0	0.124	178.5	5.6	31.9	116.9	62.5	11,168	1,994
Health Care Inpatient	60,152.0	0.124	7,479.1	241.4	31.0	113.6	62.5	467,794	1,938
Health Care Outpatient	985.0	0.124	122.5	10.4	11.8	43.2	62.5	7,660	737
Lodging	3,578.0	0.124	444.9	35.8	12.4	45.6	62.5	27,826	777
Retail (Other Than Mall).......................	720.0	0.124	89.5	9.7	9.2	33.8	62.5	5,599	577
Office	1,376.0	0.124	171.1	14.8	11.6	42.4	62.5	10,701	723
Public Assembly	1,338.0	0.124	166.4	14.2	11.7	43.0	62.5	10,405	733
Public Order and Safety	1,791.0	0.124	222.7	15.5	14.4	52.7	62.5	13,928	899
Religious Worship	440.0	0.124	54.7	10.1	5.4	19.9	62.5	3,422	339
Service	501.0	0.124	62.3	6.5	9.6	35.1	62.5	3,896	599
Warehouse and Storage	764.0	0.124	95.0	16.9	5.6	20.6	62.5	5,942	352
Other	3,600.0	0.124	447.6	21.9	20.4	74.9	62.5	27,997	1,278
Vacant	294.0	0.124	36.6	14.1	2.6	9.5	62.5	2,286	162

Sources

All data in black text — King County, DNRP. Contact: Matt Kuharic, matt.kuharic@kingcounty.gov

Energy consumption for residential buildings — 2007 Buildings Energy Data Book: 6.1 Quad Definitions and Comparisons (National Average, 2001)
Table 6.1.4: Average Annual Carbon Dioxide Emissions for Various Functions
http://buildingsdatabook.eren.doe.gov/
Data also at: http://www.eia.doe.gov/emeu/recs/recs2001_ce/ce1-4c_housingunits2001.html

Energy consumption for commercial buildings and Floorspace per building — EIA, 2003 Commercial Buildings Energy Consumption Survey (National Average, 2003)
Table C3. Consumption and Gross Energy Intensity for Sum of Major Fuels for Non-Mall Buildings, 2003
http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set9/2003excel/c3.xls

Note: Data in plum color is found in both of the above sources (buildings energy data book and commercial buildings energy consumption survey).

Carbon Coefficient for Buildings — Buildings Energy Data Book (National average, 2005)
Table 3.1.7. 2005 Carbon Dioxide Emission Coefficients for Buildings (MMTCE per Quadrillion Btu)
http://buildingsdatabook.eere.energy.gov/?id=view_book_table&TableID=2057
Note: Carbon coefficient in the Energy Data book is in MTCE per Quadrillion Btu.
To convert to MTCO2e per million Btu, this factor was divided by 1000 and multiplied by 44/12.

Residential floorspace per unit — 2001 Residential Energy Consumption Survey (National Average, 2001)
Square footage measurements and comparisons
http://www.eia.doe.gov/emeu/recs/sqft-measure.html

average lief span of buildings, estimated by replacement time method

	Single Family Homes	Multi-Family Units in Large and Small Buildings	All Residential Buildings
New Housing Construction, 2001	1,273,000	329,000	1,602,000
Existing Housing Stock, 2001	73,700,000	26,500,000	100,200,000
Replacement time:	57.9	80.5	62.5

(national average, 2001)

Note: Single family homes calculation is used for mobile homes as a best estimate life span.
Note: At this time, KC staff could find no reliable data for the average life span of commercial buildings.
Therefore, the average life span of residential buildings is being used until a better approximation can be ascertained.

Sources:

New Housing Construction, 2001 **Quarterly Starts and Completions by Purpose and Design - US and Regions (Excel)**
http://www.census.gov/const/quarterly_starts_completions_cust.xls
See also: http://www.census.gov/const/www/newresconstindex.html

Existing Housing Stock, 2001 **Residential Energy Consumption Survey (RECS) 2001**
Tables HC1:Housing Unit Characteristics, Million U.S. Households 2001
Table HC1-4a. Housing Unit Characteristics by Type of Housing Unit, Million U.S. Households, 2001
Million U.S. Households, 2001
http://www.eia.doe.gov/emeu/recs/recs2001/hc_pdf/housunits/hc1-4a_housingunits2001.pdf

Transportation Emissions Worksheet

Type (Residential) or Principal Activity (Commercial)	# people/ unit or building	# thousand sq feet/ unit or building	# people or employees/ thousand square feet	vehicle related GHG emissions (metric tonnes CO2e per person per year)	MTCO2e/ year/ unit	MTCO2e/ year/ thousand square feet	Average Building Life Span	Life span transportation related GHG emissions (MTCO2e/ per unit)	Life span transportation related GHG emissions (MTCO2e/ thousand sq feet)
Single-Family Home..................................	2.8	2.53	1.1	4.9	13.7	5.4	57.9	792	313
Multi-Family Unit in Large Building	1.9	0.85	2.3	4.9	9.5	11.2	80.5	766	904
Multi-Family Unit in Small Building	1.9	1.39	1.4	4.9	9.5	6.8	80.5	766	550
Mobile Home...	2.5	1.06	2.3	4.9	12.2	11.5	57.9	709	668
Education	30.0	25.6	1.2	4.9	147.8	5.8	62.5	9247	361
Food Sales	5.1	5.6	0.9	4.9	25.2	4.5	62.5	1579	282
Food Service	10.2	5.6	1.8	4.9	50.2	9.0	62.5	3141	561
Health Care Inpatient	455.5	241.4	1.9	4.9	2246.4	9.3	62.5	140506	582
Health Care Outpatient	19.3	10.4	1.9	4.9	95.0	9.1	62.5	5941	571
Lodging	13.6	35.8	0.4	4.9	67.1	1.9	62.5	4194	117
Retail (Other Than Mall)............................	7.8	9.7	0.8	4.9	38.3	3.9	62.5	2394	247
Office	28.2	14.8	1.9	4.9	139.0	9.4	62.5	8696	588
Public Assembly	6.9	14.2	0.5	4.9	34.2	2.4	62.5	2137	150
Public Order and Safety	18.8	15.5	1.2	4.9	92.7	6.0	62.5	5796	374
Religious Worship	4.2	10.1	0.4	4.9	20.8	2.1	62.5	1298	129
Service	5.6	6.5	0.9	4.9	27.6	4.3	62.5	1729	266
Warehouse and Storage	9.9	16.9	0.6	4.9	49.0	2.9	62.5	3067	181
Other	18.3	21.9	0.8	4.9	90.0	4.1	62.5	5630	257
Vacant	2.1	14.1	0.2	4.9	10.5	0.7	62.5	657	47

Sources

All data in black text	King County, DNRP. Contact: Matt Kuharic, matt.kuharic@kingcounty.gov
# people/ unit	Estimating Household Size for Use in Population Estimates (WA state, 2000 average) Washington State Office of Financial Management Kimpel, T. and Lowe, T. Research Brief No. 47. August 2007 http://www.ofm.wa.gov/researchbriefs/brief047.pdf Note: This analysis combines Multi Unit Structures in both large and small units into one category; the average is used in this case although there is likely a difference
Residential floorspace per unit	2001 Residential Energy Consumption Survey (National Average, 2001) Square footage measurements and comparisons http://www.eia.doe.gov/emeu/recs/sqft-measure.html
# employees/thousand square feet	Commercial Buildings Energy Consumption Survey commercial energy uses and costs (National Median, 2003) Table B2 Totals and Medians of Floorspace, Number of Workers, and Hours of Operation for Non-Mall Buildings, 2003 http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set1/2003excel/b2.xls Note: Data for # employees/thousand square feet is presented by CBECS as square feet/employee. In this analysis employees/thousand square feet is calculated by taking the inverse of the CBECS number and multiplying by 1000.

vehicle related GHG emissions

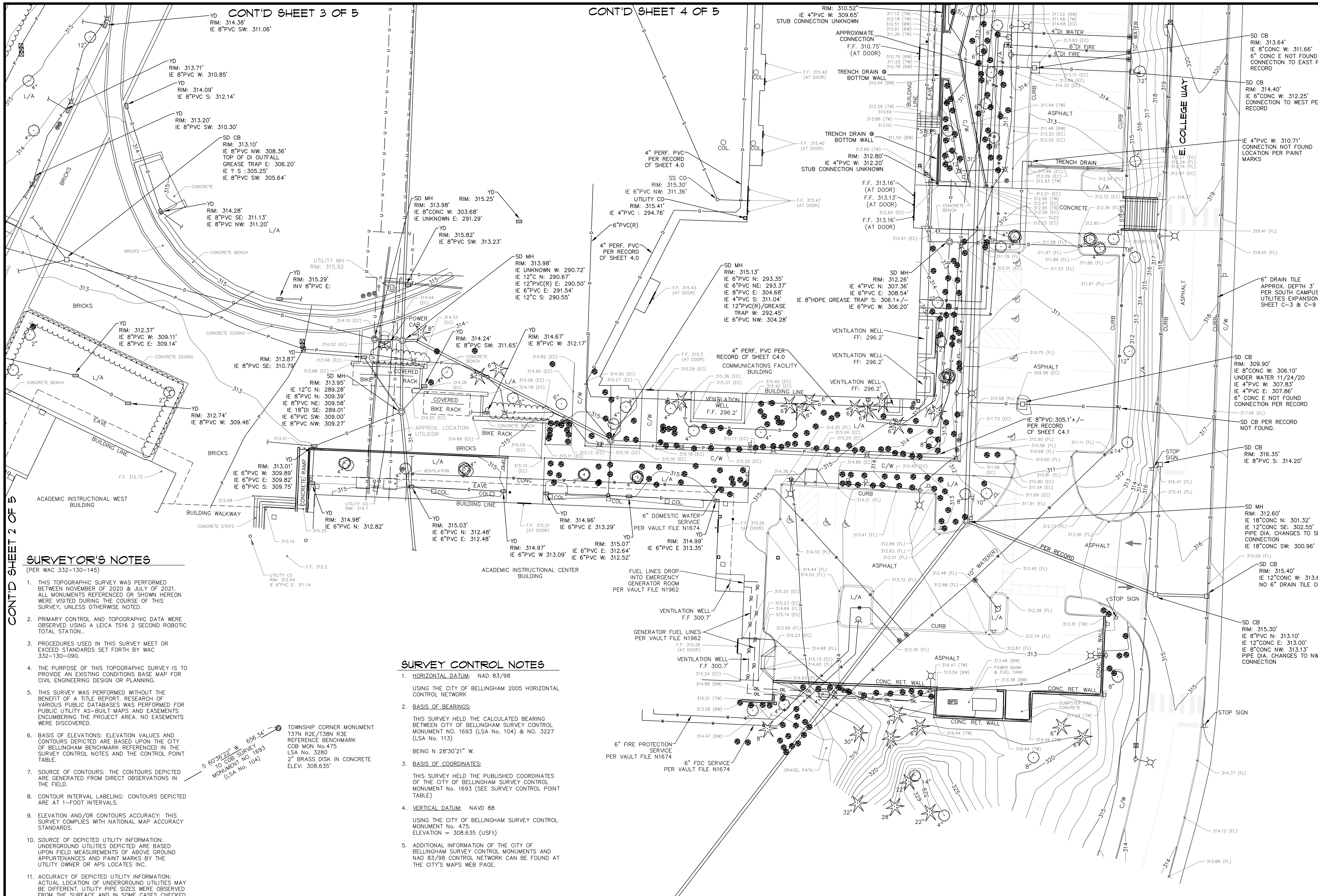
Estimate calculated as follows (Washington state, 2006)_

56,531,930,000	2006 Annual WA State Vehicle Miles Traveled	
		Data was daily VMT. Annual VMT was 365*daily VMT.
		http://www.wsdot.wa.gov/mapsdata/tdo/annualmileage.htm
6,395,798	2006 WA state population	
		http://quickfacts.census.gov/qfd/states/53000.html
8839	vehicle miles per person per year	
0.0506	gallon gasoline/mile	
		This is the weighted national average fuel efficiency for all cars and 2 axle, 4 wheel light trucks in 2005. This includes pickup trucks, vans and SUVs. The 0.051 gallons/mile used here is the inverse of the more commonly known term “miles/per gallon” (which is 19.75 for these cars and light trucks).
		Transportation Energy Data Book. 26th Edition. 2006. Chapter 4: Light Vehicles and Characteristics. Calculations based on weighted average MPG efficiency of cars and light trucks.
		http://cta.ornl.gov/data/tedb26/Edition26_Chapter04.pdf
		Note: This report states that in 2005, 92.3% of all highway VMT were driven by the above described vehicles.
		http://cta.ornl.gov/data/tedb26/Spreadsheets/Table3_04.xls
24.3	lbs CO2e/gallon gasoline	
		The CO2 emissions estimates for gasoline and diesel include the extraction, transport, and refinement of petroleum as well as their combustion.
		Life-Cycle CO2 Emissions for Various New Vehicles. RENew Northfield.
		Available: http://renewnorthfield.org/wpcontent/uploads/2006/04/CO2%20emissions.pdf
		Note: This is a conservative estimate of emissions by fuel consumption because diesel fuel,
2205		with a emissions factor of 26.55 lbs CO2e/gallon was not estimated.
4.93	lbs/metric tonne	
	vehicle related GHG emissions (metric tonnes CO2e per person per year)	

average lief span of buildings, estimated by replacement time method	See Energy Emissions Worksheet for Calculations
Commercial floorspace per unit	EIA, 2003 Commercial Buildings Energy Consumption Survey (National Average, 2003)
	Table C3. Consumption and Gross Energy Intensity for Sum of Major Fuels for Non-Mall Buildings, 2003
	http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set9/2003excel/c3.xls

APPENDIX C

Tree Survey



SURVEYOR'S NOTES

(PER WAC 332-130-145)

1. THIS TOPOGRAPHIC SURVEY WAS PERFORMED BETWEEN NOVEMBER OF 2020 & JULY OF 2021. ALL MONUMENTS REFERENCED OR SHOWN HEREON WERE VISITED DURING THE COURSE OF THIS SURVEY, UNLESS OTHERWISE NOTED.
2. PRIMARY CONTROL AND TOPOGRAPHIC DATA WERE OBSERVED USING A LEICA TS16 2 SECOND ROBOTIC TOTAL STATION..
3. PROCEDURES USED IN THIS SURVEY MEET OR EXCEED STANDARDS SET FORTH BY WAC 332-130-090.
4. THE PURPOSE OF THIS TOPOGRAPHIC SURVEY IS TO PROVIDE AN EXISTING CONDITIONS BASE MAP FOR CIVIL ENGINEERING DESIGN OR PLANNING.
5. THIS SURVEY WAS PERFORMED WITHOUT THE BENEFIT OF A TITLE REPORT. RESEARCH OF VARIOUS PUBLIC DATABASES WAS PERFORMED FOR PUBLIC UTILITY AS-BUILT MAPS AND EASEMENTS ENCUMBERING THE PROJECT AREA. NO EASEMENTS WERE DISCOVERED.
6. BASIS OF ELEVATIONS: ELEVATION VALUES AND CONTOURS DEPICTED ARE BASED UPON THE CITY OF BELLINGHAM BENCHMARK REFERENCED IN THE SURVEY CONTROL NOTES AND THE CONTROL POINT TABLE.
7. SOURCE OF CONTOURS: THE CONTOURS DEPICTED ARE GENERATED FROM DIRECT OBSERVATIONS IN THE FIELD.
8. CONTOUR INTERVAL LABELING: CONTOURS DEPICTED ARE AT 1-FOOT INTERVALS.
9. ELEVATION AND/OR CONTOURS ACCURACY: THIS SURVEY COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS.
10. SOURCE OF DEPICTED UTILITY INFORMATION: UNDERGROUND UTILITIES DEPICTED ARE BASED UPON FIELD MEASUREMENTS OF ABOVE GROUND APPURTENANCES AND PAINT MARKS BY THE UTILITY OWNER OR APS LOCATES INC.
11. ACCURACY OF DEPICTED UTILITY INFORMATION: ACTUAL LOCATION OF UNDERGROUND UTILITIES MAY BE DIFFERENT. UTILITY PIPE SIZES WERE OBSERVED FROM THE SURFACE AND IN SOME CASES CHECKED AGAINST AS-BUILT MAPS OF RECORD. EXTENSIVE SEARCHES WERE CONDUCTED TO VERIFY AND/OR DETERMINE UTILITY PIPE AND STRUCTURE CONNECTIONS, IN SOME CASES UNSUCCESSFULLY. ALL UTILITIES AND SIZES SHOULD BE VERIFIED BEFORE COMMENCING CONSTRUCTION. THE LOCATION OF UNDERGROUND UTILITIES BEYOND AS DESCRIBED ABOVE WAS NOT PART OF THIS SURVEY'S CONTRACTED SCOPE OF WORK.
12. LIMITATIONS REGARDING UTILITY-DEPICTION ACCURACY: THIS SURVEY DOES NOT GUARANTEE THE ACCURACY OF DEPICTED UNDERGROUND UTILITIES BASED UPON THIRD-PARTY RECORD INFORMATION OR PAINT MARKS.

SURVEY CONTROL NOTES

1. HORIZONTAL DATUM: NAD 83/98

   USING THE CITY OF BELLINGHAM 2005 HORIZONTAL CONTROL NETWORK

2. BASIS OF BEARINGS:

   THIS SURVEY HELD THE CALCULATED BEARING BETWEEN CITY OF BELLINGHAM SURVEY CONTROL MONUMENT NO. 1693 (LSA No. 104) & NO. 3227 (LSA No. 113)

   BEING N 28°30'21" W.

3. BASIS OF COORDINATES:

   THIS SURVEY HELD THE PUBLISHED COORDINATES OF THE CITY OF BELLINGHAM SURVEY CONTROL MONUMENT No. 1693 (SEE SURVEY CONTROL POINT TABLE)

4. VERTICAL DATUM: NAVD 88

   USING THE CITY OF BELLINGHAM SURVEY CONTROL MONUMENT No. 475.
   ELEVATION = 308.635 (USFt)

5. ADDITIONAL INFORMATION OF THE CITY OF BELLINGHAM SURVEY CONTROL MONUMENTS AND NAD 83/98 CONTROL NETWORK CAN BE FOUND AT THE CITY'S MAPS WEB PAGE.

LEGEND (NOV. & DEC., 2020)

- FOUND BRASS DISK
- SET MAG NAIL AND SHINER
- SET SCRIBED "X"
- SET SPIKE
- SANITARY SEWER MANHOLE
- SANITARY SEWER CLEANOUT
- STORM MANHOLE
- CATCH BASIN
- STORM CLEANOUT
- YARD DRAIN
- WATER VAULT
- WATER VALVE
- WATER BLOW-OFF VALVE
- IRRIGATION VALVE
- WATER METER
- POST INDICATOR VALVE
- FIRE DEPARTMENT CONNECTION
- FIRE HYDRANT
- POWER CABINET
- TRAFFIC SIGNAL CABINET
- POWER VAULT
- BACKUP POWER SUPLY
- POWER JUNCTION BOX
- STREET LIGHT
- YARD LIGHT
- UTILITY MANHOLE - UNKNOWN
- UTILITY CLEANOUT - UNKNOWN
- GAS VALVE
- STREET SIGN
- POST OR BOLLARD
- DECIDUOUS TREE
- CONIFER TREE
- SHRUB
- S — SANITARY SEWER LINE
- FM — SANITARY SEWER FORCE MAIN
- D — STORM LINE
- D — STORM LINE CONNECTION UNDETERMINED
- W — WATER LINE
- W — WATER SERVICE LINE
- G — GAS LINE
- P — UNDERGROUND POWER LINE
- T — UNDERGROUND COMMUNICATION LINE
- U — APPROXIMATE UTILITY TUNNEL EXTENTS (RECORD)
- OIL — GENERATOR FUEL SUPPLY LINE (RECORD)
- FENCE LINE
- C/W — CONCRETE WALK
- L/A — LANDSCAPE AREA
- COL. — BUILDING COLUMN
- (R) — RECORD
- (TW) — EL @ TOP OF WALL
- (BW) — EL @ BOTTOM OF WALL
- (EC) — EL @ EDGE OF CONCRETE
- (FL) — EL @ FLOW LINE

SURVEY CONTROL POINT TABLE (USFT)

POINT #	NORTHING	EASTING	ELEVATION	DESCRIPTION
LSA 3280	636049.26	1241530.42	308.635	COB No. 475 BRASS DISK (PROJECT BENCHARK)
LSA 104	635727.12	1240958.58	311.68	COB No. 1693 BRASS DISK
LSA 113	636713.56	1240422.86	432.82	COB No. 3227 BRASS DISK

ERICH A. KLEINKNECHT
STATE OF WASHINGTON
45787
REGISTERED
PROFESSIONAL LAND SURVEYOR
09/16/21

LARRY STEELE & ASSOCIATES
LAND SURVEYORS
SUITE 1
1334 KING ST.
BELLINGHAM, WA 98229
360-676-9350

EXISTING CONDITIONS MAP

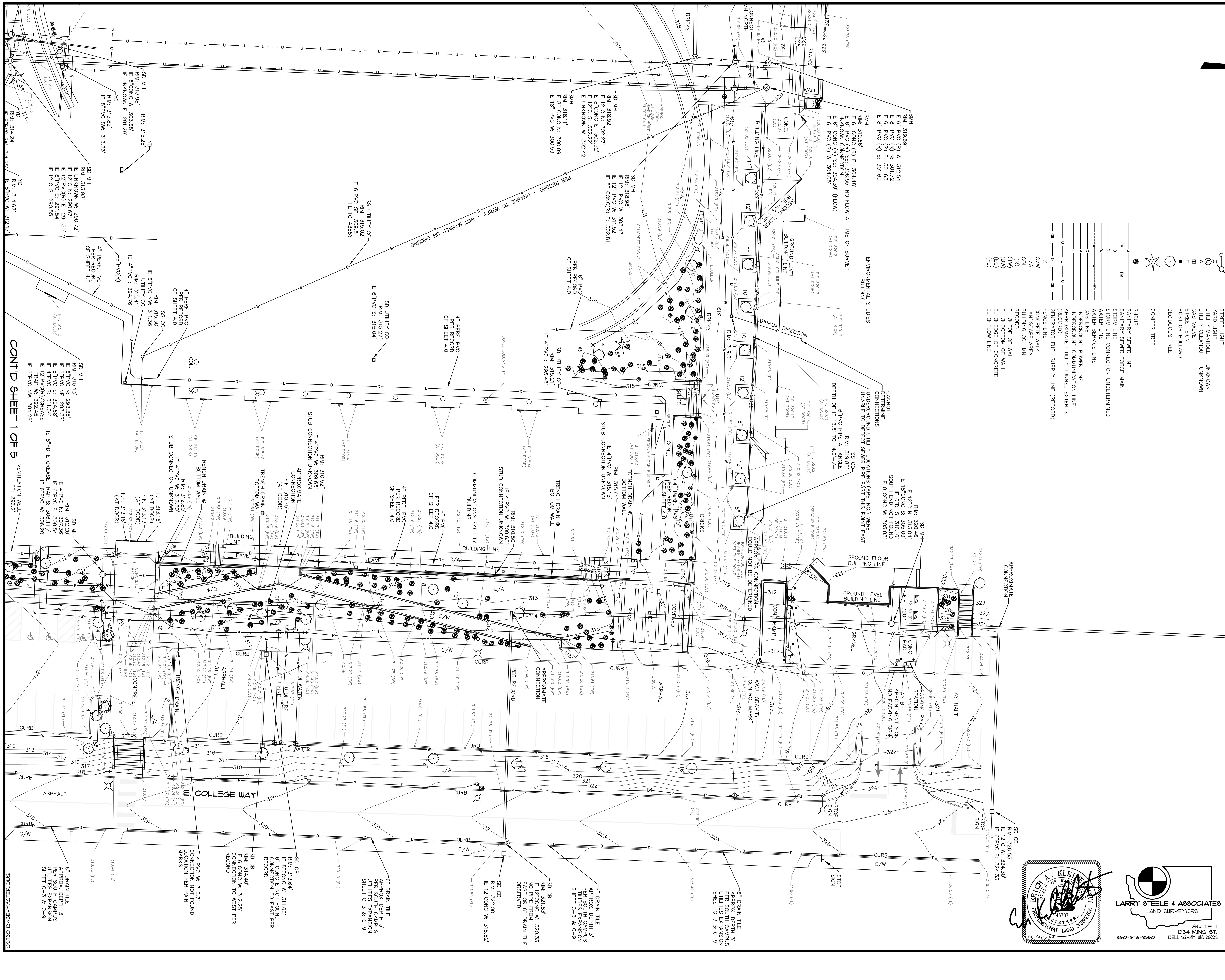
SCALE: 1" = 20'	APPROVED BY:	DRAWN BY: SL
DATE: 9/16/2021	EAK BK 685/44	REVISED:

FOR
WESTERN WASHINGTON UNIVERSITY

BEING A PTN. OF THE SW 1/4 SW 1/4, SEC. 31, TWP. 38 N., RGE. 3 E., W.M. WHATCOM COUNTY, WASHINGTON

JOB NUMBER: 09720

09720 BASE-MASTER.DWG

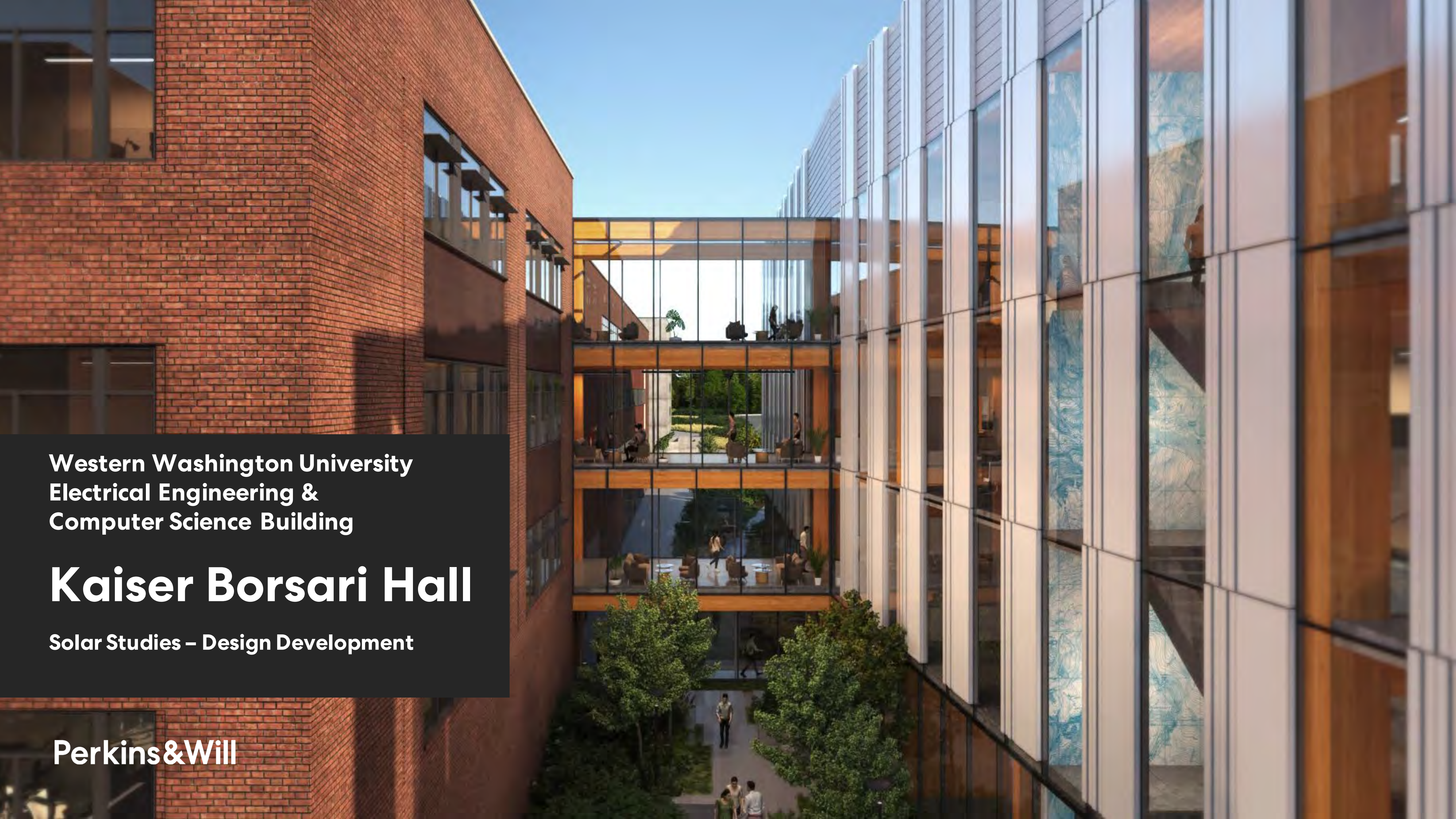


SHEET 4 OF 5

EXISTING CONDITIONS MAP		
SCALE: 1" = 20'	APPROVED BY:	DRAWN BY: SL
DATE: 9/16/2021	EAK BK 685/44	REVISED:
FOR WESTERN WASHINGTON UNIVERSITY		
BEING A PTN. OF THE SW 1/4 SW 1/4, SEC. 31, TWP. 38 N., RGE. 3 E., W.M., WHATCOM COUNTY, WASHINGTON		JOB NUMBER: 09720

APPENDIX D

Shadow Study



Western Washington University
Electrical Engineering &
Computer Science Building

Kaiser Borsari Hall

Solar Studies – Design Development

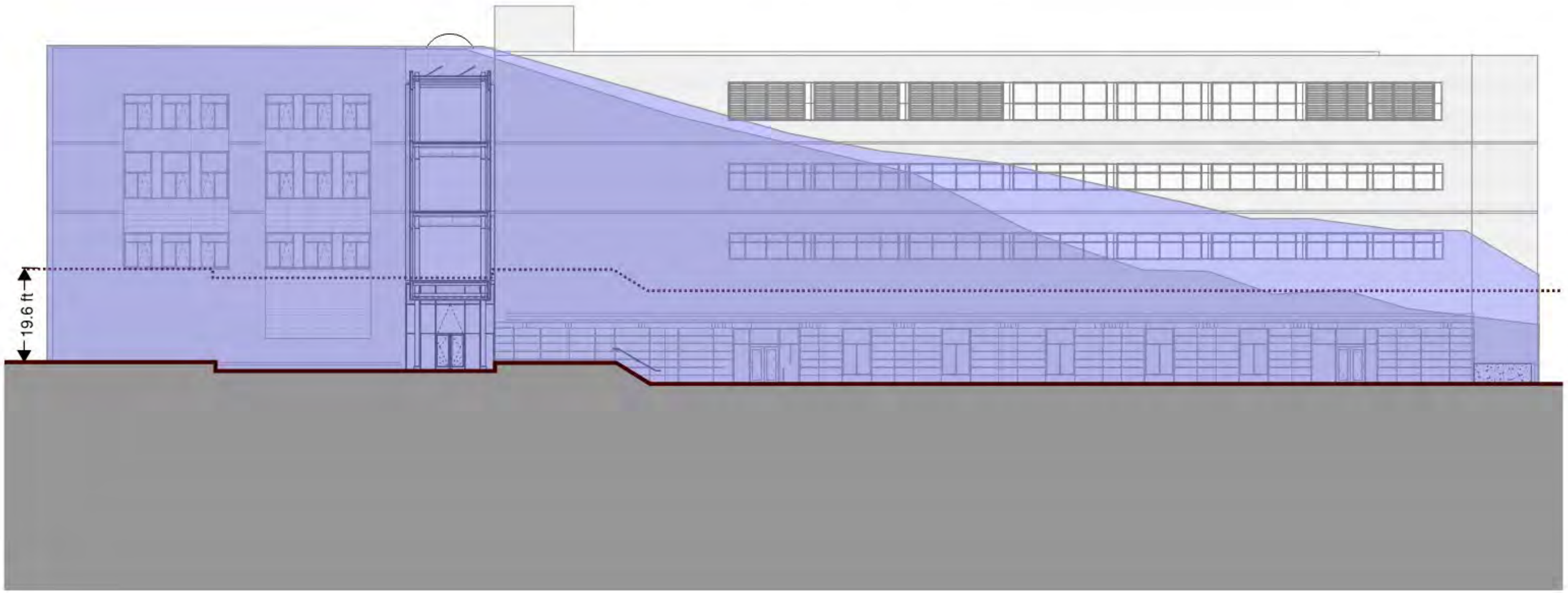
Perkins&Will

WWU EE/CS

Solar Shading of Adjacent Communications Facility

The new EE/CS building casts a small amount of shade on the existing CF Building on Winter Solstice, primarily between 10:30am and noon. Prior to this time, the site is shaded by Sehome Arboretum to the east. By noon, the sun has moved far enough west to leave the Communications Facility's east façade in shade.

Total shade cast between 10am and noon on Winter Solstice: **1,785 SF**



East Façade of Communications Facility

Existing Shade Conditions

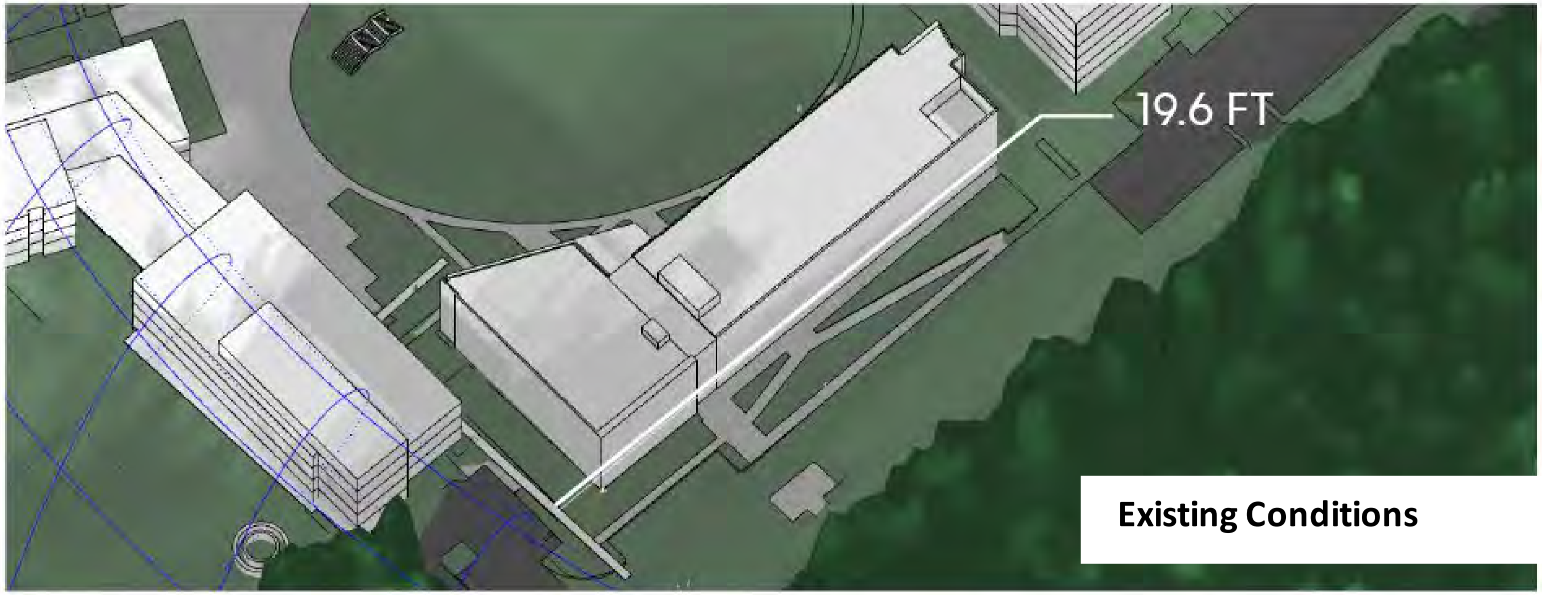
Additional Shade from New Building

Perkins&Will

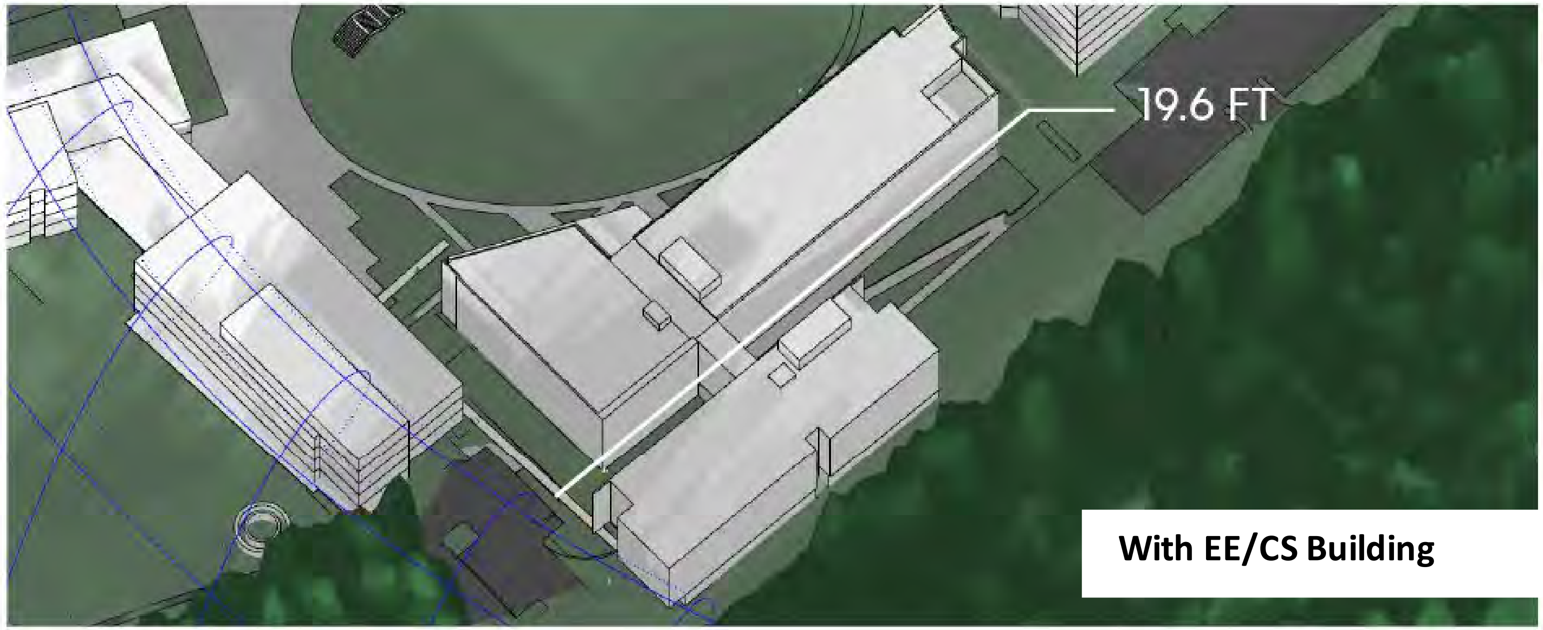
WWU EE/CS

Solar Shading of Adjacent Communications Facility

Existing Conditions, 10am-2pm:
In the morning, the west face of the existing building is already shaded by the hillside to the east on Winter Solstice. By noon, the sun leaves this side of the building in shade.

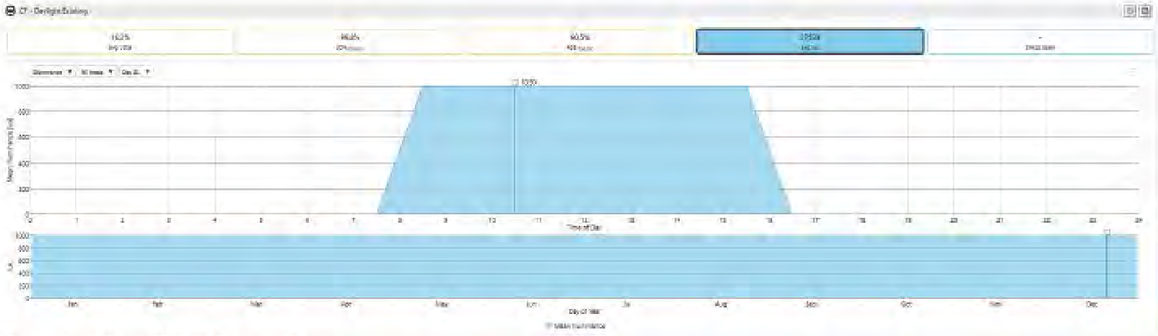


With EE/CS Building, 10am-2pm:
The new building creates a small amount of additional shade between 10:30am and noon on Winter Solstice.



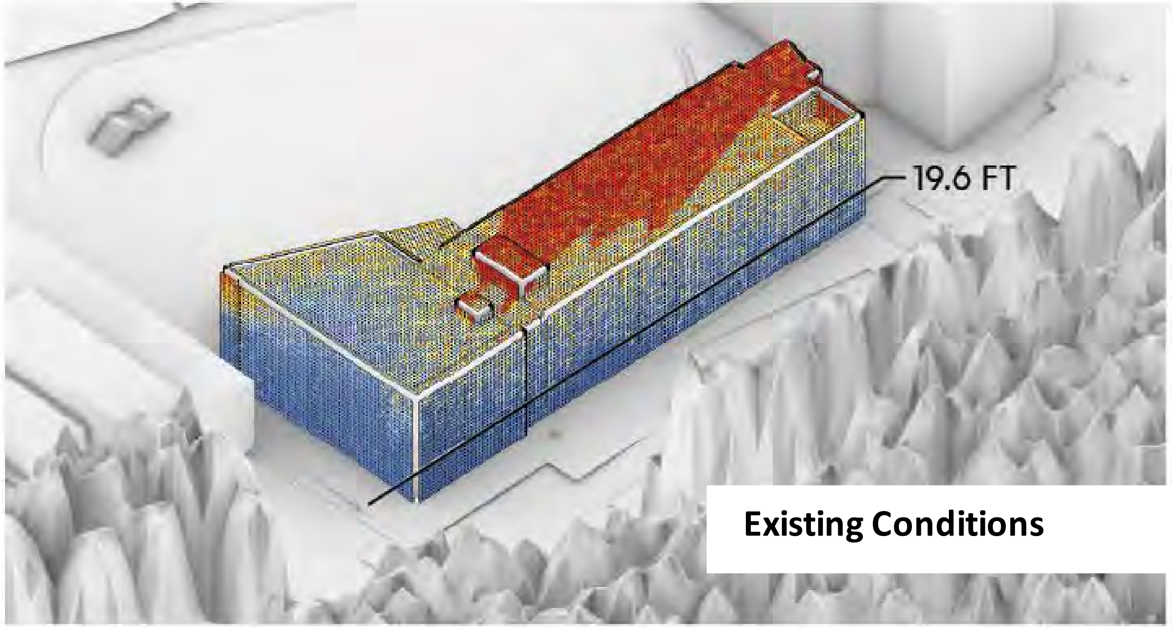
Perkins&Will

WWU EE/CS

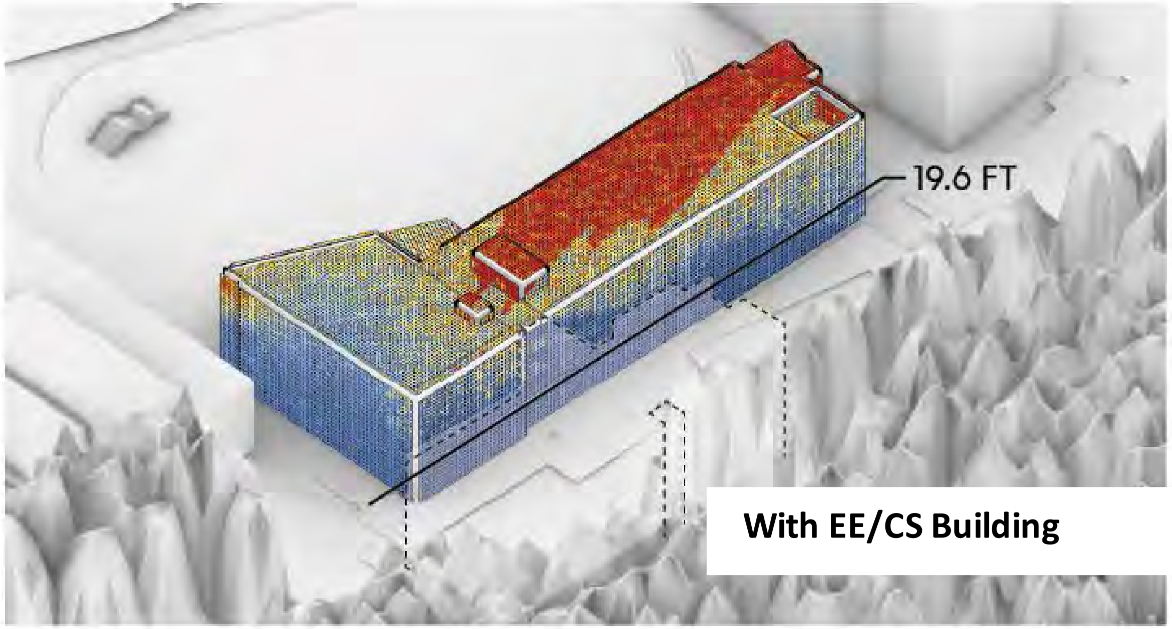


Average Lux (Illuminance)

1000 - Shade
32,000 - Direct Sunlight

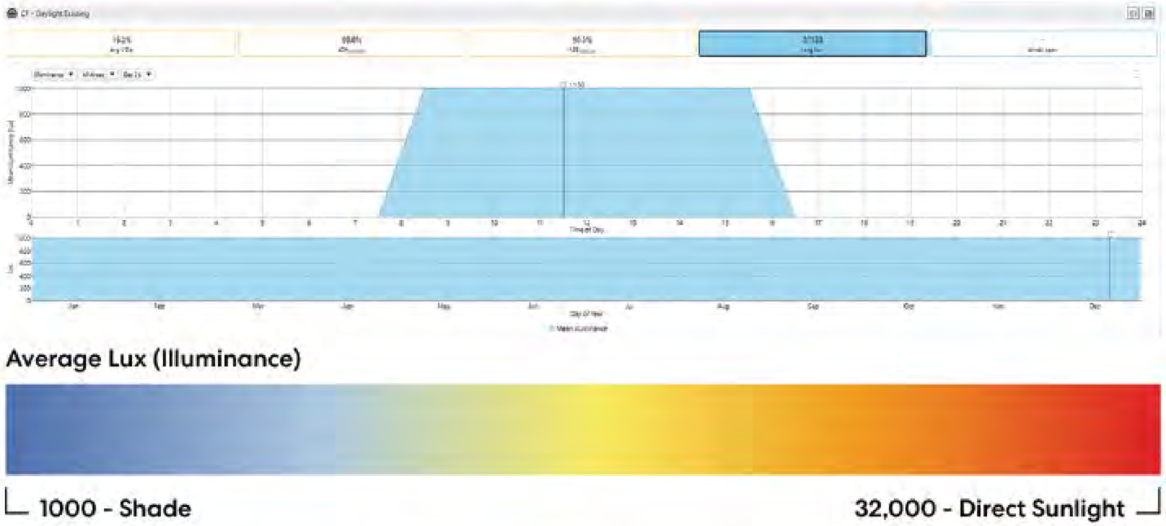


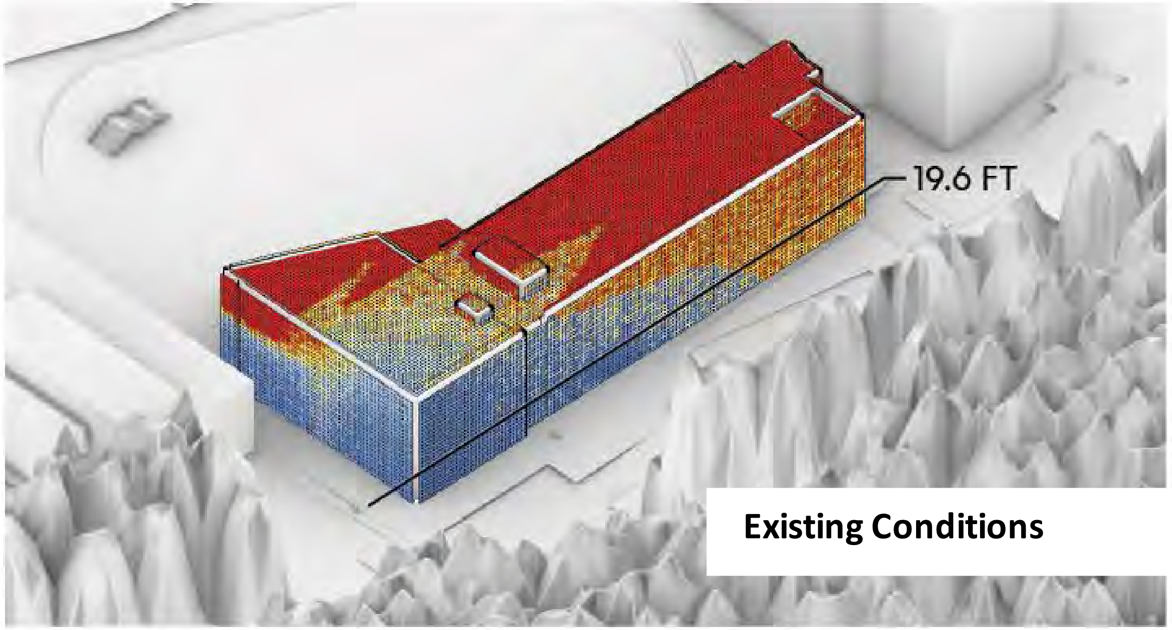
Solar Shading of Adjacent Communications Facility:
Winter Solstice, December 21st at 10:30 am



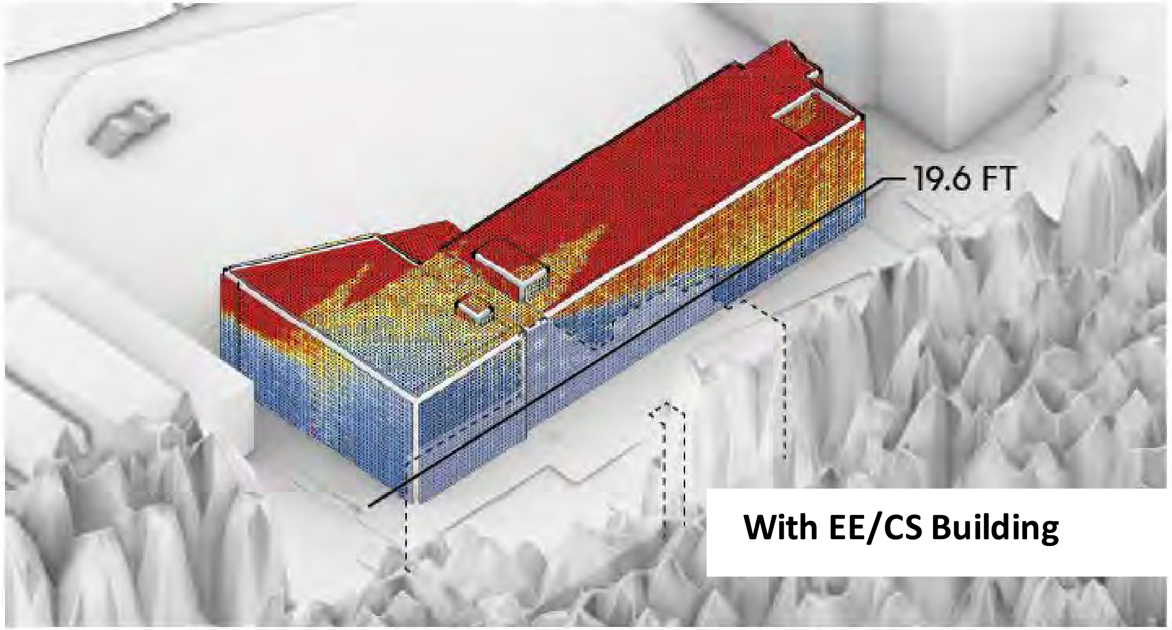
Perkins&Will

WWU EE/CS



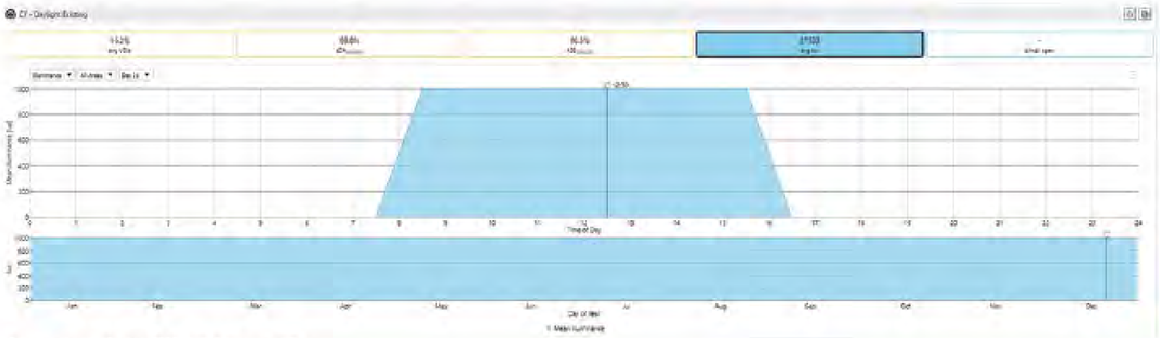


Solar Shading of Adjacent Communications Facility:
Winter Solstice, December 21st at 11:30 am



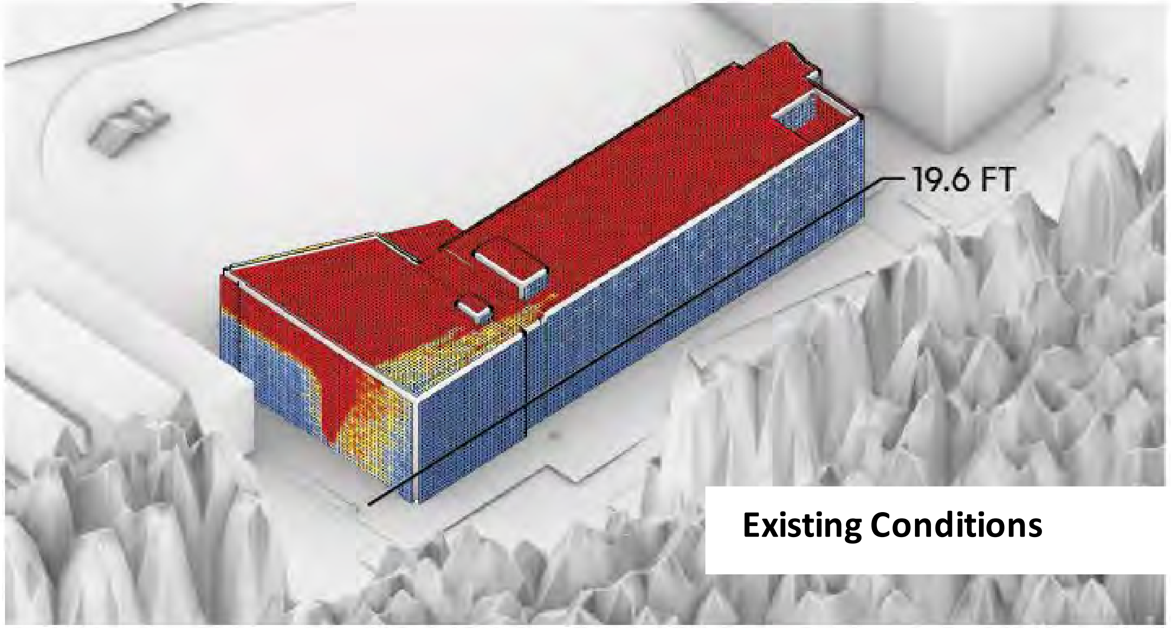
Perkins&Will

WWU EE/CS

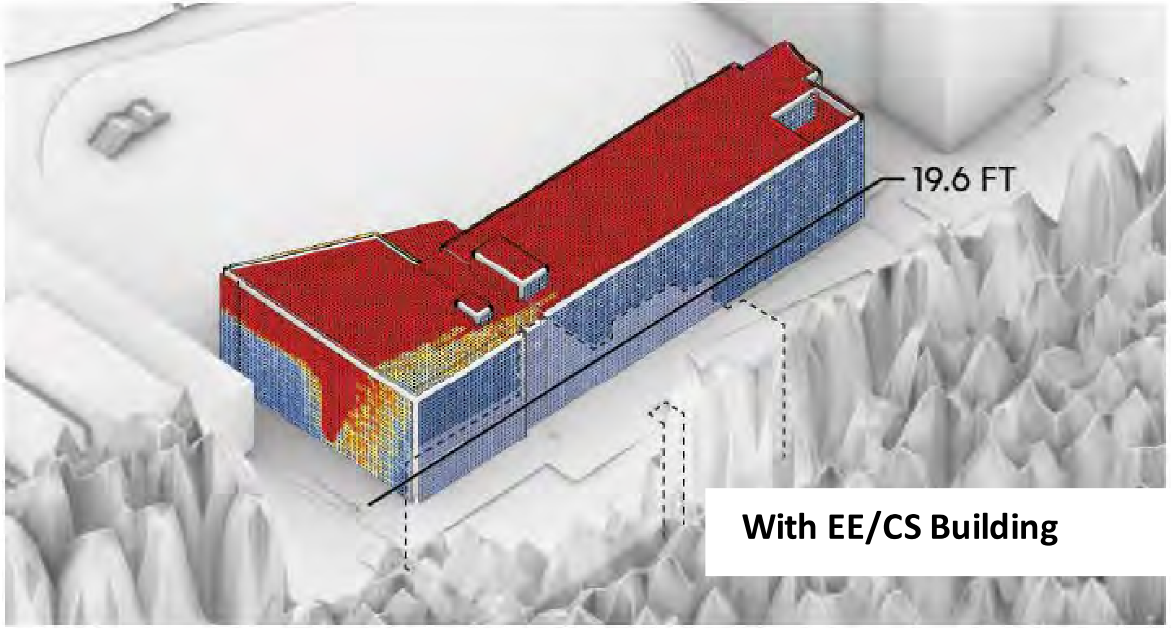


Average Lux (Illuminance)

1000 - Shade 32,000 - Direct Sunlight



Solar Shading of Adjacent Communications Facility:
Winter Solstice, December 21st at 12:00pm



Perkins&Will