SR 302 Victor Area Corridor Study
MP 0 to MP 7.7

June 2023

Washington State Department of Transportation
Olympic Region Multimodal Planning
7407 31st Avenue NE
Lacey, WA 98516

Prepared by
Parametrix
719 2nd Avenue, Suite 200
Seattle, WA 98104
T. 206.394.3700 F. 1.855.542.6353

Title VI Notice to Public

It is the Washington State Department of Transportation's (WSDOT) policy to assure that no person shall, on the grounds of race, color, national origin or sex, as provided by Title VI of the Civil Rights Act of 1964, be excluded from participation in, be denied the benefits of, or be otherwise discriminated against under any of its federally funded programs and activities. This is also reflected in WSDOT Executive Order 1087. Any person who believes his/her Title VI protection has been violated, may file a complaint with WSDOT's Office of Equity and Civil Rights (OECR). For additional information regarding Title VI complaint procedures and/or information regarding our non-discrimination obligations, please contact OECR's Title VI Coordinator at (360) 705-7090.

Americans with Disabilities Act (ADA) Information

This material can be made available in an alternate format by emailing the Office of Equal Opportunity at wsdotada@ wsdot.wa.gov or by calling toll free, 855-362-4ADA(4232). Persons who are deaf or hard of hearing may make a request by calling the Washington State Relay at 711.

Translation Services

If you have difficulty understanding English, you may, free of charge, request language assistance services by calling (360) 705-7090 or email us at: TitleVI@WSDOT.WA.GOV.

Spanish servicios de traducción

Aviso a personas con dominio limitado del idioma inglés: Si usted tiene alguna dificultad en entender el idioma inglés, puede, sin costo alguno, solicitar asistencia lingüística con respecto a esta información llamando al (360) 705-7090, o envíe un mensaje de correo electrónico a: TitleVI@WSDOT.WA.GOV.

한국어

번역 서비스

영어로 소통하는 것이 불편하시다면, (360) 705-7090으로 전화하시거나 다음 이메일로

연락하셔서 무료 언어 지원 서비스를 요청하실 수 있습니다: TitleVI@WSDOT.WA.GOV.

tiếng Việt

các dịch vụ dịch thuật

Nếu quý vị không hiểu tiếng Anh, quý vị có thể yêu cầu dịch vụ trợ giúp ngôn ngữ, miễn phí, bằng

cách gọi số (360) 705-7090 hoặc email cho chúng tôi tại: TitleVI@WSDOT.WA.GOV.

Washington State
Department of Transportation

Washington State Department of Transportation
Olympic Region
Lacey, Washington

SR 302 Victor Area Corridor Study

Approved by:

______________________________ June 28, 2023

Steve Roark
Olympic Region, Regional Administrator

Date

Concurrence:

______________________________ 6/28/2023

Norene Pen
Director of Multimodal Planning and Data Division

Date

Washington State Department of Transportation

CONTENTS

FIGURES

TABLES

APPENDICES

ACRONYMS AND ABBREVIATIONS

CAC – Collision Analysis Corridor

CAL – Collision Analysis Location

CIVA – Climate Impact Vulnerability Assessment

CMF – crash modification factor

EHD – environmental health disparities

FHWA – Federal Highway Administration

GIS – geographic information system

HCM – Highway Capacity Manual

ITE – Institute of Transportation Engineers

LOS – level of service

LTS – level of traffic stress

MP – milepost

n.d. – no date

NHTS – National Highway Safety Administration

OWSC – one-way stop control

PSRC – Puget Sound Regional Council

RTPO – Regional Transportation Planning Organization

SAC – Study Advisory Committee

SMA – Shoreline Management Act

SR – State Route

STIP – Statewide Transportation Improvement Program

TIP – Transportation Improvement Program

TWSC – two-way stop control

v/c – volume-to-capacity

WSDOT – Washington State Department of Transportation

EXECUTIVE SUMMARY

Background and Context

State Route (SR) 302 is an important transportation corridor that connects the communities of Allyn-Grapeview and Purdy on the Kitsap Peninsula, spanning both Mason and Pierce Counties. Lack of alternative routes in the local roadway system makes SR 302 a key regional east-west corridor that links the Key Peninsula rural communities of Victor, Glencove, and Wauna to the Purdy and Gig Harbor communities. SR 302 is used by freight, local traffic, rural commuters, and recreational traffic.

Over the past 20 years, landslides and roadway collapses have resulted in partial or full closures of SR 302 within the study area. These closures resulted in long detours around the affected area. Since then, there has been increased landslide activity along SR 302 between SR 3 and Wright Bliss Road NW, which requires additional analysis and further study of improvement strategies.

In 2021, the Washington State Legislature directed WSDOT to complete a study of SR 302 near the Victor area to address landslides and roadway operations. The 2021-23 Transportation Budget (SSB 5165, Section 218 (6)) instructed WSDOT to "do a corridor study of the SR 302 (Victor Area) to recommend safety and infrastructure improvements to address current damage and prevent future roadway collapse and landslides that have caused road closures." The SR 302 Victor Area Study includes a geotechnical study to specifically address landslide issues. The study is also intended to identify a set of transportation improvements along the corridor between SR 3 and Wright Bliss Road that improve both public safety and highway infrastructure, including improvements to active transportation facilities.

Study Purpose, Problem Statement, Vision Statement, and Goals

The SR 302 Victor Area Study was initiated by establishing a study purpose, problem statement, vision statement, and goals for the study, per the WSDOT Practical Solutions Performance Framework (WSDOT no date (a) [n.d.a]). This study framework was developed by WSDOT and confirmed by the Study Advisory Committee (SAC).

Study Purpose

The SR 302 Victor Area Study is intended to study the cause of landslides and identify potential solutions. In addition, the study will evaluate SR 302 from SR 3 to Wright Bliss Road to look at public safety and infrastructure improvements to the roadway, including improvements for active transportation.

Problem Statement

SR 302 in the Victor area of Mason County is at high risk of roadway closure due to flooding and landslides, causing resiliency and infrastructure issues. Landslides cause frequent damage to the

Vision Statement

Provide a resilient and efficient multimodal transportation system that improves mobility by identifying solutions to prevent impacts to the highways from landslides and improving the roadway for all users.

Study Goals

- **Advancing Equity** – Improve and protect health, safety, and accessibility for vulnerable populations, especially in low-income communities and communities that spend more, and longer, to get where they need to go.
- **Safety** – Enhance crash reduction potential for active transportation users.
- **Environment** – Identify environmental resources that need to be protected.
- **Multimodal** – Create a transportation system that enables safe, convenient access for all types of transportation options: walking, biking, driving, and riding transit.
- **Mobility** – Improve the predictable movement of goods and people.
- **Economic Vitality** – Increase access to work and non-work destinations by multiple modes.
- **Resiliency** – Create a transportation system that is resilient against climate change and natural disaster impacts.

Study Process

The SR 302 Victor Area Study followed the WSDOT Practical Solutions approach, which is a performance-based approach to transportation decision-making. This data-driven approach uses the latest tools and performance measures to seek lower cost efficiencies in operating highways, ferries, transit, and rail and reduce travel demand to save money and reduce the need for building costly new infrastructure. This study will identify agreed-upon needs-ranked strategies and will assist WSDOT and others to make decisions on improving transportation along the SR 302 corridor within the study area.

The major work elements completed as part of this study include:

- Section 3 – Guidance from the SAC and input through community engagement, including an online open house.
- Section 4 – Documenting existing characteristics of the SR 302 corridor within the study area.
- Section 5 – Summarizing existing geotechnical conditions and recommendations.
- Section 6 – Analyzing existing and future transportation conditions and crash analysis.

- Section 7 – Documenting existing environmental characteristics of the SR 302 corridor within the study area.
- Section 8 – Documenting how strategies to address the study purpose along the SR 302 corridor within the study area were developed and evaluated.
- Section 9 – Documenting list of recommendations presented to the SAC for support.
- Section 10 – Recommending next steps.

Strategy Development and Screening

Geotechnical Strategy Development

The legislative proviso to perform the SR 302 Victor Area Study included identifying solutions to address landslides that have caused recent road closures. The consultant team performed a geotechnical engineering study that evaluated the soil and ground water conditions in the slide study area to aid in the development and evaluation of a landslide repair. From the subsurface exploration and the laboratory testing of samples collected, two main issues were identified: roadway movements and ancient slide.

Several strategies were evaluated to address drainage issues and roadway stability in the short term and midterm, and additional long-term strategies were evaluated to address the ancient slide. These strategies were screened according to performance measures for slope stability; design efforts; surfaces exposed to wave action, flood, and tides; roadway shoulder width on each side of the road; permittable; maintenance intervals; maintenance effort and impacts; cost; and detours and delays during construction.

These geotechnical recommendations were identified first before any transportation strategies were developed and screened. The recommended geotechnical solutions all allow the roadway to be expanded, if necessary, to accommodate transportation strategy recommendations.

Transportation Strategy Development

A multistep screening process was used to identify, screen, evaluate, and rank potential strategies. The first step in the screening process was to generate ideas with potential to address the needs of the corridor. Based on the study purpose and the transportation analysis of existing and future No Build conditions, the study team and SAC developed transportation strategies to address the corridor issues. Suggestions were also collected from the public through the online open house. Safety concerns were noted by participants in the online open house, as discussed in Section 3.3. In fact, safety was noted as the biggest existing challenge for travelers on the SR 302 corridor within the study area. Participants suggested strategies such as better lighting, better signage, and reduced speed limits. As discussed in Section 6.3, SR 302 has not been identified as a CAL/CAC within the study area. Safety has not been identified as a transportation need for the SR 302 corridor within the study area at this time, so safety countermeasures were not evaluated as potential strategies. A total of eight transportation strategies, not related to safety countermeasures, were identified and evaluated for this study.

Level 1 Screening

Level 1 Screening was a high-level screening process meant to screen out any transportation strategies that would not meet the study goals. For Level 1 Screening, five questions related to the study goals were developed. If the answer to all five questions for a strategy was a "yes," then the strategy passed Level 1 Screening. Four of the strategies evaluated for Level 1 Screening passed, and four strategies did not pass.

Level 2 Screening

Level 2 Screening was a more detailed screening process meant to narrow down the strategies to a preferred strategy or strategies. The strategies evaluated were No Build, Strategy #1 Improved Shoulder on SR 302, and Strategy #2 Shared-Use Path Adjacent to SR 302.

For Level 2 Screening, performance measures were developed based on the study goals and the WSDOT Practical Solutions Performance Framework (WSDOT n.d.a). For each performance measure, scores from 1 to 3 were assigned, with a score of 1 being low performing and a score of 3 being high performing. Each strategy was evaluated for each corridor segment separately. Planning-level cost estimates were developed for each strategy, the ranges of which are shown below:

- **Strategy #1 Improved Shoulder on SR 302:**
  - Segment 1: $2.8 million to $3.8 million
  - Segment 2: $31.1 million to $41.5 million
  - Segment 3: $14.5 million to $19.3 million
- **Strategy #2 Shared-Use Path Adjacent to SR 302:**
  - Segment 1: $3 million to $4 million
  - Segment 2: $38.7 million to $51.6 million
  - Segment 3: $14.4 million to $19.1 million

The highest scoring strategy was Strategy #2 Shared-Use Path Adjacent to SR 302. The pros of Strategy #2 Shared-Use Path are that it would provide improvements to active transportation user safety, multimodal mobility, accessibility, environment, and resiliency. The cons of Strategy #2 Shared-Use Path are that it would impact the number of conflict points, would have potential impacts to residential property in historically disadvantaged communities, and would require the highest cost of all the strategies due to widening and related retaining walls. This strategy would have minimal impacts to vehicles and freight.

Recommendations

- **Short-term/lower cost partial mitigation:** the geotechnical recommendation is lightweight cellular concrete fill with drainage improvements. The intention is to reduce groundwater levels to improve the stability of the roadway slope. For transportation, the recommendation is to improve communication during roadway closures of SR 302 for both planned construction and potential emergencies.
- **Mid-term/partial mitigation:** the geotechnical recommendation is aggregate shafts with drainage improvements. The intention is to replace weak soils below the roadway and improve the stability of the roadway slope by improving the strength parameters of the existing soils.
- **Long-term/full mitigation:** the long-term geotechnical recommendation is anchored slope stabilization with drainage improvements. The intention is to stabilize the ancient slide and roadway slope. For transportation, the recommendation is to continue to evaluate active transportation facilities on SR 302. Either Strategy #1 Improved Shoulder or Strategy #2 Shared-Use Path could be considered, as both would provide improvements to active transportation user safety, multimodal mobility, accessibility, and resiliency on SR 302 in the study area. Both types of active transportation facilities along SR 302 in the study area would also include high costs and potential impacts to environmental resources and right-of-way. However, as part of the planning-level cost estimates, it was assumed that any environmentally sensitive areas that would be impacted by these strategies would be improved or mitigated. Due to the context of the study area and the high costs of these strategies, it is recommended that any active transportation facility along SR 302 in the study area be considered in relation to a regional trail network, consistent with both Mason County and Pierce County long-term planning documents.

Next Steps

The recommendations identified in this study will assist WSDOT in addressing the landslide and transportation issues along the SR 302 corridor between SR 3 and Wright Bliss Road NW. This corridor study will be submitted to the legislature.

These strategies will be prioritized on a statewide basis for future implementation, but due to limited state funding, will need to compete for funding with other proposed improvements throughout the state absent other funding sources. Upon completion of this report, funding to implement the recommended strategies, whether from the state, grants, developer contributions, or other sources, needs to be pursued. There is no funding identified for design and construction of the recommended strategies. WSDOT should work with local and regional agencies to incorporate the recommendations of this study into local, regional, and state plans.

1. INTRODUCTION AND BACKGROUND

1.1 Introduction

State Route (SR) 302 is an important transportation corridor that connects the communities of Allyn-Grapeview and Purdy on the Kitsap Peninsula, spanning both Mason and Pierce Counties. Lack of alternative routes in the local roadway system makes SR 302 a key regional east-west corridor that links the Key Peninsula rural communities of Victor, Glencove, and Wauna to the Purdy and Gig Harbor communities. SR 302 is used by freight, local traffic, rural commuters, and recreational traffic.

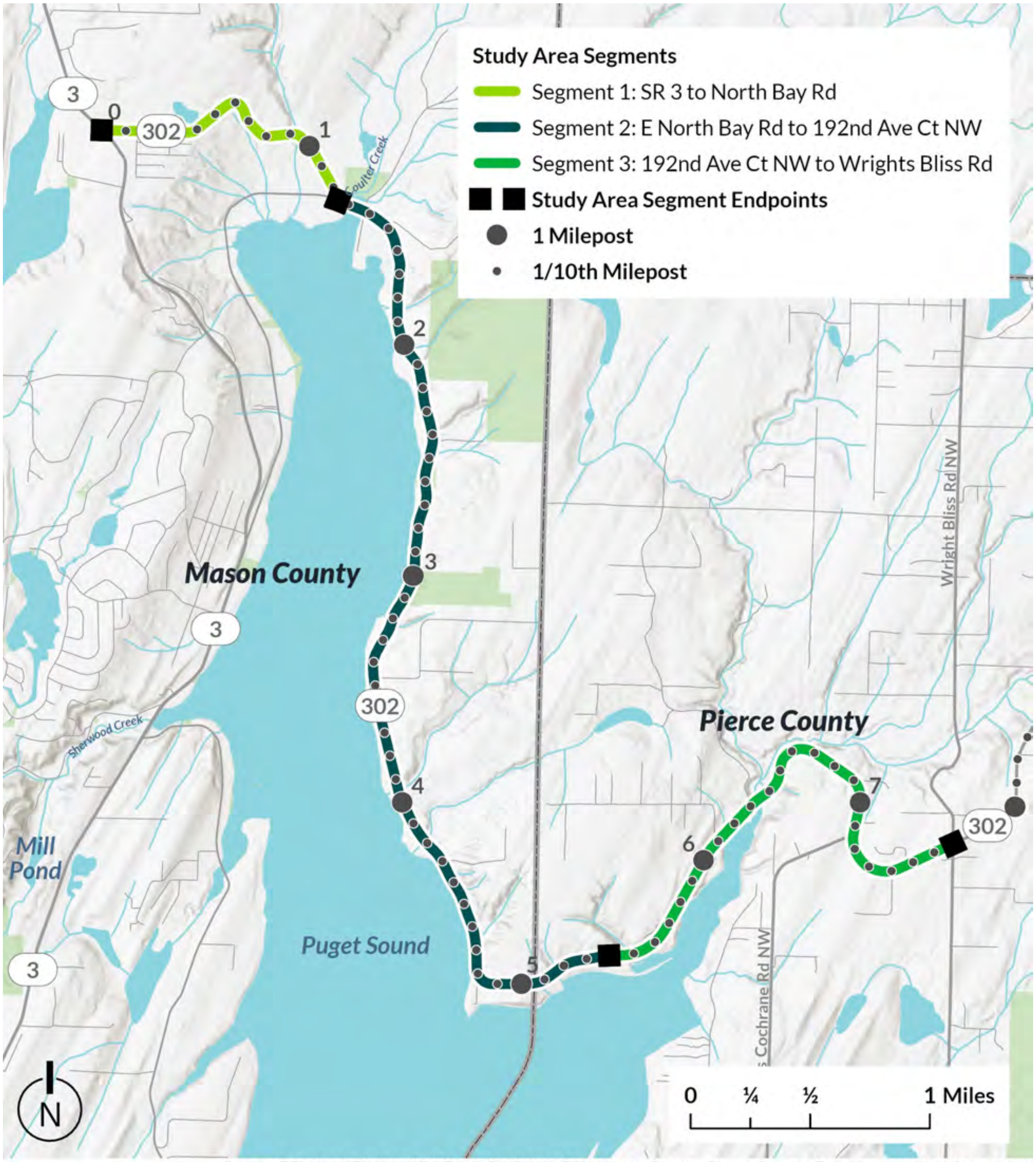
Over the past 20 years, landslides and roadway collapses have resulted in partial or full closures of SR 302 within the study area. These closures resulted in long detours around the affected area. In 2008, the Washington State Department of Transportation (WSDOT) conducted a study to address safety and congestion issues on SR 302. Since then, there has been increased landslide activity along SR 302 between SR 3 and Wright Bliss Road NW, which requires additional analysis and further study of improvement strategies.

In 2021, the Washington State Legislature directed WSDOT to complete a study of SR 302 near the Victor area to address landslides and roadway operations. The proviso instructed WSDOT to "do a corridor study of the SR 302 (Victor Area) to recommend safety and infrastructure improvements to address current damage and prevent future roadway collapse and landslides that have caused road closures." The SR 302 Victor Area Study is intended to identify a set of transportation improvements along the corridor between SR 3 and Wright Bliss Road that improve both safety and highway infrastructure, including improvements to active transportation facilities. A geotechnical study is also being prepared to specifically address landslide issues.

1.2 Study Area

This SR 302 Victor Area Study evaluated SR 302 between SR 3 (milepost [MP] 0.0) and Wright Bliss Road NW (MP 7.7). Given the varying speed limits and roadway characteristics along the SR 302 corridor within the study area, the corridor was divided into three segments. For the strategy development and screening process, each transportation strategy was evaluated separately for each of the three corridor segments.

Segment 1 has a posted speed limit of 30 mph and is characterized by residential areas and businesses. Segment 2 is 40 mph and mostly has residences close to the roadway on the shoreline side and steeper slopes on the non-shoreline side. Since the SR 302 corridor changes orientation several times within the study area, the two sides of SR 302 are referred to as the shoreline side (mostly west or south of the corridor centerline) and the non-shoreline side (mostly east or north of the corridor centerline). Segment 3 is 45 mph and has some residences close to the roadway on the shoreline side. The area south of SR 302 along Segment 3 is defined as a population center, as discussed in Section 6.2.3. Dividing the corridor into these three segments allowed for strategies to be evaluated separately for each segment given the different needs and considerations for each segment. The segments are shown in Figure 1.



Source: FEMA, USFWS, WSDOT, WA DNR, WA ECY, Mason County, Pierce County, Esri, Mapbox, OpenStreetMap

Figure 1. Corridor Segments

1.3 Study Purpose, Problem Statement, Vision Statement, and Goals

The SR 302 Victor Area Study was initiated by establishing a study purpose, problem statement, vision statement, and goals for the study, per the WSDOT Practical Solutions Performance Framework (WSDOT n.d.a). This study framework was developed by WSDOT and confirmed by the Study Advisory Committee (SAC).

1.3.1 Study Purpose

The SR 302 Victor Area Study is intended to study the cause of landslides and identify potential solutions. In addition, the study will evaluate SR 302 from SR 3 to Wright Bliss Road to look at public safety and infrastructure improvements to the roadway, including improvements for active transportation.

1.3.2 Problem Statement

SR 302 in the Victor area of Mason County is at high risk of roadway closure due to flooding and landslides, causing resiliency and infrastructure issues. Landslides cause frequent damage to the roadway, requiring long detours due to lack of alternative routes in the area. SR 302 in the study area also lacks complete active transportation facilities that hinders mobility.

1.3.3 Vision Statement

Provide a resilient and efficient multimodal transportation system that improves mobility by identifying solutions to prevent impacts to the highways from landslides and improving the roadway for all users.

1.3.4 Study Goals

- **Advancing Equity** – Improve and protect health, safety, and accessibility for vulnerable populations, especially in low-income communities and communities that spend more, and longer, to get where they need to go.
- **Safety** – Enhance crash reduction potential for active transportation users.
- **Environment** – Identify environmental resources that need to be protected.
- **Multimodal** – Create a transportation system that enables safe, convenient access for all types of transportation options: walking, biking, driving, and riding transit.
- **Mobility** – Improve the predictable movement of goods and people.
- **Economic Vitality** – Increase access to work and non-work destinations by multiple modes.
- **Resiliency** – Create a transportation system that is resilient against climate change and natural disaster impacts.

1.4 Previous Studies

In 2005, the Washington State Legislature directed WSDOT to study and implement improvements to SR 302 to address congestion and safety issues on the highway. The SR 302 Corridor Study (WSDOT 2008) was completed in 2008 and analyzed existing and projected safety and mobility conditions, identified ways to improve safety and mobility on SR 302, and identified the associated environmental effects of the alternatives. Several new SR 302 corridor alignments were identified, all of which crossed areas of steep topography that would require relatively extensive earthwork to maintain reasonable grades. A preferred alternative was not identified as part of this study.

In 2018, WSDOT developed a corridor sketch summary of SR 302 for the full corridor between SR 3 and SR 16. The corridor sketch summary (WSDOT 2018a) outlined many of the key issues and concerns related to the corridor, including:

- 11% of the corridor experiences congestion on a regular basis.
- There is one bridge rehabilitation need on the corridor.
- The corridor is prone to extreme weather closures due to flooding and rockslides.
- There are fish passage barriers present on the corridor.

Many of these issues were present along the east end of the SR 302 corridor near SR 16, but closures and fish passage barriers are present along the west end of the SR 302 corridor near SR 3.

In 2020, WSDOT completed the SR 3 Freight Corridor Planning Study (WSDOT 2020). This project will construct a new SR 3 corridor that will intersect with the existing SR 3 corridor near the west end of the SR 302 corridor. This project is included in the Future No Build Condition for this SR 302 Victor Area Study and is discussed more in Section 6.1.1.

1.5 Local, Regional, and State Plans

Local, regional, and state plans were reviewed to provide a plan and policy context for this SR 302 Victor Area Study. This review summarized plans, policies, and projects related to the SR 302 corridor to form a basis for developing new policies, approaches, and recommendations for this study.

1.5.1 WSDOT Strategic Plan

The WSDOT Strategic Plan (n.d.c) provides the vision, mission and values that guide the work of the agency. WSDOT's mission is to provide safe, reliable, and cost-effective transportation options to improve communities and economic vitality for people and businesses through the values of safety, engagement, innovation, integrity, leadership, and sustainability. The important work of the agency is focused in three key areas: diversity-equity-inclusion, resilience, and workforce development, the most relevant of which to this study are equity and resilience.

WSDOT's goals for equity are focused on both outreach and outcome. WSDOT is committed to conducting an inclusive planning process that aims to break down barriers to involvement for all members of the community, from long-time participants in transportation and urban planning to new voices who represent the increasingly diverse communities in the study area. WSDOT is also committed to evaluating and implementing strategies that improve and protect health, safety, and accessibility for vulnerable populations, especially in low-income communities and communities that spend more, and longer, to get where they need to go.

WSDOT's goal for resilience is to plan and/or invest resources to improve the ability to mitigate, prepare for, and respond to emergencies; combat climate change; and build a transportation system that provides equitable services, improves multimodal access, and supports Washington's long-term resilience. To improve the resilience of the transportation system, WSDOT is focused on the following:

- Seismic Resilience – prioritize and strengthen the elements of the transportation system most critical to emergency response after a seismic event, such as an earthquake or tsunami.
- Asset Management – build resilience and reduce vulnerabilities while proactively managing the preservation and maintenance of WSDOT's assets necessary to achieve and sustain a state of good repair.
- Climate and Natural Hazard Resilience – prioritize actions that reduce risk and build climate preparedness.
- Operational Resilience – support and enhance security for all WSDOT staff and properties and improve WSDOT's Emergency Preparedness for response and recovery from natural and manmade incidents (including cyber).

1.5.2 Other Relevant Plans

The following additional plans and policies were reviewed and are summarized in Table 1.

- Mason County Transportation Plan (2016)
- Mason County Six Year Transportation Improvement Program (TIP) 2023–2028 (2022)
- Peninsula Regional Transportation Planning Organization (RTPO) Peninsula Regional Non-Motorized Connectivity Study (2019b)
- Pierce County Comprehensive Plan (2021a)
- Pierce County Transportation Improvement Program (TIP) 2022–2027 (2021b)
- Pierce Country Nonmotorized Transportation Plan (1997)
- Key Peninsula Community Plan (2007)
- WSDOT Complete Streets (2022a)

- WSDOT Environmental Manual Chapter 200 (2022b)
- Guidance for Considering Impacts of Climate Change in WSDOT Plans (n.d.b)
- WSDOT Practical Solutions Performance Framework (n.d.a)
- WSDOT Safety Guidance for Corridor Planning (2015)
- WSDOT Statewide Transportation Improvement Program (STIP) 2023–2026 (2022c)
- Washington State Active Transportation Plan (2021a)

Table 1. Plan and Policy Review

Plan or Policy	Summary of Relevant Information
Mason County Transportation Plan (2016)	• Coordinate transportation and land use decisions to enhance multimodal travel options by supporting alternatives to driving alone, identifying and funding projects that expand travel options for more people, and integrating trails with the County's transportation system. • Reduce impacts to the natural environment by recognizing the value of walking and biking. This goal could be fulfilled by updating environmental requirements to minimize the footprint of transportation and its impacts to habitats, improving the ability of children to walk or bike to school, and tailoring Complete Streets principles to a primarily rural context. • Coordinate with school districts to enhance safe and efficient school transportation, including student walking routes and crossings. • Develop a regional trail network by connecting destinations, locating trails close to population centers, enhancing mobility in rural centers, accommodating all potential users, and providing access to water.
Mason County Six Year TIP 2023-2028 (2022)	• No relevant projects in study area.

Table 1. Plan and Policy Review (continued)

Plan or Policy	Summary of Relevant Information
Peninsula RTPO Peninsula Regional Non-Motorized Connectivity Study (2019b)	• The SR 3 Freight Corridor project should be considered an opportunity to revisit regional priorities for non-motorized connectivity, especially at the southern end. The Peninsula RTPO could pursue a shared-use path as part of the corridor that could connect at the south end to either the rail-trail corridor or the utility or continue to rely on road shoulders for providing bicycle connectivity.
Pierce County Comprehensive Plan (2021a)	• Improve the safety and aesthetics of the built environment by physical separating pedestrian pathways from roadways, focusing lighting in areas of concern to maintain rural character, encouraging visual consistency, and promoting clear identification of businesses. • Develop a safe and comfortable trail system to provide recreational access and commute opportunities for people of all ages and abilities, including safe street crossings and connections to other transportation modes. • Complement Washington's zero death and disabling injury target by avoiding the construction of new roads or addition of travel lanes in rural areas, using traffic calming measures instead. • Locate utility lines underground, wherever practicable, and reduce or eliminate stormwater drainage impacts from roadways onto adjacent areas.
Pierce County TIP 2022–2027 (2021b)	• No relevant projects in study area.
Pierce Country Nonmotorized Transportation Plan (1997)	• Designate and improve a system of safe nonmotorized facilities on the rural roadway system and separated trail network using national best practices that connect major activity centers and destinations. • Use a Complete Streets ordinance to provide features for all users when building new roadway connections or completing major reconstructions. • Coordinate with school districts to plan for safe routes to schools and work to develop a regional Trail system and network of community connectors that link schools, parks, and neighborhoods. • Two projects identified in the plan intersect with SR 302: Bliss Cochrane Rd NW (shoulders or path) and Wright Bliss Rd NW (paved shoulders, wide lanes, or trail north of SR 302 and paved shoulders or trail south of SR 302).

Table 1. Plan and Policy Review (continued)

Plan or Policy	Summary of Relevant Information
Key Peninsula Community Plan (2007)	• The Key Peninsula Community is planning to amend Pierce County Development Regulations – Zoning to update development standards relating to the forested buffer adjacent to SR 302. Current regulations designate a "Rural State Route and Rural Highway Buffer" that is intended to provide physical and visual filter and separator between uses and passing motorists along rural state routes in order to maintain the aesthetic character of the surrounding area and to provide a noise and air quality buffer. • Amend development regulations to encourage the joint use of access roads along SR 302, encourage the provision of nonmotorized facilities in developments and roadway construction, and require the dedication of trails during the site development process. • Coordinate with local and state partners to strategize the implementation of an interconnected system of nonmotorized improvements and traffic calming measures in the area. • One project included in the Key Peninsula Community Plan is along SR 302 within the study area: improve existing alignment, intersections, and paved shoulders and/or construct a new northern route with a regional multiuse trail and pedestrian facilities in commercial centers.
WSDOT Complete Streets (2022a)	• Complete Streets analysis occurs during the predesign phase for select projects. • WSDOT projects that implement Complete Streets principles are expected to meet minimum threshold criteria with respect to public engagement, overburdened communities, network gaps, level of traffic stress, visibility, route directness, and operating speeds. In addition, they are expected to use a documented process for establishing and selecting the most advantageous and practical design(s).
WSDOT Environmental Manual Chapter 200 (2022b)	• Environmental screenings for WSDOT transportation planning efforts should identify existing environmental assets that must be protected, detect other key environmental factors that have the potential to influence the scope of future investments, and determine if additional environmental review is necessary prior to project development.

Table 1. Plan and Policy Review (continued)

Plan or Policy	Summary of Relevant Information
Guidance for Considering Impacts of Climate Change in WSDOT Plans (n.d.b)	• WSDOT projects undergoing environmental review will document how climate change and extreme weather vulnerability are considered and propose ways to improve resilience. Project teams should examine the results of WSDOT's 2011 climate impact vulnerability assessment for the project area, collaborate with planning partners, and develop planning-level strategies that integrate resilience.
WSDOT Practical Solutions Performance Framework (n.d.a)	• Apply a practical solutions approach that relies on performance-based, data-driven decision-making that guides strategic investments for all travel modes, involving interdisciplinary and collaborative decision-making with an emphasis on context, performance, and community engagement.
WSDOT Safety Guidance for Corridor Planning (2015)	• WSDOT has identified three levels of analysis for the safety chapter of a corridor study: basic, intermediate, and advanced. Regardless of the level of safety analysis needed for a study, the project team should hold an internal consultation meeting and follow the basic outline of the safety chapter when drafting the corridor study.
WSDOT STIP 2023-2026 (2022c)	• One project is identified along SR 302 within the study area: Fish Barrier Removal at SR 302/Victor Creek.
Washington State Active Transportation Plan (2021a)	• Create and connect a comfortable and efficient walking and rolling network with a level of traffic stress of 2 or less by coordinating with partners across jurisdictional boundaries, implementing design or operational changes, and identifying local alternatives. • Eliminate deaths and serious injuries of people walking and rolling by reevaluating speed limits, improving active transportation crash data and methods of analysis, develop active transportation volume estimates, and analyzing the state highway system to identify high injury network locations. • Eliminate disparities in active transportation access by integrating equity criteria into decision making, evaluation, and reporting and prioritizing investments in historically overburdened and transportation disadvantaged communities. • Increase the percentage of trips made by walking or bicycling by increasing comfortable access to transit, making the system legible for all users, working with disadvantaged schools to develop walking maps, and working with local partners to assess the need for new improvements to the network.

2. STUDY PROCESS

The SR 302 Victor Area Study followed the WSDOT Practical Solutions approach, which is a performance-based approach to transportation decision-making. This data-driven approach uses tools, data analytics, performance measures, and stakeholder input to (1) seek lower-cost approaches and efficiencies in expanding and operating the multimodal transportation system to reduce travel demand and the need for building costly new infrastructure, (2) identify, evaluate, analyze, and manage risk to WSDOT's strategic objectives, and (3) identify and implement agency efficiencies. Part of this process is to identify the financial needs and responsibilities related to maintenance of the newly preserved, reconstructed, or new assets to avoid maintenance issues down the road. If the recommendation includes capital construction that adds new infrastructure assets to the system, it is important to identify the impact of this capital construction to maintenance operations. The major work elements completed as part of the study are shown in Figure 2.

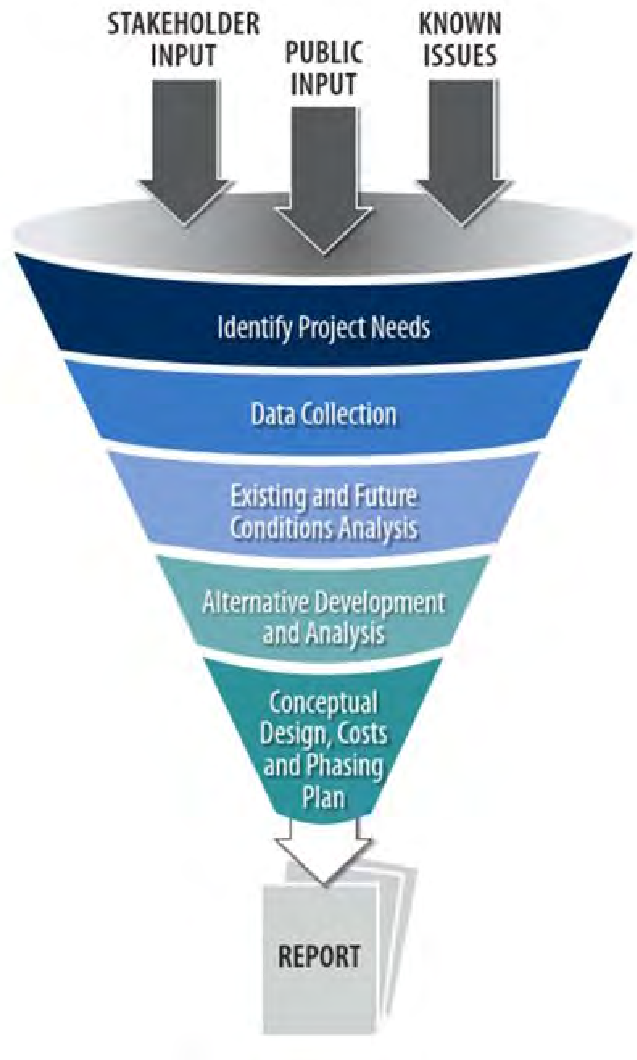


Figure 2. Practical Solutions Approach

WSDOT's Practical Solutions framework is shown in Figure 3 and shows where this SR 302 Victor Area Study lies in the overall process. This study will identify agreed-upon needs-ranked strategies and will assist WSDOT and others to make decisions on improving transportation along the SR 302 corridor within the study area.

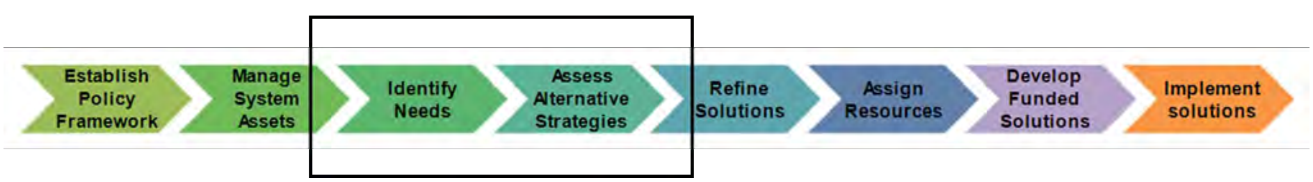


Figure 3. WSDOT Practical Solutions Framework

The major work elements completed as part of this study include:

- Section 3 – Guidance from the SAC and input through community engagement, including an online open house.
- Section 4 – Documenting existing characteristics of the SR 302 corridor within the study area.
- Section 5 – Summarizing existing geotechnical conditions and recommendations.
- Section 6 – Analyzing existing and future transportation conditions and crash analysis.
- Section 7 – Documenting existing environmental characteristics of the SR 302 corridor within the study area.
- Section 8 – Documenting how strategies to address the study purpose along the SR 302 corridor within the study area were developed and evaluated.
- Section 9 – Documenting list of recommendations presented to the SAC for support.
- Section 10 – Recommending next steps.

3. ENGAGEMENT AND OUTREACH

The study team conducted outreach to nearby jurisdictions, agencies, and the public to help identify and respond to concerns along the corridor. The outreach process involved SAC meetings and outreach, an online survey, and an online open house. Feedback from the involvement process helped inform the development of strategies throughout the study process.

3.1 Community Engagement Plan

This involvement process was consistent with WSDOT's Community Engagement Plan (2016). A Community Engagement Plan was completed at the beginning of the study.

The project's communications strategy was designed to accomplish the following goals:

- Clearly communicate the need, purpose, and benefits of the project to the public.
- Clearly communicate the project schedule and limits to implementation once the study report is completed.
- Inform the public about existing problems or performance gaps along the corridor and share any proposed solutions from the project team.
- Provide timely, accurate, and consistent information to people driving and nearby residents and businesses.
- Provide a means for people to ask questions, convey concerns and requests, and ensure reasonable and prompt response from the project team.
- Reinforce positive WSDOT relationships with partner agencies, individuals, and groups.
- Inform the public of the results of the study.

The audiences for this project were primarily divided into the public and the SAC, which consisted of representatives from nearby agencies and organization. The public was invited to participate in this project through one online open house and survey. The public was not expected to participate in SAC meetings. The outreach team engaged the following public groups during the study:

- Community Centers
- Community groups
- Businesses
- Media
- Nonprofits
- Schools/School Districts
- Interest groups
- Residents
- People traveling through the area
- Religious Institutions

Demographic data in and near the study area was analyzed for the Community Engagement Plan. This data was used to inform the outreach and engagement approach for the study. Census tracts 9604.01 and 726.01 were evaluated for language needs, neighborhood demographics, and internet access, as shown in Table 2, Table 3, and Table 4.

Since 5% of the total population primarily speaks Spanish at home, the outreach team recommended translating key project materials, such as the online open house, into Spanish. However, since this population was not necessarily identified as being a low English proficiency population, the outreach team did not translate all materials.

Table 2. Study Area Languages Spoken at Home

Language Group	Census Tracts 9604.01 and 726.01 Number	Census Tracts 9604.01 and 726.01 Percentage
English	10,284	94%
Spanish	537	5%
French, Haitian, or Cajun	33	0%
German or other West Germanic	0	0%
Russian, Polish, or Other Slavic	10	0%
Other Indo-European	10	0%
Korean	10	0%
Chinese (incl. Mandarin, Chinese)	0	0%
Vietnamese	0	0%
Tagalog (incl. Filipino)	31	0%
Other Asian and Pacific Island	60	1%
Arabic	0	0%
Other	0	0%
Total:	**10,975**	**100%**

Source: EJScreen ACS 2016-2020 Report 9604.01, EJScreen ACS 2016-2020 Report 726.01

Table 3. Study Area Neighborhood Demographics

Population Group	Census Tracts 9604.01 and 726.01 Number	Census Tracts 9604.01 and 726.01 Percentage
Total Population	11,511	100%
Minority	2,310	20%
Population by Race		
White Alone	9,201	80%
Black Alone	157	1%
American Indian Alone	103	1%
Asian Alone	178	1%
Pacific Islander Alone	0	
Hispanic Alone	983	9%
Other Race Alone	248	2%
Two or More Races Alone	641	6%
Population by Age		
Age 0–4	536	5%
Age 5–17	2,027	18%
Age 18–64	6,653	58%
Age 65+	2,295	20%
Households by Household Income		
< $15,000	272	2%
$15,000 – $25,000	65	1%
$25,00 – $49,000	642	6%
$50,000 – $74,000	721	6%
$75,000 +	2,177	19%

Source: EJScreen ACS 2016-2020 Report 9604.01, EJScreen ACS 2016-2020 Report 726.01

Table 4. Study Area Internet Access

Population Group	Census Tract 9604.01 Estimate	Census Tract 726.01 Estimate
Internet Access With an Internet Subscription	1,788	1,866
Internet Access Without a Subscription	43	27
No Internet Access	114	39
Total:	**1,945**	**1,932**

Source: American Community Survey (2020 estimates)

3.2 Study Advisory Committee

A SAC with representatives from relevant agencies was engaged to provide feedback throughout the study. Agencies helped develop the problem and vision statements and provided feedback on technical data, proposed strategies, study recommendations, and study documents. The agencies that participated by attending SAC meetings are shown to the right. The agencies that were invited to particpate are included in the Engagement Report. The SAC participants included:

- Sam Johnston – WSDOT Geotechnical Office
- Michael Rosa – WSDOT Headquarters Bridge Office
- Sarah Ott – WSDOT Headquarters Traffic Office
- Kerri Woehler – WSDOT Headquarters Multimodal Planning Division
- Manuel Abarca – WSDOT Olympic Region
- George Mazur – WSDOT Olympic Region
- Matt Pahs – Federal Highway Administration
- Shawn Phelps – Pierce County
- Ryan Medlen – Pierce County
- Loretta Swanson – Mason County
- Mark Neary – Mason County
- Scott Cooper – North Mason Fire Department
- Thera Black – Peninsula RTPO
- Sarah Grice – Pierce County
- Brent Kellog – Skokomish Tribe
- Marty Allen – Skokomish Tribe
- Jennifer Keating – Puyallup Tribe
- Robert Brandon – Puyallup Tribe

Four SAC meetings were held at key milestones throughout the study to share information and solicit feedback on the presented information. The meeting dates and topics are summarized in Table 5 and the meeting summaries are included in the Engagement Report in Appendix A.

Table 5. Study Advisory Committee Meeting Summary

Meeting	Date	Topics
SAC Meeting #1	January 26, 2023	Study overview, baseline conditions, performance evaluation overview
SAC Meeting #2	March 28, 2023	Geotechnical findings and preliminary screening results, transportation strategies, and preliminary Level 1 screening results
SAC Meeting #3	April 27, 2023	Preliminary Level 2 screening results, and preliminary preferred strategy
SAC Meeting #4	May 23, 2023	Recommendations and draft report

3.3 Online Open House

WSDOT held an online open house from March 6 to March 21, 2023. On the online open house, users could learn about the study and share their feedback with the study team. The goals for the online open house were to promote awareness about the study, the study process, and its purpose and need. The survey was developed to collect community input to be used to understand how people currently use the corridor and to generate ideas for improvement strategies for all types of transportation users.

There were 453 people who visited the online open house, and 162 people completed the survey. Forty-six percent of respondents live in the area. Using a vehicle of any type, 161 respondents travel along SR 302, with 18 respondents also traveling by walking, biking, or rolling. One respondent does not use a vehicle of any type to travel along SR 302.

Participants were asked to rank or score the biggest existing challenges for travelers along SR 302. The biggest existing challenges for travelers along SR 302 ranked from most challenging to least challenging were:

1. Safety concerns for people driving
2. Limited detour options when SR 302 is closed or at capacity
3. Environmental hazards, including roadway flooding and landslides
4. Safety concerns for non-driving populations, including people walking, rolling, or biking
5. Lack of multimodal transportation options, such as bike lanes, transit service, or infrastructure for people walking or rolling

Participants were given the option to choose from a list of strategies to improve travel for both people driving and people biking, walking, and rolling. Participants were able to select more than one option. Of the suggested strategies to improve travel for people driving, the most popular were new roadway connections (50% of respondents) and improved intersections operations (37% of respondents). Of the suggested strategies to improve travel for people biking, walking, and rolling, the most popular were providing more separation between vehicles and those biking, walking, and rolling (60% of respondents) and improved lighting (35% of respondents).

Participants were able to provide additional suggestions for strategies to improve travel. The following strategies were suggested by online open house participants, which were considered as part of the screening process discussed in Section 8.

- Widen lanes
- Speed humps
- Freight restrictions
- Floating road grid (floating bridge)
- Additional lanes or turn lanes at intersections
- Improved communication about road closures

More detailed information is available in the Engagement Report in Appendix A.

4. CORRIDOR CHARACTERISTICS

4.1 Roadway Classification

Within the study area, SR 302 travels through Mason and Pierce Counties. WSDOT classifies SR 302 as a State Highway of Regional Significance and has not identified SR 302 as a Highway of Statewide Significance. Operational standards are set by the Peninsula RTPO for the portion of SR 302 within Mason County and by Puget Sound Regional Council (PSRC) for the portion of SR 302 within Pierce County.

4.2 Freight and Goods Transportation System Classification

WSDOT classifies all highways, county roads, and city streets by reported annual gross truck tonnage, ranging from T-1, with the highest tonnage, to T-5, with the least tonnage. SR 302 is identified as a T-3 route in the Statewide Freight and Goods Transportation System, which means the corridor carries 300,000 to 4 million tons per year.

4.3 Existing Roadway Conditions

Within the study area, SR 302 is primarily a two-lane facility, with posted speed limits ranging from 30 to 45 mph. The posted speed limits are shown in Figure 4. The travel lanes are about 11 feet wide, and the shoulder widths range from 2 to 3 feet wide on both sides. There is no median. The right-of-way width varies along the corridor, ranging from 40 feet to over 100 feet wide.

Pavement conditions as catalogued in the WSDOT geographic information system (GIS) maps range from “poor” to “very good” along the SR 302 corridor, with most of the corridor in the study area classified as “good.” Pavement conditions are shown in Figure 5.

1

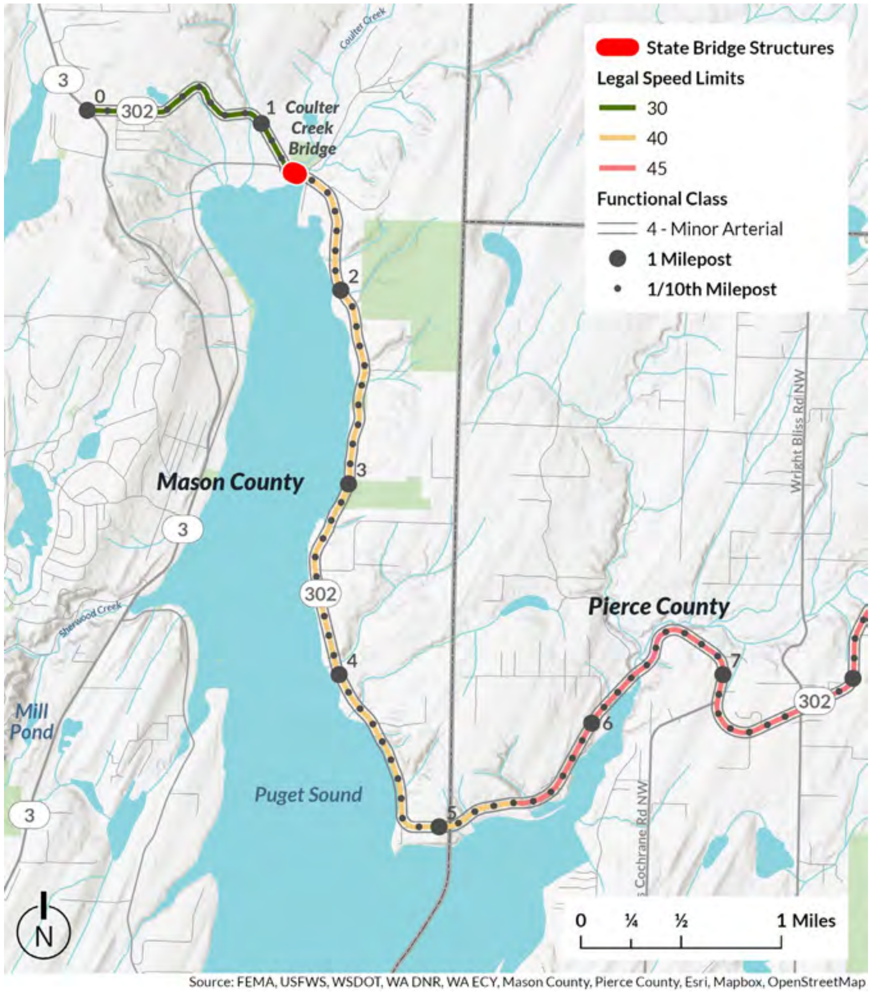


Figure 4. Corridor Speed Limits

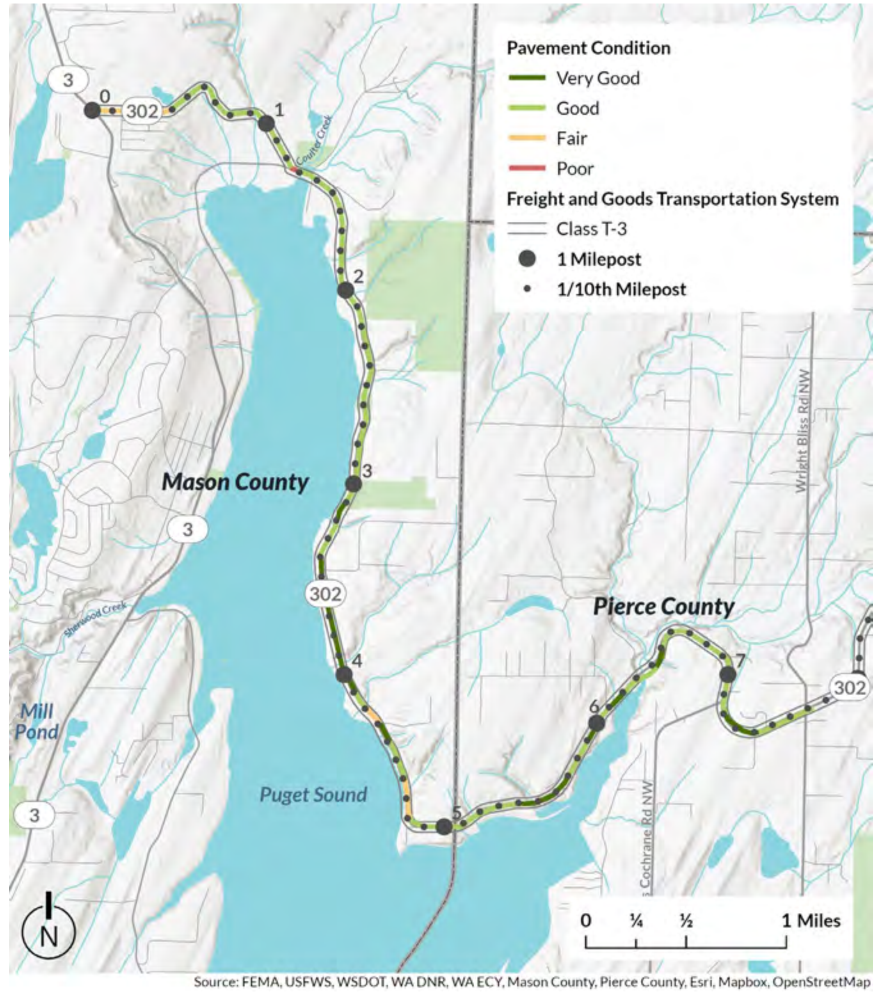


Figure 5. Corridor Pavement Conditions

4.4 Active Transportation Facilities

Active transportation is defined as using a human-scale and, often, human-powered means of travel to get from one place to another. This includes walking, bicycling, using a mobility assistive or adaptive device such as a wheelchair or walker, using micromobility devices, and using electric-assist devices such as e-bikes and e-foot scooters. Active transportation facilities are not currently provided along the SR 302 corridor within the study area. Active transportation users are permitted to travel along the existing shoulders, which are 2 feet to 3 feet wide on both sides.

4.5 Transit Facilities

Public transportation is not provided by either Mason Transit or Pierce Transit along SR 302 within the study area. School bus service is provided along the SR 302 corridor within the study area, with a few bus stops located along the shoulders. These bus stop locations change from year to year based on where riders live.

4.6 Land Use

For the portion of the SR 302 corridor that travels through Mason County (MP 0 to MP 5), the zoning is mostly rural residential with one parcel designated as agricultural resource lands near the intersection of SR 302 and E North Bay Road/SR 302. For the portion of the SR 302 corridor within the study area that travels through Pierce County (MP 5 to MP 7.69), the zoning is a mix of rural, rural sensitive resource, and rural neighborhood center near the intersection of SR 302 and Wright Bliss Road NW.

5. GEOTECHNICAL CONDITIONS

The legislative proviso to perform the SR 302 Victor Area Study included addressing solutions to address landslides that have caused recent road closures. The consultant team performed a geotechnical engineering study that is documented in the Geotechnical Report included in Appendix B. This section summarizes the geotechnical issues and recommendations.

This geotechnical engineering study evaluated the soil and ground water conditions in the slide study area to aid in the development and evaluation of a landslide repair. From the subsurface exploration and the laboratory testing of samples collected, two main issues were identified: roadway movements and ancient slide. Roadway movement is caused by groundwater drainage issues and a slide surface plane located approximately 35 feet below the ground surface. The ancient slide appears to be inactive but could represent a risk to the roadway if it reactivates. There is also evidence of tidal erosion; however, mitigation work along the shoreline would be difficult to permit.

Several strategies were evaluated to address drainage issues and roadway stability in the short term and midterm, and additional long-term strategies were evaluated to address the ancient slide. These strategies were screened according to performance measures for slope stability; design efforts; exposed surfaces to wave action, flood, and tides; roadway shoulder width on each side of the road; permittable; maintenance intervals; maintenance effort and impacts; cost; and detours and delays during construction. The recommendations are as follow:

- **Short-term/lower cost partial mitigation:** Lightweight cellular concrete fill (option #2) with drainage improvements
- **Mid-term/partial mitigation:** Aggregate shafts (option #4) with drainage improvements
- **Long-term/full mitigation:** Anchored slope stabilization (option #6) with drainage improvements

These geotechnical recommendations were identified first before any transportation strategies were developed and screened, as discussed in Section 8. The geotechnical recommendations were considered through the screening and selection of the recommended transportation strategy.

More detailed information on the geotechnical conditions, subsurface exploration, and screening and selection of recommendation strategies is included in the Geotechnical Report in Appendix B.

6. TRANSPORTATION ANALYSIS

Incorporating proposed geotechnical solutions documented in Section 5, this SR 302 Victor Area Study looked at safety and infrastructure improvements to the roadway, including improvements for active transportation. To understand the existing and future baseline conditions along the SR 302 corridor within the study area, traffic operations, active transportation, and crash history were analyzed for this study.

6.1 Traffic Operations Analysis

6.1.1 Study Conditions

The SR 302 corridor within the study area was evaluated for the following conditions.

Year 2022 Existing Conditions

The Year 2022 Existing Conditions represent the existing transportation conditions as documented in Section 4.

Year 2030 Future No Build Condition

As mentioned in Section 1.4 improvements from the SR 3 Freight Corridor Planning Study (WSDOT 2020) are expected to be completed by Year 2030. The recommended south-end connection for the new SR 3 freight corridor includes two single-lane roundabouts at the SR 3 Business Loop/SR 3 Freight Corridor and SR 3 Freight Corridor/SR 302 intersections, as shown in Figure 6. No other changes to the SR 302 corridor within the study area are expected for the Year 2030 Future No Build Condition.

Year 2050 Future No Build Condition

The Year 2050 Future No Build Condition includes the same improvements as the Year 2030 Future No Build Condition.

6.1.2 Traffic Volumes

Existing traffic data was collected on Tuesday, November 15, 2022, between 3 and 5 p.m. Turning movement counts were collected for eight study intersections. Traffic data are included in Appendix C. Because the volumes were collected in November when volumes are typically lower, a seasonal factor was applied to the turning movements counts. SR 302 within the study area is in the rural, non-interstate, non-recreational west group named GR-05 in the WSDOT Short Count Factoring Guide (WSDOT 2019b). For a GR-05, a seasonal factor of 1.07 is applied to midweek counts collected in November.

Figure 6. SR 3 Freight Corridor Study Improvements

An annual growth rate was used to forecast PM peak hour traffic volumes to future Year 2030 and Year 2050. Volume data for the Year 2000 and Year 2021 along SR 302 at SR 3 (MP 0.00), E North Bay Road (MP 1.26), and Wright Bliss Road NW (MP 7.69) from the WSDOT Geoportal (WSDOT n.d.d) were used to estimate historical growth rates. Between 2000 and 2021, the annual growth rate for the SR 302 corridor within the study area was approximately 1.0%. This annual growth rate was applied to the Year 2022 existing volumes to forecast Year 2030 and Year 2050 volumes for seven study intersections on SR 302. For the new roundabouts to be constructed at SR 3 and SR 302, the future volumes were forecasted based on the Year 2025 and Year 2040 volumes developed in the SR 3 Freight Corridor Planning Study (WSDOT 2020). The intersection traffic volumes are shown in Appendix D.

Year 2022 average daily traffic along SR 302 ranges from 4,200 towards the west end of the study area and 5,700 towards the east end of the study area.

6.1.3 Intersection Operations

6.1.3.1 Level of Service

Synchro (version 11) was used to measure level of service (LOS) for the study intersections along SR 302. The analysis followed the guidance in the WSDOT Synchro & SimTraffic Protocol (WSDOT 2018b). LOS is a common method of measuring traffic operations, defined in terms of average intersection delay on a scale ranging from A to F, depending on the delay conditions at the intersection. LOS A represents the best conditions, with minimal delay, and LOS F represents the worst conditions, with severe congestion.

Two factors determine delay: (1) the capacity of the intersection as defined by the number of lanes, lane widths, pedestrian volumes, and other features; and (2) signal timing. Capacity, delay, and LOS are calculated for each traffic movement or group of traffic movements at an intersection. The weighted average delay across all traffic movements determines the overall LOS for a signalized intersection. The LOS at unsignalized intersections that are stop controlled on one or two approaches are also defined in terms of delay, but only for the worst stop-controlled approach, which is typically the minor street. Table 6 summarizes the criteria used to define LOS.

Table 6. Level of Service Criteria

LOS	Average Control Delay (sec/veh) Signalized Intersections	Average Control Delay (sec/veh) Unsignalized Intersections	Traffic Flow Characteristics
A	< 10	< 10	Virtually free flow; completed unimpeded.
B	> 10 and < 20	> 10 and < 15	Stable flow with slight delays; less freedom to maneuver.
C	> 20 and < 35	> 15 and < 25	Stable flow with delays; less freedom to maneuver.
D	> 35 and < 55	> 25 and < 35	High density but stable flow.
E	> 55 and < 80	> 35 and < 50	Operations conditions at or near capacity; unstable flow.
F	> 80	> 50	Forced flow; breakdown conditions.

Sec/veh = seconds per vehicle

Note: the LOS criteria are based on control delay, which includes initial deceleration delay, final deceleration delay, stopped delay, and queue move-up time.

Source: Transportation Research Board Highway Capacity Manual (HCM), Sixth Edition: A Guide for Multimodal Mobility Analysis

The LOS standard for the SR 302 corridor is set by the Peninsula RTPO in the Regional Transportation Plan 2040 (2019a) and PSRC in the Adopted Level of Service Standards for Regionally Significant State Highways (n.d.). The LOS standard for both organizations is LOS C.

6.1.3.2 Volume-to-Capacity Ratio

Sidra (version 9) was used to measure the volume-to-capacity (v/c) ratio for the proposed roundabouts along SR 302. The analysis followed the guidance in the WSDOT Sidra Policy Settings (WSDOT n.d.e). Unlike other intersection control types, the primary MOE for roundabouts is not LOS. Instead, it is a mix of MOEs. V/c ratio is the primary measure of effectiveness for roundabouts, followed by delay, queues and then LOS. V/c measures the amount of traffic on a given roadway relative to the amount of traffic the roadway was designed to accommodate. The goal for roundabouts is for the v/c ratio to be between 0.85 and 0.90. If LOS is reported as D or better while v/c or queues are unacceptable, consider LOS as failing.

6.1.3.3 Analysis Results

The LOS results for the unsignalized intersections and the v/c ratio results for the roundabouts for the Year 2022 Existing Conditions, Year 2030 Future No Build Condition, and Year 2050 Future No Build Condition are shown in Table 7 and Figure 7. The unsignalized intersections all meet LOS standards and operate within LOS C. In the Year 2050 No Build Condition, the SR 3 Business Loop/SR 3 Freight Corridor intersection (#1a) is expected to operate with a v/c ratio of 0.99, which exceeds the goal of a v/c ratio between 0.85 and 0.90. The Synchro and Sidra reports are available in Appendix E.

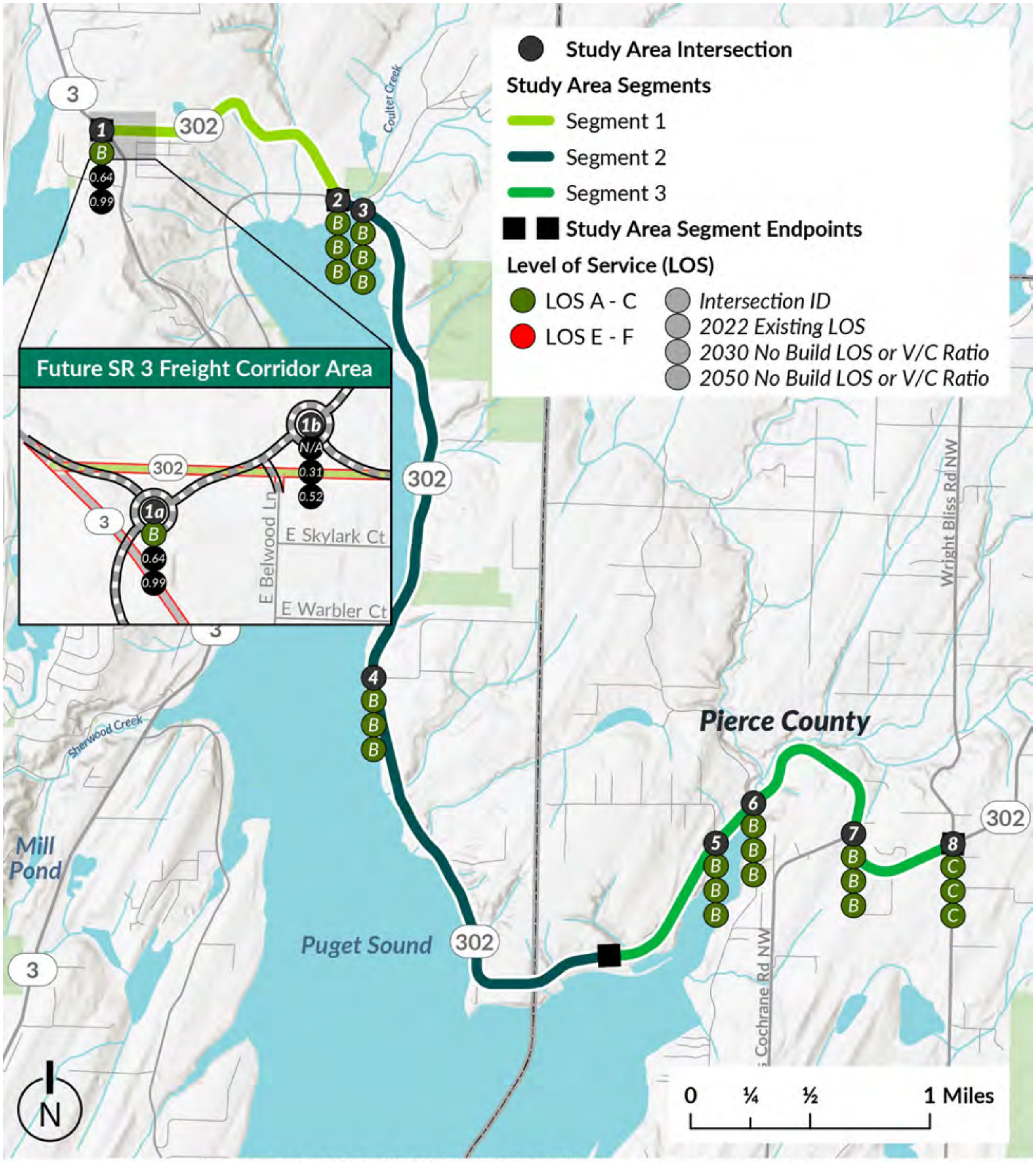
Table 7. Intersection Level of Service and V/C Ratio – PM Peak Hour

Study Intersection	Intersection Control	Year 2022 Existing Delay (s)	Year 2022 Existing LOS	Year 2030 No Build Delay (s)	Year 2030 No Build LOS	Year 2030 No Build v/c ratio	Year 2050 No Build Delay (s)	Year 2050 No Build LOS	Year 2050 No Build v/c ratio
#1. SR 3 and SR 302	OWSC	14.4	B	-	-	-	-	-	-
#1a. SR 3 Business Loop and SR 3 Freight Corridor	Roundabout	-	-	7.1	A	0.64	18.8	B	**0.99**
#1b. SR 3 Freight Corridor and SR 302	Roundabout	-	-	6.2	A	0.31	7.1	A	0.52
#2. SR 302 and E North Bay Road/SR 302	OWSC	11.6	B	12.1	B	-	13.0	B	-
#3. S Coulter Creek Road and SR 302	TWSC	12.7	B	13.3	B	-	14.6	B	-
#4. SR 302 and E Victor Road	OWSC	10.1	B	10.1	B	-	10.4	B	-
#5. SR 302 and 184th Avenue Court NW	OWSC	10.4	B	10.6	B	-	10.9	B	-
#6. SR 302 and Rocky Creek Road NW	OWSC	12.1	B	12.2	B	-	12.8	B	-
#7. SR 302 and Bliss Cochrane Road NW	OWSC	10.0	B	10.1	B	-	10.3	B	-
#8. Wright Bliss Road NW and SR 302	TWSC	18.7	C	19.3	C	-	24.8	C	-

LOS = level of service; OWSC = one-way stop-control; s = seconds; TWSC = two-way stop-control; v/c = volume-to-capacity

For stop-controlled intersections, delays are reported for the stop-controlled approach.

Results for OWSC and TWSC intersection are reported using HCM 6 methodology.



Source: FEMA, USFWS, WSDOT, WA DNR, WA ECY, Mason County, Pierce County, Esri, Mapbox, OpenStreetMap

Figure 7. Intersection Level of Service and V/C Ratio – PM Peak Hour

6.1.4 Freight

Based on the existing PM peak hour traffic counts, heavy vehicles are up to 1.4% of all traffic in the westbound direction and up to 10.2% of all traffic in the eastbound traffic. The number of heavy vehicles is larger on the east end of the study area towards Wright Bliss Road NW than on the west end of the study area towards SR 3.

6.2 Active Transportation Analysis

6.2.1 Active Transportation Level of Traffic Stress

Level of traffic stress (LTS) is a quantitative evaluation of road segments and crossings based on posted speed limits, number of vehicle travel lanes, traffic volumes, and the existence of a bike lane (for bicycle LTS). LTS is calculated on a scale of 1 to 4, with 1 being generally suitable for all ages and abilities to use and 4 being used only out of necessity. The metrics used to evaluate LTS are from the WSDOT Design Bulletin #2022-01 Designing for Level of Traffic Stress (WSDOT 2022e).

LTS can be evaluated for pedestrians and bicyclists separately, but since there are no designated bicycle facilities or sidewalk along SR 302 within the study area, LTS was evaluated for mixed traffic. Along the SR 302 corridor within the study area, the LTS ranges from 3 to 4 as shown in Figure 8.

6.2.2 Active Transportation Destinations

The active transportation destinations within the study area are shown in Figure 9. These destinations were defined using destination connectivity criteria in the WSDOT Active Transportation Plan (WSDOT 2021), which includes banks, education, entertainment, restaurants, grocery, health, public services, recreation, and shopping. Within the study area, there are three schools, public clamming access, and a gas station with food. In addition, destinations in communities such as Belfair, Allyn, and Purdy are within a 5-mile bicycle ride of homes near the east and west ends of the study area.

6.2.3 Active Transportation Gaps

Active transportation gaps are defined in the WSDOT Active Transportation Plan (WSDOT 2021a) as segments within population centers that are LTS 3 or LTS 4. The section of the SR 302 corridor that is within Pierce County is within a population center, so this section of SR 302 is defined as an active transportation gap, as shown in Figure 8.

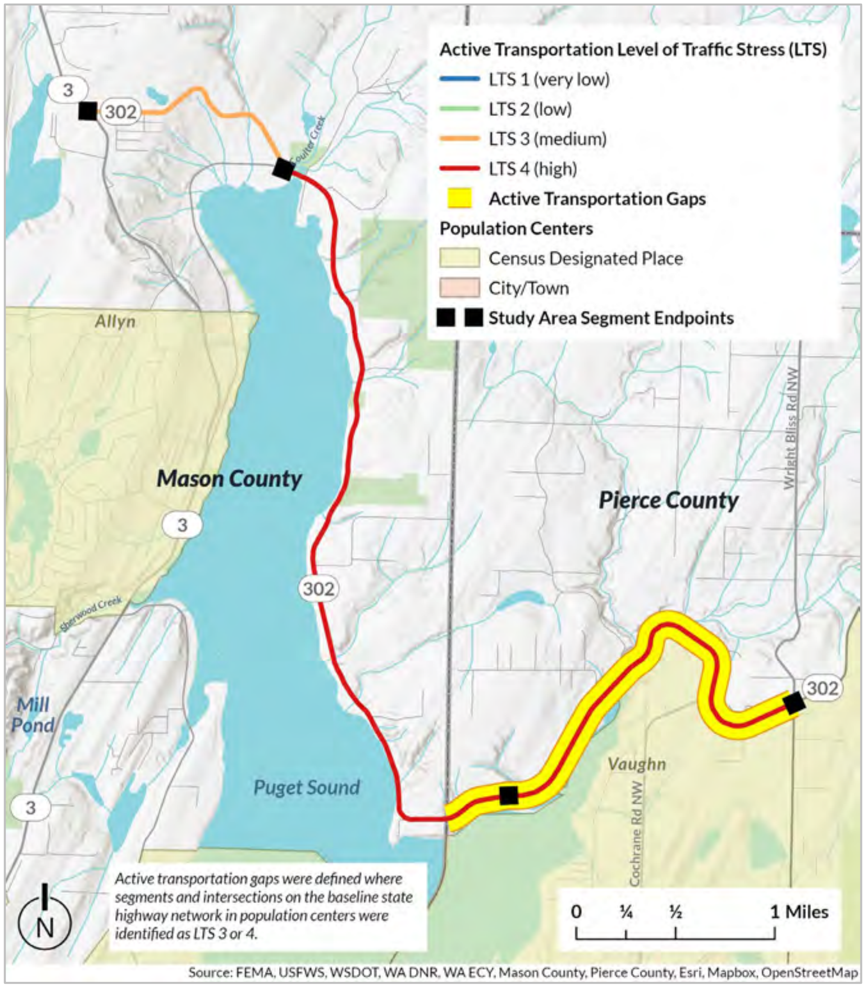


Figure 8. Active Transportation Level of Traffic Stress

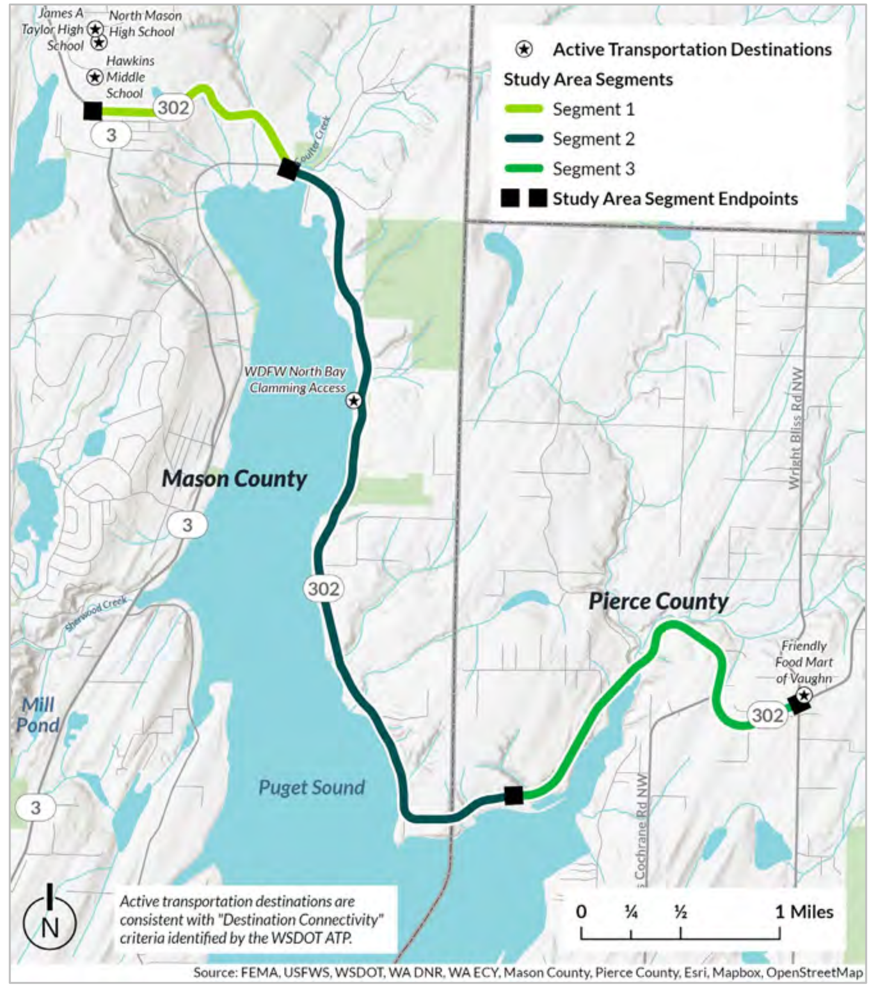


Figure 9. Active Transportation Destinations

6.3 Crash Analysis[1]

One component of the legislative proviso was to recommend safety improvements along SR 302 in the Victor Area. Following WSDOT Safety Guidance for Corridor Planning (WSDOT 2015), and discussions with staff in the WSDOT Olympic Region Traffic office, a basic analysis level was selected for this study. This includes an assessment of the observed crash history to identify any trends about current conditions.

Collision data were obtained from WSDOT between January 1, 2017, and December 31, 2021. During the analysis period, 131 total crashes occurred on the corridor between SR 3 and Wright Bliss Road NW. This included one fatal crash and two serious injury crashes, although about 70% of crashes were crashes that had property damage only. Over 28% of crashes (37 crashes) were intersection related and about 8% were driveway related (11 crashes). There were no crashes that involved a pedestrian or bicyclist.

The majority of crashes (34%) were fixed object crashes followed by angle crashes (22%) and non-collision crashes (21%). The fixed object crashes and non-collision[2] crashes suggest a trend in the occurrence of run-off-the-road crashes along the corridor, many of which are clustered in or near horizontal curves. The angle crashes on the corridor occurred primarily at intersections or driveways. More detailed information is included in Appendix F.

Consideration of the primary contributing factors of the crashes can also help to highlight potential trends and opportunities for improvements along the corridor. More detailed information regarding the primary contributing factors of the crashes on the corridor are included in Appendix F.

Washington State's Strategic Safety Plan – Target Zero (2019a) forms the basis for how Washington State measures safety performance and sets priorities and emphasis areas for safety performance investments. Target Zero's intent is to reduce fatal and serious injury crashes and includes emphasis areas with priorities based on the number of fatalities or number of serious injuries. The plan highlights the need for multimodal approaches to safety by including emphasis areas for pedestrians, bicyclists, motorcyclists, heavy trucks, older drivers, and younger drivers. Using Target Zero as its guide, WSDOT uses a priority programming system to identify and

---

[1] Under 23 U.S. Code § 148 and 23 U.S. Code § 407, safety data, reports, surveys, schedules, lists compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential crash sites, hazardous roadway conditions, or railway-highway crossings are not subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

[2] A non-collision crash is a collision where the first harmful event is not a collision with a fixed or non-fixed object or another vehicle (e.g., overturn, jackknife).

determine what locations have the highest potential for the reduction of fatal and serious injury crashes and return the greatest benefit for the cost of the project.

The WSDOT Highway Safety Improvement Program (n.d.f) has been developed to address both the occurrence and potential for crashes. The State highway system is screened every 2 years to identify segments and intersections where the expected number of fatal and serious injury crashes are greater than what would be anticipated at a similar site. These locations, called Collision Analysis Locations/Collision Analysis Corridors (CALs/CACs), are then analyzed and evaluated by the regions.

While a number of crashes have occurred along the SR 302 corridor within the study area, SR 302 has not been identified as a CAL/CAC. As a result, WSDOT Olympic Region has not identified any priority safety projects on the corridor at this time.

7. ENVIRONMENTAL CONTEXT

7.1 Natural Environment

WSDOT defines the environmental context of a transportation corridor during planning following a stepwise assessment of conditions within the corridor. The agency begins by identifying environmental assets that it manages within a corridor and other existing environmental needs. The environmental screening followed the WSDOT Environmental Manual Chapter 200 (WSDOT 2022b).

GIS-mapped environmental resources were provided by WSDOT and Pierce County, as shown in Figure 10 and Figure 11. GIS data was not available from Mason County. Figure 10 shows fish passage barriers, habitat connectivity investment priorities, and Pierce County wetlands. Figure 11 shows asset criticality and potential impact from the climate impact vulnerability assessment (CIVA), and flood hazard zones. Chronic environmental deficiencies, noise walls, historic bridges, and stormwater best management practice sites and retrofit priorities were also evaluated per the WSDOT Environmental Manual Chapter 200 (WSDOT 2022b), but none of these resources are located in the study area.

Potential impacts within the study area include:

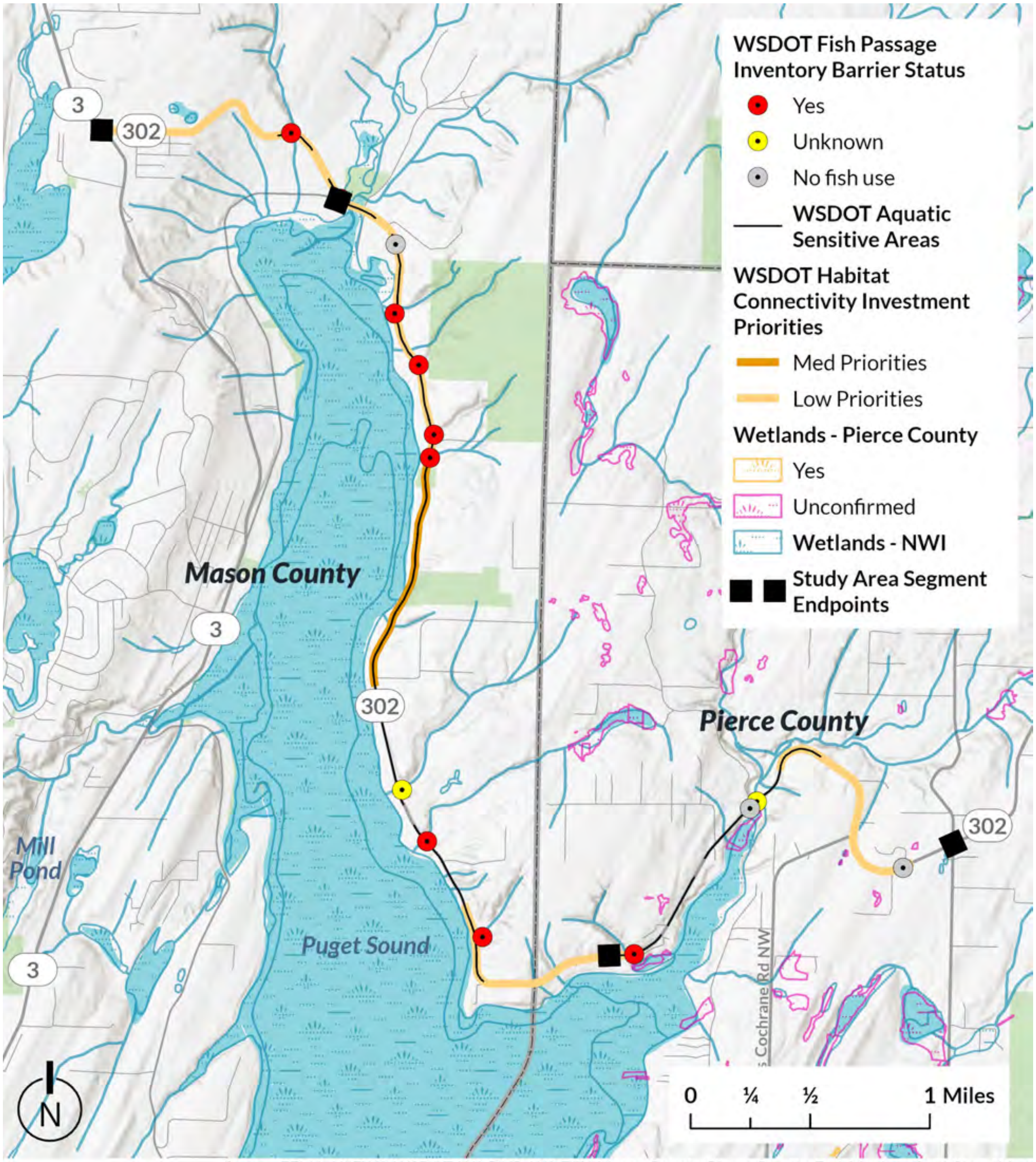
- 13 fish passage barriers
- Stream crossings between MPs 2 to 3 and MPs 6 to 7
- Section along MPs 4 to 5 is within 100 feet of floodplain and SMA shoreline
- 13 hazardous material sites
- High asset criticality west of Wright Bliss Rd NW

CIVA ratings are assessed by WSDOT based on criticality (how critical the corridor is to overall transportation operations and public safety) and impact (potential climate change impacts to corridor operations). Several data sources are used to assess these CIVA ratings, including sea-level rise data from 2009. WSDOT provided additional 2018 sea-level rise data from the University of Washington Climate Impact Group, which is consistent with the 2009 data.

7.2 Vulnerable Populations and Overburdened Communities

Per guidance in the Washington State Active Transportation Plan (2021a), disparities in active transportation access for vulnerable populations and overburdened communities should be considered when evaluating strategies. For the transportation strategy screening process, indicators from the Justice40 Initiative (USDOT 2023) were used to evaluate potential impacts to vulnerable populations and overburdened communities from the proposed transportation strategies.

The full study area exceeds the 50th percentile for transportation access disadvantage. The portion of Mason County within the study area exceeds the 50th percentile for economic disadvantage and equity disadvantage.



Source: FEMA, USFWS, WSDOT, WA DNR, WA ECY, Mason County, Pierce County, Esri, Mapbox, OpenStreetMap

Figure 10. Environmental Context 1

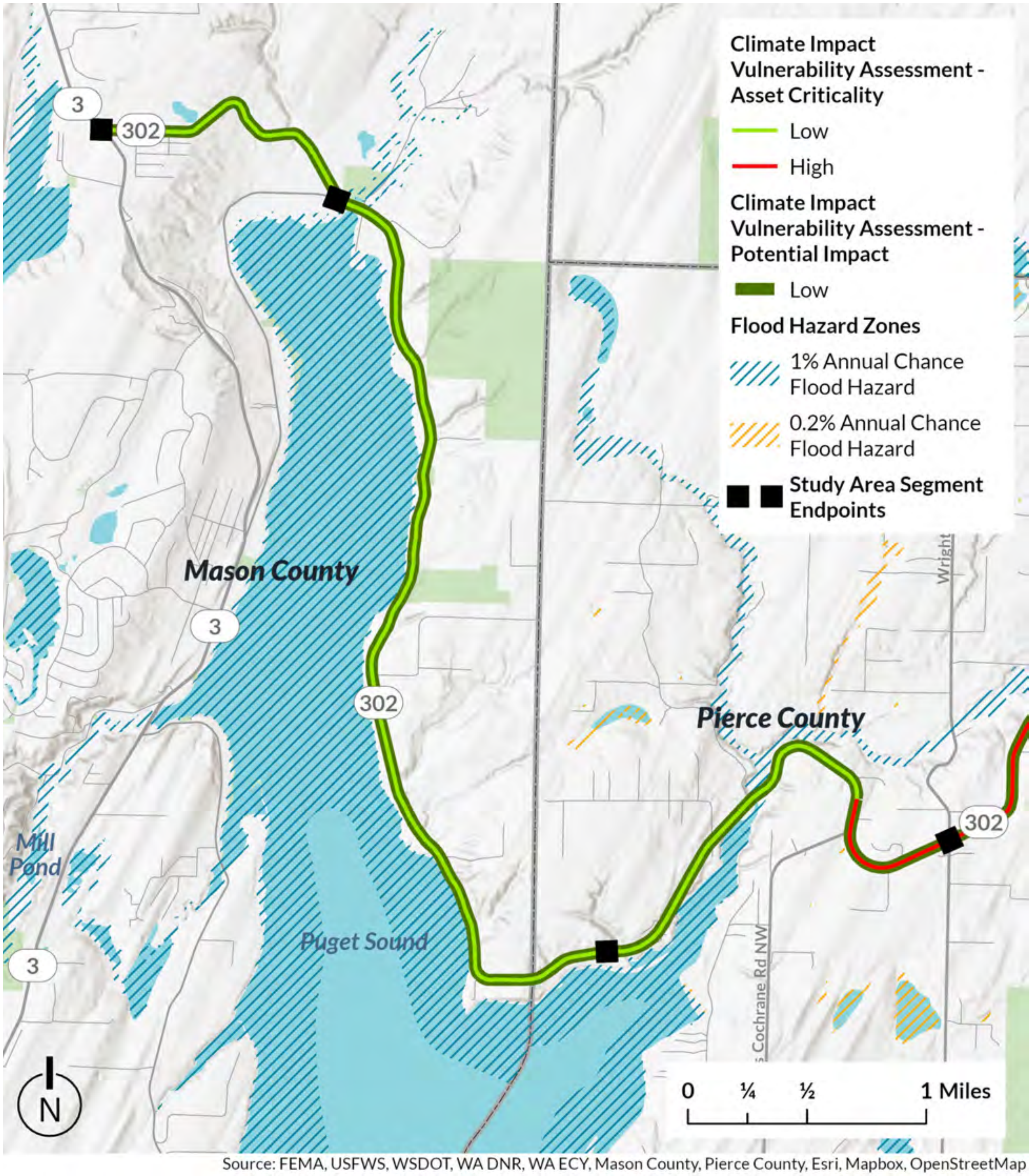


Figure 11. Environmental Context 2

7.3 Environmental Health Disparity

The Washington Environmental Health Disparities (EHD) Map is an interactive mapping tool that evaluates environmental health risk factors in communities and compares communities across the state for environmental health disparities. It estimates a cumulative environmental health impact score for each census tract, reflecting pollutant exposures and factors that affect people's vulnerability to environmental pollution. The model takes into account both threat (represented by indicators that account for pollution burden) and vulnerability (represented by indicators of socioeconomic factors and sensitive populations) to help compare health and social factors that may contribute to disparities in a community. Census tracts with overall EHD ranks of 1 have lower impacts environmental risks to sensitive populations than tracts with EHD ranks of 10.

SR 302 within the study area spans two census tracts (see Figure 12): tract 9604.01 in Mason County and tract 726 in Pierce County. Both census tracts ranked low for overall environmental health disparities (2 to 3 out of 10). Both Mason County and Pierce County census tracts show similar medium levels of risk for environmental exposures (6 out of 10) for ozone concentrations and toxics releases from facilities from the Risk Screening Environmental Indicators model. The study area measured high for socioeconomic vulnerability (7 out of 10), which includes factors such as high school diploma attainment, transportation expense, unemployment, and low birth weight.

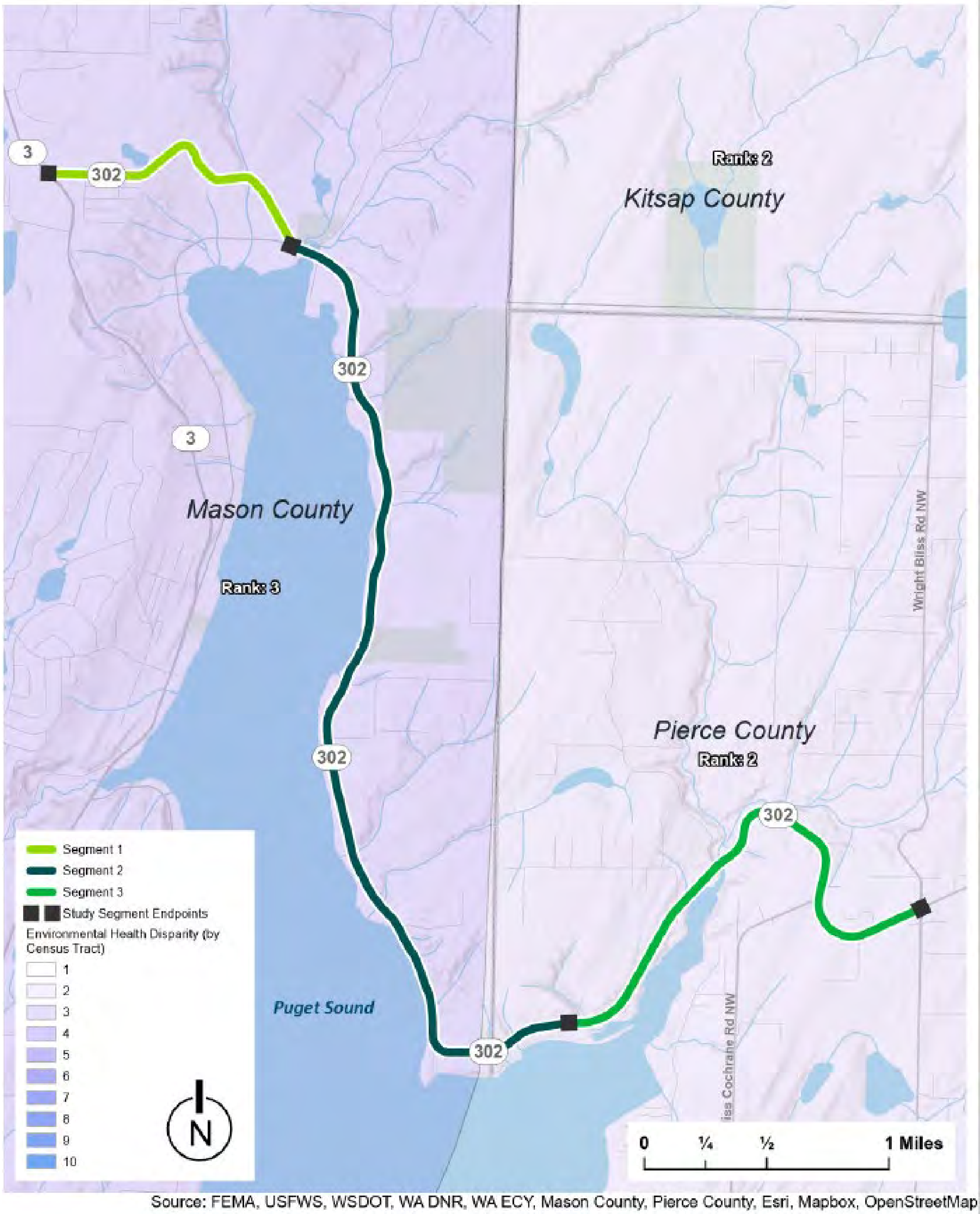


Figure 12. Environmental Health Disparity

8. STRATEGY DEVELOPMENT AND SCREENING PROCESS

8.1 Strategy Development and Overall Screening Process

A multistep screening process was used to identify, screen, evaluate, and rank potential strategies. The first step in the screening process was to generate ideas with potential to address the needs of the corridor. Based on the study purpose and the transportation analysis of existing and future No Build conditions, the study team and SAC developed transportation strategies to address the corridor issues. Suggestions were also collected from the public through the online open house. Safety concerns were noted by participants in the online open house, as discussed in Section 3.3. In fact, safety was noted as the biggest existing challenge for travelers on the SR 302 corridor within the study area. Participants suggested strategies such as better lighting, better signage, and reduced speed limits. As discussed in Section 6.3, SR 302 has not been identified as a CAL/CAC within the study area. Safety has not been identified as a transportation need for the SR 302 corridor within the study area at this time, so safety countermeasures were not evaluated as potential strategies.

A few strategies were evaluated for both sides of SR 302 within the study area. Since the SR 302 corridor changes orientation several times within the study area, these sides are referred to as the shoreline side (mostly west or south of the corridor centerline) and the non-shoreline side (mostly east or north of the corridor centerline).

A total of eight transportation strategies were identified and evaluated for this study. The strategies and potential benefit of each are shown in Table 8.

Table 8. Transportation Strategies

Strategy Description	Potential Benefit
Bike lane on shoulder *(evaluated for shoreline and non-shoreline side)*	Improves bicyclist LTS and connectivity by providing a dedicated facility
Shared-use path *(evaluated for shoreline and non-shoreline side)*	Improves active transportation LTS and connectivity by providing a dedicated facility
Flexible delineators or barriers for bike lanes	Improves active transportation safety by making bike lanes more conspicuous and/or by providing more protection between drivers and bicyclists
New roadway alignment	Improves vehicle mobility by providing an alternate roadway with no or fewer conflict points or intersections
Freight restrictions	Improves general-purpose vehicle and active transportation safety by reducing crashes related to speeding and improves noise pollution

Table 8. Transportation Strategies (continued)

Strategy Description	Potential Benefit
Floating road grid (floating bridge)	Improves vehicle mobility by providing an alternate roadway with no or fewer conflict points or intersections
Additional lanes or turn lanes at intersections	Improves vehicle mobility by reducing time spent traveling through intersections
Improved communication about road closures	Improves mobility by provide advance warning to travelers of any potential closures

8.2 Level 1 Screening (High Level)

The study team evaluated the list of strategies through a high-level screening process to identify which strategies meet WSDOT goals and policies. Improvement ideas that met the initial screening criteria were processed through a detailed screening that evaluated how well the different strategies addressed the study goals.

8.2.1 Level 1 Screening Metrics

Level 1 Screening was a high-level screening process meant to screen out any transportation strategies that would not meet the study goals. For Level 1 Screening, five questions related to the study goals were developed, as shown in Table 9. If the answer to all five questions for a strategy was a "yes," then the strategy passed Level 1 Screening.

Table 9. Level 1 Screening Questions

Study Goal	Screening Question
Study Needs	Is the strategy compatible with proposed geotechnical solutions, and does it meet the vision, goals and objectives for the study area?
Safety	Does the strategy have the potential to improve safety for active transportation users?
Multimodal Mobility	Does the strategy likely support the multimodal transportation network and improve mobility?
Environment	Is the strategy likely able to mitigate any potential significant environmental impacts?
Resilience	Does the strategy produce a more resilient transportation system?

8.2.2 Level 1 Screening Results

Four of the strategies evaluated for Level 1 Screening passed, and four strategies did not pass. The strategies that did not pass are shown in Table 10. The full results for Level 1 Screening are included in Appendix G.

Table 10. Strategies That Failed Level 1 Screening

Strategy Description	Segment(s) Where Strategy Failed	Study Goal Failed	Explanation for Study Goal Failed
New roadway alignment	1, 2, 3	Study Needs	A new roadway alignment does not follow WSDOT's Practical Solutions process in addressing the current geotechnical issues along the SR 302 corridor.
Freight restrictions	1, 2, 3	Multimodal Mobility	Restricting freight would require heavy vehicles to detour 22 miles along SR 16 and SR 3 and through the Gorst area. Freight is up to 10% of total traffic during the PM peak hour, and restricting these vehicles would worsen their mobility. Additionally, this suggestion from the online open house was meant to reduce noise pollution, reduce speeding to get around trucks, and reduce stress and cracks in the road. Vehicle weight (heavy trucks) does not correlate with roadway cracks.
Floating road grid (floating bridge)	1, 2, 3	Study Needs	Similar to building a new roadway in an alternate location, any new roadway structures or new alignments on the water would have to happen in tandem with improvements to the existing roadway.
Additional lanes or turn lanes at intersections	1, 2, 3	Multimodal Mobility	All study intersections currently operate within LOS standards, so additional lanes are not needed for traffic operations.

FHWA = Federal Highway Administration; ITE = Institute of Transportation Engineers

8.3 Level 2 Screening (Detailed)

Level 2 Screening was a more detailed screening process meant to narrow down the strategies to a preferred strategy or strategies. The transportation strategies that passed Level 1 Screening were divided into two different strategies to be evaluated as a group instead of individually. The Year 2050 Future No Build Condition was also evaluated in order to compare the proposed strategies to a baseline condition. Improved communication about road closures is intended to be an interim strategy before the landslides are addressed by the geotechnical recommendations outlined in Section 5 and was not evaluated as part of Level 2 Screening. The strategies are shown in Table 11.

Table 11. Strategies Included in Level 2 Screening

Segment	Strategies	Strategy #1 Improved Shoulder	Strategy #2 Shared-Use Path
1, 2, 3	Bike lane on shoulder (both sides)	X	
1, 2, 3	Shared-use path (non-shoreline side only)		X
1, 2, 3	Flexible delineators or barriers for bike lanes	X	
1, 2, 3	Improved communication about road closures		

Strategy #1 – Improved Shoulder

This strategy is intended to improve active transportation mobility while minimizing widening. The key feature of this strategy is expanding the roadway shoulder to include bike lanes on both sides of the roadway. In order to minimize impacts and maintain the existing edge of pavement on the shoreline side of the roadway, it was assumed that the roadway centerline would shift to the non-shoreline side and the roadway would be regraded to align the crown of the roadway with the new centerline.

Strategy #2 – Shared-Use Path

This strategy is intended to improve active transportation mobility. The key feature of this strategy is a full-width shared-use path designed according to the WSDOT Design Manual (WSDOT 2022d).

8.3.1 Level 2 Screening Metrics

Level 2 Screening was a more detailed screening process meant to narrow down to a preferred strategy or strategies. For Level 2 Screening, performance measures were developed based on the study goals and the WSDOT Practical Solutions Performance Framework (WSDOT n.d.a). The descriptions for each category of performance measures are as follows:

- **Safety:** Encourage and support active transportation use by improving active transportation user safety and experience. The implementation of design characteristics to improve safety at access points along the highway.
- **Multimodal Mobility:** The ease of reaching major destinations (e.g., jobs, services, schools, ports) from a specific location by different travel modes.
- **Social Equity and Environmental Justice:** The improvement and protection of health, safety, and accessibility outcomes for vulnerable populations, especially in low-income communities and communities that spend more, and longer, to get where they need to go.
- **Environment:** The impact of disturbing sensitive areas (wetlands, cultural areas, flood hazards, wildlife habitat, etc.) on the environment, and potential mitigations or improvements to protect and restore the environment.

- **Network Resiliency:** Strengthening transportation elements vulnerable to natural disaster, extreme weather, and climate impacts.
- **Cost and Implementation**: Planning-level costs, including potential right-of-way acquisition. Incremental, phased solutions should be considered, especially for solutions with high costs and complex implementation.

For each performance measure, scores from 1 to 3 were assigned, with a score of 1 being low performing and a score of 3 being high performing. Each strategy was evaluated for each corridor segment separately. A score was also calculated for the corridor as a whole, for each strategy. These corridor scores were averaged to develop an overall strategy score. The performance measures and scoring thresholds for each are shown in Table 12.

Table 12. Level 2 Screening Metrics

Category	Measure	Metric	Scoring
Safety	Active Transportation User Safety	Potential to improve active transportation user safety	1 – Potential to worsen active transportation user safety 2 – Active transportation user safety likely to remain the same 3 – Potential to improve active transportation user safety
Safety	Conflict points	Number of driveway/roadway crossings, length of exposure to driveways & roadways	1 – Increases the number of conflict points 2 – No change to the number of conflict points 3 – Reduces the number of conflict points
Multimodal Mobility	Motorist quality of service	Travel times Level of service (LOS) at intersections	1 – Maintains LOS and travel times 2 – Improves LOS (meets LOS standards) and/or travel times 3 – Improves LOS (meets LOS standards) and travel times
Multimodal Mobility	Ped/bike quality of service	Bicycle level of traffic stress (BLTS)	1 – BLTS 3 or higher 2 – BLTS 2 3 – BLTS 1
Multimodal Mobility	Ped/bike quality of service	Pedestrian level of traffic stress (PLTS)	1 – PLTS 3 or higher 2 – PLTS 2 3 – PLTS 1
Multimodal Mobility	Connectivity	Improves connections to active transportation destinations (e.g., schools, hospitals) and/or helps complete future active transportation network (consistent with local plans)	1 – Does not maintain or improve connections to active transportation destinations 2 – Maintains connections to active transportation destinations consistent with local plans 3 – Improves connections to active transportation destinations consistent with local plans
Social Equity and Environmental Justice	Historically disadvantaged communities	Impacts in communities with economic or equity disadvantages	1 – Some impacts or displacements for residential or business areas identified with economic or equity disadvantages 2 – Minimal impacts or displacements for residential or business areas identified with economic or equity disadvantages 3 – No impacts or displacements for residential or business areas identified with economic or equity disadvantages

Table 12. Level 2 Screening Metrics (continued)

Category	Measure	Metric	Scoring
Social Equity and Environmental Justice	Accessibility	Improves connectivity in transportation disadvantaged communities	1 – Does not improve transportation connections for transportation disadvantaged communities 2 – May improve transportation connections for transportation disadvantaged communities 3 – Provides improved transportation connections for transportation disadvantaged communities
Environment	Improves the natural environment	Improves fish passage, wetland habitat, habitat connectivity; maintains environmental compliance; reduces impacts to fish at chronic environmental deficiency sites	1 – Minimal or no improvement 2 – Improves one sensitive area 3 – Improves 2 or more sensitive areas
Environment	Improves stormwater management	Number of acres of previously untreated existing pavement now treated	1 – Less than 30% improvement 2 – 30%–70% improvement 3 – >70% improvement
Network Resiliency	Resiliency	Strategy would increase resiliency to natural disasters, extreme weather, and climate impacts	1 – Maintains current CIVA category 2 – Improves short-term resiliency 3 – Improves long-term resiliency
Cost and Implementation	Cost	Planning-level cost estimate	1 – > $5,000,000 2 – $1,000,000 to $5,000,000 3 – < $1,000,000
Cost and Implementation	Detours/delays during construction	Estimated hours of additional delay during construction	1 – Large impacts during construction 2 – Moderate impacts during construction 3 – Minimal to no impact during construction

BLTS = bicycle level of traffic stress; CIVA = climate impact vulnerability assessment; CMF = crash modification factor; LOS = level of service; NHSTA = National Highway Safety Administration; PLTS = pedestrian level of traffic stress

8.3.2 Planning-Level Cost Estimates

Planning-level cost estimates were developed for each strategy, incorporating probable costs associated with engineering, environmental, right-of-way, construction, and project-related costs. The cost estimates were developed using the WSDOT Planning Level Cost Estimation tool, which was developed with 2016 unit cost data. Based on actual and forecasted WSDOT construction cost data from the WSDOT Planning Level Cost Estimation User Manual (WSDOT 2019c), a 26% escalation was used to scale the cost estimates to calibrate the WSDOT Planning Level Cost Estimation tool to report 2023 dollars.

Per WSDOT's Maintenance guidance for planning studies (n.d.g), if the recommendation includes capital construction that adds new infrastructure assets to the system, it is important to identify the impact of this capital construction to maintenance operations. To estimate these system addition impacts, the established rule of multiplying estimated capital construction costs by 0.5% should be applied. The product of this calculation represents the ongoing biennial expenses needed to maintain this new infrastructure.

The planning-level cost estimate ranges for each strategy are shown in Table 13.

Table 13. Planning-Level Cost Estimate Ranges

Segment	Cost Type	Strategy #1 Improved Shoulder	Strategy #2 Shared-Use Path
1	Construction Cost	$2.8 million to $3.8 million	$3 million to $4 million
1	Operations and Maintenance Biennial Expenses	$14,000 to $19,000	$15,000 to $20,000
2	Construction Cost	$31.1 million to $41.5 million	$38.7 million to $51.6 million
2	Operations and Maintenance Biennial Expenses	$155,000 to $207,000	$194,000 to $258,00
3	Construction Cost	$14.5 million to $19.3 million	$14.4 million to $19.1 million
3	Operations and Maintenance Biennial Expenses	$72,000 to $97,000	$72,000 to $96,000

Note: Costs are shown in 2023 dollars. Operations and maintenance biennial expenses assumed to be 0.5% of capital constructions costs.

8.3.3 Level 2 Screening Results

The total strategy scores for Level 2 Screening are shown in Figure 13. Of the two strategies, Strategy #2 performed the best, with an average segment score of 26. The full results for Level 2 Screening are included in Appendix H.

	No Build			#1 Improved Shoulder			#2 Shared Use Path		
	Score			Score			Score		
	Seg 1	Seg 2	Seg 3	Seg 1	Seg 2	Seg 3	Seg 1	Seg 2	Seg 3
TOTAL	21	21	21	25	24	23	27	25	25
SEGMENT AVERAGE	21			24			26		

Figure 13. Level 2 Screening Results Summary

A summary of the benefits and challenges of each strategy is as follows:

- **No Build**
  - Pros: No impacts or cost
  - Cons: No improvement to active transportation user safety, multimodal mobility, accessibility, environment, or resiliency
- **Strategy #1 Improved Shoulder**
  - Pros: Improvements to active transportation user safety, multimodal mobility, accessibility, environment, and resiliency. Additionally, property owners along the SR 302 corridor would be able to access their property more safely by walking or biking. It is assumed that any environmentally sensitive areas that would be impacted by this strategy would be improved or mitigated.
  - Cons: Impacts to the number of conflict points due to crossing driveways along the shoreline side and high cost due to widening. Some property acquisitions may also be required. An improved shoulder does not accommodate pedestrians of all ages and abilities, and pedestrians would be walking facing traffic, which conflicts with bicyclists that move with traffic.
- **Strategy #2 Shared-Use Path**
  - Pros: Improvements to active transportation user safety, multimodal mobility, accessibility, environment, and resiliency. Additionally, property owners along the SR 302 corridor would be able to access their property more safely by walking or biking. It is assumed that any environmentally sensitive areas that would be impacted by this strategy would be improved or mitigated.
  - Cons: Impacts to the number of conflict points due to crossing driveways along the shoreline side or crossing SR 302 to access the non-shoreline side, potential impacts to residential property in historically disadvantaged communities, and highest cost due to widening and related retaining walls. Some property acquisitions may also be required.

9. RECOMMENDATIONS

The recommendations were presented at SAC Meeting #4 and were supported by the SAC. With all future strategies, specifically long term, WSDOT will reevaluate the investment value and benefit before proceeding with a project level design. The geotechnical recommendations are all compatible with the transportation recommendations.

9.1 Short-Term Recommendations

As noted in Section 5, the short-term/lower-cost partial mitigation geotechnical recommendation is lightweight cellular concrete fill with drainage improvements, as shown in Figure 14. The intention is to reduce groundwater levels to improve the stability of the roadway slope.

For transportation, the recommendation is to improve communication during roadway closures for both planned construction and potential emergencies.

Figure 14. Lightweight Cellular Concrete – Example

Source: HWA GeoSciences Inc.

During planned construction closures:

- Coordinate and inform times of closure so that local EMS can schedule contingency ambulances.
- Develop communicator's responders list for updates.
- Provide responders with 24/7 contact.
- Provide active transportation elements that, at a minimum, match existing conditions.

During potential emergency closures:

- Continue WSDOT best practices for communications during emergency roadway closures.
- Work to keep at least one lane open, with alternating one-lane traffic.
- If active transportation facilities cannot be adequately maintained, establish a detour for the duration of the emergency closure.

9.2 Mid-Term Recommendations

As noted in Section 5, the mid-term/partial mitigation geotechnical recommendation is aggregate shafts with drainage improvements, as shown in Figure 15. The intention is to replace weak soils below the roadway and improve the stability of the roadway slope by improving the strength parameters of the existing soils.

There are no mid-term recommendations for transportation.

Figure 15. Aggregate Shafts – Example
Source: PT. Rekakarya

9.3 Long-Term Recommendations

As noted in Section 5, the long-term/full mitigation geotechnical recommendation is anchored slope stabilization with drainage improvements, as shown in Figure 16. The intention is to stabilize the ancient slide and roadway slope.

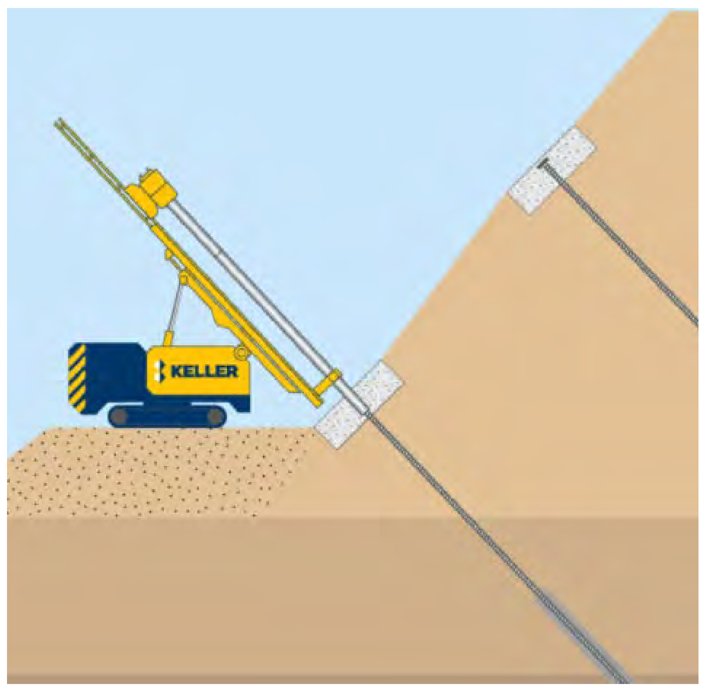


Figure 16. Anchored Slope Stabilization – Example
Source: Keller

For transportation, the recommendation is to continue to evaluate active transportation facilities. Either Strategy #1 Improved Shoulder or Strategy #2 Shared-Use Path could be considered, as both would provide improvements to active transportation user safety, multimodal mobility, accessibility, and resiliency. It should be noted that while a shared-use path benefits both bicyclists and pedestrians, a shoulder bike lane primarily benefits bicyclists. Both types of active transportation facilities would also include high costs and potential impacts to environmental resources and right-of-way. However, it was assumed that any environmentally sensitive areas that would be impacted by this strategy would be improved or mitigated.

For Strategy #1 Improved Shoulder, an example buffered bike lane (Segment 1), per WSDOT Design Manual guidance (WSDOT 2022d), is shown in Figure 17. For Segments 2 and 3, where the speed limit exceeds 35 mph, a barrier would be needed instead of a flexible delineator.

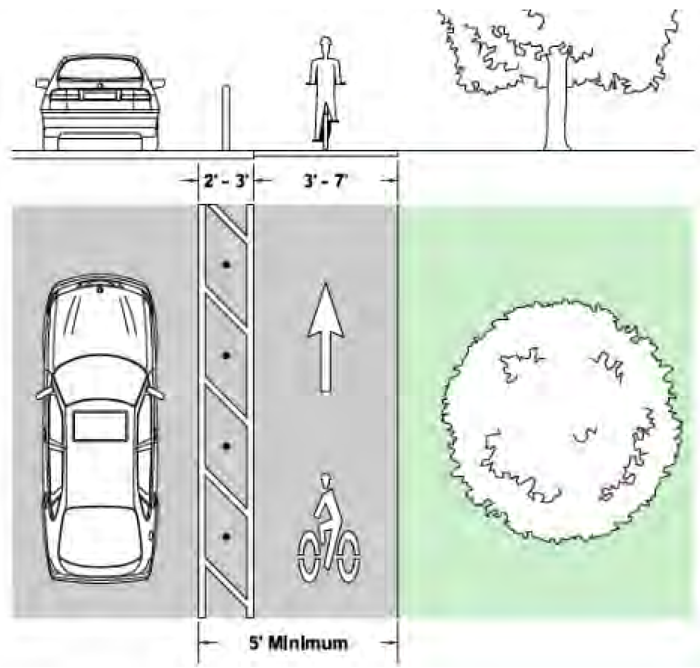


Figure 17. Buffered Bike Lane
Source: WSDOT Design Manual (WSDOT 2022d)

For Strategy #2 Shared-Use Path, two examples of two-way shared-use paths, per WSDOT Design Manual guidance (WSDOT 2022d), are shown in Figure 18 and Figure 19. Figure 18 should be referenced for roadway speeds of 35 mph and lower (Segment 1), and Figure 19 should be referenced for roadway speeds greater than 35 mph.

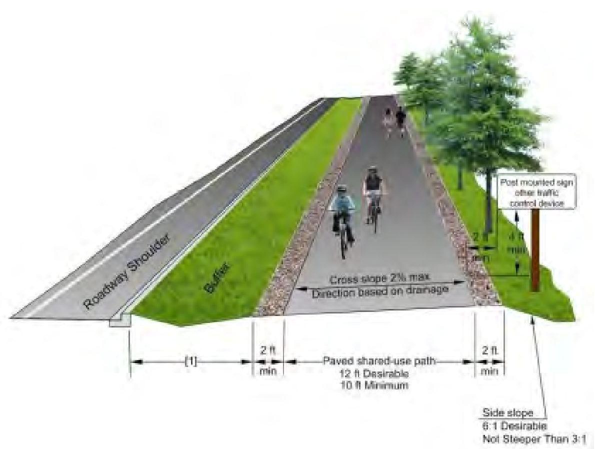


Figure 18. Shared-Use Path (≤ 35 mph)
Source: WSDOT Design Manual (WSDOT 2022d)

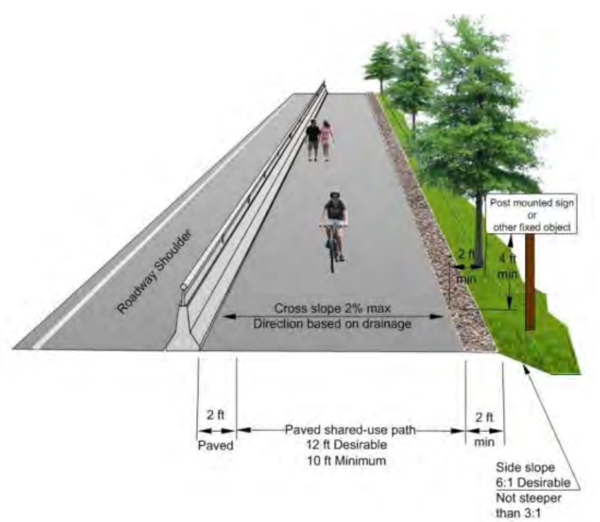


Figure 19. Shared-Use Path (> 35 mph)
Source: WSDOT Design Manual (WSDOT 2022d)

Due to the context of the study area and the high costs of these strategies, it is recommended that any active transportation facility along this corridor be considered in relation to a regional trail network, consistent with both Mason County and Pierce County long-term planning documents.

10. NEXT STEPS

The recommendations identified in this study will assist WSDOT in addressing the landslide and transportation issues along the SR 302 corridor between SR 3 and Wright Bliss Road NW. This corridor study will be submitted to the legislature.

These strategies will be prioritized on a statewide basis for future implementation, but due to limited state funding, will need to compete for funding with other proposed improvements throughout the state absent other funding sources. Upon completion of this report, funding to implement the recommended strategies, whether from the state, grants, developer contributions, or other sources, needs to be pursued. There is no funding identified for design and construction of the recommended strategies. WSDOT should work with local and regional agencies to incorporate the recommendations of this study into local, regional, and state plans.

WSDOT will seek continuing consultation from tribes in the study area to understand existing cultural resources and potential impacts from the recommendations.

11. REFERENCES

Mason County. 2016. Mason County Transportation Plan. Adopted June 21, 2016. https://masoncountywa.gov/community-services/planning/2036-comp-plan-update/Trans-Plan-060216.pdf.

Mason County. 2022. Six Year Transportation Improvement Program (TIP) 2023-2028. https://www.masoncountywa.gov/forms/public-works/6%20YEAR%20TIP%202023-%202028%20UPDATED.pdf.

Peninsula RTPO (Regional Transportation Planning Organization). 2019a. Regional Transportation Plan 2040. November 15, 2019. https://static1.squarespace.com/static/5eebd256bac4f23605781ccb/t/5f5276a772a11826cd52168b/1599239899220/PRTPO+Regional+Transportation+Plan+2040.pdf.

Peninsula RTPO. 2019b. Peninsula Regional Non-Motorized Connectivity Study. Prepared for Peninsula RTPO by Parametrix, Seattle, WA. July. January 2019.

Pierce County. 1997. Pierce Country Nonmotorized Transportation Plan. Effective August 3, 1997. https://www.piercecountywa.gov/DocumentCenter/View/7146/NMTP-final?bidId=.

Pierce County. 2007. Pierce County Comprehensive Plan: Key Peninsula Community Plan. Adopted October 23, 2007. https://www.piercecountywa.gov/DocumentCenter/View/38488/ADOPTED-Key-Peninsula-Community-Plan?bidId=.

Pierce County. 2021a. Pierce County Comprehensive Plan, as amended. Effective October 1, 2021. https://www.piercecountywa.gov/DocumentCenter/View/38259/ADOPTED-Comprehensive-Plan-with-Community-Plans-Effective-10-1-2021?bidId=.

Pierce County. 2021b. Transportation Improvement Program (TIP) 2022-2027. Ordinance No. 2021-94S2. Effective December 11, 2021. https://www.piercecountywa.gov/ArchiveCenter/ViewFile/Item/7304.

PSRC (Puget Sound Regional Council). N.d. Adopted Level of Service Standards for Regionally Significant State Highways. https://www.psrc.org/our-work/adopted-level-service-standards-regionally-significant-state-highways.

TRB (Transportation Research Board). 2017. Highway Capacity Manual, 6th Edition: A Guide for Multimodal Mobility Analysis. National Academies of Science, Engineering, and Medicine, Washington, DC.

USDOT (U.S. Department of Transportation). 2023. Justice40 Initiative. https://www.transportation.gov/equity-Justice40.

WSDOT (Washington State Department of Transportation). 2008. SR 302 Corridor Study: Existing Conditions and Problem Definition Report.

WSDOT. 2015. Safety Guidance for Corridor Planning. System Analysis & Planning Office, Multimodal Planning Division. https://wsdot.wa.gov/sites/default/files/2021-10/SafetyGuidance_CorridorPlanningStudies_June2016.pdf.

WSDOT. 2016. Community Engagement Plan – 2016 Update. Washington State Department of Transportation, Olympia, WA. https://wsdot.wa.gov/construction-planning/statewide-plans/community-engagement-plan.

WSDOT. 2018a. Corridor 311 – SR 3 to SR 16 Jct Summary. WSDOT Corridor Sketch Summary. October 25, 2018.

WSDOT. 2018b. WSDOT Synchro & SimTraffic Protocol. Synchro version 10. https://wsdot.wa.gov/sites/default/files/2021-03/TrafficOps-WSDOTSynchroProtocol_0.pdf.

WSDOT. 2019a. Target Zero. Washington State Strategic Highway Safety Plan 2019. Washington Traffic Safety Commission Olympia, WA. https://wsdot.wa.gov/construction-planning/statewide-plans/strategic-highway-safety-plan-target-zero.

WSDOT. 2019b. Short Count Factoring Guide. https://www.wsdot.wa.gov/mapsdata/travel/pdf/ShortCountFactoringGuide2019.pdf

WSDOT. 2019c. Planning Level Cost Estimation User Manual. https://ftp.wsdot.wa.gov/incoming/PLCE2016/2016%20PLCE%20User%20Manual%20Update%2008.28.2019-opt.pdf.

WSDOT. 2020. SR 3 Freight Corridor Planning Study. Prepared for Washington State Department of Transportation by Parametrix, Bremerton, WA. July.

WSDOT. 2021a. Washington State Active Transportation Plan 2020 and Beyond. https://wsdot.wa.gov/construction-planning/statewide-plans/active-transportation-plan.

WSDOT. 2021b. EBASE User's Guide. May 2021. https://wsdot.wa.gov/sites/default/files/2021-10/EBASE-Manual-May-2021.pdf.

WSDOT. 2022a. Complete Streets. https://wsdot.wa.gov/construction-planning/complete-streets.

WSDOT. 2022b. Environmental Manual, Chapter 200. Publication M 31-11. https://wsdot.wa.gov/engineering-standards/all-manuals-and-standards/manuals/environmental-manual.

WSDOT. 2022c. Statewide Transportation Improvement Program (STIP) 2023-2026. https://wsdot.wa.gov/business-wsdot/support-local-programs/delivering-your-project/statewide-transportation-improvement-program-stip.

WSDOT. 2022d. Design Manual. Publication M 22-01. Engineering and Regional Operations Development Division, Design Office. https://wsdot.wa.gov/engineering-standards/all-manuals-and-standards/manuals/design-manual.

WDOT. 2022e. Designing for Level of Traffic Stress. Design Bulletin #2022-01. WSDOT Development Division Multimodal Development and Delivery. Available at https://wsdot.wa.gov/sites/default/files/2022-06/DesignBulletin2022-01.pdf.

WSDOT. 2022f. Project Delivery Memo #22-03 – Complete Streets Implementation. From Mark Gaines, Development Division Director, State Design Engineer, to WSDOT Project Develop Engineers, June 27, 2002.

WSDOT. n.d.a. Practical Solutions Performance Framework. https://performanceframework.wsdot-sites.com/. Accessed April 2023.

WSDOT. n.d.b. Guidance for Considering Impacts of Climate Change in WSDOT Plans. https://wsdot.wa.gov/sites/default/files/2021-10/Guidance-Doc-Considering-Climate-Change-In-WSDOT-Plans.pdf. Accessed April 2023.

WSDOT. n.d.c. Strategic Plan. https://wsdot.wa.gov/about/secretary-transportation/strategic-plan. Accessed April 2023.

WSDOT. n.d.d. GeoPortal Map Application: Traffic Count Database System. https://wsdot.public.ms2soft.com/tcds/tsearch.asp?loc=Wsdot&mod=TCDS. Accessed April 2023.

WSDOT. n.d.e. Sidra Policy Settings. Reference Guide for Sidra 8. https://wsdot.wa.gov/sites/default/files/2021-03/TrafficOps-WSDOTSidraPolicyAndSettings.pdf. Accessed April 2023.

WSDOT. n.d.f. Highway Safety Improvement Program. https://wsdot.wa.gov/business-wsdot/support-local-programs/funding-programs/highway-safety-improvement-program.

WSDOT. n.d.g. Maintenance guidance for planning studies. https://wsdot.wa.gov/engineering-standards/planning-guidance/planning-study-guidance/maintenance-guidance-planning-studies

Appendix A

Engagement Report

COMMUNITY ENGAGEMENT PLAN

SR 302 Victor Area Corridor Study

TABLE OF CONTENTS

BACKGROUND

A communications and outreach consultant team was brought together to engage local agencies, Tribes, and community members. These stakeholders helped develop a list of strategies, screening criteria, and strategy packages that were considered by the study team to be included in the Final Corridor Report. The Final Corridor Report and Geotechnical Report is informed by technical analysis and input from community members and key stakeholders. This document summarizes engagement tactics, tools, and findings from community members and key stakeholders and how they informed the development of the Final Corridor Report.

ENGAGEMENT GOALS

- Clearly communicate the need, purpose, and benefits of the study to the Study Advisory Committee and the public.
- Clearly communicate the study schedule and limits to implementation once the Final Corridor Report is completed.
- Inform the public about existing problems or performance gaps along the corridor and share any proposed solutions from the study team.
- Provide timely, accurate, and consistent information to people driving and nearby residents and businesses.
- Provide a means for people to ask questions, convey concerns and requests, and ensure reasonable and prompt response from the study team.
- Reinforce positive WSDOT relationships with partner agencies, individuals, and groups.
- Inform the community of the results of the study.

ENGAGEMENT STRATEGY

Community engagement occurred in two phases to help inform the study's analysis. In the first phase, the study team gathered input from the Study Advisory Committee and people who travel through and/or reside near SR 302 to advance the study team's understanding of existing conditions and challenges for travelers. For the second phase, the study team worked with the Study Advisory Committee to help develop screening criteria for the study and propose strategies to be evaluated.

Methods

Communications and outreach efforts to build awareness about the study took place on an ongoing basis throughout the duration of the study.

This table summarizes the study team's engagement activities:

Supporting materials			
Activity	**Date(s)**	**Audience**	**Key Messages**
Key Messaging	November 2022	All	• Study background • Study need • How to stay informed • Next steps
Fact sheet	December 2022		
Study website	December 2022		
Outreach			
Activity	**Date(s)**	**Audience**	**Key Messages**
Study Committee meetings	January – May 2023	Representatives from state/local agencies, elected officials, and Tribes	• Introduce study • Gather input to inform study approach
Outreach to overburdened communities	March 2023	Community groups/organizations	• Introduce study • Gather input to inform study approach
Online Open House and Survey	March 2023	All	• General study information, with potential feedback or comment period option

Equitable Engagement Approach

WSDOT is committed to conducting an inclusive planning process that aims to break down barriers to involvement for all members of the community, from long-time participants in transportation and urban planning to new voices who represent the increasingly diverse communities in the study area. WSDOT reached out to overburdened communities early in the process to make sure the study team was on the right track and ensure those who may be most impacted by the study's findings were able to voice their concerns. Community-based organizations were invited to share their feedback via the online open house and survey. In addition to the invite, briefings were offered to the organizations if they were interested in providing their feedback directly to the study team or if they would like to learn more about the study. The outreach team requested that the organizations also share the online open house via their communications channels in order to gather feedback from the communities that are served by the organizations.

For broader communications and outreach, the study team prepared some key materials in Spanish. Though Spanish is spoken by a small percentage of the population within the study area, amongst that group is a population that speaks English “less than very well,” increasing the importance of language access measures.

When promoting engagement opportunities, WSDOT provided Americans with Disabilities Act Information and Title VI notice to the public. Additionally, the study team approached community engagement based upon the following practices:

- Use simple, easy-to-understand language when communicating study information. Use visuals and graphics where possible.
- Translate study materials and other essential study information in Spanish. On study promotional materials, make clear how to request translations in other languages, using in-language text. Translate study information into other languages upon request.
- Use alt text to describe or summarize visual elements, as is WSDOT standard.

Online Open House and Survey

As part of the study, WSDOT hosted an online open house with a survey between March 6, 2023 and March 21, 2023. The online open house was designed to inform the public about the study and collect data on how travelers use the existing corridor which will help WSDOT to develop strategies to improve operations, resiliency, and mobility for all users. WSDOT provided the online open house and questionnaire in English and Spanish.

When visiting the online open house, participants could:

- Learn about why WSDOT is conducting the study
- Review study area maps
- Review data about existing geotechnical and roadway conditions
- Provide input on how the community currently uses this corridor, and where there are opportunities and challenges to increase safety and mobility for all users.

Goals of Online Open House

- Promote awareness about the study, the study process, and its purpose and need.
- Collect community input that will be used to prioritize evaluating potential safety and infrastructure improvement strategies for all types of transportation.

Promotions

WSDOT is committed to conducting an inclusive planning process that aims to break down barriers to involvement for all members of the community. The study team shared information about the online open house and questionnaire through several channels to varied audiences and communities. The table below details the activities to promote participation in the online open house and survey:

Outreach method	Promotion details
Media release	WSDOT sent a media release on March 6, 2023
Blog post	WSDOT launched a blog post on March 6, 2023
Emails to community-based organizations	The study team emailed 21 community-based organizations and interest groups with information about the online open house and survey on March 6, 2023.
Study Advisory Committee (SAC) emails	The study team emailed members of the SAC to remind them to take the survey and share the online open house and survey with their network.

Online Open House Activity

Between March 6, 2023 and March 21, 2023, 453 individuals visited the online open house. The website received more than 590 total pageviews (the total number of times all pages were viewed).

162 people completed the survey. All survey responses were in English.

Key Feedback Themes

Below are high-level key themes represented in the online survey.

Safety improvements: Making changes to improve the safety for those driving, walking, biking, and rolling was a prevalent theme throughout the survey. The most common suggestions for improvements included:

- Wider shoulders and lanes for vehicle traffic
- Reduced speed limits
- Adding a bike lane and walking path for people walking and biking.

Limiting freight traffic: Respondents believe that the load bearing freight vehicles are exacerbating the cracks along the roadway and that they should be using HWY 3 instead of SR 302. Others mentioned a prevalence of cars speeding to get ahead of freight traffic and believe that by limiting freight traffic, the amount of cars speeding will also be reduced.

Weight restrictions: Respondents expressed the importance of reducing the gross vehicle weight rating (GVWR) as SR 302 sits along a fault line and is already prone to road closures due to seismic events. They believe that reducing the weight capacity for commercial and freight vehicles on SR 302 will help preserve the road.

Better drainage systems: Respondents expressed the desire for lasting and efficient drainage systems to reduce landslides and flooding. They specifically mentioned drainage systems that properly slope into culverts.

Non-motorized improvements: We received several comments from respondents questioning the need for non-motorized improvements along SR 302. Respondents stated that due to the dangerous nature of the road very few individuals currently walk, bike, or roll on the road.

Moving the highway: Respondents are proponents of moving the highway inland. Residential properties along SR 302 are the target of many accidents due to reduced visibility and curved roads.

Landscape improvements: Respondents addressed the importance of landscape improvements and minimizing the tree overhang to improve visibility. Respondents specifically mentioned the need for vegetation management at Milepost 3, as it is hindering visibility for motorists and cyclists.

Building a floating bridge: Respondents mentioned interest in a floating bridge or floating grid to improve accessibility, safety, and resilience.

ENGAGEMENT ACTIVITIES

Community-based Organization Emails

To inform engagement activities, build relationships, and begin to identify community issues, concerns and priorities, the study team emailed 21 community-based organizations and interest groups with information about the online open house and survey on March 6, 2023. The email also offered briefings and presentations to community-based organizations.

The study team contacted the following community-based organizations:

- Victor Improvement Club
- North Mason School District
- Peninsula School District
- Allyn Community Association
- Key Peninsula Community Services
- North Mason Chamber of Commerce
- Canterwood HOA
- Lakeland Village Community Club/ HOA
- Port of Allyn
- North Mason Rotary Club
- North Mason FOE #4226
- Key Peninsula Community Services
- Key Peninsula Bischoff Food Bank
- North Mason Habitat for Humanity
- Key Peninsula Baptist Fellowship
- WayPoint Church
- North Mason Bible church
- Newlife Church North Mason
- North Bay Lutheran Community Church
- Peninsula Life Church
- King of Glory Lutheran Church

The study team did not receive any requests for briefings and presentations.

Study Advisory Committee Meetings

WSDOT formed a Study Advisory Committee consisting of representatives from Pierce County, Mason County, WSDOT, Tribes and other agencies. Study Advisory Committee meetings helped inform baseline analysis, screening criteria, alternative development, screening results, alternative design and establishing the preferred alternative.

The table below lists advisory committee members who attended at least one meeting and their affiliations:

Name	Organization
Sam Johnston	WSDOT – Geotech Office
Michael Rosa	WSDOT – HQ Bridge Office
Sarah Ott	WSDOT – HQ Traffic Office
George Mazur	WSDOT – OR
Kerri Woehler	WSDOT – HQ Multimodal Planning Division
Manuel Abarca	WSDOT Olympic Region
Shawn Phelps	Pierce County
Ryan Medlen	Pierce County – Planning and Public Works
Sarah Grice	Pierce County – Traffic
Matt Pahs	Federal Highway Administration
Loretta Swanson	Mason County – Public Works
Thera Black	Peninsula Regional Transportation Planning Organization
Marty Allen	Skokomish Tribe
Brent Kellogg	Skokomish Tribe
Jennifer Keating	Puyallup Tribe
Robert Brandon	Puyallup Tribe

Name	Organization
Mark Neary	Mason County
Scott Cooper	North Mason Fire Department

The table below lists advisory committee members (and their affiliations) who were invited to all SAC meetings but did not attend:

Name	Organization
Jeff Sawyer	WSDOT – Olympic Region Environmental Office
Yvette Liufau	WSDOT – Olympic Region Complete Streets
Matt Kunic	Federal Highway Administration
Angie Silvia	Pierce County – Planning and Public Works
Anne Nesbit	Key Peninsula Fire Department
Edward Coviello	Kitsap Transit
Katherine Weatherwax	Washington State Patrol District 8
Luke Strong-Cvetich	Jamestown S'Klallam Tribe
Tom Ostrom	Suquamish Tribe
Allison O'Sullivan	Suquamish Tribe
Joe Sparr	Port Gamble S'Klallam Tribe
Jackie Smith	Skokomish Tribe
Penni Restivo	Squaxin Tribe
Heidi Thomas	Nisqually Tribe
Andrew Strobel	Puyallup Tribe

The study team hosted four meetings. The meetings covered the following topics:

Meeting 1: January 26, 2023

Topics covered at the meeting:

- Provide an overview of the study
- Review roles and responsibilities
- Review baseline conditions
- Review strategy evaluation criteria
- Gather feedback on study goals, objectives, problem statement, and outcomes

Input received from the SAC included:

- Questions, comments and reactions to existing conditions data
- Feedback on draft problem statement

Meeting 2: March 28, 2023

Topics covered at the meeting:

- Review strategies developed by the study team.
- Review Geotech analysis findings and preliminary recommendations.
- Review screening criteria for different strategies.
- Review Level 1 screening results and suggested Level 2 strategy packages

Input received from the SAC included:

- Feedback on updated problem statement
- Feedback on preliminary online open house and survey results

Meeting 3: April 27, 2023

Topics covered at the meeting:

- Review updated strategy list and Level 1 screening results.
- Review Level 1 and Level 2 screening results.
- Review preliminary preferred strategy package

Input received from the SAC included:

- Feedback on Level 1 and Level 2 screening results
- Feedback on Preliminary Preferred Strategy Packages

Meeting 4: May 24, 2023

Topics covered at the meeting:

- Updated Level 1 and Level 2 screening results
- Preferred Strategy Packages

Input received from the SAC included:

- Determine how to proceed with other alternatives near the study area that were not considered in this study

INCORPORATING FEEDBACK

Feedback from the Study Advisory Committee and the general public helped inform the study team's analysis at each step of the process. The types of feedback that were incorporated into the study process included:

- Gathering feedback on the problem statement and overall direction of the corridor study.
  - The problem statement was revised through the study process to best reflect the goals of the community and to best address the direction in the proviso.
- Understanding existing challenges for travelers along SR 302.
  - The study team proposed strategies to address the challenges, which were screened and evaluated.
- Learning from the community what they would like to see for the future of the corridor.
  - The study team screened the most frequently suggested strategies from the online open house.
- Understanding how the Study Advisory Committee would like strategies to be screened throughout the study process.
  - The Level 1 and Level 2 screening criteria were updated throughout the process.
- Revising and updating both individual strategies and strategy packages to best address resiliency and feasibility along the corridor.

A detailed list of how the feedback was incorporated and evaluated can be found in the main Final Corridor Report.

Appendix B

Geotechnical Report

PRELIMINARY GEOTECHNICAL REPORT

SR 302 Victor Area Study
Mason County, Washington

HWA Project No. 2022-043-21

Parametrix

June 30, 2023

GEOSCIENCES INC.
DBE/MWBE

HWA GEOSCIENCES INC.
DBE/MWBE

June 30, 2023
HWA Project No. 2022-043-21

Parametrix
719 2nd Avenue, #200
Seattle, Washington 98104

Attention: Alex Atchison, PE

Subject: **PRELIMINARY GEOTECHNICAL REPORT**
SR 302 Victor Area Study
Mason County, Washington

Dear Ms. Atchison:

We are pleased to present this preliminary geotechnical report prepared in support of the SR 302 Victor Area Study, which included evaluation of the potential slope stabilization of WSDOT's USMS Slopes 177, 178, and 3035 along SR 302, located between mile post 3.0 to 6.0, south of Victor, Washington. The purpose of our study was to evaluate the soil and ground water conditions around the existing roadway to provide geotechnical recommendations in support of potential landslide mitigation repairs.

We appreciate the opportunity to provide geotechnical engineering services on this project. If you have any questions regarding this report or require additional information or services, please contact us at your convenience.

Sincerely,

HWA GEOSCIENCES INC.

William R. Rosso, P.E.
Geotechnical Engineer

Sandy R. Brodahl, P.E.
Geotechnical Engineer, Principal

TABLE OF CONTENTS

Page

List of Figures (Following Text)

Appendices

PRELIMINARY GEOTECHNICAL REPORT
SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

1.0 INTRODUCTION

1.1 GENERAL

This report presents the results of a geotechnical engineering study performed by HWA GeoSciences, Inc. (HWA) in support of the SR 302 Victor Area Study in Mason County, Washington. The purpose of this study was to evaluate the soil and ground water conditions along the alignment of SR 302 to aid in development and evaluation of a landslide repair for WSDOT's Unstable Slope Management System Slope Number 177, 178, and 3035.

These slopes have caused damage to the SR 302 roadway in the past during settlement and/or landslide events. WSDOT Olympic Region has received a legislative proviso to "*do a corridor study of the SR 302 (Victor Area) to recommend safety and infrastructure improvements to address current damage and prevent future roadway collapse and landslides that have caused road closures.*" The approximate location of the project corridor is shown on the Vicinity Map, Figure 1 and the Site and Exploration Plan, Figure 2. Our work for this project included reviewing the existing information provided by WSDOT, performing a site reconnaissance, planning and conducting a site investigation program, performing geotechnical engineering evaluations of potential mitigations, and providing this summary report.

1.2 HISTORICAL SITE ACTIVITY

The slide study area is located approximately 1½ miles south of Victor Washington along SR302 between about current milepost 3.0 to 6.0. The roadway in this area is generally located between undeveloped property to the east and west, atop steep slopes approximately 30 feet above North Bay. Some single family residential developments are located east and west of the roadway in the vicinity of slopes 177 and 3035. WSDOT provided us with a number of documents related to Slopes 177 and 178, but little information was available for Slope 3035. Based on a review of these documents, the area south of Victor along SR 302 has been affected by landslide activity at various locations going as far back as the 1930s. Slides have frequently occurred in this area during the winter months and have required varying levels of effort to repair.

WSDOT also provided a number of photographs of the slides and site vicinity, which appear to go as far back as the 60s. These photographs consistently document crescent shaped cracks with varying amounts of vertical and horizontal displacement in the roadway surface, and also document consistent scarps within or near these cracks. Understanding what trigged these past slides and evaluating the success of the solutions or repairs is critical to identifying solutions that are most likely to succeed.

Some of the slides in the documents provided by WSDOT did not initially appear to have occurred at our specific study slope; however, historical milepost noted in the documents may not be accurate relative to the current roadway alignment. Milepost limits can sometimes change after highway realignments and/or roadway improvements and each of the documented events are within the overall SR 302 corridor study area. Since the site conditions and settlement issues in these documents were similar to those at slopes 177 and 178, this information was reviewed and incorporated into our study, as applicable.

1959 Event

A one-page letter dated January 6, 1959, by Arthur Ritchie and Joe Cashman documents that a slide occurred approximately 1¼ miles south of Victor and that similar events have caused "constant maintenance problems in the past." The letter submits that the cause of these slide events is subsurface water flowing through sand beds overly impervious "glacial clay," and recommends that the correction for the landslide problem would be the cut off the flow of water from below the roadway section.

This letter includes a sketch illustrating the proposed drainage ditch recommended to mitigate the slide, and also includes a rough approximation of the damage to the roadway caused by tensions cracks reflecting in the roadway surface. The letter does not include any documentation of the actual construction of the drainage ditch, nor does it provide any documentation of, or recommend, any subsurface investigations.

1971 Event

The 1971 event is documented in a letter dated July 9, 1976, by H. Frankmoelle. In December of 1971 about 50 linear feet of SR 302 slid into North Bay exposing numerous layers of asphalt concrete up to about 10 feet deep. The letter states that maintenance crews have been placing layers of asphalt and fill material to repair the roadway after these slides for thirty years. Frankmoelle estimates that the actual thickness of the fill and asphalt layers may be 15 feet thick, or more, below the roadway. The document does not include an exact location for the slide described; however, based on the description of the site and the cross section attached to this document we believe that this letter is describing the area between about mile post 4.7 and 4.8 on SR 302.

This letter presents that there are three major factors causing the settlement/landslides; the first is water traveling through the subsurface from higher elevations, the second is the additional weight of the asphalt placed during the numerous repairs performed, and the third is tidal action on the west side of the roadway. In the letter Frankmoelle states that settlements are typically more rapid during extreme high tide events in the winter. This letter documents that when the roadway was repaired riprap was placed in the areas with the worst settlements and that settlements in the armored areas were "less than half" when compared to previous years despite the placement of the riprap being "less than necessary" due to funding. This letter also documents that there was also some minor settlement distress to the private property upslope of the roadway during excavation attempts to improve drainage at the cross-culverts and also cautions that considerable settlements or slides are possible during excavations.

1983 Event

The 1983 event is briefly described in a WSDOT Memorandum dated March 21, 2001, by J.R. Struthers. A WSDOT intra-departmental communication letter dated June 9, 1983, by D. D. Rude also describes the issues and possible solutions in more detail. Based on the memorandum, an area of SR 302 between mile post 5.37 and 5.46 settled about 10 inches over a 60-day period in April of 1983. After the slide occurred, WSDOT engineers recommended that additional investigation of the lightweight fill be performed and to install drainage provisions previously recommended for the area in 1979.

The 1983 letter states that inclinometer data indicated a minor shear zone at approximately 10 feet bgs and a primary shear zone at approximately 30 feet bgs and documents tension cracks in the roadway and scarp faces in the material between the roadway fill and the beach. The letter also states that high water levels within the sawdust (lightweight) fill is adding weight and creating saturated conditions between the roadway and the beach, and further indicates that the riprap at the beach is in poor condition due to past slides. Rude states in the letter that high tides could saturate the soil above the normal water level which could cause rapid drawdown within the loose material and that rapid drawdown after the tides recede could be a direct cause of the slide movement.

1997 Event

A WSDOT memorandum dated June 20, 2001, by T.M. Allen and J.R. Struthers provides some additional history of the large ancient slide upslope of the road between mile post 4.4 to 4.8. According to the memorandum a developer was working on the property in the mid-nineties and the associated grading or utility installation caused a "pretty big" slide about 275 feet upslope of the roadway. This slide damaged the existing concrete access road through the site and also created some of the scarps that can be seen from SR 302.

2001 Event

On February 28, 2001, a moment magnitude 6.8 earthquake, known as the Nisqually earthquake, occurred approximately 35 miles below the surface near Olympia. This earthquake caused significant movement of the slides in the Victor area as shown in photos provided to us by WSDOT. A WSDOT Memorandum dated March 21, 2001, by J.R. Struthers reports that as much as 2½ feet of vertical displacement and as much as ¼ feet of lateral displacement was observed the day after the earthquake at slope 178. The WSDOT memorandum dated June 20, 2001, by T.M. Allen and J.R. Struthers reports vertical offsets on the order of about 1 to 3 feet in the vicinity of about mile post 4.40 to 4.79.

2011 Event

WSDOT provided us photos dated February 10, 2011, of what appeared to be shallow slides along the east side of SR 302, between about mile post 3.11 to 3.18 at the base of the steep slopes above the road. Based on relative features in the photos the slides appear to be about 15 feet high and on the order of 5 feet deep. No other information was available beyond the photos and our understanding is that no other slides in this area have been reported since these photos were taken.

Slope 177 and slope 178 have been well documented and studied by WSDOT; however, little information exists beyond these photos regarding Slope 3035. Based on a review of historical photographs in Google Earth the residences were constructed sometime between 2006 and 2009. During our review of these photos, we observed several changes in the topography at the top of the slope that are likely related to these developments. Changes in vegetation, surface drainage, and surcharges related to construction at the top of the slope are often factors that can impact the stability of a slope. The slides documented in the photos are likely related to the steep slopes above the roadway, but stability may also have been affected by these residential developments and activities atop the slope.

Recent Landslide Activity

Recent landslide activity was summarized by Michael Mulhern who conducted a site visit in January of 2021 which was summarized in an email dated January 14, 2021. This summary included a description of the cracking observed in the pavement which was estimated to be about 2 to 3 inches wide and vertically offset by about 5 to 6 inches. During WSDOT’s site visit they observed ground cracking patterns similar to past events between MP 4.50 and 4.55 and that a new layer of asphalt pavement has been added to restore the grade at this location in both 2019 and 2021.

Stephen Newman visited the site a year later on January 11, 2022, and summarized their visit in an email dated January 13, 2022. Stephen observed a number of issues at the site including cracking in the roadway and drainage issues. The email includes a series of photographs and a description of the recent pavement distress caused by the slide movement. The email documents ground cracking near mile post 4.45 and between 4.50 to 4.55. The email also states the area had experienced significant rainfall and snow melt in the weeks prior to the embankment settlement, and one or more irregularly high ‘king’ tides had recently occurred. Based on the images in both emails the cracks are in approximately the same locations and are a similar pattern to past failures.

1.3 Historical Landslide Repairs

It is our understanding that the Victor slide area is repaired almost every year during the winter season near mile post 4.40 to 4.70 along SR 302. These repairs generally consist of filling cracks and resurfacing the road so that it can be reopened to the public as quickly as possible, but in a few cases more robust repairs have been undertaken.

1959 – Trench and Drainage Improvements

The January 6, 1959, letter by Arthur Ritchie and Joe Cashman documenting the slide included recommendations for drainage improvements and a sketch of their recommendations. The sketch recommends a 10-foot-deep drainage ditch and a drainage culvert under the road to discharge the water into North Bay. During our site walk we observed a drainage ditch along the east side of SR 302 in most areas; however, the depth of the ditch and condition of the drains could not be observed due to vegetation.

1978 – Lightweight Fill

A report by J. D. Belling, dated January 13, 1978, describes recommendations to replace sections of the damaged roadway within Victor slide area with lightweight sawdust fill near mile post 5.1. Subsequent reports indicate that the use of lightweight fill in this area was not fully successful in mitigating the landslide, and resulted in an environmental issue when the sawdust became saturated with groundwater. Effluent leaked from the fill and stained the nearby area leading to complaints from local property owners and fines by the Department of Ecology. Trenches and drains were installed later to lower the groundwater table below the fill, and this appears to have also improved the stability of the area.

2017 – Cellular Concrete Fill

In 2014 WSDOT was planning to repair two of the culverts running beneath the roadway between mile post 4.5 to 4.6. The drainage improvements were also located near an area where settlement of the slope had created a 120-foot tension crack located along the edge of the southbound lane. During the planning process for the drainage improvements the team proposed excavating below the roadway and backfilling with lightweight cellular concrete (LCC) to also help mitigate the slide.

In 2017 the team installed the new drains and over excavated about 5 to 6 feet of material to backfill with LCC below the southbound lane. Based on our recent site visits the roadway appears to be in relatively good condition and is in significantly better condition compared to other unimproved areas nearby. We did observe that a small tension crack about ¼ inch wide and about 30 feet long has developed at the roadway centerline, near the edge of the cellular concrete placement. No other significant signs of distress were observed on the pavement during our site visits.

Other Repairs Considered by WSDOT

Upon reviewing the documents provided, it appears that WSDOT has considered more extensive measures to address the settlement and landslide issues, such as over excavation, stone columns, and bridging over the slide. However, our understanding is that these options were not implemented at the site.

2.0 FIELD AND LABORATORY INVESTIGATION AND TESTING

2.1 PREVIOUS INVESTIGATIONS

Based on the documentation provided to us by WSDOT, surficial observations were used to support the initial repair recommendations for the Victor area slide under the assumption that the slide was not deeply seated. In the 1970's WSDOT installed an inclinometer near what was noted as mile post 5.5 at the time, to begin monitoring an area of the slide to evaluate the slide and identify the slide plane. These early explorations identified a minor shear zone at approximately 10 feet below the round surface and a primary shear zone at approximately 30 feet below the ground surface.

After the 2001 Nisqually earthquake, WSDOT advanced borings to install inclinometers and monitoring wells at seven locations between about mile post 4.4 to 4.7. The approximate locations of these borings are shown on the Site and Exploration plan, Figure 2. Logs of these boring are presented in Appendix C of this report. In general, the drilled borings within the slide area along the roadway encountered loose to medium dense Landslide deposits overlying dense Pre-Vashon deposits. The soils encountered are described in greater detail in Section 3.2 of this report. Two borings at Slope 177 were drilled outside WSDOT's right-of-way, within and outside the larger ancient slide (borings H-7 and H-6) upslope of SR 302. These borings generally encountered dense to very dense Till and Pre-Vashon deposits within the boring through to its termination depth of approximately 120 feet bgs.

WSDOT monitored the groundwater conditions and the inclinometers for approximately 2 years after their installation. Groundwater data for the site indicates that the water level is relatively shallow near the roadway and can fluctuate daily in response to the tides. Inclinometer data indicates a slide plane at around 30 feet below the ground surface near the roadway, similar to what was described in WSDOT's 1983 letter. Inclinometer data from WSDOT boring H-6 indicates the ancient slide may be experiencing slope creep along plane at a depth of about 50 feet bgs. Copies of the WSDOT groundwater data and inclinometer data for their study can be found in Appendix C of this report.

2.2 SLOPE RECONNAISSANCE

HWA visited the site on November 1st, 2022, and met with WSDOT representative Sam Johnston. The purpose of our site visit was to familiarize our team with the slide area, observe the surface conditions at the site, and mark preliminary boring locations for utility locates. Our site reconnaissance primarily focused on evaluating the USMS Slope 177 area between mile post 4.40 and 4.72, and slope 178 area between mile post 4.69 and 4.79. The team also briefly visited the Slope 3035 area, between mile post 3.11 and 3.18. Per the Subsurface Exploration Plan (SEP), the proposed borings were located within mile post 4.40 to 4.79 (areas of major slide/settlement activity).

During our site walk we observed a long longitudinal tension crack reflecting in the asphalt in the vicinity of Slope #177. The crack was ellipsoidal and extended for about 100 to 200 feet along the roadway, as shown on Figure 2. At the north end of the crack in the asphalt the tension crack within the soil continued along the slope below the roadway. The full length of this crack could not be determined due to the thick blackberry bramble. Specific observations made during the reconnaissance are:

- It appears that the main scarp for the larger slide, referred to as the ancient slide in this report, is located approximately 50 feet east of WSDOT boring H-6, as shown in the LiDAR image presented in Figure 2A. There are near vertical scarp faces exposing the dense deposits in this area. WSDOT boring H-7 is located approximately 70 feet higher in elevation and 200 feet east of H-6, outside the apparent extent of the ancient slide.

- During our site walk we noticed that numerous trees in the vicinity of the ancient slide display slight tilting, suggesting ongoing gradual movement.

- The landslide deposits appear to extend approximately 500 feet east, upslope, from the North Bay shoreline. Based on a review of available information, our understanding is that the toe of the slide is estimated to be below shoreline approximately 80 feet offshore.

- The top of the ancient slide is approximately 100 feet above mean sea level and the overall slope of the ancient slide area, east of the roadway, is between approximately 3:1 to 2:1 (Horizontal:Vertical). In general, slopes below the roadway are much steeper, generally appearing to be about 1½:1, however some areas along the shoreline have eroded to approximately ½:1 or steeper.

- During our site walk we observed that the drainage culverts in most areas did not appear to be functioning. During our multiple trips to the site to log the field explorations and to collect monitoring data, our team observed the drainage ditch along the east side of SR 302 was often full of water, but little to no water was observed draining from the culverts into North Bay.

- We observed slight seepage discharging from the lightweight cellular concrete repair between what appeared to be joints formed when placing the LCC in lifts; however, it appears the drainage system for this particular area is operating as intended, unlike the areas noted above.

- The pavement above the cellular concrete and lightweight fill appears to be in overall good condition and it is our understanding that this pavement has required less maintenance than unimproved areas.

- Our team observed a scarp or tension crack forming within the Slope 177 immediately west of SR302 between mile post 4.75 to 4.79. This scarp appears to be a localized instability of the fill soils against the roadway, which are steeply sloped at approximately 1:1 (H:V).

- WSDOT installed inclinometer casings and monitoring wells during a field investigation conducted in 2001. With WSDOTs assistance we were able to locate and identify WSDOT inclinometers and monitoring wells at the locations for explorations TH-1-01 (also labeled as H-1 in other documents), H-2-01, H-3-01, H-4-01, H-6-01, and H-7-01 in the field. Our personnel in the field were unable to locate boring H-5-01.

    - The inclinometer casing at H-1-01 has experienced deformation, preventing us from lowering our inclinometer probe beyond approximately 30 feet. However, we are able to lower a measuring tape down to approximately 80 feet below the top of the casing.

    - Our team was unable to locate exploration H-2-01. Our understanding is that this boring was located closer to the shore and may have completely sheared off. The most recent photograph of H-2 at an angle of approximately 50 to 60 degrees out of plum. It is our understanding that this instrument has been abandoned.

    - Our team was unable to locate boring H-5-01, however, WSDOT was able to locate it and noted it appeared to be in good condition. This exploration is not easily accessible and may be outside of WSDOTs right of way.

    - There is an obstruction within boring H-6A-01 at approximately 14 feet below the top of the casing which prevented us from collecting a groundwater measurement. We anticipate that this obstruction could be cleared if the well was developed. However, well development is outside our scope and the boring is outside of WSDOTs right of way.

- No explorations were performed in the vicinity of milepost 3.11 to 3.18 due to access concerns. During our site walk we observed that the slope to the east of SR 302 is steeply sloped at approximately 1:1 (H:V) near the roadway.

- No obvious signs of instability below the roadway such as tension cracks or uneven pavement were observed at Slope 3035. We did observe that several trees above the roadway were slightly tilted or curved which is an indicator of instability, but trees below the roadway did not appear to be tilted or curved. However, due to developments below the roadway the trees are generally younger and are fewer in number.

2.3 Geotechnical Field Investigation

Our geotechnical exploration program included advancing eleven (11) machine-drilled borings, designated HWA-1Si-23 through HWA-11Si-23, to depths ranging from approximately 35 to 100 feet bgs. Five (5) of these borings were completed as slope inclinometers and three (3) borings were completed as monitoring wells after being advanced to their target depth. Borings completed as slope inclinometers were designated with an Si (e.g., HWA-2Si-23), monitoring wells were designated with P (e.g., HWA-3P-23), and borings without a designation (e.g., HWA-4-23) were backfilled with bentonite chips and patched with concrete at the surface.

With the exception of HWA-9-23, each boring was advanced through the existing roadway surface using mud rotary tooling. The roadway borings were advanced by Holocene Drilling of Puyallup, Washington, under subcontract to HWA using a Diedrich D-70 track-mounted drill rig equipped with mud rotary tooling. HWA-9-23 was advanced down slope of the roadway using a limited access rig equipped with hollow stem auger tooling by Geologic Drill Partners of Fall City, Washington, also under subcontract to HWA.

HWA-1Si-23 through HWA-10Si-23 were advanced in the vicinity of Slope 177 near milepost 4.5. At the request of WSDOT and in response to review comments on our SEP, HWA-11Si-23 was advanced in the vicinity of slope 178 near milepost 4.7 and was completed as an inclinometer. The approximate locations of these borings are shown on the Site and Exploration plan, Figure 2. Logs for each boring are presented in Appendix A of this report.

Standard Penetration Testing (SPT) was performed using a 2-inch outside diameter, split-spoon sampler driven by a 140-pound auto hammer. During the test, a sample was obtained by driving the sampler 18 inches into the soil with the hammer free-falling 30 inches. The number of blows required for each 6 inches of sampler penetration in the field is recorded in our boring logs. The N-value (or resistance in terms of blows per foot) is defined as the number of blows recorded to drive the sampler the final 12 inches. If a total of 50 blows was recorded within a single 6-inch interval, the test was terminated, and the blow count was recorded as 50 blows for the number of inches of penetration achieved. This resistance, or N-value, provides an indication of the relative density of granular soils and the relative consistency of cohesive soils.

Additionally, a larger 3-inch outside diameter California sampler was utilized at specific depths to collect ring samples to perform laboratory testing, and/or to improve sample recovery. The samples collected with this sampler have blow counts that do not reflect standardized values as they utilized the larger sampler with the standard 140-lb hammer. These values have been adjusted in our analyses to reflect standard SPT N-value blow counts for the purpose of our design.

The explorations were completed under the full-time observation of a geologist or geotechnical engineer from HWA, who collected pertinent information including soil sample depths, stratigraphy, soil engineering characteristics, and ground water occurrence as the explorations were advanced. Soils were classified in general accordance with the classification system described on Figure A-1, which also provides a key to the exploration log symbols. The exploration logs are presented on Figures A-2 through A-41.

The stratigraphic contacts shown on the individual logs represent the approximate boundaries between soil types. Actual transitions may be more gradual. The soil and ground water conditions depicted are only for the specific dates and locations reported, and therefore, are not necessarily representative of other locations and times.

2.4 Laboratory Testing

Laboratory tests were conducted on selected samples retrieved from HWA's explorations to characterize relevant engineering properties and index parameters of the soils encountered at the site. The tests included visual classification, natural moisture content determination, Atterberg Limits, organic content, direct shear analysis, and grain size distribution analysis. The tests were conducted in the HWA laboratory in general accordance with appropriate American Society of Testing and Materials (ASTM) standards and are discussed in further detail in Appendix B. The test results are also presented in Appendix B, and/or displayed on the exploration logs in Appendix A, as appropriate.

2.5 Field Instrumentation

WSDOT installed inclinometer casing within each of the seven explorations that they advanced at the Victor area slide in 2001. Based on a review of the documentation provided to us by WSDOT, data was collected from the inclinometers periodically between 2001 and 2003. Over this period of time, WSDOT recorded approximately ½ inch of movement from ground surface to about 30 feet bgs in boring H-1-01, and less than ¼ inch of movement in borings H-3-01 and H-4-01 to a depth of about 32 feet bgs. In H-2-01 WSDOT recorded about ¼ inch of movement between approximately 8 to 42 feet bgs. From ground surface to about 8 feet bgs the inclination became significant and resulted in a total displacement of approximately 2 to 3 inches at the top of the casing.

Our field exploration program included installing slope inclinometer casing within five of our explorations. The slope inclinometer casings extended between approximately 70 to 90 feet below the existing ground surface. Our team collected data from the inclinometer casings installed by WSDOT within H-1-01, H-3-01, H-4-01, and H-6-01; and HWA's slope inclinometer casings installed during our field mobilization. Slope inclinometer readings were taken approximately at the date of installation and three additional readings were collected after completing our exploration program. Our initial readings indicate little to no movement in most locations, however, approximately ¼ inch of total moment was observed across two site visits in February and in May of 2023. This movement was observed starting at approximately 25 feet bgs in HWA-7Si-22 and a little less than ¼ of an inch of movement was observed in H-3-01 and H-4-01 starting at about 30 feet bgs. A third set of inclinometer readings was collected in June 2023, indicating minimal to no additional movement compared to the readings collected in May.

Approximately a ¼ inch of movement was also observed in H-1-01 starting at approximately 18 feet bgs across these site visits. However, it should be noted that the inclinometer probe could not be completely lowered below about 30 feet within the inclinometer casing due to the casing having deformed at a deeper depth this data should only be used to indicate that movement is occurring; however, the degree and depth of movement should not be considered reliable. Copies of the collected slope inclinometer data for this study are presented in Appendix D of this report.

3.0 SITE CONDITIONS

3.1 SITE GEOLOGY

The Victor area is located within the Puget Lowland which has repeatedly been occupied by a portion of the continental glaciers that developed during the ice ages of the Quaternary period. During at least four periods, portions of the ice sheet advanced south from British Columbia into the lowlands of Western Washington. The southern extent of these glacial advances was near Olympia, Washington. Each major advance included numerous local advances and retreats, and each advance and retreat resulted in its own sequence of erosion and deposition of glacial lacustrine, outwash, till, and drift deposits. Between and following these glacial advances, sediments from the Olympic and Cascade Mountains accumulated in the Puget Lowland. As the most recent glacier retreated, it uncovered a sculpted landscape of elongated, north-south trending hills and valleys between the Cascade and Olympic Mountain ranges, composed of a complex sequence of glacial and interglacial deposits.

Specific geologic information for the project area was obtained from the *Geologic Map of the Vaughn 7.5-minute Quadrangle, Pierce and Mason Counties, Washington* (Logan, Walsh, 2007) which suggests that the near surface soils are landslide deposits, which overly older non-glacial and glacial deposits. The landslide deposits were deposited during the current Holocene epoch and are described as being generally loose, jumbled, tan to gray, silty sandy gravel with few to no discernible sedimentary structures. The landslides in the area occur as deep-seated slides, or as shallow surface failures or block falls.

The sediments near Victor were deposited by glaciers and proglacial streams consisting of rocks from the Coast Range of British Columbia. Within the eastern part of the Puget Lowlands glacial streams emanating from the Cascade Range reworked glacial sediments, but these streams never made it as far west as the Victor area between glaciation events. Additionally, glacial advances were both depositional and erosional, and because of these factors the pre-Vashon nonglacial deposits in the Vaughn quadrangle are challenging to differentiate from glacially derived sediments. This resulted in truncation of relatively flat-lying pre-Vashon sediments by Vashon ice erosion, and deposition of Vashon till on top of both Vashon-age advance outwash and much older glacial or nonglacial sediments.

The soils encountered in our explorations were generally consistent with the surface geology characterized by the referenced map. Our explorations encountered a variety of fill materials placed below the roadway overlying the loose sands deposited by landslides. Below the landslide deposits our explorations encountered medium dense to dense Pre-Vashon deposits, hard Pre-Vason Lacustrine clays and silt, and very dense Pre-Vashon Till deposits.

3.2 SUBSURFACE CONDITIONS

The results of our subsurface explorations indicate that SR 302 is generally underlain by Fill material, Landslide Deposits, fine- and coarse-grained Pre-Vashon Deposits, Pre-Vashon Lacustrine soils, and both Pre-Vashon and Vashon Till deposits. WSDOTs exploration H-6 and H-7 advanced upslope of the roadway indicate a similar soil profile, however, the Pre-Vashon deposits appear to become thicker and there is a more recent Vashon Till deposit at the top of the slope. Our interpretation of the geologic conditions in the are shown in geologic cross sections A-A' (Figure 3A) and the alignment of the cross section is shown on the Site and Exploration Plan, Figure 2. The soil units encountered in our explorations are described in more detail as follows:

- **Fill:** Due to the site history, we anticipate that the thickness and composition of fill below the roadway will vary along the corridor. Generally, the fill soils were brown to olive brown, gravelly, silty sands and between about 4 to 10 feet thick with. Fill material observed in our borings was encountered immediately below the asphalt pavement and was very loose to very dense base on the uncorrected field N-values ranged from 1 to 50 blows for 1 inch.. These N-values represent the highest and lowest values observed in this unit within the borings advanced at the site. This unit was placed during construction of the roadway, however, based on our review of reports provided to us by WSDOT additional fill has been placed and reworked in various areas to repair damages caused by slides and/or settlements.

In boring HWA-8P-23 we encountered approximately 20 feet of loose to medium dense gravelly fill below the pavement. Based on pavement cracking observed in the roadway surface and our understanding of the slide repairs we believe that this boring was advanced within a tension crack that was filled with pea gravel backfill after a previous slide event.

In HWA-11Si-23 we also encountered fill soils to deeper depths below the roadway surface. The fills were comprised of lightweight wood fill extending from approximately 5 to 12 feet bgs which was very loose to medium dense base on the uncorrected field N-values ranged from 2 to 11. This type of fill is comprised primarily of wood pulp or sawdust and was placed in the 1970's in an effort to stabilize the roadway in this area. Below the wood fill we encountered medium dense granular fill soils extending to approximately 25 feet bgs. Fills were also noted at deeper depths in the logs for WSDOT borings H-03-01 and H-04-01.

The use of lightweight wood fill was once a relatively common practice and may be encountered in other areas. Lightweight Cellular Concrete fill was not encountered in our explorations but was placed at the site in 2017 and may also be encountered in other areas.

- **Landslide Deposits:** Landslide deposits comprised of colluvium were observed in each of our explorations underlying the fill below the roadway or starting at just below the ground surface in HWA-9P-22. The landslide deposits encountered were generally loose to medium dense moist to wet sandy soils with varying amounts of olive brown silt and gravels. This deposit generally ranged from approximately 21 to 30 feet thick and extended to between 25 to 33 feet bgs. The Landslide deposits are very loose to dense soils based on the uncorrected field N-values, which ranged from 0 to 41 . These N-values represent the highest and lowest values in this unit within the borings we advanced at the site.

- **Pre-Vashon Deposits:** Coarse- and fine-grained Pre-Vashon deposits were encountered below the Landslide deposits and are similar in composition to the Landslide and Pre-Vashon Lacustrine Silts. They were encountered in borings HWA-8P-22, HWA-10Si-22, and HWA-11Si-23; and range from approximately 6 to 10 feet thick but may be thicker in other areas where landslides have not occurred. These deposits are generally either medium dense to dense, or stiff to very stiff, and consist of moist to wet grey fine-grained silty sands to sandy silts. Uncorrected field N-values ranged from 4 to 64. These N-values represent the highest and lowest values in this unit in the borings we advanced at the site.

- **Pre-Vashon Lacustrine Silt:** The Pre-Vashon Lacustrine Silt deposits were encountered below the Pre-Vashon or below the Landslide deposits and ranged from about 11 to over 46 feet thick. Some of our borings terminated within this unit and it may be thicker than noted, however, this unit was observed to generally be about 20 to 30 feet thick. The Pre-Vashon Lacustrine soils consist of moist to wet, grey silts and fat clays which were generally very stiff to hard. Uncorrected field N-values ranged from 15 to 50 blow for 4 inches. These N-values represent the highest and lowest values in this unit in the borings we advanced at the site.

- **Pre-Vashon Till:** Pre-Vashon Till deposits were encountered below the Pre-Vashon Lacustrine soils in our deeper explorations (HWA-2Si-23, HWA-6Si-22, HWA-7Si-22, HWA-8P-22, and HWA-10Si-22). Borings that did not terminate in the Pre-Vashon Lacustrine Silt terminated in the Pre-Vashon Till. The Pre-Vashon Till was generally very dense, grey, dry to moist silty sands with fine gravel. Soil recovery was generally poor in this unit and the uncorrected field N-values ranged from 50 blow for 5 inches to 50 blows for 0 inches. These N-values represent the highest and lowest values in this unit in the borings we advanced at the site.

- **Vashon Till:** Till deposits were encountered only in WSDOT boring H-7-01 at the top of the slope. The Till deposits extended to approximately 65 feet below the ground surface before transitioning to Pre-Vashon Deposits. Blow counts in WSDOT's logs for H-7-01 ranged from 43 to 50 blows for 4 inches. The Till at the top of the slope was generally very dense, grey, dry to moist silty sands with fine gravel.

3.3 GROUNDWATER

Groundwater was encountered during drilling in each of our explorations at depths ranging between approximately 8 to 14 feet bgs. Our review of the WSDOT boring logs from 2001 indicated that soil samples recovered during drilling became wet at similar depths within the vicinity of SR 302; however, samples recovered from H-6 and H-7 during drilling became wet at much deeper depths, approximately 25 feet bgs and 45 feet bgs, respectively.

The information provided to us by WSDOT included groundwater monitoring data between 2001 to 2003 from wells installed in borings H-1A-01 through H-6A-01. The groundwater data for H-1A-01 and H-2A-01 indicates that groundwater fluctuates between approximately 12 to 16 feet bgs, which is similar to our observations during drilling. In borings H-3A-01 and H-4A-01 groundwater fluctuates between about 4 feet below the ground surface, which appears to be a higher elevation than the depth groundwater was observed in our nearby exploration HWA-11Si-22. Table 3.3 below summarizes the groundwater data collected from the monitoring wells at the site.

Table 3.3: Approximate High and Low Groundwater Readings Collected from Monitoring Wells

Exploration ID	Approximate High Groundwater (Feet bgs)	(Elev. Feet)	Approximate Low Groundwater (Feet bgs)	(Elev. Feet)
H-1A-01	10.0	22.4	15.8	16.6
	(Feb-2002)		(Sept-2002)	
H-2A-01	8.4	N/A	13	N/A
	(Dec-2002)		(Aug-2001)	
H-3A-01	1.1	16.3	3.6	13.8
	(Dec-2002)		(Nov-2001)	
H-4A-01	0	20.4	4.7	15.8
	(Jan-2001)		(Nov-2002)	
H-5A-01	36.8	N/A	39.1	N/A
	(Feb-2002)		(Dec-2002)	
H-6A-01	19.5	60.7	23.8	56.4
	(April-2002)		(Sept-2002)	
HWA-1P-22	8.4	24	9.7	25.1
	(Jan-2023)		(April-2023)	
HWA-3P-22	9.2	23.4	11.1	25.2
	(Jan-2023)		(Feb-2023)	
HWA-8P-22	8.9	25.1	10.5	26.7
	(Dec-2022)		(Feb-2023)	

Notes: N/A - elevation unavailable due to lack of recent data

The groundwater monitoring data indicates that the water level is strongly influenced by tidal flows in many locations, particularly in H-2A through H-4A, which are located closest to the shore. The groundwater data provided by WSDOT indicates the groundwater level near the shore commonly fluctuates by as much as 3 feet per day. In locations further from the shore fluctuations generally vary by a few inches between each day but there are occasional spikes of a few feet possibly caused by anomalous high tide events also known as “king” tides. Piezometer reports showing groundwater data collected during this study can be found in Appendix D (Figures D9 and D10) of this report.

4.0 CONCLUSIONS

4.1 SEISMIC CONSIDERATIONS

4.1.1 Design Parameters

Earthquake loading for the project location was developed in accordance with the General Procedure provided in Section 3.4 of the *AASHTO Guide Specifications for LRFD Seismic Bridge Design*, 2nd Edition, 2011(AASHTO, 2011) with 2012, 2014 and 2015 Interim Revisions. For seismic analysis, the Site Class is required to be established and is determined based on the average soil properties in the upper 100 feet below the ground surface. Based on our explorations and understanding of site geology, it is our opinion that the proposed alignment is underlain by soils consistent with Site Class D. Therefore, Site Class D should be used with AASHTO seismic evaluations for this project. Table 4.1.1 presents recommended seismic coefficients based on a design seismic event with a 7 percent probability of exceedance in 75 years (equal to a return period of 1,033 years) using the Spectra BridgeLink software.

Table 4.1.1: Seismic Coefficients

Site Class	Peak Horizontal Bedrock Acceleration PBA, (g)	Spectral Bedrock Acceleration at 0.2 sec S_s, (g)	Spectral Bedrock Acceleration at 1.0 sec S_1, (g)	Site Coefficients			Peak Horizontal Acceleration PGA (A_s), (g)
				F_{pga}	F_a	F_v	
D	0.493	1.114	0.336	1.107	1.054	1.964	0.546

4.1.2 Near Fault Ground Motion Considerations

Our review of the geologic literature indicates that SR 302 crosses over a mapped trace of the Tacoma Fault Zone within our study area. The Tacoma fault is a reverse fault which has been interpreted as a back thrust on the trailing edge of the belt, making the belt doubly vergent. The fault zone generally trends from west to east and extends from about two miles north of Mason Lake to Auburn. Within the Victor slide area, the fault zone consists of one mapped fault trace which expands into four traces north of Gig Harbor. The four traces trend southeast into Federal Way, Auburn, and Tacoma. The east-striking, western Tacoma fault forms the northwestern boundary of the Tacoma basin and the southwestern boundary of the Seattle uplift.

The north-side up movement on the western Tacoma fault is indicated by gravity and magnetic anomalies, seismic tomography, seismic-reflection data, and paleo seismology. Paleo seismologic investigations of shoreline deposits and trenching studies have been performed by others within the vicinity of the Tacoma fault. The USGS states that investigations imply late Holocene land-level changes are interpreted as the results of uplift or subsidence caused by large earthquakes in the Puget Lowland. Some coastal study sites nearby in the area have indicated an absence of late Holocene land-level changes, tsunami deposits, and other earthquake related features. These sites do not appear to record direct evidence of earthquake and faulting events.

The slip rate for the fault is estimated to be on the order of 0.2 mm/year to 1 mm/year. The information collected from trenching was used to infer vertical offsets of about 3 meters at the 16,000 year old glacial surface found along the Catfish Lake scarp. The most recent displacement at Lynch Cove shows evidence for uplift between about 800 to 1,200 years ago, trenching studies indicate that the land level changes were on the order of about 2 meters. Horizontal offsets were not determined from the excavations and could add to these displacements. The recurrence interval for these events is unknown.

4.1.3 Surface Rupture Hazards

Non-uniform ground motions could occur along the roadway in the event that a large seismic event triggers strong shaking in the Puget Sound region. Horizontal displacements of up to about 1 foot and vertical displacements of up to about 3 feet were observed at the site after the 2001 Nisqually earthquake. An earthquake along the Tacoma fault could create displacements of several feet resulting from ground rupture. Although the fault traces have been mapped, the uncertainty of the locations where ground rupture could occur is still significant and in addition to the uncertainty of the fault locations, there is also uncertainty of the magnitude and mechanism for faulting. The available data indicates that the vertical fault displacements would be on the order of several feet; however, marine seismic reflection investigation in Case Inlet suggest that displacement on the Tacoma fault zone may express as folds rather than surface ruptures.

4.1.4 Liquefaction

Liquefaction is a temporary loss of soil shear strength due to earthquake shaking. Loose, saturated cohesionless soils are highly susceptible to earthquake-induced liquefaction; however, recent experience and research has shown that certain silts and low-plasticity clays are also susceptible. Primary factors controlling the development of liquefaction include the intensity and duration of strong ground motions, the characteristics of subsurface soils, in-situ stress conditions and the depth to groundwater. In addition to earthquake-induced liquefaction, static liquefaction caused by a rapid rise in water pressure in a slope, such as rising tides, may also lead to a loss of the soil shear strength. To evaluate the liquefaction susceptibility of the soils along the project alignment, the simplified procedure originally developed by Seed and Idriss (1971), updated by Youd et al 2001, and also by Idriss and Boulanger (2004, 2006) was used.

The groundwater table appears to be at a depth of approximately 8 to 15 feet below the road surface and at varying other depths outside the roadway. Our analysis suggests that the Landslide deposits and portions of the Pre-Vashon sands below the groundwater table are prone to liquefaction during the design earthquake. Material below these liquefiable zones did not appear to be susceptible to liquefaction, however, potentially liquefiable soils may extend past the termination depth of our explorations.

The onset of liquefaction is expected to result in a temporary reduction in the shear strength of the liquefiable soils and liquefaction induced settlement. Liquefaction is expected to occur at depth greater than about 8 feet below the ground surface. We anticipate that the reduction in strength will affect the stability of the slopes supporting the roadway.

4.1.5 Liquefaction Induced Settlement

Unsaturated loose sand deposits tend to densify when they are subject to earthquake shaking. For saturated sand deposits, excess pore water pressure builds up during the earthquake excitation, leading to loss of strength or liquefaction. After the shaking stops, excess pore water pressures dissipate toward a zone where water pressure is relatively lower, usually the ground surface. The dissipation is accompanied by a reconsolidation of the soils (Ishihara and Yoshimine, 1992 & Tokimatsu and Seed, 1987). The reconsolidation is manifested at the ground surface as vertical settlement, usually termed as liquefaction-induced settlement or seismic settlement.

The potential for liquefaction-induced settlement was evaluated at each of the boring locations. The magnitudes of potential liquefaction-induced settlement were evaluated using the methodologies developed by Idriss and Boulanger (2008), which are based on the relationship between cyclic stress ratio, corrected SPT blow counts, and volumetric strain. Using these methods, liquefaction-induced settlement was estimated to be approximately 4 to 12 inches.

We expect that the liquefaction-induced settlement will be differential along short distances and could result in damage to the roadway, utilities, and other improvements, which will require repairs after the design earthquake.

4.1.6 Post Liquefaction Residual Shear Strength

Residual shear strengths for the liquefiable soils at the above-described locations were developed using a weighted average of the results of the Idriss (2007), Olson and Stark (2002), Idriss and Boulanger (2007) and Kramer (2008) relationships. The residual shear strengths assigned are a function of the equivalent clean sand SPT value, (N1)60cs, the potential for void redistribution, and the initial effective overburden stress. At locations where (N1)60cs is less than 10, we assumed void redistribution effects could be significant, which gives an appropriate conservative estimate of residual shear strength. Residual shear strength parameters of the liquefiable soils were calculated to evaluate global stability under static loading conditions for the post liquefaction event.

4.1.7 Liquefaction Induced Slope Instability

Initiation of liquefaction is triggered by the generation of increased pore water pressures within the liquefiable soils. As the pore water pressures increase, the soil loses shear strength. When the soil is fully liquefied the soil shear strength is at its lowest level, this is termed “residual shear strength.” This reduction in shear strength can result in liquefaction-induced slope instability. Liquefaction-induced slope failures can either occur as a lateral spreading event or as a flow failure.

Liquefaction-induced lateral spreading occurs as the shear strength of liquefiable soils decreases during seismic shaking, but does not decrease to the point that a complete flow failure would occur. Lateral spreading occurs cyclically when the horizontal ground accelerations combine with gravity to create driving forces which temporarily exceed the available strength of the soil mass. This is a type of failure known as cyclic mobility. The result of a lateral spreading failure is horizontal movement of the partially liquefied soils and any overlying crust of non-liquefied soils. Displacements associated with lateral spreading are generally quantifiable and on the order of several feet. The actual magnitude of displacement depends on the site geometry, soil characteristics and earthquake loading.

In contrast, liquefaction-induced flow failures result when the residual strength of the liquefied mass is not sufficient to withstand the static stresses that existed before the earthquake. Upon initiation of liquefaction-induced flow failure, the liquefied soil behaves like a debris flow, characterized by very large displacements. Flow failures involve horizontal and vertical movements of the liquefied soils and any overlying crust of non-liquefied soils. The chaotic nature of flow failures is such that estimation of the magnitude of displacement is not reasonable.

Global stability analyses as described in Section 4.2 were conducted to evaluate post-liquefaction instability due to the reduction in shear strength of the liquefiable soils at the project site. The analyses suggest that portions of the project site can experience lateral spreading and/or flow sliding events under design seismic and post-liquefaction condition.

4.2 SLOPE STABILITY EVALUATION

4.2.1 General Causes

Documents provided by WSDOT present a history of slope instability of the Victor area along SR 302, between milepost 4.40 to 4.79. After reviewing the information provided by WSDOT, publicly available LiDAR imagery, and our field explorations, it has become apparent that several key factors are contributing to the instability of the soils underneath SR 302. Some of these factors are:

- **Loose weak soils to about 30 feet deep**: The slope failures within the deposits below the roadway developed from movement along the contact between the Landslide and fine-grained Pre-Vashon or Pre-Vashon Lacustrine deposits at around 30 feet below the ground surface.

- **Intense Rainfall.** Landslide movements have been documented after intense and long duration rainfall within the study area. Significant rainfall leads to elevated groundwater levels and increased surface runoff. Both of these conditions cause erosion of the face and increase the potential for localized failure on the slope face. Additionally, increases in pore-water pressure (saturated material) could lead to a reduction in the shear strength of the soils.

- **Rapid drawdown**: The soils at the toe of this slope may also be weakened due to rapid drawdown after the tides recede, as the pore pressures cannot dissipate as quickly as the sea level drops. These events reduce the shear strength of the soils which leads to increased instability. A.P. Kilian (WSDOT) identified static liquefaction as a potential slope instability trigger due to rapid drawdown in a letter dated September 19, 1991, by R.G. Finkle and A.P. Kilian.

- **Fluvial/wave erosion of the slope toe**. We observed evidence of slope erosion associated with wave action along the waterfront. Erosion that causes the toe of the slope to become over-steepened will increase instability of the slope by reducing the resisting forces at the toe of the slope and could result in roadway embankment failures and/or movement of the ancient slide.

- **Overly steep slopes**, as observed at Slope 3035 above the roadway in the field and at select areas below the roadway near Slope 177 and slope 178 in the field.

- **Earthquake shaking**, as documented during the Nisqually earthquake event.

- **Slope Creep**. In addition to the factors contributing to the instability observed at the roadway, slope creep of the ancient slide at Slope 177 is a possible driving factor related to the frequent slide events at SR 302. WSDOT proposed that the ancient slide is a flow slide in a letter dated April 1, 1977, by R.V. LeClerc. Our review of the inclinometer data provided by WSDOT indicates slight movement of this ancient slide, about a tenth of an inch, at about 50 feet below the ground surface in H-6 between 2002 and 2003. However, during our short monitoring period we did not observe similar movement.

4.2.2 Slope Stability Back Analysis

To verify the assumed geometry, soil properties and the trigger events of the observed landslides, HWA conducted slope stability modeling of the geologic cross section A-A'. HWA modeled the surface of the slope using publicly available topographic information (surveying of the area was not performed) and developed the subsurface profile using information collected during our field exploration and from the boring logs provided to us by WSDOT. The soil shear strength parameters were determined based on shear strength testing and empiric correlations, where possible. A weak layer was added to simulate the slide plane observed in the inclinometer data. HWA adjusted the modeled parameters to bring the factor of safety of the slope to approximately 1.0 for the modeled slope cross section under static high groundwater conditions at the site. The soil parameters used to represent the existing conditions in our model are presented in Table 4.2.2 below.

Table 4.2.2: Slope Stability Modeling Soil Parameters

Soil Unit / Material	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)
Fill	120	0	34
Landslide Deposits	115	0	33
Pre-Vashon Deposits	130	0	36
Pre-Vashon Lacustrine Silts	130	2000	21
Pre-Vashon Till	140	1000	40
Vashon Till	135	1000	40
Post-Liquefaction Residual Strength of Soils	110	0	12
Slide Plane / Weak Layer	100	0	21
Lightweight Cellular Concrete	30	500	35
Aggregate Shafts	110	0	40
Riprap	135	0	33

4.2.3 Static Stability

The stability of slope was evaluated, under static loading conditions, using limit equilibrium methods utilizing the computer program Slide2 (Rocscience, 2022). Limit equilibrium methods consider force (or moment) equilibrium along potential failure surfaces. Results are provided in terms of a factor of safety, which is computed as the ratio of the summation of the resisting forces to the summation of the driving forces. Both Spencer's method and Janbu's simplified methods for circular and non-circular failure surfaces were considered. Where the factor of safety is less than 1.0, instability is predicted. With limit equilibrium, the shear strength available is assumed to mobilize at the same rate at all points along the failure surface. As a result, the factor of safety is constant over the entire failure surface.

The results of the static slope stability modeling are shown in Appendix E, Figure E-1. Per Section 10.3.1 of the GDM, the design factor of safety for static slope stability should be 1.25. Factors of safety greater than 1.0, but less than 1.25 were calculated under the modeled static conditions. These results do not meet the minimum design factor of safety for slopes as recommended on the WSDOT GDM; however, they do indicate that under static conditions the slide area is relatively stable.

4.2.4 Static High Groundwater Stability

When modeling for high groundwater conditions along geologic cross section A-A' the factor of safety decreases to approximately 1.0 indicating that fluctuations in the groundwater table is the primary cause for instability. Both Spencer's method and Janbu's simplified method were used in this evaluation and both circular and non-circular failure planes were evaluated. The results of the saturated slope stability model are shown in Appendix E, Figure E-2. Under these loading conditions, factors of safety generally closer to 1.0 were calculated within the soils below the roadway, indicating that slope failures are more likely to occur when the soil becomes saturated.

Variations were observed in the factor of safety under these conditions based on the modeled water level for North Bay. When the water level in North Bay is increased to simulate high tides the factor of safety also increases under static and high groundwater conditions, which reflects the additional resisting force provided by the weight of the water along the beach during high tides. When the tides recede this water level lowers and the factor of safety decreases, which reflects the reduction in resisting forces as the water level drops in the bay. This behavior observed in our model is consistent with the documents we reviewed for this report which indicated that failures often occur after unusually high "King" tide events. These events reduce the shear strength of the soils, which leads to increased instability.

4.2.5 Pseudo Static Stability

The stability of the slope along geologic cross section A-A' was also evaluated using pseudo-static methods to evaluate the response of the slope under earthquake loading. Both Spencer's method and Janbu's simplified method were used in this evaluation and both circular and non-circular failure planes were evaluated. Pseudo-static slope stability analyses model the anticipated earthquake loading as a constant horizontal force applied to the soil mass. For our analyses, we used a horizontal seismic coefficient of 0.273g, which is one-half of the peak ground acceleration (PGA). The results of the pseudo-static slope stability model are shown in Appendix E, Figure E-3. Under pseudo-static loading conditions, factors of safety less than 1.05 were calculated for the roadway slope and the ancient slide. This suggests that slope failures are expected to occur as a result of the design earthquake under the current slope configuration.

4.2.6 Post Liquefaction Stability

The soil geometry along geologic cross section A-A' was also evaluated under post liquefaction conditions. Post liquefaction conditions were modeled by assuming static loading, and reduced residual strength parameters for the liquefiable soil layers. Liquefiable soils were encountered within the Landslide and Pre-Vashon deposits below the water table. These deposits appear to be thinner near the head of ancient slide and become thicker at the base of the slope below the roadway. Both Spencer's method and Janbu's simplified method were used in this evaluation and a circular and non-circular failure plane passing through these weakened layers. The results of the post liquefaction slope stability model are shown in Appendix E, Figure E-4. Post liquefaction analysis yields a factor of safety of less than 1.0. The analyses suggest that failure surfaces under post-liquefaction condition can extend beyond the roadway section and that lateral and/or flow failure could be anticipated.

4.3 SLOPE INSTABILITY MITIGATION OPTIONS

4.3.1 General

Based on our review of the existing documentation provided by WSDOT, the frequent settlement related distress of the roadway near Slope 177 was suspected to be primarily driven by fluctuations of groundwater levels caused by high tide and heavy rains. This assertion is supported by our modeling which indicates that increases in the groundwater level decrease the factor of safety for the slopes below the roadway to less than 1.0 or about 1.0. Our modeling indicates that the ancient slide has a factor of safety of about 1.1 for the steeply slope area at the headscarp and about 1.2 for the shallower slope within the main body of the ancient slide near the roadway under static conditions. During our site walks we observed that many of the trees within the slide area are slightly titled which may indicate slope creep within the ancient slide area. Slope creep is caused by insufficient resisting forces at the base of a slope and manifests a very slow, very gradual downslope movement of soil which can be observed through tilted electricity/phone poles, trees, or other object secured into or on a hillside. Because the toe of the slope is located along the shoreline, erosion may be removing material which would very gradually reduce the resisting forces at the base of the slide. Our inclinometer data indicates that the ancient slide upslope of the roadway did not appear to move during this study period (slope inclinometer H-6-01. However, slope inclinometer HWA-7Si-23 showed a deep-seated movement at about 25 feet bgs. It should be noted that as the slopes below the roadway fail or are eroded away the resisting forces at the base of the ancient slide are reduced, which may cause the slope to creep at rate that requires long term data collection to observe.

At slope 178 our model indicates that the factor of safety is generally close to 1.15 within the steep cut above the roadway, and 1.02 within the slopes just below the roadway. These potential failure surfaces may explain the tension cracking observed during our site walks, or they may be related to the deep seated movement observed in the inclinometers H-3-01 and H-4-01. Our understanding is that the last significant failure at Slope 178 was caused by the Nisqually earthquake in 2001. The deep-seated movement may be a result of continued movement of the slope after the Nisqually earthquake. It is common for slopes that fail under seismic loads to develop weak layers/shear planes where the strength of the soil is reduced to its residual strength. Movement was not observed in HWA-11Si-23 in the area indicating that the inclinometer was either installed outside the slide plane or that movement in this area could be limited to within the slopes below the roadway.

Our analysis of both Slopes177 and Slope 178 indicates that the factor of safety decreases below 1.0 under pseudo static conditions. Without mitigation it is likely that a seismic event could cause slope failures similar or more significant to what was observed in 2001, depending on the magnitude of the seismic event. Additionally, slope stability analyses indicate that the roadway could experience lateral spreading and/or flow sliding as a result of a seismic event.

Most of the recommendations presented in the following sections (Sections 4.3.2 through 4.36) are considered ground improvement mitigation measures, which are not required to be evaluated or designed for the design seismic event. However, HWA evaluated these options under seismic scenarios to have a better understanding of the expected response of each solution under the design seismic event.

HWA and WSDOT brainstormed a list of potential mitigation options that could be implemented for this project and options that advanced beyond HWA and WSDOTs initial screening are presented in the following sections. Other options that were not considered included replacing or realigning the roadway, multi-span bridge construction, excavation and removal of the larger ancient slide mass, installation of buttresses/toe berms. These options were not considered due to factors such as implementation feasibility, cost, design effort, right-of-way limitations, and permitting requirements or potential environmental impacts.

Permitting along beaches in Washington can be challenging due to the anticipated impacts to the environment when work will severely impact or modify beaches. Securing permits for strategies such as a roadway realignment, or extensive excavations would likely require environmental impact studies, right-of-way acquisition, as well as the review and approval of the proposed mitigation measures by multiple agencies to secure permits.

A discussion of the selected mitigation options is presented in the following sub-sections. Each section includes a discussion of the analysis of the proposed mitigation methods, the potential pros and cons, approximate extents where the improvement should be implemented, and preliminary cost estimates related to construction. The preliminary cost estimates do not include costs related to unknown costs such as design efforts, permitting, and right of way acquisition.

The discussions regarding mitigation strategies generally focus on contextualizing full vs partial mitigation strategies. A partial mitigation strategy improves the factor of safety of the slope stability under static conditions, but does not address the deep-seated issues noted at the site and also may not fully improve it above the factor of safety above WSDOT's design guidance of 1.25 for static conditions. Slope failures during a seismic event could be expected with partial mitigation measures. A full mitigation strategy works to address the deep seated issues and also improves the factor of safety above WSDOT's design guidance for slopes under static and seismic conditions.

4.3.2 Drainage Improvements

Fluctuating groundwater levels within the study area appears to be the primary cause of frequent instability within the slopes below the roadway, particularly near Slope 177. Seepage forces act to increase the driving forces on a landslide. Drainage improvements could reduce the weight of the mass tending to cause the material to slide and increase the strength of the materials in the slope resisting movement by reducing pore-water pressures. Previous efforts to manage groundwater through shallow drainage ditches in this area appear to have been insufficient.

Our analysis indicates that further lowering the groundwater table by installing horizontal drains should improve the stability of the slope to a greater degree than the existing shallow ditches. Therefore, we recommend that horizontal drainage be implemented with other potential slope mitigation options. Regardless of if horizontal drains are implemented or not, we recommend that at the existing drainage facilities within the project corridor be improved.

Simulating horizontal drainage improvements in our model to lower the groundwater level to 2 feet above the MHHW (Mean Higher High Water) elevation of approximately 12 feet AMSL (Above Mean Sea Level) generally resulted in increases in the slope factor of safety below the roadway. Compared to static high groundwater conditions, the factor of safety for the slopes below the roadway generally increased when modeling the groundwater to an elevation of 14 feet AMSL at the shoreline and extending the lowered water level approximately 150 feet east of the shoreline at about a 2% slope. A greater improvement in stability was observed if the drains were extended beyond the headscarp of the ancient slide, approximately 600 feet east of the shoreline.

Horizontal drains are not required to be designed for seismic loads as they are ground improvement and not structures. However, HWA did evaluate the stability of the slope under pseudo static conditions with a lowered groundwater table and observed that the drainage improvements did not improve the factor of safety ancient slide or the slopes below the roadway above 1.05. Under post-liquefaction conditions the increase to the factor of safety was less significant and slope instability should be anticipated during a seismic event.

Horizontal drains should be considered a partial mitigation technique and it is unlikely that they can fully stabilize the roadway slope or the larger ancient slide without being combined with other mitigation options. Overtime continued natural movement within the subsurface soils will likely reduced performance of the drains and can eventually lead to failure. However, horizontal drains are a lower cost option and easier to construct relative to other mitigation options. Based on our conversations with WSDOT, the permitting process for working along the shoreline for North Bay is also not anticipated to be as challenging as other potential mitigation options, and the impacts to roadway users during construction are anticipated to be less extensive.

Horizontal drains will require periodic maintenance and should be designed so that they can easily be maintained, but also so that the flow of water is managed to prevent accelerated erosion of the beach. Horizontal drains should also be designed to resist corrosion and to minimize possible backflow into the drains. Pavement maintenance such as a crack seal and slurry coating program should be performed prior to each winter season to prevent accelerated deterioration of the pavement. Pavement cracks that are left unfilled may increase the pore water pressure within the subsurface soils and could lead to increased instability.

Detailed information about the soil and groundwater conditions would be required to properly model subsurface groundwater flows to identify the most effective spacing and installation pattern for horizontal drains. A common approach is to install the drains with a wide spacing, for example 100 feet, and evaluate the groundwater flow out of the drains and install additional drains within more closely space intervals, such as 25 to 50 feet, in areas where the groundwater flow observed is insufficient to lower the groundwater table. Horizontal drains can also be more challenging to install in sandy soils, especially beyond about 200 feet. Since this length would extend beyond WSDOT’s right of way we also anticipate that longer lengths would require additional permitting and access agreements. These additional factors are unknown and could vary depending on when the project moves to construction, so they are not included in our cost estimate.

We estimate that the cost to install horizontal drains between mile post 4.40 to 4.70 at Slope 177 could range from approximately $410,000 to $1,650,000 for installation lengths of between 150 feet to 600 feet, spaced every 25 feet as the basis for our estimate. We estimate that the cost to install horizontal drains in the same pattern from mile post 4.70 to 4.79 at Slope 178 could range from approximately $140,000 to $530,00.

4.3.3 Lightweight Cellular Concrete and Horizontal Drainage

Lightweight cellular concrete fill (LCC) and horizontal drainage could be used to improve the local stability below the roadway by reducing the driving forces on the slopes. LCC has already been used at the site in conjunction with shallow drainage improvements constructed in 2017. Based on our discussions with WSDOT and our observations at the site, this approach has reduced the maintenance frequency in this area of the slide.

Under static conditions our model indicates that replacing approximately 5 feet of the existing material with LCC increases the stability of the material below the roadway. Increasing the LCC thickness further improved the stability of the roadway; however, we anticipate that replacing existing material beyond a depth of about 10 feet will become impractical. Lightweight Cellular Concrete and other lightweight fills are not required to be designed for seismic loads as they are ground improvement and not a structure. However, HWA did evaluate the stability of the slope under pseudo static and post liquefaction conditions and observed that the LCC did little to improve the overall stability of the slope in our model.

The granular soils below the roadway have shifted and settled due to erosion of the toe or due to slope creep and tension cracks have been observed reflecting through to the pavement. LCC would reduce driving forces on the roadway slope, but we also anticipate that it would provide a more stable subgrade for the pavement that would be more resistant to reflection cracking. A strong subgrade would extend the life of the roadway pavement. Our modeling indicates that replacing just the lane on the shoreline side would be sufficient to increase the factor of safety to about 1.25 under static conditions but we recommend that both lanes be replaced to maximize improvements to the road subgrade.

If LCC is selected, it should be paired with horizontal drainage to the greatest extent practical. The scope for LCC placement should include time to replace the nonfunctioning drainage culverts and improve the existing drainage ditch to improve drainage similar to the work performed by WSDOT in 2017. LCC should be considered a partial mitigation technique and it is unlikely that they can fully stabilize the roadway slope or the larger ancient slide without being combined with other mitigation options.

We anticipate that removing the existing roadway subgrade and placing LCC will require temporary closures of at least one lane of the roadway during placement. Pavement maintenance such as a crack seal and slurry coating program should be performed prior to each winter season to prevent accelerated deterioration of the fill and pavement. Pavement cracks that are left unfilled may increase the pore water pressure within the LCC or the slope and lead to increased instability. Lightweight cellular concrete fill placed at the roadway will not reduce the driving forces of the ancient landslide, but may reduce the resisting forces. Our modeling indicates that up to 10 feet of fill will not have significant impacts on the stability of the ancient slide mass. However, impacts to the ancient slide at depths beyond 10 feet were not evaluated and excessive replacement of the existing soils with LCC may reduce the resisting forces of the slide which could result in unanticipated impacts to stability.

In addition to the potential mitigation benefits, this mitigation option is conducive for allowing the roadway to be widened to accommodate multimodal mobility improvements. The lightweight LCC fill could be placed on the shoreline side to expand the roadway without significantly increasing the driving forces at the edge of the slopes in many areas. Removing and replacing the existing material may also reduce the driving forces on the slopes; however, areas where material is removed should be modeled to evaluate if the removal of material may also reduce the resisting forces for areas upslope of SR 302.

Because portions of the estimate area for Slope 177 have already been improved with LCC fill from about MP 4.60 to 4.65 we estimate the extent of the remaining work would be approximately 1,400 linear feet. To replace both lanes of SR 302 within this area would require approximately 6,200 cubic yards of LCC fill and would cost approximately $780,000 for both lanes. To replace both lanes of SR 302 within the estimated area for slope 178 would require approximately 6,200 cubic yards of LCC fill and would cost approximately $310,000 for both lanes in this area.

4.3.4 Shoreline Armor or Buttressing and Drainage

The erosion caused by tidal movements at the shoreline immediately below the roadway is likely a contributing factor causing the slopes to steepen. As the slopes become steeper the factor of safety decreases for the slopes below the road because of the reduction of the resisting forces as sediment is eroded at the toe of the slope and due to the change in the slope geometry. Armoring the shoreline is anticipated to slow the erosion of these slopes and the installation of a buttress at the base of the roadway or at the toe of the slide could reduce further regression of the steep slopes.

Previous evaluations have estimated that the toe of the ancient landslide slope is likely located about 80 feet off the shoreline below the water surface. As mentioned, permitting along beaches in Washington can be challenging due to the anticipated impacts to the environment when work will modify beaches. Securing permits to modify beaches often requires extensive evaluations of environmental impacts.

Armoring could include using rip rap, dynamic revetments, or other suitable armoring methods. We anticipate shoreline armoring would have minimal impacts to traffic patterns on SR 302; however, the permitting process could be challenging, especially for more robust types of armor such as rip rap. Dynamic revetments or cobble berms are typically able to mimic Washington beach environments, and are therefore more likely to be permitted, but offer less protection and typically require periodic maintenance to restore the protection of the shore. Shoreline armoring is unlikely to significantly improve the roadway slope factor of safety on its own and should be placed in conjunction with other mitigation options such as lightweight cellular concrete and drainage improvements to maximize the increases to stability. It should be noted that slope instability due to erosion caused by wave action could be significant throughout the design life of the roadway.

Shoreline armoring is unlikely to significantly improve the stability of the roadway slope during a seismic event, but armoring can reduce the rate of shoreline erosion, which is a lead cause of slope instability. Accurately modelling the impacts different types of armoring can be challenging and but we did observe an improvement to the factor of safety in our slide model to about 1.25 by placing a 3 foot thick zone of rip rap approximately 65 linear feet of exposed beach. The benefits of shoreline armoring are well known and many of the documents provided to us by WSDOT indicate erosion is a likely cause of instability within the SR 302 study area. Shoreline armor should be considered a partial mitigation technique and it is unlikely that they can fully stabilize the roadway slope or the larger ancient slide without being combined with other mitigation options.

Constructing an exposed buttress along the base of the slope may be a more economical option from a materials standpoint, however, the costs associated with acquiring permitting would likely include additional studies to evaluate impacts to the environment that may increase the cost of implementation. Because these costs are unknown we have not provided a cost estimate for an exposed buttress on the beach.

Riprap has already been used in some areas below slopes 177 and 178. Preliminary cost estimates the cost to place a 3 foot thick zone of riprap to be approximately $1,550,000 along the entirety of Slope 177 and $490,000 along the entirety of slope 178.

4.3.5 Aggregate Shafts and Horizontal Drainage

Based on our conversations with WSDOT we understand they have used aggregate shafts as a ground improvement option to mitigate slope instability. The mitigation design consists of quarry spall filled drilled shafts. HWA evaluated replacing a significant portion of the landslide deposits via the construction of aggregate shafts below the roadway. These shafts would be installed by auguring within a cased hole to remove the landslide deposits and replacing the removed material with large aggregate such as quarry spalls. The casing is then removed, and the aggregate becomes a composite material with the existing soil, which improves the overall shear strength of the existing soils.

In our models we extended the aggregate shafts approximately 38 feet below the road surface so that they are embedded at least 5 feet into the dense/hard Pre-Vashon and Pre-Vashon Lacustrine deposits. We assumed that the shafts could be installed with offset tangent spacing resulting in about 1 foot of clear space between each pile. Based on this spacing and assuming a 6-foot diameter shafts, we estimated the composite properties of the aggregate and soils to model as a replacement unit below the roadway. Under static conditions our model indicates that replacing about 20 linear feet of the soils below the roadway, measuring from the roadway centerline to the shoreline, increases the factor of safety for the roadway slide to greater degree than LCC or horizontal drains.

Aggregate shafts also resulted in a greater increase in the factor of safety in the roadway slope under post liquefaction conditions. Because the shafts replace the liquefiable soils below the roadway they should not weaken when groundwater fluctuates. In some models there was also a modest additional increase to the factor of safety when reducing the height of the shafts to about 5 feet below the roadway surface and replacing the remaining section above the shafts with LCC. The increase in void ratio created by the aggregate shafts could also provide additional resistance to issues related to fluctuations in the groundwater level. We anticipate that combining the aggregate shafts with horizontal drainage would greatly improve the factor of safety for the soils below the roadway.

Our model indicated that there are some slight improvements to the factor of safety under pseudo static conditions, but the general stability remained relatively unchanged. A wider replacement area with the aggregate shafts was evaluated by replacing 70 linear feet of landslide deposits within WSDOT's right of way, and improvements to the factor of safety of the ancient slide were observed but the slope was not fully mitigated against sliding. To fully mitigate the ancient slide area for with aggregate shafts the replacement area would likely extend far beyond WSDOTs right of way and would require access to private property or property acquisitions.

We do not anticipate that aggregate shafts would be a feasible solution to fully mitigate slope instability under pseudo static conditions but since aggregate shafts are a ground improvement application this is not required. Aggregate shafts should be considered a partial mitigation technique and it is unlikely that they can fully stabilize the roadway slope or the larger ancient slide without being combined with other mitigation options.

We anticipate that combining the aggregate shafts with up to 5 feet of lightweight cellular concrete and horizontal drainage would greatly improve the factor of safety for the soils below the roadway. Including 5 feet of LCC fill would improve the subgrade immediately below the roadway. If the aggregate shafts below the roadway settle or shift over time the LCC would help mitigate this settlement manifesting within the pavement surface. Additionally, it could be used as a method to widen the roadway without installing additional shafts, while the horizontal drains would help manage the fluctuations in the groundwater table. Costs for the placement of LCC fill and horizontal drains are anticipated to be similar to the costs described in Section 4.3.3 and Section 4.3.2.

Installing aggregate shafts will have a greater impact to roadway users compared to horizontal drains, LCC, or shoreline armor. We anticipate it would take large size equipment to install the casing and drill the shafts which would likely require a lane closure at a minimum with the potential of road closure. Additionally, the shafts would require a staging area for equipment and a large stockpile of aggregate be available.

Aggregate shafts could also be used to improve the shear strengths of soils outside of the roadway and allow for greater widening of the roadway compared to other mitigation options. At Slope 177 our modeling shows that installing 4 rows of 6 foot diameter shafts below the roadway along the shoreline side should be sufficient to improve the strength of the soils below the roadway and resist continued soil movement under static conditions. The costs to mitigate the area within the recent unstable areas, noted as ground cracks on Figure 2, is anticipated to be approximately $1,130,000, compared to approximately $2,395,000 for the entire area of historical activity between 4.40 to 4.70. At slope 178 the cost is estimated to be approximately $775,000 for the same shaft installation geometry between about mile posts 4.70 to 4.79.

4.3.6 Anchor Systems

HWA also considered anchor systems as a mitigation option for stabilizing the Victor area landslide. These systems utilize anchors such as tie backs or soils nails to apply an external restraint which increases the resisting forces on the slide at an anchor point. Hybrid approaches combining piles such as H-piles, drilled shafts, or Micro piles could also be used to stabilize the slide and the systems can also be paired with meshed netting to help distribute the anchoring force. Anchor stabilization is more commonly used to stabilize rockslides but can also be used to stabilize the soil mass within a slow-moving landslide.

An anchor system could be designed to fully mitigate the ancient slide; however, extensive modeling and data collection would need to be completed to determine the extents and geometry of the larger ancient slide to fully implement this mitigation solution. This would also require access agreements to enter into private properties outside of WSDOT's right-of-way.

This mitigation option could be reduced to improve just the soil below the roadway, which could protect the roadway embankment from tidal erosion. Traditional anchors or advanced techniques such as soil nail launching could be used to improve the area immediately below the roadway slope. It is likely that these techniques could be implemented with less impact to road users compared to lightweight fill or aggregate shafts. This mitigation option is conducive for allowing the roadway to be widened to accommodate multimodal mobility improvements but would likely need to be combined with additional options to widen the roadway on the shoreline side. This option could be used to retain soils upslope of the roadway to support an expansion; however, areas where material is removed should be modeled to evaluate if the removal of material may also reduce the resisting forces for areas upslope of SR 302.

Due to the estimated depth of the slide plane at Slope 177 we modeled the slope anchors as micro piles at average spacing of every 15 feet to an average depth of 50 feet. In our model this reinforcement pattern was sufficient to raise the factor of safety under pseudo static conditions above 1.05. Cost estimating for this mitigation option is approximately $45,000,000 for 225,000 linear feet of micro piles over about 1,000,000 square feet. At Slope 178 and Slope 3035 the area coverage area is not as large and the required installation depths are anticipated to not be as deep so grouted soil nails would likely be appropriate and are cheaper than micro piles. Cost estimates for approximately to cover approximately 150,000 square feet with soil nails embedded to 40 feet spaced at 15 feet is estimated to be about $4,000,000 at Slope 177. At Slope 3035 the estimated cost for embedding soil nails to 40 feet spaced at 15 feet over about 125,000 square feet is $3,400,000.

4.3.7 Retaining Wall Structure

Since the sliding plane for the landslide appears to be at a depth of about 30 feet below the roadway, HWA also evaluated installing a large retaining wall structure to mitigate the settlement events observed in the roadway. A retaining wall structural solution would likely involve installation of large diameter drilled shafts through the slide plane into the hard Pre-Vashon Lacustrine Silt deposits. These shafts would be constructed using cast in place reinforced concrete and would likely need to be deeply embedded into the stable soils to achieve sufficient resistance to the lateral movement of the slide. The depth of the concrete shafts is anticipated to be much deeper than aggregate shafts and additional reinforcement such as tiebacks would be required to develop sufficient resistance to the anticipated lateral loads associated with the slide mass.

The mitigation strategies presented in sections 4.3.1 through 4.3.6 are considered ground improvements. A retaining wall is a potential structural solution to mitigate the slope instability observed at the roadway and would need to be designed to resist the design seismic event. Additional modeling, data collection and coordination with the structural designer will be required to determine the geometry, orientation, and feasibility of the required structural solution. Based on the dimensions of the larger ancient slide, the depth of the observed slide plane, and the proximity to a mapped fault trace we would expect that implementation of a structural solution to mitigate the observed soil movements would be challenging and likely cost prohibitive.

Our modeling indicates it would be challenging for a standalone wall to be able to support the roadway under pseudo static conditions at Slope 177. The wall was modeled below the roadway with 5 rows of tiebacks embedded 120 feet . The model indicates that slopes within the immediate vicinity of the roadway could be stabilized with a retaining wall, but the large ancient slide may fail through the road. The cost estimate for this wall along Slope 177 is approximately $120,000,000. Based on this estimate it is unlikely that a retaining wall will be cost effective at this location. It should be noted that a retaining wall should be design by structural engineer and the evaluation we are performing for this study is for a conceptual

For slope 178 our modeling indicates that a tie-back wall constructed below the roadway would also be challenging. A similar wall as described for Slope 177 could be constructed at this location, but our modeling indicates that the steep slopes above the roadway would need to be cut shallower to reduce the loading on the retaining wall under pseudo static conditions. We estimate the cost for a retaining wall in this area to be approximately $46,000,000.

Based on this estimate it is unlikely that a retaining wall will be cost effective at this location. This mitigation option could allow the roadway to be widened to accommodate multimodal mobility improvements. Shorter retaining walls may be a more appropriate option in other more stable areas to facilitate expanding the roadway. This option could be used to retain short, shallow slopes in areas upslope of the roadway to support an expansion. Retaining walls could also be considered downslope of SR 302 but would likely require more robust designs than walls upslope. Areas where material is added or removed should be carefully modeled to evaluate if the changes reduce the resisting forces or increase the driving forces for areas along SR 302. Drainage of the material is also critical to retaining wall design and horizontal drains should be included with this mitigation strategy. Other methods to control drainage include drainage tunnels, high permeability backfill, or French drains may also be needed to manage drainage behind the wall where practical.

It is important to note that the design of retaining walls should be carried out by a qualified structural engineer. The evaluation being performed for this study is a conceptual evaluation, which means it serves as an initial assessment and does not involve detailed design.

4.4 Geotechnical Screening Matrix and Recommendations

4.4.1 Geotechnical Screening Matrix

In addition to the slope stability analysis conducted to evaluate the potential mitigation options, HWA evaluated these options using a screening scoring matrix which was developed based on feedback from meetings with community leaders and WSDOT. A description of the screening criteria is presented on Figure 5A, and the scoring matrix for each slope is presented on Figure 5B and Figure 5C.

Horizontal drains combined with lightweight cellular concrete fill (option #2 on the screening matrix) scored the highest in the screening matrix for Slope 177, as shown in Figure 5B. Both of these individual mitigation strategies improve slope stability, but the combination of the two offers a greater improvement to the stability of the roadway relative to the costs and impact to roadway users during construction. LCC and drainage improvements are a proven cost-effective way to improve the stability of SR 302 under static conditions within the vicinity of the Victor area slide and are also conducive to some expansion of the roadway to support multimodal mobility without other significant design efforts. LCC can also be used in other areas outside the Victor area slide to expand the roadway and will likely require less design effort relative to other options.

Aggregate shafts (option #4) and drainage improvements (option #2) have a tied score on the screening matrix for Slope 177. The installation of aggregate shafts will improve the stability of the slopes below SR 302 at Slope 177 and Slope 178. Aggregate shafts would likely be more expensive and have a greater impact to roadway users during construction compared to LCC and horizontal drains. However, these shafts have been successfully used by WSDOT on other landslide mitigation projects and are a more robust option compared to LCC or horizontal drains. They offer an excellent opportunity to improve the subsurface soil underneath SR 302 by removing the weak layers and replacing them with materials that have much higher shear strengths. Aggregate shafts are anticipated to allow for a greater expansion of the roadway towards the shoreline side relative to horizontal drains and LCC. LCC could also be used in conjunction with these shafts to further expand the roadway. Aggregate shafts are a robust improvement and are likely not a cost-effective option for expanding the roadway in areas where the slopes appear stable.

Option #3, shoreline armor, scored in 3rd place at Slope 177 and 178. Controlling the erosion of the slopes below SR 302 with shoreline armor is important for the long-term stability of the roadway. Many slopes along the shoreline are very steeply sloped and the exposure to the tides could accelerate the erosion process, resulting in slope instability of the roadway embankment. Permitting shoreline erosion control could be challenging and does not allow for the expansion of the roadway without the implementation of other mitigation options. Due to the anticipated level of effort for permitting and the possible maintenance requirements this option would likely take more time to implement relative to other options. These factors lowered the overall score of the shoreline armoring, but it should be strongly considered for the long-term stability of the roadway and implemented where possible.

Retaining walls (option#5) and anchoring the slopes (option #6) are both robust mitigation options that can be implemented within the Victor area slide and in other areas to expand the roadway, but also have the highest cost. Removing or adding materials by anchoring the slopes or installing retaining structures around the SR 302 area can improve the stability of the roadway and allow for expansion; however, both also require additional design efforts to be properly implemented. Additionally, these two options also have greater impacts to roadway users during construction and may take longer to implement compared to other options, they may also require access to property outside of WSDOT's right-of-way to be properly implemented. Because of these factors anchored slopes and retaining walls scored somewhat lower in the screening matrix.

Compared to other options, these options are more robust and could be designed to fully mitigate slope instability. However, their implementation may take longer due to the higher level of design efforts required, as well as associated permitting requirements.

4.4.2 Slope Mitigation Recommendations

Until the instability observed at the noted slopes is mitigated, we recommend that inclinometer and groundwater data be collected from the site twice a year, once before and once after the winter season to monitor for signs of increasing instability. In the case of Slope 177, monitoring over a longer period could especially be used to determine if the ancient slide is undergoing slope creep. LiDAR mapping of the slopes during these visits could be used to evaluate changes in these slopes and would also be particularly useful at Slope 3035 since the area is inaccessible to conventional methods to collect geotechnical information about the slope.
The inclinometer data obtained from Slopes 177 and 178 indicates that the slopes within the roadway at both locations are moving. Therefore, it can be expected that this behavior will continue until mitigation measures are implemented.

Slope 177

Existing reports document a long history of instability at Slope 177. Tension cracking was observed reflecting through the pavement and in the slope below the roadway during our site visits and movement was observed in the inclinometers installed at the site about a depth of 30 feet bgs.

Combining the results of the slope stability analysis and the screening matrix, it is our recommendation that for Slope 177 horizontal drains combined with lightweight cellular concrete fill (option #2) could be implemented as a partial mitigation solution for the static loading conditions. Aggregate shafts (option #4) could be implemented as a full mitigation for static conditions but at a higher cost and greater impacted to roadway users. A full mitigation solution for the static, pseudo static, and post liquefaction loading conditions would be a much higher cost but could be achieved by implementing anchored slope stabilization with drainage (option #6).

Slope 178

Our inclinometer data indicates that there is a deep seated movement at about 30 feet bgs, a similar depth to Slope 177. Combining the results of the slope stability analysis and the screening matrix, it is our recommendation that for Slope 178 aggregate shafts (option #4) be implemented as a full mitigation for static conditions. Since the deep seated instability may have been initiated by the Nisqually earthquake it should be noted that Aggregate shafts would not be a full mitigation option for the pseudo static or post liquefaction loading conditions; however, as stated previously ground improvements are not required to be designed for seismic events. A benefit of the aggregate shafts is that removing the existing material to place the quarry spalls would remove the weak soils along the slide plane and improve the strength of the material below the roadway.

Horizontal drains combined with lightweight cellular concrete fill (option #2) could be implemented as a partial mitigation solution for the static loading conditions if aggregate shafts are not used. LCC fill would modernize the existing lightweight wood fill, which over time will degrade and eventually lead to deformations manifesting at the roadway surface. A full mitigation/long term solution for the static, pseudo static and post liquefaction loading conditions could be achieved by implementing anchored slope stabilization with drainage (option #6).

Slope 3035

Our understanding of Slope 3035 is that shallow planar slides have been observed at this site originating from the steep slope above the roadway. Existing information for this slope is limited to a few photos of a shallow slide in 2011 and our review of historical images in Google Earth. that the slope area at this location is inaccessible to typical drilling equipment therefore, no soil borings were planned for this area. Reviewing publicly available LiDAR and topographic imagery for Slope 3035, the steep slope appears to be hummocky which is evidence of past slides originating above the road.

Recommendations for this slope are based on limited surficial information and should be reviewed with subsurface information. Based on our understanding of the slope and our observations of the area anchored slope stabilization (option #6) is likely the best mitigation option for this area to address the steep slopes and risk of shallow slides.

4.4.3 General Construction Considerations

The frequent distress of the roadway appears to be primarily driven by fluctuations in local groundwater levels related to high tides and heavy rains and we recommend that work to mitigate the slide and expand the roadway take place between the late spring and early fall. Heavy rains related to high groundwater conditions are common during the late fall, winter, and early spring in the pacific northwest and should be carefully considered when considering and implementing any mitigation option at the Victor Area Slide.

Groundwater levels observed during our study ranged from approximately 8 to 12 feet below the roadway and were encountered at shallower depths closer to North Bay. The contractor should be prepared to manage groundwater in excavations deeper than 5 feet, excavations up to about 12 feet can likely be managed with sumps and pumps during dryer times of the year. Any excavation deeper than 12 feet will likely require dewatering and shoring designed to control sloughing of the sandy soils at the site.

Our review of existing documentation revealed that a previous attempt to develop some of the private property east of SR 302 may have triggered a slide event. Large or heavy equipment, construction stockpiles, or other potential loads and sources of vibration may increase the driving forces on the slopes in the area and should be considered when selecting and implementing a mitigation strategy. Removal of material for improvements can reduce the resisting forces of the slide. Because slopes 178 and 3035 have existing developments upslope we recommended that a preconstruction survey of these developments be performed and periodic settlement monitoring of these structures be part of the project.

Most sections of SR 302 within the Victor Slide vicinity do not have a shoulder, and both sides of SR 302 are typically either steeply sloped or function as a drainage ditch to channel groundwater and runoff under the road. These conditions will impact factors such as construction staging and traffic control within the area and should also be considered when selecting a mitigation strategy.

5.0 CONDITIONS AND LIMITATIONS

We have prepared this report for the Washington Department of Transportation and Parametrix for use in evaluation of this project. The conclusions and interpretations presented in this report should not be construed as our warranty of subsurface conditions at the site. Experience has shown that soil and ground water conditions can vary significantly over small distances and with time. Inconsistent conditions can occur between explorations that may not be detected by a geotechnical study of this scope and nature.

Within the limitations of approved scope, schedule and budget, HWA attempted to execute these services in accordance with generally accepted professional principles and practices in the fields of geotechnical engineering and engineering geology at the time the report was prepared. No warranty, express or implied, is made.

HWA does not practice or consult in the field of safety engineering. We do not direct the contractor's operations and cannot be responsible for the safety of personnel other than our own on the site. As such, the safety of others is the responsibility of the contractor. However, the contractor should notify the owner if any of the recommended actions presented herein are considered unsafe.

We appreciate the opportunity to provide geotechnical services on this project. Should you have any questions or comments, or if we may be of further service, please do not hesitate to call.

Sincerely,

June 30, 2023
HWA Project No. 2022-043-21

HWA GEOSCIENCES INC.

William R. Rosso, P.E.
Geotechnical Engineer

Sandy R. Brodahl, P.E.
Geotechnical Engineer, Principal

6. LIST OF REFERENCES

American Association of State Highway and Transportation Officials, 2011, *AASHTO Guide Specifications for LRFD Seismic Bridge Design,* 2nd edition, American Association of State Highway and Transportation Officials. Washington, DC.

American Society of Civil Engineers (ASCE) 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

Dragovich, J.D., Littke, H.A., Anderson, M.L., Wessel, G.R., Koger, C.J., Saltonstall, J.H., MacDonald Jr., J.H., Mahan, S.A., and DuFrane, S.A., *Geologic Map of Carnation 7.5-minute Quadrangle, King County, Washington*, Washington Division of Geology and Earth Resources Open File Report 2010-1. June 2010.

Idriss I.M., Boulanger R.W., 2007, *SPT- and CPT-Based Relationships for The Residual Shear Strength of Liquefied Soils*. Earthquake Geotechnical Engineering, Geotechnical, Geological and Earthquake Engineering, vol 6.

Idriss, I.M, and Boulanger, RW, 2004, *Semi-Empirical Procedures for Evaluating Liquefaction Potential During Earthquakes*, presented at the Joint 11th ISCDEE & 3rd ICEGE, January 2004.

Idriss, I.M., and Boulanger, R.W., 2006, "Semi-empirical procedures for evaluating liquefaction potential during earthquakes", *Soil Dynamics and Earthquake Engineering*, 11th International Conference on Soil Dynamics and Earthquake Engineering (ICSDEE): Part II, Volume 26, Issues 2–4, February–April 2006, Pages 115–130.

Kramer. S.L. and Wang, C.-H., 2008. *Estimation of the residual strength of liquefied soil, in preparation.*

Lorilla Engineering, Inc., P.S., 2005, *Geotechnical Engineering Study Final Design Report, Tolt Bridge No. 1834A Replacement, King County Washington*, dated September 2005, prepared for Lin & Associates, Inc.

Olson, S.M. and Stark, T.D. (2002). *Liquefied strength ratio from liquefaction flow failure case histories*, Canadian Geotechnical Journal, 39(5), 629-647.

Petersen, M.D., Moschetti, M.P., Powers, P.M., Mueller, C.S., Haller, K.M., Frankel, A.D., Zeng, Yuehua, Rezaeian, Sanaz, Harmsen, S.C., Boyd, O.S., Field, Ned, Chen, Rui, Rukstales, K.S., Luco, Nico, Wheeler, R.L., Williams, R.A., and Olsen, A.H., 2014, *Documentation for the 2014 update of the United States national seismic hazard maps*, U.S. Geological Survey Open-File Report 2014–1091, 243 p.

Rocscience Inc., 2020, SLIDE 2018 8.032, Computer Software.

Seed, H.B. and Idriss, I.M., 1971, Simplified Procedure for Evaluating Soil Liquefaction Potential. *Journal of Soil Mechanics Foundation Division*, ASCE, Vol. 97, No. SM9, pp. 1249-1273.

Seed, R.B., and Harder, L.F., Jr., 1990, *SPT-Based Analysis of Cyclic Pore Pressure Generation and undrained Residual Strength,* H.B. Seed Memorial Symposium, Bi-Tech Publishing Ltd., Vol. 2, pp. 351-376.

Tokimatsu, K. and Seed, H.B., 1987. *Evaluation of Settlement in Sands Due to Earthquake Shaking*. ASCE Journal of Geotechnical Engineering, Vol. 113, No. 8, August 1987.

U.S. Geological Survey, Quaternary Fault and Fold Database of the United States, Tacoma fault (Class A) No. 581, accessed 4/4/2023.

WSDOT, 2020, *Bridge Design Manual (LRFD)*, Washington State Department of Transportation, M 23-50.20, September 30, 2020.

WSDOT, 2021, *Geotechnical Design Manual,* Washington State Department of Transportation, M 46-03, December 14, 2021.

WSDOT, Memo to Designers ,2017, *AASHTO Guide Specifications for LRFD Seismic Bridge Design Amendments* dated January 8, 2017

WSDOT, Letter to Carl E. Minor from Arthur M. Ritche and Joe B. Cashman, dated January 6, 1959

WSDOT, Intra-Departmental Communication, *C.S. 2332, SR 302, Victor Vicinity – Settlement from H. Frankmoelle*, dated July 9, 1976

WSDOT, Intra-Departmental Communication, SR-302 *CS 2332, L-5013, Victor Vicinity Slide from R.V. LeClerc & A.P. Kilian*, dated July 9, 1976

WSDOT, Intra-Departmental Communication, SR-302 *CS 2332, L-5013, Victor Vicinity Slide from R.V. LeClerc & A.P. Kilian*, dated July 9, 1976

WSDOT, *Soils Report SR 302 Coulter Road to Victor Vicinity & Elgin – Clifton Road to Goodrich Drive Vicinity,* prepared by J.D. Belling, dated January 13, 1978

WSDOT, Memorandum, *SR-302 Victor Landslide Historical Review from J.R. Struthers,* dated March 21, 2001

WSDOT, Memorandum, *SR-302, MP 5.5 DMC-041, Estimated Costs for Geotechnical Investigation and Analysis, Victor Landslide Failures, from T.M. Allen / J.R. Struthers,* dated June 20, 2001

WSDOT, Plan Set, *SR 302 1.15 Miles S of E Victor Road Major Drainage,* dated July 1, 2016

WSDOT, Electronic Mail, *Geotechnical Site Visit Report, 2022-01-11 – Victor Slide, SR 302, MP 4.5 from Stephen Newman,* dated January 13, 2022.

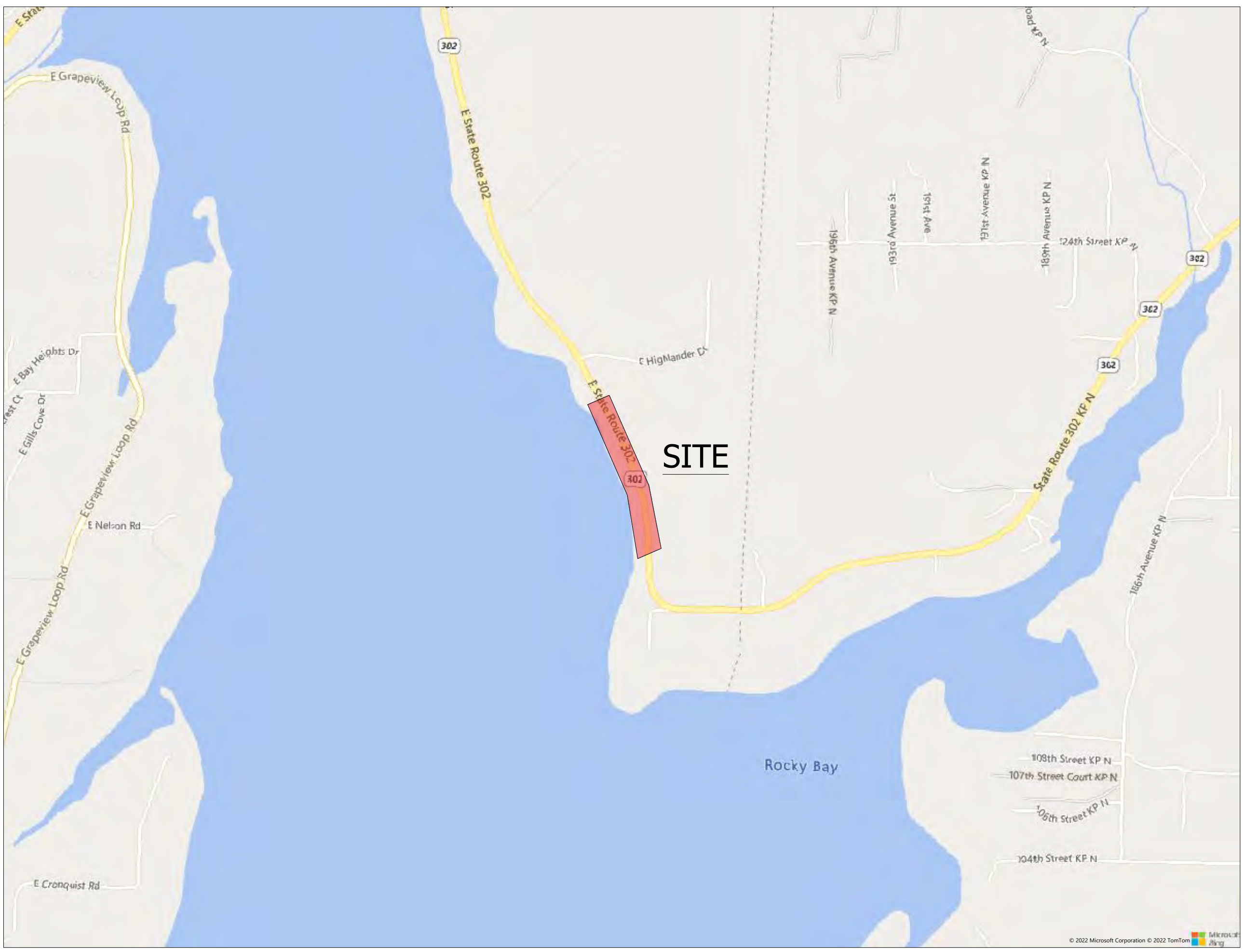
WSDOT, Electronic Mail, *SR 302 vicinity MP 4.5 Embankment Failure/Landslide - Geotechnical Office Response from Michael Mulhern,* dated January 15, 2021.

Youd, T.L., et al., 2001, *Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils*, Journal of Geotechnical and Geoenvironmental Engineering, Geo-Institute of the American Society of Civil Engineers (ASCE), Vol. 127, No. 10, October, 2001.

SITE MAP

0 200' 400' 600' 800'

SCALE: 1" = 400'



VICINITY MAP

0 1000' 2000' 3000' 4000'

SCALE: 1" = 2000'

HWA GEOSCIENCES INC.
DBE/MWBE

SITE AND VICINITY MAP

SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

FIGURE NO.: 1

DRAWN BY: CF
CHECK BY: WRR

PROJECT # 2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR 302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY.DWG <1> Plotted: 11/4/2022 2:48 PM

EXPLORATION LEGEND

HWA-1P-22 50'-80'	(red)	BORING DESIGNATION, DEPTH, AND APPROXIMATE LOCATION
HWA-9-22 20'-30'	(purple)	LIMITED ACCESS BORING DESIGNATION, DEPTH, AND APPROXIMATE LOCATION
HWA-2Si-22 (100')	(blue)	BORING WITH INCLINOMETER DESIGNATION, DEPTH, AND APPROXIMATE LOCATION
TH-1A-01	(yellow)	EXISTING WDSOT 1-INCH MONITORING WELL, DESIGNATION AND APPROXIMATE LOCATION (2001)
TH-1-01	(orange)	EXISTING WDSOT INCLINOMETER, DESIGNATION AND APPROXIMATE LOCATION (2001)

BASE MAP PROVIDED BY: BING & CONTOURS ESTIMATED USING 1887-2017 USGS CoNED TOPOBATHY DEM DATA (COMPLIED 2020)

SR 302

Scale: 1" = 120'-0"

MP 4.1 MILEPOST - 1/10th Mile

GROUND CRACKS OBSERVED ON 01.11.2022

A ——— A' GEOLOGIC CROSS SECTION

0 60 120 180 240

SCALE: 1" = 120'

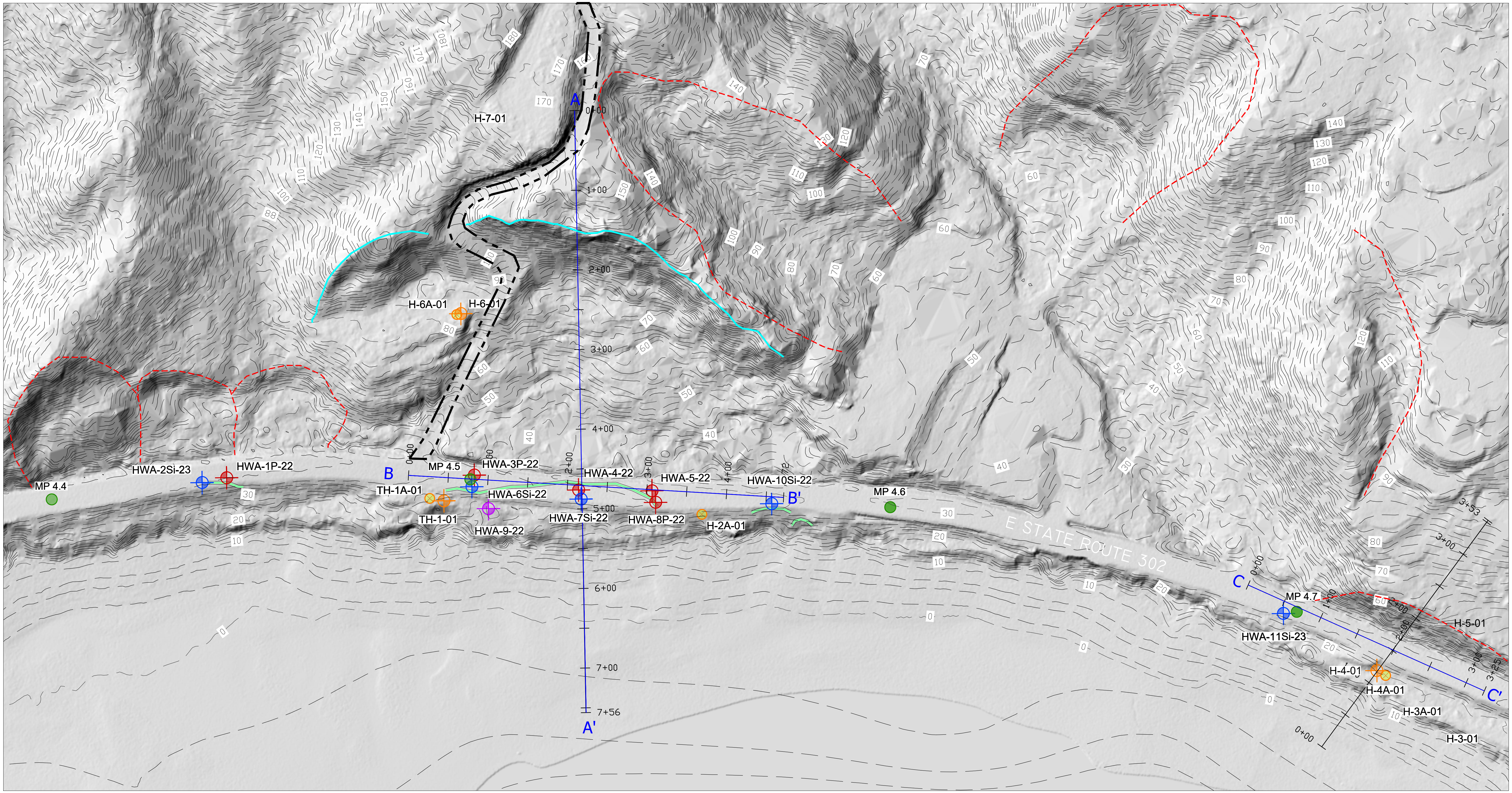
HWA GEOSCIENCES INC. DBE/MWBE

SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

SITE & EXPLORATION PLAN

DRAWN BY:	FIGURE NO.:
CF	2
CHECK BY:	PROJECT NO.:
WRR	2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR 302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY.DWG <2> Plotted: 6/28/2023 9:20 PM



EXPLORATION LEGEND

HWA-1P-22 50'-80' — BORING DESIGNATION, DEPTH, AND APPROXIMATE LOCATION

HWA-9-22 20'-30' — LIMITED ACCESS BORING DESIGNATION, DEPTH, AND APPROXIMATE LOCATION

HWA-2Si-22 (100') — BORING WITH INCLINOMETER DESIGNATION, DEPTH, AND APPROXIMATE LOCATION

TH-1A-01 — EXISTING WDSOT 1-INCH MONITORING WELL, DESIGNATION AND APPROXIMATE LOCATION (2001)

TH-1-01 — EXISTING WDSOT INCLINOMETER, DESIGNATION AND APPROXIMATE LOCATION (2001)

BASE MAP PROVIDED BY: BING & CONTOURS ESTIMATED USING 1887-2017 USGS CoNED TOPOBATHY DEM DATA (COMPLIED 2020)

SR 302

Scale: 1" = 120'-0"

MP 4.1 — MILEPOST - 1/10th Mile

GROUND CRACKS OBSERVED ON 01.11.2022

GEOLOGICE CROSS SECTION

POSSIBLE PREVIOUS LANDSLIDES

ANCIENT SLIDE HEADSCARP

PRIVATE CONCRETE ROAD

0 60 120 180 240

SCALE: 1" = 120'

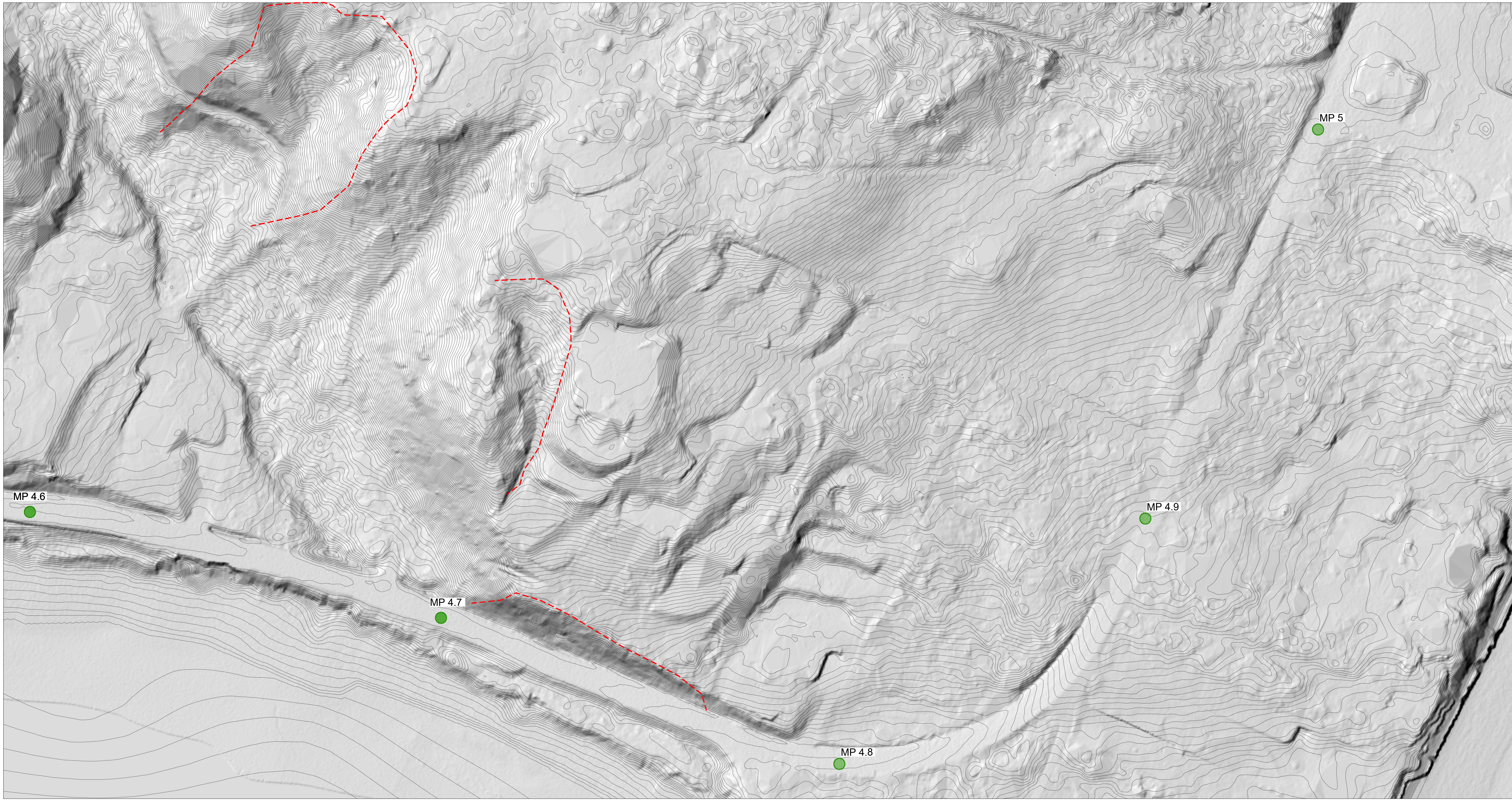
HWA GEOSCIENCES INC. DBE/MWBE

SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

SLOPE 177
LIDAR AND
EXPLORATION PLAN

DRAWN BY:	FIGURE NO.:
CF	2A
CHECK BY:	PROJECT NO.:
WRR	2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR 302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY.DWG <2A> Plotted: 6/28/2023 9:23 PM



SR 302
Scale: 1" = 120'-0"

EXPLORATION LEGEND

MP 4.6 ● MILEPOST - 1/10th Mile

- - - - - POSSIBLE PREVIOUS LANDSLIDES

0 60 120 180 240
SCALE: 1" = 120'

BASE MAP PROVIDED BY: BING & CONTOURS ESTIMATED USING 1887-2017 USGS CoNED TOPOBATHY DEM DATA (COMPLIED 2020)

HWA GEOSCIENCES INC.
DBE/MWBE

SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

SLOPE 178
LIDAR & CONTOUR
MAP

DRAWN BY:	FIGURE NO.:
CF	2B
CHECK BY:	PROJECT NO.:
WRR	2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY.DWG <2B> Plotted: 6/8/2023 10:58 PM

SR 302
Scale: 1" = 120'-0"

EXPLORATION LEGEND

MP 4.1 — MILEPOST - 1/10th Mile

- - - - - POSSIBLE PREVIOUS LANDSLIDES

0 60 120 180 240

SCALE: 1" = 120'

BASE MAP PROVIDED BY: BING & CONTOURS ESTIMATED USING 1887-2017 USGS CoNED TOPOBATHY DEM DATA (COMPLIED 2020)

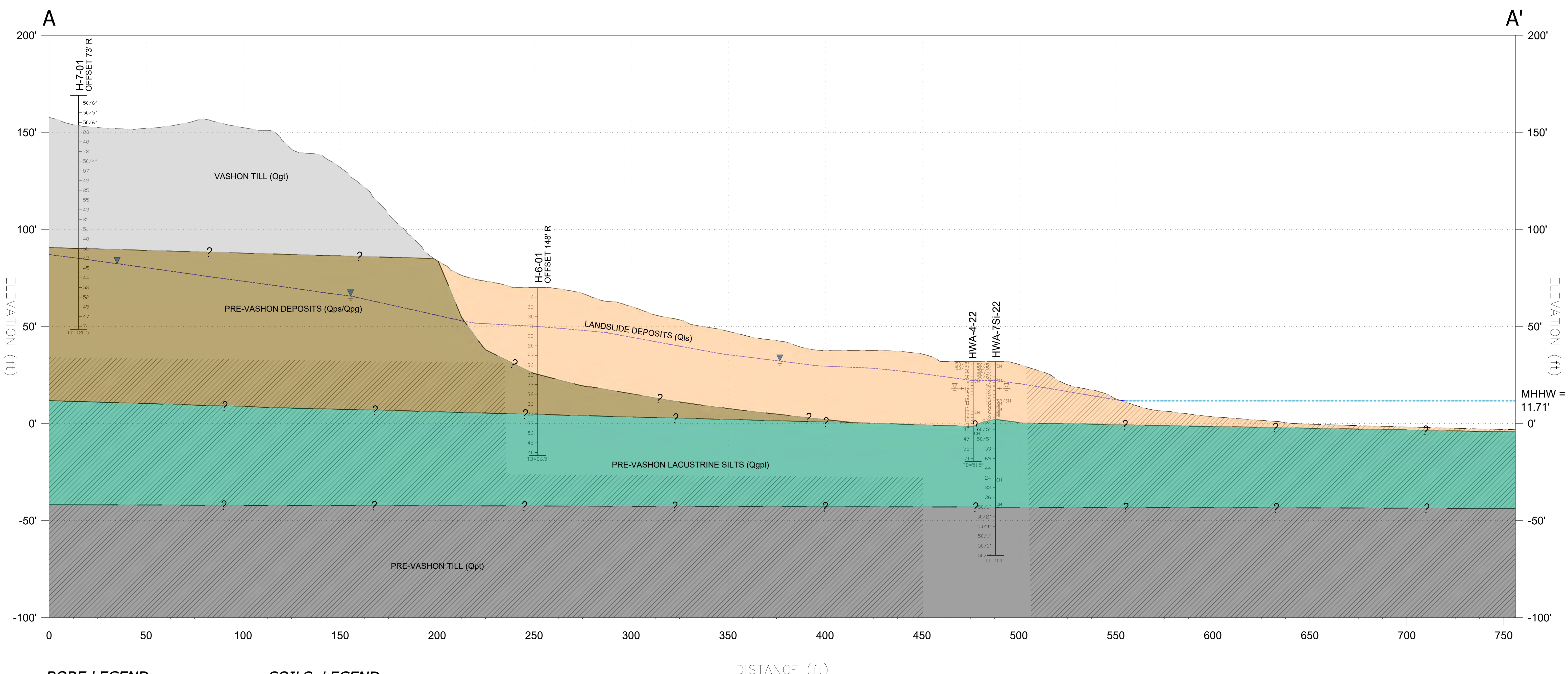
HWA GEOSCIENCES INC.
DBE/MWBE

SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

SLOPE 3035
LIDAR & CONTOUR
MAP

DRAWN BY:	FIGURE NO.:
CF	2C
CHECK BY:	PROJECT NO.:
WRR	2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY.DWG <2C> Plotted: 6/8/2023 10:57 PM



BORE LEGEND

HWA-3P-22 — EXPLORATION DESIGNATION

BLOW COUNT "N-VALUE "

WATER LEVEL IN WELL DURING DRILLING

INFERRED GEOLOGIC CONTACT

BOTTOM OF EXPLORATION

SOILS LEGEND

- VASHON TILL (Qgt)
- LANDSLIDE DEPOSITS (Qls)
- PRE-VASHON DEPOSITS (Qps/Qpg)
- PRE-VASHON LACUSTRINE SILTS (Qgpl)
- PRE-VASHON TILL (Qpt)
- NO DATA AVAILABLE, UNITS ARE INFERRED FROM EXISTING INFORMATION FOR ANALYSIS PURPOSES
- MEAN HIGH HIGH WATER TIDE (MHHW)
- ESTIMATED DESIGN GROUND WATER LEVELS

NOTE: THE SUBSURFACE CONDITIONS SHOWN ARE BASED ON WIDELY SPACED BORINGS AND SHOULD BE CONSIDERED APPROXIMATE. FURTHERMORE, THE CONTACT LINES SHOWN BETWEEN UNITS ARE INTERPRETIVE IN NATURE AND MAY VARY LATERALLY OR VERTICALLY OVER RELATIVELY SHORT DISTANCES ON SITE.

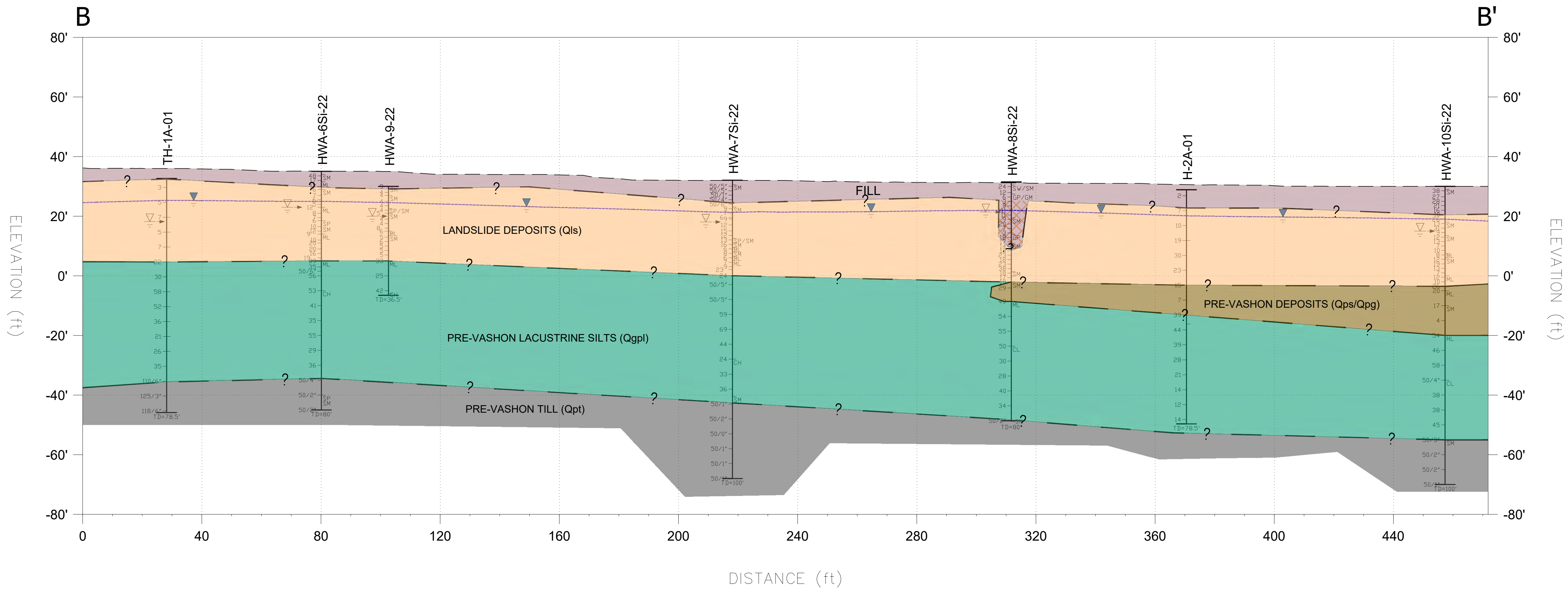
0 25 50 75 100

HORIZ./VERT. SCALE: 1" = 50'

GROUND SURFACE PROFILE WAS ESTIMATED USING 1887-2017 USGS CoNED TOPOBATHY DEM DATA (COMPLIED 2020)

HWA GEOSCIENCES INC. DBE/MWBE	SR 302 VICTOR AREA STUDY MASON COUNTY, WASHINGTON	GEOLOGIC CROSS SECTION A-A'	DRAWN BY: CF CHECK BY: WRR	FIGURE NO.: 3A PROJECT NO.: 2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY.DWG <3A> Plotted: 6/9/2023 8:20 PM



BORE LEGEND

HWA-3P-22 — EXPLORATION DESIGNATION

BLOW COUNT "N-VALUE "

WATER LEVEL IN WELL DURING DRILLING

INFERRED GEOLOGIC CONTACT

BOTTOM OF EXPLORATION

SOILS LEGEND

- FILL
- LANDSLIDE DEPOSITS (Qls)
- PRE-VASHON DEPOSITS (Qps/Qpg)
- PRE-VASHON LACUSTRINE SILTS (Qgpl)
- PRE-VASHON TILL (Qpt)
- NO DATA AVAILABLE, UNITS ARE INFERRED FROM EXISTING INFORMATION FOR ANALYSIS PURPOSES
- ESTIMATED DESIGN GROUND WATER LEVELS

NOTES:

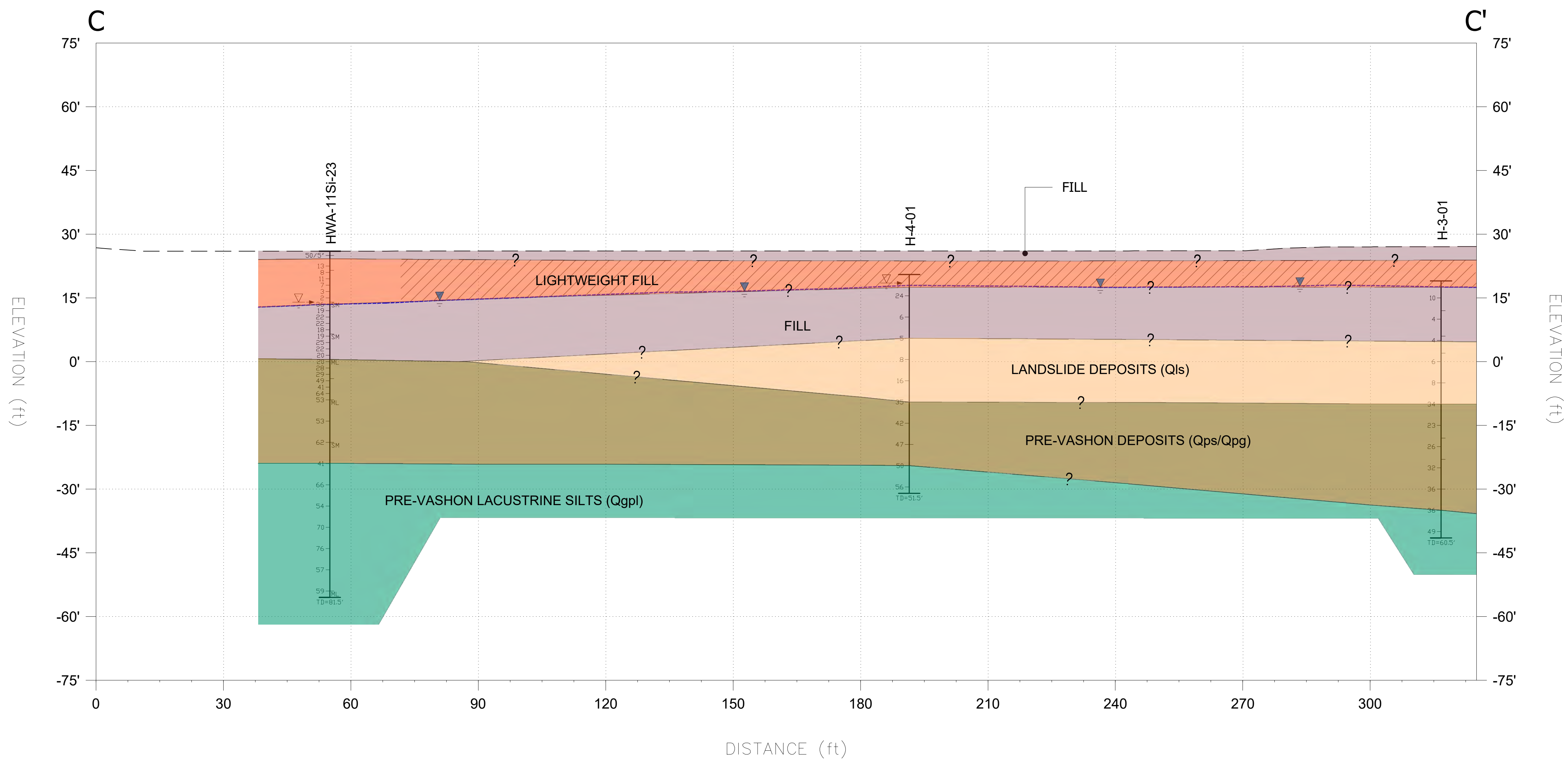
1. THE SUBSURFACE CONDITIONS SHOWN ARE BASED ON WIDELY SPACED BORINGS AND SHOULD BE CONSIDERED APPROXIMATE. FURTHERMORE, THE CONTACT LINES SHOWN BETWEEN UNITS ARE INTERPRETIVE IN NATURE AND MAY VARY LATERALLY OR VERTICALLY OVER RELATIVELY SHORT DISTANCES ON SITE.
2. EXPLORATION HWA-8P-22 ENCOUNTERED FINE SUBROUNDED GRAVEL FILL SOILS (PEA GRAVEL) STARTING BELOW THE PAVEMENT SECTION TO APPROXIMATELY 20 1/2 FEET BELOW THE EXISTING GROUND SURFACE. THIS FILL MATERIAL IS A DIFFERENT COMPOSITION AND SIGNIFICANTLY THICKER THAN FILL SOILS OBSERVED IN OTHER EXPLORATIONS. BASED ON THE DEPTH OF FILL AND THE TENSION CRACKING OBSERVED IN THE PAVEMENT AT THE SURFACE, WE BELIEVE THE BORING WAS ADVANCED WITHIN THE BACKFILL OF A SCARP THAT FORMED DURING A PREVIOUS SLIDE EVENT.

0 20 40 60 80
HORIZ./VERT. SCALE: 1" = 40'

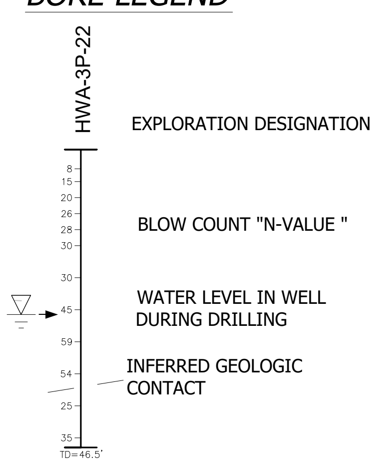
HWA GEOSCIENCES INC. DBE/MWBE	SR 302 VICTOR AREA STUDY MASON COUNTY, WASHINGTON	GEOLOGIC CROSS SECTION B-B'	DRAWN BY: CF	FIGURE NO.: 3B
			CHECK BY: WRR	PROJECT NO.: 2022-043-21

GROUND SURFACE PROFILE WAS ESTIMATED USING 1887-2017 USGS CoNED TOPOBATHY DEM DATA (COMPLIED 2020)

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY.DWG <3B> Plotted: 6/9/2023 8:21 PM



BORE LEGEND



SOILS LEGEND

- FILL
- LIGHTWEIGHT FILL
- LANDSLIDE DEPOSITS (Qls)
- PRE-VASHON DEPOSITS (Qps/Qpg)
- PRE-VASHON LACUSTRINE SILTS (Qgpl)
- NO DATA AVAILABLE, UNITS ARE INFERRED FROM EXISTING INFORMATION FOR ANALYSIS PURPOSES
- ESTIMATED DESIGN GROUND WATER LEVELS

NOTE: THE SUBSURFACE CONDITIONS SHOWN ARE BASED ON WIDELY SPACED BORINGS AND SHOULD BE CONSIDERED APPROXIMATE. FURTHERMORE, THE CONTACT LINES SHOWN BETWEEN UNITS ARE INTERPRETIVE IN NATURE AND MAY VARY LATERALLY OR VERTICALLY OVER RELATIVELY SHORT DISTANCES ON SITE.

0 15 30 45 60
HORIZ./VERT. SCALE: 1" = 30'

GROUND SURFACE PROFILE WAS ESTIMATED USING 1887-2017 USGS CoNED TOPOBATHY DEM DATA (COMPLIED 2020)

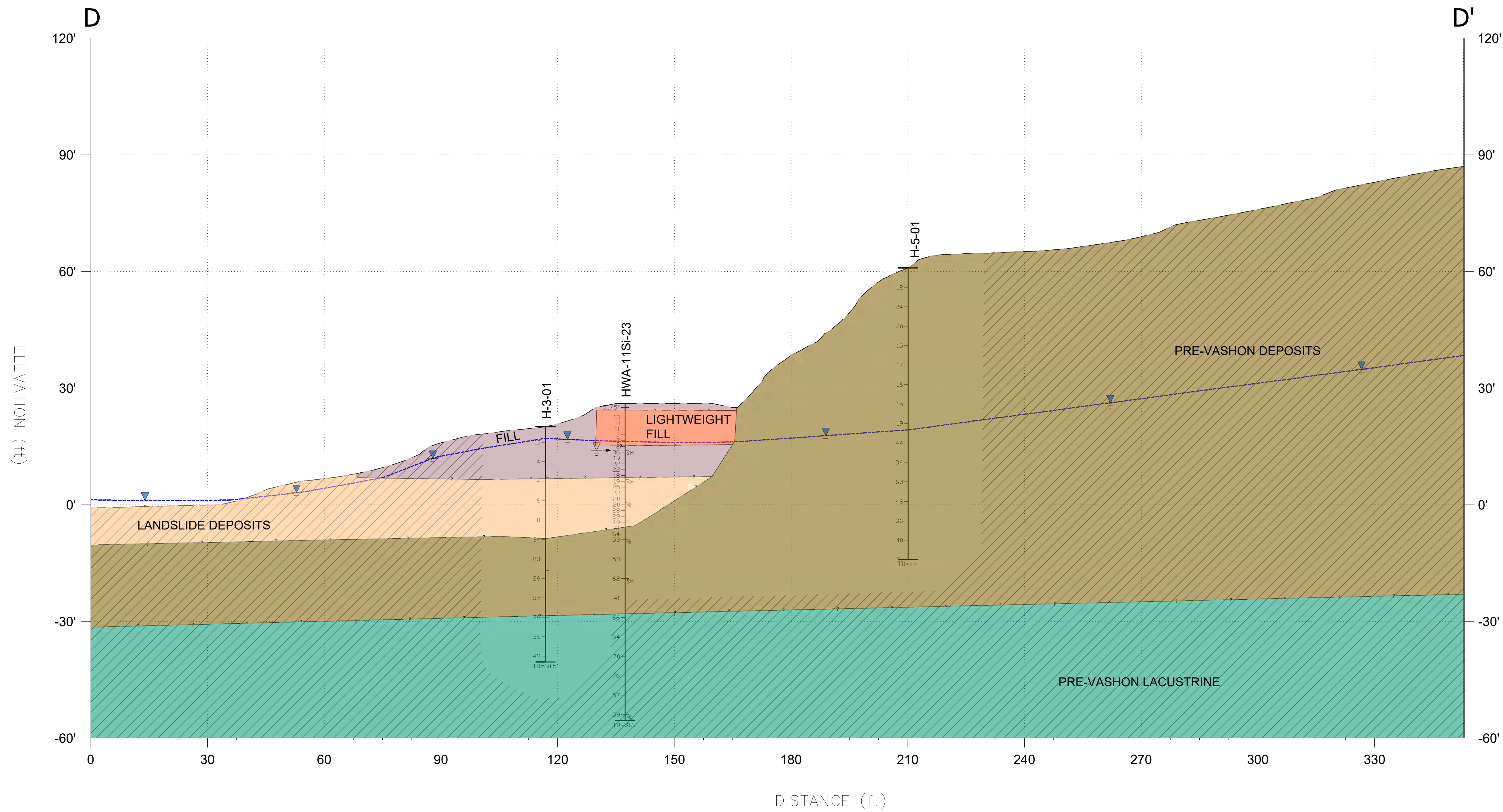
HWA GEOSCIENCES INC. DBE/MWBE

SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

GEOLOGIC CROSS SECTION C-C'

DRAWN BY:	FIGURE NO.:
CF	3C
CHECK BY:	PROJECT NO.:
WRR	2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY.DWG <3C> Plotted: 6/9/2023 8:29 PM



BORE LEGEND

HWA-3P-22 — EXPLORATION DESIGNATION

BLOW COUNT "N-VALUE "

WATER LEVEL IN WELL DURING DRILLING

INFERRED GEOLOGIC CONTACT

BOTTOM OF EXPLORATION

SOILS LEGEND

- FILL
- LIGHTWEIGHT FILL
- LANDSLIDE DEPOSITS (Qls)
- PRE-VASHON DEPOSITS (Qps/Qpg)
- PRE-VASHON LACUSTRINE SILTS (Qgpl)
- NO DATA AVAILABLE, UNITS ARE INFERRED FROM EXISTING INFORMATION FOR ANALYSIS PURPOSES
- ESTIMATED DESIGN GROUND WATER LEVELS

NOTE: THE SUBSURFACE CONDITIONS SHOWN ARE BASED ON WIDELY SPACED BORINGS AND SHOULD BE CONSIDERED APPROXIMATE. FURTHERMORE, THE CONTACT LINES SHOWN BETWEEN UNITS ARE INTERPRETIVE IN NATURE AND MAY VARY LATERALLY OR VERTICALLY OVER RELATIVELY SHORT DISTANCES ON SITE.

0 15 30 45 60

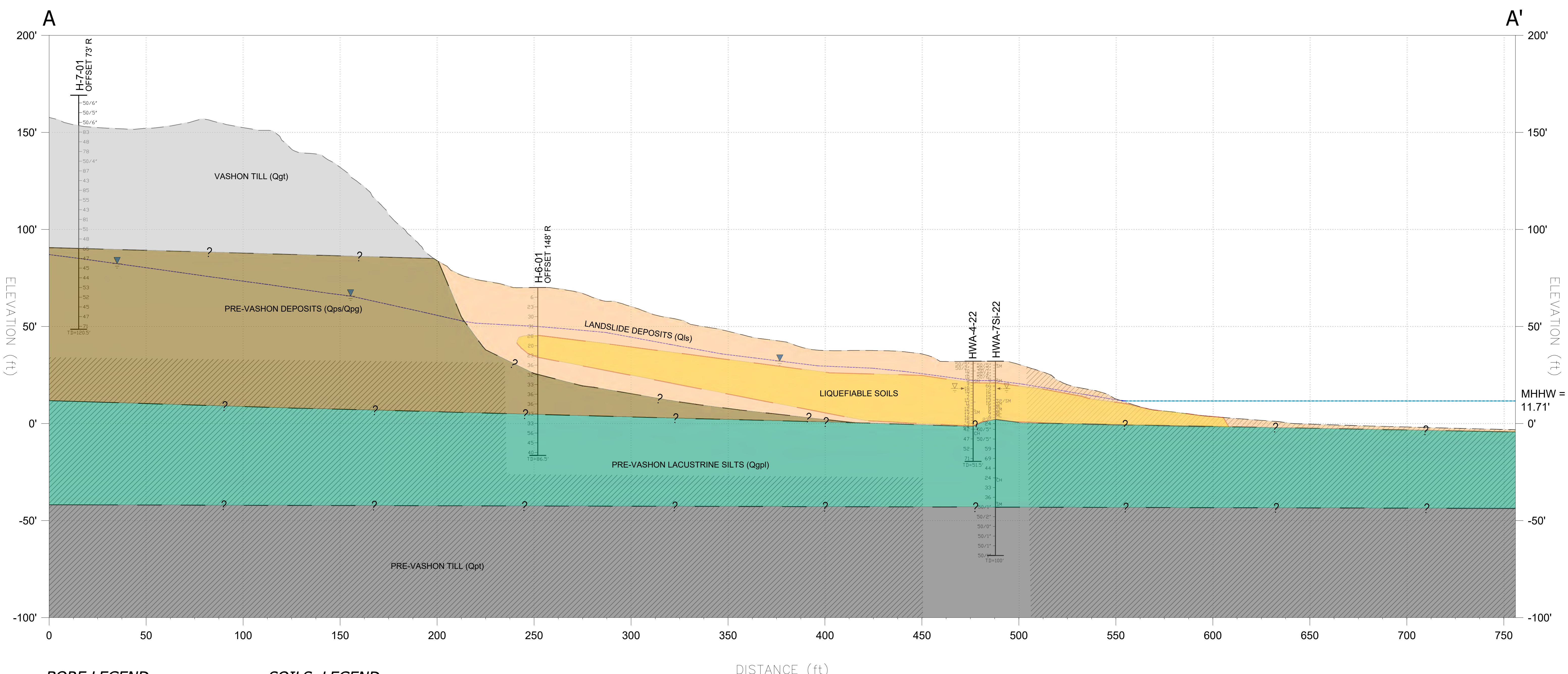
HORIZ./VERT. SCALE: 1" = 30'

GROUND SURFACE PROFILE WAS ESTIMATED USING 1887-2017 USGS CoNED TOPOBATHY DEM DATA (COMPLIED 2020)

HWA GEOSCIENCES INC. DBE/MWBE

SR 302 VICTOR AREA STUDY MASON COUNTY, WASHINGTON	GEOLOGIC CROSS SECTION D-D'	DRAWN BY: CF	FIGURE NO.: 3D
		CHECK BY: WRR	PROJECT NO.: 2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY.DWG <3D> Plotted: 6/11/2023 12:55 PM



BORE LEGEND

- HWA-3P-22 — EXPLORATION DESIGNATION
- BLOW COUNT "N-VALUE "
- WATER LEVEL IN WELL DURING DRILLING
- INFERRED GEOLOGIC CONTACT
- BOTTOM OF EXPLORATION

SOILS LEGEND

- VASHON TILL (Qgt)
- LANDSLIDE DEPOSITS (Qls)
- PRE-VASHON DEPOSITS (Qps/Qpg)
- PRE-VASHON LACUSTRINE SILTS (Qgpl)
- PRE-VASHON TILL (Qpt)
- NO DATA AVAILABLE, UNITS ARE INFERRED FROM EXISTING INFORMATION FOR ANALYSIS PURPOSES
- MEAN HIGH HIGH WATER TIDE (MHHW)
- ESTIMATED DESIGN GROUND WATER LEVELS
- LIQUEFIABLE SOILS

NOTE: THE SUBSURFACE CONDITIONS SHOWN ARE BASED ON WIDELY SPACED BORINGS AND SHOULD BE CONSIDERED APPROXIMATE. FURTHERMORE, THE CONTACT LINES SHOWN BETWEEN UNITS ARE INTERPRETIVE IN NATURE AND MAY VARY LATERALLY OR VERTICALLY OVER RELATIVELY SHORT DISTANCES ON SITE.

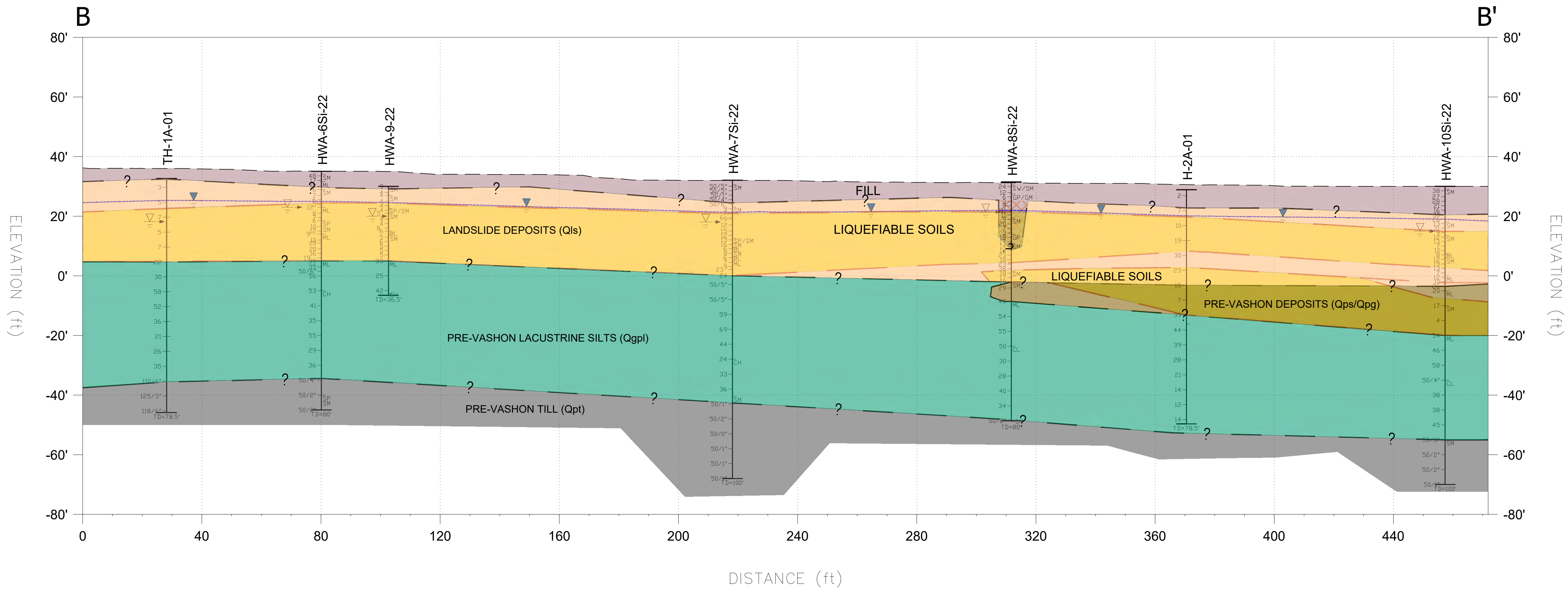
0 25 50 75 100
HORIZ./VERT. SCALE: 1" = 50'

GROUND SURFACE PROFILE WAS ESTIMATED USING 1887-2017 USGS CoNED TOPOBATHY DEM DATA (COMPLIED 2020)

HWA GEOSCIENCES INC. DBE/MWBE

SR 302 VICTOR AREA STUDY MASON COUNTY, WASHINGTON	LIQUEFIABLE ZONES CROSS SECTION A-A'	DRAWN BY: CF	FIGURE NO.: 4A
		CHECK BY: WRR	PROJECT NO.: 2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY.DWG <4A> Plotted: 6/9/2023 8:21 PM



BORE LEGEND

HWA-3P-22 — EXPLORATION DESIGNATION

BLOW COUNT "N-VALUE "

WATER LEVEL IN WELL DURING DRILLING

INFERRED GEOLOGIC CONTACT

BOTTOM OF EXPLORATION

SOILS LEGEND

- FILL
- LANDSLIDE DEPOSITS (Qls)
- PRE-VASHON DEPOSITS (Qps/Qpg)
- PRE-VASHON LACUSTRINE SILTS (Qgpl)
- PRE-VASHON TILL (Qpt)
- NO DATA AVAILABLE, UNITS ARE INFERRED FROM EXISTING INFORMATION FOR ANALYSIS PURPOSES
- LIQUEFIABLE SOILS
- ESTIMATED DESIGN GROUND WATER LEVELS

NOTES:

1. THE SUBSURFACE CONDITIONS SHOWN ARE BASED ON WIDELY SPACED BORINGS AND SHOULD BE CONSIDERED APPROXIMATE. FURTHERMORE, THE CONTACT LINES SHOWN BETWEEN UNITS ARE INTERPRETIVE IN NATURE AND MAY VARY LATERALLY OR VERTICALLY OVER RELATIVELY SHORT DISTANCES ON SITE.
2. EXPLORATION HWA-8P-22 ENCOUNTERED FINE SUBROUNDED GRAVEL FILL SOILS (PEA GRAVEL) STARTING BELOW THE PAVEMENT SECTION TO APPROXIMATELY 20 1/2 FEET BELOW THE EXISTING GROUND SURFACE. THIS FILL MATERIAL IS A DIFFERENT COMPOSITION AND SIGNIFICANTLY THICKER THAN FILL SOILS OBSERVED IN OTHER EXPLORATIONS. BASED ON THE DEPTH OF FILL AND THE TENSION CRACKING OBSERVED IN THE PAVEMENT AT THE SURFACE, WE BELIEVE THE BORING WAS ADVANCED WITHIN THE BACKFILL OF A SCARP THAT FORMED DURING A PREVIOUS SLIDE EVENT.

0 20 40 60 80

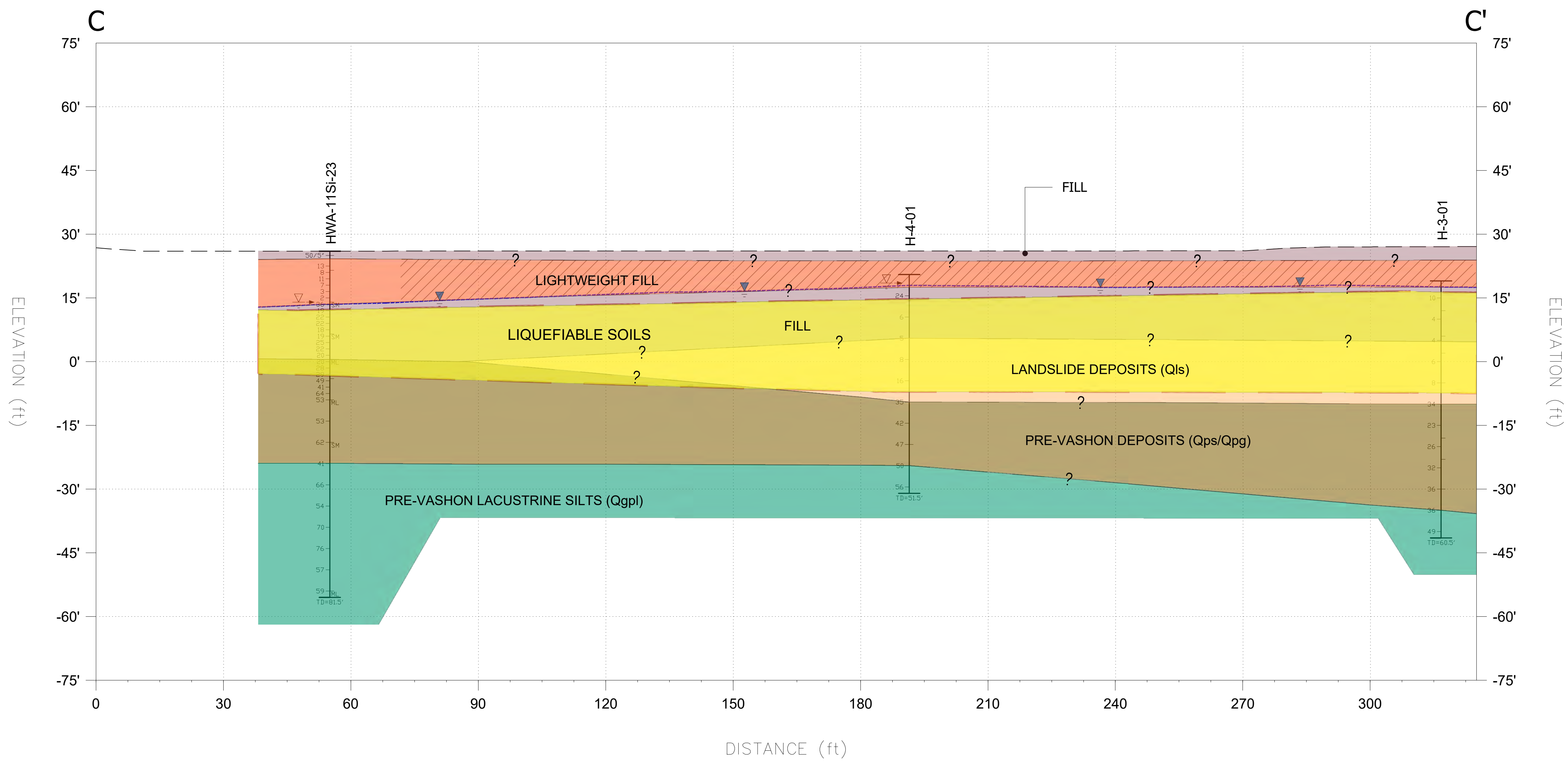
HORIZ./VERT. SCALE: 1" = 40'

GROUND SURFACE PROFILE WAS ESTIMATED USING 1887-2017 USGS CoNED TOPOBATHY DEM DATA (COMPLIED 2020)

HWA GEOSCIENCES INC. DBE/MWBE

SR 302 VICTOR AREA STUDY MASON COUNTY, WASHINGTON	LIQUEFIABLE ZONES CROSS SECTION B-B'	DRAWN BY: CF	FIGURE NO.: 4B
		CHECK BY: WRR	PROJECT NO.: 2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY.DWG <4B> Plotted: 6/9/2023 8:22 PM



BORE LEGEND

HWA-3P-22 — EXPLORATION DESIGNATION

BLOW COUNT "N-VALUE "

WATER LEVEL IN WELL DURING DRILLING

INFERRED GEOLOGIC CONTACT

BOTTOM OF EXPLORATION

SOILS LEGEND

- FILL
- LIGHTWEIGHT FILL
- LANDSLIDE DEPOSITS (Qls)
- PRE-VASHON DEPOSITS (Qps/Qpg)
- PRE-VASHON LACUSTRINE SILTS (Qgpl)
- NO DATA AVAILABLE, UNITS ARE INFERRED FROM EXISTING INFORMATION FOR ANALYSIS PURPOSES
- LIQUEFIABLE SOILS
- ESTIMATED DESIGN GROUND WATER LEVELS

NOTE: THE SUBSURFACE CONDITIONS SHOWN ARE BASED ON WIDELY SPACED BORINGS AND SHOULD BE CONSIDERED APPROXIMATE. FURTHERMORE, THE CONTACT LINES SHOWN BETWEEN UNITS ARE INTERPRETIVE IN NATURE AND MAY VARY LATERALLY OR VERTICALLY OVER RELATIVELY SHORT DISTANCES ON SITE.

0 15 30 45 60
HORIZ./VERT. SCALE: 1" = 30'

GROUND SURFACE PROFILE WAS ESTIMATED USING 1887-2017 USGS CoNED TOPOBATHY DEM DATA (COMPLIED 2020)

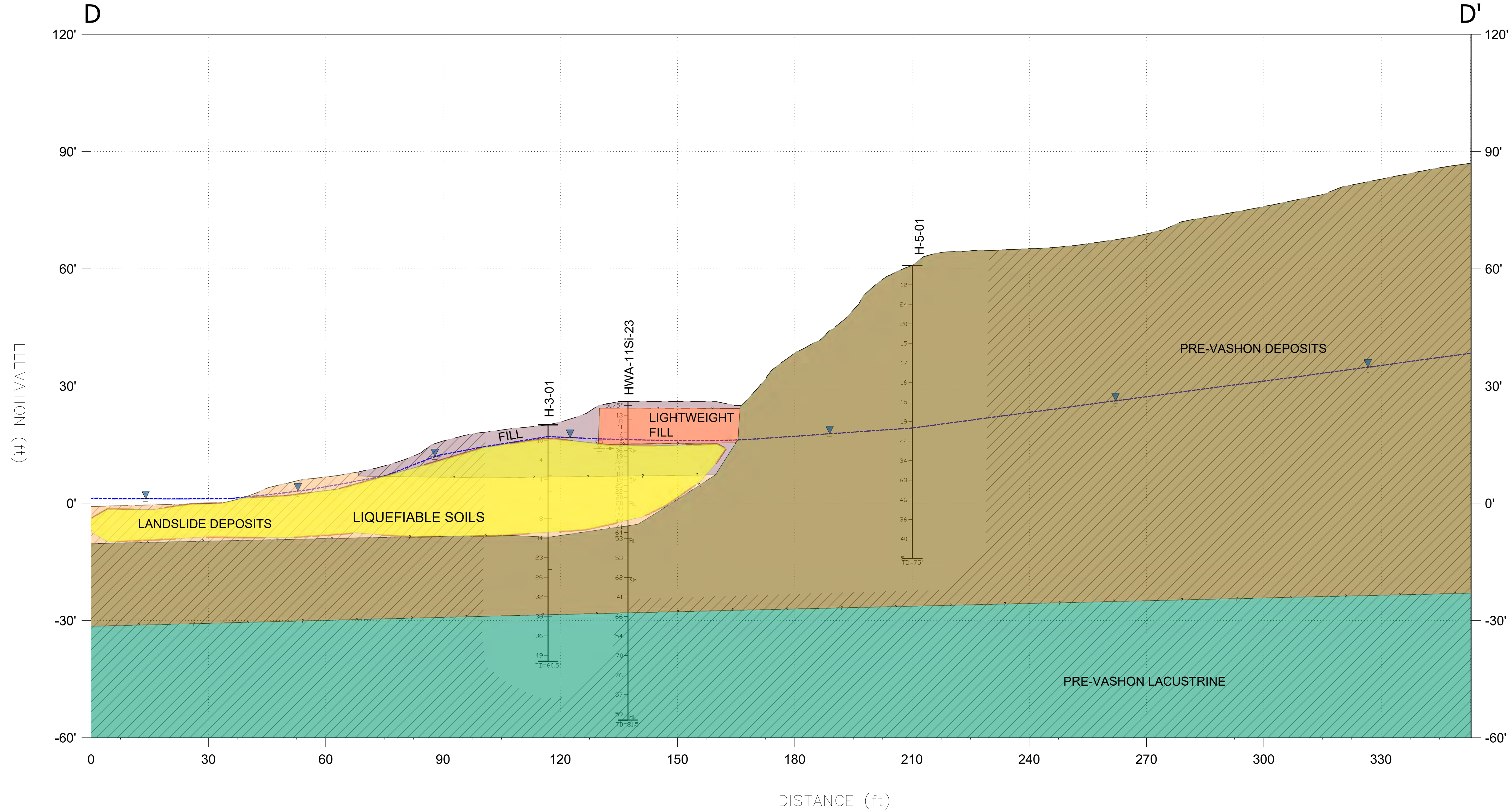
HWA GEOSCIENCES INC. DBE/MWBE

SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

LIQUEFIABLE ZONES
CROSS SECTION C-C'

DRAWN BY:	FIGURE NO.:
CF	4C
CHECK BY: WRR	PROJECT NO.: 2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY.DWG <4C> Plotted: 6/9/2023 8:29 PM



BORE LEGEND

HWA-3P-22

EXPLORATION DESIGNATION

BLOW COUNT "N-VALUE "

WATER LEVEL IN WELL DURING DRILLING

INFERRED GEOLOGIC CONTACT

BOTTOM OF EXPLORATION

SOILS LEGEND

- FILL
- LIGHTWEIGHT FILL
- LANDSLIDE DEPOSITS (Qls)
- PRE-VASHON DEPOSITS (Qps/Qpg)
- PRE-VASHON LACUSTRINE SILTS (Qgpl)
- NO DATA AVAILABLE, UNITS ARE INFERRED FROM EXISTING INFORMATION FOR ANALYSIS PURPOSES
- ESTIMATED DESIGN GROUND WATER LEVELS
- LIQUEFIABLE SOILS

NOTE: THE SUBSURFACE CONDITIONS SHOWN ARE BASED ON WIDELY SPACED BORINGS AND SHOULD BE CONSIDERED APPROXIMATE. FURTHERMORE, THE CONTACT LINES SHOWN BETWEEN UNITS ARE INTERPRETIVE IN NATURE AND MAY VARY LATERALLY OR VERTICALLY OVER RELATIVELY SHORT DISTANCES ON SITE.

0 15 30 45 60

HORIZ./VERT. SCALE: 1" = 30'

GROUND SURFACE PROFILE WAS ESTIMATED USING 1887-2017 USGS CoNED TOPOBATHY DEM DATA (COMPLIED 2020)

HWA GEOSCIENCES INC. DBE/MWBE	SR 302 VICTOR AREA STUDY MASON COUNTY, WASHINGTON	GEOLOGIC CROSS SECTION D-D'	DRAWN BY: CF CHECK BY: WRR	FIGURE NO.: 4D PROJECT NO.: 2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY.DWG <4D> Plotted: 6/11/2023 12:55 PM

Figure 5A - Mitigation Options Scoring Criteria

SR 302 Victor Area Study - Level 2 Screening

Categories	Descriptions	Measures	Metrics	Scoring
Safety/Resiliency	Improves the stability of the roadway to resist sliding and therefore reduce road closures. Slope stability factors of safety should be assessed based on section 7 of the WSDOT Geotechnical Design Manual and will depend on overall the design considerations for the proposed landslide mitigation. For example, a score of 1 may improve the stability of the slope by managing increasing groundwater but does not significantly improve the stability of the slope during a seismic event.	Slope Stability	Slide factor of safety under likely scenarios such as increases in groundwater levels, seismic events, and post liquefaction residual strength.	0 – Roadway stability unimproved 1 – Marginal roadway stability improvement but does not meet the minimum factor of safety for each likely scenario 2 – Improves stability of the roadway for likely scenarios 3 – Improves stability of the roadway and the large ancient slide for likely scenarios
Design Effort Required	Design effort required to evaluate, analyze and designed the mitigation alternatives. This effort could included seismic design, ground improvement, lateral earth loads, slope analysis, etc	Design efforts	Level of effort	1 – > 500 hour 2 – 160 to 500 hours 3 – < 160 hours
Erosion Control	Protects the roadway embankment/slope from erosion due to wave action, flood, and tides. Erosion causes the slope to lose its soil retention properties, resulting in the loss of road shoulder and compromising the travel lane's stability.	Exposed Surfaces to wave action, flood and ties.	Qualitative - Protection of the slopes below the roadway from erosion	1 – Low or no protection 2 – Moderate protection 3 – High protection
Multimodal Mobility	Will the proposed mitigation method be conducive to expanding the roadway for different travel modes (walking, biking, etc.) without requiring additional engineered structures or significant additional efforts during construction	Roadway shoulder width on each side of the road	Additional shoulder width (feet)	0 – Shoulder cannot be improved without additional efforts 1 – Shoulder can be expanded up to 2½ feet 2 – Shoulder can be expanded up to 5 feet 3 – Shoulder can be expanded up to 7½ feet
Environment	The impact of disturbing of sensitive areas (wetlands, cultural areas, flood hazards, wildlife habitat, etc.) on the environment	Permittable	Qualitative – Level of effort and likelihood of acquiring all necessary permits	1 – High effort, low probability of acquiring permits 2 – Low effort, low probability of acquiring permits 2 – High effort, high probability of acquiring permits 3 – Low effort, high probability of acquiring permits
Maintenance	Mitigation method, maintenance intervals and level of effort required (do nothing, restricted access, equipment, etc.). This category also factors in impacts to the roadway users, such as roadway closures, during maintenance.	Maintenance intervals	Years between maintenance cycles	1 – 1 year or less 2 – 1 to 5 years 3 – 5 years or more
		Maintenance effort	Qualitative - Maintenance level of effort and impacts to roadway users	1 – High effort 2 – Moderate effort 3 – Low effort
Cost/Implementation	Planning level costs, including potential right of way (ROW) acquisition.	Cost	Planning Level Cost Estimate	1 – > $5,000,000 2 – $1,000,000 to $5,000,000 3 – < $1,000,000
		Detours/Delays during construction	Estimated hours of additional delay during construction	1 – Large impacts during construction 2 – Moderate impacts during construction 3 – Minimal to no impact during construction

Figure 5B - Mitigation Options Scoring Matrix

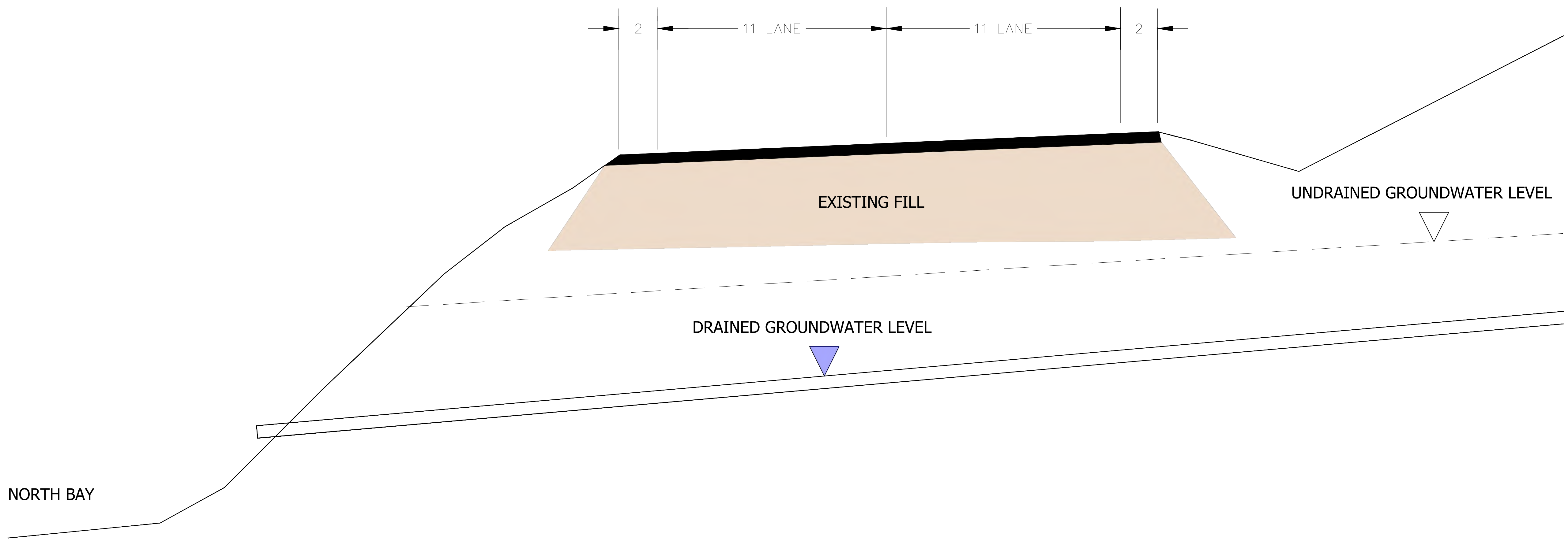
SR 302 Victor Area Study - Level 2 Screening

Measures	Metrics	Scoring	No Build	#1 Drainage Improvements Only	#2 Lightweight Fill + Drainage	#3 Aggregate-Filled Drilled Shafts + Drainage	#4 Shoreline Armor + Drainage	#5 Shoring Wall + Drainage	#6 Anchored slope stabilization + Drainage
			Score	Score	Score	Score	Score	Score	Score
Slope Stability	Slide factor of safety	0 – Roadway stability unimproved for any scenario 1 – Marginal roadway stability improvement but does not meet the minimum factor of safety for each likely scenarios 2 – Improves stability of the roadway for likely scenario 3 – Improves stability of the roadway and the large ancient slide for likely scenarios	0	1	1	2	1	2	3
Design efforts	Level of effort	1 – > 500 hour 2 – 160 to 500 hours 3 – < 160 hours	3	3	3	2	3	1	1
Exposed Surfaces to wave action, flood and ties	Qualitative - Toe slope protection	1 – Low or no protection 2 – Moderate protection 3 – High protection	1	1	1	1	3	1	2
Roadway shoulder width on each side of the road	Additional shoulder width (feet)	0 – No improvement to Shoulder 1 – Shoulder can be expanded up to 2½ feet 2 – Shoulder can be expanded up to 5 feet 3 – Shoulder can be expanded up to 7½ feet	0	1	2	2	1	3	2
Permittable	Qualitative – Level of effort and likelihood of acquiring all necessary permits	1 – High effort, low probability of acquiring permits 2 – Low effort, low probability of acquiring permits 2 – High effort, high probability of acquiring permits 3 – Low effort, high probability of acquiring permits	3	3	3	3	1	2	1
Maintenance intervals	Years between maintenance cycles	1 – 1 year or less 2 – 1 to 5 years 3 – 5 years or more	1	1	2	2	2	2	2
Maintenance effort and impacts	Qualitative - Maintenance level of effort and impacts to roadway users	1 – High 2 – Moderate 3 – Low	1	2	3	3	2	3	3
Cost	Planning-level cost estimate	1 – > $5,000,000 2 – $1,000,000 to $5,000,000 3 – < $1,000,000	3	3	2	2	2	1	1
Detours/Delays during construction	Estimated hours of additional delay during construction	1 – Large impacts during construction 2 – Moderate impacts during construction 3 – Minimal to no impact during construction	1	3	2	1	2	1	1
		TOTAL	13	18	19	18	17	16	16

Figure 5C - Slope 178 Mitigation Options Scoring Matrix

SR 302 Victor Area Study - Level 2 Screening

			No Build	#1 Drainage Improvements Only	#2 Lightweight Fill + Drainage	#3 Aggregate-Filled Drilled Shafts + Drainage	#4 Shoreline Armor + Drainage	#5 Shoring Wall + Drainage	#6 Anchored slope stabilization + Drainage
Measures	**Metrics**	**Scoring**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**
Slope Stability	Slide factor of safety	0 – Roadway stability unimproved for any scenario 1 – Marginal roadway stability improvement but does not meet the minimum factor of safety for each likely scenarios 2 – Improves stability of the roadway for likely scenario 3 – Improves stability of the roadway and the large ancient slide for likely scenarios	0	1	1	2	1	3	2
Design efforts	Level of effort	1 – > 500 hour 2 – 160 to 500 hours 3 – < 160 hours	3	3	3	2	3	1	1
Exposed Surfaces to wave action, flood and ties	Qualitative - Toe slope protection	1 – Low or no protection 2 – Moderate protection 3 – High protection	1	1	1	1	3	2	2
Roadway shoulder width on each side of the road	Additional shoulder width (feet)	0 – No improvement to Shoulder 1 – Shoulder can be expanded up to 2½ feet 2 – Shoulder can be expanded up to 5 feet 3 – Shoulder can be expanded up to 7½ feet	0	1	2	2	1	3	2
Permittable	Qualitative – Level of effort and likelihood of acquiring all necessary permits	1 – High effort, low probability of acquiring permits 2 – Low effort, low probability of acquiring permits 2 – High effort, high probability of acquiring permits 3 – Low effort, high probability of acquiring permits	3	3	3	3	1	2	1
Maintenance intervals	Years between maintenance cycles	1 – 1 year or less 2 – 1 to 5 years 3 – 5 years or more	1	1	2	2	2	2	2
Maintenance effort and impacts	Qualitative - Maintenance level of effort and impacts to roadway users	1 – High 2 – Moderate 3 – Low	1	2	3	3	2	3	3
Cost	Planning-level cost estimate	1 – > $5,000,000 2 – $1,000,000 to $5,000,000 3 – < $1,000,000	3	3	2	2	2	1	1
Detours/Delays during construction	Estimated hours of additional delay during construction	1 – Large impacts during construction 2 – Moderate impacts during construction 3 – Minimal to no impact during construction	1	3	2	1	2	1	1
		TOTAL	**13**	**18**	**19**	**18**	**17**	**18**	**16**



NOT TO SCALE

CONCEPT ONLY. NOT INTENDED FOR USE AS
CONSTRUCTION PLAN OR DOCUMENT

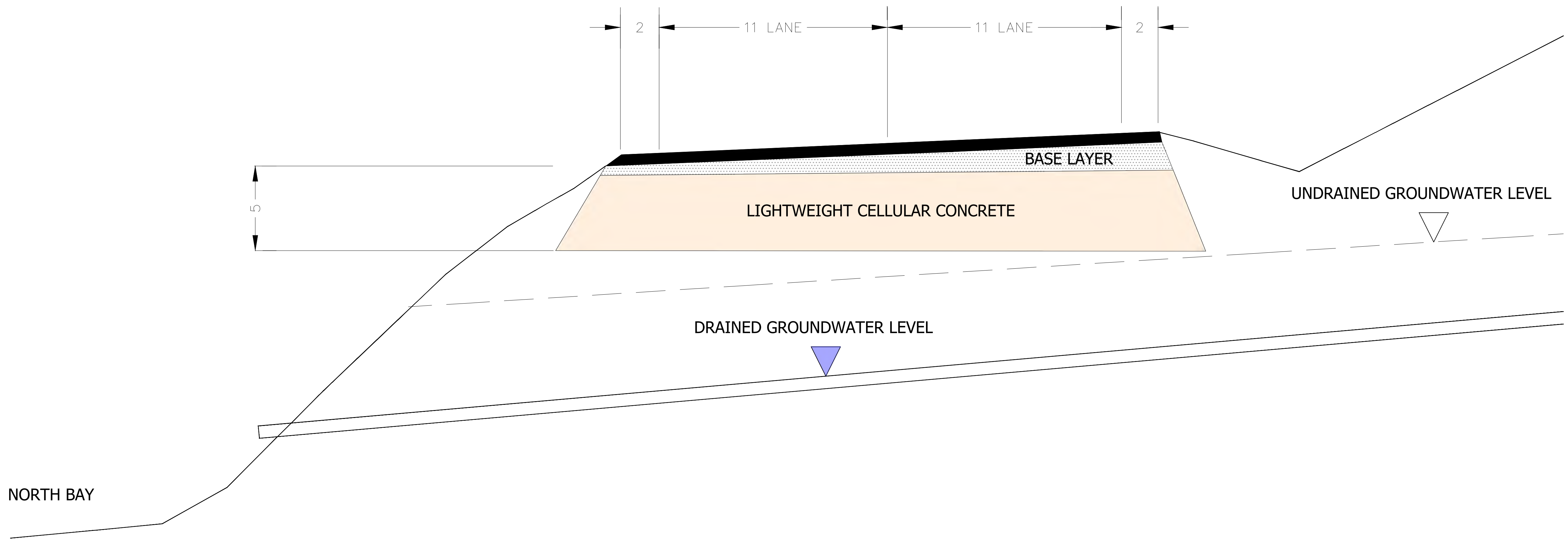
HWA GEOSCIENCES INC.
DBE/MWBE

SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

HORIZONTAL DRAINS
CONCEPTUAL DIAGRAM

DRAWN BY:	FIGURE NO.:
CF	6A
CHECK BY:	PROJECT NO.:
WRR	2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY_DETAIL.DWG <6A> Plotted: 6/8/2023 7:53 PM



NOT TO SCALE

CONCEPT ONLY. NOT INTENDED FOR USE AS CONSTRUCTION PLAN OR DOCUMENT

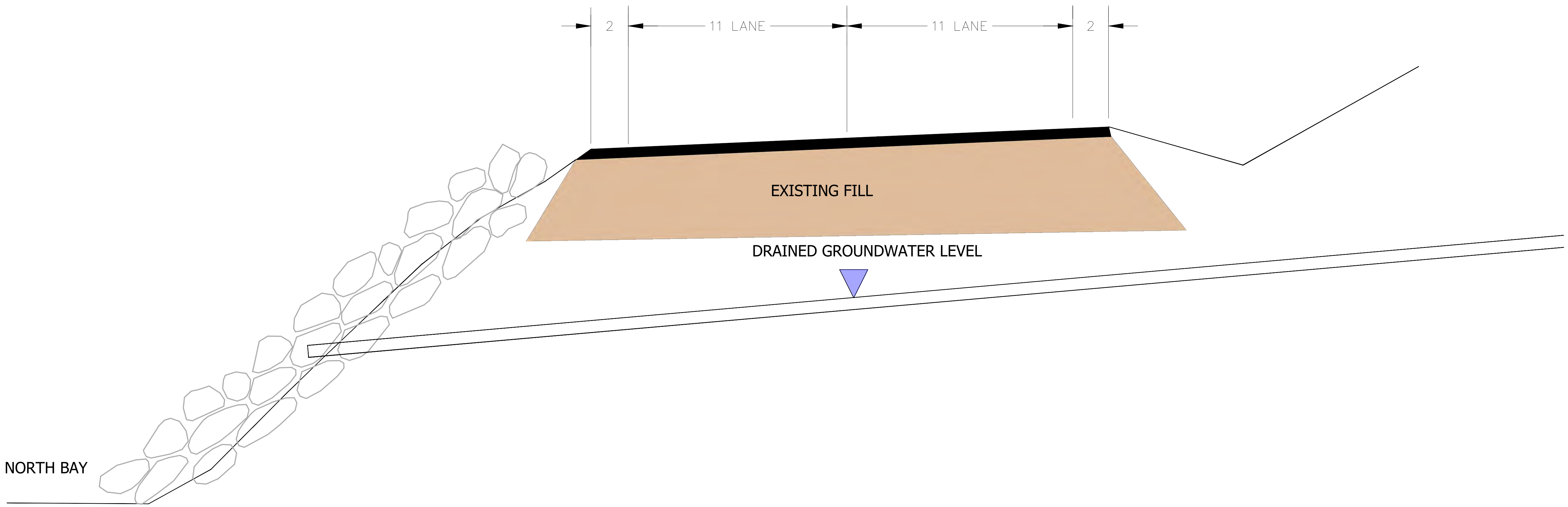
HWA GEOSCIENCES INC.
DBE/MWBE

SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

LIGHTWEIGHT CELLULAR CONCRETE CONCEPTUAL DIAGRAM

DRAWN BY: CF	FIGURE NO.: 6B
CHECK BY: WRR	PROJECT NO.: 2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY_DETAIL.DWG <6B> Plotted: 6/8/2023 7:55 PM



NOT TO SCALE

CONCEPT ONLY. NOT INTENDED FOR USE AS CONSTRUCTION PLAN OR DOCUMENT

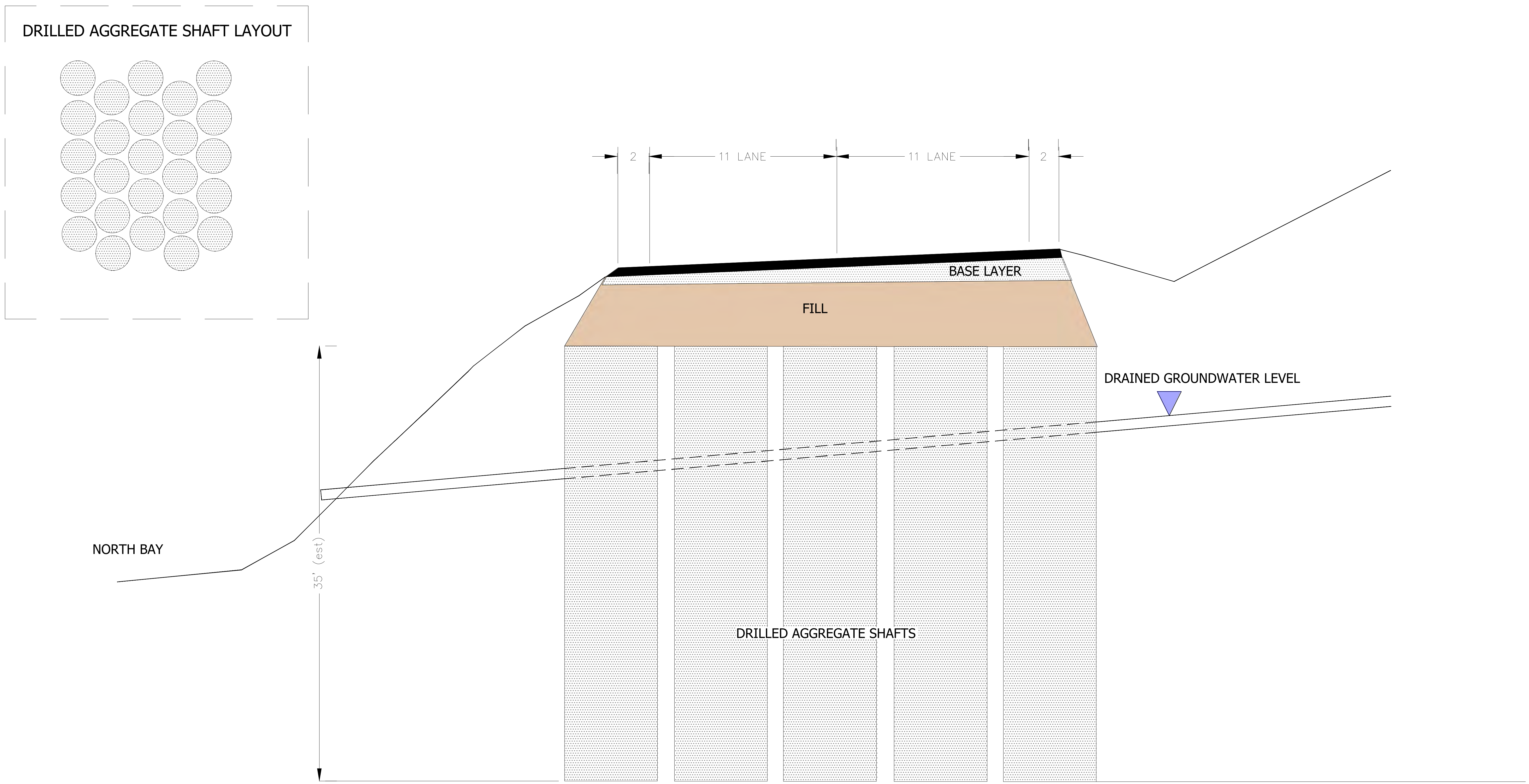
HWA GEOSCIENCES INC.
DBE/MWBE

SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

SHORELINE ARMOR
CONCEPTUAL DIAGRAM

DRAWN BY: CF
CHECK BY: WRR
FIGURE NO.: 6C
PROJECT NO.: 2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY_DETAIL.DWG <6C> Plotted: 6/8/2023 9:46 PM



NOT TO SCALE

CONCEPT ONLY. NOT INTENDED FOR USE AS CONSTRUCTION PLAN OR DOCUMENT

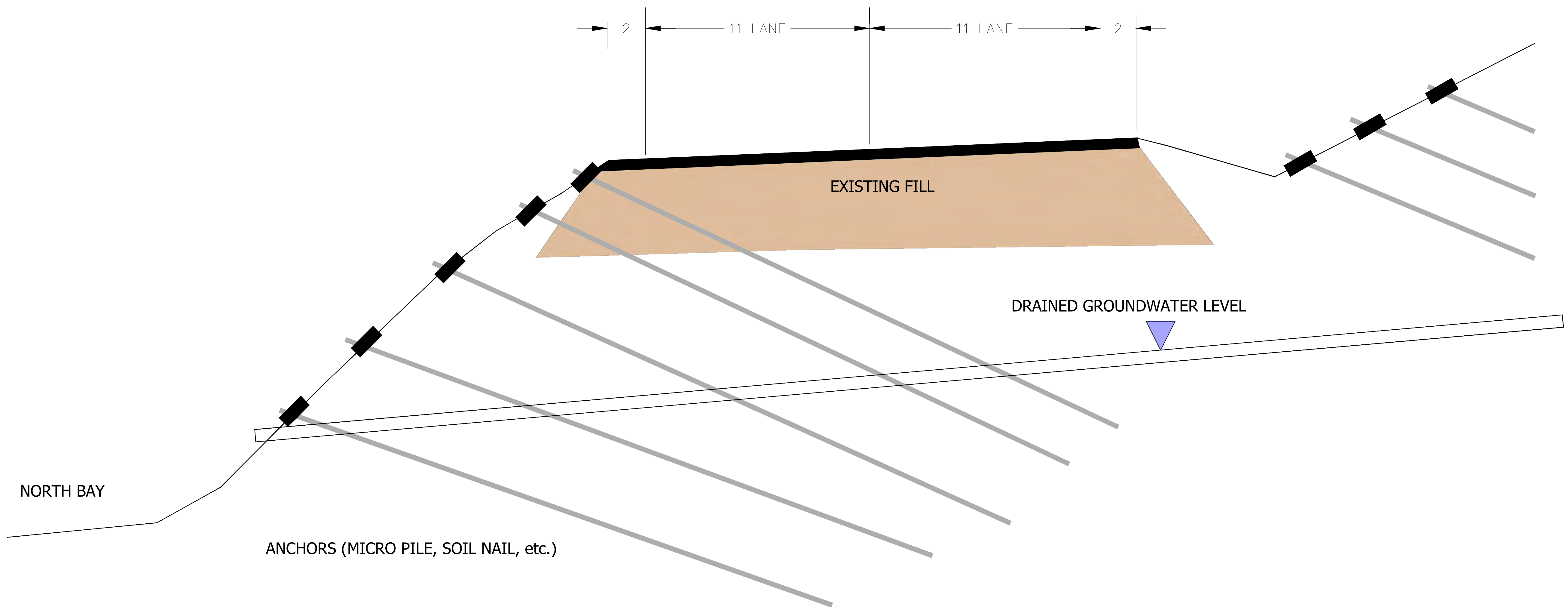
HWA GEOSCIENCES INC. DBE/MWBE

SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

AGGREGATE SHAFTS CONCEPTUAL DIAGRAM

DRAWN BY:	FIGURE NO.:
CF	6D
CHECK BY:	PROJECT NO.:
WRR	2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY_DETAIL.DWG <6D> Plotted: 6/8/2023 8:40 PM



NOT TO SCALE

CONCEPT ONLY. NOT INTENDED FOR USE AS CONSTRUCTION PLAN OR DOCUMENT

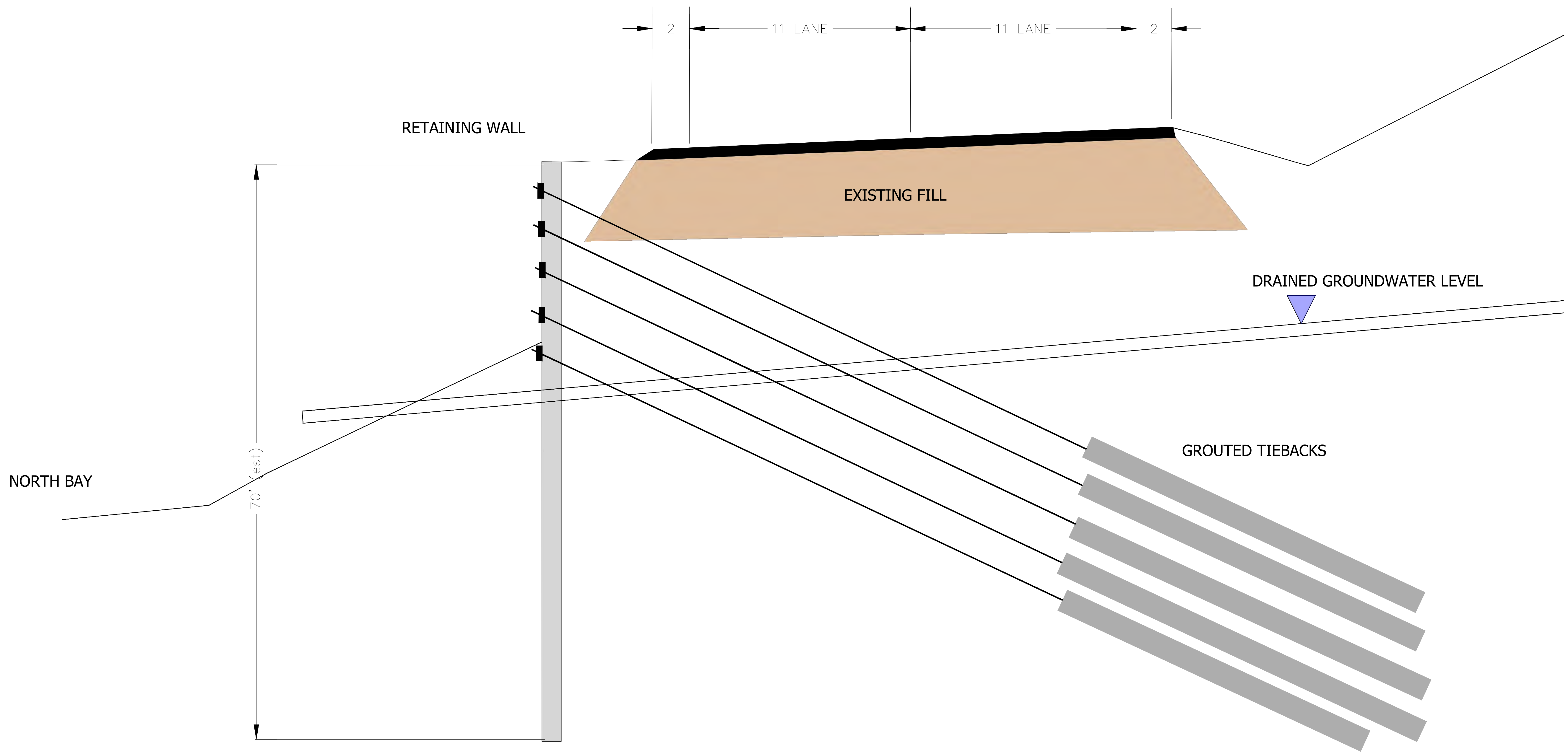
HWA GEOSCIENCES INC. DBE/MWBE

SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

ANCHORED SLOPE
CONCEPTUAL DIAGRAM

DRAWN BY:	FIGURE NO.:
CF	6E
CHECK BY:	PROJECT NO.:
WRR	2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY_DETAIL.DWG <6E> Plotted: 6/8/2023 8:41 PM



NOT TO SCALE

CONCEPT ONLY. NOT INTENDED FOR USE AS CONSTRUCTION PLAN OR DOCUMENT

HWA GEOSCIENCES INC. DBE/MWBE

SR 302 VICTOR AREA STUDY
MASON COUNTY, WASHINGTON

RETAINING WALL
WITH TIE BACKS
CONCEPTUAL DIAGRAM

DRAWN BY:	FIGURE NO.:
CF	6F
CHECK BY:	PROJECT NO.:
WRR	2022-043-21

C:\USERS\CFRY\DESKTOP\2022-043-21 SR-302 VICTOR AREA STUDY\2022-043-21 SR 302 VICTOR AREA STUDY_DETAIL.DWG <6F> Plotted: 6/8/2023 8:41 PM

APPENDIX A

FIELD EXPLORATION

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE

COHESIONLESS SOILS			COHESIVE SOILS		
Density	N (blows/ft)	Approximate Relative Density(%)	Consistency	N (blows/ft)	Approximate Undrained Shear Strength (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 - 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	over 50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

ASTM SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP DESCRIPTIONS	
Coarse Grained Soils	Gravel and Gravelly Soils	Clean Gravel (little or no fines)	GW	Well-graded GRAVEL
			GP	Poorly-graded GRAVEL
	More than 50% of Coarse Fraction Retained on No. 4 Sieve	Gravel with Fines (appreciable amount of fines)	GM	Silty GRAVEL
			GC	Clayey GRAVEL
More than 50% Retained on No. 200 Sieve Size	Sand and Sandy Soils	Clean Sand (little or no fines)	SW	Well-graded SAND
			SP	Poorly-graded SAND
	50% or More of Coarse Fraction Passing No. 4 Sieve	Sand with Fines (appreciable amount of fines)	SM	Silty SAND
			SC	Clayey SAND
Fine Grained Soils	Silt and Clay	Liquid Limit Less than 50%	ML	SILT
			CL	Lean CLAY
			OL	Organic SILT/Organic CLAY
50% or More Passing No. 200 Sieve Size	Silt and Clay	Liquid Limit 50% or More	MH	Elastic SILT
			CH	Fat CLAY
			OH	Organic SILT/Organic CLAY
Highly Organic Soils			PT	PEAT

TEST SYMBOLS

MC	Moisture Content
GS	Grain Size Distribution
%F	Percent Fines
CN	Consolidation
UC	Unconfined Compression
DS	Direct Shear
CD	Consolidated Drained Triaxial
CU	Consolidated Undrained Triaxial
UU	Unconsolidated Undrained Triaxial
OC	Organic Content
pH	pH of Soils
Res	Resistivity
PID	Photoionization Device Reading
AL	Atterberg Limits: PL Plastic Limit, LL Liquid Limit
M	Resilient Modulus
SL	Slake Test

SAMPLE TYPE SYMBOLS

- 2.0" OD Split Spoon (SPT) (140 lb. hammer with 30 in. drop)
- Shelby Tube
- 3.0" OD Split Spoon with Brass Rings
- Small Bag Sample
- Large Bag (Bulk) Sample
- Core Run
- Non-standard Penetration Test (with split spoon sampler)

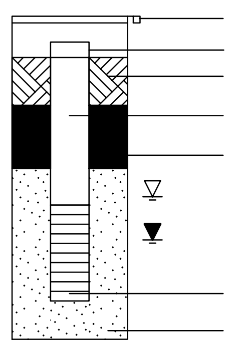
COMPONENT PROPORTIONS

DESCRIPTIVE TERMS	RANGE OF PROPORTION
Clean	< 5%
Slightly (Clayey, Silty, Sandy)	5 - 12%
Clayey, Silty, Sandy, Gravelly	12 - 30%
Very (Clayey, Silty, Sandy, Gravelly)	30 - 50%

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No 4 (4.5mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No 4 (4.5mm)
Sand	No. 4 (4.5 mm) to No. 200 (0.074 mm)
Coarse sand	No. 4 (4.5 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Smaller than No. 200 (0.074mm)

GROUNDWATER WELL COMPLETIONS



NOTES: Soil classifications presented on exploration logs are based on visual and laboratory observation in general accordance with ASTM D 2487 and ASTM D 2488. Soil descriptions are presented in the following general order:

Density/consistency, color, modifier (if any) GROUP NAME, additions to group name (if any), moisture content. Proportion, gradation, and angularity of constituents, additional comments. (GEOLOGIC INTERPRETATION)

Please refer to the discussion in the report text as well as the exploration logs for a more complete description of subsurface conditions.

MOISTURE CONTENT

DRY	Absence of moisture, dusty, dry to the touch.
MOIST	Damp but no visible water.
WET	Visible free water, usually soil is below water table.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

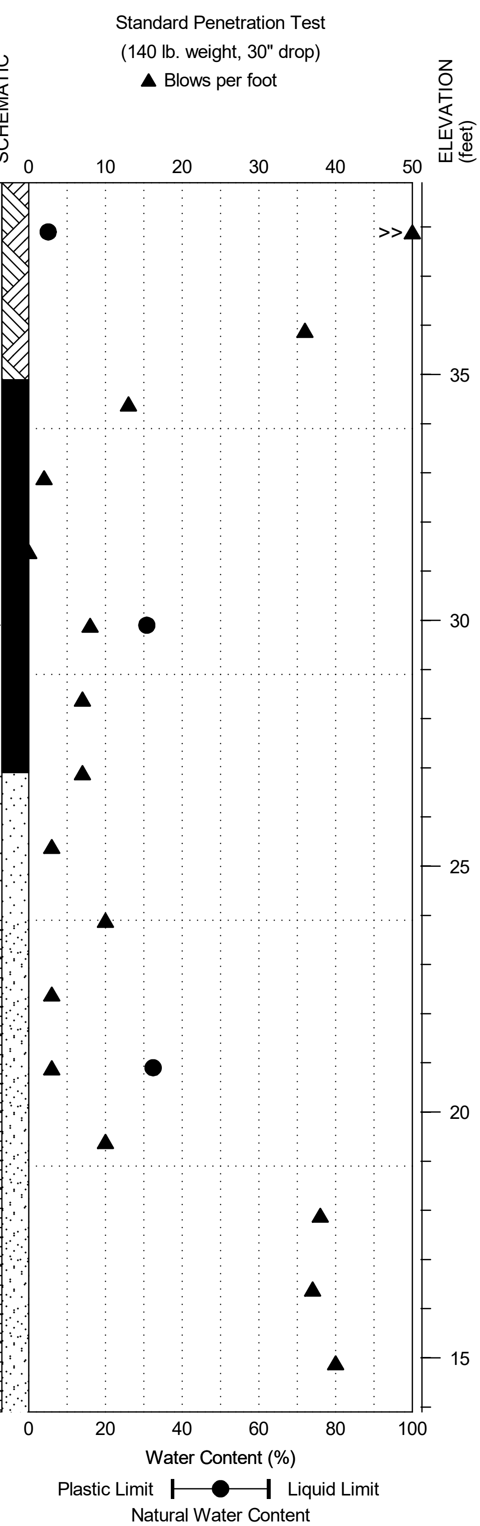
LEGEND OF TERMS AND SYMBOLS USED ON EXPLORATION LOGS

PROJECT NO.: 2022-043-21 FIGURE: A1

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36541921, Long: -122.8080195, Datum: WGS84

DATE STARTED: 12/29/2022
DATE COMPLETED: 12/29/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 38.9 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
0		Asphalt (12 inches) **(HMA)**			
	SM	Very dense, dark reddish brown to dark brown, silty, very gravelly SAND, dry. Coarse crushed gravel. Recovered: 14 inches. **(FILL)**	S-1	42-40-43	GS
		Becomes dense, wet. Grain size decreases, fines increase with depth. Recovered: 10 inches.	S-2	30-19-17	
5		Becomes medium dense, dark yellow brown. Fine sub-angular gravel. Recovered: 4 inches.	S-3	8-7-4	
	SM	Loose, dark yellow brown, silty SAND, wet. **(LANDSLIDE DEPOSITS)**	S-4	4-1-1	
		No recovery	S-5	1-0-0	
	ML	Medium stiff, olive gray, very sandy SILT. Recovered: 8 inches.	S-6	3-3-5	GS
10		Fines content increases, silt lens approximately 1 inch thick. Recovered: 12 inches.	S-7	2-3-4	
		Fines content increases. Recovered: 14 inches.	S-8	3-3-4	
		Soft, dark gray, sandy SILT, wet. Recovered: 16 inches.	S-9	2-2-1	
15		Becomes stiff. No recovery	S-10	3-7-9	
		Becomes very soft Recovered: 15 inches.	S-11	2-2-1	
		Recovered: 16 inches.	S-12	4-2-1	GS
20		Becomes stiff, fines increase. Recovered: 16 inches.	S-13	4-4-6	
	SM	Dense, gray, very silty to silty SAND, wet. Fine sand. Recovered: 16 inches.	S-14	8-17-21	
		Silt lens 2 inches thick. Recovered: 16 inches.	S-15	4-17-20	
25		Fines content increases. Recovered: 14 inches.	S-16	15-17-23	



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-01P-22

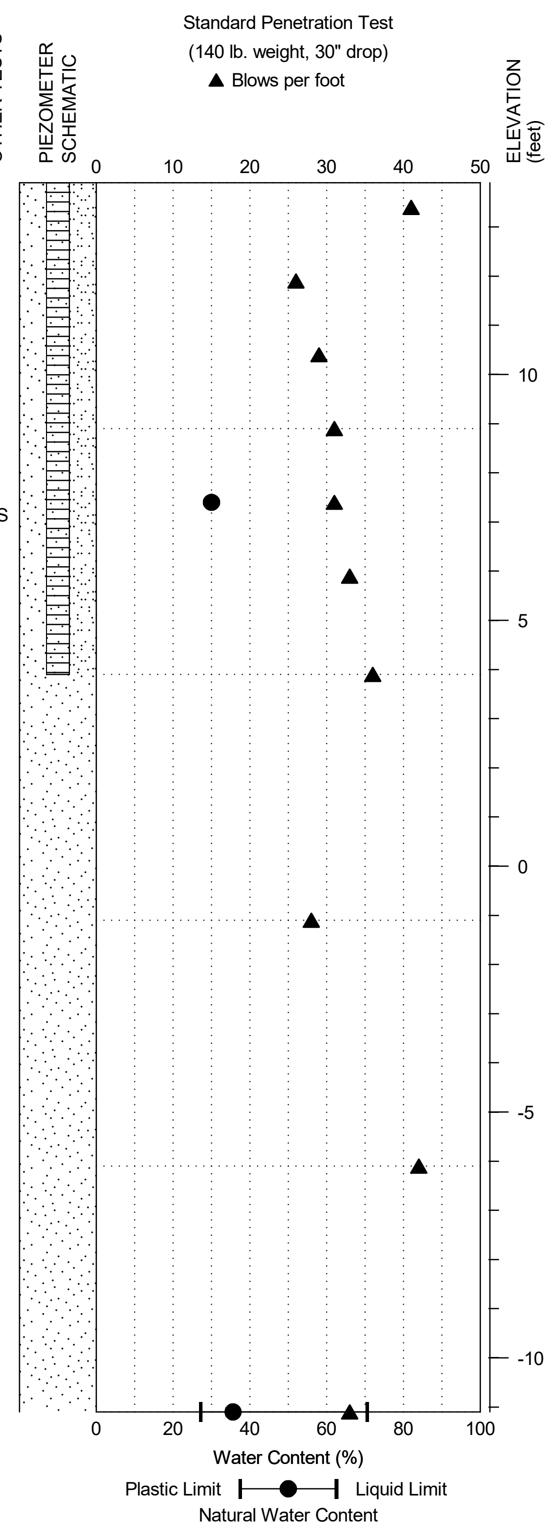
PROJECT NO.: 2022-043-21 FIGURE: A2

PZO-DSM 2022-043.GPJ 6/26/23

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36541921, Long: -122.8080195, Datum: WGS84

DATE STARTED: 12/29/2022
DATE COMPLETED: 12/29/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 38.9 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
25		Dense, gray, very silty to silty SAND, wet. Fines increase, fine sand. Recovered: 12 inches.	S-17	7-21-20	
		Medium dense. Recovered: 16 inches.	S-18	7-12-14	
		Silt lens 1 inch thick. Recovered: 14 inches.	S-19	9-11-18	
30	ML	Hard, dark gray, sandy SILT, wet. Recovered: 17 inches. **(PRE-VASHON LACUSTRINE SILTS)**	S-20	12-13-18	
		Recovered: 12 inches.	S-21	12-13-18	GS
		Fines content increases. Recovered: 17 inches.	S-22	12-15-18	
35		Fines content decreases, fine sand. Recovered: 14 inches.	S-23	14-15-21	
40		Very stiff. Series of alternating 1-2 inch thick sand and silt lenses, grain size decreases to very fine sand, silt content increases in sand lenses. Recovered: 18 inches.	S-24	14-15-13	
45		Becomes hard. Recovered: 18 inches.	S-25	15-18-24	
50					



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-01P-22

PROJECT NO.: 2022-043-21 FIGURE: A2

PZO-DSM 2022-043.GPJ 6/26/23

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36541921, Long: -122.8080195, Datum: WGS84

DATE STARTED: 12/29/2022
DATE COMPLETED: 12/29/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 38.9 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	PIEZOMETER SCHEMATIC
50		CH	Hard, gray, fat CLAY, moist. Recovered: 16 inches.		S-26	13-15-18	AL %F	

Boring was terminated at approximately 51½ feet bgs and converted to an inclinometer, DOE Well ID #BPQ 406. Groundwater was observed at approximately 13 feet bgs during drilling.

Depth (feet): 50, 55, 60, 65, 70, 75

Elevation (feet): -15, -20, -25, -30, -35

Standard Penetration Test
(140 lb. weight, 30" drop)
▲ Blows per foot
0 10 20 30 40 50

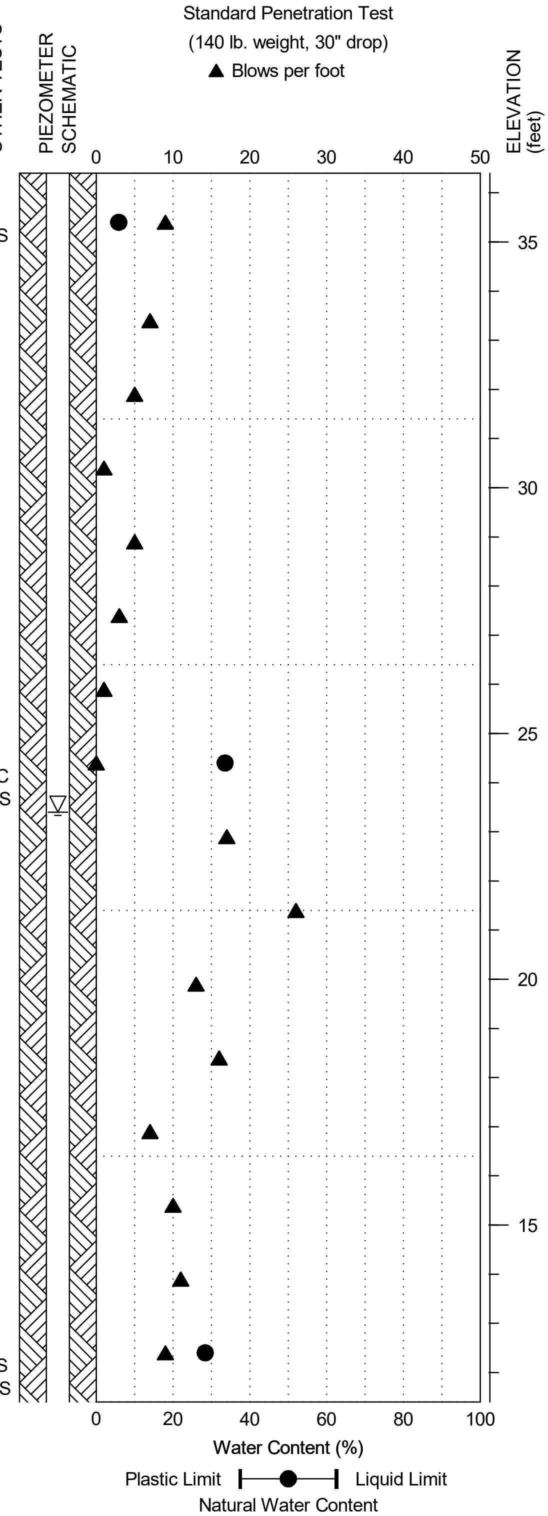
0 20 40 60 80 100
Water Content (%)
Plastic Limit ⊢—●—⊣ Liquid Limit
Natural Water Content

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36548848, Long: -122.8080948 Datum: WGS84

DATE STARTED: 1/4/2023
DATE COMPLETED: 1/4/2023
LOGGED BY: R. Mueller
SURFACE ELEVATION: 36.4 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
0		Asphalt (12 inches) **(HMA)**			
	GW GM	Loose, very dark gray, slightly silty, very sandy, well-graded GRAVEL, moist. Coarse, angular gravel. Recovered: 4 inches. **(FILL)**	S-1	8-4-5	GS
		Becomes very dark brown, wet. Recovered: 6 inches.	S-2	5-3-4	
5		Recovered: 2 inches.	S-3	6-3-2	
		Becomes very loose. Rusty brown sand lens. Recovered: 4 inches.	S-4	3-1-0	
	ML	Medium stiff, dark olive brown, very sandy SILT, wet. Recovered: 4 inches. **(LANDSLIDE DEPOSITS)**	S-5	4-2-3	
		Becomes soft. No recovery.	S-6	4-1-2	
10		Becomes olive brown. Medium sand, single coarse subrounded gravel. Recovered: 4 inches.	S-7	2-1-0	
	SM	Very loose, olive gray, very silty SAND, wet. Fine sand, wood piece in sample. Recovered: 18 inches.	S-8	0	OC GS
		Becomes medium dense, no recovery.	S-9	5-7-10	
15		No recovery.	S-10	11-12-14	
		Becomes gray, fine sand. 1-inch thick silt lens near bottom of sample. Recovered: 18 inches.	S-11	5-6-7	
		Becomes dark gray, fines increase. Recovered: 12 inches.	S-12	5-9-7	
20		Becomes loose, grain size increases. 1/2-inch thick silt lenses near top of sample. Recovered: 12 inches.	S-13	4-4-3	
		Becomes medium dense, grain size decreases. Recovered: 10 inches.	S-14	2-4-6	
		Grain size increases. 1/2-inch silt lenses throughout sample. Recovered: 10 inches.	S-15	5-5-6	
25	ML	Stiff, dark gray, slightly sandy SILT, wet. Recovered: 12 inches.	S-16	9-7-8	DS GS



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

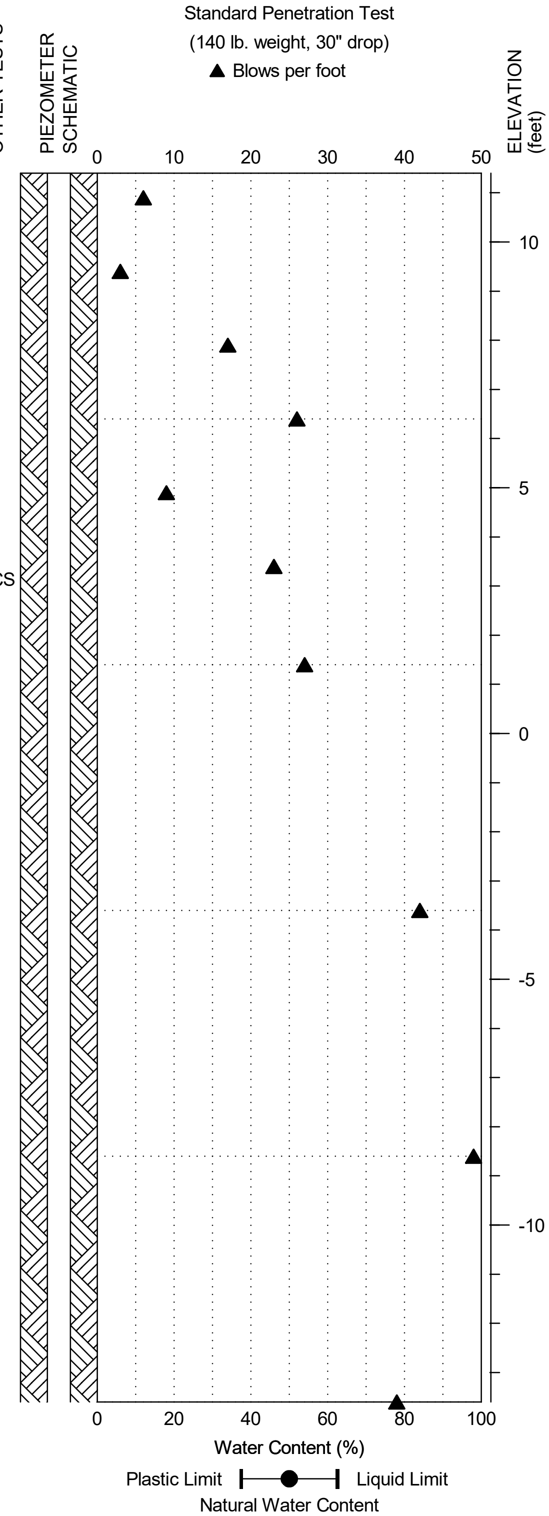
BORING:
HWA-02Si-23

PROJECT NO.: 2022-043-21 FIGURE: A3

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36548848, Long: -122.8080948 Datum: WGS84

DATE STARTED: 1/4/2023
DATE COMPLETED: 1/4/2023
LOGGED BY: R. Mueller
SURFACE ELEVATION: 36.4 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
25		Stiff, dark gray, slightly sandy SILT, wet.			
		Becomes medium stiff. Recovered: 10 inches.	S-17	1-3-3	
		Becomes soft. Recovered: 10 inches.	S-18	0-1-2	
	ML	Very stiff, dark gray, very sandy SILT, wet. Fine to medium sand. Recovered: 12 inches.	S-19	5-6-11	
30		**(PRE-VASHON LACUSTRINE SILTS)** Sand becomes fine. Recovered: 12 inches.	S-20	15-19-23	
		Becomes medium stiff. No recovery.	S-21	11-8-7	
		Becomes very stiff. Recovered: 12 inches.	S-22	11-14-23	UCS
35		Recovered: 10 inches.	S-23	7-11-16	
40		Becomes hard. Recovered: 14 inches.	S-24	14-19-23	
45		Recovered: 16 inches.	S-25	17-18-31	
50					



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

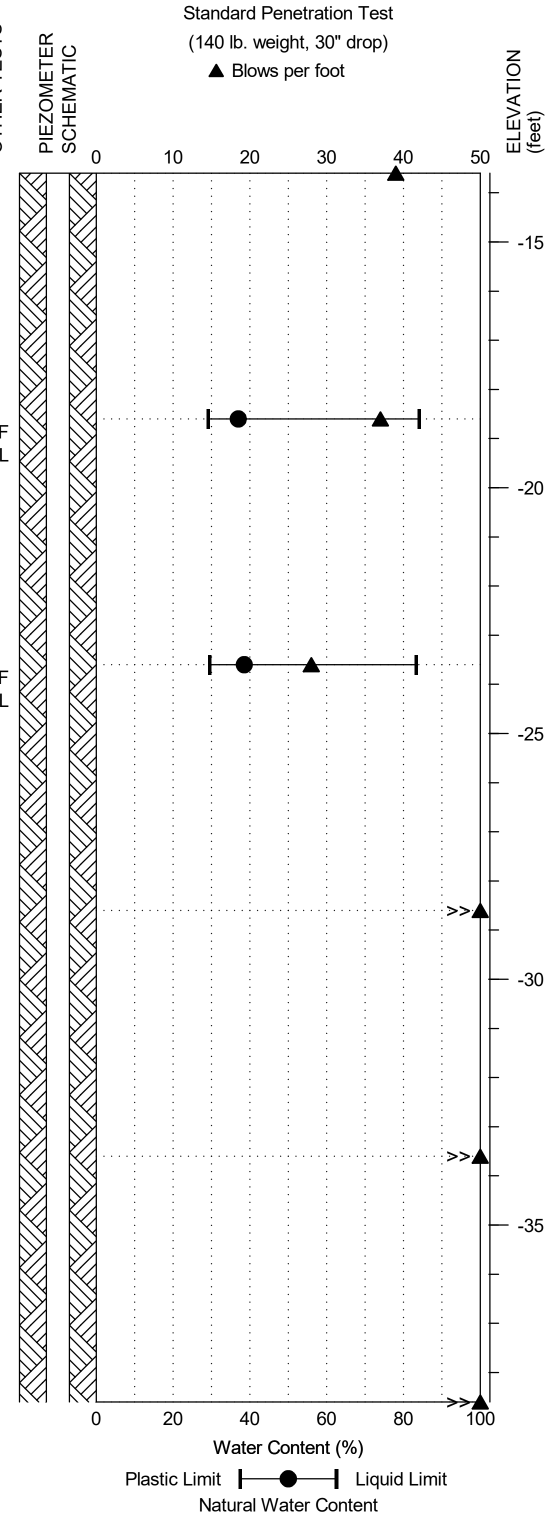
BORING:
HWA-02Si-23

PROJECT NO.: 2022-043-21 FIGURE: A3

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36548848, Long: -122.8080948 Datum: WGS84

DATE STARTED: 1/4/2023
DATE COMPLETED: 1/4/2023
LOGGED BY: R. Mueller
SURFACE ELEVATION: 36.4 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	ELEVATION (feet)
50		Stiff, dark gray, slightly sandy SILT, wet. Thin silt lenses throughout sample. Recovered: 18 inches.	S-26	15-17-22		-15
55	CH	Hard, gray, fat CLAY, moist. Laminated. Recovered: 18 inches.	S-27	13-17-20	%F AL	-20
60		Becomes very stiff, dark gray. Recovered: 18 inches.	S-28	8-12-16	%F AL	-25
65		Becomes hard, olive gray at bottom of sample. Recovered: 17 inches.	S-29	10-12-50/5		-30
70	SM	Very dense, olive gray, slightly gravelly, silty SAND, wet. Fine, rounded gravel. Recovered: 1 inch. **(PRE-VASHON GLACIAL TILL DEPOSITS)**	S-30	50/1		-35
75						



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-02Si-23

PROJECT NO.: 2022-043-21 FIGURE: A3

PZO-DSM 2022-043.GPJ 6/26/23

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36548848, Long: -122.8080948 Datum: WGS84

DATE STARTED: 1/4/2023
DATE COMPLETED: 1/4/2023
LOGGED BY: R. Mueller
SURFACE ELEVATION: 36.4 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	PIEZOMETER SCHEMATIC	ELEVATION (feet)
75			Very dense, olive gray, slightly gravelly, silty SAND, wet Recovered: 1 inch.	☒	S-31	50/5			
			Boring was terminated at approximately 75½ feet bgs and converted to an inclinometer, DOE Well ID #BPQ 407. Groundwater was observed at approximately 13 feet bgs during drilling.						-40
80									-45
85									-50
90									-55
95									-60
100									

Standard Penetration Test (140 lb. weight, 30" drop)
▲ Blows per foot (0, 10, 20, 30, 40, 50)

Water Content (%) (0, 20, 40, 60, 80, 100)
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

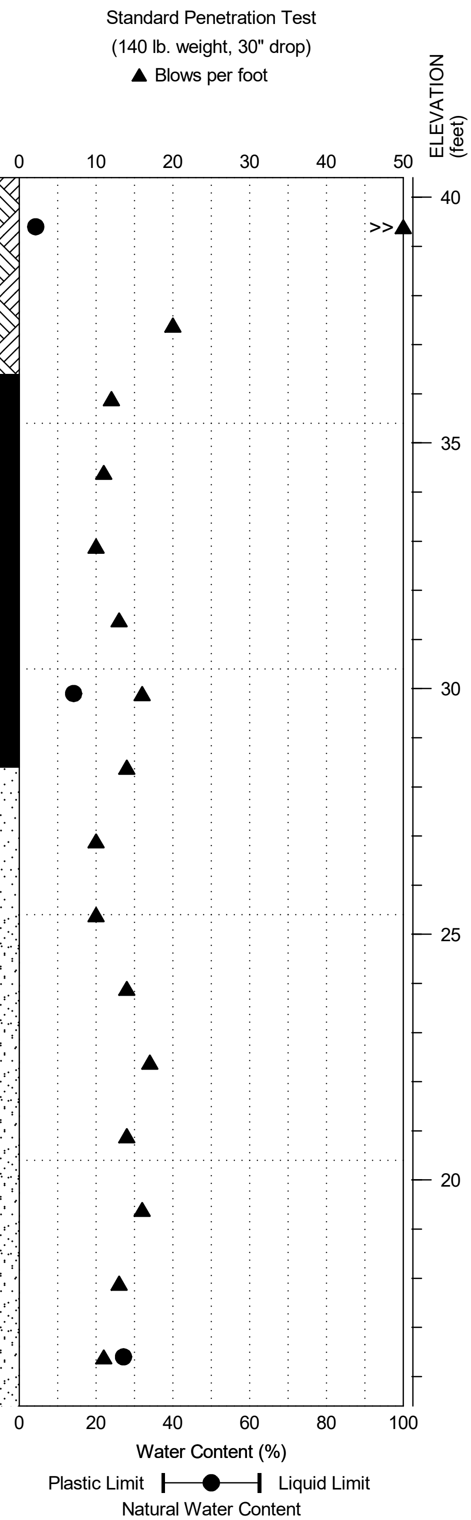
BORING:
HWA-02Si-23

PROJECT NO.: 2022-043-21 FIGURE: A3

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36465205, Long: -122.8074712, Datum: WGS84

DATE STARTED: 12/27/2022
DATE COMPLETED: 12/27/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 40.4 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
0		Asphalt (12 inches) **(HMA)**			
	GW GM	Very dense, dark grayish brown, slightly silty, very sandy, well-graded GRAVEL, moist. Coarse subangular gravel. Recovered: 12 inches. **(FILL)**	S-1	42-37-22	GS
	SM	Medium dense, olive gray, silty SAND, moist. Fine sand, rust mottling. Recovered: 16 inches. **(LANDSLIDE DEPOSITS)**	S-2	15-10-10	
5		Becomes orange-brown to olive gray. Recovered: 10 inches.	S-3	7-6-6	
		Becomes orange-brown to light olive brown, fine to very fine sand. Recovered: 12 inches.	S-4	6-5-6	
		Becomes olive brown. Recovered: 14 inches.	S-5	4-5-5	
		Fines content increases. Recovered: 12 inches.	S-6	5-6-7	
10		Becomes light olive brown. Recovered: 12 inches.	S-7	8-11-14	DS GS
		Becomes dark brown, fines content decreases, grain size increases to medium sand. Recovered: 12 inches.	S-8	7-7-7	
		Becomes wet. Recovered: 12 inches.	S-9	6-5-5	
15		Fines content increases, grain size decreases. Recovered: 10 inches.	S-10	4-5-5	
		Becomes olive brown, fines content increases, grain size decreases. Recovered: 10 inches.	S-11	5-7-7	
		Recovered: 12 inches.	S-12	8-8-9	
20		Silt content decreases, grain size increases to medium sand. Recovered: 10 inches.	S-13	9-7-7	
		Silt content decreases. Recovered: 14 inches.	S-14	6-8-8	
		Becomes dark olive brown. Recovered: 10 inches.	S-15	3-6-7	
25		Becomes olive gray. Recovered: 10 inches.	S-16	7-5-6	GS



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

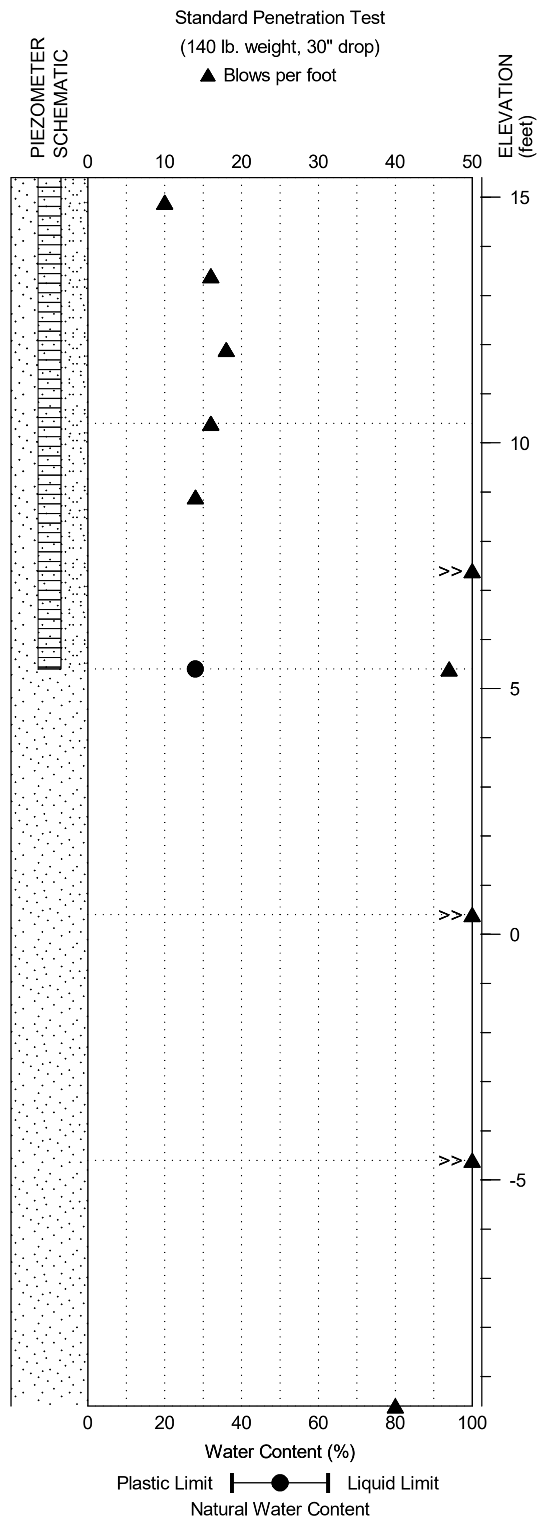
BORING:
HWA-03P-22

PROJECT NO.: 2022-043-21 FIGURE: A4

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36465205, Long: -122.8074712, Datum: WGS84

DATE STARTED: 12/27/2022
DATE COMPLETED: 12/27/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 40.4 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
25	SM	Medium dense, olive gray, very silty SAND, wet. Becomes olive brown, very silty, wet. Recovered: 10 inches.	S-17	4-5-5	
		Becomes dark olive brown, fines content decreases, medium sand. Recovered: 12 inches.	S-18	7-7-9	
		Fines content increases in bottom 10 inches of sample. Recovered: 12 inches.	S-19	8-9-9	
30		Medium dense, becomes very silty, fine sand. Recovered: 12 inches.	S-20A S-20B	9-7-9	
		Recovered: 12 inches.	S-21	6-6-8	
	ML	Hard, gray, slightly sandy SILT, moist. Recovered: 18 inches. **(PRE-VASHON LACUSTRINE SILTS)**	S-22	19-38-32	
35		Sand lenses throughout sample. Recovered: 12 inches.	S-23	16-17-30	GS
40		Sand lenses throughout sample, sand content decreases. Recovered: 12 inches.	S-24	33-42-50/5	
45		Sand content decreases, plasticity increases. Recovered: 18 inches.	S-25	18-21-30	
50					



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-03P-22

PROJECT NO.: 2022-043-21 FIGURE: A4

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36465205, Long: -122.8074712, Datum: WGS84

DATE STARTED: 12/27/2022
DATE COMPLETED: 12/27/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 40.4 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	PIEZOMETER SCHEMATIC	ELEVATION (feet)
50		ML	Stiff, gray, slightly sandy SILT, wet. Recovered: 12 inches.		S-26	13-18-22			-10

Boring was terminated at approximately 51½ feet bgs and converted to a monitoring well, DOE Well ID #BPQ 405. Groundwater was observed at approximately 14 feet bgs during drilling.

Depth (feet): 50, 55, 60, 65, 70, 75
Elevation (feet): -10, -15, -20, -25, -30

Standard Penetration Test
(140 lb. weight, 30" drop)
▲ Blows per foot
0 10 20 30 40 50

0 20 40 60 80 100
Water Content (%)
Plastic Limit ├──●──┤ Liquid Limit
Natural Water Content

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

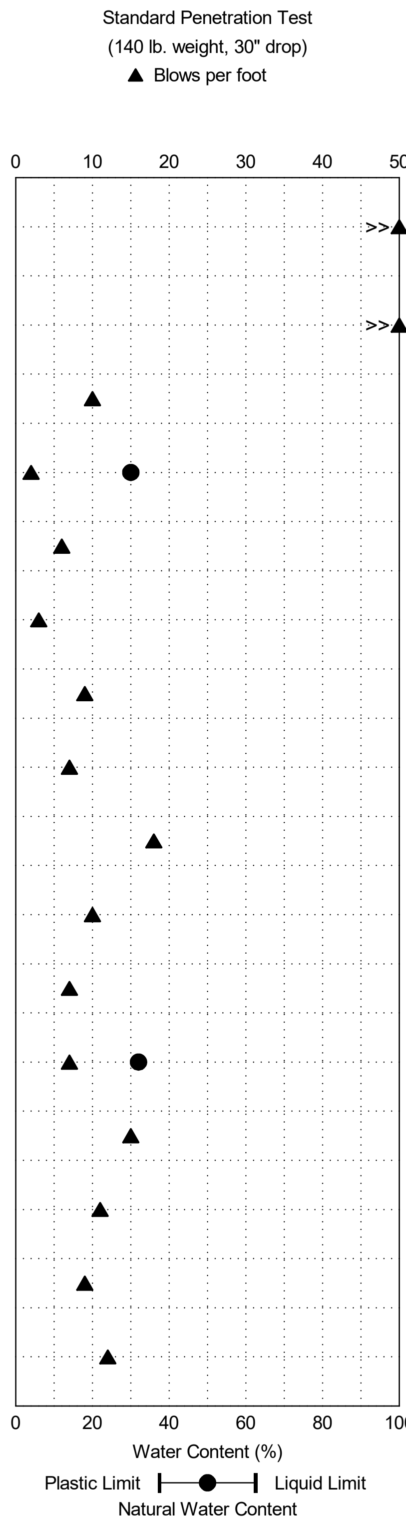
BORING:
HWA-03P-22

PROJECT NO.: 2022-043-21 FIGURE: A4

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36430568, Long: -122.8073136, Datum: WGS84

DATE STARTED: 12/27/2022
DATE COMPLETED: 12/28/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 30.8 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER	ELEVATION (feet)
0		Asphalt (12 inches) **(HMA)**					30
	SM	Very dense, very dark brown, gravelly, silty SAND, moist. Becomes lighter and dry bottom 4 inches of sample, coarse, angular gravel. Recovered: 17 inches. **(FILL)**	S-1	32-38-50/5			
		No recovery	S-2	33-50/2			
5		Becomes medium dense, gravel becomes less coarse. Recovered: 6 inches.	S-3	14-6-4			25
	SM	Very loose, olive brown, slightly gravelly, silty SAND, wet. Medium sand. Recovered: 4 inches. **(LANDSLIDE DEPOSITS)**	S-4	4-1-1	GS		
		Becomes loose. No recovery.	S-5	7-5-5			
		Becomes very loose. No recovery.	S-6	2-1-2			
10		Becomes loose. No recovery.	S-7	0-4-5			20
		Fine sand. Recovered: 12 inches.	S-8	3-3-4			
		Medium dense, becomes slightly gravelly. Recovered: 1 inch.	S-9	5-8-10		▽	
15		Fines decrease, grain size increases with depth. Recovered: 12 inches.	S-10	6-5-5			15
		Becomes loose, dark olive brown, fines content decreases. Recovered: 18 inches.	S-11	5-3-4			
		Becomes olive gray, becomes very silty. Recovered: 10 inches.	S-12	3-3-4	GS		
20		Becomes medium dense. No recovery.	S-13	4-6-9			10
		Recovered: 14 inches.	S-14	6-5-6			
		Becomes loose. No recovery.	S-15	8-4-5			
25		Becomes medium dense. No recovery.	S-16	7-5-7			



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-04-22

PAGE: 1 of 3

PROJECT NO.: 2022-043-21 FIGURE: A5

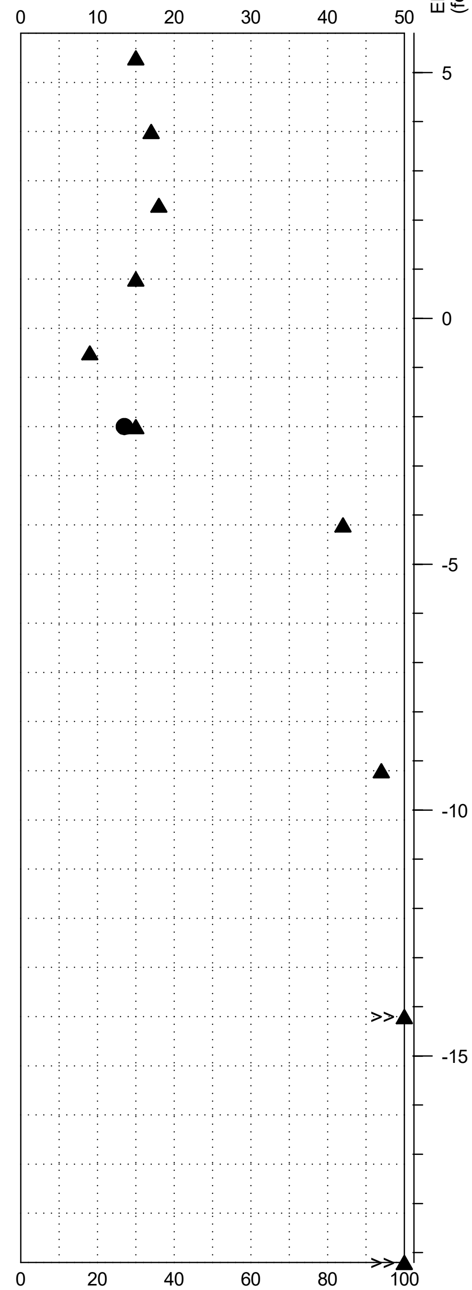
BORING-DSM 2022-043.GPJ 6/26/23

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36430568, Long: -122.8073136, Datum: WGS84

DATE STARTED: 12/27/2022
DATE COMPLETED: 12/28/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 30.8 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
25	SM	Medium dense, gray, silty to very silty, SAND, wet. Fine sand. Recovered: 2 inches.	S-17	9-6-9		
		Recovered: 16 inches.	S-18	6-7-10		
		Recovered: 18 inches.	S-19	7-8-10		
30		Fine, subrounded gravel in sample. Recovered: 10 inches.	S-20	8-7-8		
		Becomes loose. Recovered: 16 inches.	S-21	5-4-5		
	ML	Stiff, dark gray, very sandy SILT, wet. Recovered: 12 inches.	S-22	8-8-16	DS GS	
35	CH	Hard, gray, sandy, fat CLAY, wet. Fine sand. Recovered: 16 inches. **(PRE-VASHON LACUSTRINE SILTS)**	S-23	13-21-21		
40		Interbedded clay to sand. Recovered: 16 inches.	S-24	13-21-26		
45		Sand content decreases. Recovered: 18 inches.	S-25	16-21-31		
50						

Standard Penetration Test
(140 lb. weight, 30" drop)
▲ Blows per foot



Plastic Limit ├──●──┤ Liquid Limit
Natural Water Content

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

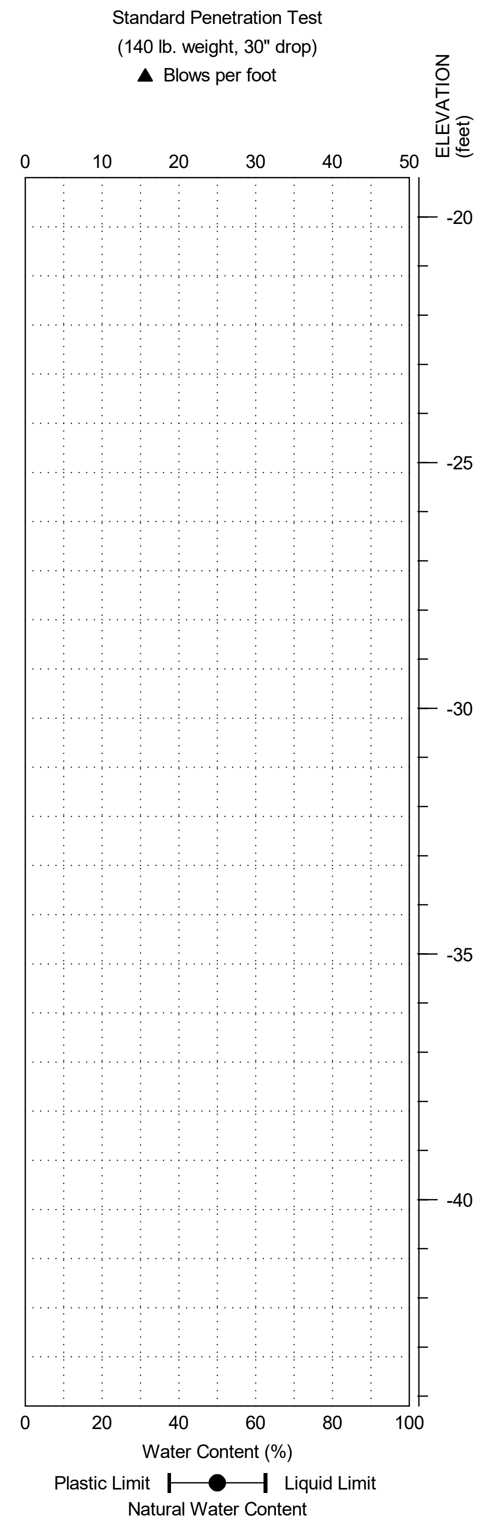
BORING:
HWA-04-22

PROJECT NO.: 2022-043-21 FIGURE: A5

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36430568, Long: -122.8073136, Datum: WGS84

DATE STARTED: 12/27/2022
DATE COMPLETED: 12/28/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 30.8 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
50			Hard, gray, sandy, fat CLAY, wet. Recovered: 18 inches.		S-26	17-26-45		
			Boring was terminated at approximately 51½ feet bgs and backfilled with bentonite chips. Groundwater encountered at approximately 14 feet bgs during drilling.					
55								
60								
65								
70								
75								



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-04-22

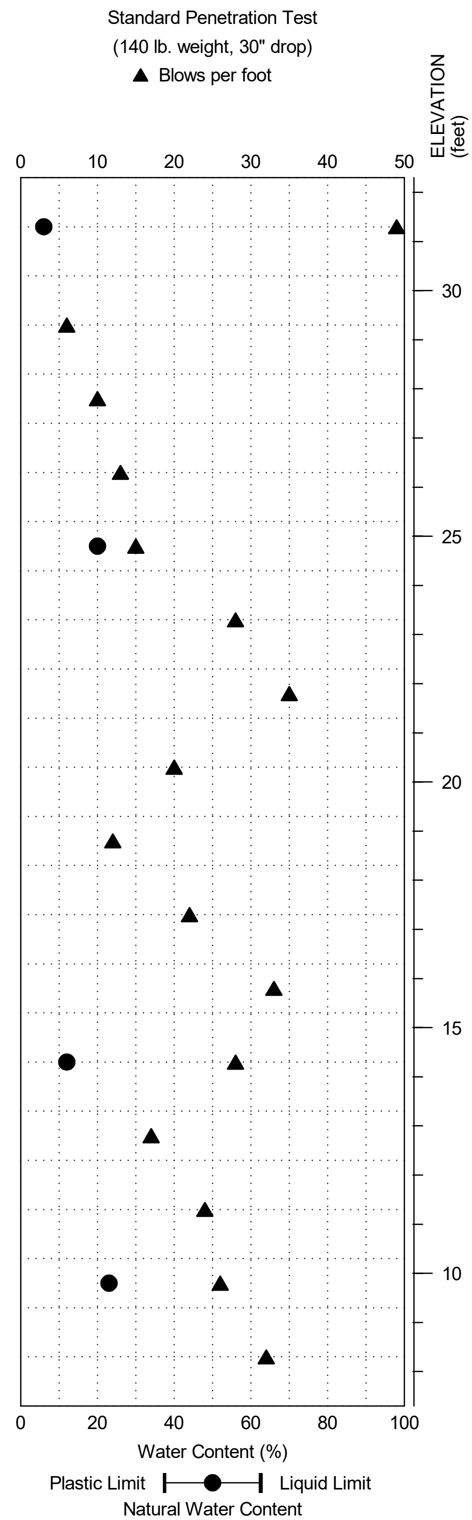
PROJECT NO.: 2022-043-21 FIGURE: A5

BORING-DSM 2022-043.GPJ 6/26/23

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36407596, Long: -122.8071581, Datum: WGS84

DATE STARTED: 12/28/2022
DATE COMPLETED: 12/28/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 32.3 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
0		Asphalt (12 inches) **(HMA)**				
	SP	Dense, very dark brown, very gravelly, poorly graded SAND, moist. Angular gravel up to 5/8". Recovered: 14 inches. **(FILL)**	S-1	30-27-22	GS	
		Loose, no recovery.	S-2	7-4-2		
5	SM	Medium dense, dark yellow-brown, silty, gravelly SAND, wet. Coarse, angular gravel. Recovered: 6 inches.	S-3	4-5-5		
		Becomes light yellow-brown, fines content decreases, gravel content decreases, coarse sand. Recovered: 6 inches.	S-4	9-7-6		
	SP SM	Medium dense, light olive brown, slightly silty, gravelly SAND, wet. Fine to medium sand, fine rounded gravel. Recovered: 12 inches. **(LANDSLIDE DEPOSITS)**	S-5	7-7-8	GS	∇
10		Becomes yellow-brown, gravel content increases, fines content increases, coarse subangular gravel. Recovered: 8 inches.	S-6	7-12-16		
		Becomes dense, gravel becomes less coarse, subrounded. Recovered: 10 inches.	S-7	12-18-17		
		Becomes medium dense, light olive brown, fines content decreases. Recovered: 12 inches.	S-8	7-10-10		
		Becomes olive brown, fines content increases. Recovered: 10 inches.	S-9	8-5-7		
15		Recovered: 3 inches.	S-10	10-9-13		
		No recovery.	S-11	18-17-16		
	SM	Medium dense, olive brown, silty SAND, wet. Recovered: 12 inches.	S-12	18-21-24	DS GS	
20		Fines content decreases with depth. Recovered: 12 inches.	S-13	10-8-9		
	SP SM	Medium dense, olive brown, slightly siltly SAND, wet. Medium sand. Recovered: 10 inches.	S-14	10-10-14		
		Becomes olive gray. Recovered: 12 inches.	S-15	8-12-14	GS	
25	SM	Dense, olive brown, silty SAND, wet. Fine sand. Recovered: 12 inches.	S-16	14-15-17		



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GeoSciences Inc.

SR 302 Victor Area Study
Mason County, Washington

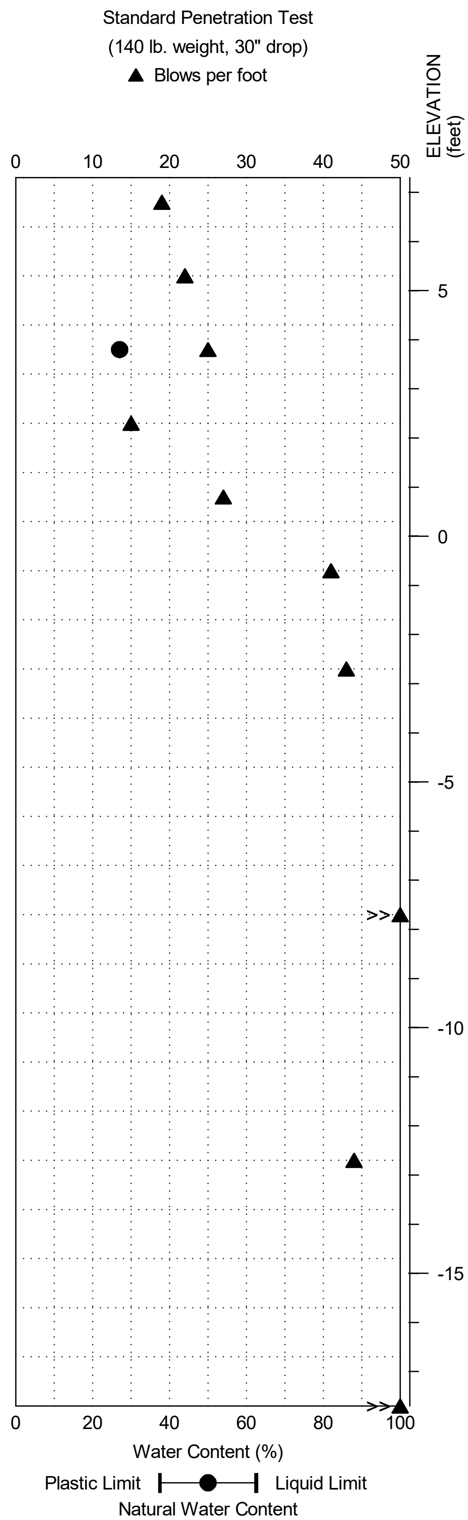
BORING:
HWA-05-22

PROJECT NO.: 2022-043-21 FIGURE: A6

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36407596, Long: -122.8071581, Datum: WGS84

DATE STARTED: 12/28/2022
DATE COMPLETED: 12/28/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 32.3 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
25	SM	Dense, olive brown, silty SAND, wet.			
		Medium dense, becomes gravelly, fine rounded gravel, fines content increases. Recovered: 10 inches.	S-17	9-6-13	
		Stratified silty to sandy lenses with trace rust mottling, fine to medium sand. Recovered: 14 inches.	S-18	8-10-12	
		Becomes olive brown, fines content increases, grain size decreases. Recovered: 14 inches.	S-19	14-12-13	GS
		Fines content increases, grain size decreases with depth. Recovered: 10 inches.	S-20	3-7-8	
31.5	SM	Medium dense, olive brown, silty SAND, wet. Fine sand, rust colored mottling. Recovered: 14 inches.	S-21	8-12-15	
		(PRE-VASHON LACUSTRINE SILTS) Becomes dense. No recovery.	S-22	16-19-22	
		Recovered: 12 inches.	S-23	18-19-24	
40	CH	Hard, gray, sandy, fat CLAY, wet. 1-inch thick sand lenses. Recovered: 12 inches.	S-24	16-21-30	
		Recovered: 14 inches.	S-25	16-19-25	



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING: HWA-05-22

PROJECT NO.: 2022-043-21 FIGURE: A6

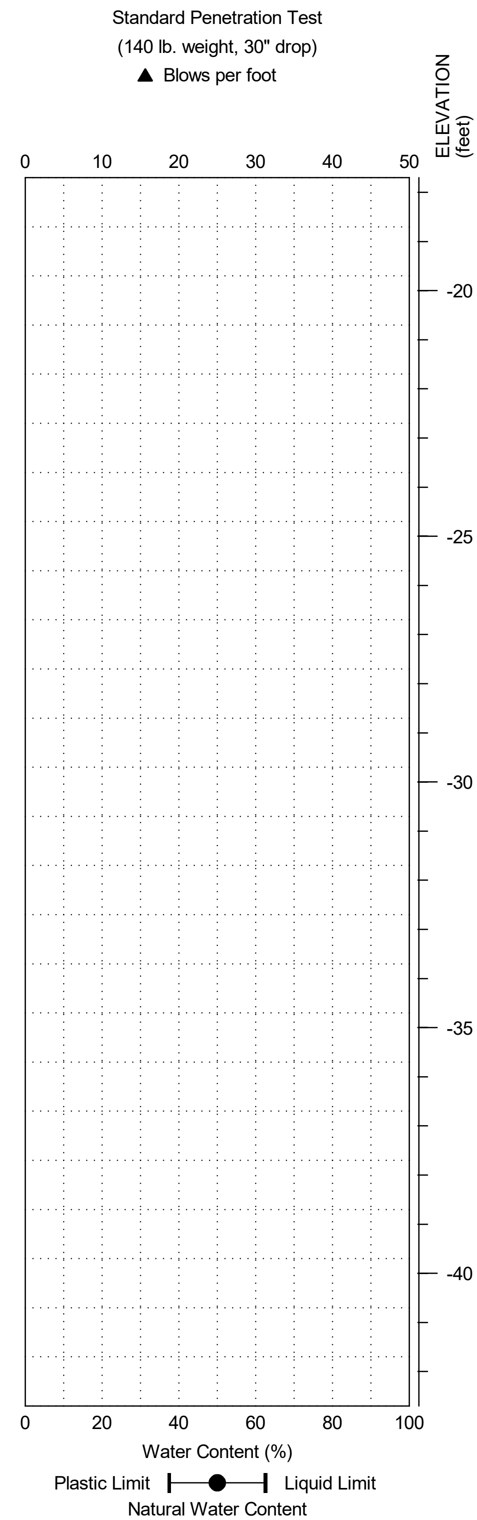
DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36407596, Long: -122.8071581, Datum: WGS84

DATE STARTED: 12/28/2022
DATE COMPLETED: 12/28/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 32.3 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
50		CH	Hard, gray, sandy, fat CLAY, wet. Sand lenses become thicker (2-inches) and more frequent. Recovered: 16 inches.		S-26	21-26-30		

Boring was terminated at approximately 51½ feet bgs and backfilled with bentonite chips. Groundwater encountered at approximately 8 feet bgs during drilling.

Depth scale: 50, 55, 60, 65, 70, 75

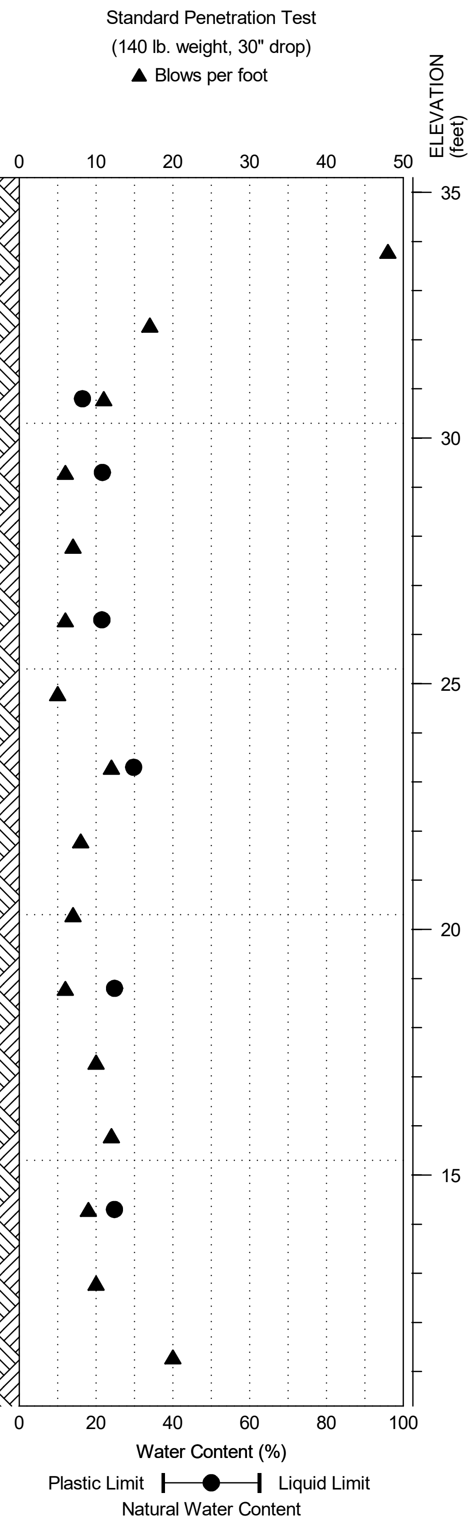


NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36464282, Long: -122.8075297, Datum: WGS84

DATE STARTED: 12/19/2022
DATE COMPLETED: 12/15/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 35.3 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
0		Asphalt (12 inches) **(HMA)**			
	SM	Dense, dark brown, silty, gravelly SAND, moist. Crushed asphalt in sample. Recovered: 12 inches. **(FILL)**	S-1	32-34-14	
		Gravel content increases. Recovered: 12 inches.	S-2	6-8-9	
	ML	Very stiff, light olive brown, very sandy SILT, moist. Recovered: 12 inches. **(LANDSLIDE DEPOSITS)**	S-3	12-9-8	DS GS
5	SM	Loose, olive brown, gravelly, very silty SAND, moist, fine sand. Recovered: 12 inches.	S-4	5-3-3	
		Recovered: 12 inches.	S-5	4-4-3	
		Gravel and fines content decreases. Recovered: 12 inches.	S-6	3-3-3	GS
10		Recovered: 6 inches.	S-7	4-2-3	
	ML	Stiff, olive brown, very sandy SILT, wet. Fine sand. Recovered: 14 inches.	S-8	5-6-6	GS AL
		Becomes medium stiff. Recovered: 2 inches.	S-9	5-4-4	
15		Recovered: 12 inches.	S-10	5-4-3	
	SP SM	Loose, dark grayish-brown, slightly silty, poorly graded SAND, wet. Fine sand. Recovered: 12 inches.	S-11	4-3-3	GS AL
		Fines content increases. Recovered: 12 inches.	S-12	3-5-5	
20		Recovered: 12 inches.	S-13	8-7-5	
	ML	Stiff, dark grayish-brown, very sandy SILT, wet. Fine sand. Recovered: 10 inches.	S-14	1-4-5	GS
		Recovered: 12 inches.	S-15	5-4-6	
25		Becomes very stiff. Recovered: 12 inches.	S-16	10-10-10	



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

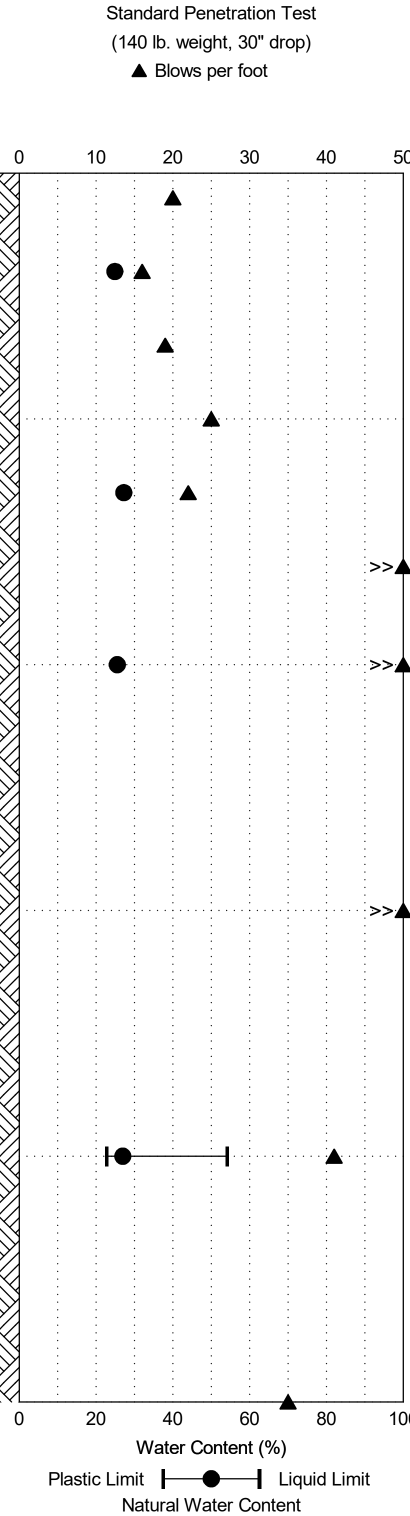
BORING:
HWA-06Si-22

PROJECT NO.: 2022-043-21 FIGURE: A7

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36464282, Long: -122.8075297, Datum: WGS84

DATE STARTED: 12/19/2022
DATE COMPLETED: 12/15/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 35.3 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	ELEVATION (feet)
25	ML	Very stiff, dark grayish-brown, very sandy SILT, wet. Recovered: 6 inches.	S-17	5-9-11		10
		Becomes dark gray. Recovered: 6 inches.	S-18	0-7-9	GS	
		Recovered: 12 inches.	S-19	8-9-10		
30	ML	Very stiff, very dark grayish-brown, sandy SILT, wet, fine sand. Recovered: 12 inches.	S-20	17-19-20	UU	5
		(PRE-VASHON LACUSTRINE SILTS) Recovered: 12 inches.	S-21	10-11-24	DS GS	
		Becomes hard. Recovered: 12 inches.	S-22	33-36-50/6	UCS	
35		Becomes dark gray, sand content decreases. Recovered: 16 inches.	S-23	21-21-35	GS	0
40	CH	Hard, dark gray, slightly sandy, fat CLAY, moist. Fine sand. Recovered: 18 inches.	S-24	17-26-27		-5
45		Becomes sandy. Recovered: 18 inches.	S-25	15-16-25	%F AL	-10
50						



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

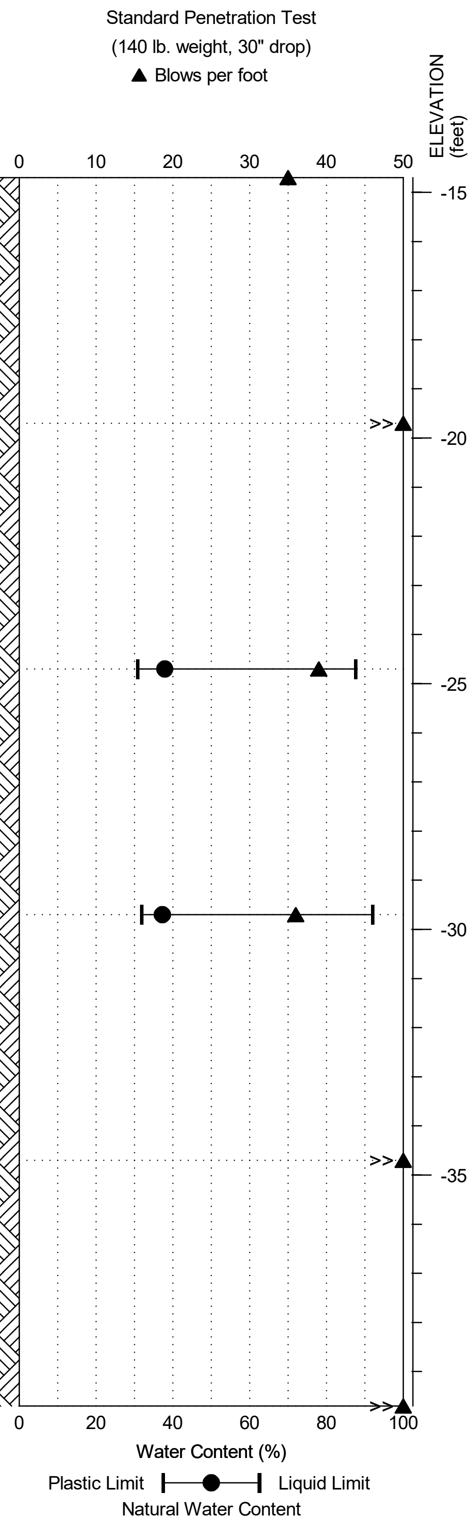
BORING:
HWA-06Si-22

PROJECT NO.: 2022-043-21 FIGURE: A7

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36464282, Long: -122.8075297, Datum: WGS84

DATE STARTED: 12/19/2022
DATE COMPLETED: 12/15/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 35.3 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	ELEVATION (feet)
50	CH	Hard, dark gray, slightly sandy, fat CLAY, moist. Recovered: 18 inches.	S-26	13-15-20		-15
55		Recovered: 18 inches.	S-27	15-21-34		-20
60		Becomes very dark gray, sand content decreases, plasticity increases. Recovered: 18 inches.	S-28	8-12-17	%F AL	-25
65		Recovered: 18 inches.	S-29	12-15-21	%F AL	-30
70	SM	Very dense, olive gray, gravelly, silty SAND, wet. Recovered: 4 inches. **(PRE-VASHON GLACIAL TILL DEPOSITS)**	S-30	50/4		-35
75						



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-06Si-22

PROJECT NO.: 2022-043-21 FIGURE: A7

PZO-DSM 2022-043.GPJ 6/26/23

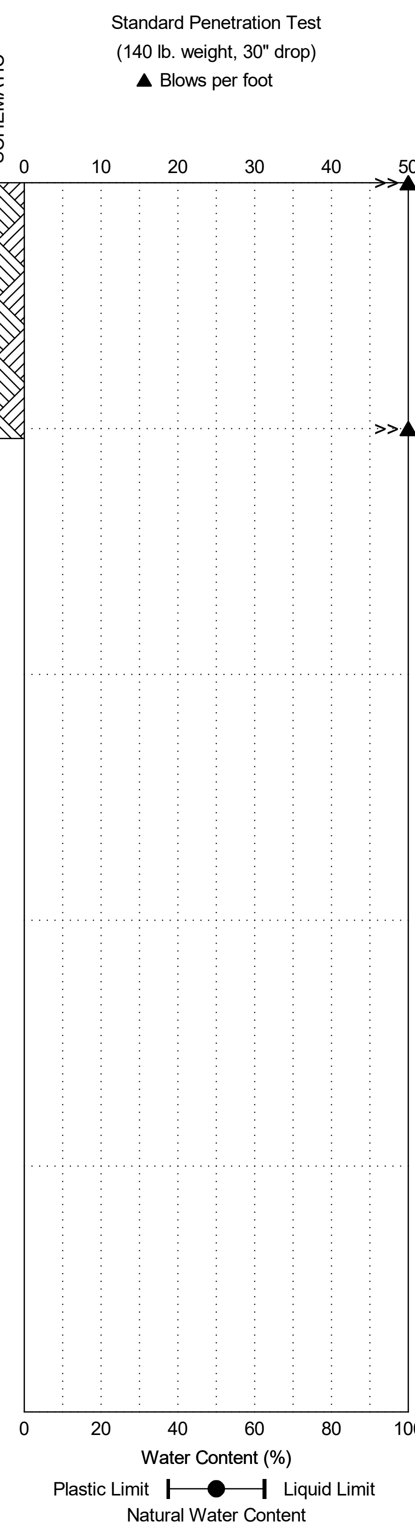
DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36464282, Long: -122.8075297, Datum: WGS84

DATE STARTED: 12/19/2022
DATE COMPLETED: 12/15/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 35.3 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	PIEZOMETER SCHEMATIC	ELEVATION (feet)
75			Recovered: 2 inches.		S-31	50/2			-40
80			Gravel content increases. Recovered: 2 inches.		S-32	50/2			-45

Boring was terminated at approximately 80 feet bgs and converted to an inclinometer, DOE Well ID #BPQ 402. Groundwater was observed at approximately 12 feet bgs during drilling.

Depth (feet): 75, 80, 85, 90, 95, 100
Elevation (feet): -40, -45, -50, -55, -60



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-06Si-22

PAGE: 4 of 4

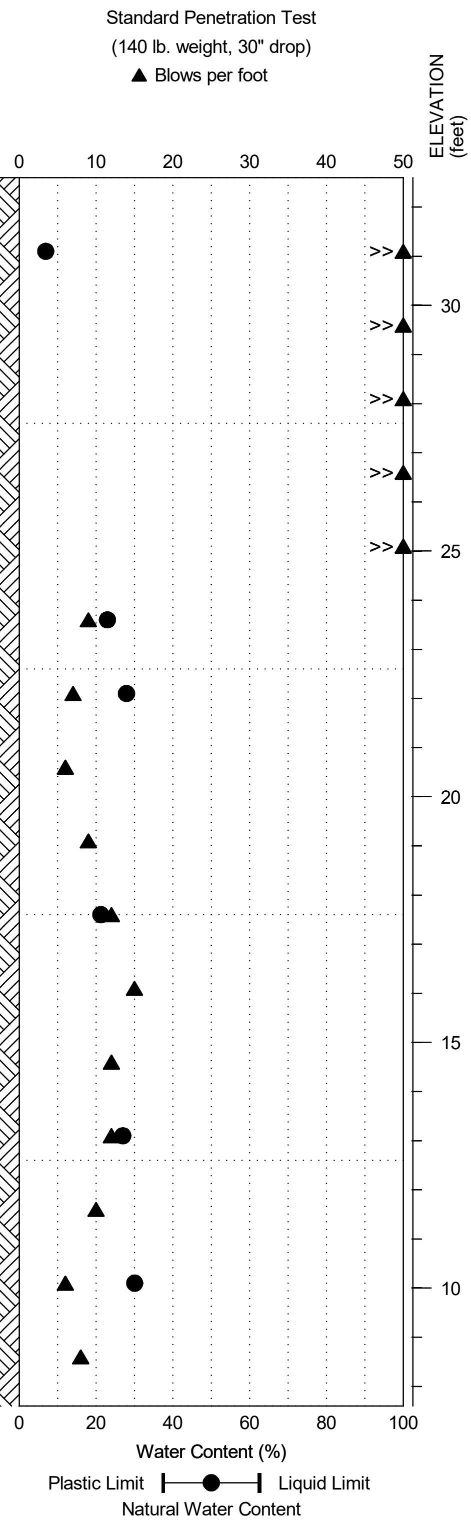
PROJECT NO.: 2022-043-21 FIGURE: A7

PZO-DSM 2022-043.GPJ 6/26/23

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36428436, Long: -122.8073498, Datum: WGS84

DATE STARTED: 12/14/2022
DATE COMPLETED: 12/15/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 32.6 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
0		Asphalt (18 inches) **(HMA)**			
	SW SM	Very dense, very dark grayish-brown, slightly silty, very gravelly, well graded SAND, moist. Recovered: 10 inches. **(FILL)**	S-1	23-50/5	GS
		Becomes blackish brown, wet, asphalt in sample. Recovered: 6 inches.	S-2	33-50/2	
5		No recovery.	S-3	50/1	
		Becomes brown. Recovered: 4 inches.	S-4	50/4	
		Becomes moist, olive brown. Recovered: 6 inches.	S-5	50/6	
	SM	Loose, olive-brown, silty to very silty SAND, moist. Fine sand. Recovered: 18 inches. **(LANDSLIDE DEPOSITS)**	S-6	9-5-4	GS
10		Becomes brown, wood pieces, interbedded organge-brown layers. Recovered: 18 inches.	S-7	2-3-4	GS
		Recovered: 12 inches.	S-8	2-2-4	
		Becomes olive brown, wet. Recovered: 12 inches.	S-9	3-4-5	
15		Becomes medium dense, dark olive brown. Recovered: 6 inches.	S-10	7-7-5	GS
		Becomes gravelly, fines content decreases. Recovered: 9 inches.	S-11	5-9-6	
		Silt content increases, silt lenses in sample. Recovered: 12 inches.	S-12	7-5-7	
20	SP SM	Medium dense, dark gray, slightly silty, poorly graded SAND, moist. Recovered: 12 inches.	S-13	7-7-6	GS
		Becomes wet. Recovered: 12 inches.	S-14	6-7-9	
	ML	Medium stiff, dark grayish brown, very sandy SILT, moist. Recovered: 12 inches.	S-15	3-3-3	GS
25	SM	Loose, olive brown, very silty SAND, wet. Recovered: 15 inches.	S-16	7-5-3	



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

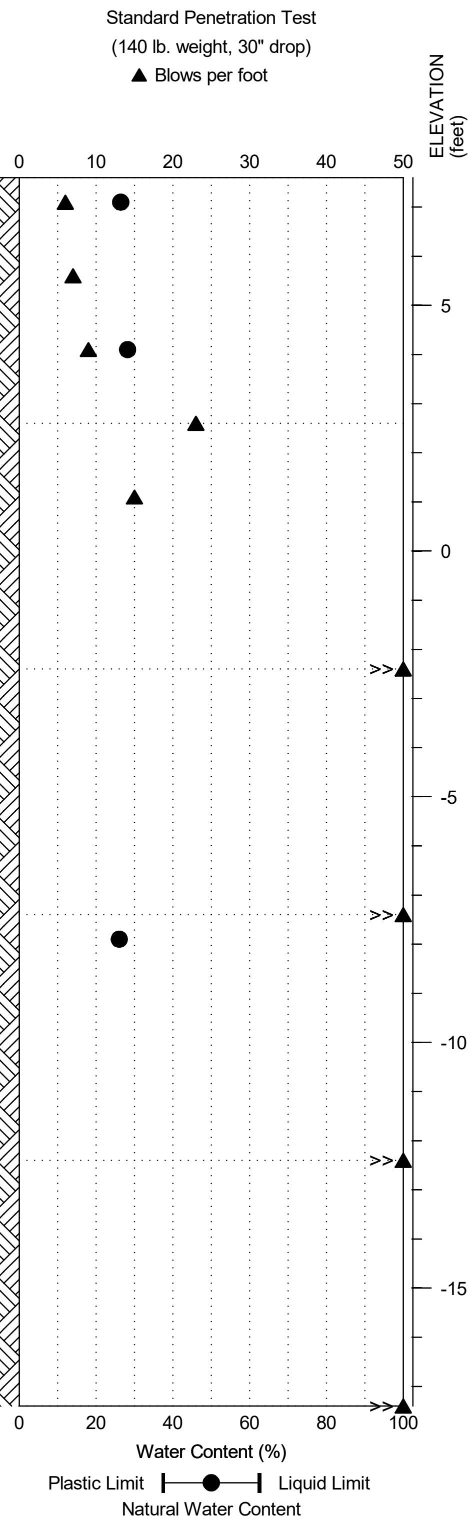
BORING:
HWA-07Si-22

PROJECT NO.: 2022-043-21 FIGURE: A8

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36428436, Long: -122.8073498, Datum: WGS84

DATE STARTED: 12/14/2022
DATE COMPLETED: 12/15/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 32.6 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
25	SM	Loose, olive brown, very silty SAND, wet.			
	ML	Medium stiff, grayish-brown, very sandy SILT, moist. Recovered: 6 inches.	S-17	1-3-3	GS
		Becomes stiff, gray, slightly sandy, wet. Recovered: 15 inches.	S-18	5-4-3	
		Recovered: 18 inches.	S-19	4-4-5	GS
30	ML	Very stiff, dark gray, very sandy SILT, moist. Recovered: 3 inches.	S-20	9-11-12	
		(PRE-VASHON LACUSTRINE SILTS)			
		Becomes stiff. Recovered: 12 inches.	S-21	9-11-13	DS
35		Becomes hard, nonplastic to low plasticity. Recovered: 12 inches.	S-22	29-33-50/5	
40		Becomes very dark gray, sandy. Recovered: 6 inches.	S-23 S-23b	20-33-50/5	UU DS GS
45		Recovered: 15 inches.	S-24	18-26-33	
50					



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

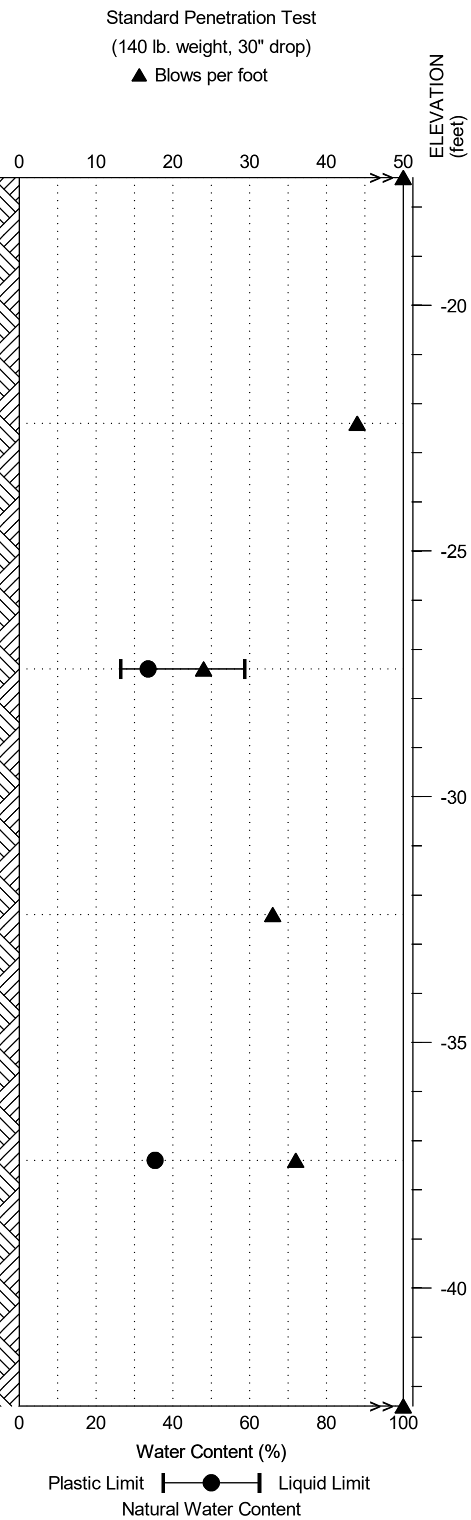
BORING:
HWA-07Si-22

PROJECT NO.: 2022-043-21 FIGURE: A8

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36428436, Long: -122.8073498, Datum: WGS84

DATE STARTED: 12/14/2022
DATE COMPLETED: 12/15/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 32.6 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
50		Medium stiff, grayish-brown, very sandy SILT, moist. Recovered: 18 inches.	S-25	16-34-35	
55		Nonplastic to low plasticity. Recovered: 18 inches.	S-26	13-20-24	
60	CH	Very stiff, very dark gray, fat CLAY, moist. Recovered: 18 inches.	S-27	7-8-16	GS AL
65		Becomes hard, laminated. Recovered: 18 inches.	S-28	11-14-19	
70		Recovered: 18 inches.	S-29	12-14-22	GS
		Drilling effort increases			
	SM	Very dense, olive gray, slightly gravelly, silty SAND, moist. Recovered: 1 inch. **(PRE-VASHON GLACIAL TILL DEPOSITS)**			
75					



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-07Si-22

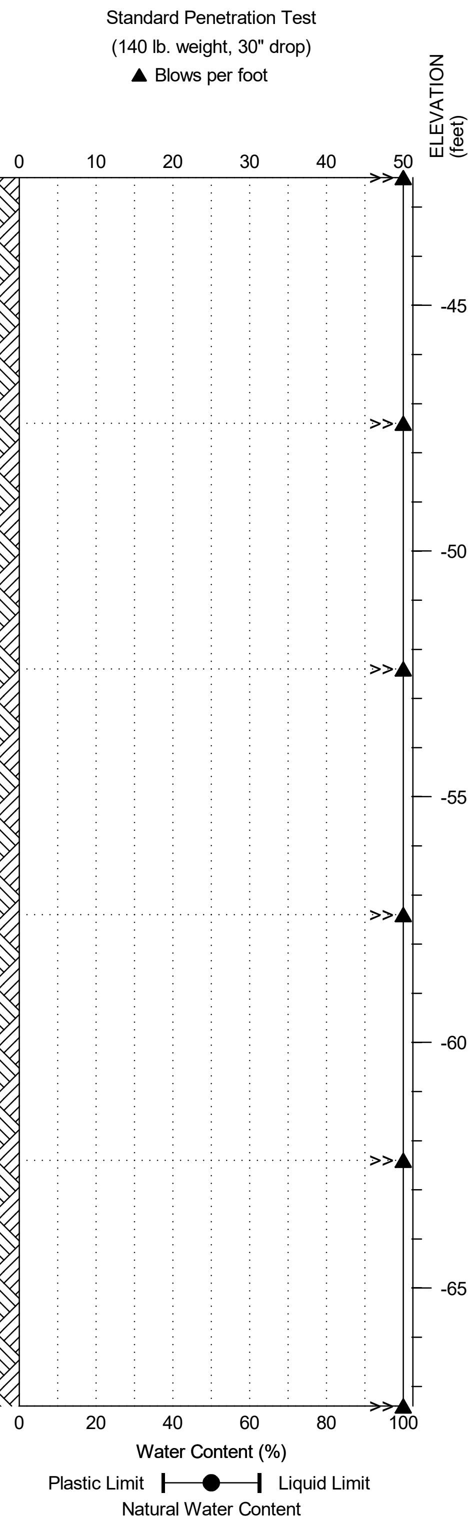
PROJECT NO.: 2022-043-21 FIGURE: A8

PZO-DSM 2022-043.GPJ 6/26/23

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36428436, Long: -122.8073498, Datum: WGS84

DATE STARTED: 12/14/2022
DATE COMPLETED: 12/15/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 32.6 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	PIEZOMETER SCHEMATIC
75			Very dense, olive gray, slightly gravelly, silty SAND, moist. Recovered: 1 inch		S-30	50/1		
80			Recovered: 2 inches.		S-31	50/2		
85			No recovery.		S-32	50/0		
90			Recovered: 1 inch		S-33	50/1		
95			Recovered: 1 inch.		S-34	50/1		
100								



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-07Si-22

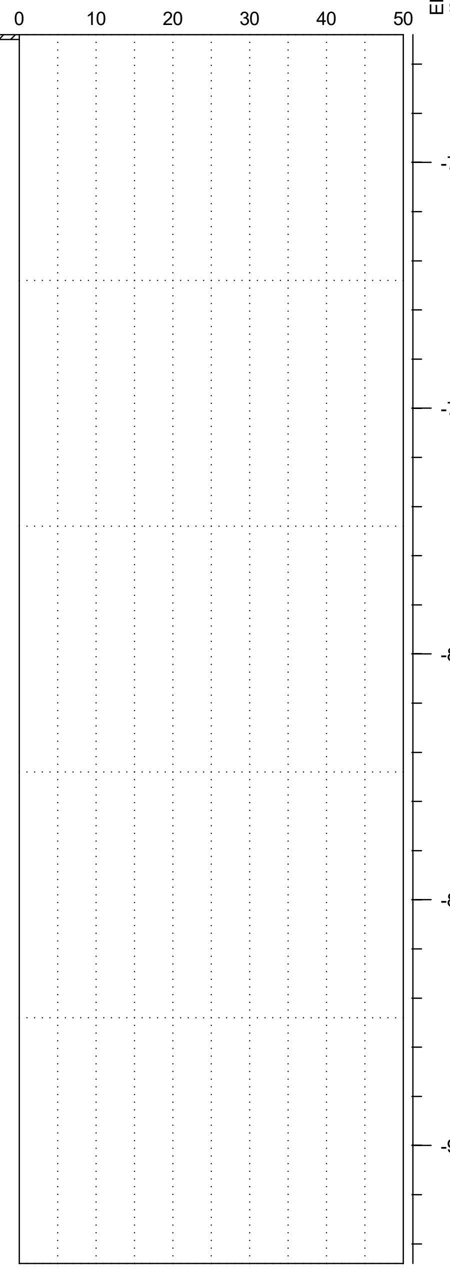
PROJECT NO.: 2022-043-21 FIGURE: A8

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36428436, Long: -122.8073498, Datum: WGS84

DATE STARTED: 12/14/2022
DATE COMPLETED: 12/15/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 32.6 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	PIEZOMETER SCHEMATIC	ELEVATION (feet)
100			No recovery.		S-35	50/1			
			Boring was terminated at approximately 100 feet bgs and converted to an inclinometer, DOE Well ID #BPQ 401. Groundwater was observed at approximately 14 feet bgs during drilling.						

Standard Penetration Test
(140 lb. weight, 30" drop)
▲ Blows per foot



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-07Si-22

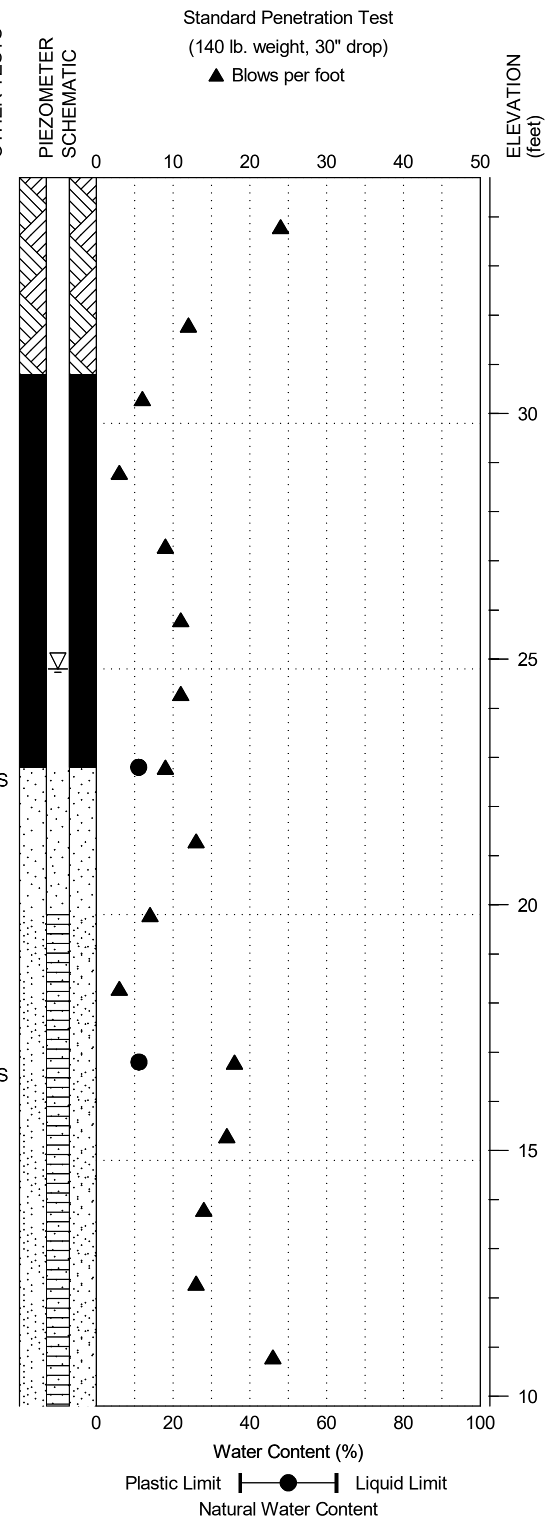
PROJECT NO.: 2022-043-21 FIGURE: A8

PZO-DSM 2022-043.GPJ 6/26/23

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36404772, Long: -122.8072034, Datum: WGS84

DATE STARTED: 12/20/2022
DATE COMPLETED: 12/19/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 34.8 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
0		Asphalt (12 inches) **(HMA)**			
	SW SM	Medium dense, dark gray, slightly gravelly, slightly silty SAND, moist. Fine subrounded to angular gravel. Recovered: 12 inches. **(FILL)**	S-1	13-13-11	
		Recovered: 12 inches.	S-2	6-7-5	
5	GP GM	Loose, brown to gray, slightly sandy GRAVEL, moist. Fine subrounded to rounded gravel (Pea Gravel). Fine sand. Recovered: 6 inches.	S-3	3-3-3	
		Becomes very loose, sand content increases. Recovered: 6 inches.	S-4	2-2-1	
		Recovered: 3 inches.	S-5	4-4-5	
		Recovered: 6 inches.	S-6	4-5-6	
10		Gravel size increases. Recovered: 6 inches.	S-7	1-6-5	
	GW GM	Loose, olive brown slightly silty, very sandy, well graded GRAVEL, wet. Fine to medium sand, fine subangular to rounded gravels. Recovered: 12 inches.	S-8	4-4-5	GS
		Becomes medium dense. No recovery.	S-9	4-8-12	
15		Becomes loose, gravel content increases. Recovered: 2 inches.	S-10	7-3-4	
		Becomes very loose. Recovered: 6 inches.	S-11	4-1-2	
	GP	Medium dense, light olive gray sandy, poorly graded GRAVEL, wet. Recovered: 6 inches.	S-12	6-6-12	GS
20		Recovered: 16 inches.	S-13	11-9-8	
	SM	Medium dense, olive brown, slightly gravelly, silty SAND, wet. Fines content increases with depth. Recovered: 12 inches. **(LANDSLIDE DEPOSITS)**	S-14	9-6-8	
		Becomes reddish brown. Recovered: 12 inches.	S-15	8-6-7	
25		Recovered: 6 inches.	S-16	10-10-13	



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-08P-22

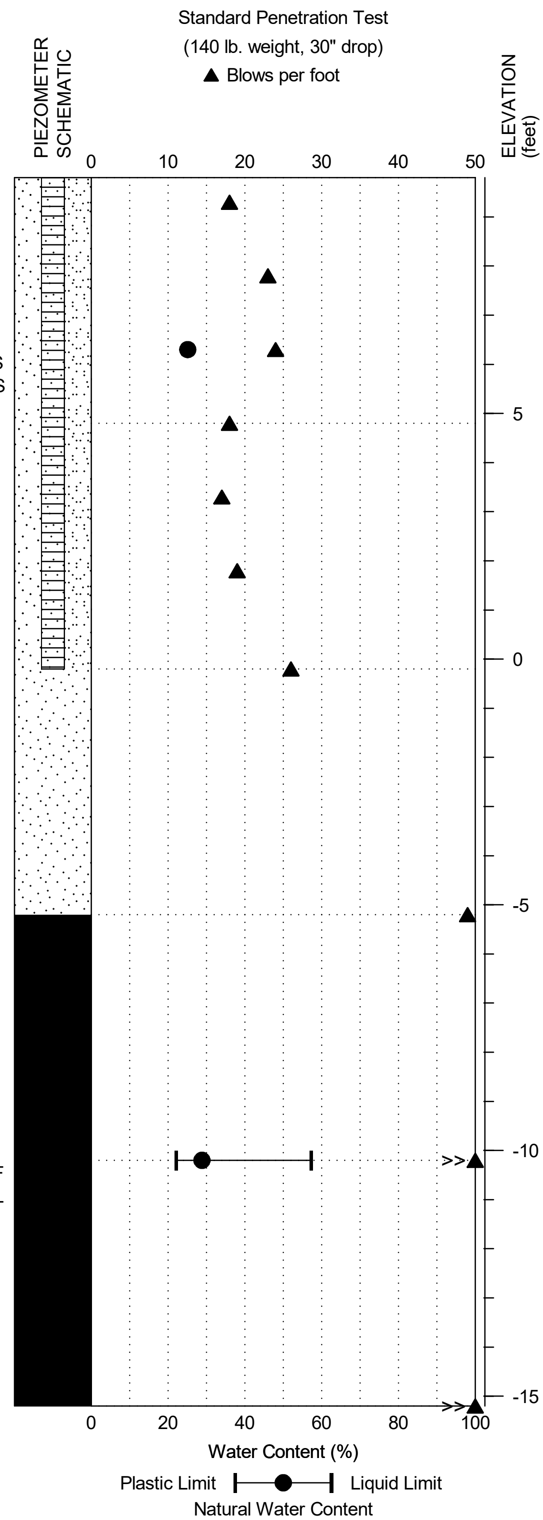
PROJECT NO.: 2022-043-21 FIGURE: A9

PZO-DSM 2022-043.GPJ 6/26/23

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36404772, Long: -122.8072034, Datum: WGS84

DATE STARTED: 12/20/2022
DATE COMPLETED: 12/19/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 34.8 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
25	SM	Medium dense, olive brown, slightly gravelly, silty SAND, wet. Recovered: 6 inches.	S-17	5-9-9	
		Recovered: 2 inches.	S-18	11-11-12	
		Recovered: 6 inches.	S-19	14-18-20	GS DS
30		Recovered: 6 inches.	S-20	9-9-9	
	ML	Stiff, olive brown, slightly sandy SILT, wet, fine sand. Recovered: 12 inches.	S-21	8-9-8	
			S-22	10-9-10	
	SM	Medium dense, olive brown, silty SAND, wet. Fine to medium sand. Recovered: 6 inches. **(PRE-VASHON DEPOSITS)**			
35		Becomes gray. Recovered: 12 inches.	S-23	10-13-16	
40	ML	Hard, gray Sandy SILT, moist. Recovered: 18 inches. **(PRE-VASHON LACUSTRINE SILTS)**	S-24	30-23-26	
45	CH	Hard, dark gray fat CLAY, moist. Recovered: 18 inches.	S-25	16-23-31	%F AL
50					

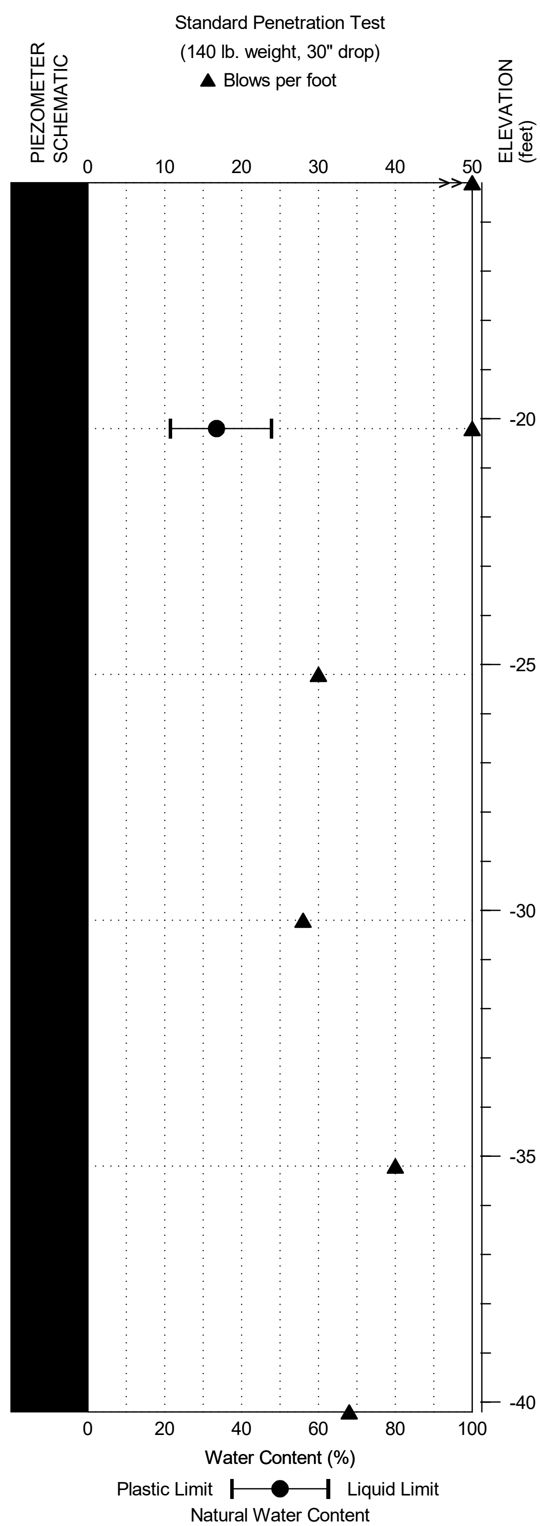


NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36404772, Long: -122.8072034, Datum: WGS84

DATE STARTED: 12/20/2022
DATE COMPLETED: 12/19/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 34.8 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	ELEVATION (feet)
50		Hard, dark gray fat CLAY, moist. Recovered: 18 inches.	S-26	19-22-33		
55	CL	Hard, dark gray, lean CLAY, moist. Laminated. Recovered: 18 inches.	S-27	19-22-28	%F AL	-20
60		Recovered: 18 inches.	S-28	13-13-17		-25
65		Becomes very stiff. Recovered: 18 inches.	S-29	8-11-17		-30
70		Becomes hard. Recovered: 18 inches.	S-30	12-19-21		-35
75						-40



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

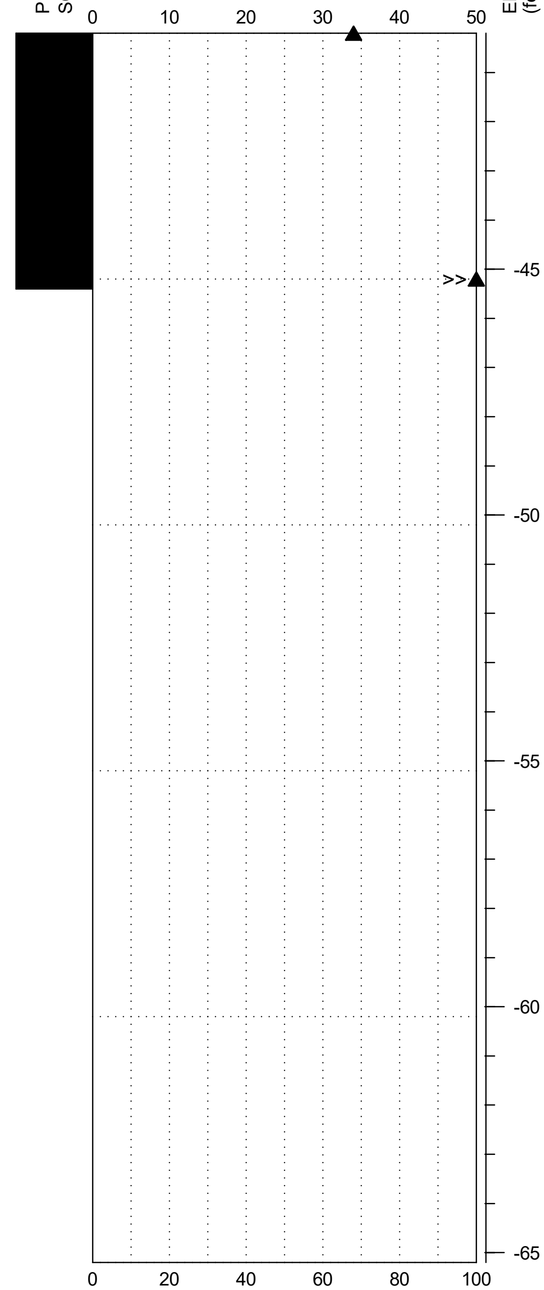
DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36404772, Long: -122.8072034, Datum: WGS84

DATE STARTED: 12/20/2022
DATE COMPLETED: 12/19/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 34.8 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
75	CL	Hard, dark gray, lean CLAY, moist. Recovered: 18 inches.	S-31	14-15-19	
80	SM	Very dense, olive gray, slightly gravelly, silty SAND, moist. Recovered: 1 inch. **(PRE-VASHON GLACIAL TILL DEPOSITS)**	S-32	50/2	

Boring was terminated at approximately 80 feet bgs and converted to an inclinometer, DOE Well ID #BPQ 403 . Groundwater was observed at approximately 10 feet bgs during drilling.

Standard Penetration Test
(140 lb. weight, 30" drop)
▲ Blows per foot



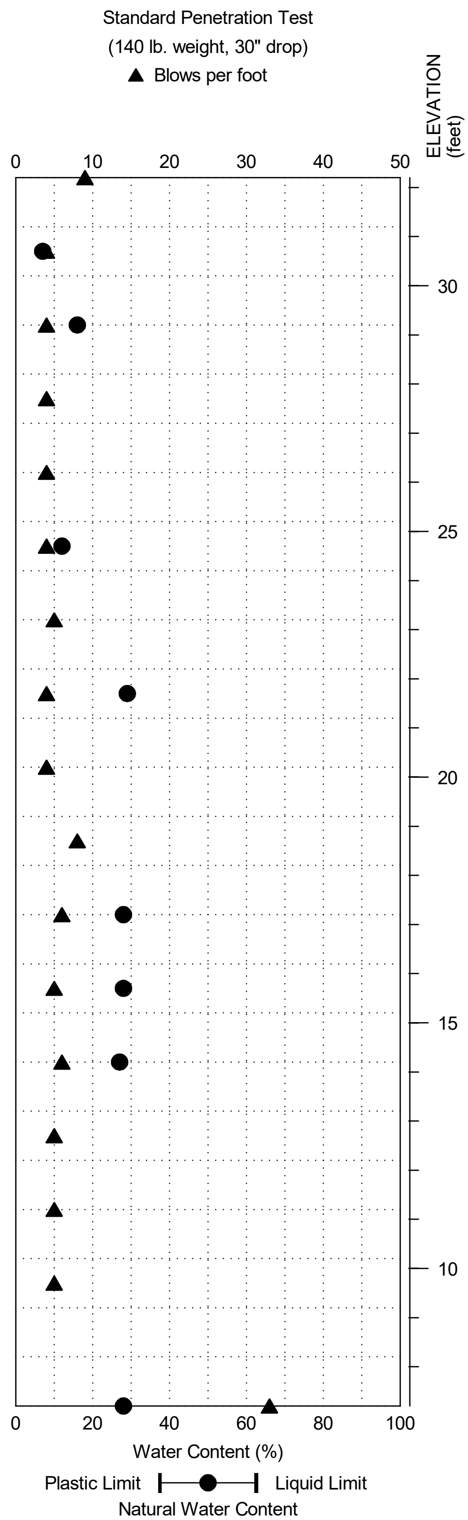
Water Content (%)
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

DRILLING COMPANY: Geologic Drill Partners
DRILLING METHOD: Hollow Stem Auger
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36455865, Long: -122.8075941, Datum: WGS84

DATE STARTED: 12/14/2022
DATE COMPLETED: 12/14/2022
LOGGED BY: W. Rosso
SURFACE ELEVATION: 32.2 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
0	GW GM	Loose, dark brown, slightly silty, very sandy, well graded GRAVEL, moist. Fine to medium sand, fine subrounded gravels, trace organics (roots, rootlets). Recovered: 3 inches. **(LANDSLIDE DEPOSITS)**	S-1	2-4-5		
		Organic content decreases, gravels become fine to coarse and subrounded to rounded. Recovered: 3 inches.	S-2	2-2-2	GS	
	SM	Loose, olive brown, silty SAND, moist. Fine to medium sand. Recovered: 11 inches.	S-3	3-2-2	GS	
5		Moisture cotent increases, trace fine rounded gravel. Recovered: 17 inches.	S-4	3-2-2		
		Recovered: 16 inches.	S-5	3-2-2		
	SP SM	Loose, dark olive-brown, slightly silty SAND, moist. Fine sand. Recovered: 5 inches.	S-6	2-2-2	GS	
	SM	Loose, dark grayish-brown, silty SAND, moist. Fine to medium sand. Recovered: 15 inches.	S-7	3-2-3		
10		Becomes wet, fines content increases. Recovered: 12 inches.	S-8	2-2-2	GS	▽
		Becomes yellowish brown. Recovered: 13 inches.	S-9	2-2-2		
		Becomes olive to olive brown, fines content increases. Recovered: 18 inches.	S-10	3-3-5		
15	ML	Medium stiff, dark grayish-brown, very sandy SILT, wet. Fine sand. Recovered: 18 inches.	S-11	3-3-3	GS	
	SM	Loose, very dark grayish-brown, very silty SAND, wet. Fine to medium sand. Recovered: 18 inches.	S-12	3-3-2	GS	
		Becomes dark gray, fines content decreases. Recovered: 18 inches.	S-13	2-2-4	GS	
20		Becomes brownish gray. Recovered: 18 inches.	S-14	3-3-2		
		Becomes dark gray. Recovered: 18 inches.	S-15	3-3-2		
			S-16	3-3-2		
		Heaving sands cause auger bind, drilling mud added to borehole, continuous sampling ends.				
25						



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-09-22

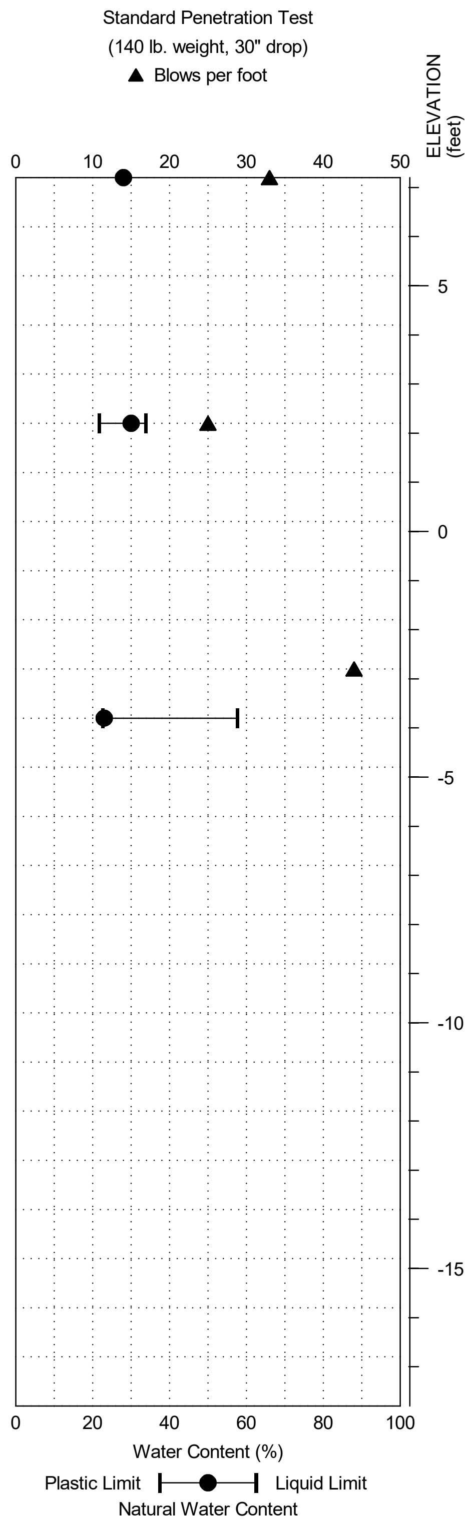
PROJECT NO.: 2022-043-21 FIGURE: A10

DRILLING COMPANY: Geologic Drill Partners
DRILLING METHOD: Hollow Stem Auger
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36455865, Long: -122.8075941, Datum: WGS84

DATE STARTED: 12/14/2022
DATE COMPLETED: 12/14/2022
LOGGED BY: W. Rosso
SURFACE ELEVATION: 32.2 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
25	ML	Hard, olive gray, sandy SILT, wet. Fine sand, 1 inch thick hard silt lenses with white mottling observed at approximately 25.5' and 26.3' bgs, fines content increases with depth. Recovered: 18 inches. **(PRE-VASHON LACUSTRINE SILTS)**	S-17	7-15-18	%F AL
30	CL	Very stiff, gray, slightly sandy, lean Clay, moist. 1 inch thick hard silt lenses with white mottling observed at approximately 30.3', 30.7', and 31.3' bgs, Recovered: 18 inches.	S-18	11-13-12	%F AL
35	CH	Very hard, gray, very sandy, fat CLAY, moist. Fine sand. Recovered: 18 inches.	S-19	10-20-22	
			S-20		%F AL

Boring was terminated at approximately 36½ feet bgs due to practical refusal and backfilled with bentonite chips. Groundwater encountered at approximately 10 feet bgs during drilling.

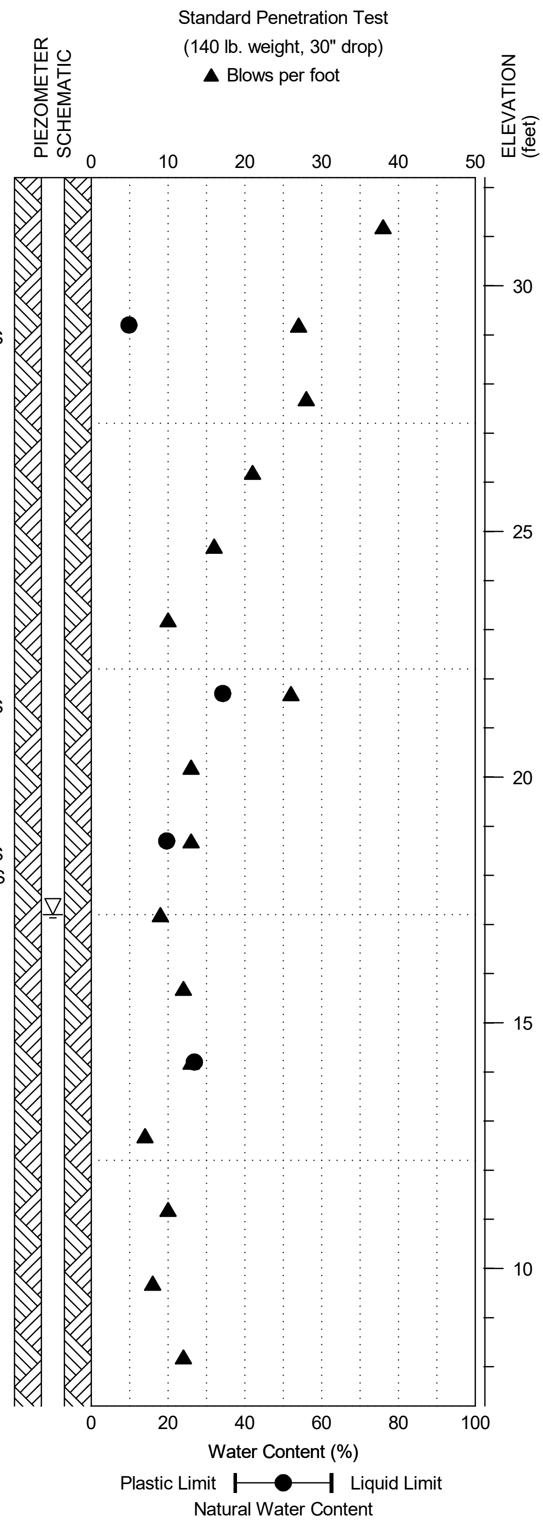


NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36368441, Long: -122.8069585, Datum: WGS84

DATE STARTED: 12/22/2022
DATE COMPLETED: 12/21/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 32.2 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
0		Asphalt (12 inches) **(HMA)**			
	SM	Dense, dark yellow brown, slightly gravelly, silty SAND, moist. Recovered: 12 inches. **(FILL)**	S-1	18-21-17	
	SP SM	Medium dense, olive to olive brown, slightly silty, very gravelly SAND, moist. Recovered: 10 inches.	S-2	10-13-14	GS
5		Becomes dark olive brown. Recovered: 10 inches.	S-3	12-14-14	
		Recovered: 6 inches.	S-4	13-10-11	
		Recovered: 6 inches.	S-5	5-8-8	
		Becomes dark gray. Recovered: 6 inches.	S-6	7-4-6	
10	SM	Medium dense, olive gray, gravelly, silty SAND, moist. Wood pieces in sample. Recovered: 12 inches. **(LANDSLIDE DEPOSITS)**	S-7	5-9-17	GS
		Medium dense, dark gray, silty SAND, wet. Recovered: 12 inches.	S-8	4-6-7	
	SP SM	Medium dense, dark gray, slightly silty SAND, poorly graded, wet. Recovered: 6 inches.	S-9	12-13-18	GS DS
15		Becomes loose, olive gray, fines content increases. Recovered: 14 inches.	S-10	3-4-5	
	SM	Medium dense, brownish yellow, silty SAND, wet. Recovered: 6 inches.	S-11	6-5-7	
		Becomes olive gray, very silty. Recovered: 12 inches.	S-12	5-7-6	
20		Recovered: 10 inches.	S-13	6-3-4	
		Becomes brownish yellow, fines content increases. Recovered: 14 inches.	S-14	5-4-6	
	ML	Stiff, yellowish brown, very sandy SILT, wet. Fine sand. Recovered: 12 inches.	S-15	4-4-4	
25	SM	Medium dense, brown, very silty SAND, wet. Fine sand. Recovered: 12 inches.	S-16	5-5-7	

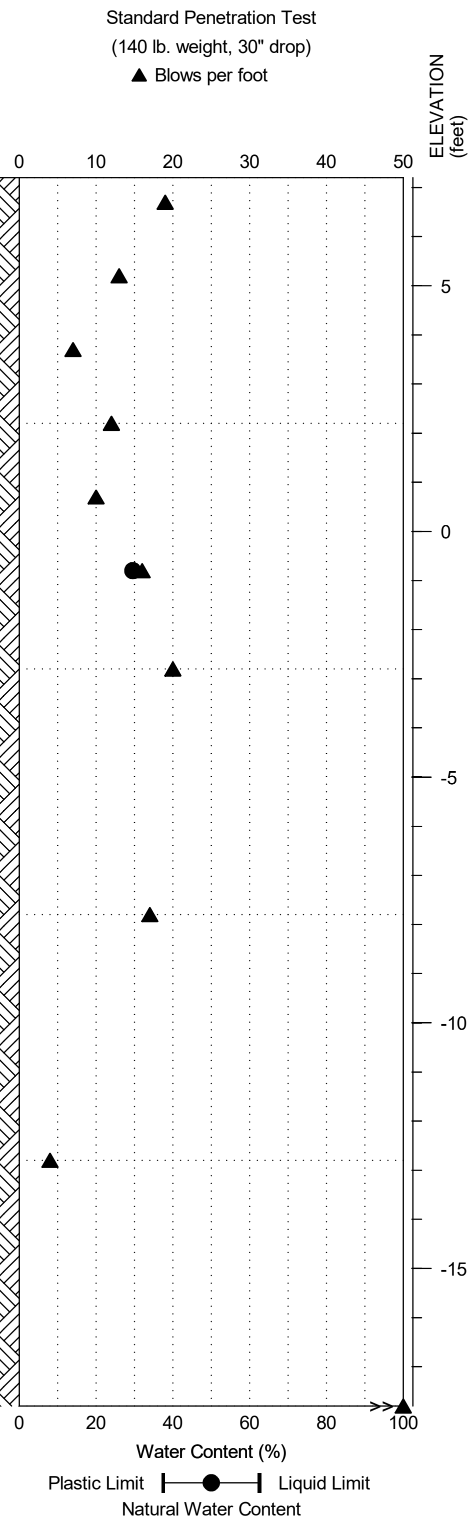


NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36368441, Long: -122.8069585, Datum: WGS84

DATE STARTED: 12/22/2022
DATE COMPLETED: 12/21/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 32.2 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
25	SM	Medium dense, brown, very silty SAND, wet. Fine sand. Recovered: 6 inches.	S-17	3-9-10	
		Recovered: 12 inches.	S-18	5-7-6	
		Becomes loose. Recovered: 16 inches.	S-19	4-3-4	
30		Recovered: 12 inches.	S-20	2-6-6	GS
		Recovered: 12 inches.	S-21	7-5-5	
	ML	Stiff, olive brown, sandy SILT, wet. Fine sand. Recovered: 12 inches. **(PRE-VASHON DEPOSITS)**	S-22	9-11-15	%F AL UCS
35		Becomes gray. Recovered: 16 inches.	S-23	8-8-12	
40	SM	Medium dense, olive brown, silty SAND, wet. Fine to medium sand. Recovered: 12 inches. **(PRE-VASHON LACUSTRINE DEPOSITS)**	S-24	10-8-9	
45		Becomes loose, gray. Recovered: 12 inches.	S-25	3-1-3	
50					

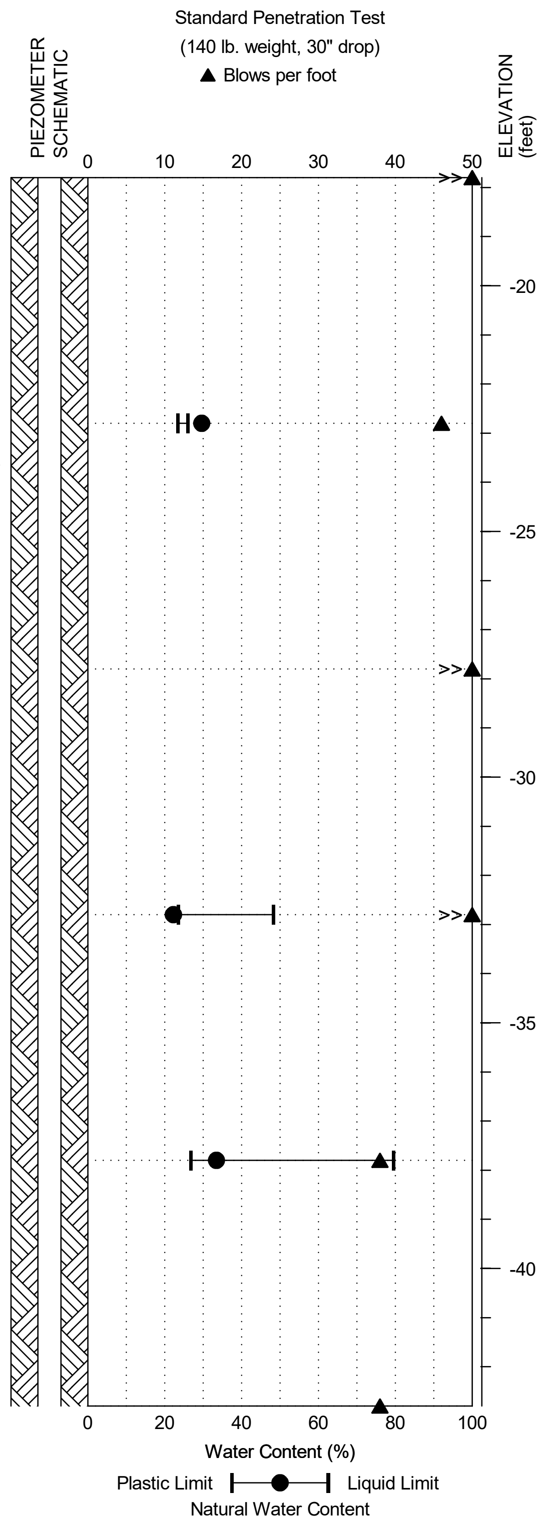


NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36368441, Long: -122.8069585, Datum: WGS84

DATE STARTED: 12/22/2022
DATE COMPLETED: 12/21/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 32.2 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
50	ML	Hard, olive gray, sandy SILT, moist. Fine sand. Recovered: 14 inches. **(PRE-VASHON LACUSTRINE SILTS)**	S-26	19-24-30	
55		Becomes dark gray. Recovered: 18 inches.	S-27	16-18-28	%F AL
60		Recovered: 18 inches.	S-28	18-26-32	
65	CL	Hard, very dark gray, lean CLAY, moist. Recovered: 12 inches.	S-29	28-45-50/4	
70	CH	Hard, gray, fat CLAY, moist. Recovered: 18 inches.	S-30	12-18-20	GS
75					



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-10Si-22

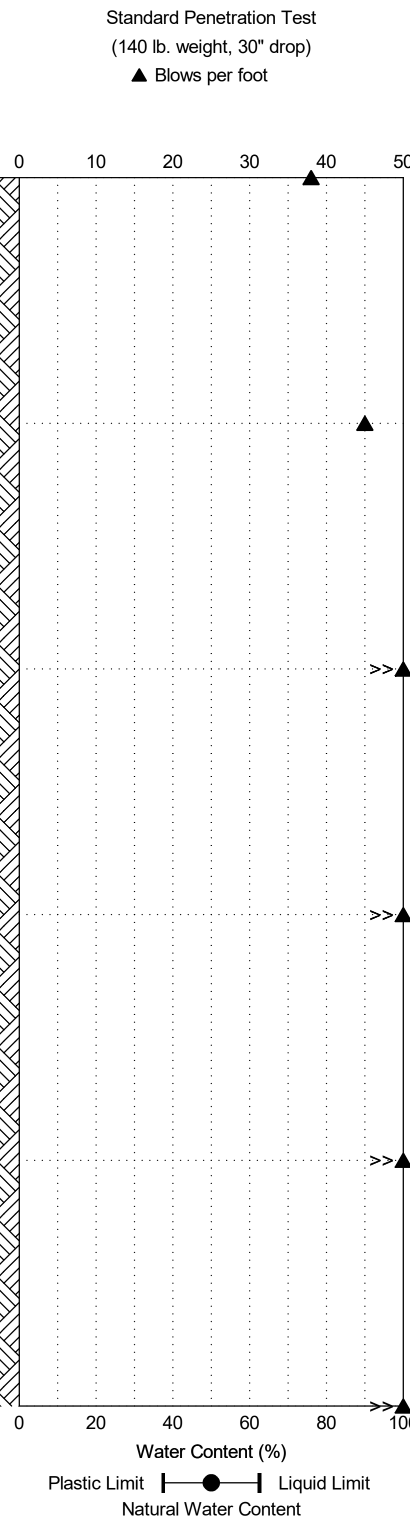
PROJECT NO.: 2022-043-21 FIGURE: A11

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36368441, Long: -122.8069585, Datum: WGS84

DATE STARTED: 12/22/2022
DATE COMPLETED: 12/21/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 32.2 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	ELEVATION (feet)
75		CH	Hard, gray, fat CLAY, moist. Recovered: 18 inches.		S-31	12-17-21	%F AL	
								-45
80			Recovered: 18 inches.		S-32	17-22-23		
								-50
85		SM	Very dense, olive brown silty SAND, moist. Recovered: 1 inch. **(PRE-VASHON GLACIAL TILL DEPOSITS)**		S-33	50/3		
								-55
90			Recovered: 1 inch.		S-34	50/2		
								-60
95			Recovered: 1 inch.		S-35	50/2		
								-65
100								

PIEZOMETER SCHEMATIC



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

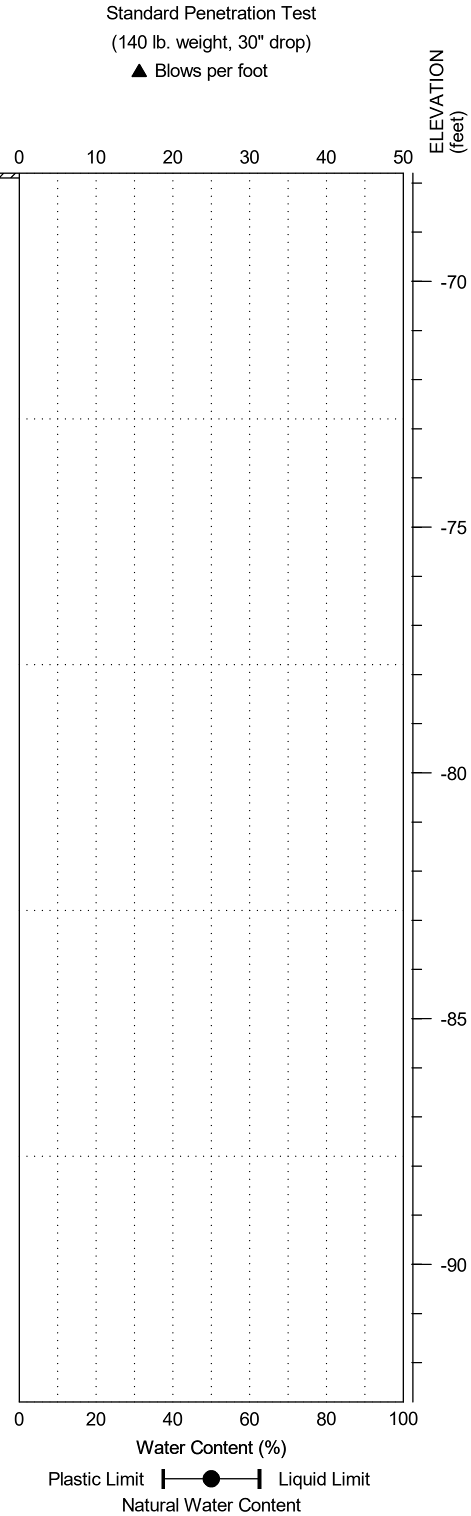
BORING:
HWA-10Si-22

PROJECT NO.: 2022-043-21 FIGURE: A11

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36368441, Long: -122.8069585, Datum: WGS84

DATE STARTED: 12/22/2022
DATE COMPLETED: 12/21/2022
LOGGED BY: R. Mueller
SURFACE ELEVATION: 32.2 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	PIEZOMETER SCHEMATIC	ELEVATION (feet)
100			No recovery.		S-36	50/1			
			Boring was terminated at approximately 100 feet bgs and converted to an inclinometer, DOE Well ID # BPQ 404. Groundwater was observed at approximately 15 feet bgs during drilling.						



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-10Si-22

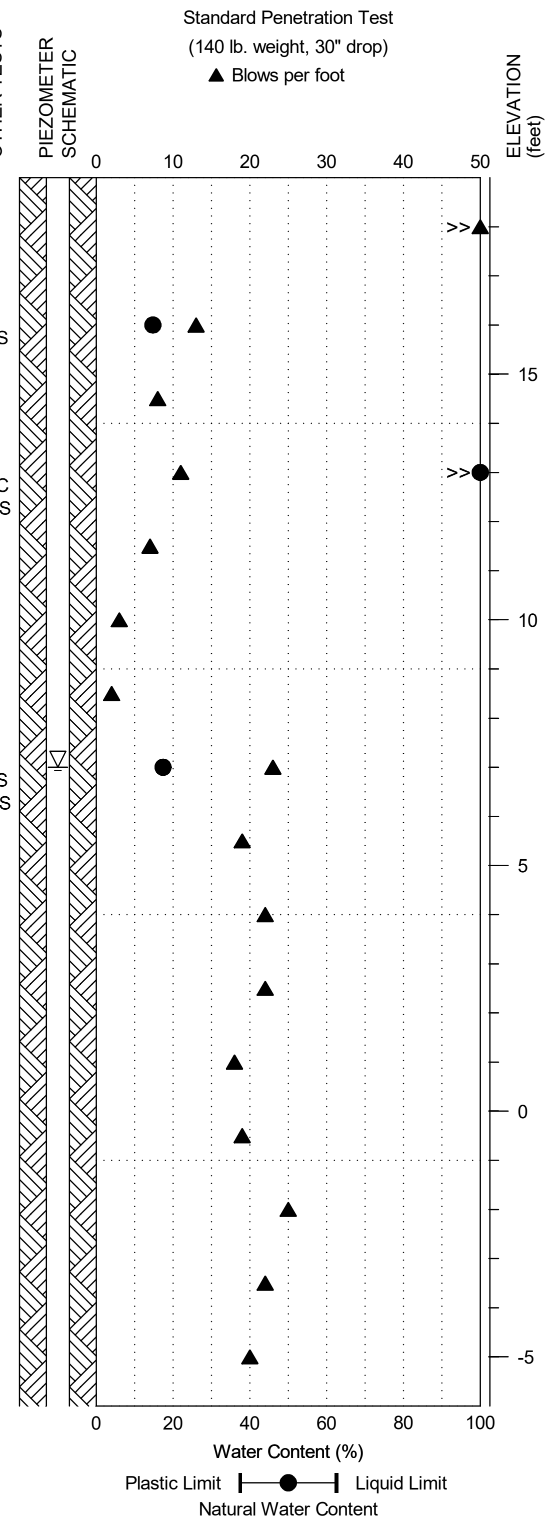
PROJECT NO.: 2022-043-21 FIGURE: A11

PZO-DSM 2022-043.GPJ 6/26/23

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36192993, Long: -122.8063533, Datum: WGS84

DATE STARTED: 1/5/2023
DATE COMPLETED: 1/5/2023
LOGGED BY: R. Mueller
SURFACE ELEVATION: 19.0 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
0		Asphalt (12 inches) **(HMA)**			
	SM	Very dense, dark brown gravelly, silty SAND, dry. Coarse, crushed gravel. Recovered: 8 inches. **(FILL)**	S-1	23-50/5	
	SP SM	Medium dense, dark grayish-brown, slightly silty, gravelly SAND, moist. Wood chips. Recovered: 10 inches.	S-2	23-9-4	GS
5		Loose, dark reddish brown wood chips. Recovered: 6 inches. **(LIGHTWEIGHT WOOD FILL)**	S-3	4-4-4	
		Becomes medium dense. Recovered: 4 inches.	S-4	3-5-6	OC GS
		Becomes loose. Recovered: 1 inch.	S-5	3-3-4	
		Becomes very loose. Recovered: 1 inch.	S-6	3-1-2	
10		No recovery.	S-7	0-1-1	
	SM	Medium dense, olive brown, very silty SAND, wet. Fine sand. Recovered: 12 inches. **(FILL)**	S-8	22-18-18	DS GS
		Becomes dark olive gray. Recovered: 12 inches.	S-9	8-9-10	
15		Becomes brown to dark brown. Recovered: 8 inches.	S-10	7-11-11	
		Recovered: 10 inches.	S-11	7-11-11	
		Rust mottling. Recovered: 14 inches.	S-12	7-9-9	
20		Becomes gray with rust mottling. Recovered: 14 inches.	S-13	9-5-14	
		Becomes olive gray, fines increase with depth. Recovered: 12 inches.	S-14	11-12-13	
		Fines content increases with depth. Recovered: 14 inches.	S-15	9-9-13	
25		Recovered: 10 inches.	S-16	10-9-11	



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-11Si-23

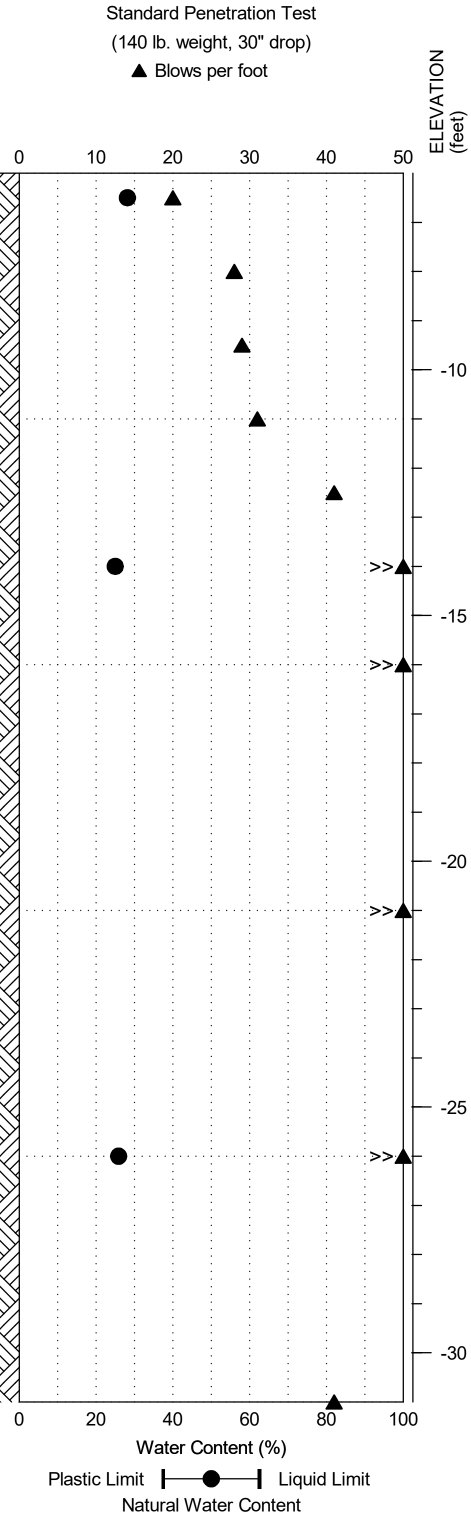
PROJECT NO.: 2022-043-21 FIGURE: A12

PZO-DSM 2022-043.GPJ 6/26/23

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36192993, Long: -122.8063533, Datum: WGS84

DATE STARTED: 1/5/2023
DATE COMPLETED: 1/5/2023
LOGGED BY: R. Mueller
SURFACE ELEVATION: 19.0 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
25	SM	Medium dense, very dark grayish brown, very silty SAND, wet. Fine sand. Recovered: 10 inches. **(PRE-VASHON DEPOSITS)**	S-17	1-8-12	GS
		Recovered: 14 inches.	S-18	12-13-15	
		Recovered: 14 inches.	S-19	11-13-16	
30		Becomes dense, dark gray. Recovered: 12 inches.	S-20	16-22-27	
		Becomes dark olive brown. Recovered: 12 inches.	S-21	13-19-22	
		Becomes very dense, very dark grayish brown. Recovered: 14 inches.	S-22	38-40-24	GS
35	ML	Hard, gray, sandy SILT, wet. Fine sand. Recovered: 14 inches. **(PRE-VASHON LACUSTRINE SILTS)**	S-23	18-23-30	
40		Fine content increases, sand content decreases. Recovered: 14 inches.	S-24	18-23-30	
45		Sand content decreases. Recovered: 16 inches.	S-25	17-26-36	GS
50					



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

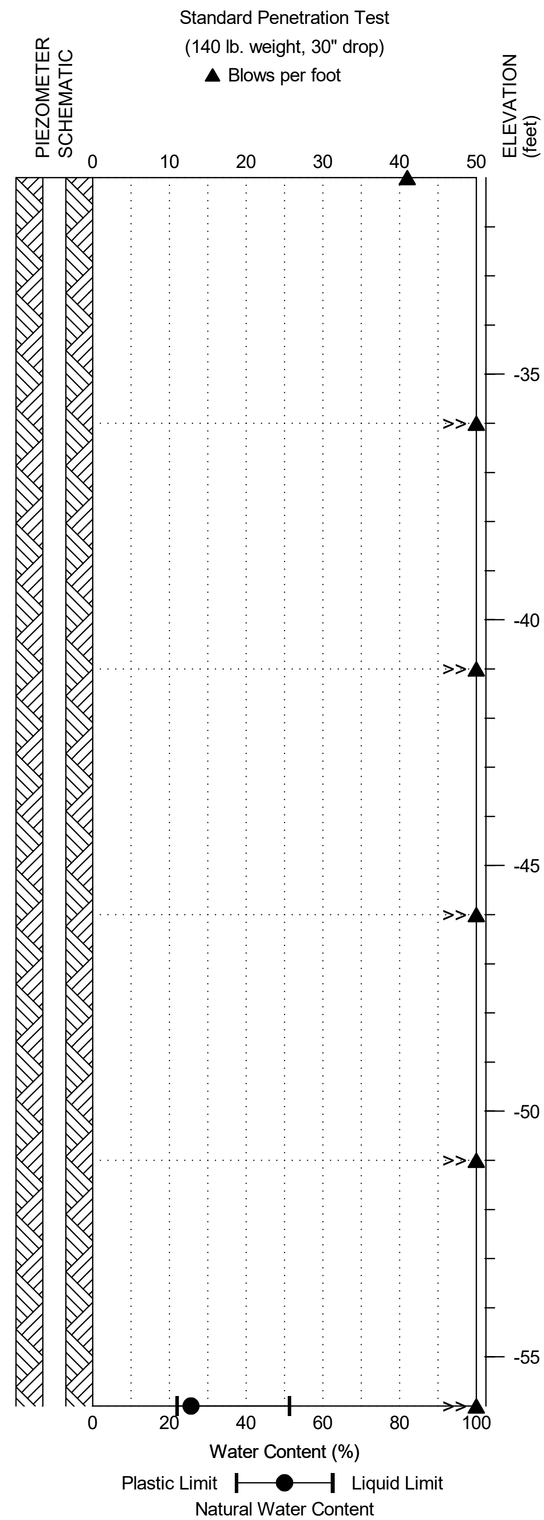
BORING:
HWA-11Si-23

PROJECT NO.: 2022-043-21 FIGURE: A12

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36192993, Long: -122.8063533, Datum: WGS84

DATE STARTED: 1/5/2023
DATE COMPLETED: 1/5/2023
LOGGED BY: R. Mueller
SURFACE ELEVATION: 19.0 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
50		ML	Hard, gray, sandy SILT, wet. Fine sand, fines content increases. Recovered: 15 inches.		S-26	12-15-26	
55			Recovered: 18 inches.		S-27	15-32-34	
60			Recovered: 16 inches.		S-28	26-21-33	
65			Recovered: 14 inches.		S-29	21-30-40	
70			Recovered: 18 inches.		S-30	26-36-40	
75							



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-11Si-23

PROJECT NO.: 2022-043-21 FIGURE: A12

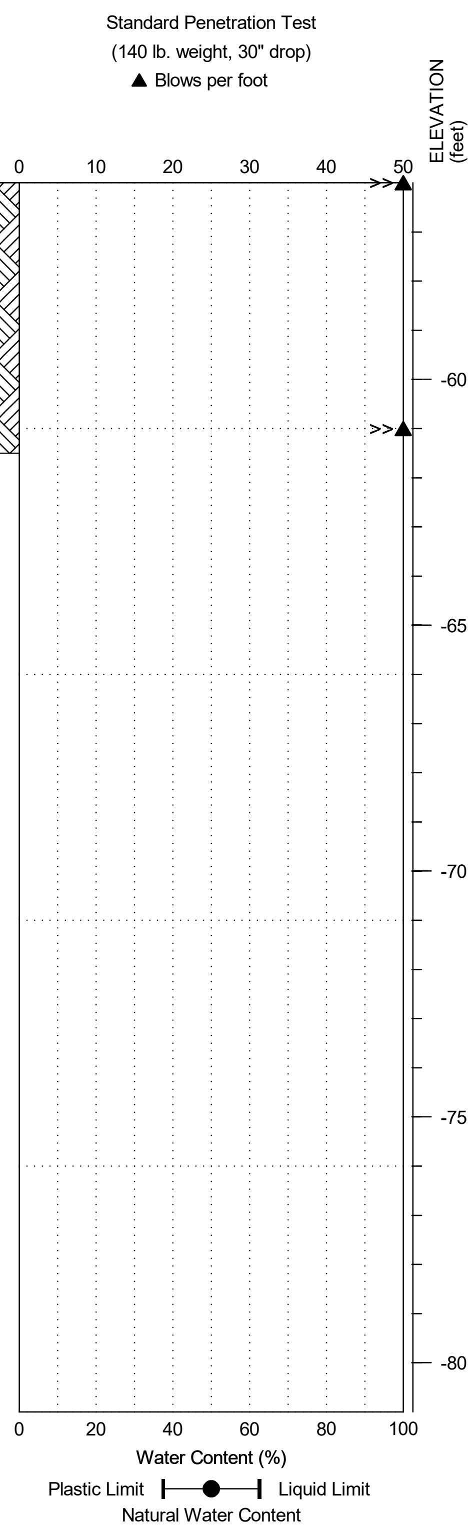
DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Mud Rotary, D70 Track Rig, 76% Hammer Efficiency
SAMPLING METHOD: SPT w/ Autohammer
LOCATION: See Figure 2, Lat: 47.36192993, Long: -122.8063533, Datum: WGS84

DATE STARTED: 1/5/2023
DATE COMPLETED: 1/5/2023
LOGGED BY: R. Mueller
SURFACE ELEVATION: 19.0 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	PIEZOMETER SCHEMATIC	ELEVATION (feet)
75		CH	Hard, dark gray, fat CLAY, moist. Recovered: 16 inches.		S-31	22-24-33	%F AL		
80		ML	Hard, dark gray SILT, moist. Clay lenses. Recovered: 16 inches.		S-32	25-27-32			

Boring was terminated at approximately 81½ feet bgs and converted to an inclinometer, DOE Well ID #BPQ 408. Groundwater was observed at approximately 12 feet bgs during drilling.

Depth scale: 75, 80, 85, 90, 95, 100
Elevation scale: -60, -65, -70, -75, -80



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

BORING:
HWA-11Si-23

PROJECT NO.: 2022-043-21 FIGURE: A12

APPENDIX B

LABORATORY PROGRAM

APPENDIX B

LABORATORY PROGRAM

Representative soil samples obtained from our explorations were placed in plastic bags to prevent loss of moisture and transported to our Bothell, Washington, laboratory for further examination and testing. Laboratory tests were conducted on selected soil samples to characterize relevant engineering and index properties of the site soils. Laboratory testing was conducted in general accordance with appropriate ASTM Standards as outlined below.

MOISTURE CONTENT OF SOIL: The moisture content of selected soil samples (percent by dry mass) was determined in general accordance with ASTM D 2216. The results are shown at the sampled intervals on the appropriate summary logs in Appendix A and on the Summary of Material Properties provided on Figures B-1 through Figure B-4 in Appendix B.

MOISTURE CONTENT, ASH, AND ORGANIC MATTER: Selected samples were evaluated in general accordance with method ASTM D 2974, using moisture content method 'A' (oven dried at 105^0 C) and ash content method 'C' (burned at 440^0 C). The test results are presented in the attached Summary of Material Properties, Figures B-1 through Figure B-4. The results are percentage by weight of dry soil.

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ATTERBERG LIMITS): Selected samples were evaluated using method ASTM D 4318, multi-point method. The results are reported on the attached Liquid Limit, Plastic Limit, and Plasticity Index report, Figure B-5 through B-7.

PARTICLE SIZE ANALYSIS OF SOILS: Selected samples were evaluated to determine the particle (grain) size distribution of material in general accordance with ASTM D 422. The results are summarized in the attached Particle Size Analysis of Soils report, Figure B-8 through Figure B-32, which also provide information regarding the classification of the sample, and the moisture content at the time of testing.

DIRECT SHEAR: Direct shear testing was conducted on selected samples, in general accordance with ASTM D 3080. The results of these tests are presented in the attached Direct Shear Strength of Soils reports, Figure B-33 through Figure B-40. The apparent cohesion and friction angle of the soils are inferred from a least-squares linear regression of the test points.

EXPLORATION DESIGNATION	TOP DEPTH (feet)	BOTTOM DEPTH (feet)	MOISTURE CONTENT (%)	ORGANIC CONTENT (%)	SPECIFIC GRAVITY	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% FINES	ASTM SOIL CLASSIFICATION	SAMPLE DESCRIPTION
						LL	PL	PI					
HWA-01P-22,S-1	1.0	2.5	5.1						30.5	57.2	12.3	SM	Brown, silty SAND with gravel
HWA-01P-22,S-6	9.0	10.5	30.8						4.3	40.3	55.4	ML	Olive-gray, sandy SILT
HWA-01P-22,S-12	18.0	19.5	32.4						0.1	20.3	79.6	ML	Dark gray, SILT with sand
HWA-01P-22,S-21	31.5	33.0	30.0						0.4	19.9	79.7	ML	Dark gray, SILT with sand
HWA-01P-22,S-26	50.0	51.5	35.6			70	27	43			99.5	CH	Gray, fat CLAY
HWA-02Si-23,S-1	1.0	2.5	5.8						55.8	38.2	6.1	GW-GM	Very dark gray, well-graded GRAVEL with silt and sand
HWA-02Si-23,S-8	12.0	13.5	33.5	1.1					1.6	65.8	32.7	SM	Olive-gray, silty SAND
HWA-02Si-23,S-16	24.0	25.5	28.4							9.9	90.1	ML	Very dark gray, SILT
HWA-02Si-23,S-27	55.0	56.5	37.0			84	29	55			99.4	CH	Gray, fat CLAY
HWA-02Si-23,S-28	60.0	61.5	38.5			83	29	54			99.0	CH	Dark gray, fat CLAY
HWA-03P-22,S-1	1.0	2.5	4.3						49.1	42.8	8.1	GW-GM	Dark grayish-brown, well-graded GRAVEL with silt and sand
HWA-03P-22,S-7	10.5	12.0	14.1							73.2	26.8	SM	Light olive-brown, silty SAND
HWA-03P-22,S-16	24.0	25.5	27.1							86.9	13.1	SM	Olive-gray, silty SAND
HWA-03P-22,S-23	35.0	36.5	27.9							9.6	90.4	ML	Dark gray, SILT
HWA-04-22,S-4	6.0	7.5	29.8						9.6	75.0	15.4	SM	Olive-brown, silty SAND
HWA-04-22,S-12	18.0	19.5	31.8							69.8	30.2	SM	Olive-gray, silty SAND
HWA-04-22,S-22	33.0	34.5	26.6							36.0	64.0	ML	Dark gray, sandy SILT
HWA-05-22,S-1	1.0	2.5	6.2						41.7	53.8	4.5	SP	Very dark brown, poorly graded SAND with gravel
HWA-05-22,S-5	7.5	9.0	19.6						8.3	81.4	10.3	SP-SM	Light olive-brown, poorly graded SAND with silt
HWA-05-22,S-12	18.0	19.5	12.4						14.7	62.7	22.6	SM	Olive-brown, silty SAND

Notes:
1. This table summarizes information presented elsewhere in the report and should be used in conjunction with the report test, other graphs and tables, and the exploration logs.
2. The soil classifications in this table are based on ASTM D2487 and D2488 as applicable.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

SUMMARY OF
MATERIAL PROPERTIES

PAGE: 1 of 4

PROJECT NO.: 2022-043-21 FIGURE: B1

EXPLORATION DESIGNATION	TOP DEPTH (feet)	BOTTOM DEPTH (feet)	MOISTURE CONTENT (%)	ORGANIC CONTENT (%)	SPECIFIC GRAVITY	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% FINES	ASTM SOIL CLASSIFICATION	SAMPLE DESCRIPTION
						LL	PL	PI					
HWA-05-22,S-15	22.5	24.0	23.5							94.9	5.1	SP-SM	Olive-gray, poorly graded SAND with silt
HWA-06Si-22,S-3	4.5	6.0	16.5						0.4	31.2	68.4	ML	Light olive-brown, sandy SILT
HWA-06Si-22,S-4	6.0	7.5	21.6						23.2	36.4	40.4	SM	Olive-brown, silty SAND with gravel
HWA-06Si-22,S-6	9.0	10.5	21.5						2.1	74.0	23.9	SM	Olive-brown, silty SAND
HWA-06Si-22,S-8	12.0	13.5	29.8						1.2	40.9	58.0	ML	Olive-brown, sandy SILT
HWA-06Si-22,S-11	16.5	18.0	24.8			NP	NP	NP	0.8	92.3	6.9	SP-SM	Dark grayish-brown, poorly graded SAND with silt
HWA-06Si-22,S-14	21.0	22.5	24.8						11.3	33.7	55.0	ML	Dark grayish-brown, sandy SILT
HWA-06Si-22,S-18	27.0	28.5	24.9						6.4	34.6	59.0	ML	Dark gray, sandy SILT
HWA-06Si-22,S-21	31.5	33.0	27.2							24.7	75.3	ML	Very dark gray, SILT with sand
HWA-06Si-22,S-23	35.0	36.5	25.5						0.6	12.2	87.2	ML	Dark gray, SILT
HWA-06Si-22,S-25	45.0	46.5	26.9			54	22	32		15.2	84.8	CH	Dark gray, fat CLAY with sand
HWA-06Si-22,S-28	60.0	61.5	37.9			87	30	57		1.1	98.9	CH	Very dark gray, fat CLAY
HWA-06Si-22,S-29	65.0	66.5	37.3			92	31	61		1.8	98.2	CH	Dark gray, fat CLAY
HWA-07Si-22,S-1	1.5	2.4	6.9						30.4	57.9	11.7	SW-SM	Very dark grayish-brown, well-graded SAND with silt and gravel
HWA-07Si-22,S-6	9.0	10.5	23.0						0.9	64.2	34.8	SM	Olive-brown, silty SAND
HWA-07Si-22,S-7	10.5	12.0	27.9						0.3	55.1	44.6	SM	Brown, silty SAND
HWA-07Si-22,S-10	15.0	16.5	21.2						12.8	68.0	19.1	SM	Dark olive-brown, silty SAND
HWA-07Si-22,S-13	19.5	21.0	27.0							88.9	11.1	SP-SM	Dark gray, poorly graded SAND with silt
HWA-07Si-22,S-15	22.5	24.0	30.0						1.2	33.1	65.6	ML	Dark grayish-brown, sandy SILT
HWA-07Si-22,S-17	25.5	27.0	26.4							41.2	58.8	ML	Dark grayish-brown, sandy SILT

Notes:
1. This table summarizes information presented elsewhere in the report and should be used in conjunction with the report test, other graphs and tables, and the exploration logs.
2. The soil classifications in this table are based on ASTM D2487 and D2488 as applicable.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

SUMMARY OF
MATERIAL PROPERTIES

PROJECT NO.: 2022-043-21 FIGURE: B2

INDEX MATSUM 3 (LONG DESCRIPTIONS) 2022-043.GPJ 6/29/23

EXPLORATION DESIGNATION	TOP DEPTH (feet)	BOTTOM DEPTH (feet)	MOISTURE CONTENT (%)	ORGANIC CONTENT (%)	SPECIFIC GRAVITY	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% FINES	ASTM SOIL CLASSIFICATION	SAMPLE DESCRIPTION
						LL	PL	PI					
HWA-07Si-22,S-19	28.5	30.0	28.2							12.7	87.3	ML	Dark gray, SILT
HWA-07Si-22,S-23b	40.5	41.4	26.0							22.5	77.5	ML	Very dark gray, SILT with sand
HWA-07Si-22,S-27	60.0	61.5	33.6			58	26	32		1.3	98.7	CH	Very dark gray, fat CLAY
HWA-07Si-22,S-29	70.0	71.5	35.4							0.7	99.3	CH	Very dark gray, fat CLAY
HWA-08P-22,S-8	12.0	13.5	11.0						51.6	39.1	9.3	GW-GM	Olive, well-graded GRAVEL with silt and sand
HWA-08P-22,S-12	18.0	19.5	11.1						75.3	20.7	4.0	GP	Olive, poorly graded GRAVEL with sand
HWA-08P-22,S-19	28.5	30.0	25.1						18.4	59.6	22.1	SM	Olive-brown, silty SAND with gravel
HWA-08P-22,S-25	45.0	46.5	28.8			57	22	35			92.4	CH	Dark gray, fat CLAY
HWA-08P-22,S-27	55.0	56.5	33.5			47	21	26			93.5	CL	Dark gray, lean CLAY
HWA-09-22,S-2	1.5	3.0	7.2						59.8	32.4	7.9	GW-GM	Dark brown, well-graded GRAVEL with silt and sand
HWA-09-22,S-3	3.0	4.5	16.3						0.8	72.7	26.5	SM	Olive-brown, silty SAND
HWA-09-22,S-6	7.5	9.0	12.5							90.2	9.8	SP-SM	Dark olive-brown, poorly graded SAND with silt
HWA-09-22,S-8	10.5	12.0	29.4							86.6	13.4	SM	Dark grayish-brown, silty SAND
HWA-09-22,S-11	15.0	16.5	28.4							49.0	51.0	ML	Dark grayish-brown, sandy SILT
HWA-09-22,S-12	16.5	18.0	27.5							59.7	40.3	SM	Very dark grayish-brown, silty SAND
HWA-09-22,S-13	18.0	19.5	26.9							77.8	22.2	SM	Dark gray, silty SAND
HWA-09-22,S-17	25.0	26.5	28.0			NP	NP	NP			69.5	ML	Very dark gray, sandy SILT
HWA-09-22,S-18	30.0	31.5	30.0			34	22	12			93.3	CL	Very dark gray, lean CLAY
HWA-09-22,S-20	36.0	36.0	23.4			58	23	35		26.7	73.3	CH	Gray, fat CLAY with sand
HWA-10Si-22,S-2	3.0	4.5	9.8						45.4	48.6	6.0	SP-SM	Olive, poorly graded SAND with silt and gravel

Notes: 1. This table summarizes information presented elsewhere in the report and should be used in conjunction with the report test, other graphs and tables, and the exploration logs.
2. The soil classifications in this table are based on ASTM D2487 and D2488 as applicable.

EXPLORATION DESIGNATION	TOP DEPTH (feet)	BOTTOM DEPTH (feet)	MOISTURE CONTENT (%)	ORGANIC CONTENT (%)	SPECIFIC GRAVITY	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% FINES	ASTM SOIL CLASSIFICATION	SAMPLE DESCRIPTION
						LL	PL	PI					
HWA-10Si-22,S-7	10.5	12.0	34.2	2.7					14.7	67.3	18.0	SM	Olive-gray, silty SAND
HWA-10Si-22,S-9	13.5	15.0	19.6						0.9	90.7	8.4	SP-SM	Dark gray, poorly graded SAND with silt
HWA-10Si-22,S-12	18.0	19.5	26.8							68.3	31.7	SM	Olive-gray, silty SAND
HWA-10Si-22,S-22	33.0	34.5	29.6			NP	NP	NP			67.8	ML	Olive-brown, sandy SILT
HWA-10Si-22,S-27	55.0	56.5	29.6			26	23	3			89.3	ML	Dark gray, SILT
HWA-10Si-22,S-29	65.0	66.3	22.2			48	23	25			97.5	CL	Very dark gray, lean CLAY
HWA-10Si-22,S-30	70.0	71.5	33.5			79	26	53			99.4	CH	Dark gray, fat CLAY
HWA-11Si-23,S-2	3.0	4.5	14.7						25.6	67.6	6.8	SP-SM	Very dark grayish-brown, poorly graded SAND with silt and gravel
HWA-11Si-23,S-4	6.0	7.5	228.2	80.9									Dark reddish-brown, Wood Chips
HWA-11Si-23,S-8	12.0	13.5	17.4						5.6	82.2	12.1	SM	Olive-brown, silty SAND
HWA-11Si-23,S-17	25.5	27.0	28.2						0.1	62.5	37.3	SM	Very dark grayish-brown, silty SAND
HWA-11Si-23,S-22	33.0	34.5	25.0							55.2	44.8	SM	Very dark grayish-brown, silty SAND
HWA-11Si-23,S-25	45.0	46.5	25.9							19.5	80.5	ML	Dark gray, SILT with sand
HWA-11Si-23,S-31	75.0	76.5	25.6			51	22	29			93.8	CH	Dark gray, fat CLAY

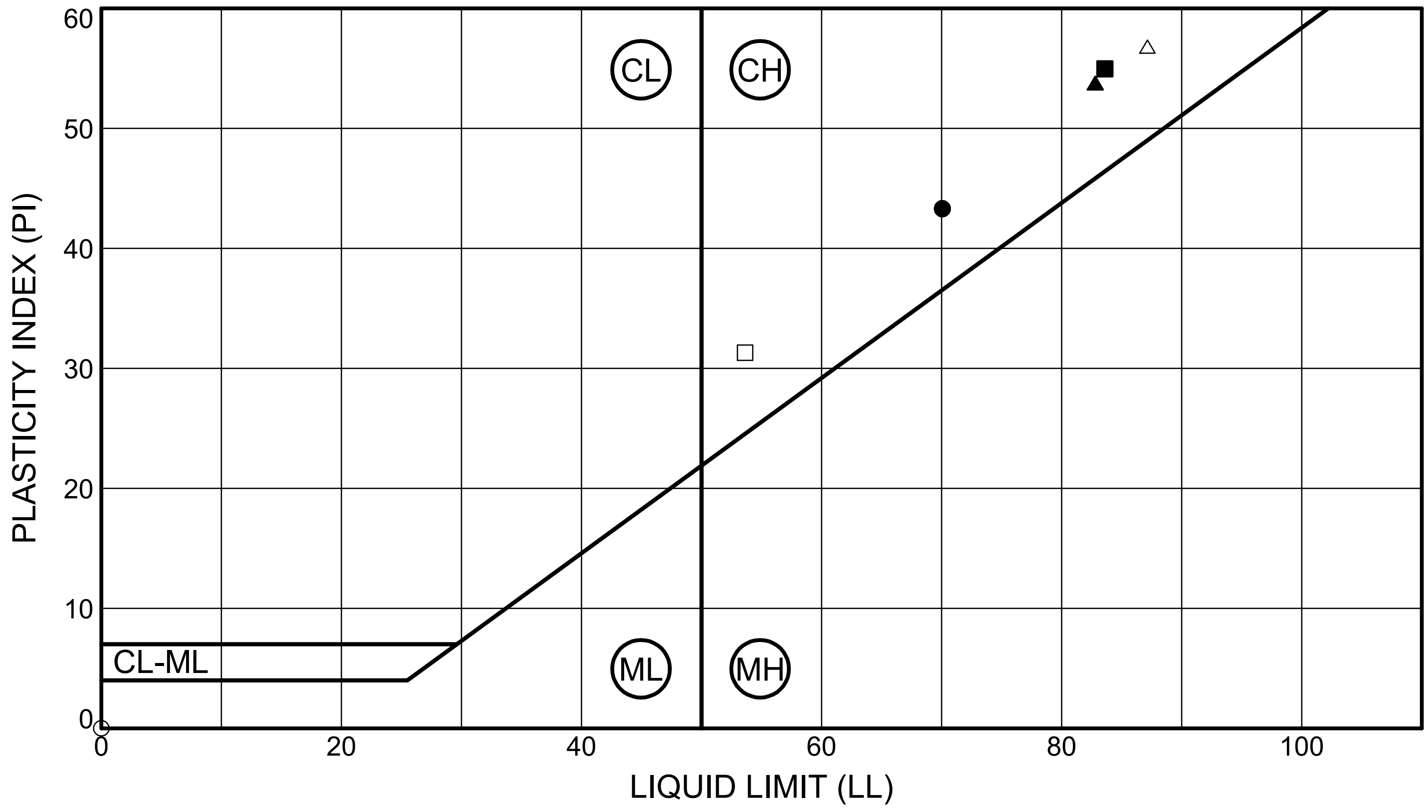
Notes:
1. This table summarizes information presented elsewhere in the report and should be used in conjunction with the report test, other graphs and tables, and the exploration logs.
2. The soil classifications in this table are based on ASTM D2487 and D2488 as applicable.

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

SUMMARY OF
MATERIAL PROPERTIES

PROJECT NO.: 2022-043-21 FIGURE: B4



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Fines
●	HWA-01P-22	S-26	50.0 - 51.5	(CH) Gray, fat CLAY	36	70	27	43	99.5
■	HWA-02Si-23	S-27	55.0 - 56.5	(CH) Gray, fat CLAY	37	84	29	55	99.4
▲	HWA-02Si-23	S-28	60.0 - 61.5	(CH) Dark gray, fat CLAY	39	83	29	54	99.0
○	HWA-06Si-22	S-11	16.5 - 18.0	(SP-SM) Dark grayish-brown, poorly graded SAND with silt	25	NP	NP	NP	6.9
□	HWA-06Si-22	S-25	45.0 - 46.5	(CH) Dark gray, fat CLAY with sand	27	54	22	32	84.8
△	HWA-06Si-22	S-28	60.0 - 61.5	(CH) Very dark gray, fat CLAY	38	87	30	57	98.9

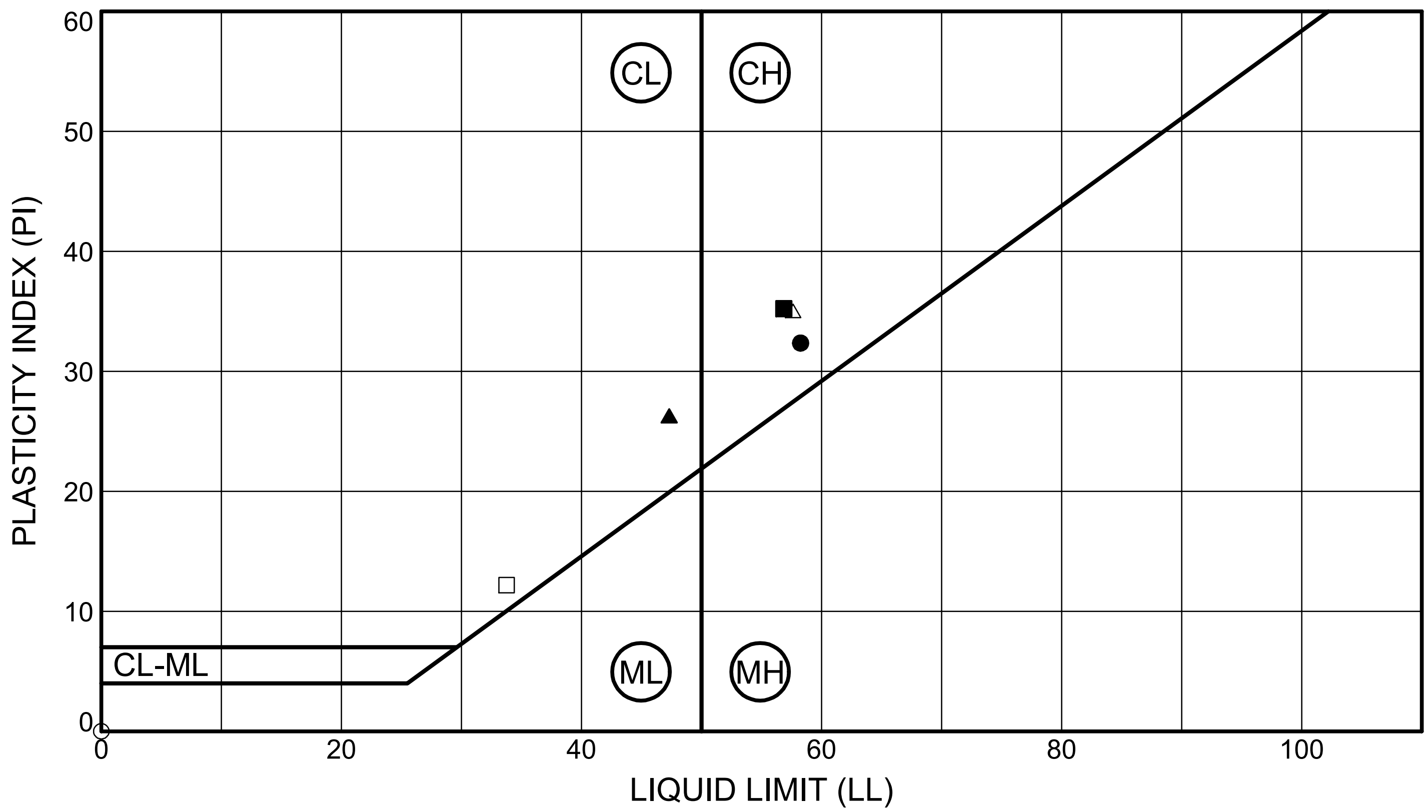
HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
METHOD ASTM D4318

PROJECT NO.: 2022-043-21 FIGURE: B5

HWAATTB EXPANDED SAMPLE COLUMN 2022-043.GPJ 6/29/23



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Fines
●	HWA-07Si-22	S-27	60.0 - 61.5	(CH) Very dark gray, fat CLAY	34	58	26	32	98.7
■	HWA-08P-22	S-25	45.0 - 46.5	(CH) Dark gray, fat CLAY	29	57	22	35	92.4
▲	HWA-08P-22	S-27	55.0 - 56.5	(CL) Dark gray, lean CLAY	33	47	21	26	93.5
○	HWA-09-22	S-17	25.0 - 26.5	(ML) Very dark gray, sandy SILT	28	NP	NP	NP	69.5
□	HWA-09-22	S-18	30.0 - 31.5	(CL) Very dark gray, lean CLAY	30	34	22	12	93.3
△	HWA-09-22	S-20	36.0 - 36.0	(CH) Gray, fat CLAY with sand	23	58	23	35	73.3

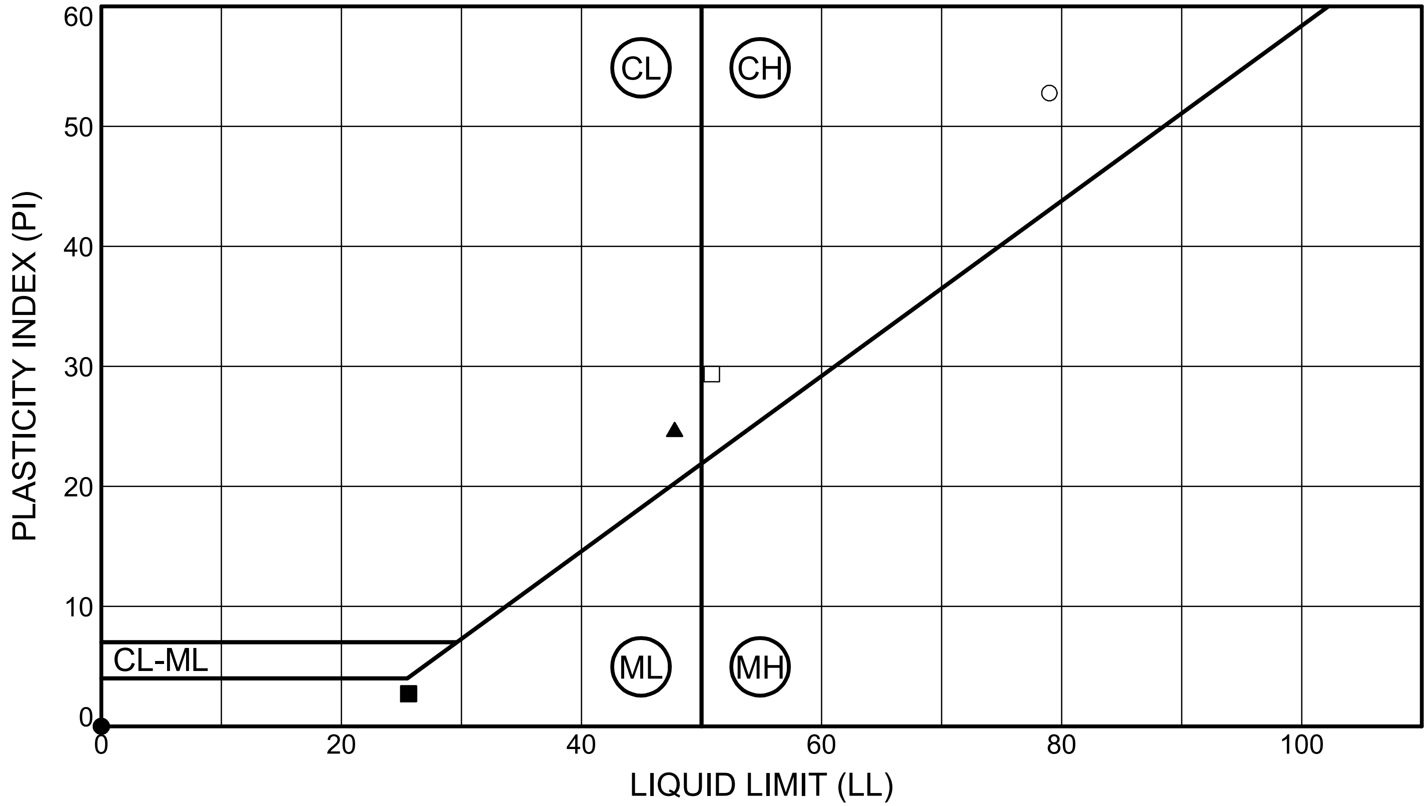
HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS METHOD ASTM D4318

PROJECT NO.: 2022-043-21 FIGURE: B6

HWAATTB EXPANDED SAMPLE COLUMN 2022-043.GPJ 6/29/23



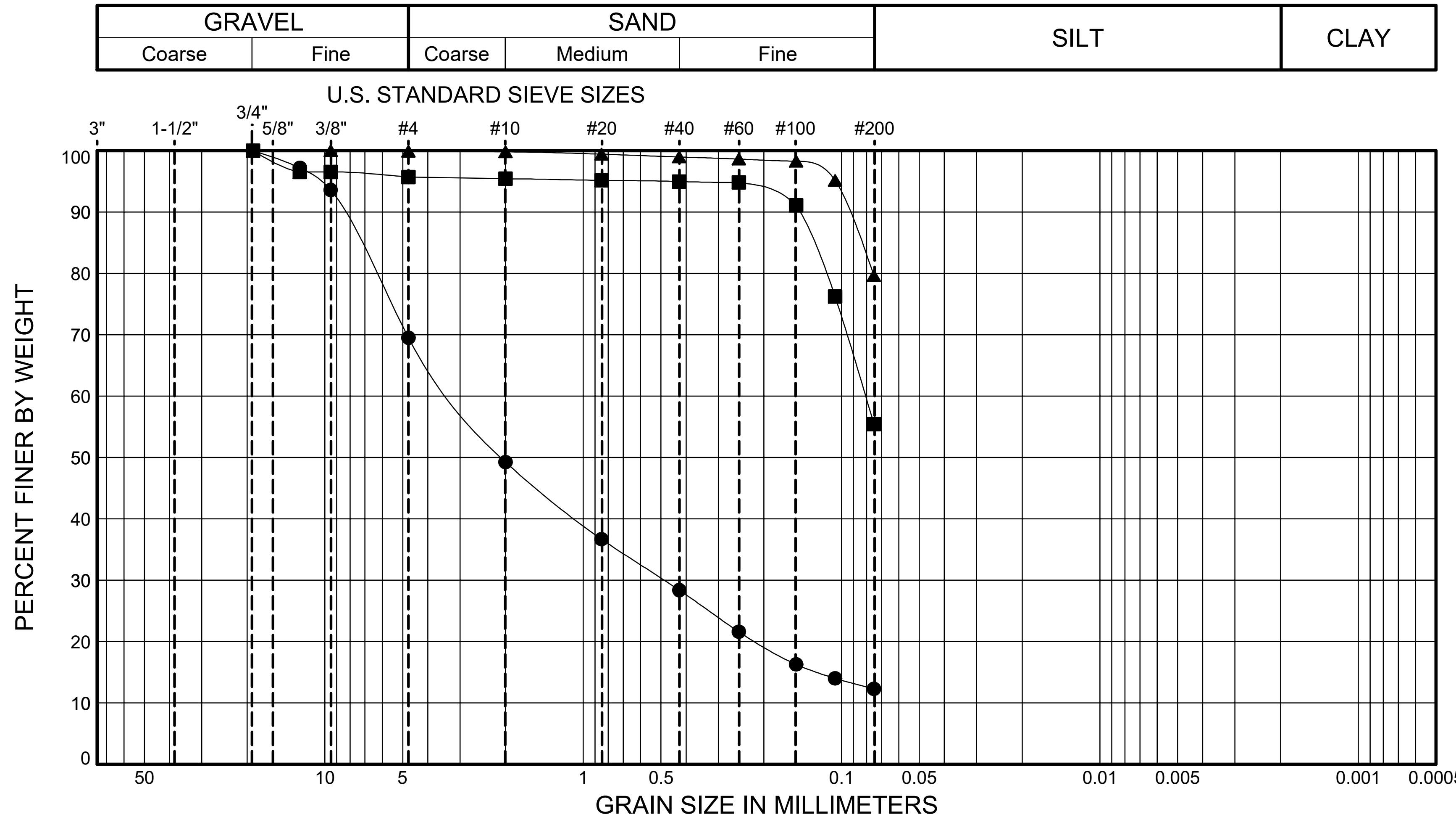
SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Fines
●	HWA-10Si-22	S-22	33.0 - 34.5	(ML) Olive-brown, sandy SILT	30	NP	NP	NP	67.8
■	HWA-10Si-22	S-27	55.0 - 56.5	(ML) Dark gray, SILT	30	26	23	3	89.3
▲	HWA-10Si-22	S-29	65.0 - 66.3	(CL) Very dark gray, lean CLAY	22	48	23	25	97.5
○	HWA-10Si-22	S-30	70.0 - 71.5	(CH) Dark gray, fat CLAY	33	79	26	53	99.4
□	HWA-11Si-23	S-31	75.0 - 76.5	(CH) Dark gray, fat CLAY	26	51	22	29	93.8

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS METHOD ASTM D4318

PROJECT NO.: 2022-043-21 FIGURE: B7



SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-01P-22	S-1	1.0 - 2.5	(SM) Brown, silty SAND with gravel	5				30.5	57.2			12.3
■	HWA-01P-22	S-6	9.0 - 10.5	(ML) Olive-gray, sandy SILT	31				4.3	40.3			55.4
▲	HWA-01P-22	S-12	18.0 - 19.5	(ML) Dark gray, SILT with sand	32				0.1	20.3			79.6

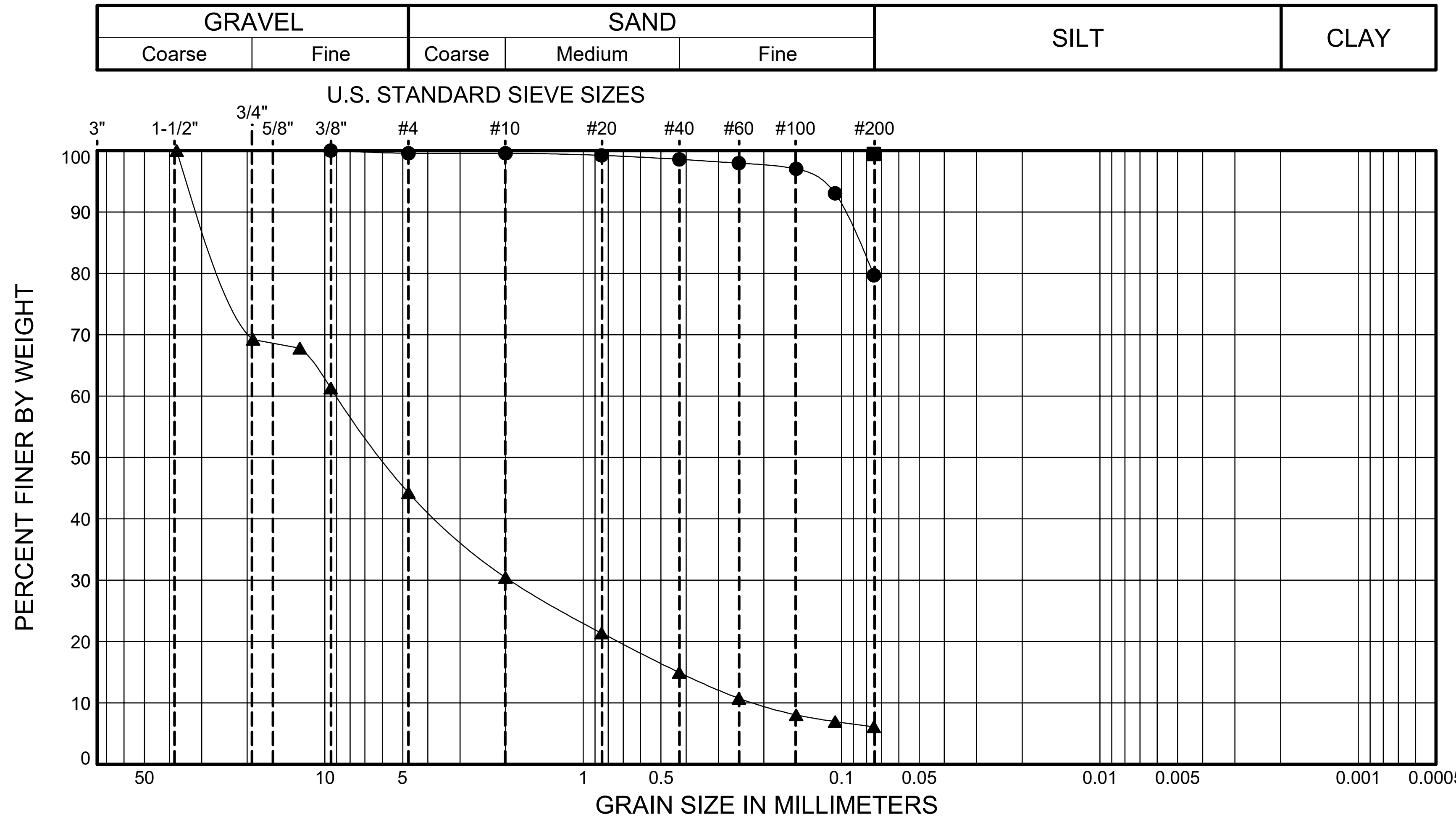
HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B8

HWAGRSZ SILT-CLAY PERCENTAGE WITH 7928 2022-043.GPJ 6/29/23



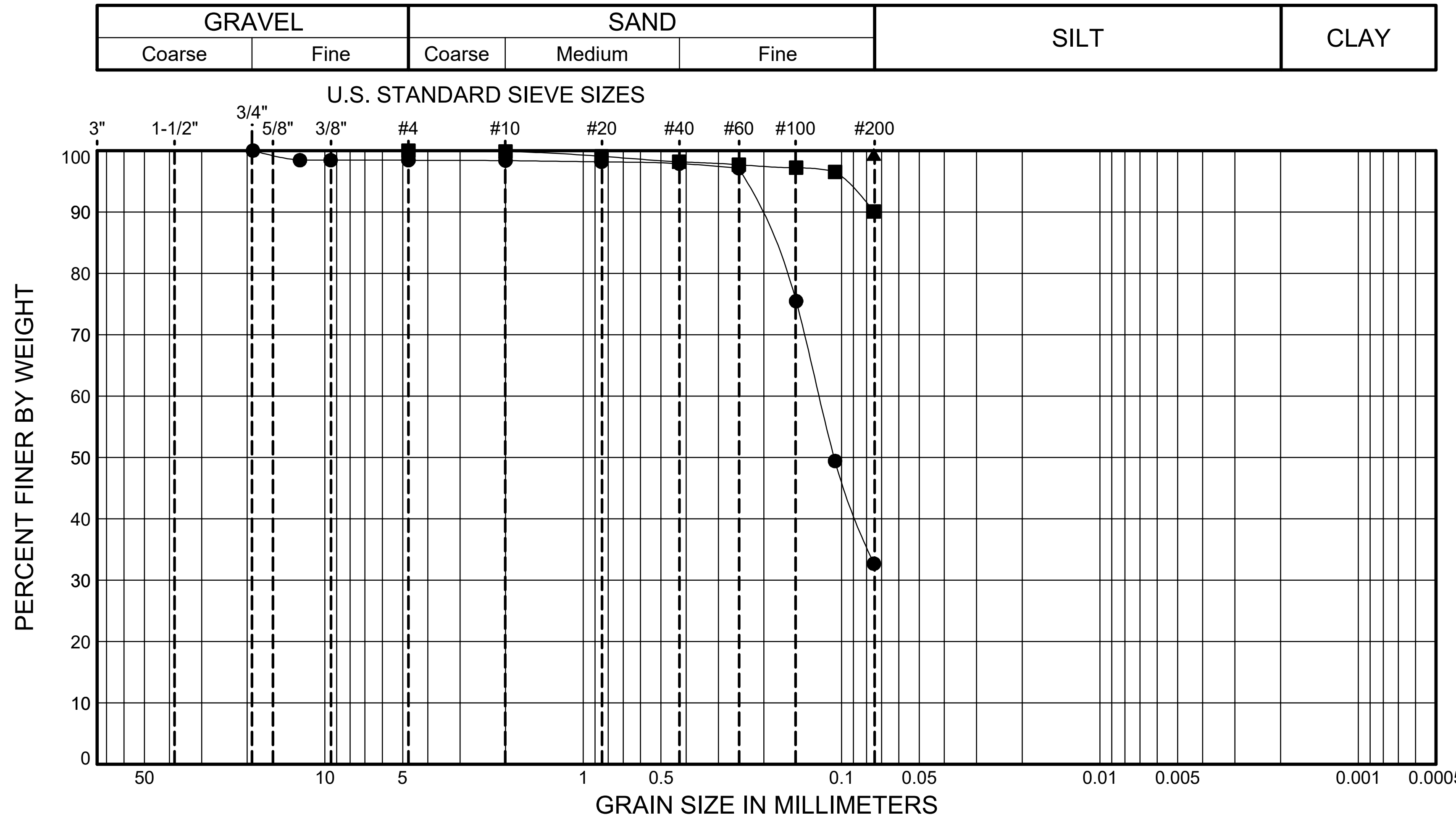
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-01P-22	S-21	31.5 - 33.0	(ML) Dark gray, SILT with sand	30				0.4	19.9			79.7
■	HWA-01P-22	S-26	50.0 - 51.5	(CH) Gray, fat CLAY	36	70	27	43					99.5
▲	HWA-02Si-23	S-1	1.0 - 2.5	(GW-GM) Very dark gray, well-graded GRAVEL with silt and sand	6				55.8	38.2			6.1

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B9



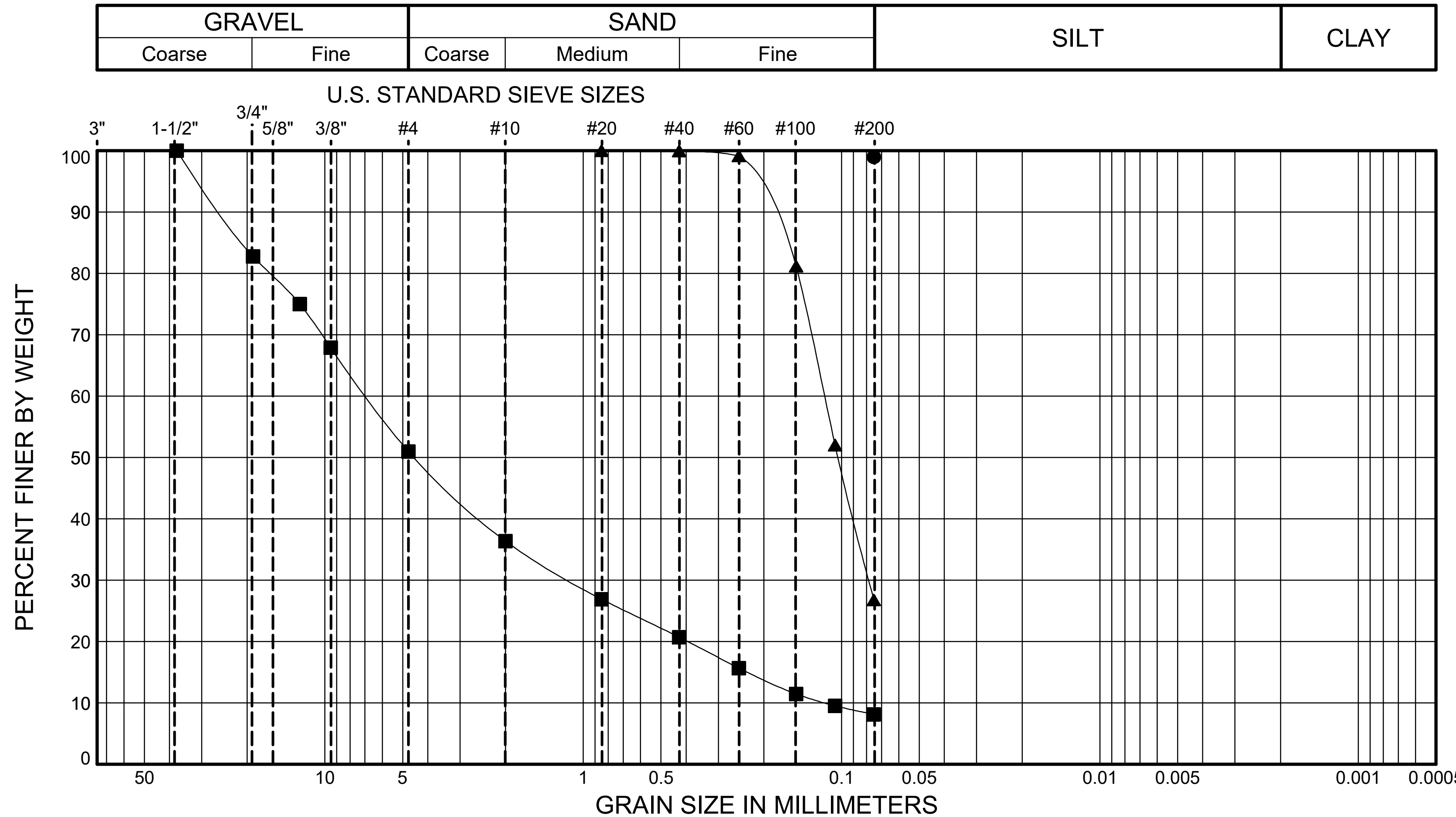
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-02Si-23	S-8	12.0 - 13.5	(SM) Olive-gray, silty SAND	34				1.6	65.8			32.7
■	HWA-02Si-23	S-16	24.0 - 25.5	(ML) Very dark gray, SILT	28					9.9			90.1
▲	HWA-02Si-23	S-27	55.0 - 56.5	(CH) Gray, fat CLAY	37	84	29	55					99.4

HWA GeoSciences Inc.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS OF SOILS METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B10



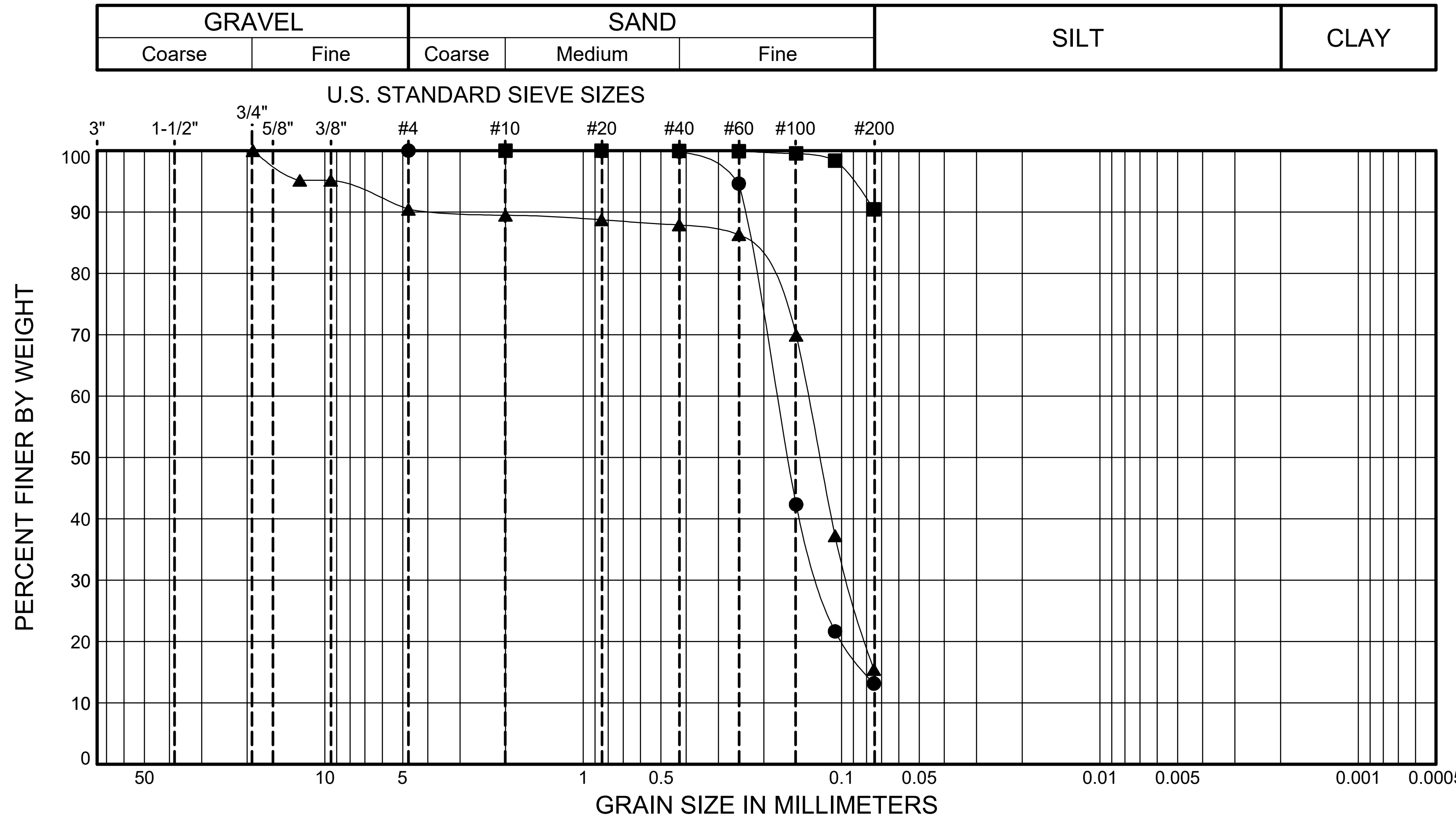
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-02Si-23	S-28	60.0 - 61.5	(CH) Dark gray, fat CLAY	39	83	29	54					99.0
■	HWA-03P-22	S-1	1.0 - 2.5	(GW-GM) Dark grayish-brown, well-graded GRAVEL with silt and sand	4				49.1	42.8			8.1
▲	HWA-03P-22	S-7	10.5 - 12.0	(SM) Light olive-brown, silty SAND	14					73.2			26.8

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS OF SOILS METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B11



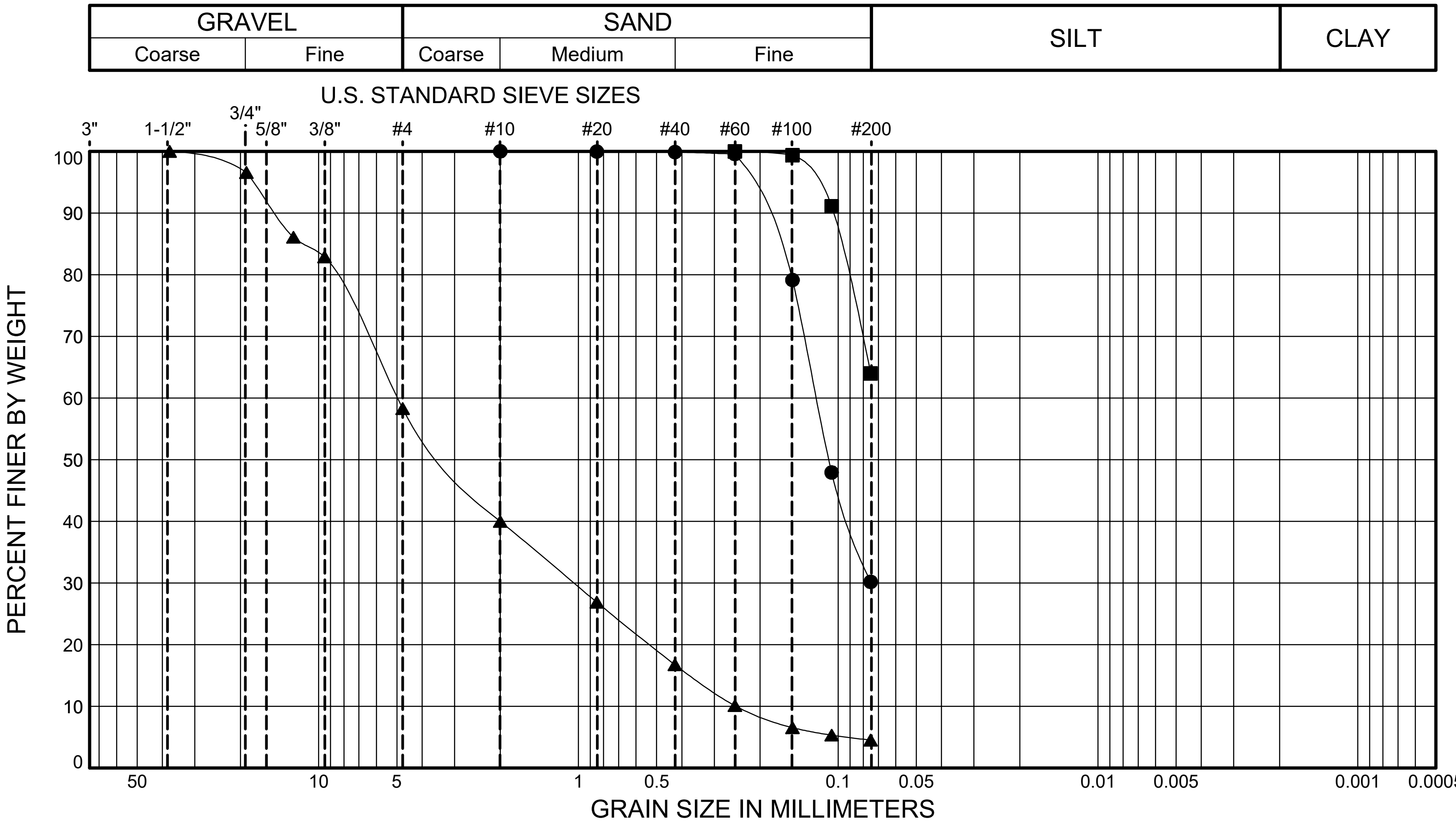
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-03P-22	S-16	24.0 - 25.5	(SM) Olive-gray, silty SAND	27					86.9			13.1
■	HWA-03P-22	S-23	35.0 - 36.5	(ML) Dark gray, SILT	28					9.6			90.4
▲	HWA-04-22	S-4	6.0 - 7.5	(SM) Olive-brown, silty SAND	30				9.6	75.0			15.4

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B12



SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-04-22	S-12	18.0 - 19.5	(SM) Olive-gray, silty SAND	32					69.8			30.2
■	HWA-04-22	S-22	33.0 - 34.5	(ML) Dark gray, sandy SILT	27					36.0			64.0
▲	HWA-05-22	S-1	1.0 - 2.5	(SP) Very dark brown, poorly graded SAND with gravel	6				41.7	53.8			4.5

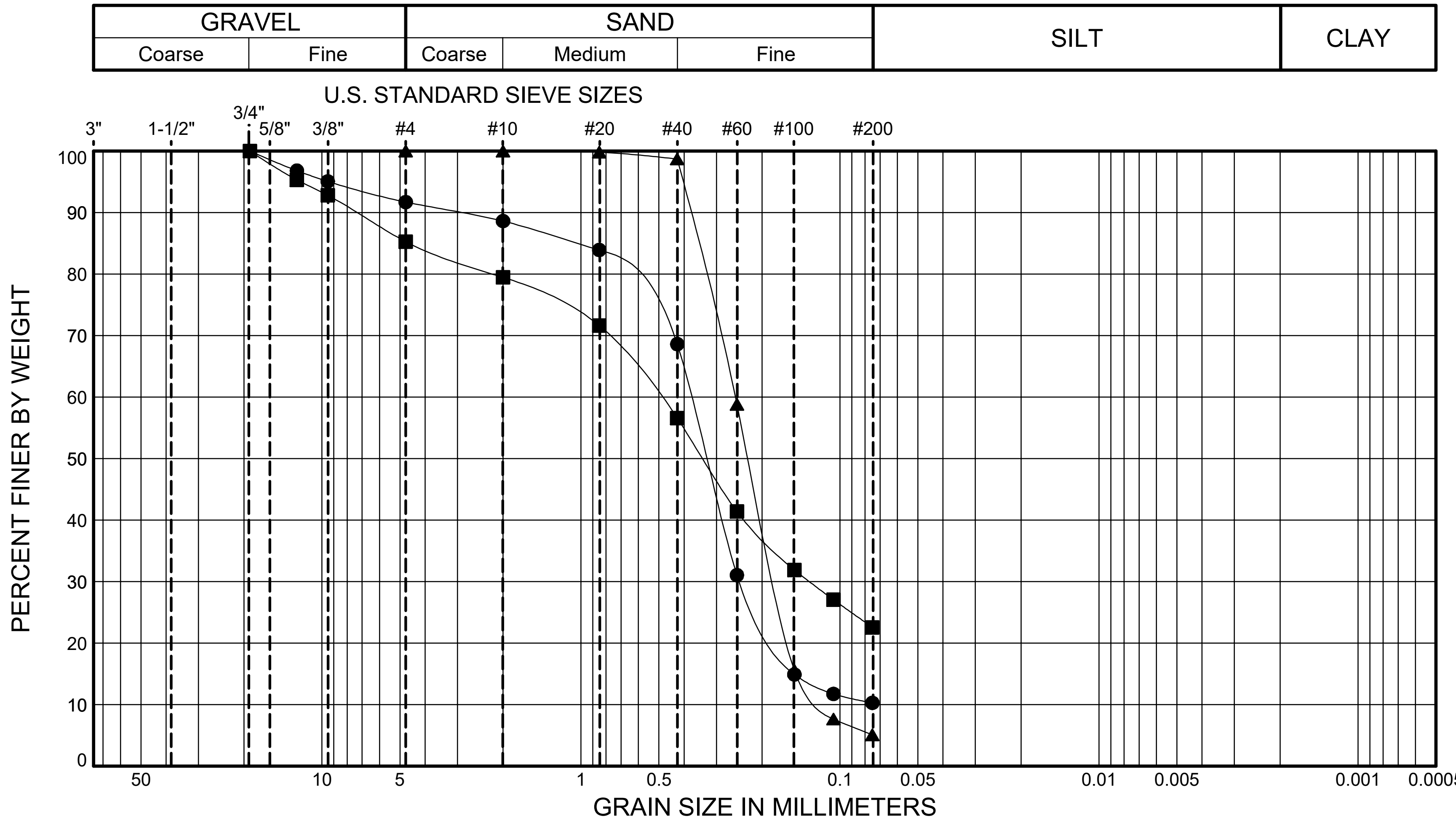
HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B13

HWAGRSZ SILT-CLAY PERCENTAGE WITH 7928 2022-043.GPJ 6/29/23



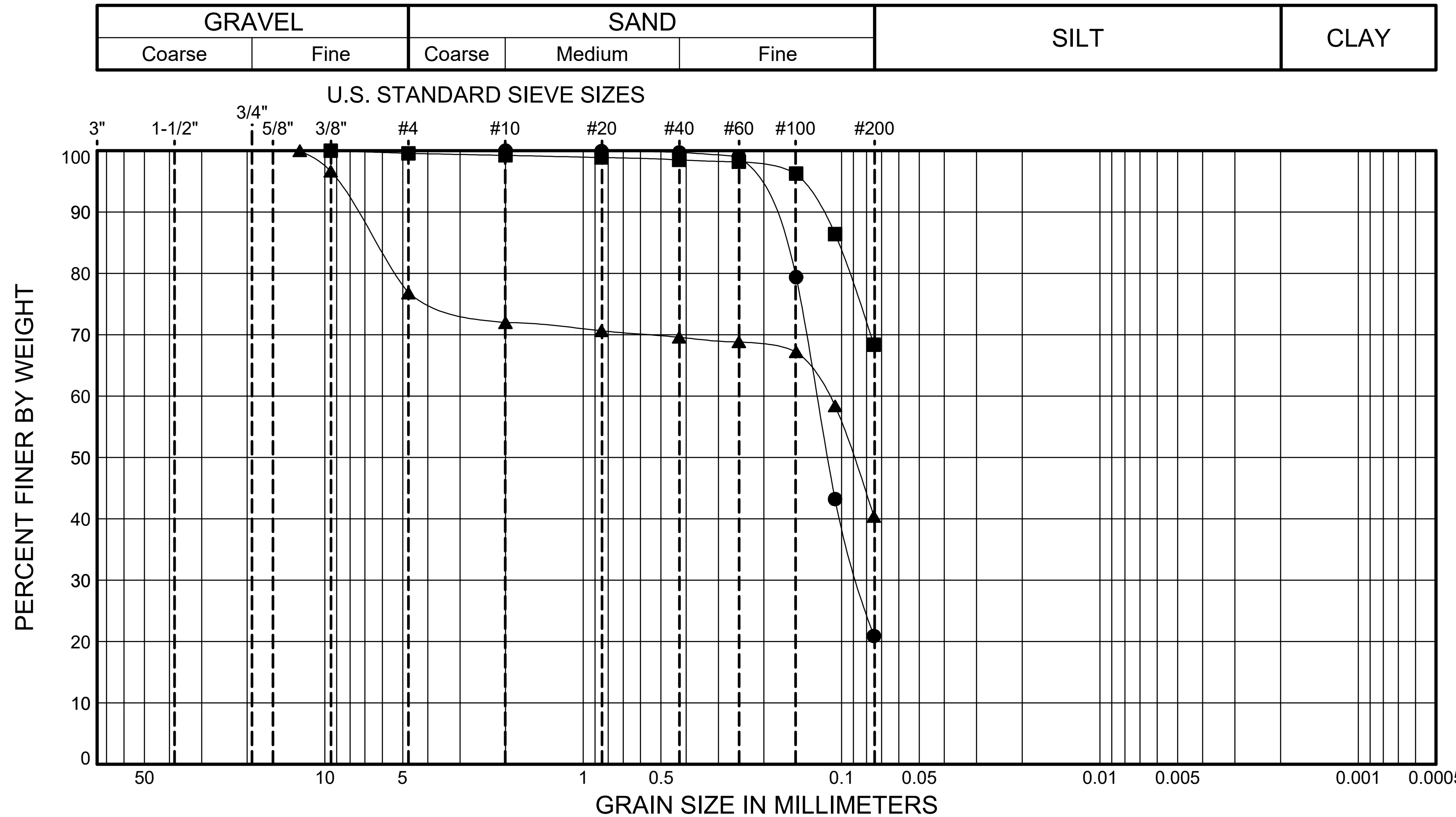
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-05-22	S-5	7.5 - 9.0	(SP-SM) Light olive-brown, poorly graded SAND with silt	20				8.3	81.4			10.3
■	HWA-05-22	S-12	18.0 - 19.5	(SM) Olive-brown, silty SAND	12				14.7	62.7			22.6
▲	HWA-05-22	S-15	22.5 - 24.0	(SP-SM) Olive-gray, poorly graded SAND with silt	23					94.9			5.1

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B14



SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-05-22	S-19	28.5 - 30.0	(SM) Olive, silty SAND	27					79.1			20.9
■	HWA-06Si-22	S-3	4.5 - 6.0	(ML) Light olive-brown, sandy SILT	16				0.4	31.2			68.4
▲	HWA-06Si-22	S-4	6.0 - 7.5	(SM) Olive-brown, silty SAND with gravel	22				23.2	36.4			40.4

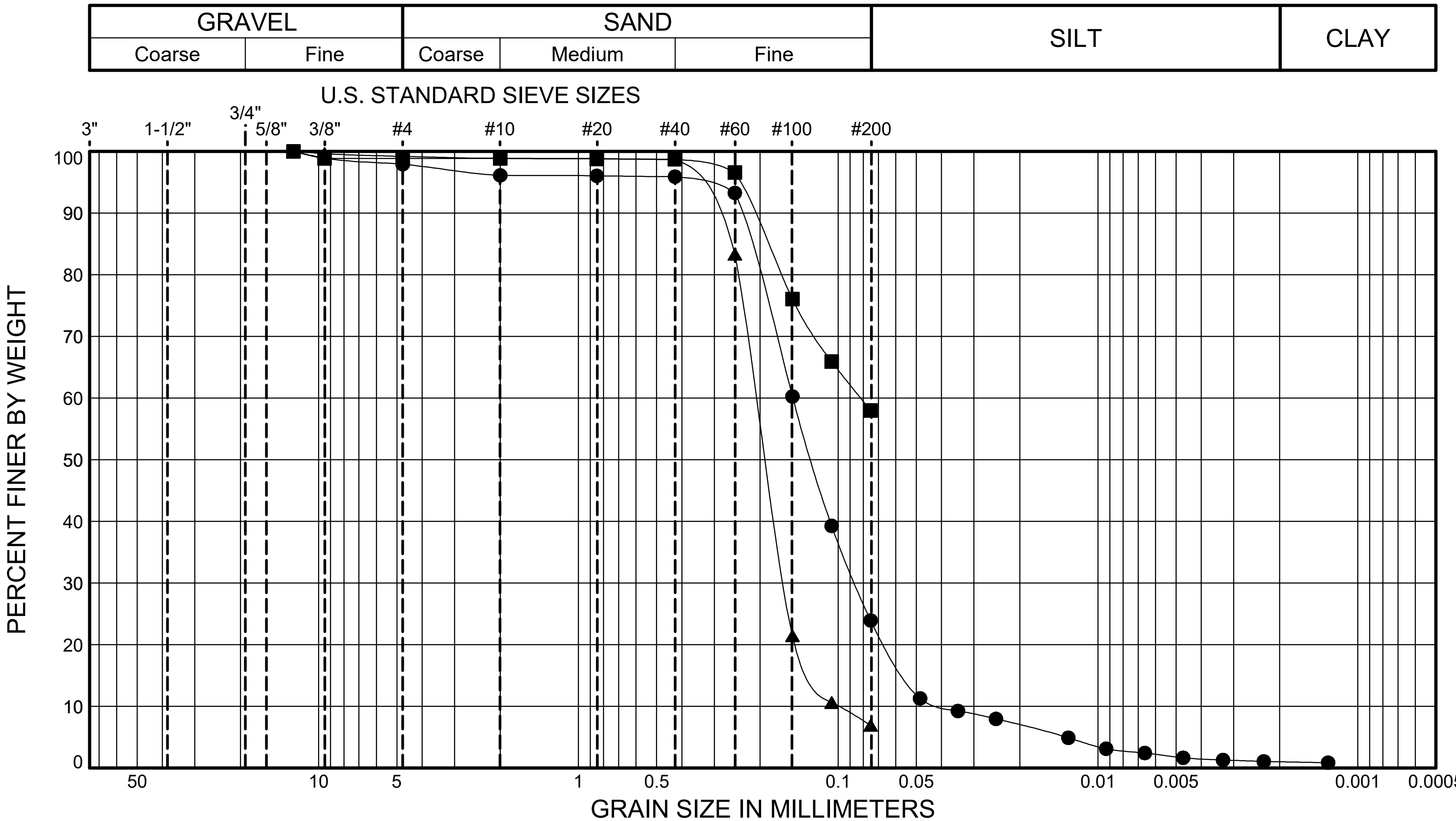
HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B15

HWAGRSZ SILT-CLAY PERCENTAGE WITH 7928 2022-043.GPJ 6/29/23



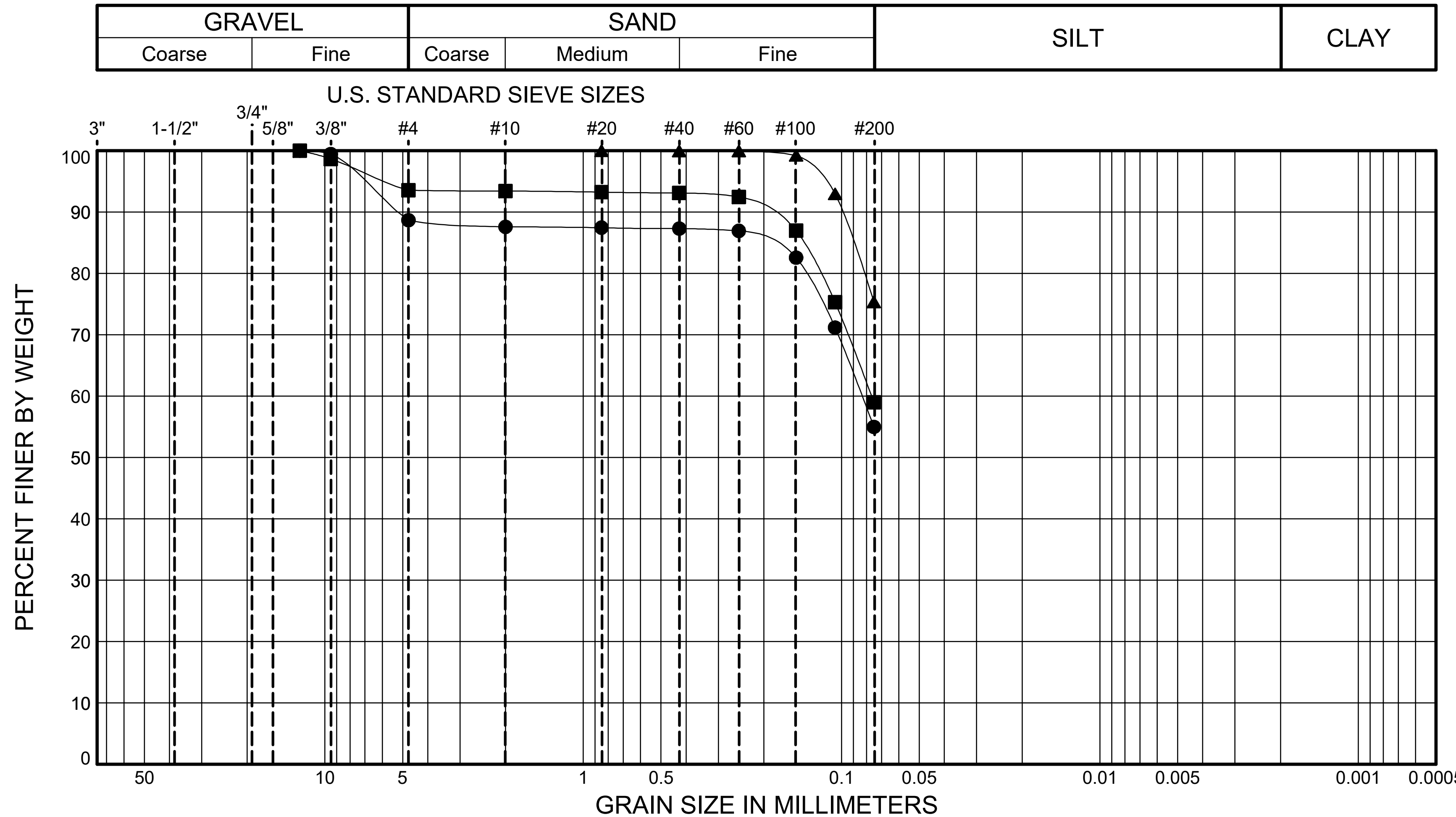
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-06Si-22	S-6	9.0 - 10.5	(SM) Olive-brown, silty SAND	21				2.1	74.0	22.9	1.0	
■	HWA-06Si-22	S-8	12.0 - 13.5	(ML) Olive-brown, sandy SILT	30				1.2	40.9			58.0
▲	HWA-06Si-22	S-11	16.5 - 18.0	(SP-SM) Dark grayish-brown, poorly graded SAND with silt	25	NP	NP	NP	0.8	92.3			6.9

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS OF SOILS METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B16



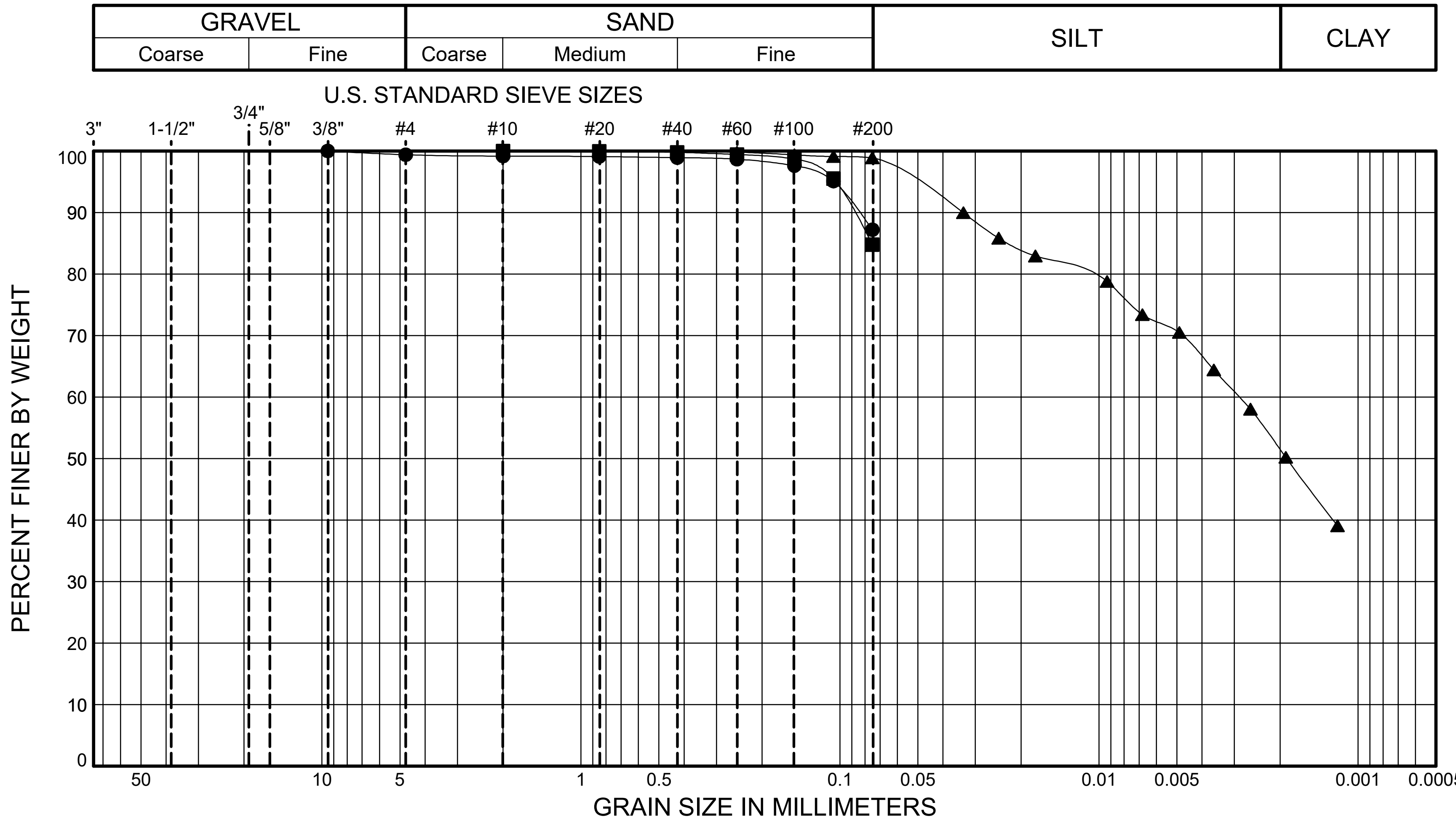
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-06Si-22	S-14	21.0 - 22.5	(ML) Dark grayish-brown, sandy SILT	25				11.3	33.7			55.0
■	HWA-06Si-22	S-18	27.0 - 28.5	(ML) Dark gray, sandy SILT	25				6.4	34.6			59.0
▲	HWA-06Si-22	S-21	31.5 - 33.0	(ML) Very dark gray, SILT with sand	27					24.7			75.3

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B17



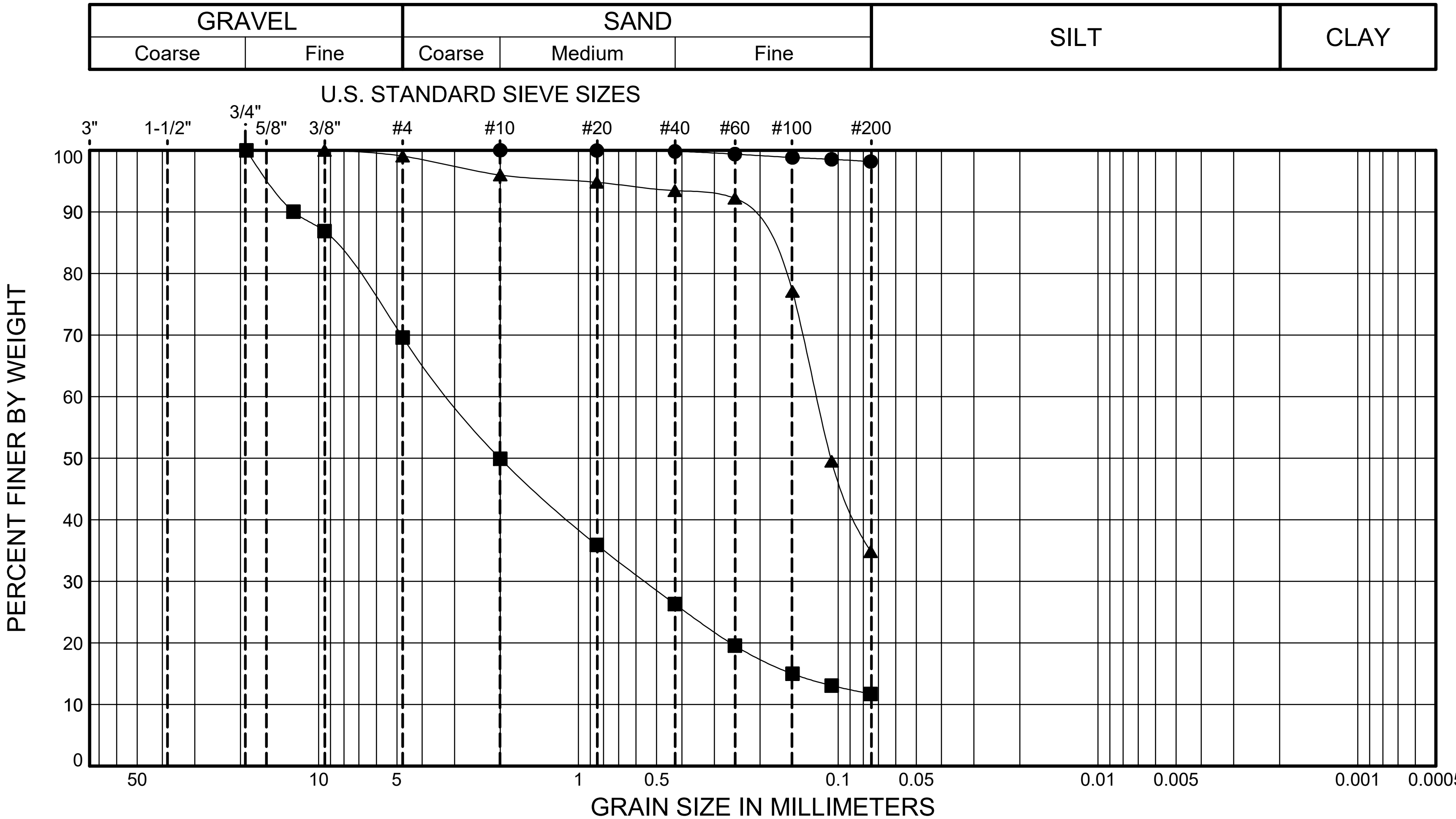
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-06Si-22	S-23	35.0 - 36.5	(ML) Dark gray, SILT	26				0.6	12.2			87.2
■	HWA-06Si-22	S-25	45.0 - 46.5	(CH) Dark gray, fat CLAY with sand	27	54	22	32		15.2			84.8
▲	HWA-06Si-22	S-28	60.0 - 61.5	(CH) Very dark gray, fat CLAY	38	87	30	57		1.1	47.4	51.5	

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS OF SOILS METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B18



SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-06Si-22	S-29	65.0 - 66.5	(CH) Dark gray, fat CLAY	37	92	31	61		1.8			98.2
■	HWA-07Si-22	S-1	1.5 - 2.4	(SW-SM) Very dark grayish-brown, well-graded SAND with silt and gravel	7				30.4	57.9			11.7
▲	HWA-07Si-22	S-6	9.0 - 10.5	(SM) Olive-brown, silty SAND	23				0.9	64.2			34.8

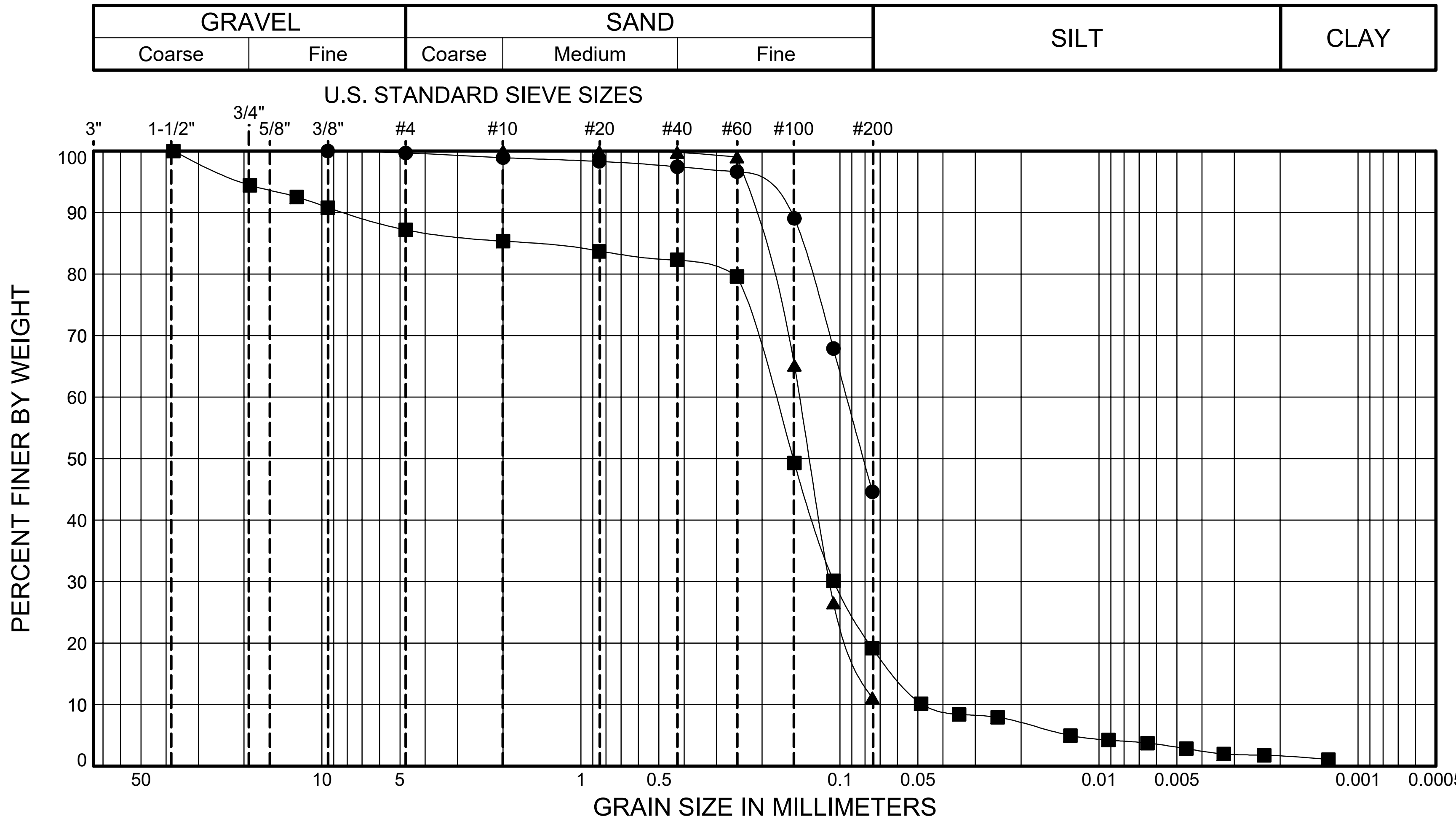
HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS OF SOILS METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B19

HWAGRSZ SILT-CLAY PERCENTAGE WITH 7928 2022-043.GPJ 6/29/23



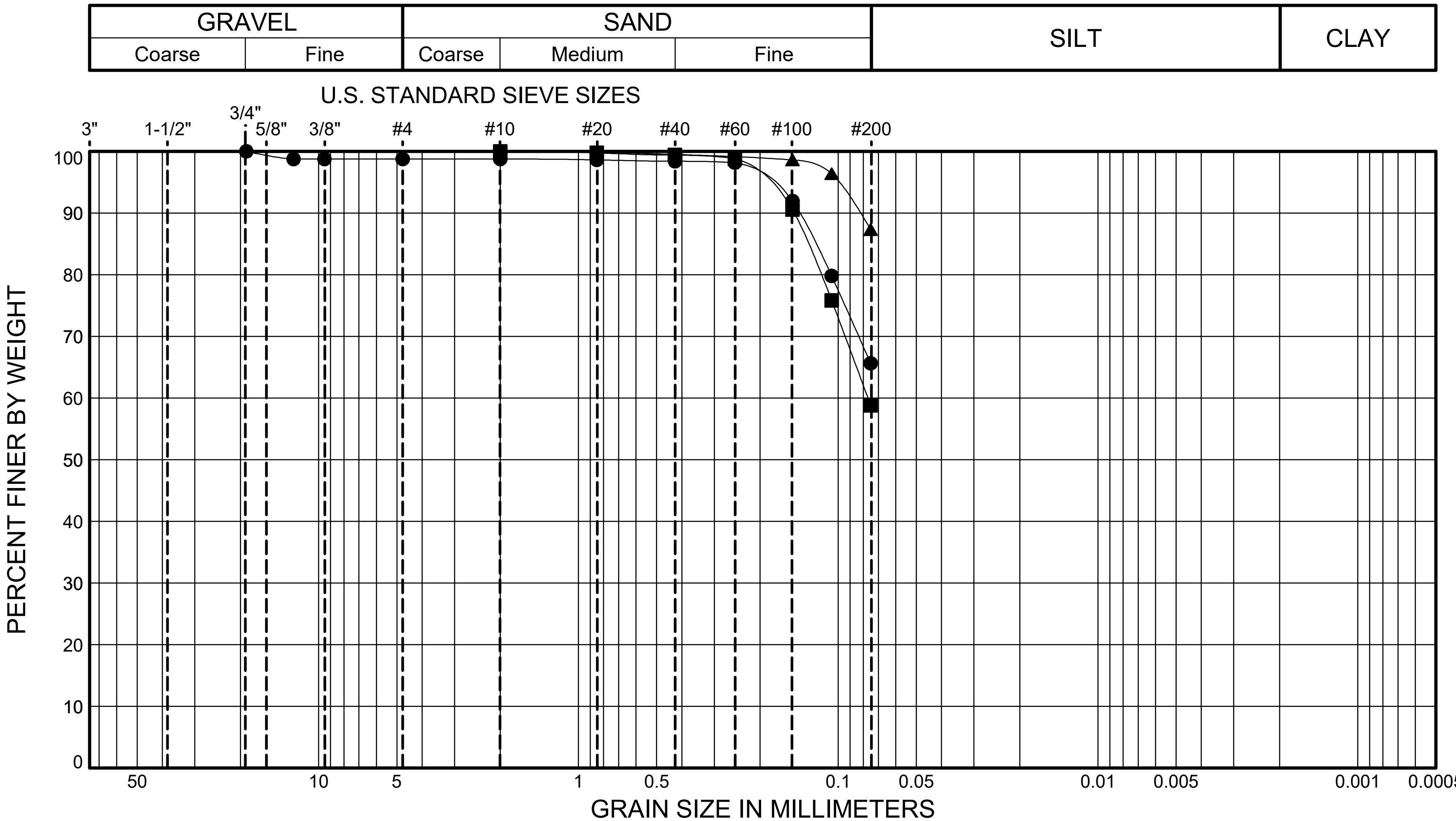
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-07Si-22	S-7	10.5 - 12.0	(SM) Brown, silty SAND	28				0.3	55.1			44.6
■	HWA-07Si-22	S-10	15.0 - 16.5	(SM) Dark olive-brown, silty SAND	21				12.8	68.0	17.5	1.6	
▲	HWA-07Si-22	S-13	19.5 - 21.0	(SP-SM) Dark gray, poorly graded SAND with silt	27					88.9			11.1

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B20



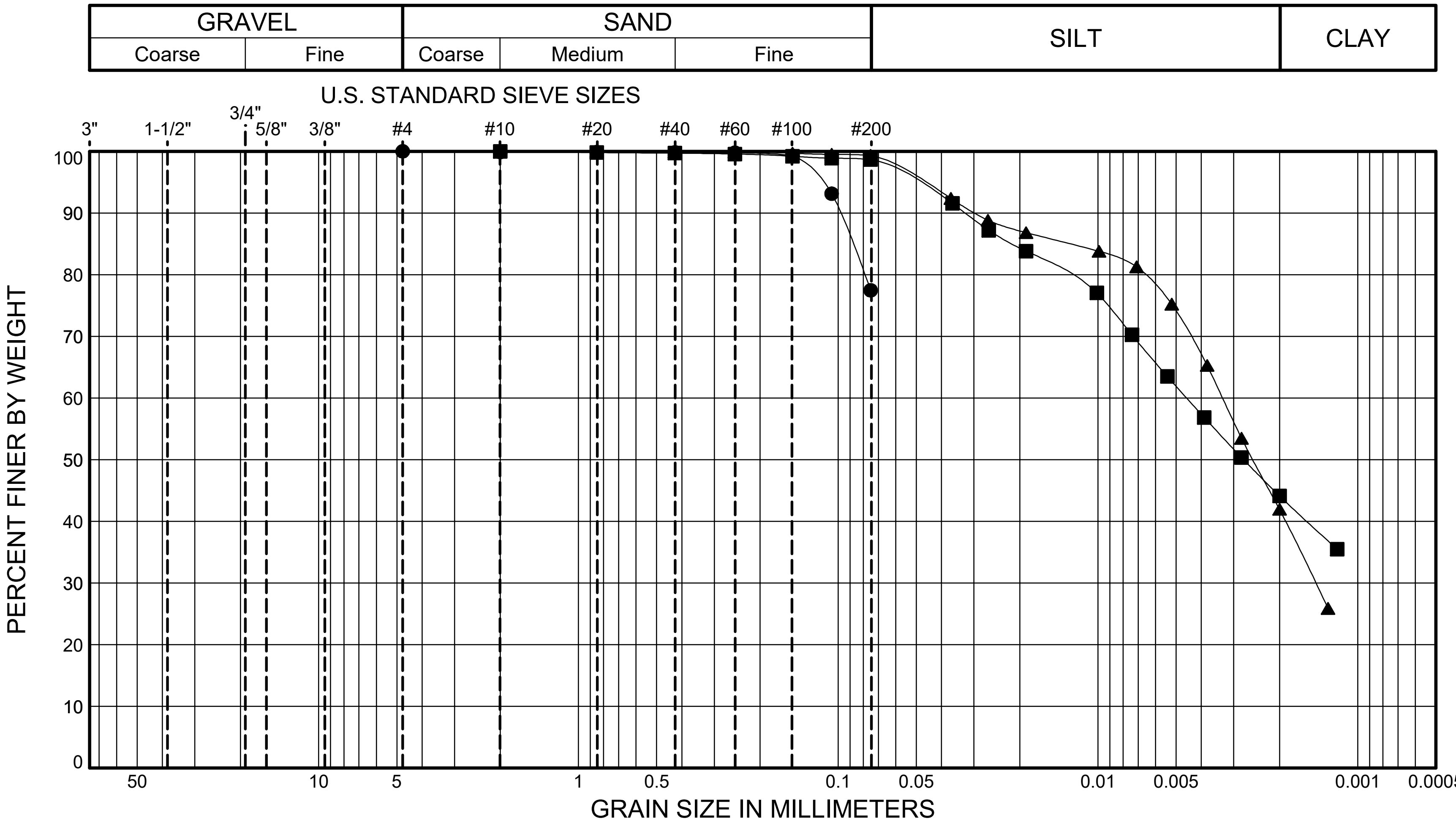
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-07Si-22	S-15	22.5 - 24.0	(ML) Dark grayish-brown, sandy SILT	30				1.2	33.1			65.6
■	HWA-07Si-22	S-17	25.5 - 27.0	(ML) Dark grayish-brown, sandy SILT	26					41.2			58.8
▲	HWA-07Si-22	S-19	28.5 - 30.0	(ML) Dark gray, SILT	28					12.7			87.3

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B21



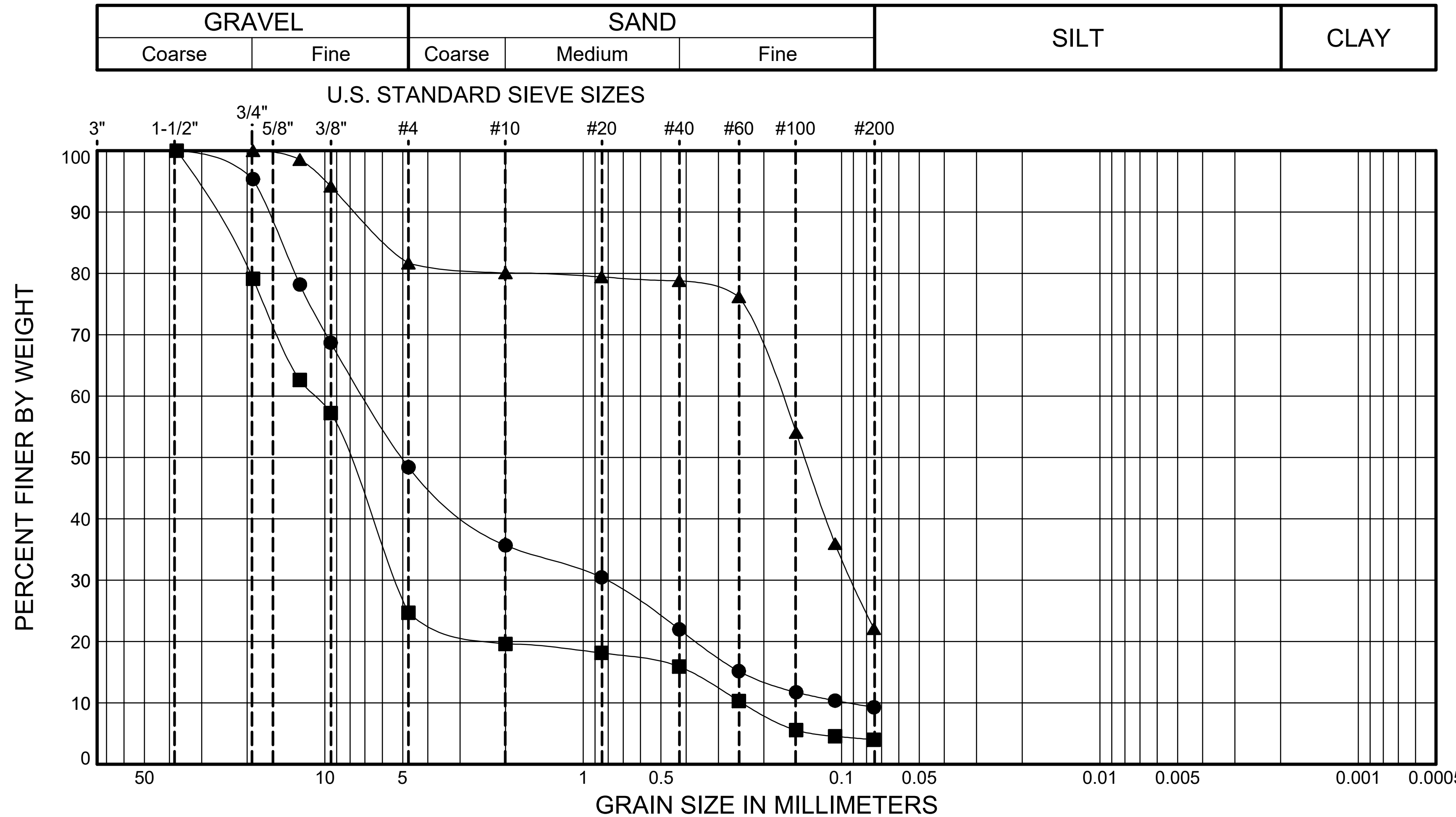
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-07Si-22	S-23b	40.5 - 41.4	(ML) Very dark gray, SILT with sand	26					22.5			77.5
■	HWA-07Si-22	S-27	60.0 - 61.5	(CH) Very dark gray, fat CLAY	34	58	26	32		1.3	54.6	44.1	
▲	HWA-07Si-22	S-29	70.0 - 71.5	(CH) Very dark gray, fat CLAY	35					0.7	57.4	41.9	

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS OF SOILS METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B22



SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-08P-22	S-8	12.0 - 13.5	(GW-GM) Olive, well-graded GRAVEL with silt and sand	11				51.6	39.1			9.3
■	HWA-08P-22	S-12	18.0 - 19.5	(GP) Olive, poorly graded GRAVEL with sand	11				75.3	20.7			4.0
▲	HWA-08P-22	S-19	28.5 - 30.0	(SM) Olive-brown, silty SAND with gravel	25				18.4	59.6			22.1

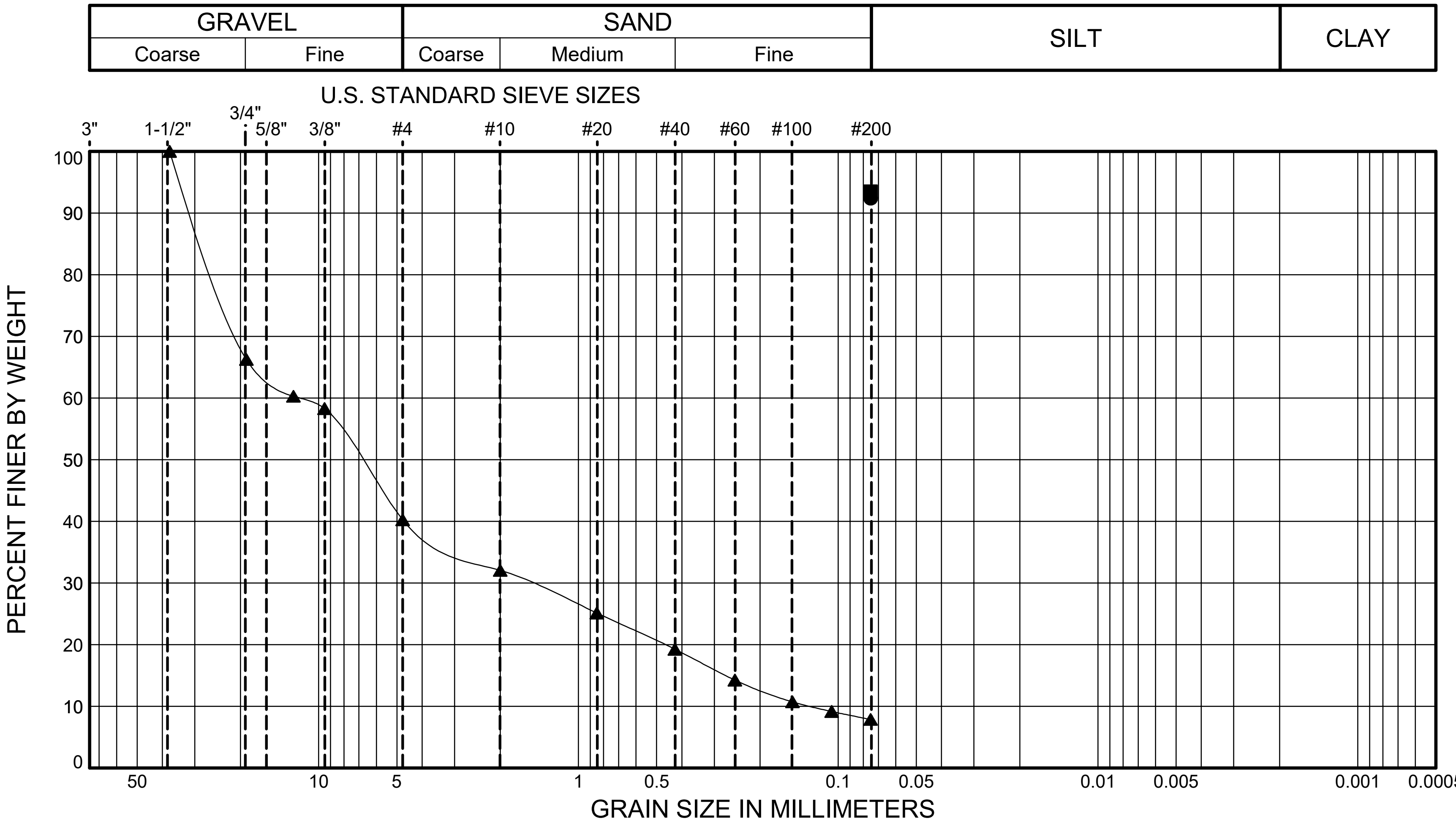
HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B23

HWAGRSZ SILT-CLAY PERCENTAGE WITH 7928 2022-043.GPJ 6/29/23



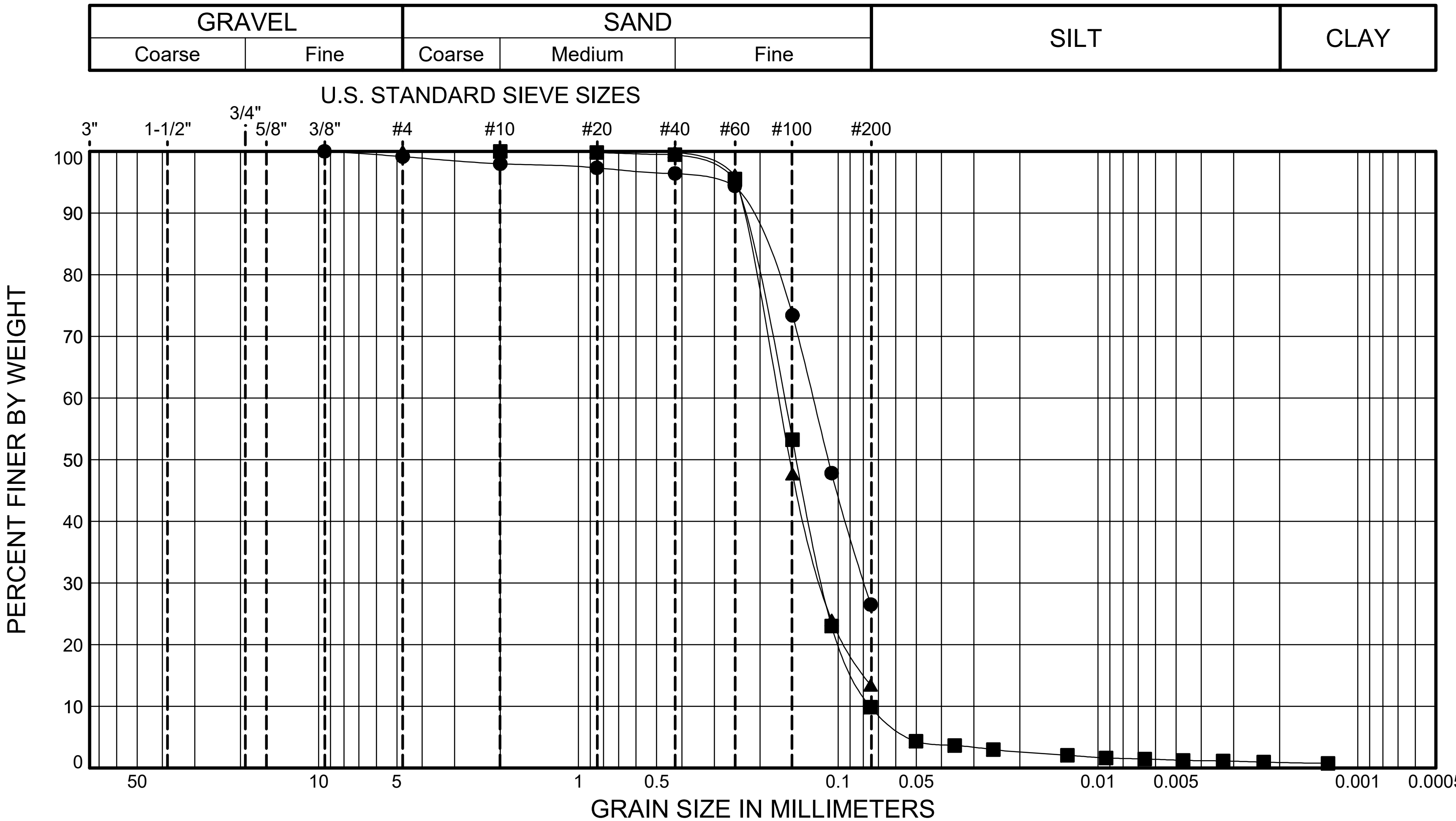
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-08P-22	S-25	45.0 - 46.5	(CH) Dark gray, fat CLAY	29	57	22	35					92.4
■	HWA-08P-22	S-27	55.0 - 56.5	(CL) Dark gray, lean CLAY	33	47	21	26					93.5
▲	HWA-09-22	S-2	1.5 - 3.0	(GW-GM) Dark brown, well-graded GRAVEL with silt and sand	7				59.8	32.4			7.9

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B24



SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-09-22	S-3	3.0 - 4.5	(SM) Olive-brown, silty SAND	16				0.8	72.7			26.5
■	HWA-09-22	S-6	7.5 - 9.0	(SP-SM) Dark olive-brown, poorly graded SAND with silt	12					90.2	9.0	0.9	
▲	HWA-09-22	S-8	10.5 - 12.0	(SM) Dark grayish-brown, silty SAND	29					86.6			13.4

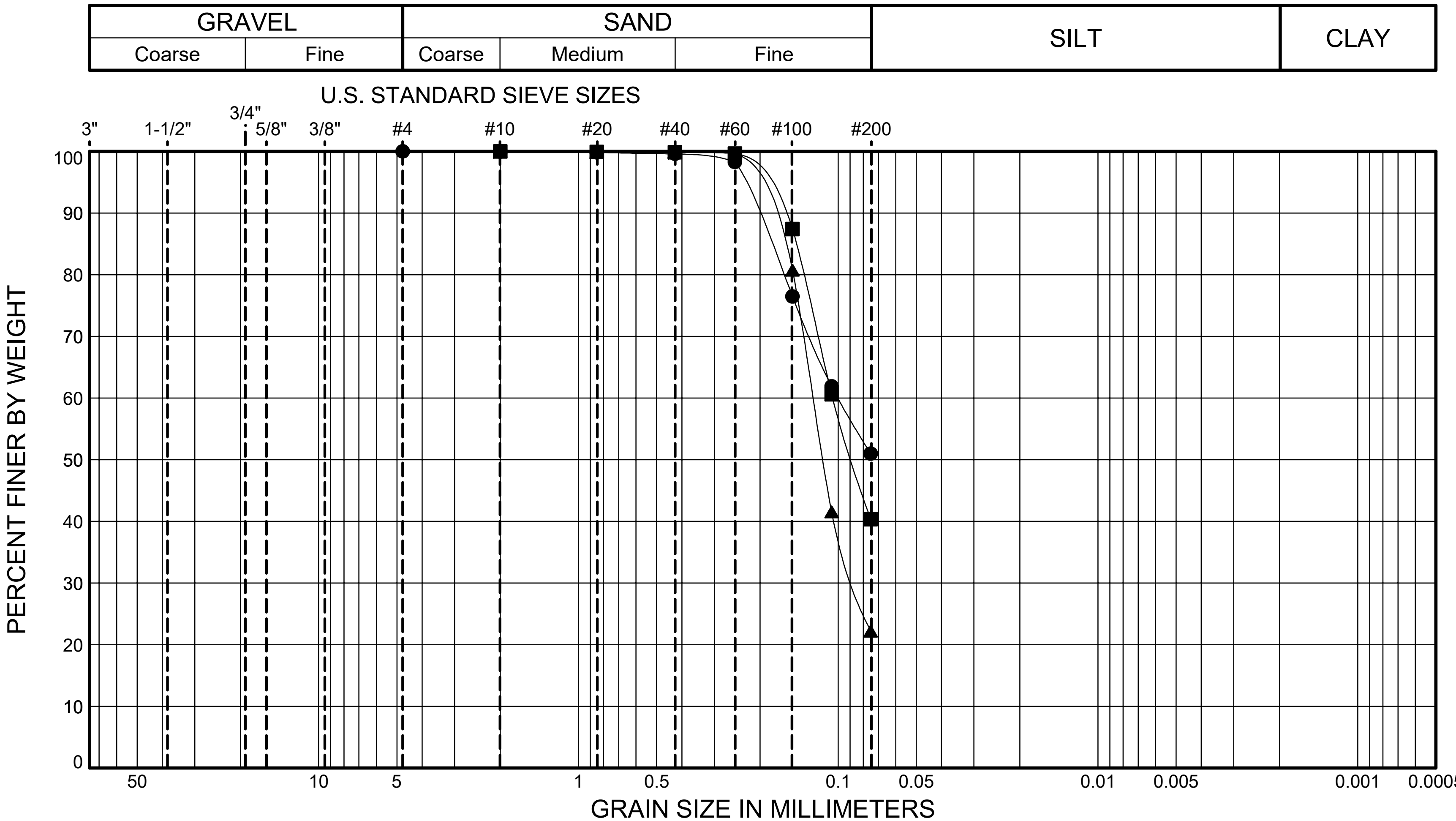
HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS OF SOILS METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B25

HWAGRSZ SILT-CLAY PERCENTAGE WITH 7928 2022-043.GPJ 6/29/23



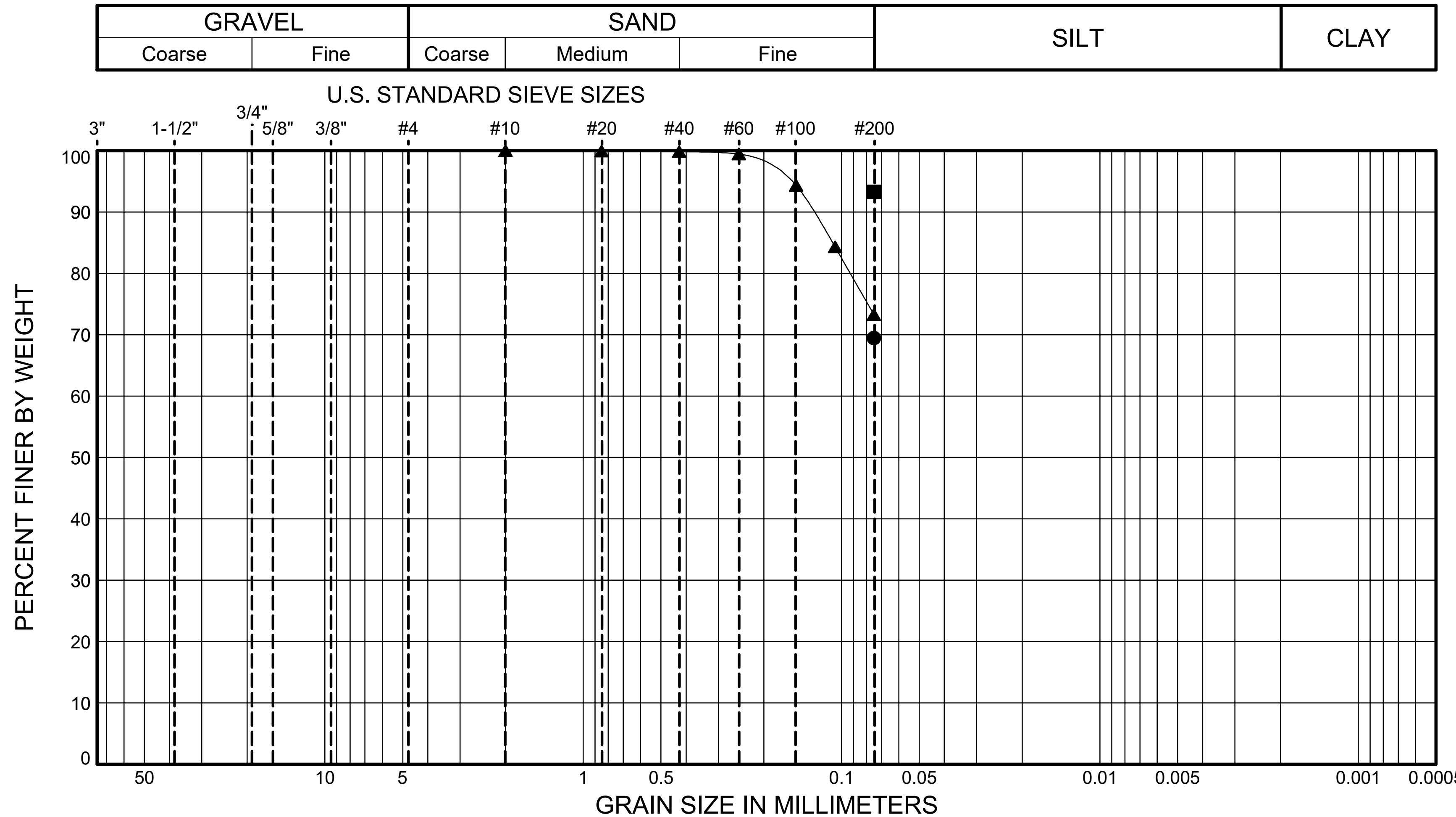
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-09-22	S-11	15.0 - 16.5	(ML) Dark grayish-brown, sandy SILT	28					49.0			51.0
■	HWA-09-22	S-12	16.5 - 18.0	(SM) Very dark grayish-brown, silty SAND	28					59.7			40.3
▲	HWA-09-22	S-13	18.0 - 19.5	(SM) Dark gray, silty SAND	27					77.8			22.2

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B26



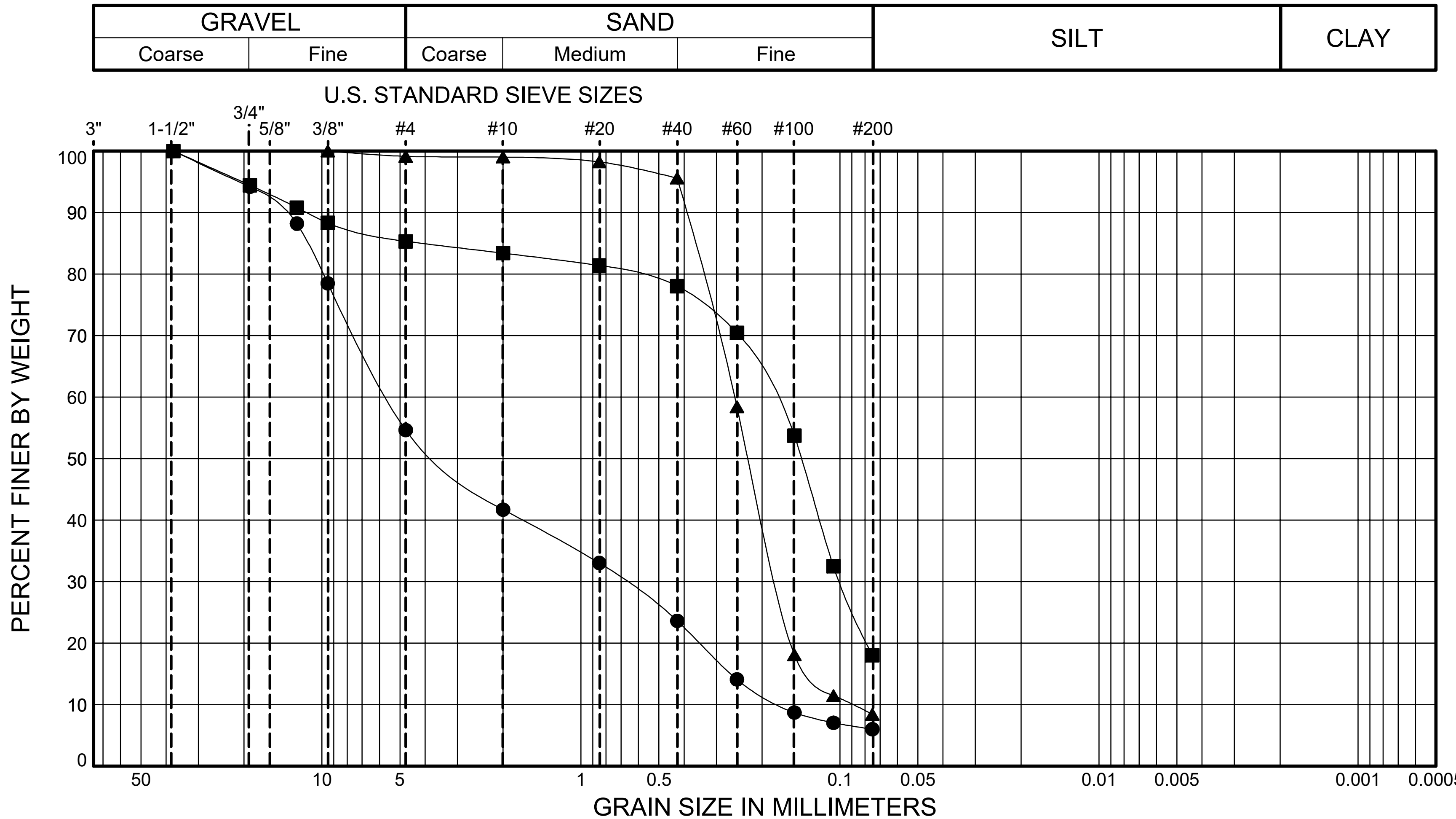
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-09-22	S-17	25.0 - 26.5	(ML) Very dark gray, sandy SILT	28	NP	NP	NP					69.5
■	HWA-09-22	S-18	30.0 - 31.5	(CL) Very dark gray, lean CLAY	30	34	22	12					93.3
▲	HWA-09-22	S-20	36.0 - 36.0	(CH) Gray, fat CLAY with sand	23	58	23	35		26.7			73.3

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS OF SOILS METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B27



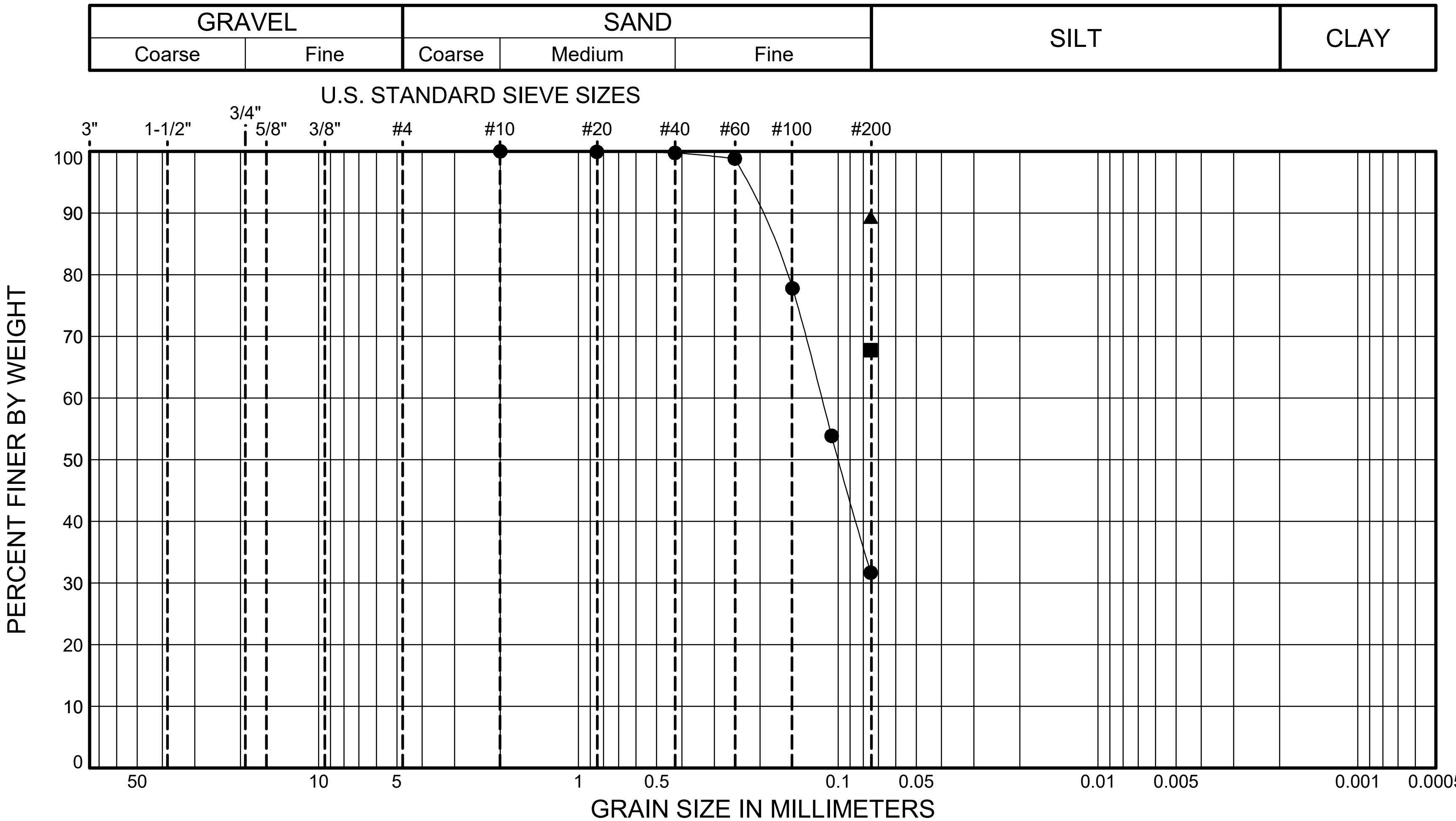
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-10Si-22	S-2	3.0 - 4.5	(SP-SM) Olive, poorly graded SAND with silt and gravel	10				45.4	48.6			6.0
■	HWA-10Si-22	S-7	10.5 - 12.0	(SM) Olive-gray, silty SAND	34				14.7	67.3			18.0
▲	HWA-10Si-22	S-9	13.5 - 15.0	(SP-SM) Dark gray, poorly graded SAND with silt	20				0.9	90.7			8.4

GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B28



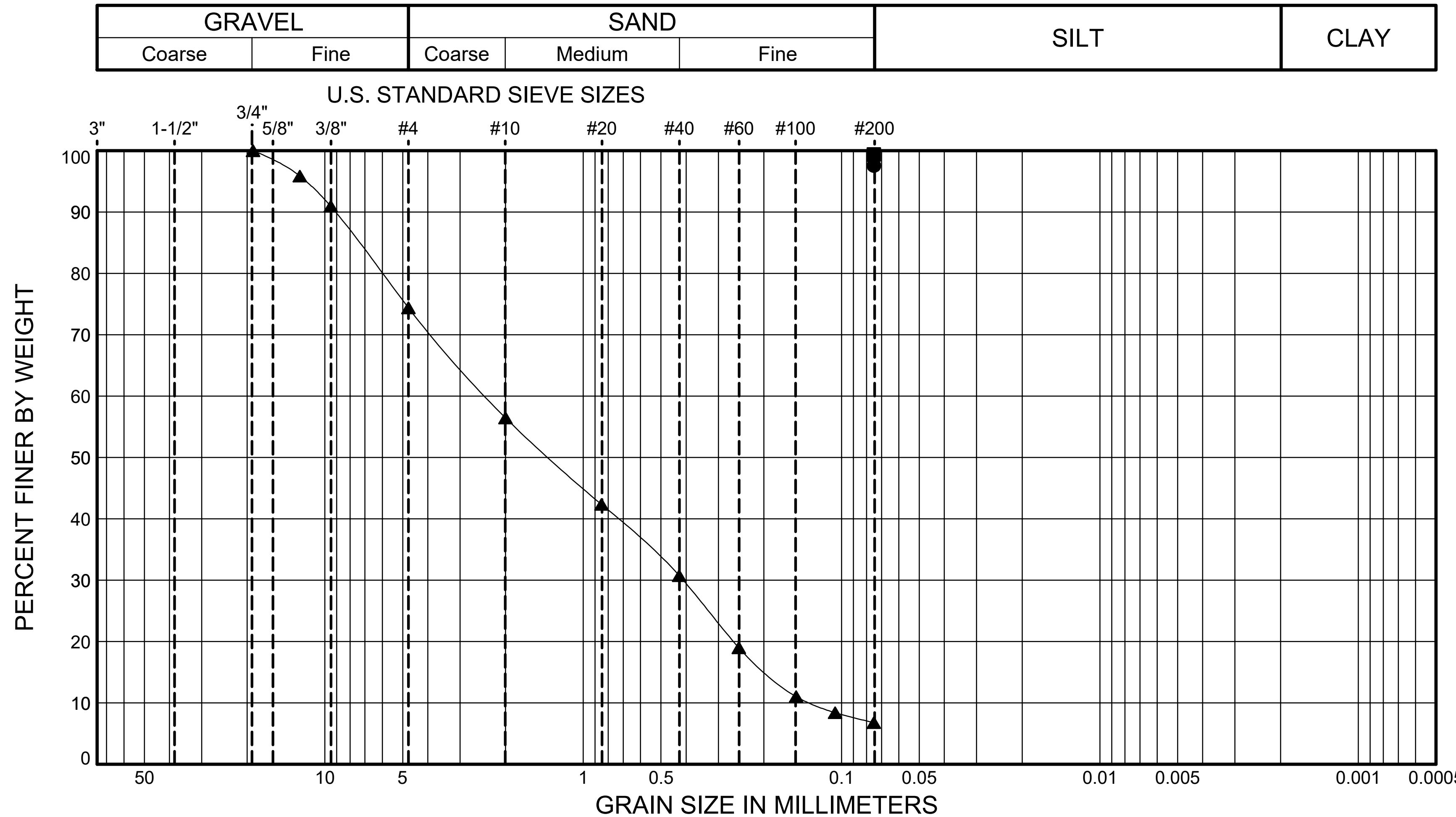
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-10Si-22	S-12	18.0 - 19.5	(SM) Olive-gray, silty SAND	27					68.3			31.7
■	HWA-10Si-22	S-22	33.0 - 34.5	(ML) Olive-brown, sandy SILT	30	NP	NP	NP					67.8
▲	HWA-10Si-22	S-27	55.0 - 56.5	(ML) Dark gray, SILT	30	26	23	3					89.3

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS OF SOILS METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B29



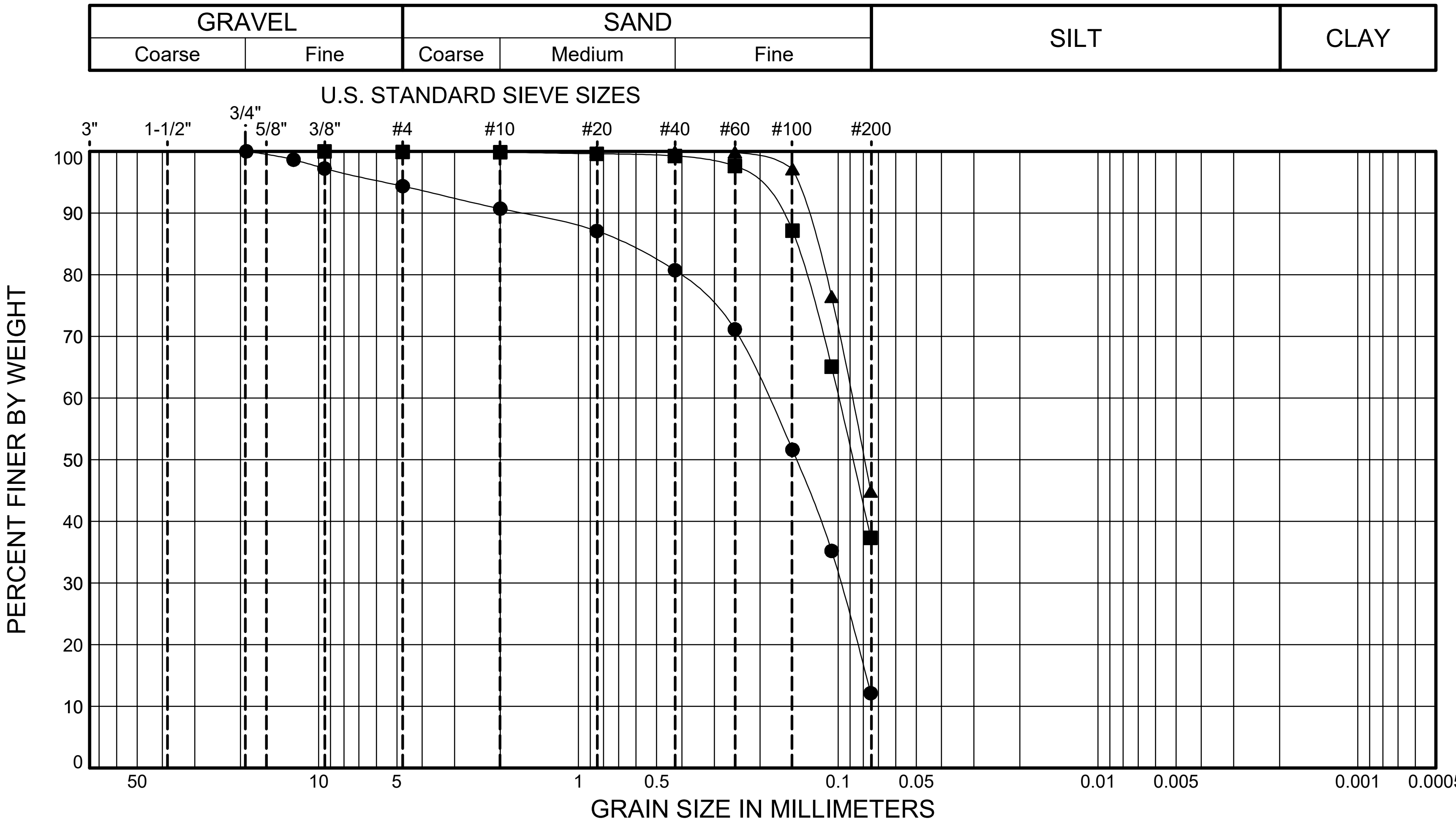
SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-10Si-22	S-29	65.0 - 66.3	(CL) Very dark gray, lean CLAY	22	48	23	25					97.5
■	HWA-10Si-22	S-30	70.0 - 71.5	(CH) Dark gray, fat CLAY	33	79	26	53					99.4
▲	HWA-11Si-23	S-2	3.0 - 4.5	(SP-SM) Very dark grayish-brown, poorly graded SAND with silt and gravel	15				25.6	67.6			6.8

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B30



SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-11Si-23	S-8	12.0 - 13.5	(SM) Olive-brown, silty SAND	17				5.6	82.2			12.1
■	HWA-11Si-23	S-17	25.5 - 27.0	(SM) Very dark grayish-brown, silty SAND	28				0.1	62.5			37.3
▲	HWA-11Si-23	S-22	33.0 - 34.5	(SM) Very dark grayish-brown, silty SAND	25					55.2			44.8

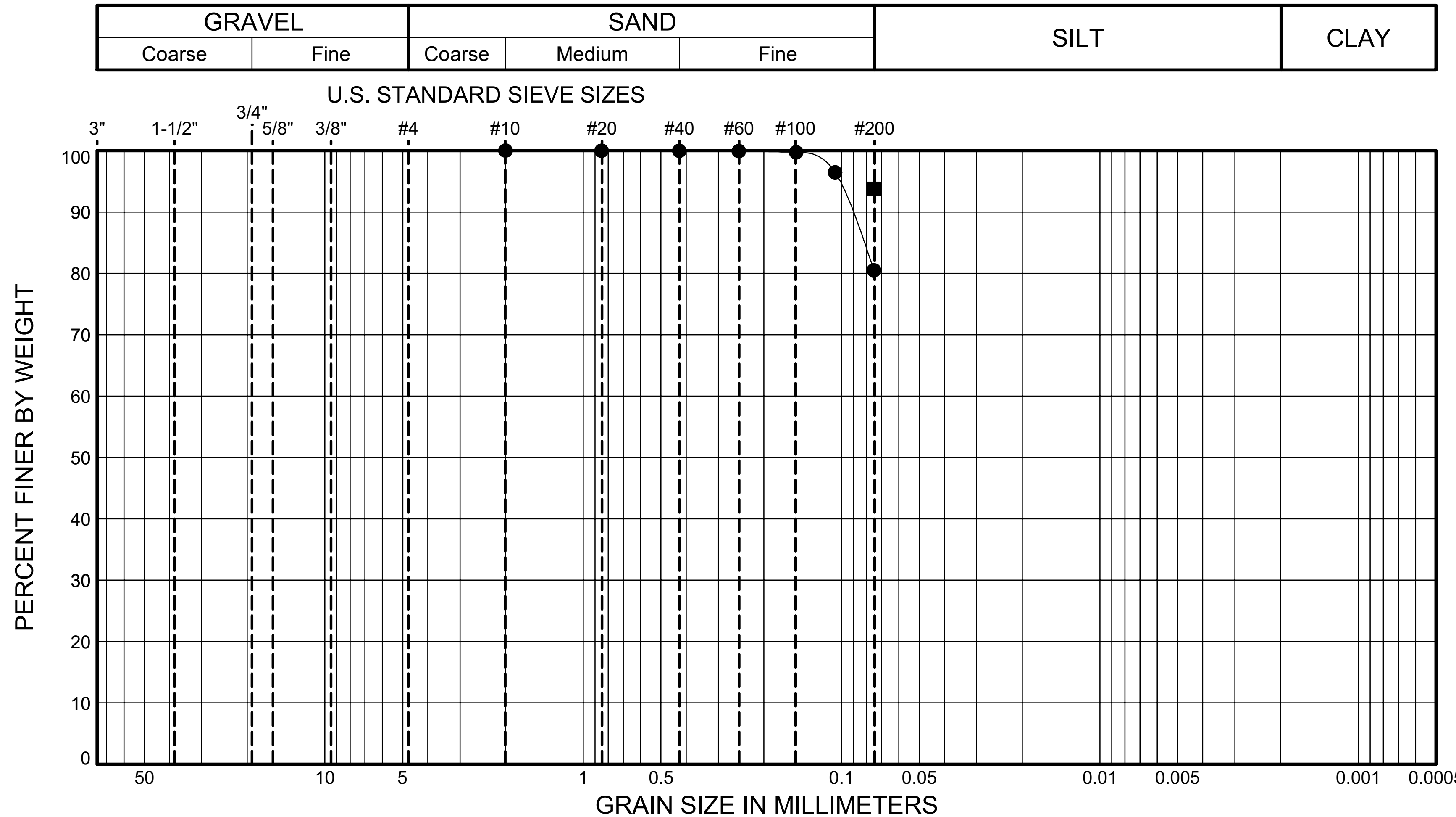
HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS
OF SOILS
METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B31

HWAGRSZ SILT-CLAY PERCENTAGE WITH 7928 2022-043.GPJ 6/29/23



SYMBOL	SAMPLE		DEPTH (ft.)	ASTM SOIL CLASSIFICATION	% MC	LL	PL	PI	Gravel %	Sand %	Silt %	Clay %	Fines %
●	HWA-11Si-23	S-25	45.0 - 46.5	(ML) Dark gray, SILT with sand	26					19.5			80.5
■	HWA-11Si-23	S-31	75.0 - 76.5	(CH) Dark gray, fat CLAY	26	51	22	29					93.8

HWA GEOSCIENCES INC.

SR 302 Victor Area Study
Mason County, Washington

PARTICLE-SIZE ANALYSIS OF SOILS METHODS ASTM D6913/D7928

PROJECT NO.: 2022-043-21 FIGURE: B32

HWA GeoSciences Inc. Materials Testing Laboratory

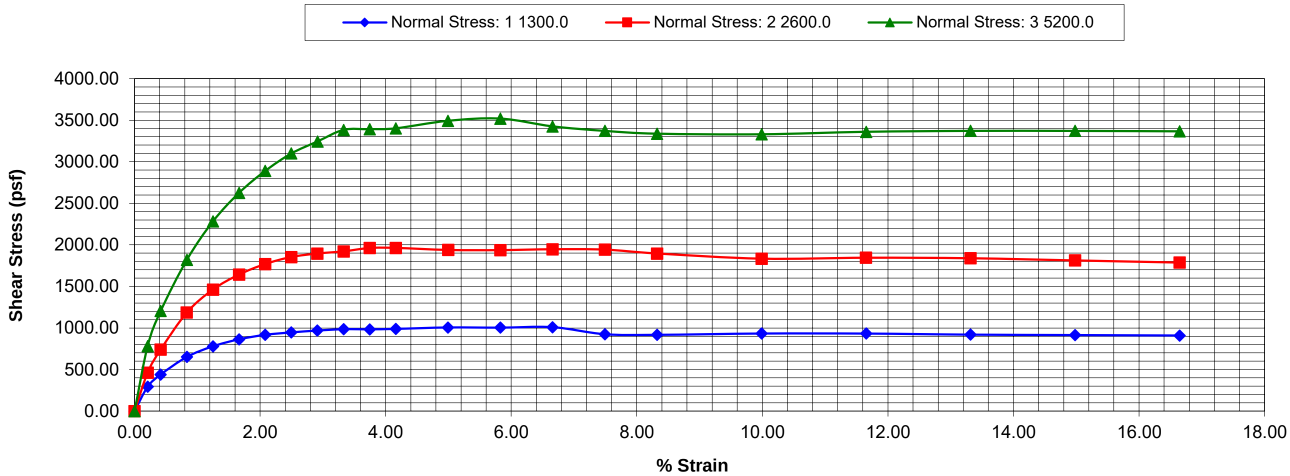
Direct Shear Test of Soils Under Consolidated Drained Conditions (ASTM D 3080)

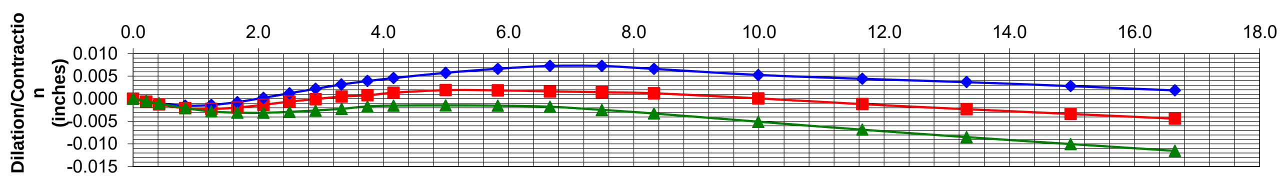
Project Name:	SR302 Landslide		**Project Number:**	2022-043	
Sample Point:	HWA-2I-22	**Sample No.:** S-16	**Sample Depth:**	24.0'	
Soil Description:	SILT				
Soil Color:	Very dark gray		Average Strain Rate:	0.5	% per min.
Soil Group Symbol:	ML		Soil Specific Gravity:	2.65	(assumed)

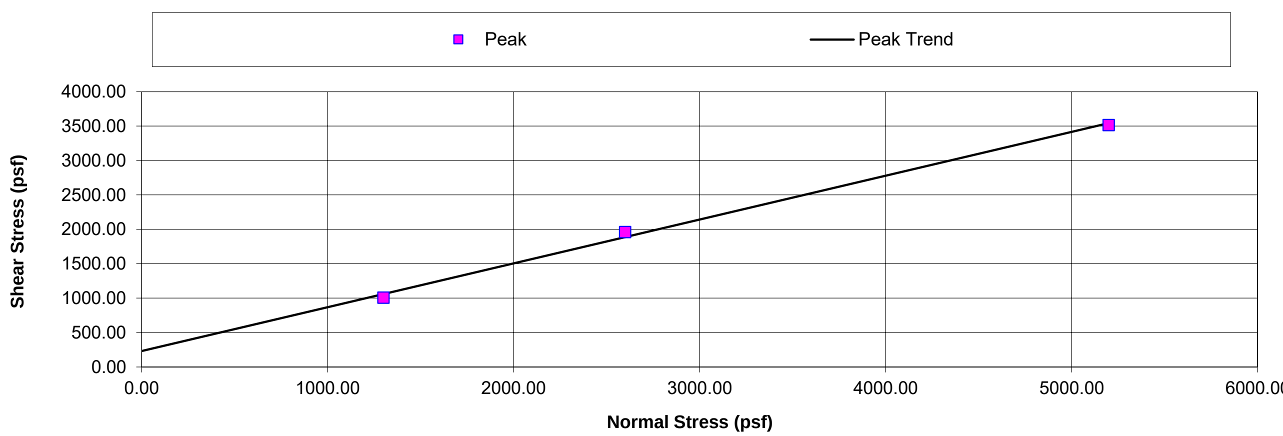
Normal Stress (psf)	1300.00	2600.00	5200.00	**Average**
Peak Stress (psf)	1009.67	1963.34	3518.86	
Initial Moisture Content (%):	28.4	28.4	28.4	28.4
Wet Unit Weight (pcf):	122.3	121.9	122.9	122.4
Dry Unit Weight (pcf):	95.3	95.0	95.7	95.3
Calculated Void Ratio	0.735	0.741	0.727	0.735
Calculated Porosity	0.424	0.426	0.421	0.423
Calculated Saturation (%)	102.2	101.4	103.3	102.3
Final Moisture Content (%)	29.5	29.5	28.9	29.3

Indicated Strength Parameters

	Cohesion psf	phi Angle (degrees)
Peak	231.9	32.5







Checked By: SEG

Figure B33

HWA GeoSciences Inc. Materials Testing Laboratory

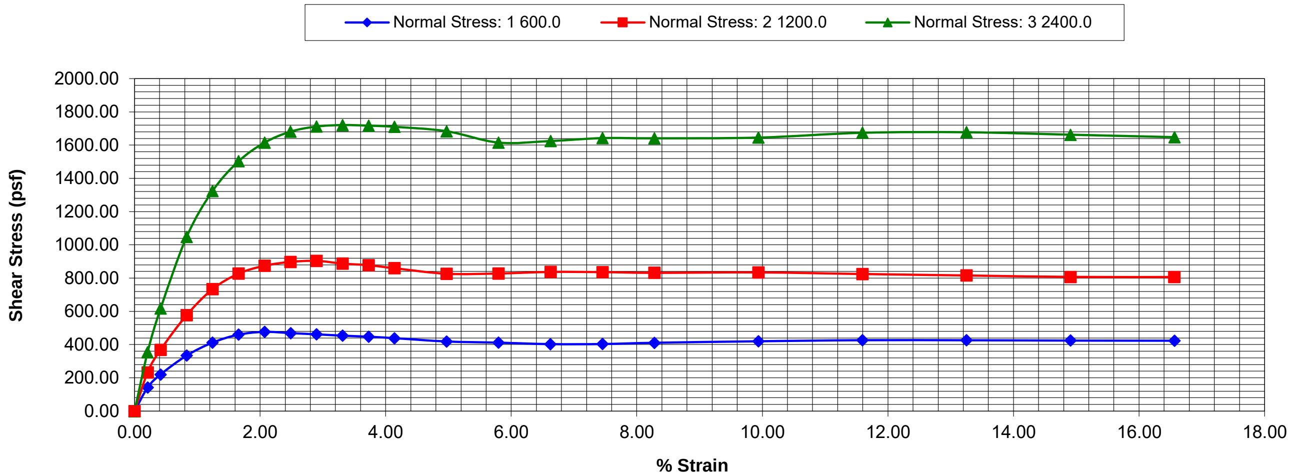
Direct Shear Test of Soils Under Consolidated Drained Conditions (ASTM D 3080)

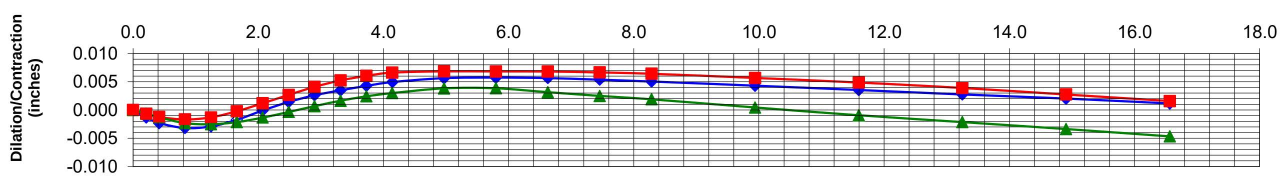
Project Name:	SR302 Landslide		**Project Number:**	2022-043
Sample Point:	HWA-3P-22	**Sample No.:** S-7	**Sample Depth:**	11.0'-11.5'
Soil Description:	silty SAND			
Soil Color:	Light olive-brown		Average Strain Rate:	0.5 % per min.
Soil Group Symbol:	SM		Soil Specific Gravity:	2.65 (assumed)

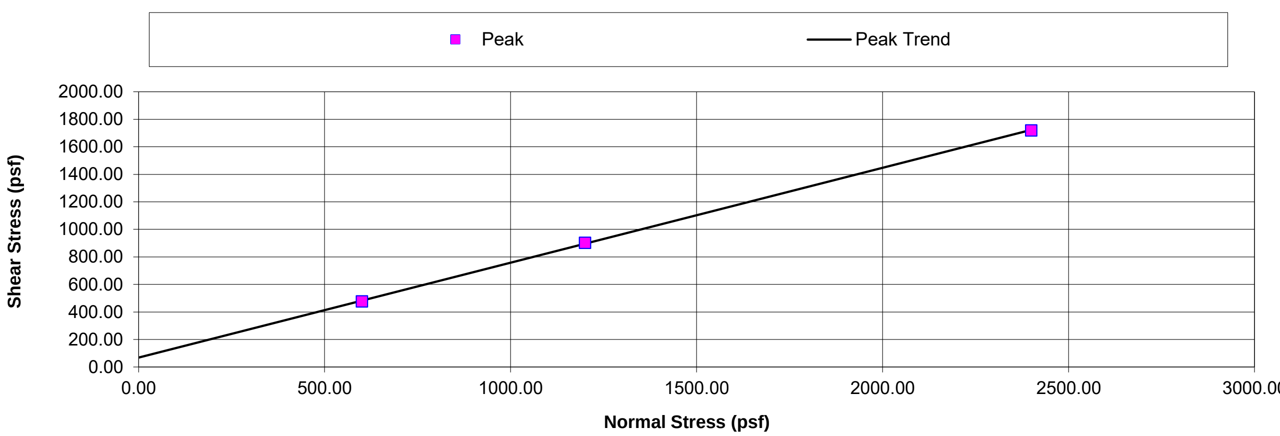
Normal Stress (psf)	600.00	1200.00	2400.00	**Average**
Peak Stress (psf)	476.69	903.75	1720.50	
Initial Moisture Content (%):	14.1	14.1	14.1	14.1
Wet Unit Weight (pcf):	107.4	109.6	106.8	107.9
Dry Unit Weight (pcf):	94.1	96.0	93.5	94.6
Calculated Void Ratio	0.757	0.722	0.768	0.749
Calculated Porosity	0.431	0.419	0.434	0.428
Calculated Saturation (%)	49.5	52.0	48.8	50.1
Final Moisture Content (%)	30.8	29.8	29.2	29.9

Indicated Strength Parameters

	Cohesion psf	phi Angle (degrees)
Peak	68.3	34.6







Checked By: SEG

Figure B34

HWA GeoSciences Inc. Materials Testing Laboratory

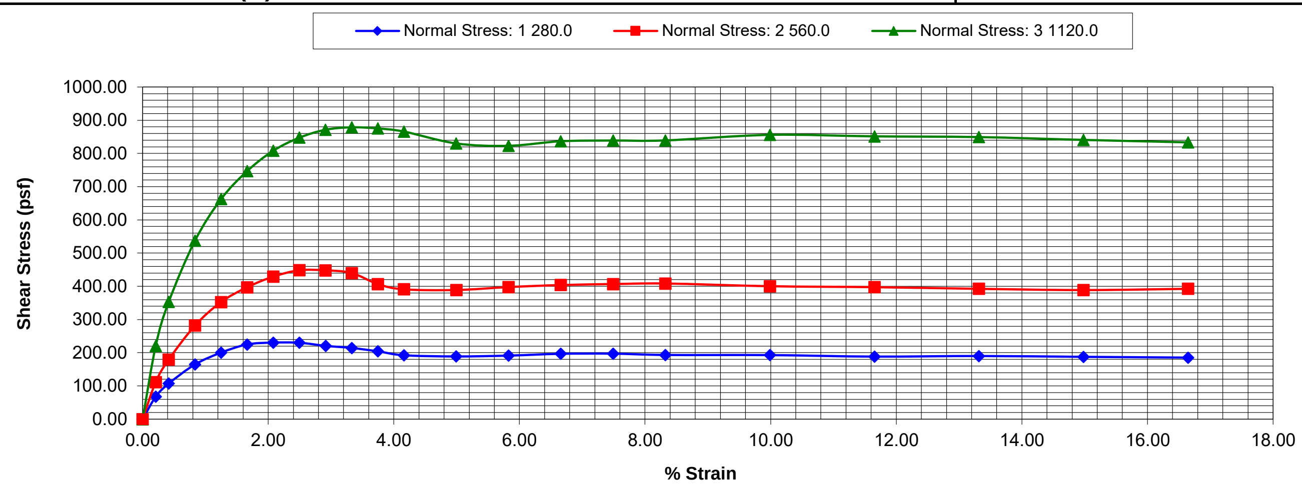
Direct Shear Test of Soils Under Consolidated Drained Conditions (ASTM D 3080)

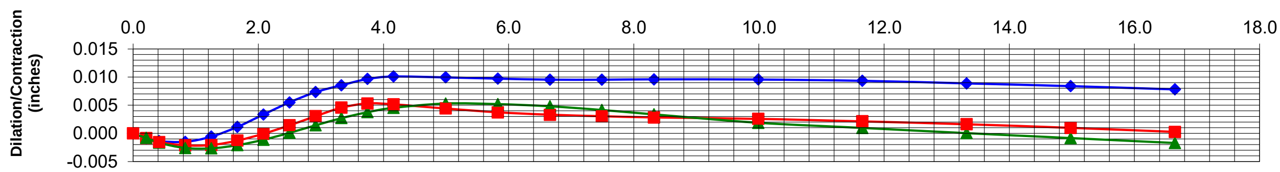
Project Name:	SR302 Landslide			**Project Number:**	2022-043
Sample Point:	HWA-6i-22	**Sample No.:**	S-3	**Sample Depth:**	4.5'
Soil Description:	sandy SILT				
Soil Color:	Light olive-brown			Average Strain Rate:	0.5 % per min.
Soil Group Symbol:	ML			Soil Specific Gravity:	2.65 (assumed)

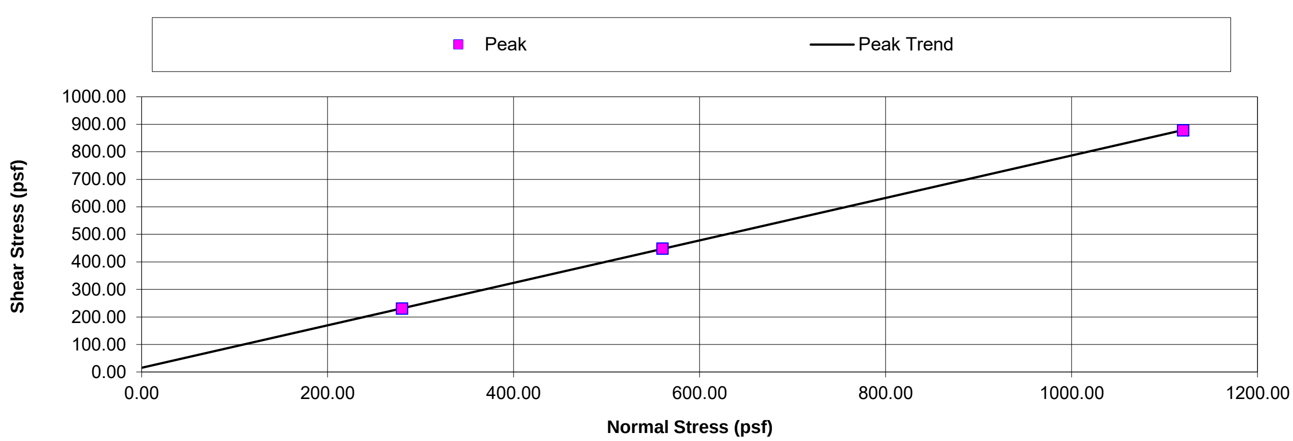
Normal Stress (psf)	280.00	560.00	1120.00	**Average**
Peak Stress (psf)	230.50	448.29	878.69	
Initial Moisture Content (%):	16.5	16.5	16.5	16.5
Wet Unit Weight (pcf):	112.9	112.6	111.3	112.3
Dry Unit Weight (pcf):	97.0	96.7	95.6	96.4
Calculated Void Ratio	0.705	0.710	0.730	0.715
Calculated Porosity	0.413	0.415	0.422	0.417
Calculated Saturation (%)	61.9	61.4	59.8	61.0
Final Moisture Content (%)	30.3	29.4	28.2	29.3

Indicated Strength Parameters

	Cohesion psf	phi Angle (degrees)
Peak	15.3	37.6







Checked By: SEG Figure B35

HWA GEOSCIENCES INC. Materials Testing Laboratory

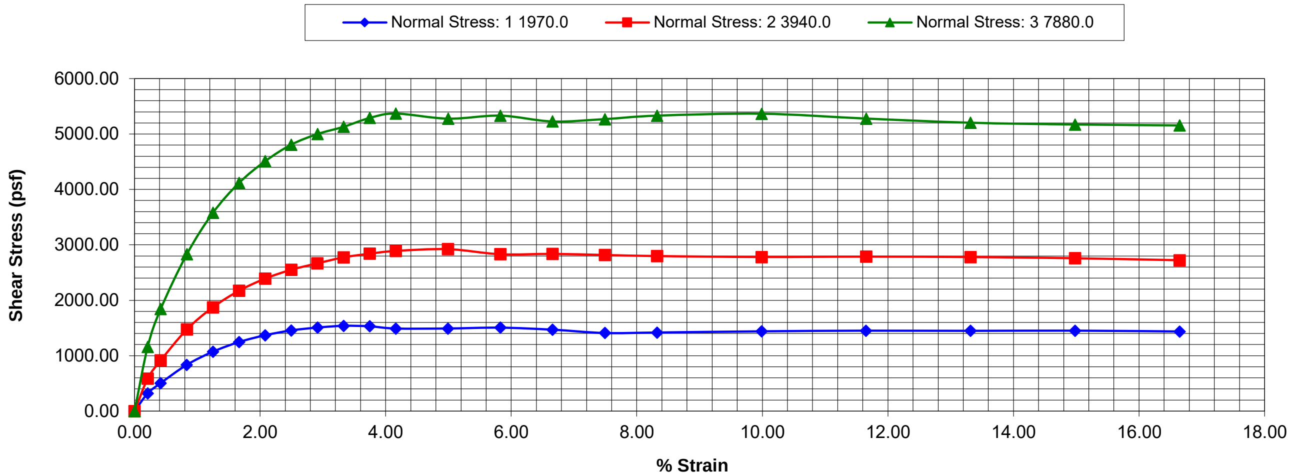
Direct Shear Test of Soils Under Consolidated Drained Conditions (ASTM D 3080)

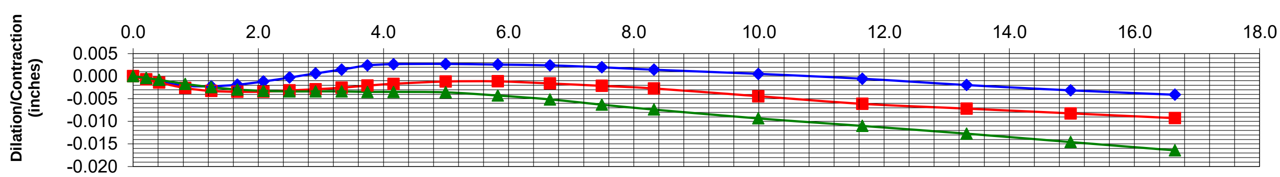
Project Name:	SR302 Landslide		**Project Number:**	2022-043
Sample Point:	HWA-7i-22	**Sample No.:** S-21	**Sample Depth:**	31.5'-32.0'
Soil Description:	Very dark gray, silty SAND			
Soil Color:	Very dark gray		Average Strain Rate:	0.4 % per min.
Soil Group Symbol:	SM		Soil Specific Gravity:	2.65 (assumed)

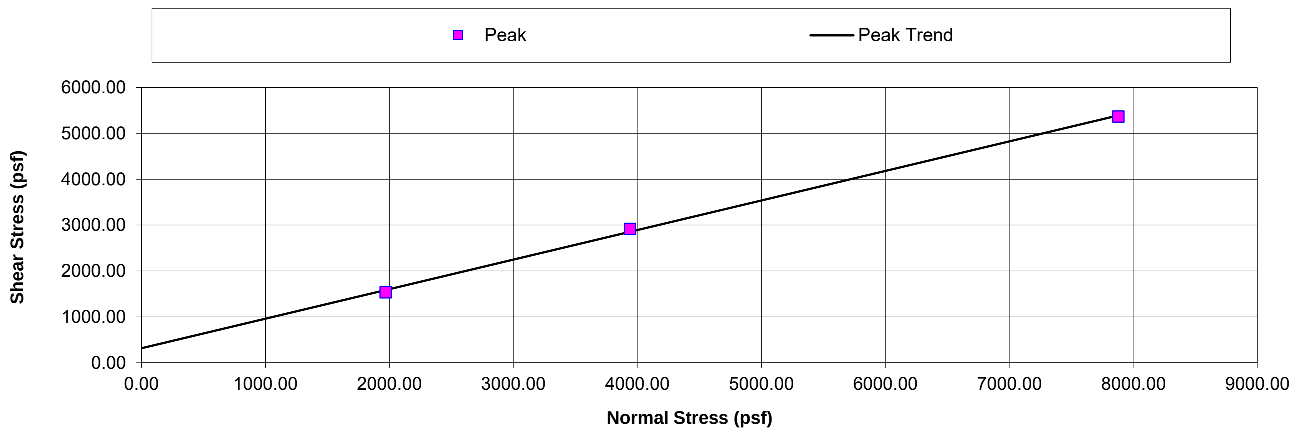
Normal Stress (psf)	1970.00	3940.00	7880.00	**Average**
Peak Stress (psf)	1539.12	2922.04	5369.05	
Initial Moisture Content (%):	29.6	29.6	29.6	29.6
Wet Unit Weight (pcf):	125.0	126.3	123.4	124.9
Dry Unit Weight (pcf):	96.4	97.5	95.2	96.4
Calculated Void Ratio	0.715	0.696	0.736	0.716
Calculated Porosity	0.417	0.410	0.424	0.417
Calculated Saturation (%)	109.6	112.6	106.4	109.5
Final Moisture Content (%)	27.3	26.0	28.4	27.2

Indicated Strength Parameters

	Cohesion psf	phi Angle (degrees)
Peak	315.6	32.8







Checked By: SEG

Figure B36

HWA GEOSCIENCES INC. Materials Testing Laboratory

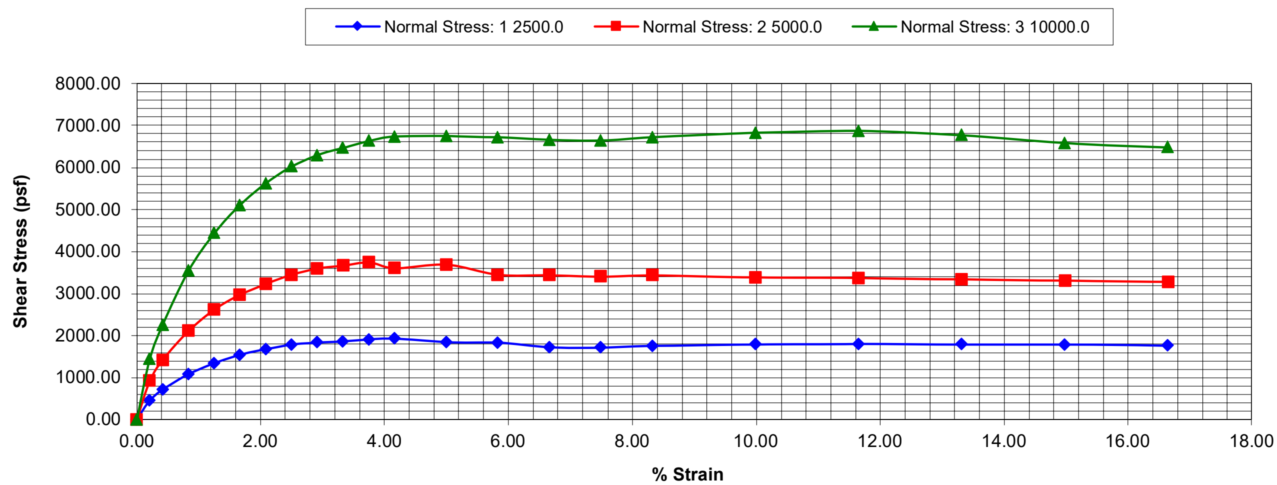
Direct Shear Test of Soils Under Consolidated Drained Conditions (ASTM D 3080)

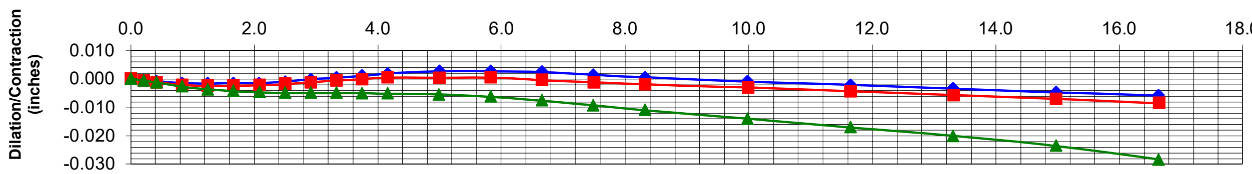
Project Name:	SR302 Landslide	**Project Number:**	2022-043
Sample Point:	HWA-7i-22 **Sample No.:** S-23	**Sample Depth:**	40.5-41.0
Soil Description:	SILT with sand		
Soil Color:	Very dark gray	Average Strain Rate:	0.4 % per min.
Soil Group Symbol:	ML	Soil Specific Gravity:	2.65 (assumed)

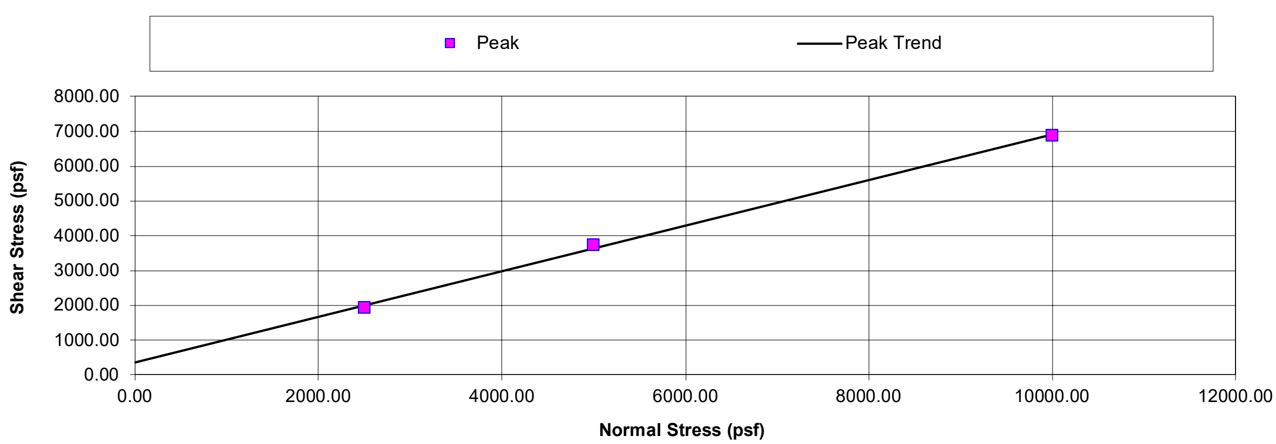
Normal Stress (psf)	2500.00	5000.00	10000.00	**Average**
Peak Stress (psf)	1927.03	3738.98	6869.28	
Initial Moisture Content (%):	26.0	26.0	26.0	26.0
Wet Unit Weight (pcf):	127.1	127.1	125.6	126.6
Dry Unit Weight (pcf):	100.8	100.8	99.6	100.4
Calculated Void Ratio	0.640	0.640	0.660	0.647
Calculated Porosity	0.390	0.390	0.397	0.393
Calculated Saturation (%)	107.8	107.7	104.6	106.7
Final Moisture Content (%)	25.2	25.3	24.4	25.0

Indicated Strength Parameters

	Cohesion psf	phi Angle (degrees)
Peak	361.9	33.2







Checked By: SEG

Figure B37

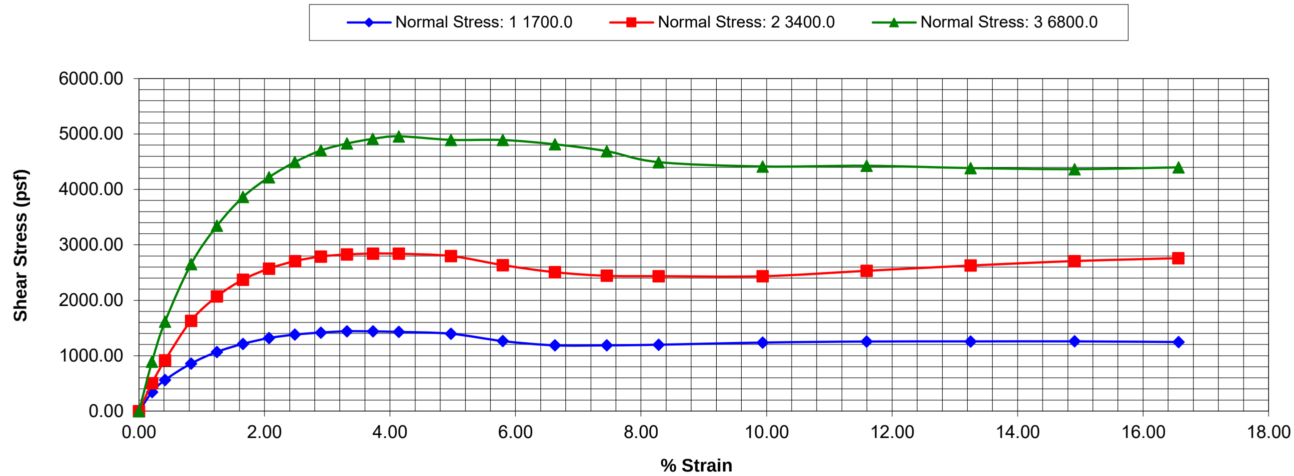
HWA GEOSCIENCES INC. Materials Testing Laboratory
Direct Shear Test of Soils Under Consolidated Drained Conditions (ASTM D 3080)

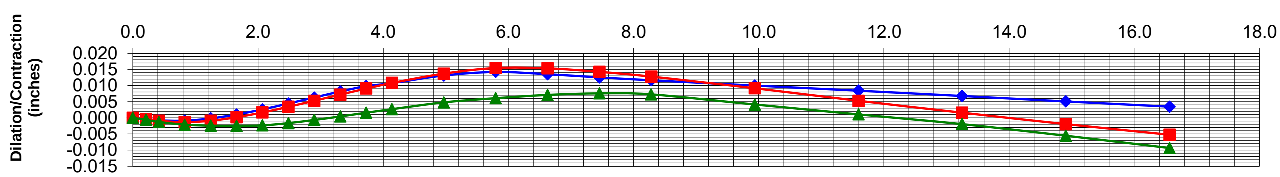
Project Name:	SR302 Landslide		**Project Number:**	2022-043
Sample Point:	HWA-8P-22	**Sample No.:** S-19	**Sample Depth:**	28.5-29.0'
Soil Description:	silty SAND with gravel			
Soil Color:	Olive-brown		Average Strain Rate:	0.5 % per min.
Soil Group Symbol:	SM		Soil Specific Gravity:	2.65 (assumed)

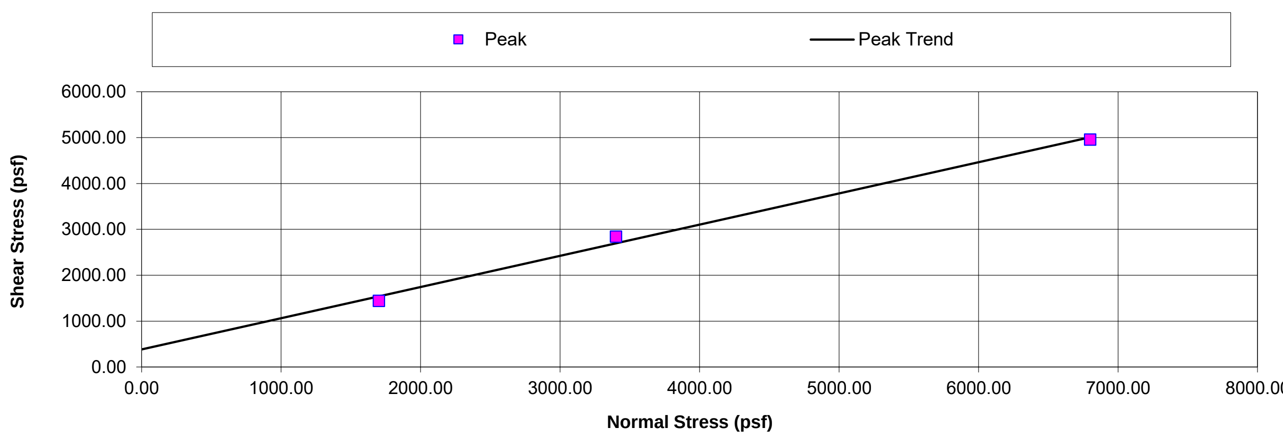
Normal Stress (psf)	1700.00	3400.00	6800.00	**Average**
Peak Stress (psf)	1441.05	2843.07	4958.64	
Initial Moisture Content (%):	25.1	25.1	25.1	25.1
Wet Unit Weight (pcf):	127.6	127.3	126.9	127.3
Dry Unit Weight (pcf):	102.0	101.7	101.4	101.7
Calculated Void Ratio	0.621	0.625	0.630	0.626
Calculated Porosity	0.383	0.385	0.387	0.385
Calculated Saturation (%)	107.1	106.4	105.6	106.4
Final Moisture Content (%)	24.3	24.6	24.6	24.5

Indicated Strength Parameters

	Cohesion psf	phi Angle (degrees)
Peak	383.3	34.2







Checked By: SEG

Figure B38

HWA GeoSciences Inc. Materials Testing Laboratory

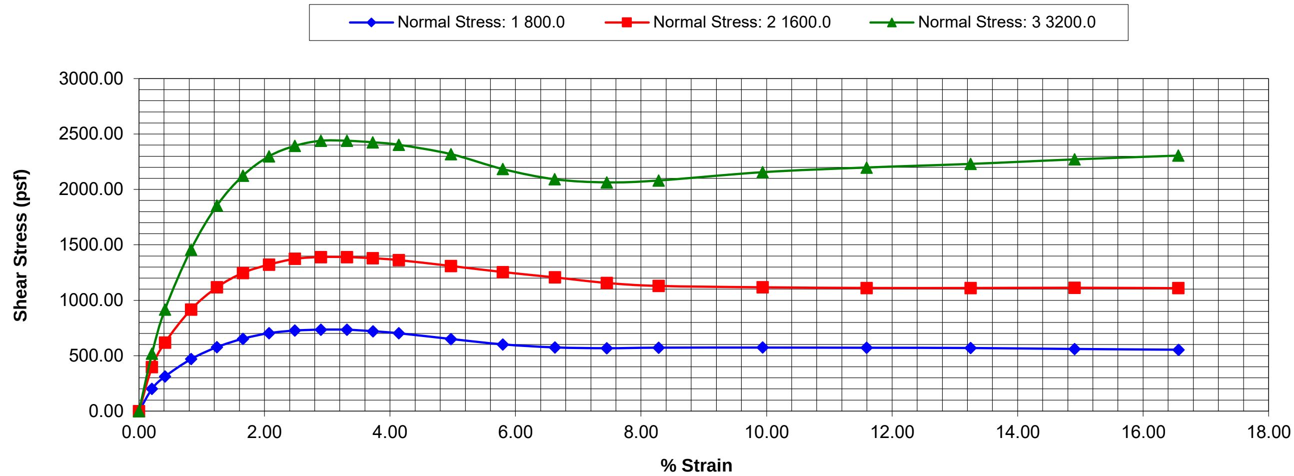
Direct Shear Test of Soils Under Consolidated Drained Conditions (ASTM D 3080)

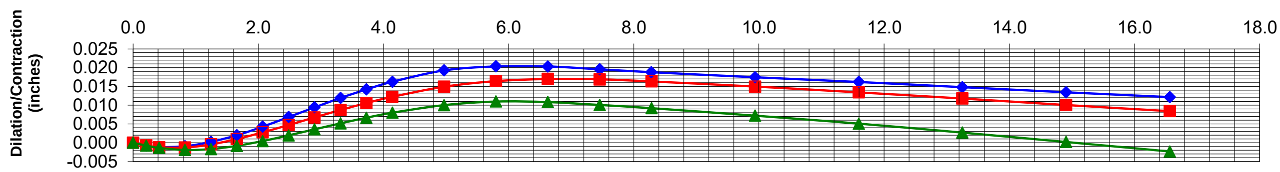
Project Name:	SR302 Landslide	**Project Number:**	2022-043
Sample Point:	HWA-10I-22 **Sample No.:** S-9	**Sample Depth:**	13.5'-14.0'
Soil Description:	poorly graded SAND with silt		
Soil Color:	Dark gray	Average Strain Rate:	0.5 % per min.
Soil Group Symbol:	SP-SM	Soil Specific Gravity:	2.65 (assumed)

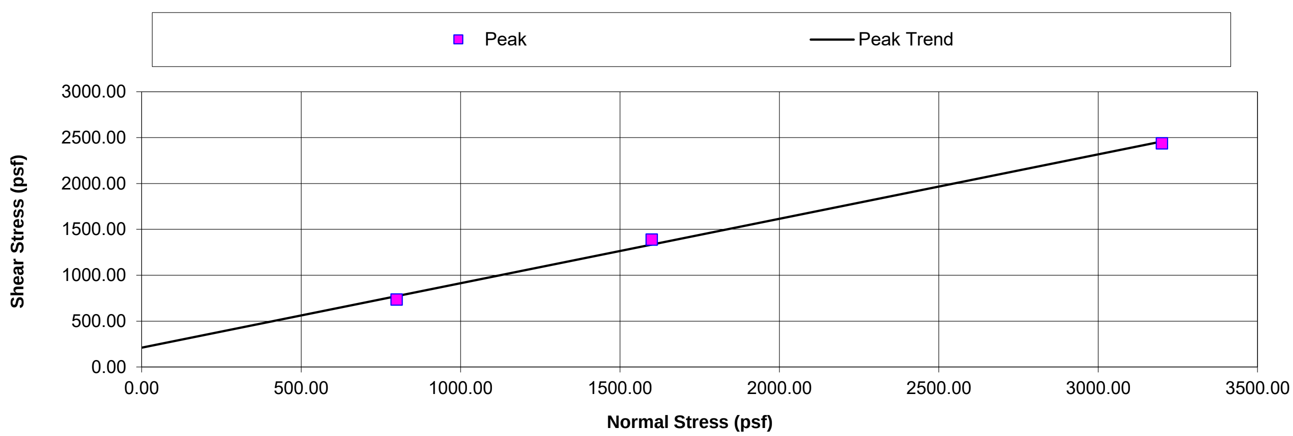
Normal Stress (psf)	800.00	1600.00	3200.00	**Average**
Peak Stress (psf)	735.07	1390.16	2439.31	
Initial Moisture Content (%):	19.6	19.6	19.6	19.6
Wet Unit Weight (pcf):	126.4	125.6	124.4	125.5
Dry Unit Weight (pcf):	105.6	105.0	104.0	104.9
Calculated Void Ratio	0.566	0.575	0.590	0.577
Calculated Porosity	0.361	0.365	0.371	0.366
Calculated Saturation (%)	92.0	90.5	88.2	90.2
Final Moisture Content (%)	25.1	25.6	25.5	25.4

Indicated Strength Parameters

	Cohesion psf	phi Angle (degrees)
Peak	210.5	35.1







Checked By: SEG Figure B39

HWA GeoSciences Inc. Materials Testing Laboratory

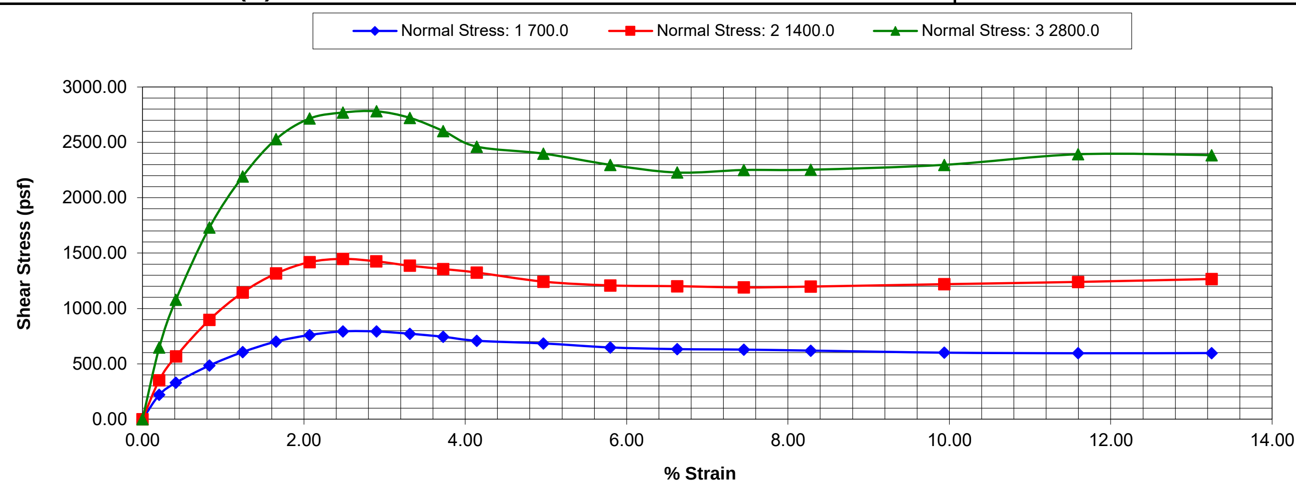
Direct Shear Test of Soils Under Consolidated Drained Conditions (ASTM D 3080)

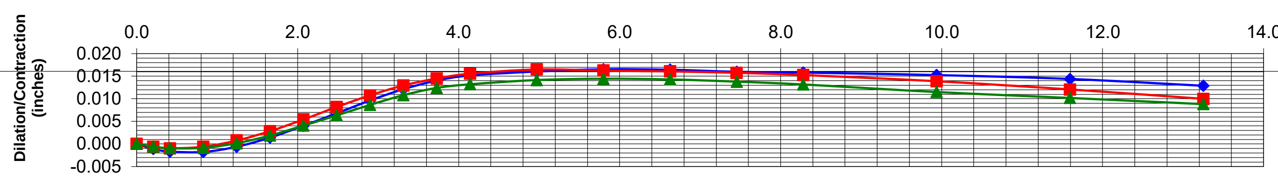
Project Name:	SR302 Landslide	**Project Number:**	2022-043
Sample Point:	HWA-11I-22 **Sample No.:** S-8	**Sample Depth:**	12.5-13.0
Soil Description:	silty SAND		
Soil Color:	Olive-brown	Average Strain Rate:	0.5 % per min.
Soil Group Symbol:	SM	Soil Specific Gravity:	2.65 (assumed)

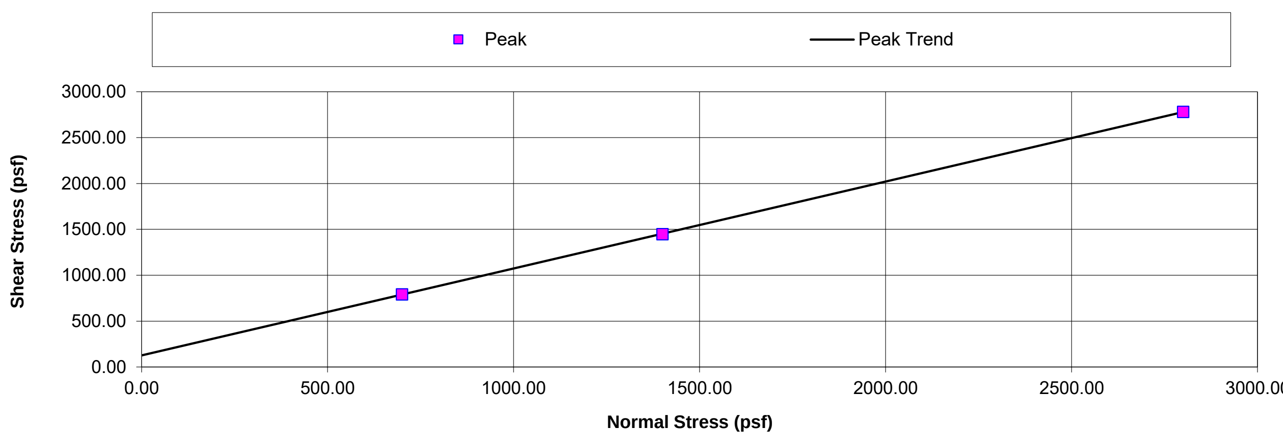
Normal Stress (psf)	700.00	1400.00	2800.00	**Average**
Peak Stress (psf)	793.05	1447.69	2780.59	
Initial Moisture Content (%):	17.4	17.4	17.4	17.4
Wet Unit Weight (pcf):	136.2	137.2	137.8	137.1
Dry Unit Weight (pcf):	116.1	116.9	117.4	116.8
Calculated Void Ratio	0.425	0.415	0.408	0.416
Calculated Porosity	0.298	0.293	0.290	0.294
Calculated Saturation (%)	108.5	111.2	112.9	110.8
Final Moisture Content (%)	16.7	16.2	16.7	16.5

Indicated Strength Parameters

	Cohesion psf	phi Angle (degrees)
Peak	126.6	43.4







Checked By: SEG

Figure B40

APPENDIX C

EXISTING INFORMATION

APPENDIX C: EXPLORATIONS BY OTHERS

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. TH-1-01

PROJECT Victor Land Slide — SR-302 Near Victor

Job No. DM-0000

S.R. 302

Station

Offset 27.0' RT. C.L.

C.S.

Equipment CME 850 w/ autohammer

Casing HQ x 35.0

Ground El (m)

Method of Boring Wet Rotary

Start Date March 6, 2001

Completion Date March 6, 2001

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				0 0 0 (0)		D-1		No Recovery		
5	1									
10	2 3									
15	4							03/06/2001	∇	
20	5 6									

SOIL DMC041-1.GPJ SOIL.GDT 3/21/01 11:39:35 A3

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **TH-1-01**

PROJECT **Victor Land Slide**

Sheet **2** of **2**

Job No. **DM-0000**

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	7									
25										
	8									
	9									
30								End of test hole boring at 30 ft below ground elevation.		
	10									
35										
	11									
	12									
40										
	13									
45										

LOG OF TEST BORING

Washington State
Department of Transportation

HOLE No. **TH-1a-01**

PROJECT **Victor Land Slide** Job No. **DMC-041**

SR-302 Near Victor S.R. **302**

Station Offset C.S.

Equipment **CME 850 w/ autohammer** Casing **HQ x 82.0'** Ground El **(m)**

Method of Boring **Wet Rotary**

Start Date **March 4, 2001** Completion Date **March 5, 2001** Sheet **1** of **4**

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1			3 2 1 (3)		D-1		Silty SAND, very loose, dark yellowish brown, moist, Stratified, no HCl reaction, with root particles and dark brown stains. Top surface weeds. 0.0' to 3.0' Silty SAND with gravel as indicated by drilling and wash return. 100% drilling fluid return. Length Recovered 1.5 ft, Length Retained 1.0 ft Check OK		
5	2									
				3 2 3 (5)		D-2		Poorly graded SAND, very dense, dark yellowish brown, moist, Stratified, no HCl reaction, with Silty SAND lenses and dark brown stains. Length Recovered 0.9 ft, Length Retained 0.9 ft Check OK		
10	3									
	4			3 3 4 (7)		D-3	GS MC	SM, MC=30% Silty SAND, loose, dark yellowish brown, wet, Homogeneous, no HCl reaction, dirty. Length Recovered 1.2 ft, Length Retained 1.0 ft 03/05/2001	∇	
15	5									
				2 3 2 (5)		D-4		Poorly graded SAND, very loose, dark yellowish brown, wet, Stratified, no HCl reaction, with Silty SAND lenses and dark brown stains. Length Recovered 1.1 ft, Length Retained 1.0 ft Check		
20	6									

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **TH-1a-01**

PROJECT **Victor Land Slide**

Job No. **DMC-041**

Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample No. (Tube No.)	Lab Tests	Description of Material
	7	3, 3, 4 (7)	D-5	GS, MC	SM, MC=25% Silty SAND, loose, dark yellowish brown, wet, Stratified, no HCl reaction, with Silty SAND lenses. Length Recovered 0.9 ft, Length Retained 0.9 ft
25	8				
		6, 7, 15 (22)	D-6	GS, MC	ML, MC=29% SILT with sand, medium dense, dark gray, wet, Stratified, no HCl reaction, with horizontal very fine grained Sand partings light gray in color. Length Recovered 1.0 ft, Length Retained 1.0 ft
30	9				
	10	9, 14, 16 (30)	D-7	GS, MC	ML, MC=25% SILT with sand, dense, dark gray, moist, Stratified, no HCl reaction, with 0.4' ft Sandy SILT and horizontal very fine grained Sand partings. Length Recovered 1.5 ft, Length Retained 1.0 ft
35	11				
		11, 21, 37 (58)	D-8	GS, MC, PI	CL, MC=26%, PI=12 Lean CLAY, very dense, olive gray, moist, Stratified, Disrupted, no HCl reaction, with horizontal blocky Silt layers with slickensided. Note at 41.0' water pressure drooped Sand indicated by drilling and wash return. Length Recovered 1.5 ft, Length Retained 1.0 ft
40	12				
	13	15, 25, 27 (52)	D-9		Sandy SILT, very dense, olive gray, wet, Stratified,Disrupted, no HCl reaction, with vertical and horizontal blocky Silt with slickensided greasy and slick. Length Recovered 1.5 ft, Length Retained 1.0 ft
45					

Standard Penetration Blows/ft: 10 20 30 40

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **TH-1a-01**

PROJECT **Victor Land Slide**

Job No. **DMC-041**

Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample No. (Tube No.)	Lab Tests	Description of Material
	14 – 15	12, 16, 20 (36)	D-10	GS, MC	ML, MC=35% OK SILT, dense, olive gray, moist, Stratified, Disrupted, no HCl reaction, with horizontal blocky Silt lenses, pockets and very fine grained Silt partings. Length Recovered 1.5 ft, Length Retained 1.0 ft
50 – 55	16	8, 10, 11 (21)	D-11	GS, MC, PI	CH, MC=46%, PI=36 Fat CLAY, medium dense, olive gray, moist, Stratified, Disrupted, no HCl reaction, with horizontal blocky Silt lenses, very fine grained thin Silt layers and partings. Length Recovered 1.5 ft, Length Retained 1.0 ft
55 – 60	17 – 18	6, 11, 15 (26)	D-12		CH SILT, dense, olive gray, moist, Stratified,Blocky,Disrupted, no HCl reaction, with horizontal Silt lenses and very fine grained Silt partings. Length Recovered 1.5 ft, Length Retained 1.0 ft
60 – 65	19	11, 15, 20 (35)	D-13		CH SILT, dense, olive gray, moist, Stratified,Blocky,Disrupted, no HCl reaction, horizontal Silt lenses and very fine grained Silt partings light gray in color. Length Recovered 1.5 ft, Length Retained 1.0 ft
65 – 70	20 – 21	110/6" (110/6")	D-14		Till Well graded GRAVEL with sand, subrounded, very dense, dark yellowish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft

SOIL DMC041-1.GPJ SOIL.GDT 4/30/01 9:45:45 A4

HOLE No. **TH-1a-01**

PROJECT **Victor Land Slide**

Job No. **DMC-041**

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	22		>>	125/3" (125/3")		D-15		Well graded GRAVEL with sand, subrounded, very dense, dark yellowish brown, wet, Homogeneous, no HCl reaction, slightly cemented with a silt matrix. Note encountered gravel at 66.0' as indicated by drilling. Length Recovered 0.2 ft, Length Retained 0.2 ft		
75	23									
			>>	118/6" (118/6")		D-16		Well graded GRAVEL with sand, subrounded, very dense, dark yellowish brown, wet, Stratified, no HCl reaction, with Silty SAND. Note bailed out hole water table stabilized at 22.5'. Length Recovered 0.5 ft, Length Retained 0.5 ft End of test hole boring at 78.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
	24									
80										
	25									
85	26									
	27									
90										
	28									
95										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-2-01**

PROJECT **Victor Land Slide** Job No. **DM-0000**

SR-302 Near Victor S.R. **302**

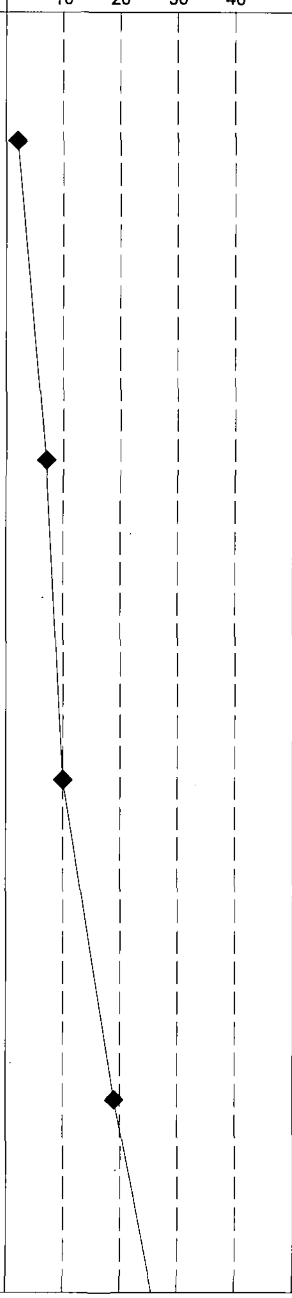
Station ____ Offset ____ C.S. ____

Equipment **CME 850 w/ autohammer** Casing **HQx82** Ground El **(m)**

Method of Boring **Wet Rotary**

Start Date **March 3, 2001** Completion Date **March 4, 2001** Sheet **1** of **4**

Standard Penetration Blows/ft (10, 20, 30, 40)



Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample No. (Tube No.)	Lab Tests	Description of Material
		0, 1, 1 (2)	D-1		Poorly graded SAND, very loose, light olive brown, moist, Stratified, no HCl reaction, with traces of wood debris and hair roots. Length Recovered 1.0 ft
		2, 3, 4 (7)	D-2		Poorly graded SAND, loose, grayish brown, moist, Homogeneous, no HCl reaction Length Recovered 0.9 ft
		5, 5, 5 (10)	D-3		Poorly graded SAND, loose, grayish brown, wet, Laminated, no HCl reaction, with FeO stains and some silt. Length Recovered 1.1 ft
		7, 8, 11 (19)	D-4		Silty SAND, medium dense, dark grayish brown, wet, Stratified,Laminated, no HCl reaction, silty sand stratified with sandy silt. Length Recovered 1.5 ft

Depth scale (ft): 5, 10, 15, 20; Meters scale: 1, 2, 3, 4, 5, 6

Columns: Profile, Sample Type, Groundwater, Instrument

SOIL DMC041~1.GPJ SOIL.GDT 3/21/01 11:38:02 A3

LOG OF TEST BORING

Washington State Department of Transportation

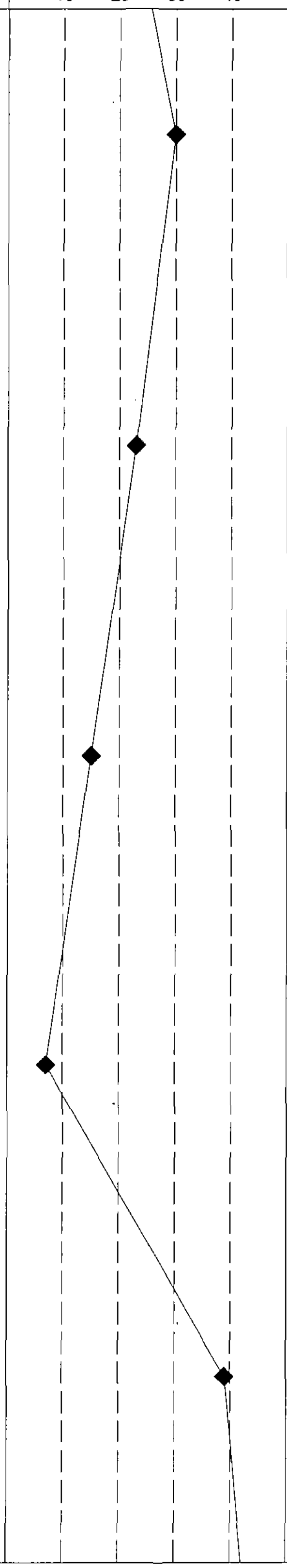
HOLE No. **H-2-01**

PROJECT **Victor Land Slide**

Job No. **DM-0000**

Depth (ft): 25, 30, 35, 40, 45 — Meters (m): 7, 8, 9, 10, 11, 12, 13

Standard Penetration Blows/ft (10, 20, 30, 40)



SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
6 12 18 (30)		D-5		Sandy SILT, dense, dark grayish brown, wet, Laminated, no HCl reaction Length Recovered 1.2 ft
16 12 11 (23)		D-6		Sandy SILT, medium dense, dark gray, wet, Laminated, no HCl reaction, at 28' to 28.5 possible slide debris with FeO stains. I split the samples A and B. Length Recovered 1.5 ft
6 7 8 (15)		D-7		Poorly graded SAND, medium dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 1.1 ft
4 4 3 (7)		D-8		Sandy SILT, loose, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 1.2 ft
8 18 21 (39)		D-9		Sandy SILT, dense, dark gray, wet, Homogeneous, no HCl reaction, possible slide debris from 47 to 47.5'. Length Recovered 1.5 ft

Groundwater | Instrument

LOG OF TEST BORING

Washington State Department of Transportation

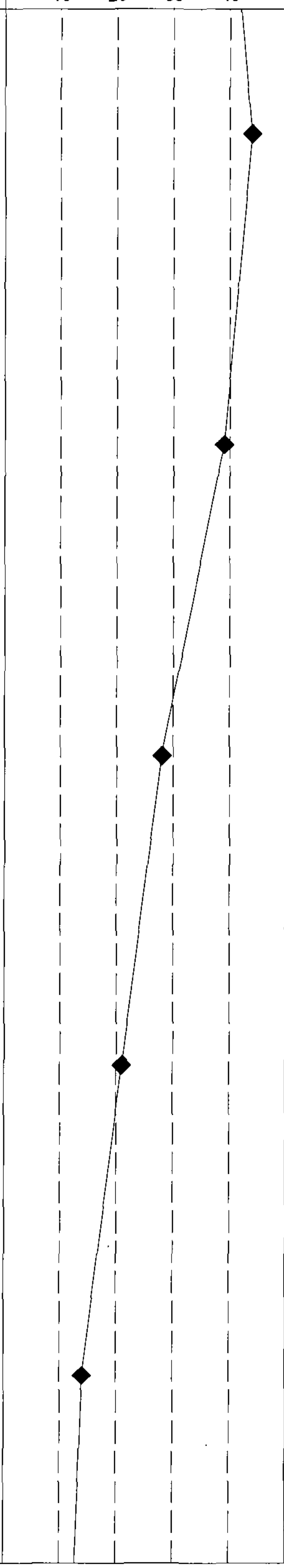
HOLE No. **H-2-01**

PROJECT **Victor Land Slide**

Job No. **DM-0000**

Depth (ft): 50, 55, 60, 65, 70
Meters (m): 14, 15, 16, 17, 18, 19, 20, 21

Standard Penetration Blows/ft



SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
11 16 28 (44)		D-10		SILT, dense, dark gray, wet, Laminated, no HCl reaction, possible slide debris from 48 to 48.5'. Length Recovered 1.5 ft		
9 15 24 (39)		D-11		SILT, dense, dark gray, moist, Laminated, no HCl reaction, the bottom 2" of the sample was dry. Length Recovered 1.5 ft		
7 13 15 (28)		D-12		SILT, dense, dark gray, moist, Laminated,Disrupted, no HCl reaction, 03/04/01 7A.M. the water table inside the casing was at 6'. Length Recovered 1.5 ft		
6 9 12 (21)		D-13		SILT, medium dense, dark gray, moist, Laminated,Disrupted, no HCl reaction, portions laminated and disrupted. Length Recovered 1.5 ft		
4 6 8 (14)		D-14		SILT, medium dense, dark gray, moist, Laminated,Disrupted, no HCl reaction, portions laminated and disrupted Length Recovered 1.5 ft		

LOG OF TEST BORING

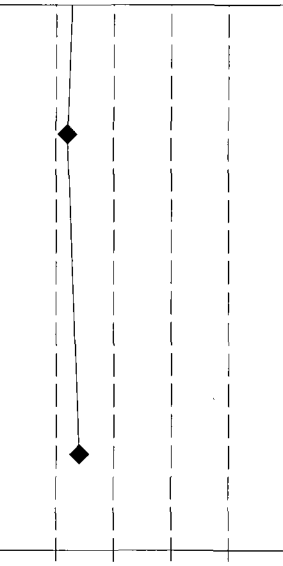
Washington State Department of Transportation

HOLE No. **H-2-01**

PROJECT **Victor Land Slide**

Job No. **DM-0000**

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	22			3 5 7 (12)		D-15		SILT, medium dense, dark gray, moist, Laminated, no HCl reaction, moist to dry Length Recovered 1.5 ft		
75	23									
				3 6 8 (14)		D-16		SILT, medium dense, dark gray, moist, Laminated, no HCl reaction, the sample was moist to dry. On 03/04/01 at 12:40 P.M. the water table inside the casing was at 9'. One hour later the water was at 9.3'. We bailed the hole to 73' and 5 minutes later it recharge to 3.5' then slowly dropped to 3.9. Length Recovered 1.5 ft End of test hole boring at 78.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
	24									
80										
	25									
85	26									
	27									
90										
	28									
95										



LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-3-01**

PROJECT **Victor Land Slide** MP 4.7 — Job No. **DMC-041**

SR-302 Near Victor — S.R. **302**

Station ____ Offset ____ C.S. ____

Equipment **CME 850 w/ autohammer** — Casing **HQ x 59.0** — Ground El **(m)**

Method of Boring **Wet Rotary**

Start Date **March 6, 2001** — Completion Date **March 6, 2001** — Sheet **1** of **3**

Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample No. (Tube No.)	Lab Tests	Description of Material
4–5.5		2 4 6 (10)	D-1		Silty SAND with gravel, loose, reddish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.1 ft Fill Check OK
9–10.5	3	2 2 2 (4)	D-2	MC GS	ML, MC=26% and sand SILT with organics, very loose, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft Fill
14–15.5		0 1 3 (4)	D-3		Silty SAND, with organics, very loose, gray, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft Check fill
19–20	6	2 3	D-4	MC GS	ML, MC=19% SILT, loose, brown, wet, Homogeneous, no HCl reaction

SOIL DMC041-1.GPJ SOIL.GDT 4/11/01 9:31:54 A4

LOG OF TEST BORING

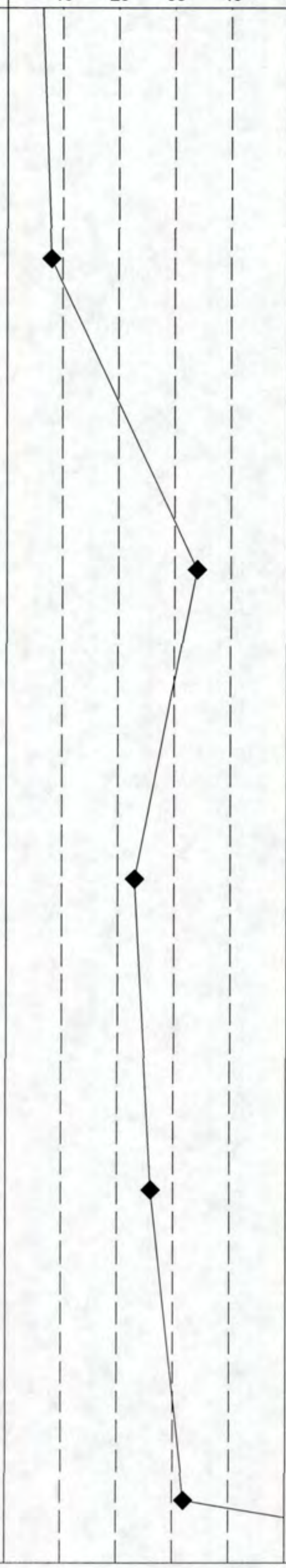
Washington State Department of Transportation

HOLE No. **H-3-01**

Sheet **2** of **3**

PROJECT **Victor Land Slide**

Job No. **DMC-041**



Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample No. (Tube No.)	Lab Tests	Description of Material
		3 (6)			Length Recovered 0.2 ft
	7				
25		4 4 4 (8)	D-5		~~Poorly graded~~ SAND, loose, gray, wet, Homogeneous, no HCl reaction Length Recovered 0.2 ft (handwritten: Silty sand; check)
	8				
30	9	9 16 18 (34)	D-6	GS MC	(handwritten: OK) SM, MC=27% Silty SAND, dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft
	10				
35		8 10 13 (23)	D-7	(handwritten: GS)	(handwritten: OK) ~~ML~~, MC=27% SILT with sand, medium dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft
	11				(handwritten, crossed out: no sample)
40	12	6 12 14 (26)	D-8		(handwritten: OK check) Silty SAND, dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft
	13				
45		10 13	D-9	GS ~~MC~~	(handwritten: OK) ML, MC=26% ~~S~~andy SILT, dense, gray, wet, Homogeneous, no HCl

Columns: Depth (ft) · Meters (m) · Profile · Standard Penetration Blows/ft · SPT Blows/6" (N) · Sample Type · Sample No. (Tube No.) · Lab Tests · Description of Material · Groundwater · Instrument

SOIL DMC041-1.GPJ SOIL.GDT 4/11/01 9:31:54 A4

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-3-01**

Sheet 3 of 3

PROJECT **Victor Land Slide**

Job No. **DMC-041**

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	14			19 (32)				reaction Length Recovered 1.0 ft		
50	15		>>	12 16 20 (361) 36		D-10		Sandy Silt ~~Check~~ ~~Silty SAND~~, dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft		
55	16 / 17			12 14 22 (36)		D-11		Sandy Silt ~~Check~~ ~~Silty SAND~~, dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft		
60	18			13 18 31 (49)		D-12	GS MC	ML, MC=25% Silt w/ sand ~~Sandy~~ SILT, dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft End of test hole boring at 60.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
65	19 / 20									
70	21									

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-4-01**

PROJECT **Victor Land Slide** Job No. **DMC-041**

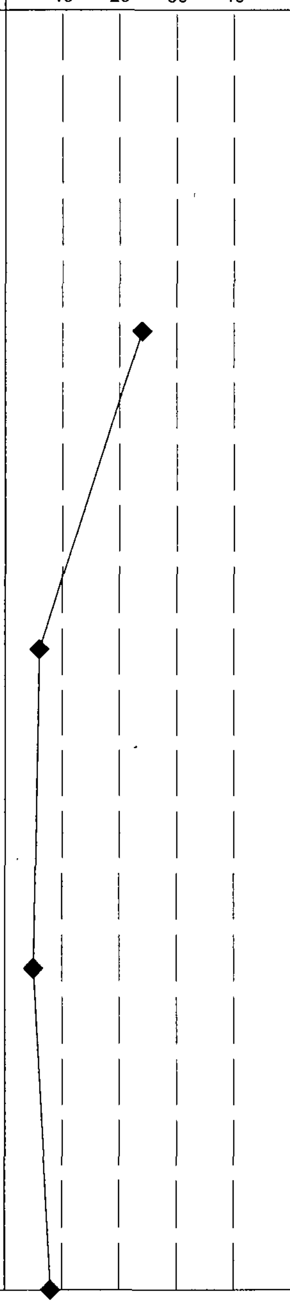
SR-302 Near Victor S.R. **302**

Station ______ Offset **15' of E fogline** C.S. ______

Equipment **CME 45 w/ autohammer** Casing **HQ** Ground El **-5.0 (-1.52 m)**

Method of Boring **Wet Rotary**

Start Date **November 27, 2001** Completion Date **November 27, 2001** Sheet **1** of **3**



Depth (ft)	Meters (m)	Profile	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
~2							11/27/2001	∇	
5			4 8 16 (24)		D-1		Well graded GRAVEL with sand, subrounded, medium dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
10	3		2 3 3 (6)		D-2		Well graded GRAVEL with sand, subrounded, loose, gray, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft		
15			2 3 2 (5)		D-3		Poorly graded SAND with gravel, loose, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
20	6								

LOG OF TEST BORING

Washington State
Department of Transportation

HOLE No. **H-4-01**

Sheet 2 of 3

PROJECT **Victor Land Slide**

Job No. **DMC-041**

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				2 3 5 (8)		D-4		Poorly graded SAND, loose, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
25	7, 8			4 7 9 (16)		D-5		Poorly graded SAND, medium dense, gray, wet, Homogeneous, no HCl reaction, w/silt lenses Length Recovered 1.0 ft, Length Retained 1.0 ft		
30	9			14 15 20 (35)		D-6		Poorly graded SAND, dense, gray, wet, Homogeneous, no HCl reaction, w/silt lenses Length Recovered 1.5 ft, Length Retained 1.5 ft		
35	10, 11			10 14 28 (42)		D-7		Poorly graded SAND, dense, gray, wet, Homogeneous, no HCl reaction, w/silt lenses and wood chips Length Recovered 1.5 ft, Length Retained 1.5 ft		
40	12			10 19 28 (47)		D-8		Silty SAND, dense, gray, wet, Homogeneous, no HCl reaction, w/silt lenses Length Recovered 1.5 ft, Length Retained 1.5 ft		
45	13									

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-4-01**

PROJECT **Victor Land Slide**

Job No. **DMC-041**

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	14			16 20 30 (50)		D-9		Silty SAND, dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
50	15		>>	19 26 30 (56)		D-10		Silty SAND, very dense, gray, wet, Homogeneous, no HCl reaction, w/silt lenses Length Recovered 1.5 ft, Length Retained 1.5 ft		
55	16, 17							End of test hole boring at 51.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
60	18, 19									
65	20, 21									
70										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-5-01**

PROJECT **Victor Land Slide** Job No. **DMC-041**

SR-302 Near Victor S.R. **302**

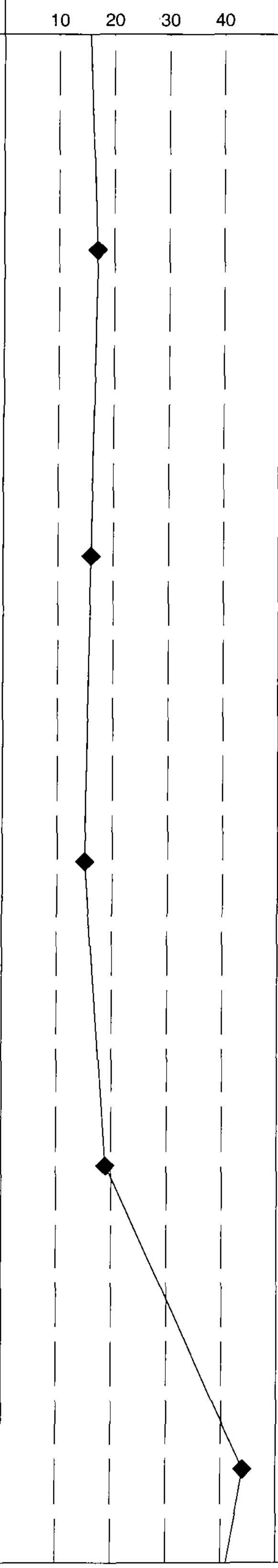
Station ______ Offset ______ C.S. ______

Equipment **CME 850 w/ autohammer** Casing **HQ** Ground El **(m)**

Method of Boring **Wet Rotary**

Start Date **November 14, 2001** Completion Date **November 15, 2001** Sheet **1** of **4**

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1									
5				3 3 9 (12)		D-1		Poorly graded SAND, with trace gravel., medium dense, olive brown., moist, Stratified, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
	2									
10	3			7 12 12 (24)		D-2		Poorly graded SAND, medium dense, olive brown, moist, Stratified, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
	4									
15				4 8 12 (20)		D-3		Poorly graded SAND, medium dense, olive brown, moist, Stratified, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
	5									
20	6			4 7 8		D-4		Poorly graded SAND, with trace silt., medium dense, olive brown, moist, Stratified, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		



Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
		(15)				
	7					
		7 8 9 (17)		D-5		Poorly graded SAND, with trace silt., medium dense, olive brown, moist, Stratified, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft
25						
	8					
		7 8 8 (16)		D-6		Poorly graded SAND, with some silt., medium dense, olive brown, wet, Stratified, no HCl reaction, Note drilling behavior indicates silt layers stratified throughout run. Some iron staining. Length Recovered 1.5 ft, Length Retained 1.5 ft
	9					
30						
	10					
		5 8 7 (15)		D-7		Poorly graded SAND, medium dense, olive brown, wet, Stratified, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft
35						
	11					
		6 8 11 (19)		D-8		Poorly graded SAND, with silt, medium dense, olive brown, moist, Stratified, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft
	12					
40						
	13					
		14 21 23		D-9		Poorly graded SAND, with trace silt., dense, olive gray, wet, Stratified, no HCl reaction, Note top .1' silt. Color change in drill fluid at 43'.
45						

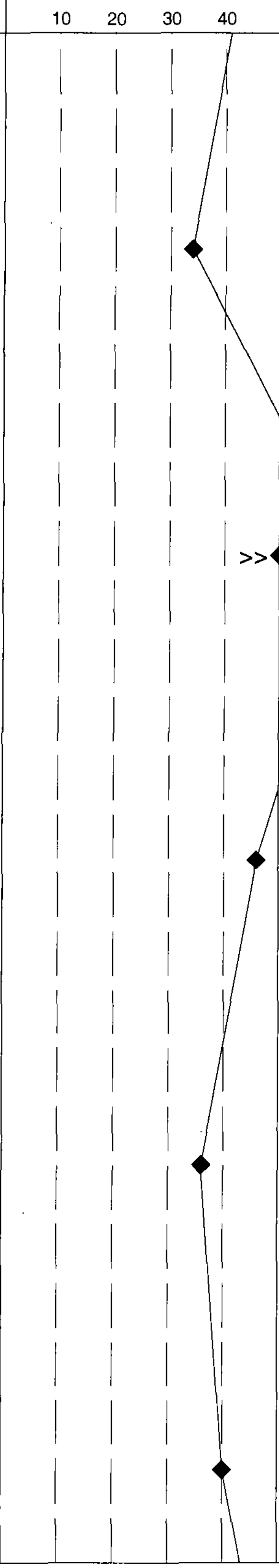
LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-5-01**

PROJECT **Victor Land Slide**

Job No. **DMC-041**



Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
	14	(44)				Length Recovered 1.2 ft, Length Retained 1.2 ft
50	15	12 16 18 (34)		D-10		Poorly graded SAND, dense, olive gray, wet, Stratified, no HCl reaction Length Recovered 0.7 ft, Length Retained 0.7 ft
55	16–17	21 29 34 (63)		D-11		Poorly graded SAND, very dense, olive gray, wet, Stratified, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft
60	18	15 22 24 (46)		D-12		Poorly graded SAND, dense, olive gray, wet, Stratified, no HCl reaction, Note some iron staining. Length Recovered 0.7 ft, Length Retained 0.7 ft
65	19–20	13 17 19 (36)		D-13		Poorly graded SAND, with silt., dense, greenish gray, wet, Stratified, no HCl reaction, Note color change in drill fluid at 61.5' Length Recovered 1.5 ft, Length Retained 1.5 ft
70	21	14 18 22		D-14		Poorly graded SAND, with silt., dense, greenish gray, wet, Stratified, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft

Columns: Depth (ft), Meters (m), Profile, Standard Penetration Blows/ft, SPT Blows/6" (N), Sample Type, Sample No. (Tube No.), Lab Tests, Description of Material, Groundwater, Instrument

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-5-01**

PROJECT **Victor Land Slide**

Job No. **DMC-041**

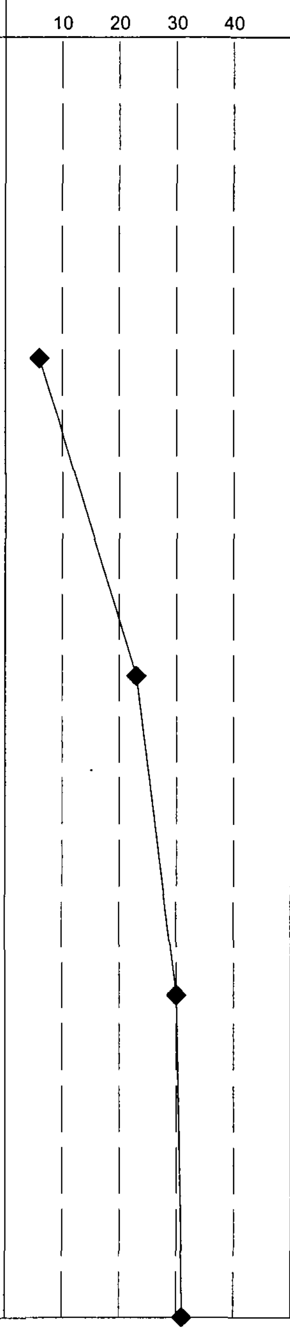
Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	22			(40)						
			>>	15 22 29 (51)		D-15		Poorly graded SAND, with silt., dense, greenish gray, wet, Stratified, no HCl reaction Length Recovered 0.6 ft, Length Retained 0.6 ft		
75	23							End of test hole boring at 75 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
	24									
80										
	25									
85	26									
	27									
90										
	28									
95										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No.	H-6-01		
PROJECT	Victor Land Slide	Job No.	DMC-041
	SR-302 Near Victor	S.R.	302
Station		Offset	
C.S.			
Equipment	CME 850 w/ autohammer	Casing	HQ
Ground El	(m)		
Method of Boring	Wet Rotary		
Start Date	November 27, 2001	Completion Date	November 28, 2001
Sheet	1 of 4		

Standard Penetration Blows/ft



Depth (ft)	Meters (m)	Profile	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1								
5			2 3 3 (6)		D-1		Poorly graded SAND, with some fine gravel & wood debris., loose, olive brown, moist, Stratified, no HCl reaction Length Recovered 0.8 ft, Length Retained 0.8 ft		
	2								
10	3		7 11 12 (23)		D-2		Poorly graded SAND, with trace silt., medium dense, olive gray, moist, Stratified, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
	4								
15			7 14 16 (30)		D-3		Poorly graded SAND, with some sandy silt., dense, olive gray, moist, Stratified, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
	5								
	6								
20									

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-6-01**

Sheet **2** of **4**

PROJECT **Victor Land Slide**

Job No. **DMC-041**

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (N plotted)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			31	10 13 18 (31)		D-4		Poorly graded SAND, with trace silt., dense, olive gray, moist, Stratified, no HCl reaction Length Recovered 1.3 ft, Length Retained 1.3 ft		
	7									
25			28	12 13 15 (28)		D-5		Poorly graded SAND, dense, olive gray, wet, Disrupted, no HCl reaction, Note top .4', sandy silt (disrupted). Remainder of sample, sand, with iron staining throughout. Length Recovered 1.3 ft, Length Retained 1.3 ft		
	8									
	9									
30			20	7 9 11 (20)		D-6		Poorly graded SAND, medium dense, olive gray, wet, Stratified, no HCl reaction Length Recovered 1.3 ft, Length Retained 1.3 ft		
	10									
35			23	7 11 12 (23)		D-7		Poorly graded SAND, with trace silt., medium dense, dark greenish gray, wet, Stratified, no HCl reaction Length Recovered 1.2 ft, Length Retained 1.2 ft		
	11									
	12									
40			36	10 16 20 (36)		D-8		Poorly graded SAND, with trace silt, dense, olive gray, wet, Stratified, no HCl reaction Length Recovered 1.3 ft, Length Retained 1.3 ft		
	13									
45										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-6-01**

Sheet **3** of **4**

PROJECT **Victor Land Slide**

Job No. **DMC-041**

Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample No. (Tube No.)	Description of Material
	14	7, 14, 18 (32)	D-9	Silty SAND, dense, dark greenish gray, wet, Stratified, no HCl reaction, Note top .8' sand & bottom .2' silt. Length Recovered 1.5 ft, Length Retained 1.5 ft
	15			
50		10, 13, 20 (33)	D-10	Sandy SILT, dense, dark greenish gray, wet, Disrupted, no HCl reaction. Length Recovered 1.3 ft, Length Retained 1.3 ft
	16			
55	17	8, 16, 20 (36)	D-11	Silty SAND, dense, dark greenish gray, wet, Disrupted, no HCl reaction. Length Recovered 1.3 ft, Length Retained 1.3 ft
	18			
60		9, 16, 20 (36)	D-12	Silty SAND, dense, dark greenish gray, wet, Stratified, no HCl reaction. Length Recovered 1.3 ft, Length Retained 1.3 ft
	19			
65	20	8, 15, 18 (33)	D13	Silty SAND, dense, dark greenish gray, wet, Stratified, no HCl reaction. Length Recovered 1.3 ft, Length Retained 1.3 ft
	21			
70				

Column headings: Depth (ft) · Meters (m) · Profile · Standard Penetration Blows/ft (10, 20, 30, 40) · SPT Blows/6" (N) · Sample Type · Sample No. (Tube No.) · Lab Tests · Description of Material · Groundwater · Instrument

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-6-01**

Sheet **4** of **4**

PROJECT **Victor Land Slide**

Job No. **DMC-041**

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				7 14 19 (33)		D-14		Sandy SILT, dense, dark greenish gray, wet, Stratified, no HCl reaction, Note bottom .4' silty sand, very wet. Length Recovered 1.3 ft, Length Retained 1.3 ft		
	22									
75	23		>>	16 24 32 (56)		D-15		Silty SAND, very dense, dark greenish gray, wet, Stratified, no HCl reaction Length Recovered 1.3 ft, Length Retained 1.3 ft		
	24									
80				10 18 27 (45)		D-16		Sandy SILT, dense, dark greenish gray, wet, Stratified, no HCl reaction, Note bottom .2', silty sand. Length Recovered 1.1 ft, Length Retained 1.1 ft		
	25									
85	26			7 17 23 (40)		D-17		Sandy SILT, dense, dark greenish gray, wet, Stratified, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
								End of test hole boring at 86.5 ft below ground elevation.		
	27							This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
90										
	28									
95										

SOIL DMC041~1.GPJ SOIL.GDT 12/3/01 7:42:10 A12

LOG OF TEST BORING

Washington State
Department of Transportation

HOLE No. **H-7-01**

PROJECT **Victor Land Slide**

SR-302 Near Victor

Job No. **DMC-041**

S.R. **302**

Station ______ Offset ______ C.S. ______

Equipment **CME 850 w/ autohammer** Casing **HQ** Ground El **(m)**

Method of Boring **Wet Rotary**

Start Date **December 3, 2001** Completion Date **December 5, 2001** Sheet **1** of **6**

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	1									
5				25 50/6 (50/6")		D-1		Silty SAND with gravel, very dense, olive brown, moist, Homogeneous, no HCl reaction, Note drilling indicates cobbles (small). Length Recovered 0.4 ft, Length Retained 0.4 ft		
	2									
10	3			37 50/5" (50/5")		D-2		Silty SAND with gravel, & cobbles., very dense, olive brown, moist, Homogeneous, no HCl reaction Length Recovered 0.9 ft, Length Retained 0.9 ft		
	4									
15				37 50/6 (50/6")		D-3		Silty GRAVEL with sand, subrounded, very dense, olive brown, moist, Homogeneous, no HCl reaction Length Recovered 0.8 ft, Length Retained 0.8 ft		
	5									
20	6		>>	31 40		D-4		Silty SAND with gravel, very dense, olive brown, moist, Homogeneous, no HCl reaction		

SOIL DMC041 VICTOR LAND SLIDE.GPJ SOIL.GDT 12/7/01 9:32:34 A12

HOLE No. **H-7-01**

PROJECT **Victor Land Slide**

Job No. **DMC-041**

Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample No. (Tube No.)	Description of Material
		43 (83)		Length Recovered 1.2 ft, Length Retained 1.2 ft
	7			
25		24 26 22 (48)	D-5	Silty GRAVEL with sand, subrounded, dense, olive brown, moist, Homogeneous, no HCl reaction, Note, drilling indicates possible cobbles (small) Length Recovered 0.8 ft, Length Retained 0.8 ft
	8			
30	9	28 36 42 (78)	D-6	Silty GRAVEL with sand, subrounded, very dense, olive gray, moist, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft
	10			
35		41 50/4" (50/4")	D-7	Silty GRAVEL with sand, subrounded, very dense, olive brown, moist, Homogeneous, no HCl reaction Length Recovered 0.7 ft, Length Retained 0.7 ft
	11			
40	12	38 41 46 (87)	D-8	Silty GRAVEL with sand, subrounded, very dense, olive brown, moist, Homogeneous, no HCl reaction Length Recovered 1.2 ft, Length Retained 1.2 ft
	13			
45		13 20	D-9	Poorly graded SAND, dense, olive, wet, Stratified, no HCl reaction

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-7-01**

Sheet **3** of **6**

PROJECT **Victor Land Slide**

Job No. **DMC-041**

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				23 (43)				Length Recovered 1.2 ft, Length Retained 1.2 ft		
	14									
	15		>>	23 40 45 (85)		D-10		Poorly graded SAND with gravel, very dense, olive gray, moist, Stratified, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
50										
	16									
55			>>	18 26 29 (55)		D-11		Poorly graded SAND, with trace silt &trace gravel., very dense, olive brown, moist, Stratified, no HCl reaction Length Recovered 0.7 ft, Length Retained 0.7 ft		
	17									
	18			18 18 25 (43)		D-12		Poorly graded SAND, dense, olive brown, wet, Stratified, no HCl reaction Length Recovered 0.7 ft, Length Retained 0.7 ft		
60										
	19									
65			>>	23 35 46 (81)		D-13		Poorly graded SAND, very dense, olive brown, wet, Stratified, no HCl reaction Length Recovered 1.3 ft, Length Retained 1.3 ft		
	20									
	21		>>	19 23		D-14		Poorly graded SAND, very dense, olive brown, wet, Stratified, no HCl reaction		
70										

LOG OF TEST BORING

Washington State
Department of Transportation

HOLE No. H-7-01

Sheet 4 of 6

PROJECT Victor Land Slide

Job No. DMC-041

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				28 (51)				Length Recovered 1.1 ft, Length Retained 1.1 ft		
75	22, 23			16 21 27 (48)		D-15		Poorly graded SAND, with some sandy silt., dense, olive brown, wet, Stratified, no HCl reaction Length Recovered 1.1 ft, Length Retained 1.1 ft		
80	24		>>	19 30 35 (65)		D-16		Silty SAND, very dense, olive brown , moist, Stratified, no HCl reaction Length Recovered 0.4 ft, Length Retained 0.4 ft		
85	25, 26			14 22 25 (47)		D-17		Poorly graded SAND, with trace silt., dense, olive brown, wet, Stratified, no HCl reaction Length Recovered 1.2 ft, Length Retained 1.2 ft		
90	27			14 20 25 (45)		D-18		12/05/2001 Poorly graded SAND, with trace silt., dense, olive brown., wet, Stratified, no HCl reaction Length Recovered 1.2 ft, Length Retained 1.2 ft	∇	
95	28			14 20		D-19		Poorly graded SAND, with trace silt., dense, olive gray, wet, Stratified, no HCl reaction, Note driller indicates color		

Depth ticks: 75, 80, 85, 90, 95 ft; Meter ticks: 22, 23, 24, 25, 26, 27, 28 m.

LOG OF TEST BORING

Washington State
Department of Transportation

HOLE No. **H-7-01**

PROJECT **Victor Land Slide**

Job No. **DMC-041**

Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample No. (Tube No.)	Description of Material
	29	24 (44)		change at 91.5' Length Recovered 1.0 ft, Length Retained 1.0 ft
	30			
100		18 24 29 (53)	D-20	Silty SAND, very dense, olive gray, wet, Stratified, no HCl reaction Length Recovered 0.9 ft, Length Retained 0.9 ft
	31			
105	32	15 25 27 (52)	D-21	Poorly graded SAND, very dense, olive gray, wet, Stratified, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft
	33			
110		16 22 23 (45)	D-22	Silty SAND, dense, olive gray, wet, Stratified, no HCl reaction, Note drilling behavior indicates, silt from 106.5 to 108. Length Recovered 0.8 ft, Length Retained 0.8 ft
	34			
115	35	12 20 27 (47)	D-23	Silty SAND, dense, olive gray, wet, Stratified, no HCl reaction Length Recovered 1.3 ft, Length Retained 1.3 ft
	36			
120		18 32	D-24	Silty SAND, very dense, olive gray, wet, Stratified, no HCl reaction

Standard Penetration Blows/ft: 10 20 30 40

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-7-01**

Sheet **6** of **6**

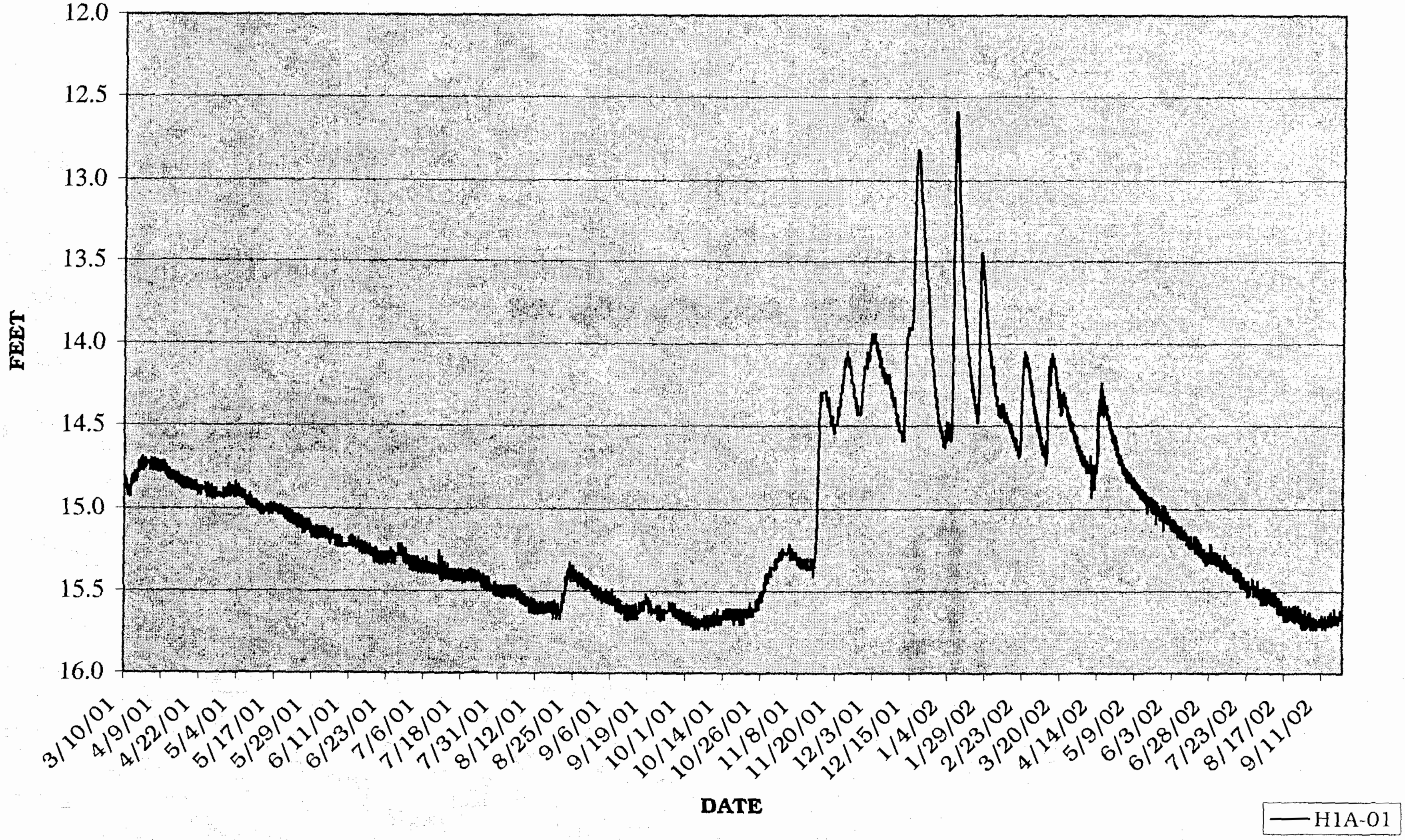
PROJECT **Victor Land Slide**

Job No. **DMC-041**

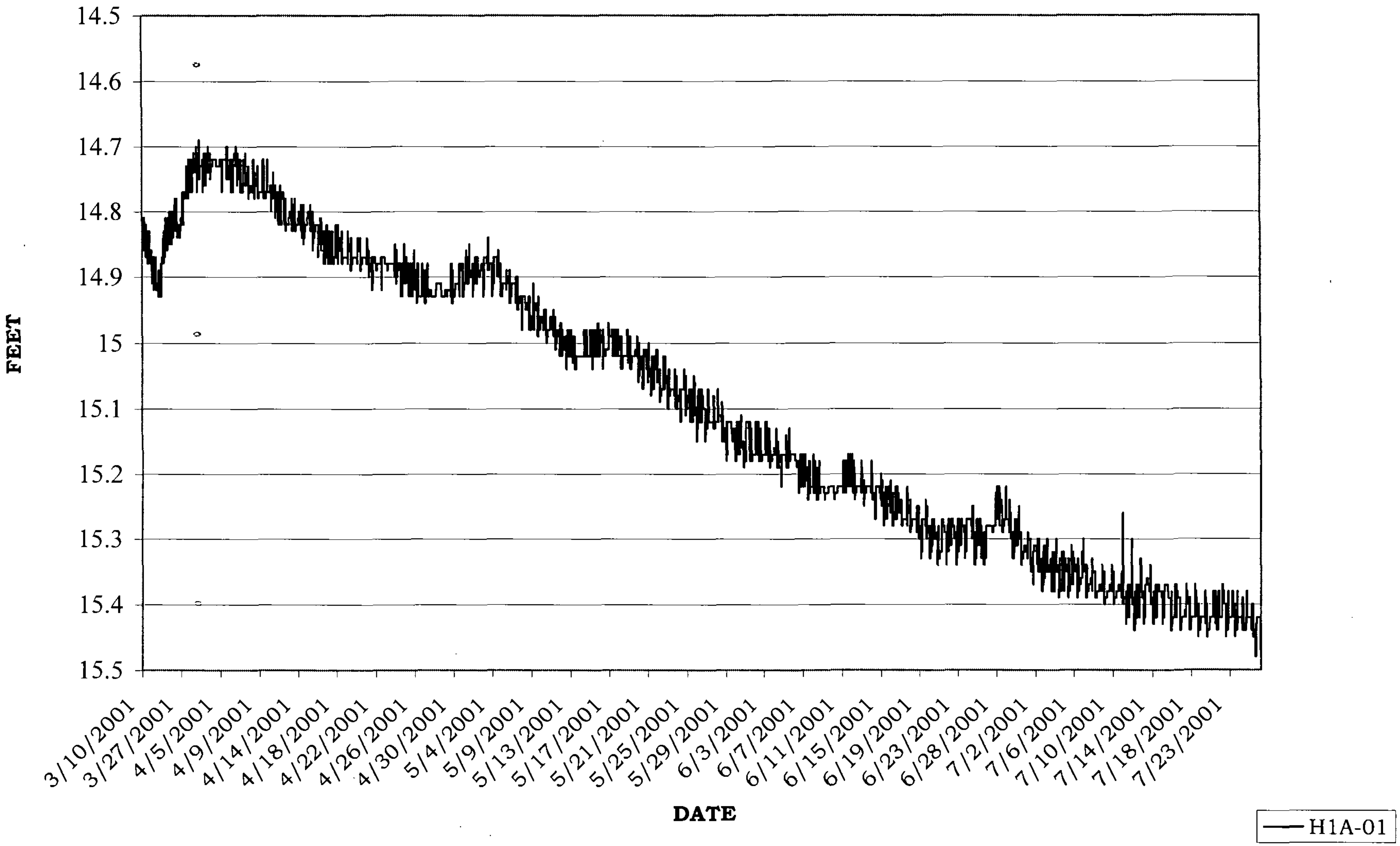
Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				39 (71)				Length Recovered 0.8 ft, Length Retained 0.8 ft		
	37							End of test hole boring at 120.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
125	38									
	39									
130	40									
135	41									
	42									
140	43									
145	44									

APPENDIX C: INSTRUMENTATION DATA COLLECTED BY OTHERS

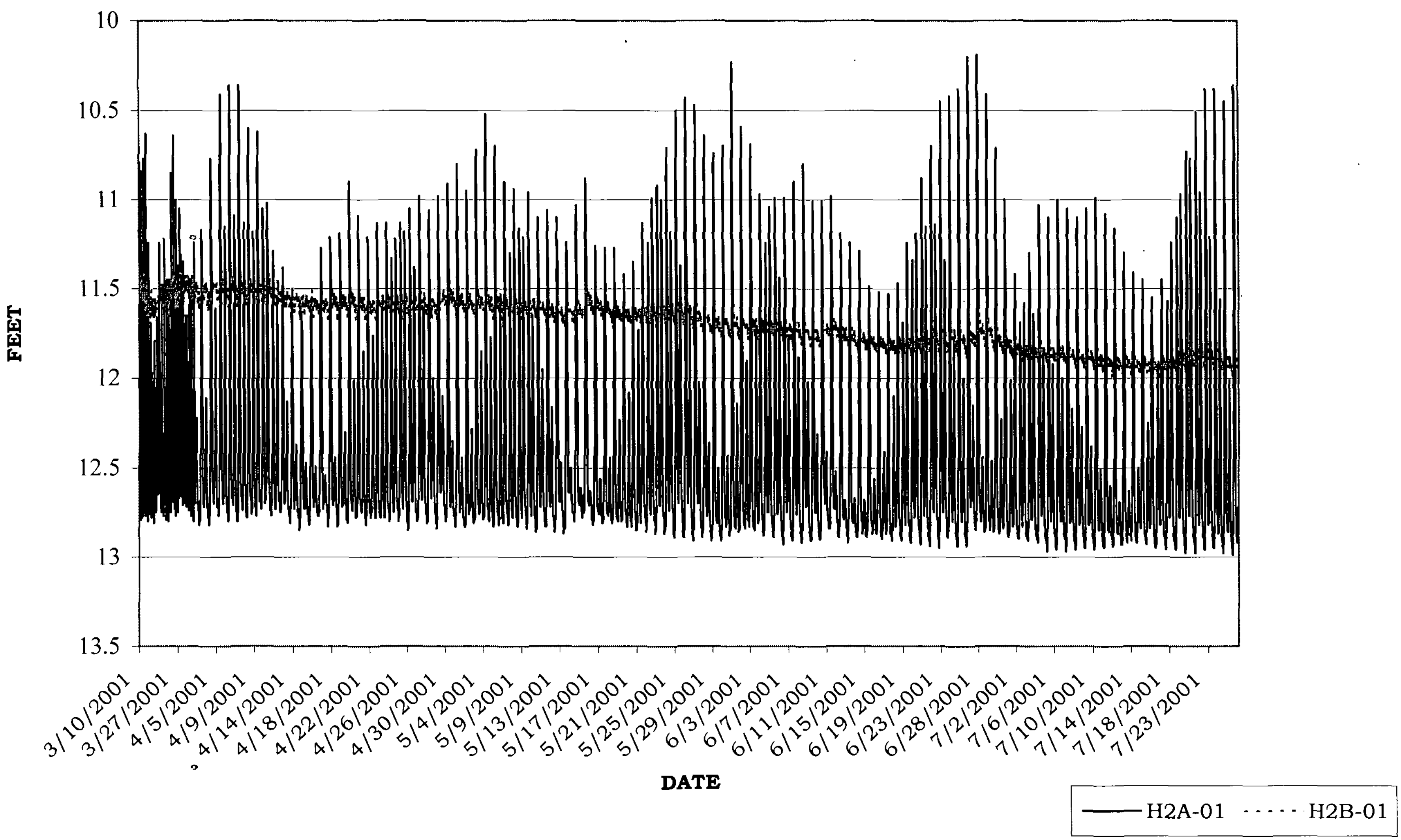
SR 302 VICTOR SLIDE

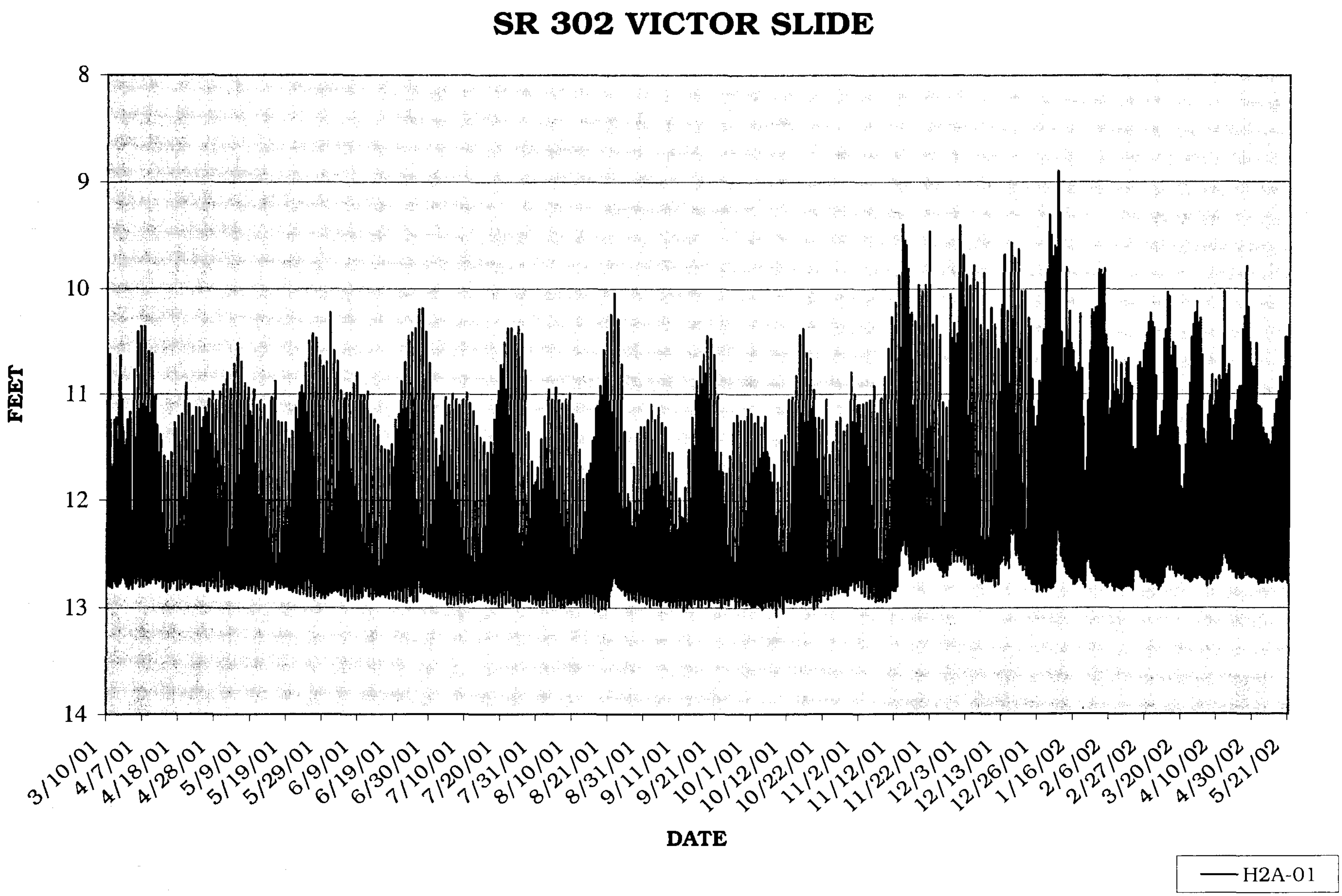


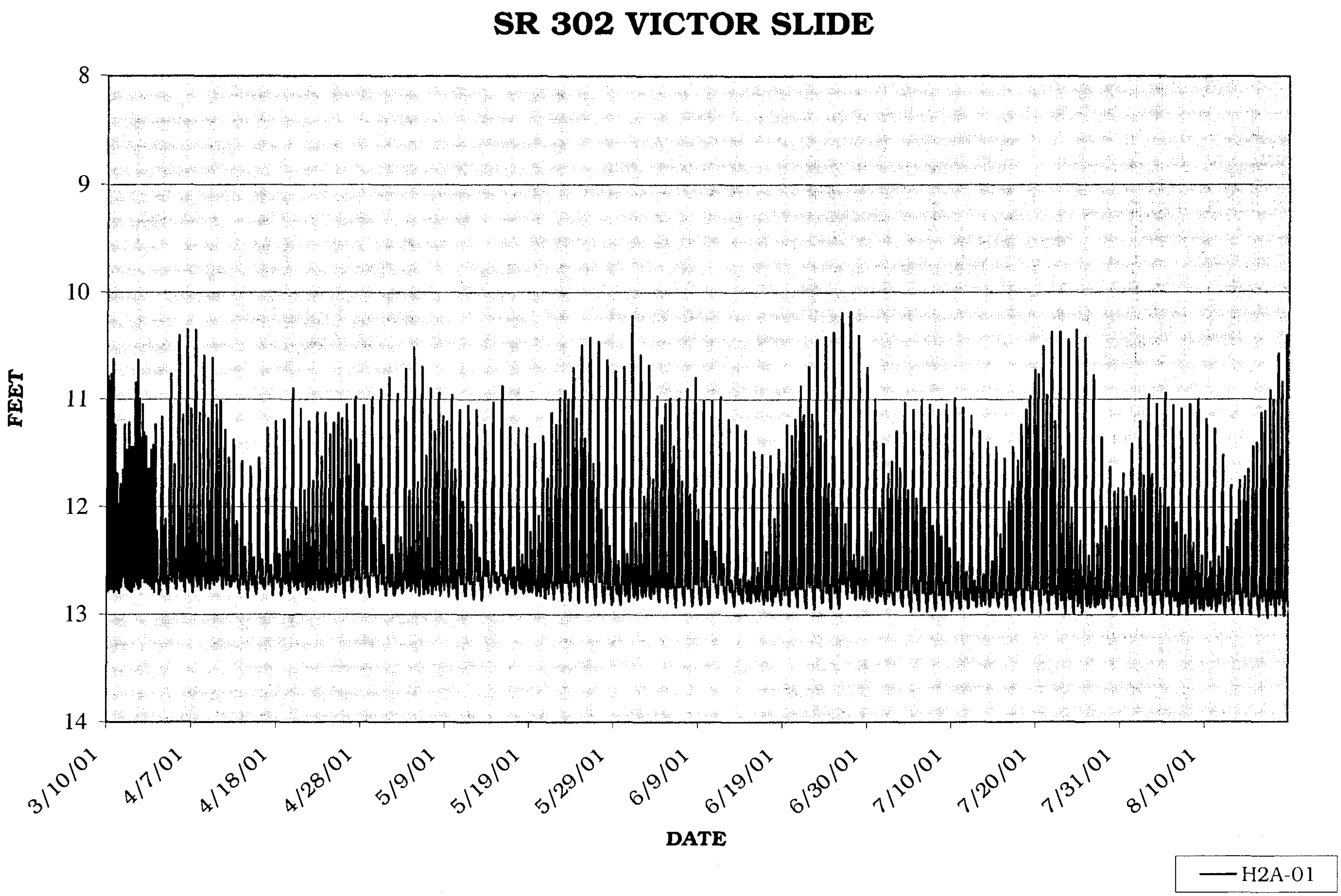
SR 302 VICTOR SLIDE



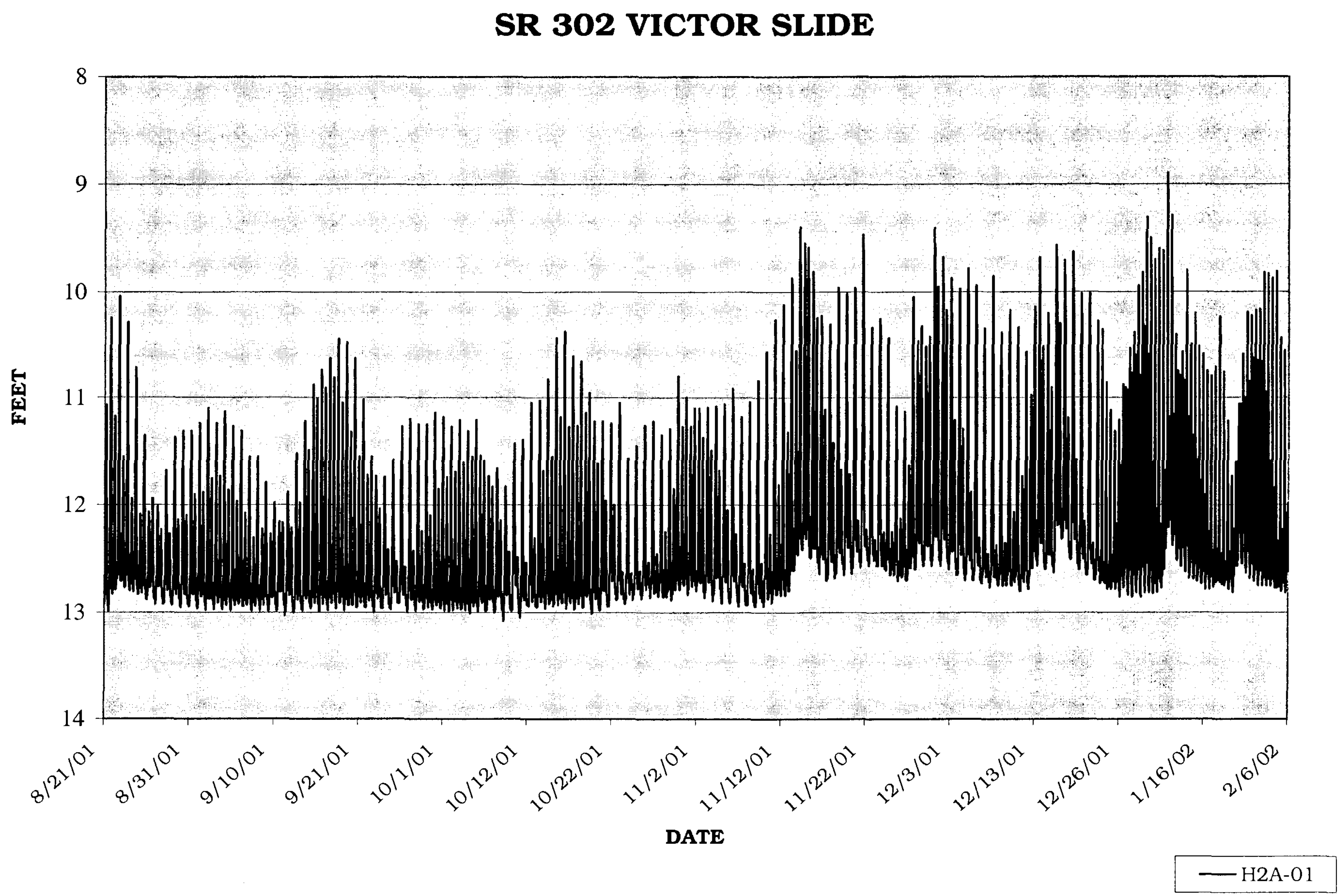
SR 302 VICTOR SLIDE



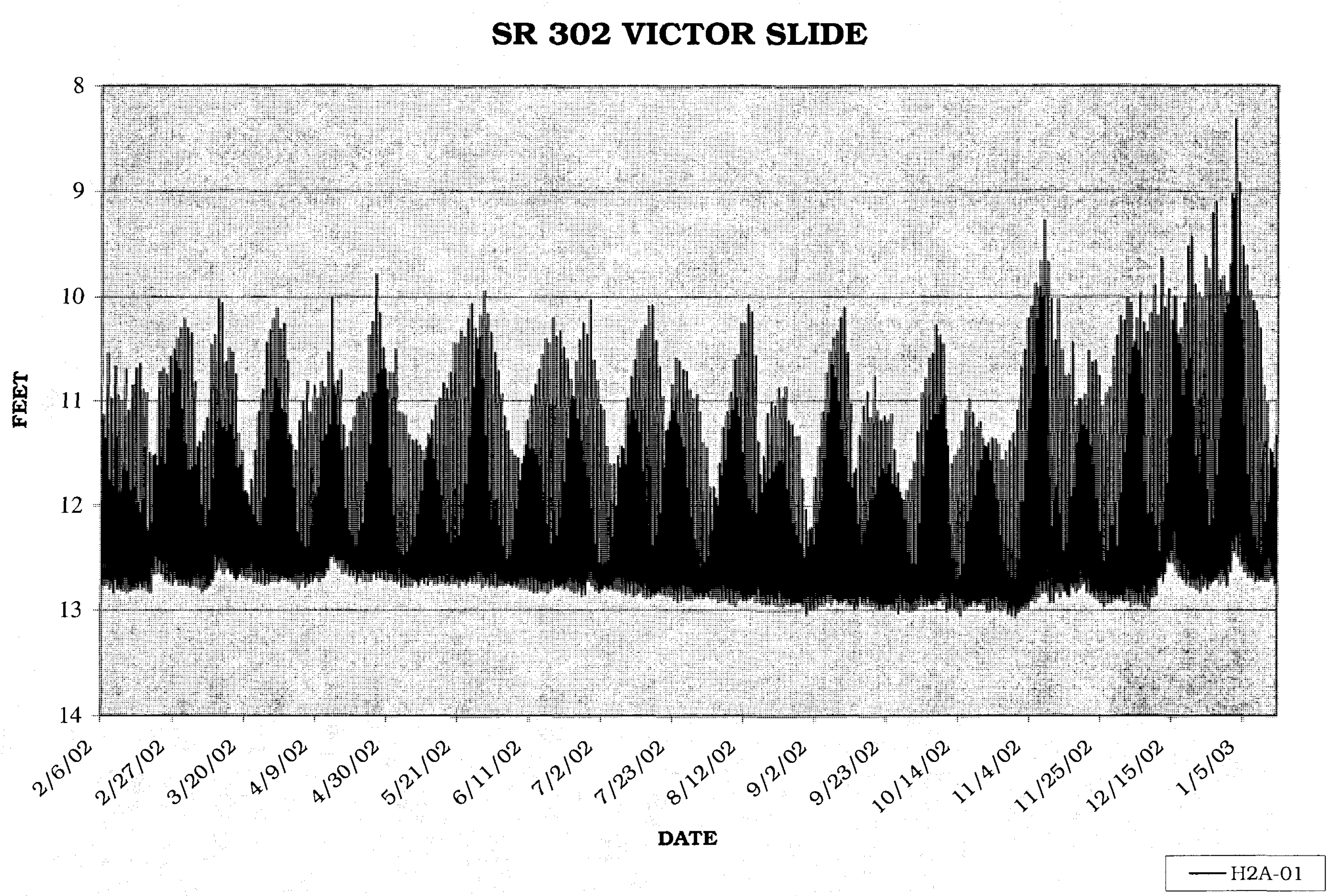

SR 302 VICTOR SLIDE
FEET
8
9
10
11
12
13
14
3/10/01
4/7/01
4/18/01
4/28/01
5/9/01
5/19/01
5/29/01
6/9/01
6/19/01
6/30/01
7/10/01
7/20/01
7/31/01
8/10/01
8/21/01
8/31/01
9/11/01
9/21/01
10/1/01
10/12/01
10/22/01
11/2/01
11/12/01
11/22/01
12/3/01
12/13/01
12/26/01
1/16/02
2/6/02
2/27/02
3/20/02
4/10/02
4/30/02
5/21/02
DATE
H2A-01



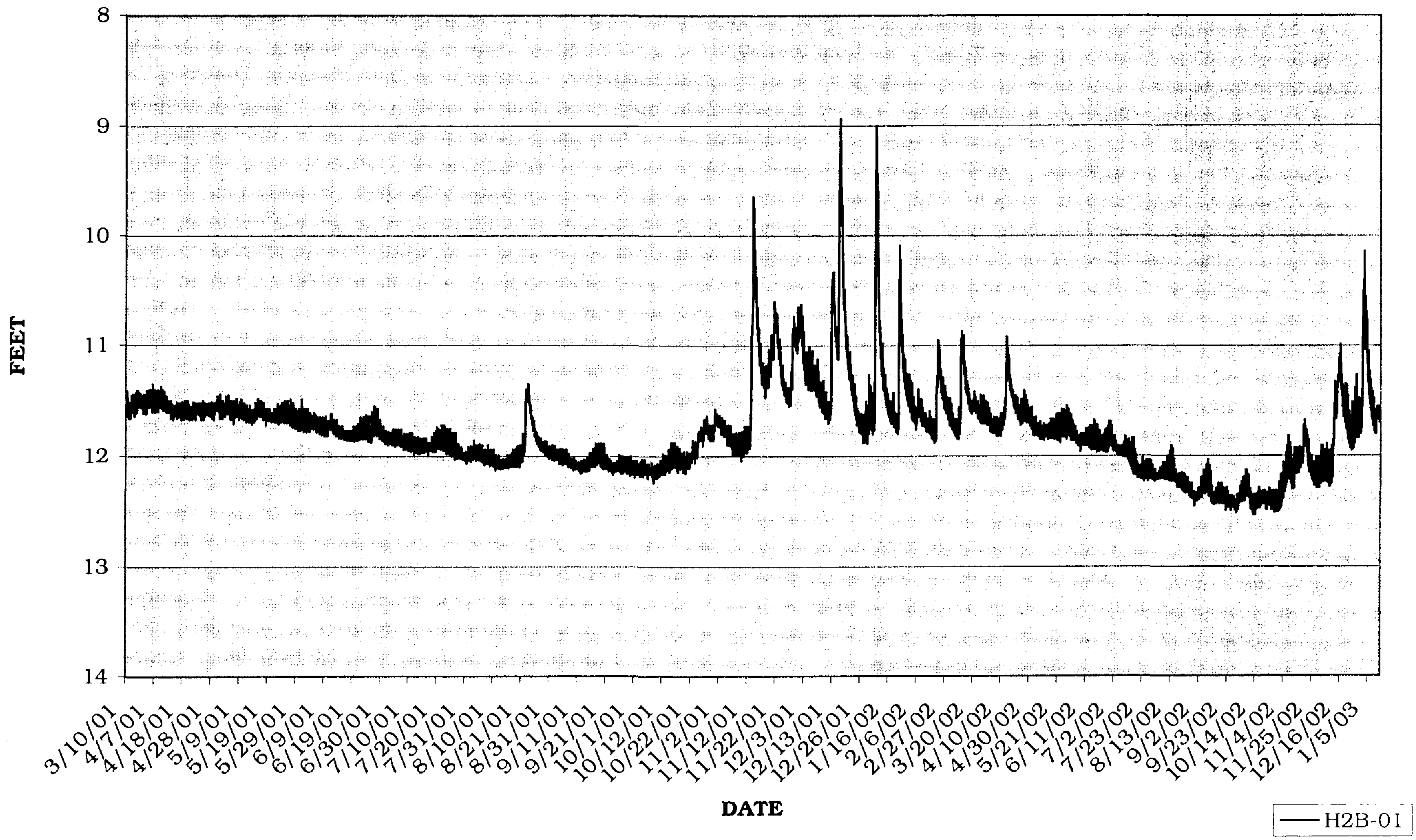
SR 302 VICTOR SLIDE
8
9
10
11
12
13
14
FEET
3/10/01
4/7/01
4/18/01
4/28/01
5/9/01
5/19/01
5/29/01
6/9/01
6/19/01
6/30/01
7/10/01
7/20/01
7/31/01
8/10/01
DATE
H2A-01

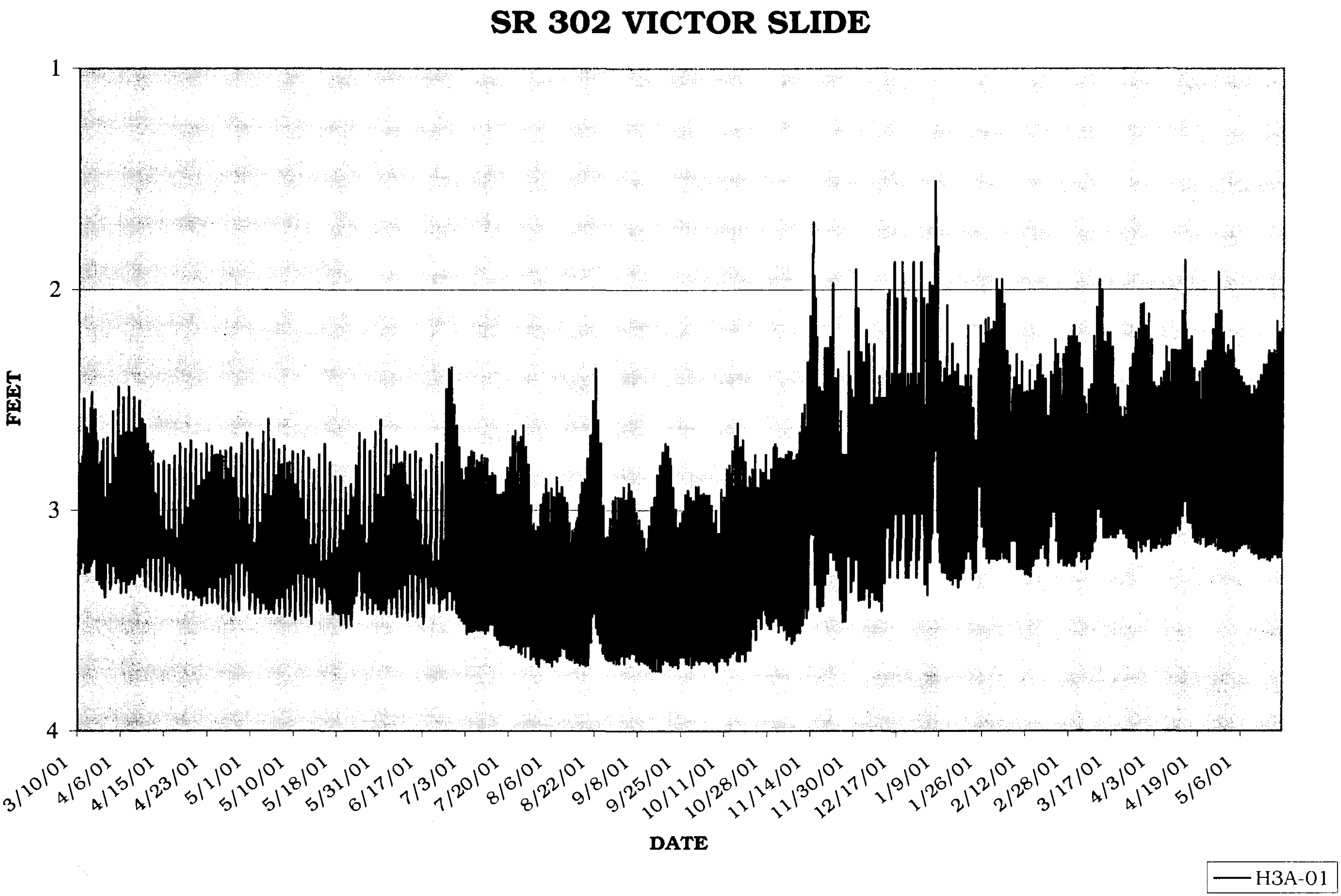


SR 302 VICTOR SLIDE
8
9
10
11
12
13
14
FEET
8/21/01
8/31/01
9/10/01
9/21/01
10/1/01
10/12/01
10/22/01
11/2/01
11/12/01
11/22/01
12/3/01
12/13/01
12/26/01
1/16/02
2/6/02
DATE
H2A-01


SR 302 VICTOR SLIDE
FEET
8
9
10
11
12
13
14
2/6/02
2/27/02
3/20/02
4/9/02
4/30/02
5/21/02
6/11/02
7/2/02
7/23/02
8/12/02
9/2/02
9/23/02
10/14/02
11/4/02
11/25/02
12/15/02
1/5/03
DATE
H2A-01

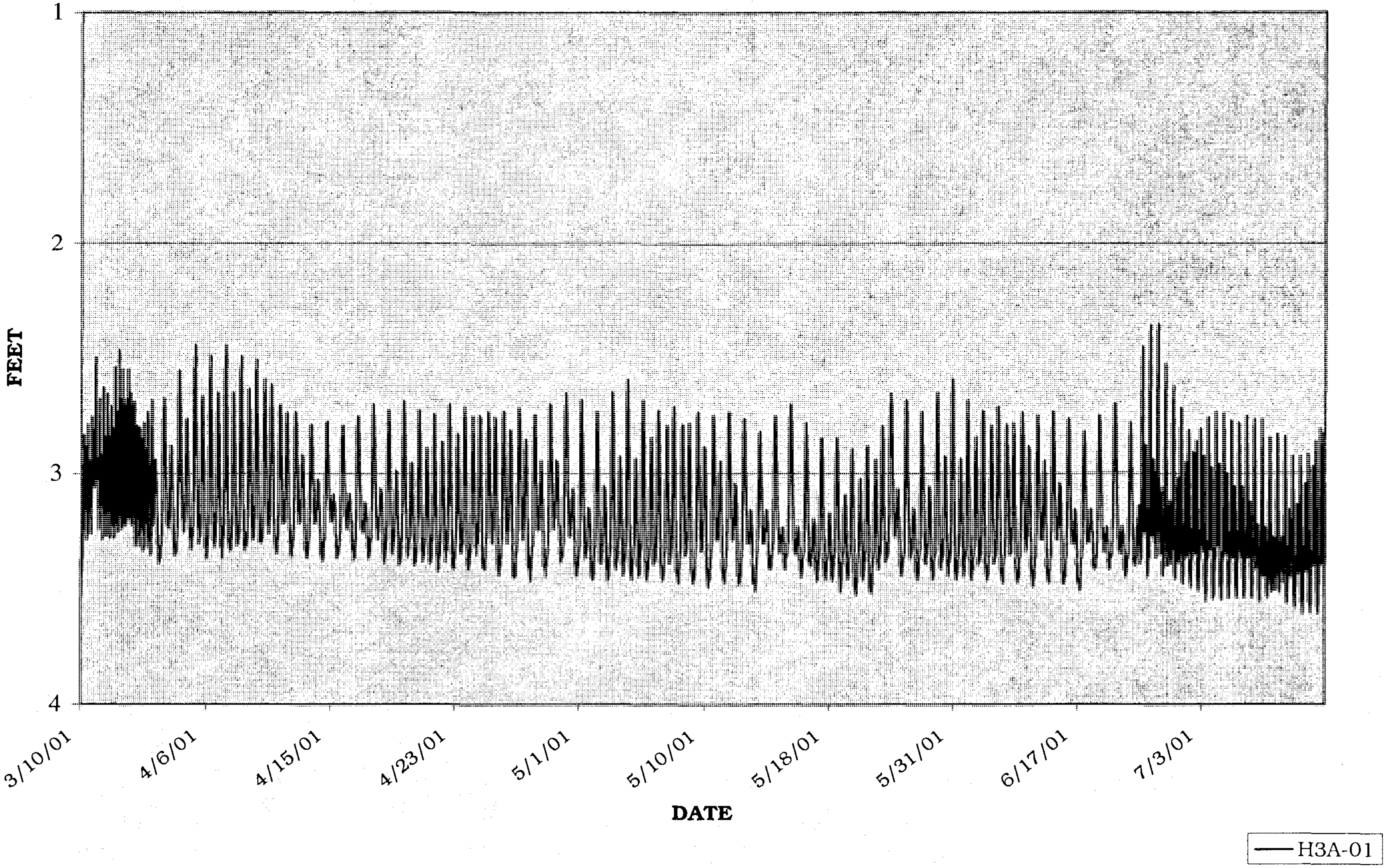
SR 302 VICTOR SLIDE



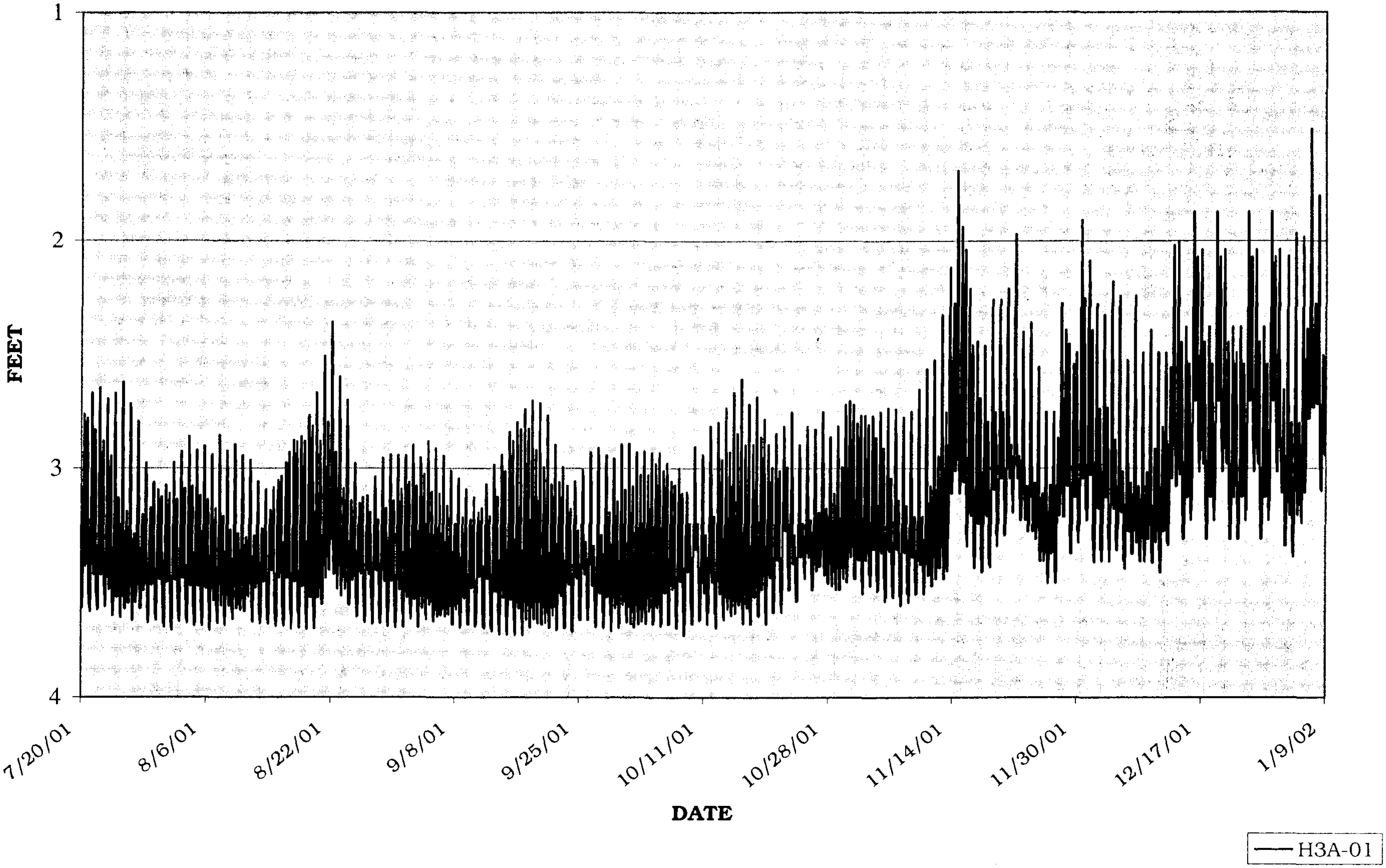


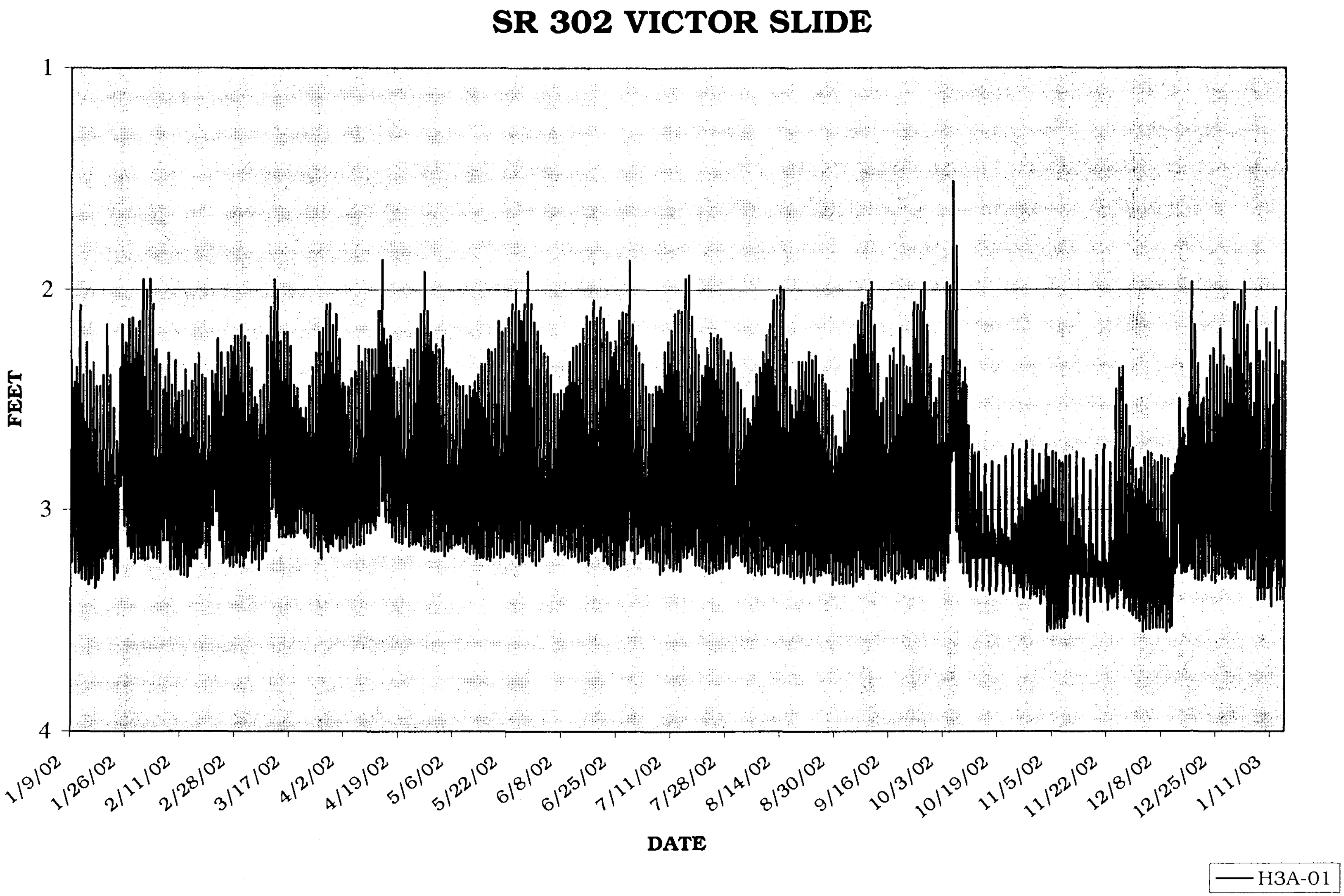
SR 302 VICTOR SLIDE
FEET
1
2
3
4
3/10/01
4/6/01
4/15/01
4/23/01
5/1/01
5/10/01
5/18/01
5/31/01
6/17/01
7/3/01
7/20/01
8/6/01
8/22/01
9/8/01
9/25/01
10/11/01
10/28/01
11/14/01
11/30/01
12/17/01
1/9/01
1/26/01
2/12/01
2/28/01
3/17/01
4/3/01
4/19/01
5/6/01
DATE
H3A-01

SR 302 VICTOR SLIDE

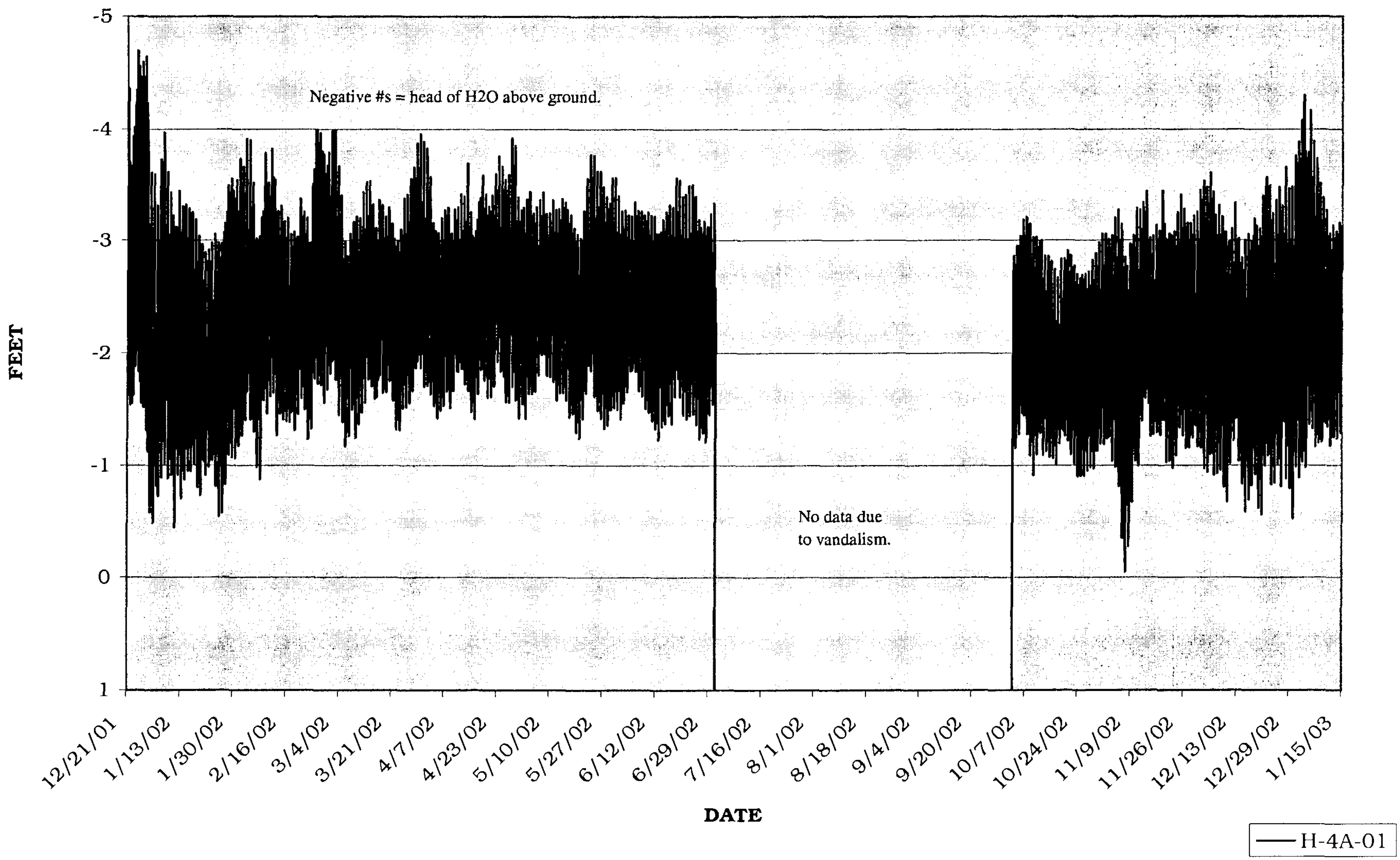


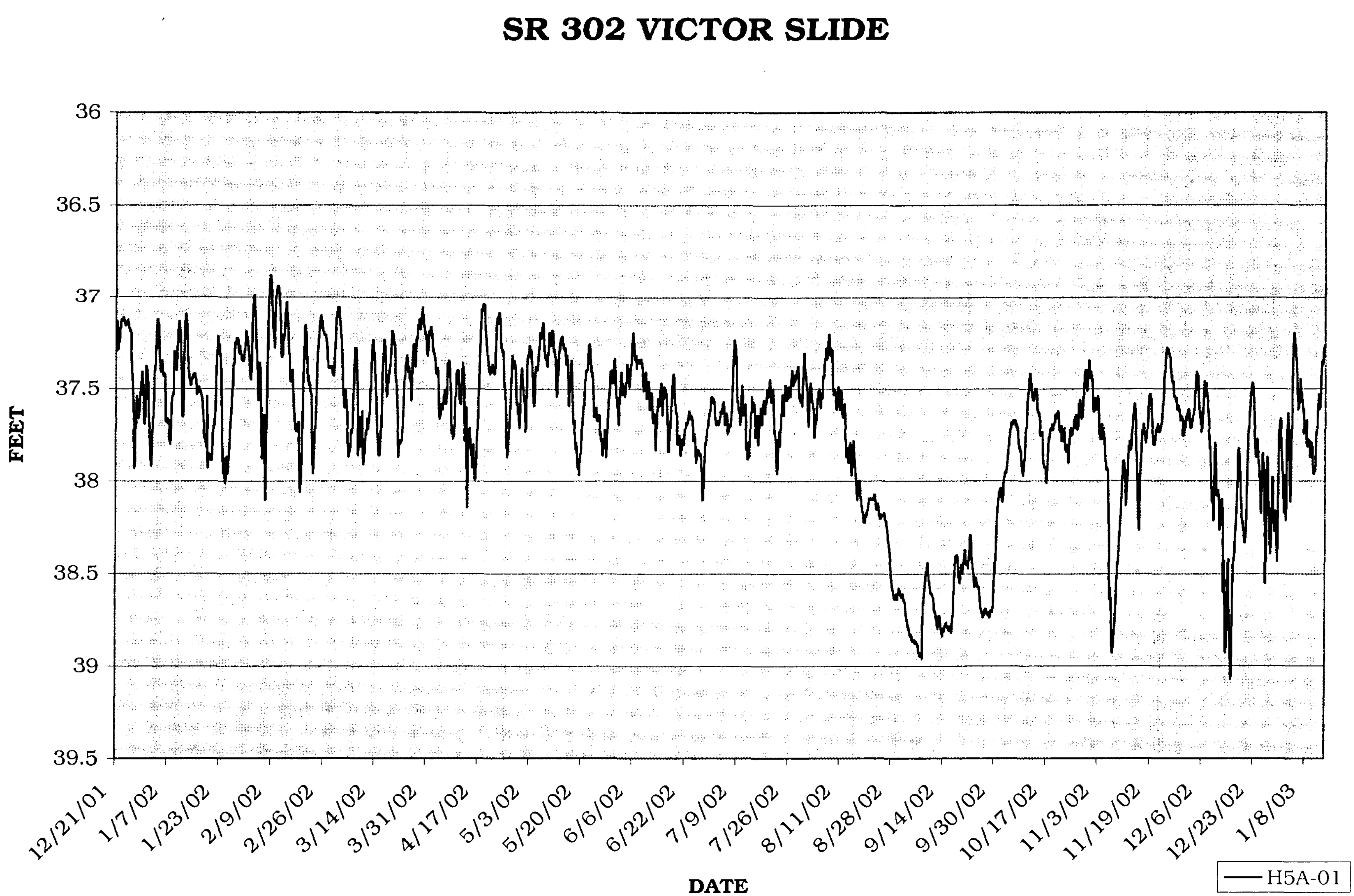
SR 302 VICTOR SLIDE



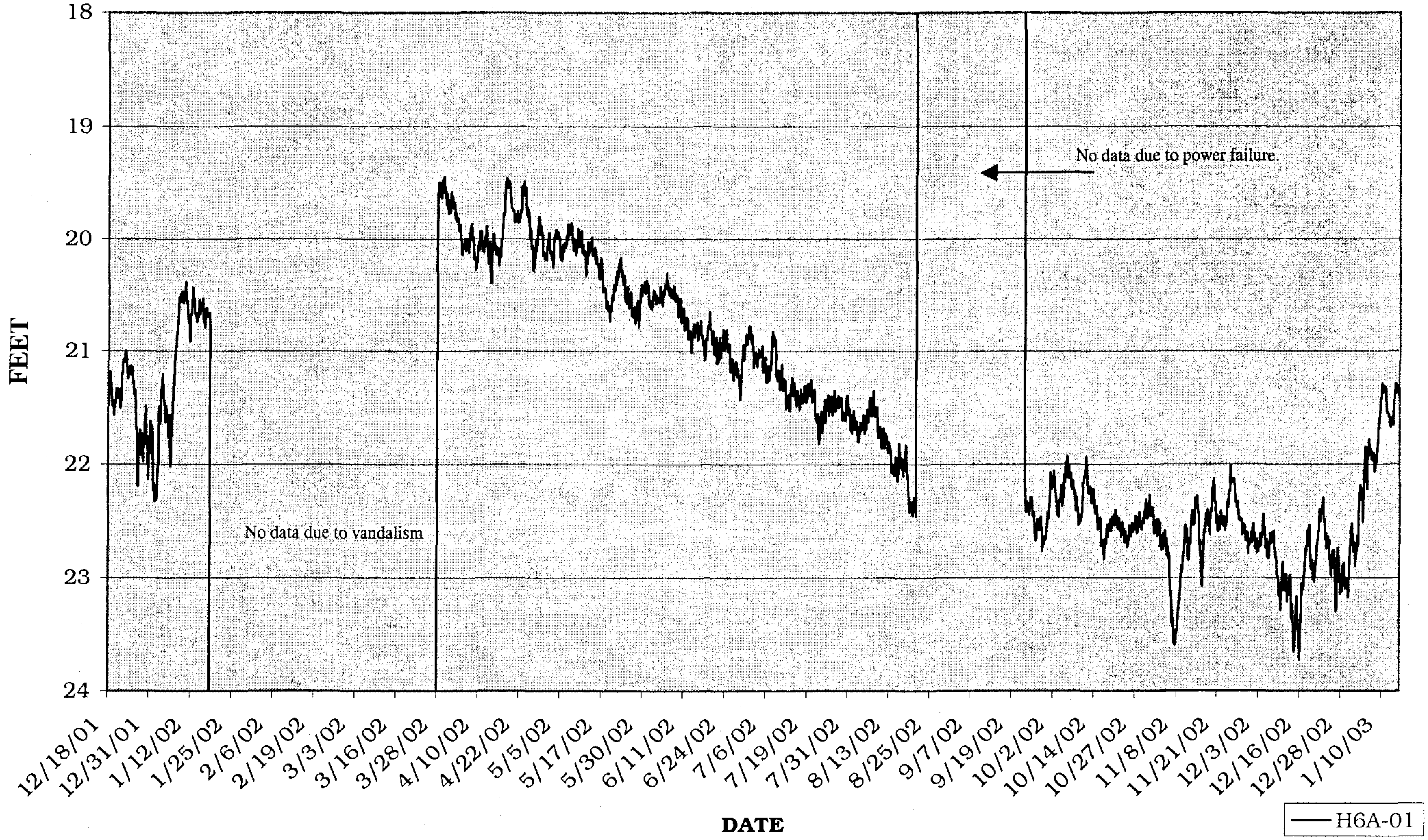

SR 302 VICTOR SLIDE
FEET
1
2
3
4
1/9/02
1/26/02
2/11/02
2/28/02
3/17/02
4/2/02
4/19/02
5/6/02
5/22/02
6/8/02
6/25/02
7/11/02
7/28/02
8/14/02
8/30/02
9/16/02
10/3/02
10/19/02
11/5/02
11/22/02
12/8/02
12/25/02
1/11/03
DATE
H3A-01

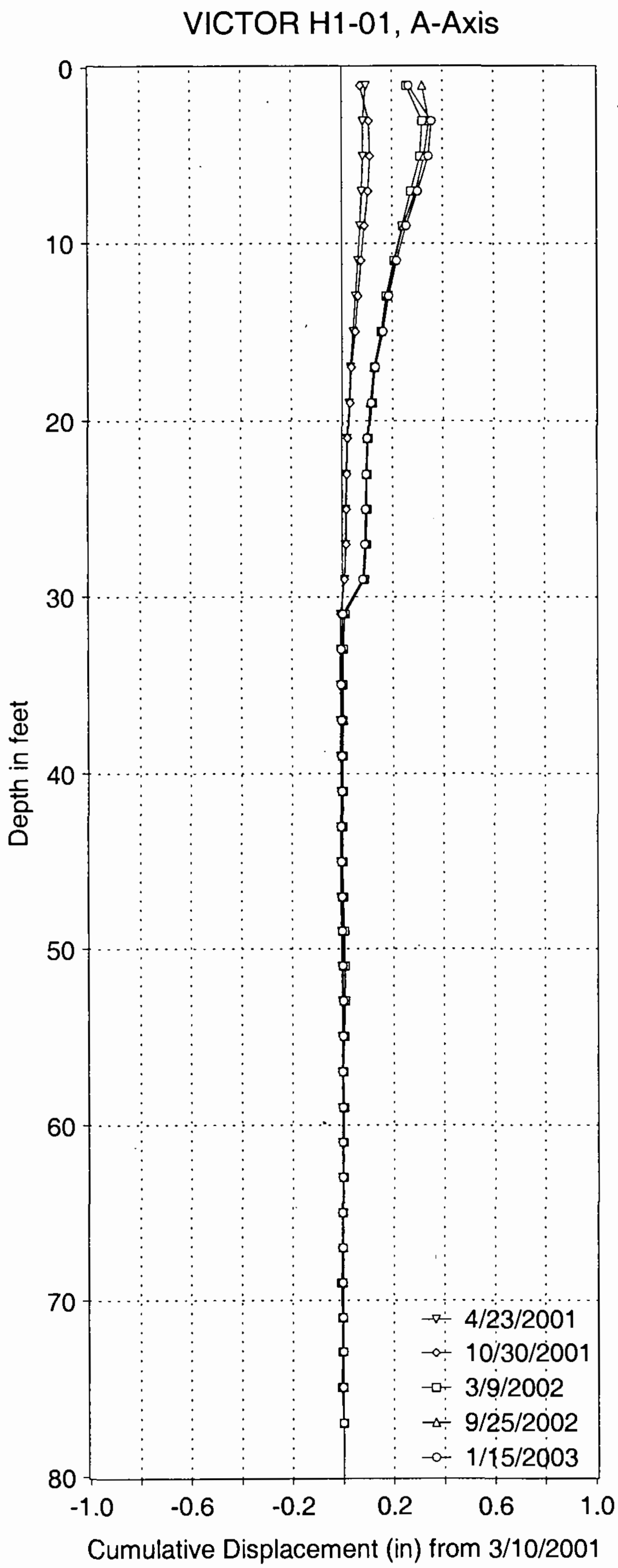
SR 302 VICTOR SLIDE

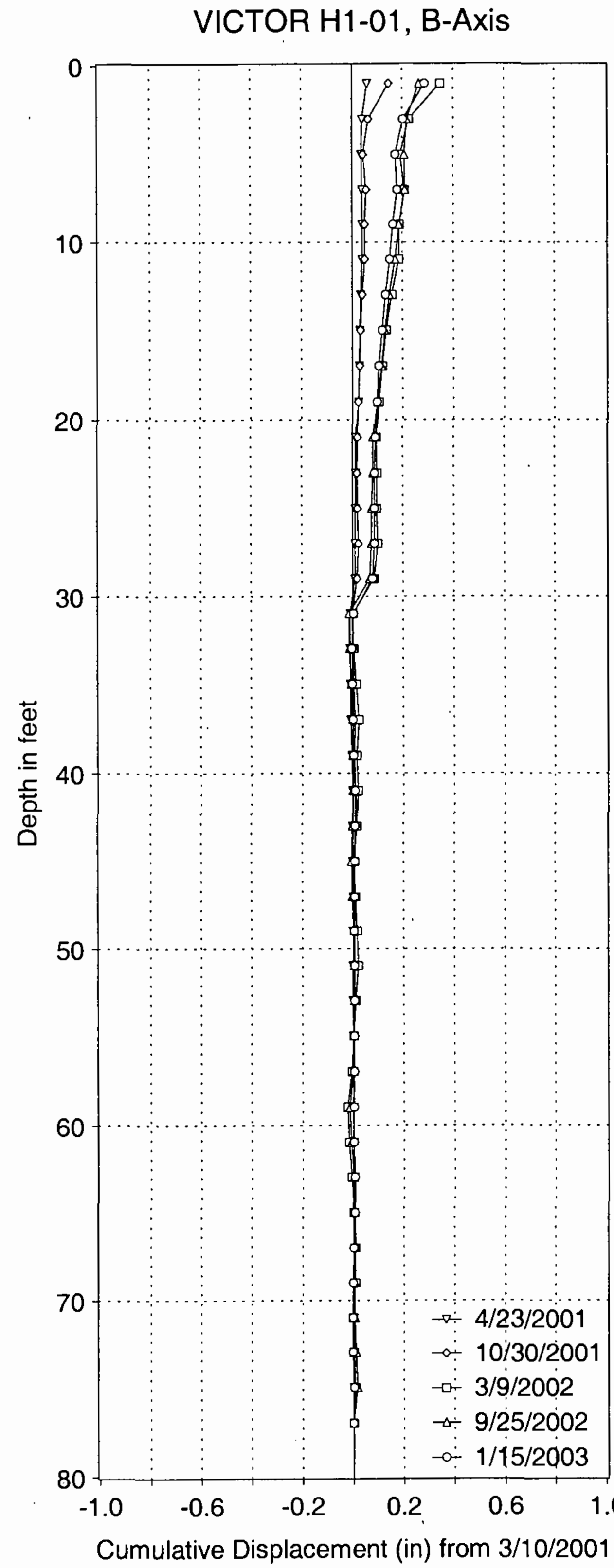



SR 302 VICTOR SLIDE
FEET
36
36.5
37
37.5
38
38.5
39
39.5
12/21/01
1/7/02
1/23/02
2/9/02
2/26/02
3/14/02
3/31/02
4/17/02
5/3/02
5/20/02
6/6/02
6/22/02
7/9/02
7/26/02
8/11/02
8/28/02
9/14/02
9/30/02
10/17/02
11/3/02
11/19/02
12/6/02
12/23/02
1/8/03
DATE
H5A-01

SR 302 VICTOR SLIDE







WSDOT
Materials Lab
Geotech Section
Olympia, WA

DMC-041 SR 302
VICTOR SLIDE
H-1-01

SITE : VICTOR
INSTALLATION : H1-01
DESCRIPTION : SR 302 VICTOR SLIDE

CURRENT SURVEY : 1/15/2003 2:50:59 PM
Probe Serial No : 28697

INITIAL SURVEY : 3/10/2001 9:38:00 AM
Probe Serial No : 28697

DATE PRINTED : 1/15/2003 3:49:10 PM

Data Reduction in Digi units for A Axis:

Depth (ft)	Initial A0	Initial A180	Initial Incr. Dev. (Diff)	Current A0	Current A180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
2	-10	-13	3	-96	51	-147	-150	0.2670
4	68	-86	154	63	-111	174	20	0.3570
6	141	-157	298	162	-207	369	71	0.3450
8	111	-128	239	135	-180	315	76	0.3024
10	-90	71	-161	-72	25	-97	64	0.2568
12	-70	52	-122	-59	10	-69	53	0.2184
14	-1	-18	17	5	-51	56	39	0.1866
16	-29	11	-40	-17	-29	12	52	0.1632
18	-17	-1	-16	-17	-28	11	27	0.1320
20	-125	97	-222	-124	72	-196	26	0.1158
22	-136	117	-253	-146	99	-245	8	0.1002
24	-135	118	-253	-147	102	-249	4	0.0954
26	-124	106	-230	-135	90	-225	5	0.0930
28	-132	131	-263	-144	105	-249	14	0.0900
30	-222	183	-405	-161	112	-273	132	0.0816
32	-193	175	-368	-200	154	-354	14	0.0024
34	-115	97	-212	-130	83	-213	-1	-0.0060
36	-41	22	-63	-55	9	-64	-1	-0.0054
38	-22	3	-25	-37	-10	-27	-2	-0.0048
40	-62	43	-105	-76	30	-106	-1	-0.0036
42	-85	65	-150	-97	50	-147	3	-0.0030
44	-89	74	-163	-105	59	-164	-1	-0.0048
46	-92	73	-165	-107	61	-168	-3	-0.0042
48	-115	99	-214	-129	85	-214	0	-0.0024
50	-227	207	-434	-243	193	-436	-2	-0.0024
52	-206	188	-394	-222	178	-400	-6	-0.0012
54	-170	151	-321	-182	136	-318	3	0.0024
56	-115	97	-212	-127	81	-208	4	0.0006
58	-70	53	-123	-86	39	-125	-2	-0.0018
60	-138	120	-258	-151	104	-255	3	-0.0006
62	-97	78	-175	-111	64	-175	0	-0.0024
64	-61	44	-105	-75	30	-105	0	-0.0024
66	-12	-8	-4	-27	-20	-7	-3	-0.0024
68	60	-77	137	46	-93	139	2	-0.0006
70	78	-96	174	63	-109	172	-2	-0.0018
72	41	-61	102	26	-75	101	-1	-0.0006
74	72	-88	160	58	-103	161	1	0.0000
76	14	-34	48	0	-47	47	-1	-0.0006
78	0	0	0	0	0	0	0	0.0000

SITE : VICTOR
INSTALLATION : H1-01
DESCRIPTION : SR 302 VICTOR SLIDE

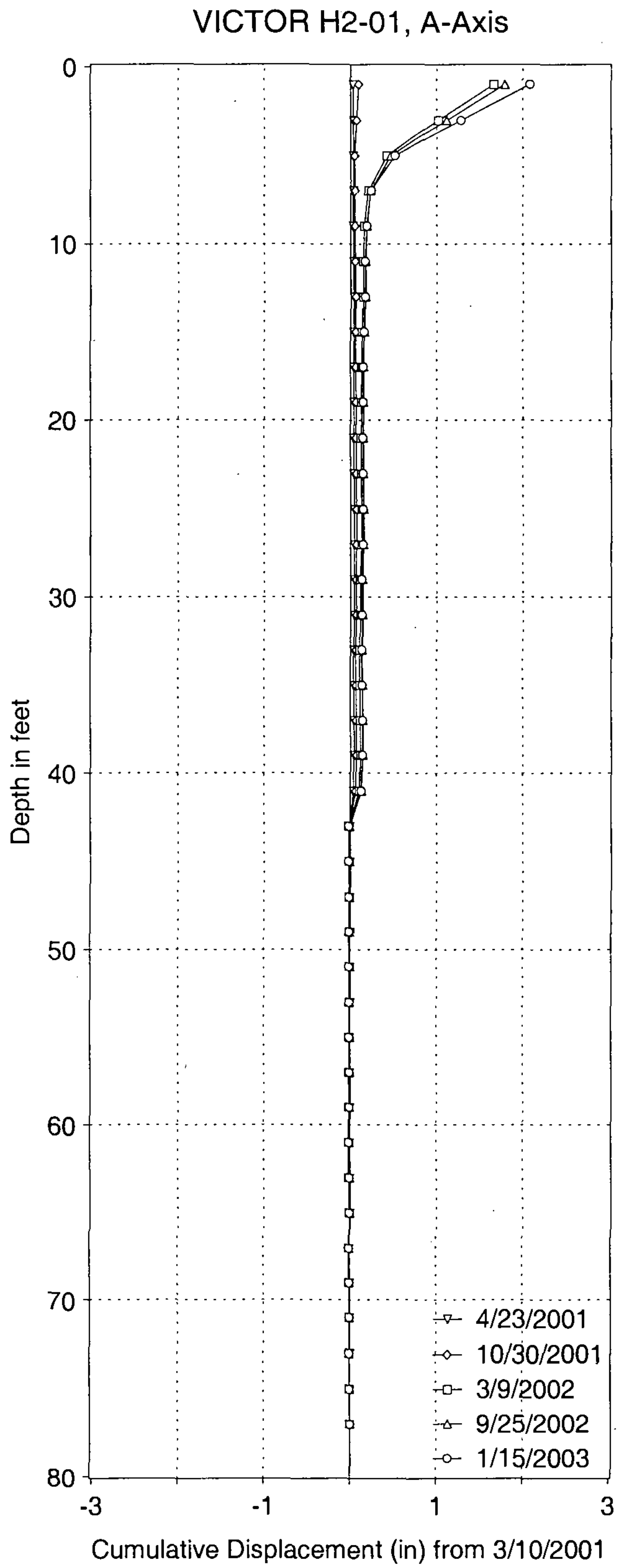
CURRENT SURVEY : 1/15/2003 2:50:59 PM
Probe Serial No : 28697

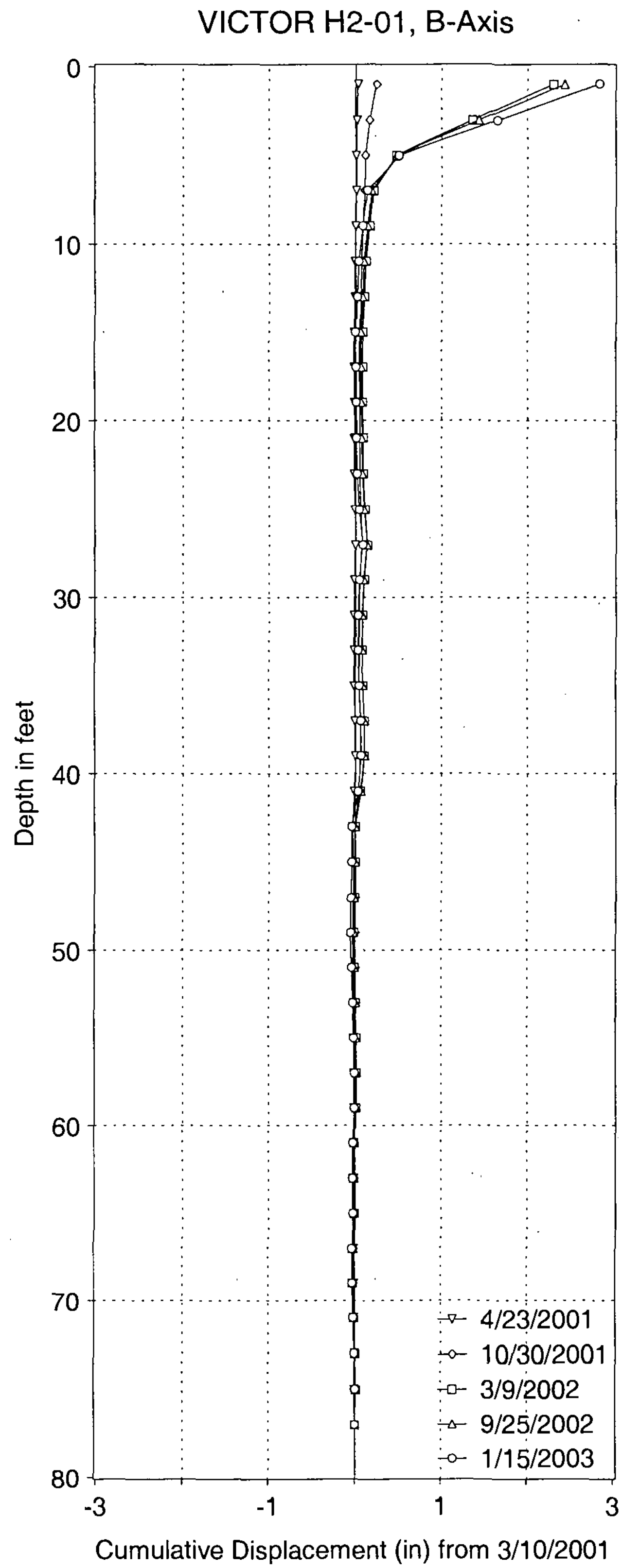
INITIAL SURVEY : 3/10/2001 9:38:00 AM
Probe Serial No : 28697

DATE PRINTED : 1/15/2003 3:49:10 PM

Data Reduction in Digi units for B Axis:

Depth (ft)	Initial B0	Initial B180	Initial Incr. Dev. (Diff)	Current B0	Current B180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
2	424	-449	873	465	-550	1015	142	0.2664
4	345	-376	721	339	-431	770	49	0.1812
6	182	-215	397	150	-234	384	-13	0.1518
8	101	-134	235	82	-181	263	28	0.1596
10	-16	-15	-1	-31	-51	20	21	0.1428
12	-51	26	-77	-66	-18	-48	29	0.1302
14	-2	-23	21	-21	-63	42	21	0.1128
16	38	-59	97	16	-101	117	20	0.1002
18	49	-71	120	23	-110	133	13	0.0882
20	42	-87	129	22	-116	138	9	0.0804
22	49	-71	120	21	-104	125	5	0.0750
24	46	-71	117	15	-102	117	0	0.0720
26	50	-71	121	19	-102	121	0	0.0720
28	25	-49	74	2	-84	86	12	0.0720
30	25	-47	72	54	-143	197	125	0.0648
32	14	-33	47	-13	-71	58	11	-0.0102
34	-17	-5	-12	-50	-34	-16	-4	-0.0168
36	-46	24	-70	-80	-5	-75	-5	-0.0144
38	-60	29	-89	-93	2	-95	-6	-0.0114
40	9	-33	42	-25	-59	34	-8	-0.0078
42	-4	-16	12	-37	-46	9	-3	-0.0030
44	-6	-15	9	-37	-47	10	1	-0.0012
46	13	-34	47	-17	-65	48	1	-0.0018
48	-5	-20	15	-35	-52	17	2	-0.0024
50	-43	17	-60	-74	-12	-62	-2	-0.0036
52	-57	33	-90	-89	2	-91	-1	-0.0024
54	-52	27	-79	-82	-3	-79	0	-0.0018
56	-51	29	-80	-82	-1	-81	-1	-0.0018
58	-50	29	-79	-79	-2	-77	2	-0.0012
60	-13	-11	-2	-45	-43	-2	0	-0.0024
62	-26	-1	-25	-58	-26	-32	-7	-0.0024
64	-63	41	-104	-95	11	-106	-2	0.0018
66	-118	93	-211	-142	62	-204	7	0.0030
68	-182	153	-335	-210	122	-332	3	-0.0012
70	-195	163	-358	-227	130	-357	1	-0.0030
72	-110	89	-199	-140	59	-199	0	-0.0036
74	-181	154	-335	-222	124	-346	-11	-0.0036
76	-274	247	-521	-313	203	-516	5	0.0030
78	0	0	0	0	0	0	0	0.0000





WSDOT Materials Lab Geotech Section Olympia, WA	DMC-041 SR 302 VICTOR SLIDE H-2-01

SITE : VICTOR
INSTALLATION : H2-01
DESCRIPTION : SR 302 Victor slide

CURRENT SURVEY : 1/15/2003 1:48:24 PM
Probe Serial No : 28697

INITIAL SURVEY : 3/10/2001 9:00:00 AM
Probe Serial No : 28697

DATE PRINTED : 1/15/2003 3:48:45 PM

Data Reduction in Digi units for A Axis:

Depth (ft)	Initial A0	Initial A180	Initial Incr. Dev. (Diff)	Current A0	Current A180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
2	113	-129	242	781	-799	1580	1338	2.0880
4	183	-200	383	820	-852	1672	1289	1.2852
6	214	-232	446	444	-458	902	456	0.5118
8	240	-257	497	279	-301	580	83	0.2382
10	158	-175	333	173	-193	366	33	0.1884
12	59	-77	136	58	-78	136	0	0.1686
14	50	-67	117	57	-77	134	17	0.1686
16	2	-21	23	7	-27	34	11	0.1584
18	-8	-10	2	-6	-13	7	5	0.1518
20	79	-98	177	79	-101	180	3	0.1488
22	91	-107	198	90	-110	200	2	0.1470
24	36	-53	89	33	-53	86	-3	0.1458
26	-44	27	-71	-48	30	-78	-7	0.1476
28	-67	49	-116	-54	33	-87	29	0.1518
30	-6	-13	7	-7	-14	7	0	0.1344
32	109	-127	236	109	-130	239	3	0.1344
34	190	-209	399	182	-203	385	-14	0.1326
36	227	-244	471	225	-243	468	-3	0.1410
38	154	-171	325	155	-174	329	4	0.1428
40	33	-50	83	42	-61	103	20	0.1404
42	44	-61	105	165	-186	351	246	0.1284
44	6	-22	28	5	-25	30	2	-0.0192
46	-5	-15	10	-10	-11	1	-9	-0.0204
48	-23	7	-30	-25	7	-32	-2	-0.0150
50	-5	-14	9	-7	-15	8	-1	-0.0138
52	14	-31	45	11	-31	42	-3	-0.0132
54	36	-54	90	34	-54	88	-2	-0.0114
56	59	-75	134	58	-77	135	1	-0.0102
58	115	-137	252	117	-140	257	5	-0.0108
60	121	-137	258	119	-138	257	-1	-0.0138
62	102	-121	223	97	-119	216	-7	-0.0132
64	102	-119	221	100	-121	221	0	-0.0090
66	94	-111	205	91	-111	202	-3	-0.0090
68	46	-65	111	43	-66	109	-2	-0.0072
70	24	-40	64	22	-41	63	-1	-0.0060
72	10	-29	39	6	-27	33	-6	-0.0054
74	7	-25	32	6	-27	33	1	-0.0018
76	-6	-11	5	-10	-11	1	-4	-0.0024
78	0	0	0	0	0	0	0	0.0000

SITE : VICTOR
INSTALLATION : H2-01
DESCRIPTION : SR 302 Victor slide

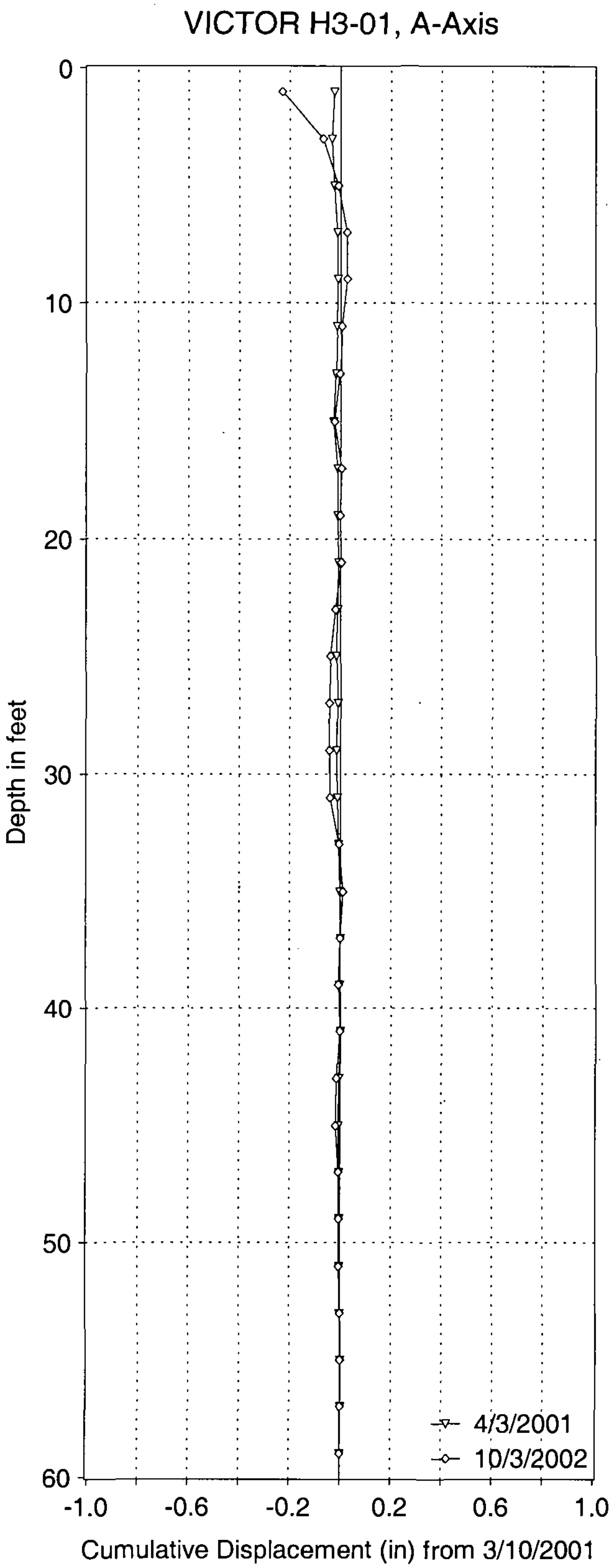
CURRENT SURVEY : 1/15/2003 1:48:24 PM
Probe Serial No : 28697

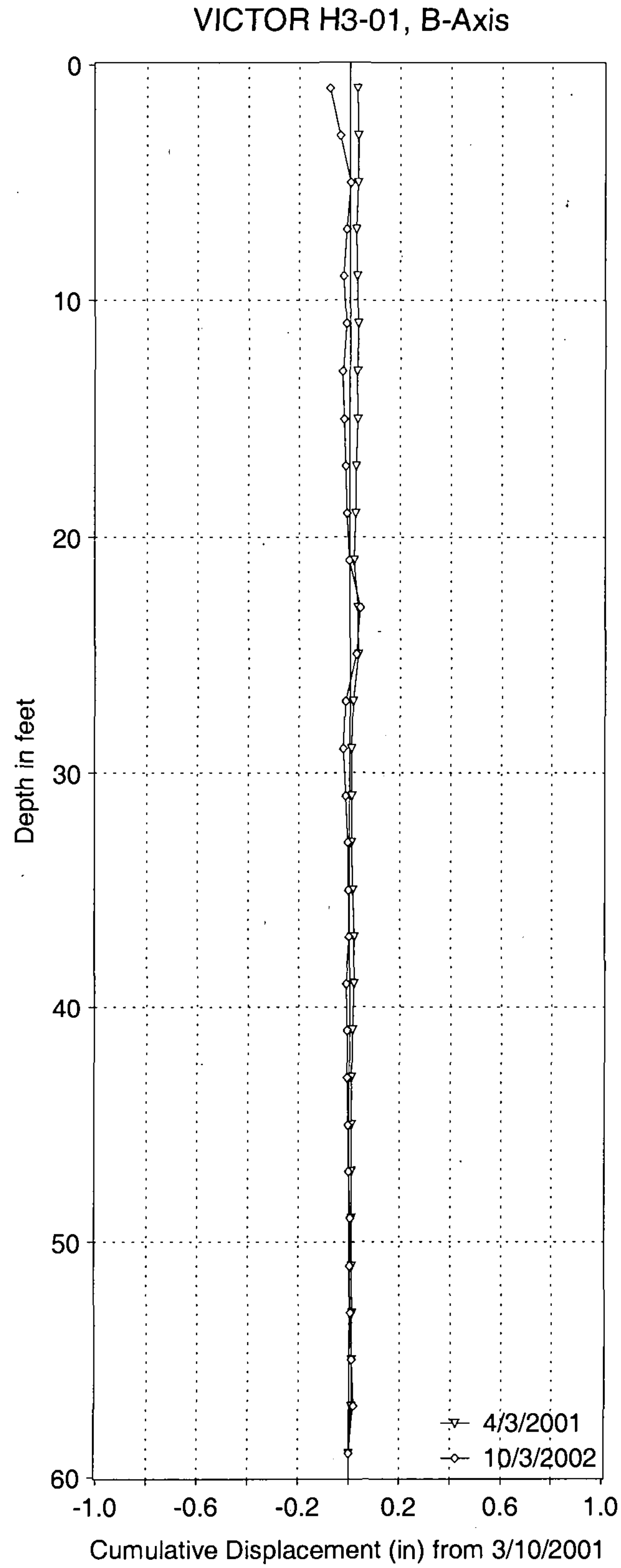
INITIAL SURVEY : 3/10/2001 9:00:00 AM
Probe Serial No : 28697

DATE PRINTED : 1/15/2003 3:48:45 PM

Data Reduction in Digi units for B Axis:

Depth (ft)	Initial B0	Initial B180	Initial Incr. Dev. (Diff)	Current B0	Current B180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
2	206	-230	436	1200	-1203	2403	1967	2.8350
4	126	-158	284	1100	-1099	2199	1915	1.6548
6	-21	-10	-11	302	-303	605	616	0.5058
8	-144	125	-269	-89	99	-188	81	0.1362
10	-159	141	-300	-103	111	-214	86	0.0876
12	-89	72	-161	-58	72	-130	31	0.0360
14	-54	38	-92	-25	34	-59	33	0.0174
16	-34	9	-43	-27	31	-58	-15	-0.0024
18	103	-135	238	125	-114	239	1	0.0066
20	154	-173	327	153	-161	314	-13	0.0060
22	126	-157	283	138	-131	269	-14	0.0138
24	41	-71	112	43	-34	77	-35	0.0222
26	-34	14	-48	-53	58	-111	-63	0.0432
28	39	-75	114	89	-81	170	56	0.0810
30	91	-107	198	119	-113	232	34	0.0474
32	147	-167	314	159	-146	305	-9	0.0270
34	127	-162	289	134	-130	264	-25	0.0324
36	5	-35	40	11	-3	14	-26	0.0474
38	-82	57	-139	-66	73	-139	0	0.0630
40	-51	35	-86	-15	23	-38	48	0.0630
42	-10	-8	-2	61	-59	120	122	0.0342
44	5	-24	29	29	-9	38	9	-0.0390
46	-1	-22	21	20	-9	29	8	-0.0444
48	57	-83	140	81	-64	145	5	-0.0492
50	43	-59	102	47	-33	80	-22	-0.0522
52	14	-30	44	19	-6	25	-19	-0.0390
54	-22	7	-29	-21	33	-54	-25	-0.0276
56	-74	54	-128	-69	69	-138	-10	-0.0126
58	-26	-9	-17	-1	12	-13	4	-0.0066
60	3	-22	25	29	-17	46	21	-0.0090
62	36	-56	92	51	-51	102	10	-0.0216
64	54	-72	126	61	-59	120	-6	-0.0276
66	33	-52	85	46	-44	90	5	-0.0240
68	49	-69	118	65	-58	123	5	-0.0270
70	3	-16	19	6	5	1	-18	-0.0300
72	-54	39	-93	-51	62	-113	-20	-0.0192
74	-103	87	-190	-103	112	-215	-25	-0.0072
76	-169	122	-291	-142	136	-278	13	0.0078
78	0	0	0	0	0	0	0	0.0000





WSDOT Materials Lab Geotech Section Olympia, WA	DMC-041 SR 302 VICTOR SLIDE H-3-01

SITE : VICTOR
INSTALLATION : H3-01
DESCRIPTION : sr 302 Victor Slide

CURRENT SURVEY : 10/3/2002 12:53:05 PM
Probe Serial No : 28697

INITIAL SURVEY : 3/10/2001 7:53:00 AM
Probe Serial No : 28697

DATE PRINTED : 10/3/2002 4:37:18 PM

Data Reduction in Digi units for A Axis:

Depth (ft)	Initial A0	Initial A180	Initial Incr. Dev. (Diff)	Current A0	Current A180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
2	-164	145	-309	-293	287	-580	-271	-0.2634
4	-195	178	-373	-248	226	-474	-101	-0.1008
6	-25	9	-34	-58	35	-93	-59	-0.0402
8	28	-45	73	23	-46	69	-4	-0.0048
10	5	-14	19	16	-35	51	32	-0.0024
12	-90	68	-158	-87	58	-145	13	-0.0216
14	-134	117	-251	-121	98	-219	32	-0.0294
16	-129	112	-241	-156	133	-289	-48	-0.0486
18	-91	73	-164	-90	65	-155	9	-0.0198
20	-82	61	-143	-92	63	-155	-12	-0.0252
22	-77	65	-142	-62	42	-104	38	-0.0180
24	-33	13	-46	-21	-6	-15	31	-0.0408
26	-32	15	-47	-31	8	-39	8	-0.0594
28	-43	27	-70	-50	26	-76	-6	-0.0642
30	-58	38	-96	-65	37	-102	-6	-0.0606
32	-156	141	-297	-190	168	-358	-61	-0.0570
34	-142	123	-265	-161	134	-295	-30	-0.0204
36	-99	79	-178	-94	67	-161	17	-0.0024
38	-51	34	-85	-51	26	-77	8	-0.0126
40	-18	1	-19	-25	1	-26	-7	-0.0174
42	-55	38	-93	-51	26	-77	16	-0.0132
44	-103	85	-188	-106	79	-185	3	-0.0228
46	-141	127	-268	-154	133	-287	-19	-0.0246
48	-165	148	-313	-170	147	-317	-4	-0.0132
50	-160	137	-297	-165	135	-300	-3	-0.0108
52	-171	158	-329	-179	159	-338	-9	-0.0090
54	-120	102	-222	-125	98	-223	-1	-0.0036
56	-85	69	-154	-88	67	-155	-1	-0.0030
58	-64	48	-112	-70	46	-116	-4	-0.0024
60	0	0	0	0	0	0	0	0.0000

SITE : VICTOR
INSTALLATION : H3-01
DESCRIPTION : sr 302 Victor Slide

CURRENT SURVEY : 10/3/2002 12:53:05 PM
Probe Serial No : 28697

INITIAL SURVEY : 3/10/2001 7:53:00 AM
Probe Serial No : 28697

DATE PRINTED : 10/3/2002 4:37:18 PM

Data Reduction in Digi units for B Axis:

Depth (ft)	Initial B0	Initial B180	Initial Incr. Dev. (Diff)	Current B0	Current B180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
2	439	-475	914	426	-418	844	-70	-0.0960
4	351	-378	729	335	-323	658	-71	-0.0540
6	142	-171	313	177	-162	339	26	-0.0114
8	145	-167	312	171	-161	332	20	-0.0270
10	187	-219	406	195	-194	389	-17	-0.0390
12	290	-307	597	316	-302	618	21	-0.0288
14	303	-321	624	311	-302	613	-11	-0.0414
16	268	-286	554	279	-263	542	-12	-0.0348
18	225	-240	465	235	-222	457	-8	-0.0276
20	173	-190	363	177	-169	346	-17	-0.0228
22	171	-191	362	145	-141	286	-76	-0.0126
24	190	-209	399	218	-210	428	29	0.0330
26	216	-236	452	268	-253	521	69	0.0156
28	220	-236	456	242	-225	467	11	-0.0258
30	197	-229	426	208	-202	410	-16	-0.0324
32	165	-185	350	176	-159	335	-15	-0.0228
34	135	-154	289	143	-140	283	-6	-0.0138
36	159	-187	346	175	-166	341	-5	-0.0102
38	221	-238	459	243	-235	478	19	-0.0072
40	223	-242	465	234	-225	459	-6	-0.0186
42	192	-209	401	204	-192	396	-5	-0.0150
44	191	-209	400	195	-198	393	-7	-0.0120
46	204	-223	427	212	-210	422	-5	-0.0078
48	199	-213	412	201	-198	399	-13	-0.0048
50	178	-205	383	194	-191	385	2	0.0030
52	263	-282	545	272	-270	542	-3	0.0018
54	283	-299	582	287	-286	573	-9	0.0036
56	275	-293	568	282	-273	555	-13	0.0090
58	227	-259	486	258	-256	514	28	0.0168
60	0	0	0	0	0	0	0	0.0000

SITE : VICTOR
INSTALLATION : H3-01
DESCRIPTION : sr 302 Victor Slide

CURRENT SURVEY : 10/3/2002 12:53:05 PM
Probe Serial No : 28697

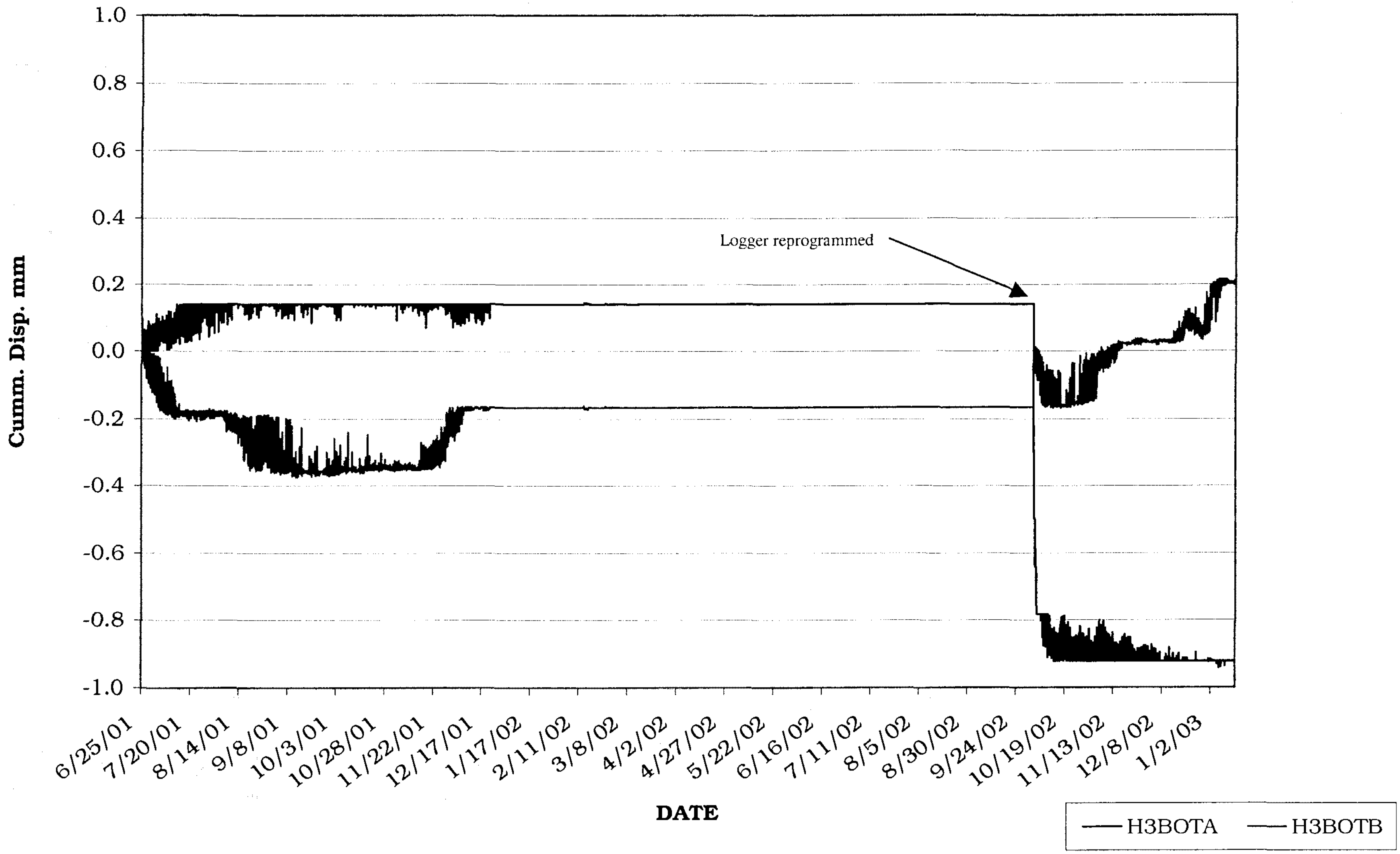
INITIAL SURVEY : 3/10/2001 7:53:00 AM
Probe Serial No : 28697

DATE PRINTED : 10/3/2002 4:37:18 PM

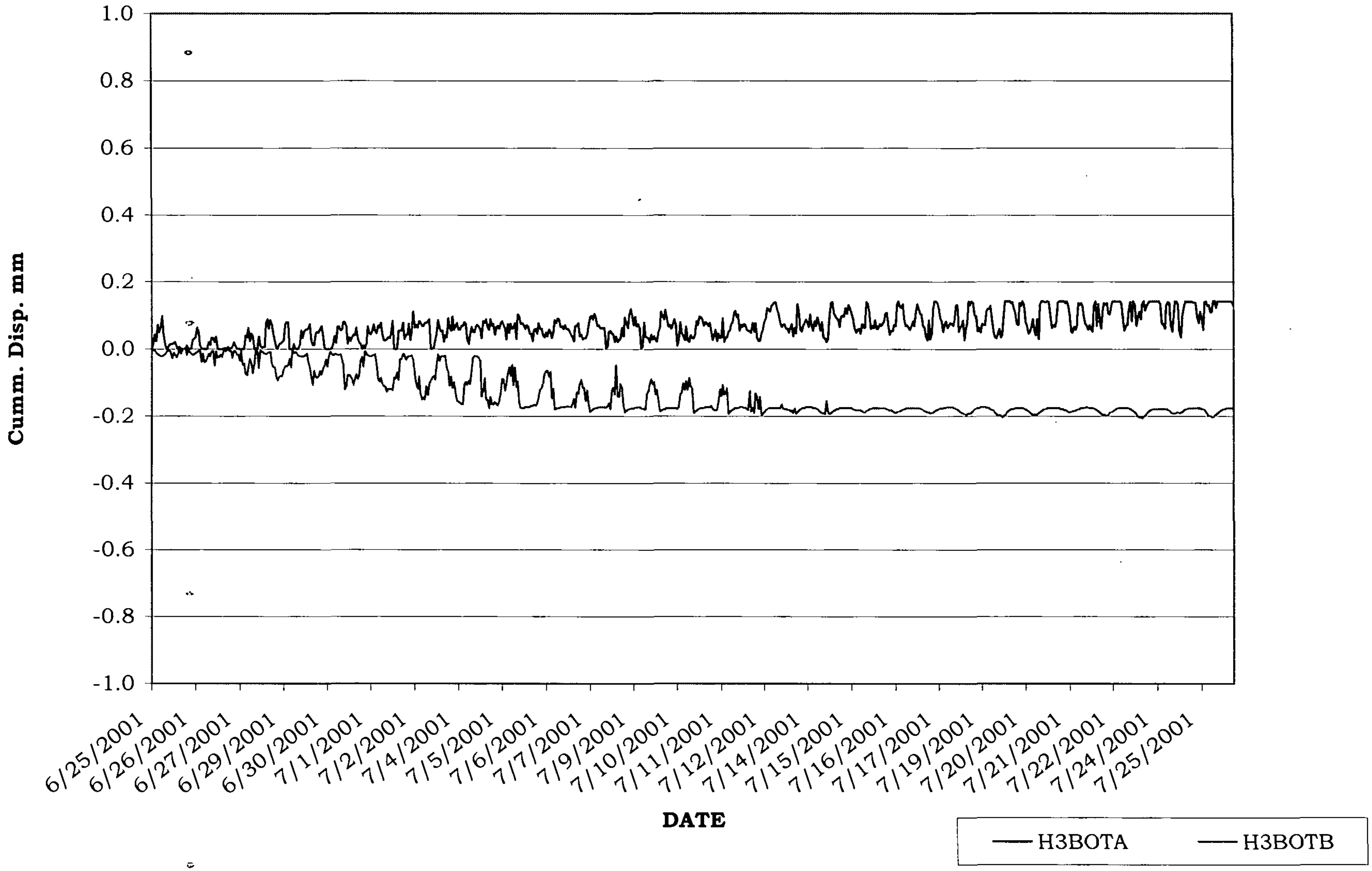
Bias Shift Summary for A and B Axes:

Depth From (ft)	Depth To (ft)	Avg. Diff. A0	Avg. Diff. A180	Avg. Shift A	Avg. Diff. B0	Avg. Diff. B180	Avg. Shift B
2	20	-22.9	18.0	-40.9	9.9	23.8	-13.9
22	40	-4.1	-3.3	-0.8	15.5	15.1	0.4
42	58	-4.9	-2.4	-2.4	10.3	13.1	-2.8
2	58	-10.8	4.3	-15.1	12.0	17.5	-5.5

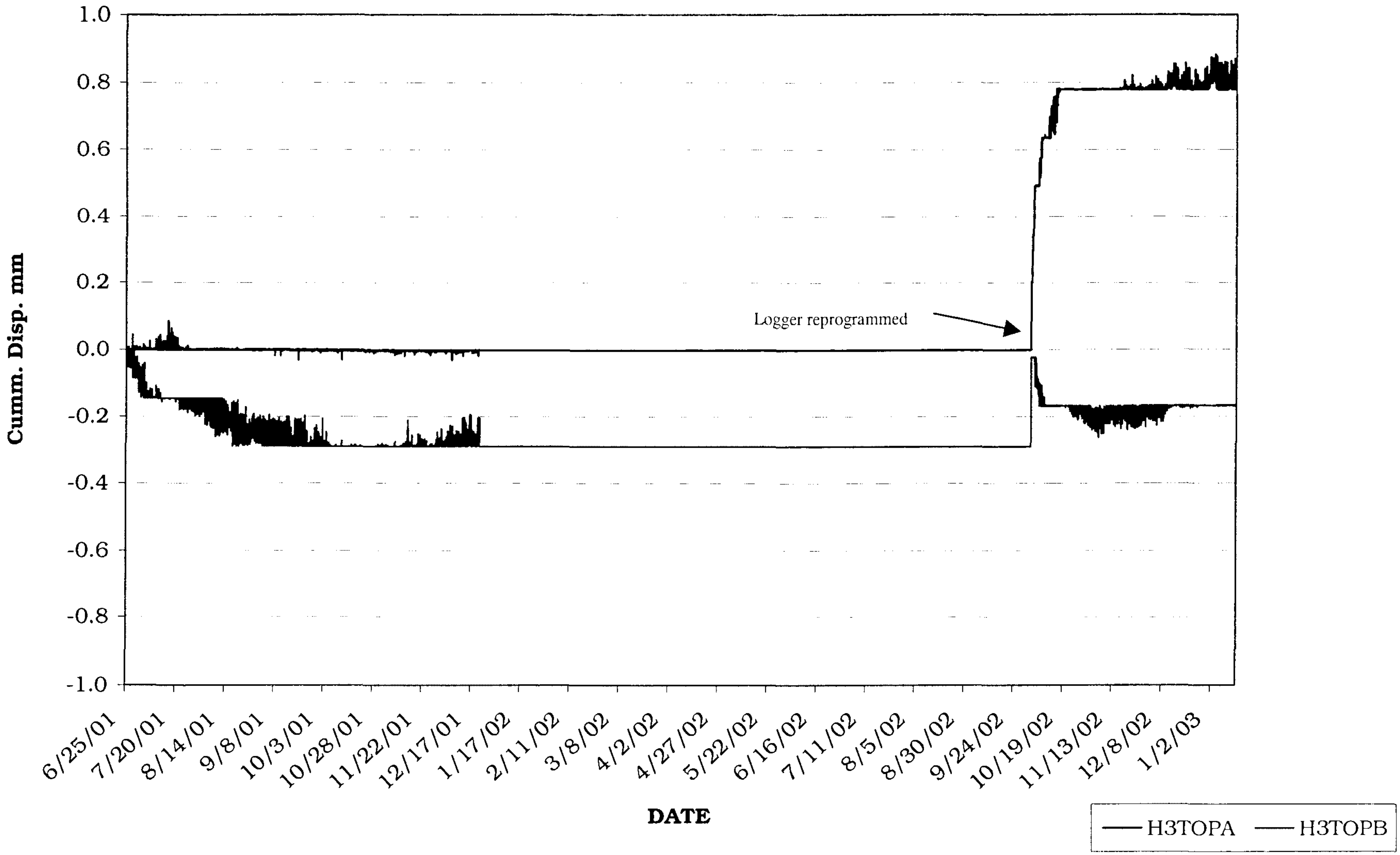
DMC-042 SR 302 VICTOR SLIDE



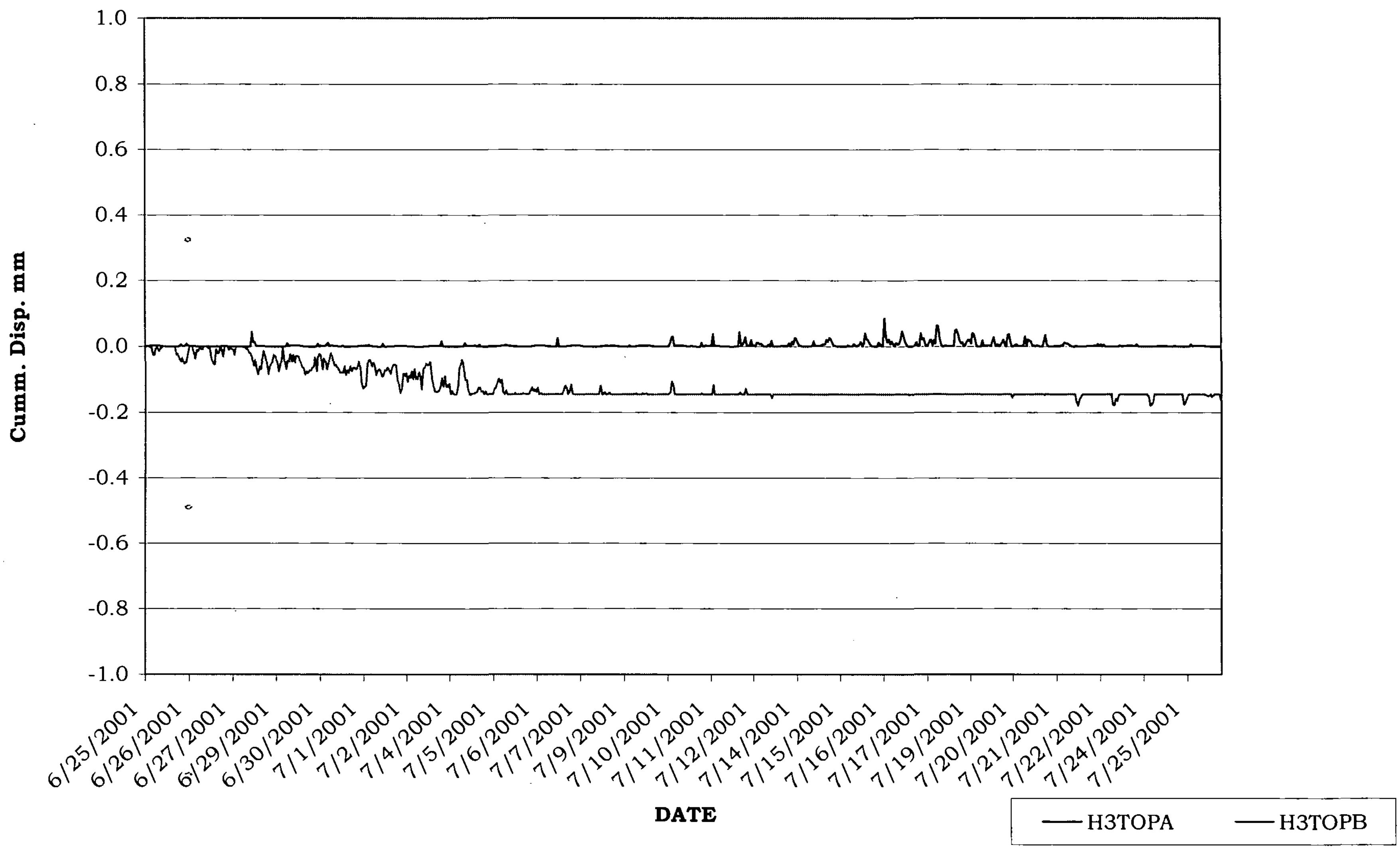
DMC-042 SR 302 VICTOR SLIDE

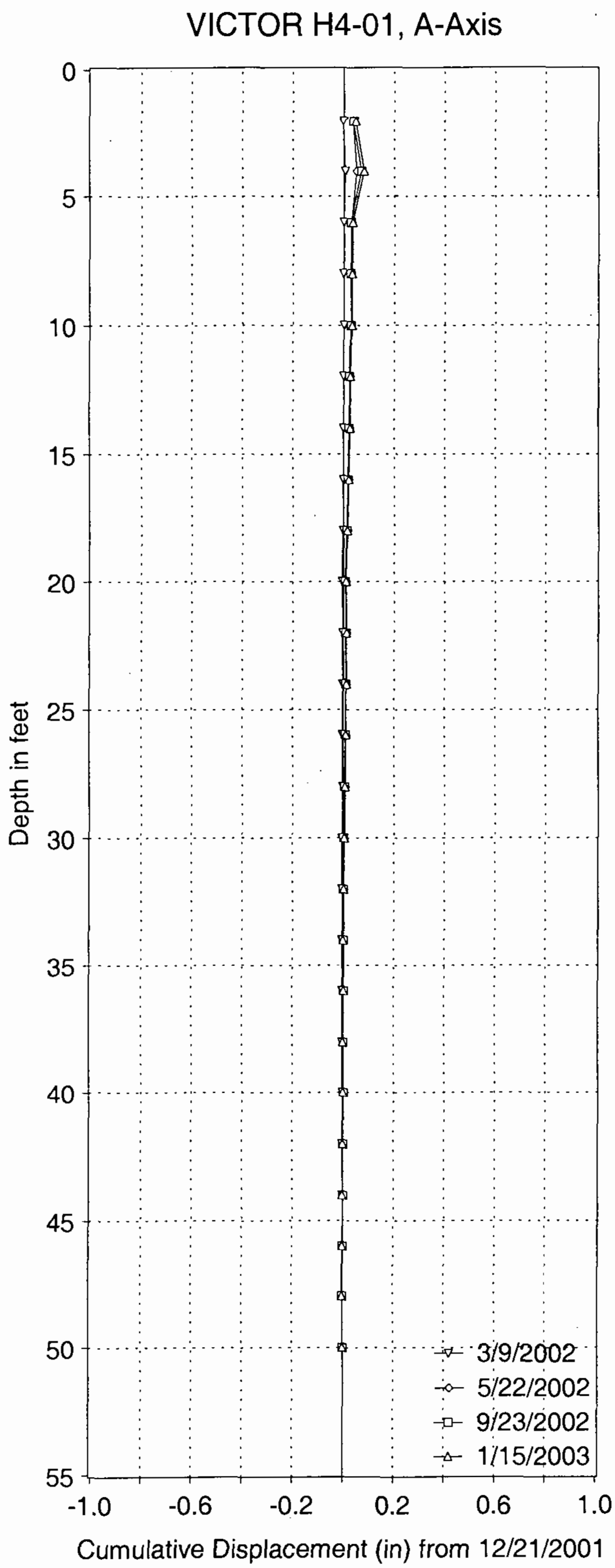


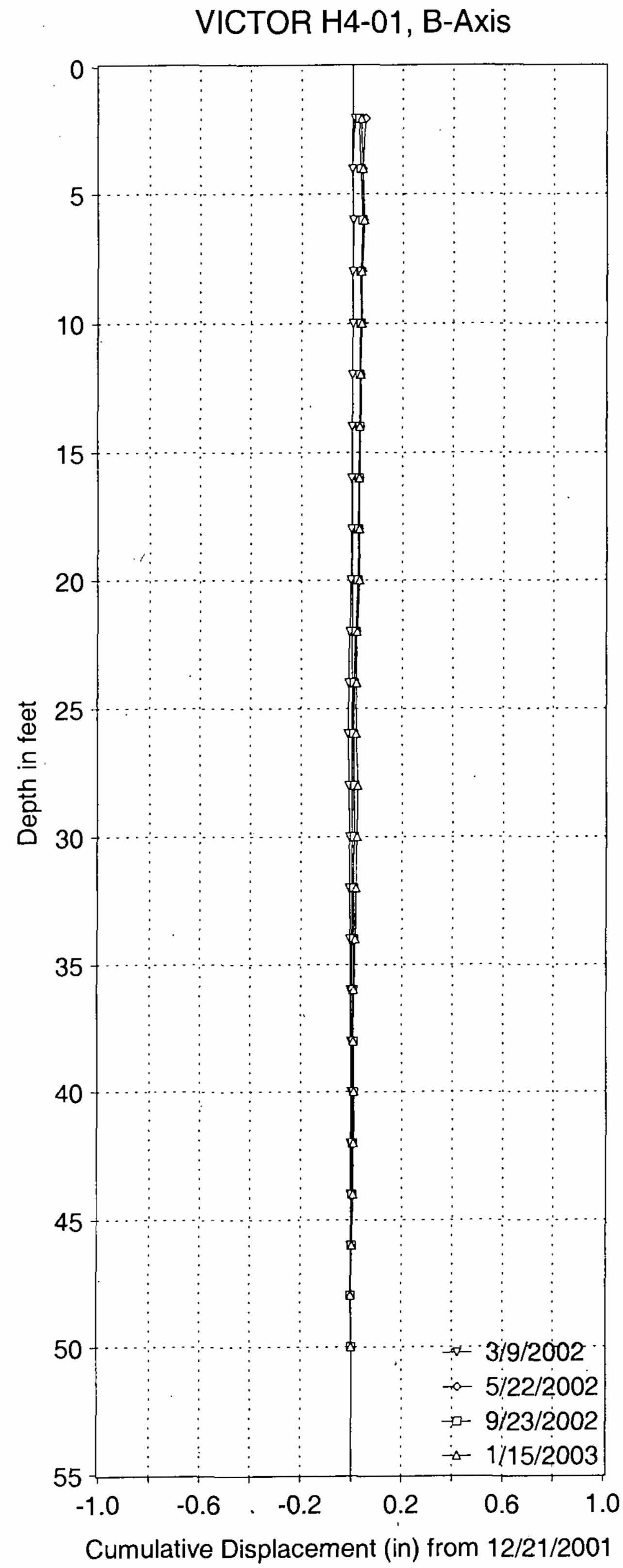
DMC-042 SR 302 VICTOR SLIDE



DMC-042 SR 302 VICTOR SLIDE







WSDOT Materials Lab Geotech Setion Olympia, WA	DMC-041 SR 302 VICTOR SLIDE H-4-01

SITE : VICTOR
INSTALLATION : H4-01
DESCRIPTION : sr 302 Victor Slide

CURRENT SURVEY : 1/15/2003 12:58:10 PM
Probe Serial No : 28697

INITIAL SURVEY : 12/21/2001 12:11:36 PM
Probe Serial No : 28697

DATE PRINTED : 1/15/2003 3:49:39 PM

Data Reduction in Digi units for A Axis:

Depth (ft)	Initial A0	Initial A180	Initial Incr. Dev. (Diff)	Current A0	Current A180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
3	-358	323	-681	-387	343	-730	-49	0.0858
5	-270	237	-507	-237	194	-431	76	0.1152
7	-321	285	-606	-323	278	-601	5	0.0696
9	-379	342	-721	-381	335	-716	5	0.0666
11	-378	341	-719	-375	331	-706	13	0.0636
13	-338	304	-642	-341	299	-640	2	0.0558
15	-315	281	-596	-315	269	-584	12	0.0546
17	-308	274	-582	-307	262	-569	13	0.0474
19	-329	292	-621	-328	283	-611	10	0.0396
21	-325	289	-614	-330	285	-615	-1	0.0336
23	-309	273	-582	-311	268	-579	3	0.0342
25	-316	280	-596	-318	274	-592	4	0.0324
27	-314	278	-592	-315	267	-582	10	0.0300
29	-310	276	-586	-313	269	-582	4	0.0240
31	-327	291	-618	-327	282	-609	9	0.0216
33	-342	308	-650	-345	302	-647	3	0.0162
35	-342	306	-648	-346	302	-648	0	0.0144
37	-301	267	-568	-303	258	-561	7	0.0144
39	-271	237	-508	-274	230	-504	4	0.0102
41	-276	240	-516	-279	234	-513	3	0.0078
43	-284	249	-533	-286	242	-528	5	0.0060
45	-327	291	-618	-331	286	-617	1	0.0030
47	-391	357	-748	-394	351	-745	3	0.0024
49	-435	401	-836	-440	395	-835	1	0.0006
51	0	0	0	0	0	0	0	0.0000

SITE : VICTOR
INSTALLATION : H4-01
DESCRIPTION : sr 302 Victor Slide

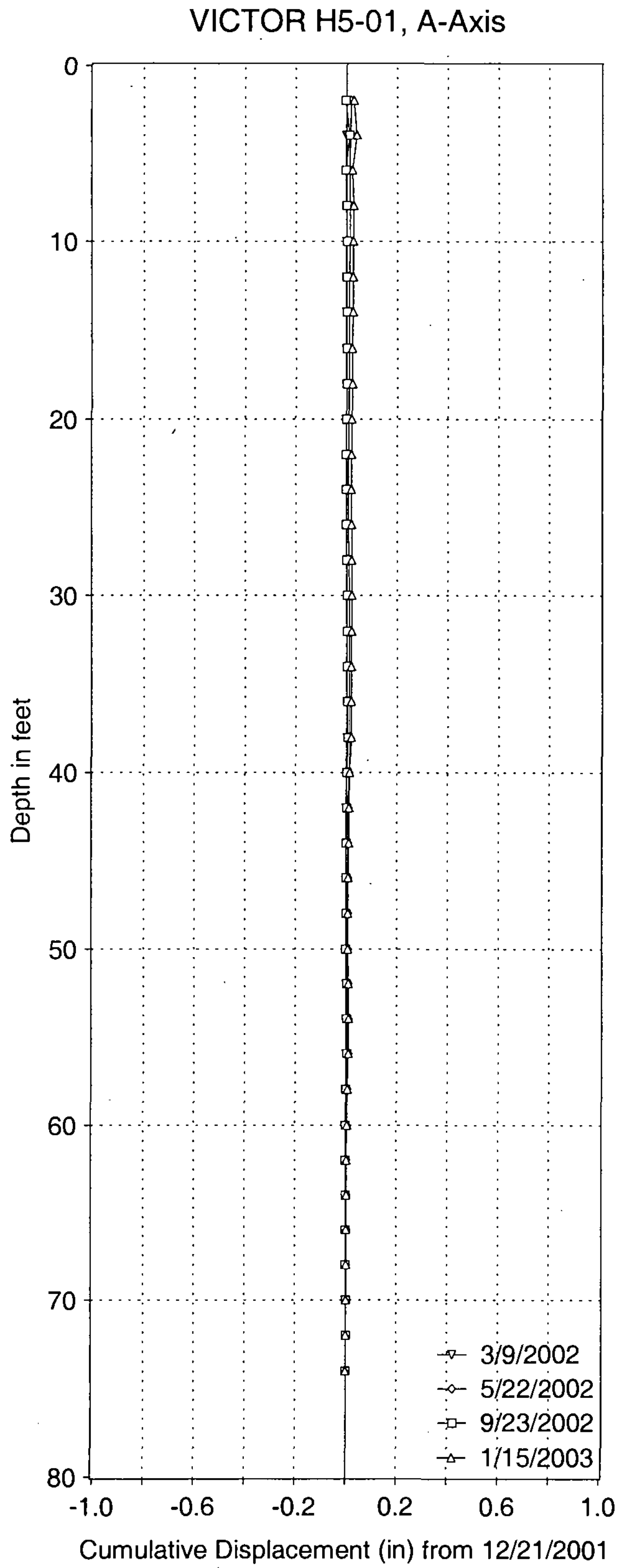
CURRENT SURVEY : 1/15/2003 12:58:10 PM
Probe Serial No : 28697

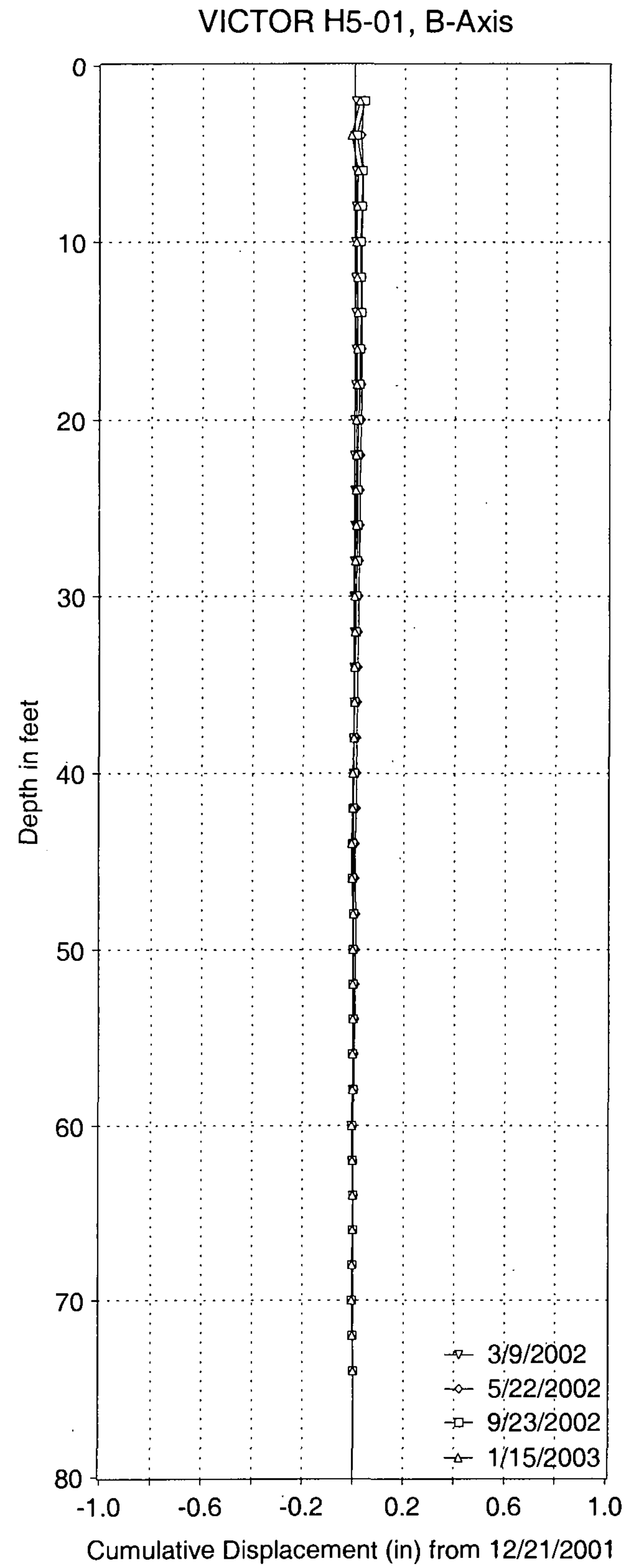
INITIAL SURVEY : 12/21/2001 12:11:36 PM
Probe Serial No : 28697

DATE PRINTED : 1/15/2003 3:49:39 PM

Data Reduction in Digi units for B Axis:

Depth (ft)	Initial B0	Initial B180	Initial Incr. Dev. (Diff)	Current B0	Current B180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
3	691	-690	1381	640	-729	1369	-12	0.0492
5	689	-686	1375	634	-734	1368	-7	0.0564
7	599	-592	1191	555	-654	1209	18	0.0606
9	498	-494	992	448	-545	993	1	0.0498
11	404	-398	802	358	-450	808	6	0.0492
13	307	-305	612	263	-355	618	6	0.0456
15	298	-294	592	251	-347	598	6	0.0420
17	307	-306	613	258	-358	616	3	0.0384
19	276	-277	553	223	-327	550	-3	0.0366
21	232	-227	459	191	-285	476	17	0.0384
23	283	-287	570	238	-337	575	5	0.0282
25	354	-354	708	307	-401	708	0	0.0252
27	423	-422	845	368	-468	836	-9	0.0252
29	472	-469	941	423	-525	948	7	0.0306
31	487	-481	968	439	-534	973	5	0.0264
33	434	-431	865	389	-482	871	6	0.0234
35	384	-381	765	338	-435	773	8	0.0198
37	308	-303	611	261	-355	616	5	0.0150
39	259	-257	516	208	-307	515	-1	0.0120
41	299	-296	595	250	-347	597	2	0.0126
43	298	-294	592	250	-347	597	5	0.0114
45	269	-259	528	219	-315	534	6	0.0084
47	224	-216	440	175	-274	449	9	0.0048
49	174	-173	347	121	-225	346	-1	-0.0006
51	0	0	0	0	0	0	0	0.0000





WSDOT
Materials Lab
Geotech Section
Olympia, WA

DMC-041 SR 302
VICTOR SLIDE
H-5-01

SITE : VICTOR
INSTALLATION : H5-01
DESCRIPTION : sr 302 Victor Slide

CURRENT SURVEY : 1/15/2003 12:39:36 PM
Probe Serial No : 28697

INITIAL SURVEY : 12/21/2001 2:16:53 PM
Probe Serial No : 28697

DATE PRINTED : 1/15/2003 3:49:55 PM

Data Reduction in Digi units for A Axis:

Depth (ft)	Initial A0	Initial A180	Initial Incr. Dev. (Diff)	Current A0	Current A180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
3	394	-428	822	389	-414	803	-19	0.0300
5	31	-65	96	52	-73	125	29	0.0414
7	-30	-5	-25	-25	7	-32	-7	0.0240
9	7	-43	50	16	-35	51	1	0.0282
11	3	-39	42	12	-33	45	3	0.0276
13	-73	39	-112	-65	47	-112	0	0.0258
15	-128	92	-220	-118	97	-215	5	0.0258
17	-135	101	-236	-127	110	-237	-1	0.0228
19	-146	111	-257	-137	118	-255	2	0.0234
21	-140	103	-243	-131	111	-242	1	0.0222
23	-129	93	-222	-120	100	-220	2	0.0216
25	-250	214	-464	-243	222	-465	-1	0.0204
27	-171	137	-308	-164	144	-308	0	0.0210
29	-131	95	-226	-123	105	-228	-2	0.0210
31	-99	65	-164	-91	71	-162	2	0.0222
33	-140	102	-242	-131	109	-240	2	0.0210
35	-123	89	-212	-116	97	-213	-1	0.0198
37	-43	6	-49	-34	15	-49	0	0.0204
39	96	-131	227	105	-131	236	9	0.0204
41	15	-50	65	26	-42	68	3	0.0150
43	-119	83	-202	-109	90	-199	3	0.0132
45	-94	57	-151	-84	64	-148	3	0.0114
47	-81	47	-128	-71	55	-126	2	0.0096
49	-175	139	-314	-167	146	-313	1	0.0084
51	-75	39	-114	-69	49	-118	-4	0.0078
53	-63	29	-92	-56	38	-94	-2	0.0102
55	-6	-29	23	2	-23	25	2	0.0114
57	-24	-10	-14	-13	-5	-8	6	0.0102
59	-110	75	-185	-102	83	-185	0	0.0066
61	-161	125	-286	-152	131	-283	3	0.0066
63	-166	132	-298	-158	139	-297	1	0.0048
65	-109	74	-183	-100	81	-181	2	0.0042
67	-94	59	-153	-86	67	-153	0	0.0030
69	-113	78	-191	-106	86	-192	-1	0.0030
71	-71	36	-107	-62	42	-104	3	0.0036
73	-102	69	-171	-93	75	-168	3	0.0018
75	0	0	0	0	0	0	0	0.0000

SITE : VICTOR
INSTALLATION : H5-01
DESCRIPTION : sr 302 Victor Slide

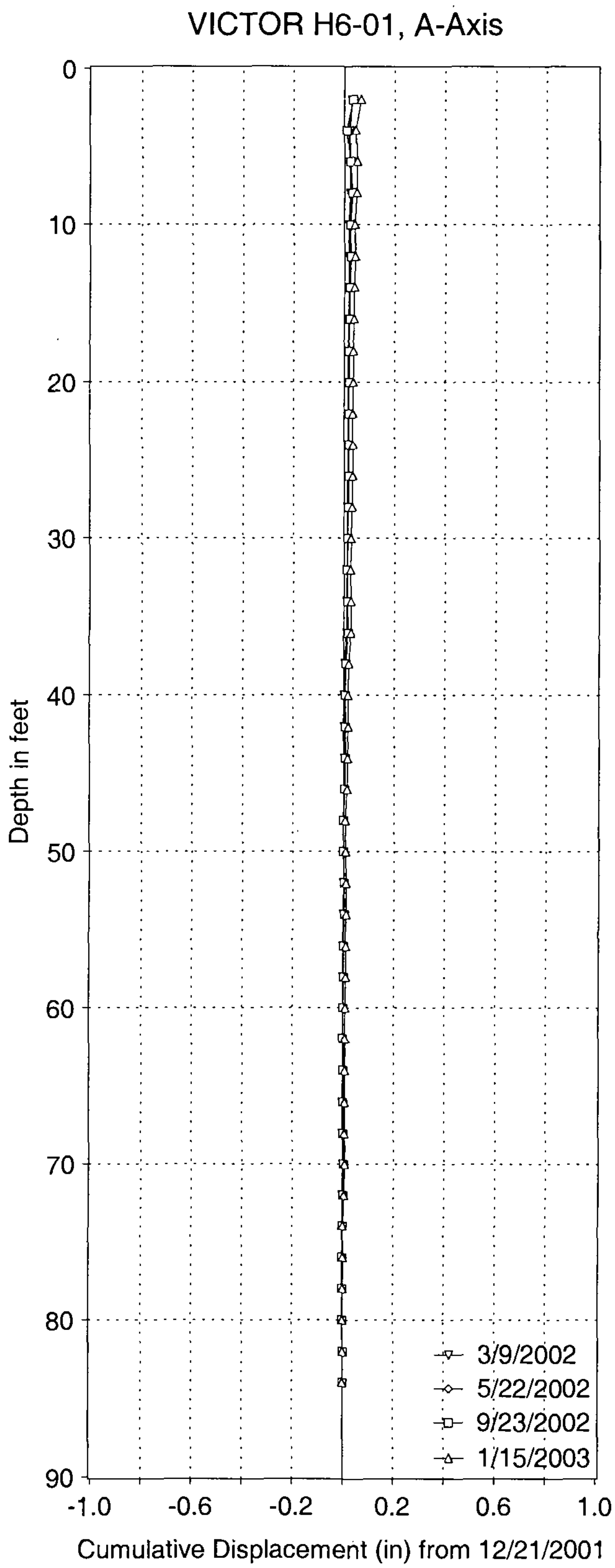
CURRENT SURVEY : 1/15/2003 12:39:36 PM
Probe Serial No : 28697

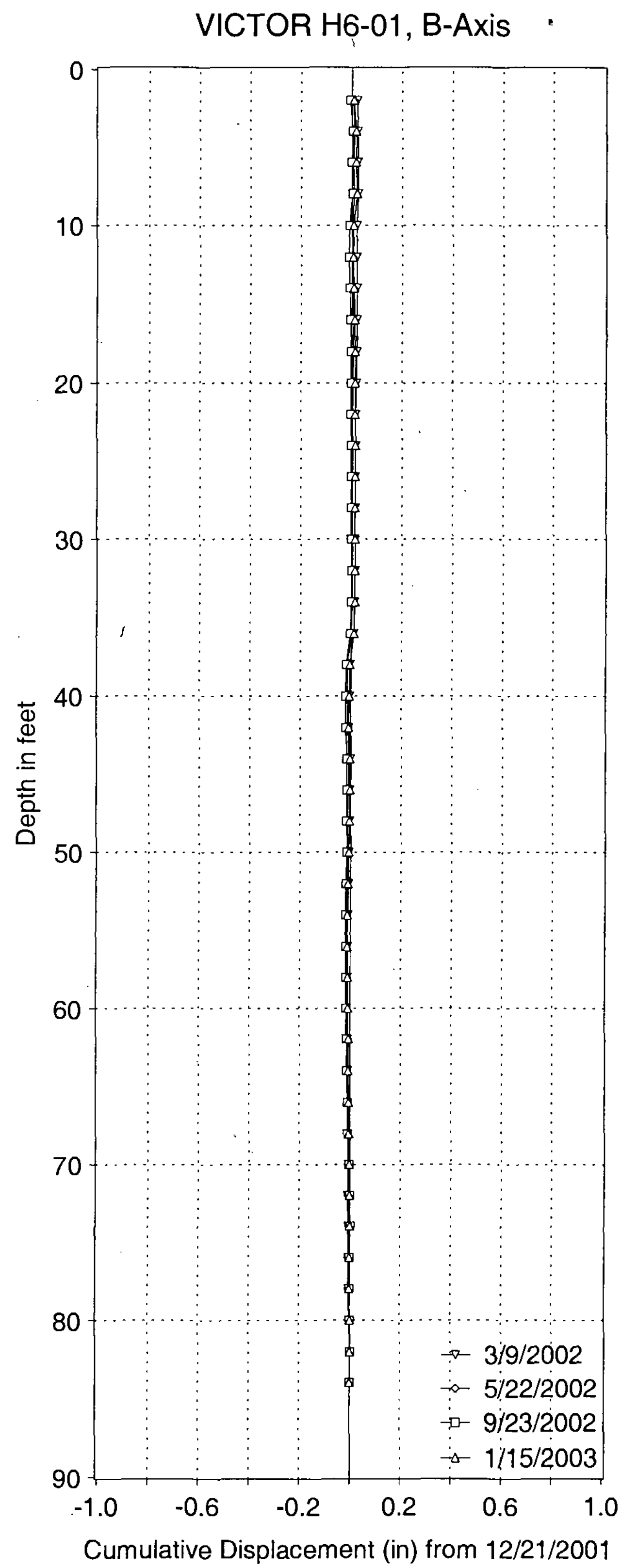
INITIAL SURVEY : 12/21/2001 2:16:53 PM
Probe Serial No : 28697

DATE PRINTED : 1/15/2003 3:49:55 PM

Data Reduction in Digi units for B Axis:

Depth (ft)	Initial B0	Initial B180	Initial Incr. Dev. (Diff)	Current B0	Current B180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
3	-277	262	-539	-241	241	-482	57	0.0642
5	-27	30	-57	-49	50	-99	-42	0.0300
7	-90	89	-179	-83	87	-170	9	0.0552
9	-107	105	-212	-103	103	-206	6	0.0498
11	-61	59	-120	-60	63	-123	-3	0.0462
13	-161	162	-323	-159	166	-325	-2	0.0480
15	-162	159	-321	-158	157	-315	6	0.0492
17	-93	89	-182	-91	86	-177	5	0.0456
19	-53	57	-110	-53	56	-109	1	0.0426
21	-68	67	-135	-64	68	-132	3	0.0420
23	-150	151	-301	-147	151	-298	3	0.0402
25	-218	217	-435	-216	218	-434	1	0.0384
27	-62	59	-121	-56	58	-114	7	0.0378
29	-48	46	-94	-43	45	-88	6	0.0336
31	-46	46	-92	-43	48	-91	1	0.0300
33	-153	152	-305	-150	150	-300	5	0.0294
35	-177	181	-358	-179	177	-356	2	0.0264
37	-292	287	-579	-289	284	-573	6	0.0252
39	-69	65	-134	-71	57	-128	6	0.0216
41	149	-145	294	149	-149	298	4	0.0180
43	95	-87	182	97	-92	189	7	0.0156
45	7	-5	12	5	-7	12	0	0.0114
47	-4	2	-6	-9	3	-12	-6	0.0114
49	9	-5	14	11	-7	18	4	0.0150
51	-11	17	-28	-13	13	-26	2	0.0126
53	-66	67	-133	-66	65	-131	2	0.0114
55	-98	105	-203	-97	101	-198	5	0.0102
57	-106	105	-211	-105	105	-210	1	0.0072
59	-75	80	-155	-74	76	-150	5	0.0066
61	-59	59	-118	-59	61	-120	-2	0.0036
63	-53	52	-105	-55	52	-107	-2	0.0048
65	-45	53	-98	-46	48	-94	4	0.0060
67	-99	101	-200	-96	98	-194	6	0.0036
69	-71	69	-140	-68	69	-137	3	0.0000
71	7	-3	10	6	-3	9	-1	-0.0018
73	71	-71	142	69	-71	140	-2	-0.0012
75	0	0	0	0	0	0	0	0.0000





WSDOT Materials Lab Geotech Section Olympia, WA	DMC-041 SR 302 VICTOR SLIDE H-6-01

SITE : VICTOR
INSTALLATION : H6-01
DESCRIPTION : sr 302 Victor Slide

CURRENT SURVEY : 1/15/2003 11:24:30 AM
Probe Serial No : 28697

INITIAL SURVEY : 12/21/2001 11:03:18 AM
Probe Serial No : 28697

DATE PRINTED : 1/15/2003 3:50:38 PM

Data Reduction in Digi units for A Axis:

Depth (ft)	Initial A0	Initial A180	Initial Incr. Dev. (Diff)	Current A0	Current A180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
3	-73	37	-110	-47	28	-75	35	0.0684
5	-130	93	-223	-125	105	-230	-7	0.0474
7	-134	100	-234	-126	107	-233	1	0.0516
9	-69	31	-100	-54	33	-87	13	0.0510
11	13	-50	63	22	-41	63	0	0.0432
13	-1	-35	34	9	-29	38	4	0.0432
15	-94	60	-154	-86	67	-153	1	0.0408
17	-155	121	-276	-145	126	-271	5	0.0402
19	-86	49	-135	-78	57	-135	0	0.0372
21	-40	5	-45	-31	12	-43	2	0.0372
23	-45	10	-55	-37	17	-54	1	0.0360
25	-33	-3	-30	-25	4	-29	1	0.0354
27	-1	-32	31	7	-26	33	2	0.0348
29	-43	6	-49	-31	11	-42	7	0.0336
31	-239	203	-442	-227	209	-436	6	0.0294
33	-307	272	-579	-301	282	-583	-4	0.0258
35	-70	34	-104	-63	43	-106	-2	0.0282
37	-57	19	-76	-41	22	-63	13	0.0294
39	89	-125	214	100	-119	219	5	0.0216
41	105	-141	246	111	-133	244	-2	0.0186
43	106	-143	249	117	-137	254	5	0.0198
45	-16	-21	5	-6	-13	7	2	0.0168
47	-102	67	-169	-88	70	-158	11	0.0156
49	-338	301	-639	-330	309	-639	0	0.0090
51	-162	123	-285	-156	134	-290	-5	0.0090
53	-33	-4	-29	-26	5	-31	-2	0.0120
55	21	-58	79	31	-51	82	3	0.0132
57	-38	3	-41	-29	12	-41	0	0.0114
59	-90	51	-141	-81	58	-139	2	0.0114
61	-88	51	-139	-78	59	-137	2	0.0102
63	-74	37	-111	-65	45	-110	1	0.0090
65	-76	39	-115	-67	47	-114	1	0.0084
67	-31	-5	-26	-23	3	-26	0	0.0078
69	19	-57	76	27	-48	75	-1	0.0078
71	71	-107	178	81	-101	182	4	0.0084
73	-10	-26	16	1	-21	22	6	0.0060
75	-105	65	-170	-96	73	-169	1	0.0024
77	-53	16	-69	-44	26	-70	-1	0.0018
79	-64	27	-91	-55	35	-90	1	0.0024
81	-46	10	-56	-37	18	-55	1	0.0018
83	-97	58	-155	-87	66	-153	2	0.0012

Depth (ft)	Initial A0	Initial A180	Initial Incr. Dev. (Diff)	Current A0	Current A180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
85	0	0	0	0	0	0	0	0.0000

SITE : VICTOR
INSTALLATION : H6-01
DESCRIPTION : sr 302 Victor Slide

CURRENT SURVEY : 1/15/2003 11:24:30 AM
Probe Serial No : 28697

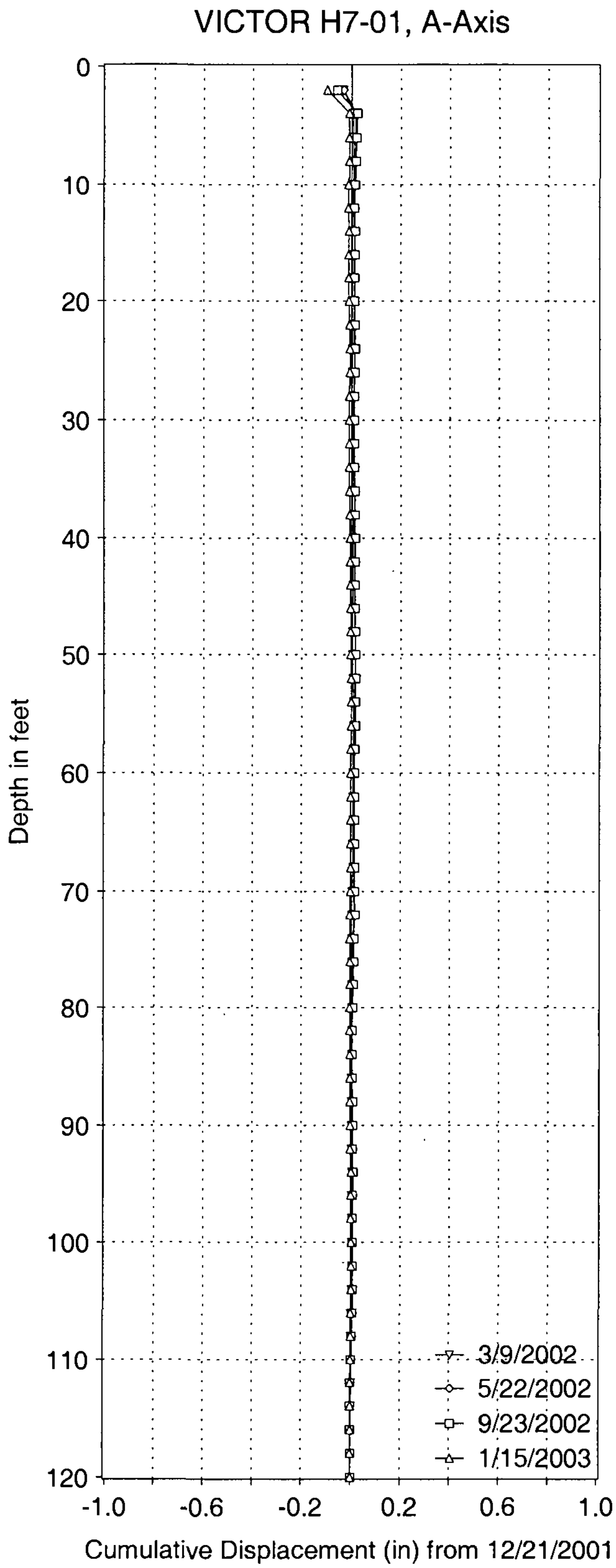
INITIAL SURVEY : 12/21/2001 11:03:18 AM
Probe Serial No : 28697

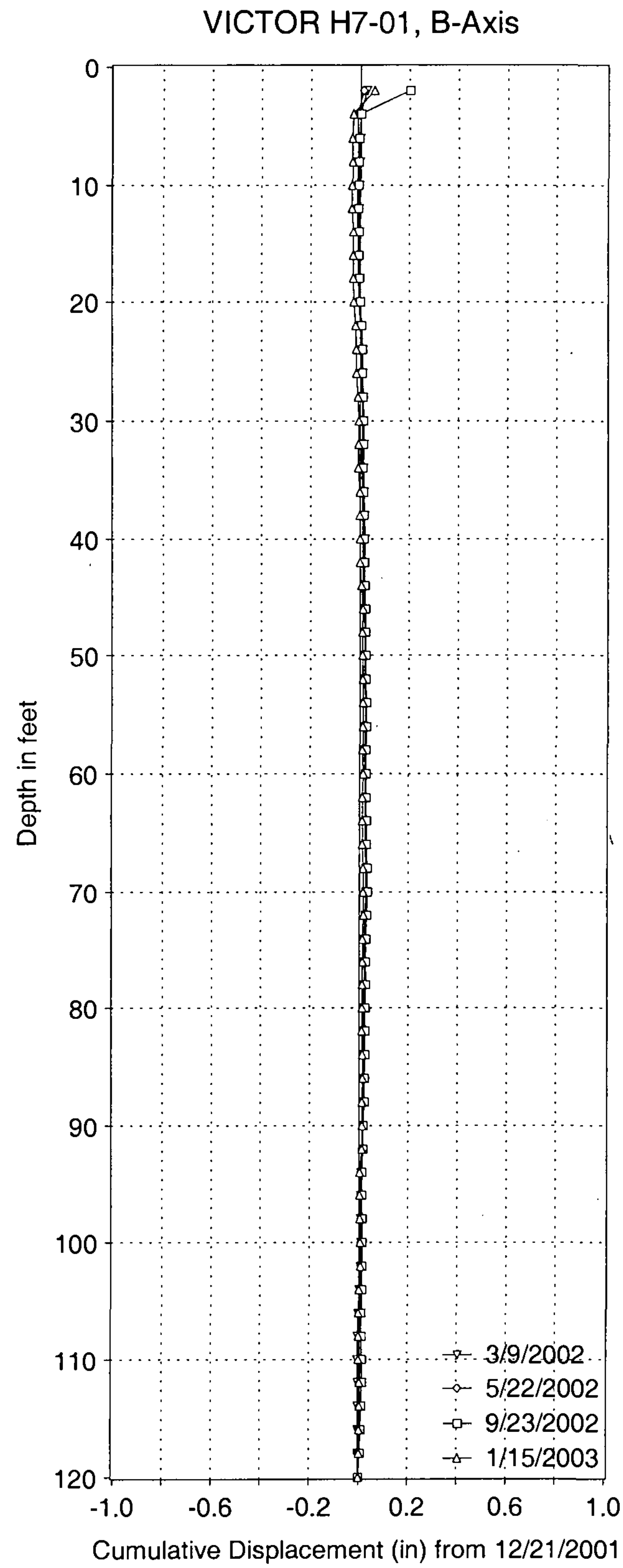
DATE PRINTED : 1/15/2003 3:50:38 PM

Data Reduction in Digi units for B Axis:

Depth (ft)	Initial B0	Initial B180	Initial Incr. Dev. (Diff)	Current B0	Current B180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
3	324	-326	650	319	-314	633	-17	0.0090
5	221	-224	445	228	-221	449	4	0.0192
7	66	-70	136	66	-62	128	-8	0.0168
9	-55	53	-108	-41	46	-87	21	0.0216
11	-175	176	-351	-169	177	-346	5	0.0090
13	-139	139	-278	-138	146	-284	-6	0.0060
15	-8	5	-13	-5	13	-18	-5	0.0096
17	99	-104	203	100	-98	198	-5	0.0126
19	46	-48	94	52	-43	95	1	0.0156
21	31	-36	67	36	-31	67	0	0.0150
23	17	-18	35	22	-13	35	0	0.0150
25	45	-51	96	49	-47	96	0	0.0150
27	65	-66	131	69	-62	131	0	0.0150
29	17	-23	40	25	-17	42	2	0.0150
31	-44	37	-81	-37	44	-81	0	0.0138
33	92	-102	194	97	-95	192	-2	0.0138
35	34	-34	68	43	-31	74	6	0.0150
37	-105	103	-208	-91	92	-183	25	0.0114
39	-41	42	-83	-36	43	-79	4	-0.0036
41	-34	37	-71	-32	38	-70	1	-0.0060
43	33	-29	62	32	-24	56	-6	-0.0066
45	26	-30	56	30	-25	55	-1	-0.0030
47	0	-1	1	5	2	3	2	-0.0024
49	26	-35	61	36	-30	66	5	-0.0036
51	39	-41	80	46	-38	84	4	-0.0066
53	-126	123	-249	-118	127	-245	4	-0.0090
55	-118	112	-230	-114	116	-230	0	-0.0114
57	-62	57	-119	-60	62	-122	-3	-0.0114
59	-71	59	-130	-65	67	-132	-2	-0.0096
61	-5	6	-11	-3	11	-14	-3	-0.0084
63	-58	53	-111	-53	58	-111	0	-0.0066
65	-32	32	-64	-31	37	-68	-4	-0.0066
67	-26	28	-54	-23	31	-54	0	-0.0042
69	-31	31	-62	-27	39	-66	-4	-0.0042
71	17	-22	39	21	-16	37	-2	-0.0018
73	179	-181	360	181	-174	355	-5	-0.0006
75	90	-94	184	98	-91	189	5	0.0024
77	-58	59	-117	-54	63	-117	0	-0.0006
79	-69	72	-141	-69	78	-147	-6	-0.0006
81	-107	103	-210	-101	106	-207	3	0.0030
83	-79	74	-153	-74	77	-151	2	0.0012

Depth (ft)	Initial B0	Initial B180	Initial Incr. Dev. (Diff)	Current B0	Current B180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
85	0	0	0	0	0	0	0	0.0000





WSDOT
Materials Lab
Geotech Section
Olympia, WA

DMC-041 SR 302
VICTOR SLIDE
H-7-01

SITE : VICTOR
INSTALLATION : H7-01
DESCRIPTION : sr 302 Victor Slide

CURRENT SURVEY : 1/15/2003 11:48:05 AM
Probe Serial No : 28697

INITIAL SURVEY : 12/21/2001 10:31:51 AM
Probe Serial No : 28697

DATE PRINTED : 1/15/2003 3:51:06 PM

Data Reduction in Digi units for A Axis:

Depth (ft)	Initial A0	Initial A180	Initial Incr. Dev. (Diff)	Current A0	Current A180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
3	-144	111	-255	-227	178	-405	-150	-0.0978
5	-113	75	-188	-115	70	-185	3	-0.0078
7	-138	101	-239	-142	98	-240	-1	-0.0096
9	-236	201	-437	-241	196	-437	0	-0.0090
11	-328	293	-621	-332	286	-618	3	-0.0090
13	-321	285	-606	-327	283	-610	-4	-0.0108
15	-276	241	-517	-280	236	-516	1	-0.0084
17	-281	245	-526	-286	240	-526	0	-0.0090
19	-340	303	-643	-346	299	-645	-2	-0.0090
21	-229	193	-422	-235	190	-425	-3	-0.0078
23	-153	118	-271	-159	115	-274	-3	-0.0060
25	-105	69	-174	-110	63	-173	1	-0.0042
27	-217	180	-397	-219	174	-393	4	-0.0048
29	-385	350	-735	-389	345	-734	1	-0.0072
31	-400	363	-763	-405	359	-764	-1	-0.0078
33	-351	317	-668	-356	311	-667	1	-0.0072
35	-283	247	-530	-289	243	-532	-2	-0.0078
37	-200	165	-365	-206	161	-367	-2	-0.0066
39	-158	123	-281	-163	119	-282	-1	-0.0054
41	-145	109	-254	-150	105	-255	-1	-0.0048
43	-203	168	-371	-208	165	-373	-2	-0.0042
45	-136	101	-237	-142	96	-238	-1	-0.0030
47	-167	130	-297	-172	126	-298	-1	-0.0024
49	-67	32	-99	-71	28	-99	0	-0.0018
51	-55	19	-74	-62	15	-77	-3	-0.0018
53	-202	165	-367	-208	160	-368	-1	0.0000
55	-279	243	-522	-283	239	-522	0	0.0006
57	-241	204	-445	-246	199	-445	0	0.0006
59	-270	234	-504	-274	229	-503	1	0.0006
61	-298	261	-559	-303	257	-560	-1	0.0000
63	-250	213	-463	-255	208	-463	0	0.0006
65	-255	220	-475	-258	215	-473	2	0.0006
67	-185	149	-334	-191	146	-337	-3	-0.0006
69	-115	79	-194	-116	74	-190	4	0.0012
71	127	-164	291	125	-169	294	3	-0.0012
73	49	-86	135	43	-92	135	0	-0.0030
75	-116	81	-197	-122	77	-199	-2	-0.0030
77	-169	133	-302	-174	127	-301	1	-0.0018
79	-266	231	-497	-270	225	-495	2	-0.0024
81	-306	270	-576	-312	265	-577	-1	-0.0036
83	-435	398	-833	-440	394	-834	-1	-0.0030

Depth (ft)	Initial A0	Initial A180	Initial Incr. Dev. (Diff)	Current A0	Current A180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
85	-373	336	-709	-377	332	-709	0	-0.0024
87	-281	244	-525	-286	240	-526	-1	-0.0024
89	-209	173	-382	-215	169	-384	-2	-0.0018
91	-222	186	-408	-227	181	-408	0	-0.0006
93	-203	166	-369	-210	165	-375	-6	-0.0006
95	-178	143	-321	-182	138	-320	1	0.0030
97	-267	230	-497	-271	226	-497	0	0.0024
99	-275	240	-515	-280	236	-516	-1	0.0024
101	-254	217	-471	-259	212	-471	0	0.0030
103	-213	175	-388	-218	171	-389	-1	0.0030
105	-189	151	-340	-193	147	-340	0	0.0036
107	-187	151	-338	-192	146	-338	0	0.0036
109	-243	207	-450	-246	202	-448	2	0.0036
111	-323	289	-612	-327	283	-610	2	0.0024
113	-398	361	-759	-402	357	-759	0	0.0012
115	-385	349	-734	-389	343	-732	2	0.0012
117	-363	326	-689	-367	321	-688	1	0.0000
119	-325	291	-616	-330	287	-617	-1	-0.0006
121	0	0	0	0	0	0	0	0.0000

SITE : VICTOR
INSTALLATION : H7-01
DESCRIPTION : sr 302 Victor Slide

CURRENT SURVEY : 1/15/2003 11:48:05 AM
Probe Serial No : 28697

INITIAL SURVEY : 12/21/2001 10:31:51 AM
Probe Serial No : 28697

DATE PRINTED : 1/15/2003 3:51:06 PM

Data Reduction in Digi units for B Axis:

Depth (ft)	Initial B0	Initial B180	Initial Incr. Dev. (Diff)	Current B0	Current B180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
3	-101	95	-196	-63	-11	-52	144	0.0576
5	-150	150	-300	-194	98	-292	8	-0.0288
7	-169	164	-333	-214	122	-336	-3	-0.0336
9	-141	135	-276	-185	90	-275	1	-0.0318
11	-111	107	-218	-152	65	-217	1	-0.0324
13	-39	35	-74	-88	-3	-85	-11	-0.0330
15	-48	43	-91	-94	-6	-88	3	-0.0264
17	-123	120	-243	-170	73	-243	0	-0.0282
19	-123	121	-244	-173	76	-249	-5	-0.0282
21	-90	89	-179	-140	50	-190	-11	-0.0252
23	-130	123	-253	-176	81	-257	-4	-0.0186
25	-143	141	-284	-190	97	-287	-3	-0.0162
27	-46	45	-91	-97	4	-101	-10	-0.0144
29	-27	19	-46	-78	-26	-52	-6	-0.0084
31	-127	129	-256	-175	79	-254	2	-0.0048
33	-176	175	-351	-222	128	-350	1	-0.0060
35	-89	86	-175	-139	47	-186	-11	-0.0066
37	-105	101	-206	-148	56	-204	2	0.0000
39	-116	107	-223	-165	62	-227	-4	-0.0012
41	-150	151	-301	-197	103	-300	1	0.0012
43	-125	123	-248	-176	83	-259	-11	0.0006
45	-113	111	-224	-163	71	-234	-10	0.0072
47	-113	111	-224	-156	63	-219	5	0.0132
49	-57	52	-109	-105	7	-112	-3	0.0102
51	41	-40	81	-10	-89	79	-2	0.0120
53	17	-16	33	-30	-62	32	-1	0.0132
55	-4	3	-7	-51	-44	-7	0	0.0138
57	-5	5	-10	-52	-42	-10	0	0.0138
59	-62	57	-119	-112	12	-124	-5	0.0138
61	-118	121	-239	-161	72	-233	6	0.0168
63	-125	128	-253	-170	82	-252	1	0.0132
65	-153	150	-303	-202	103	-305	-2	0.0126
67	-163	158	-321	-215	111	-326	-5	0.0138
69	-58	59	-117	-111	7	-118	-1	0.0168
71	21	-20	41	-27	-67	40	-1	0.0174
73	-211	208	-419	-257	157	-414	5	0.0180
75	-154	151	-305	-199	105	-304	1	0.0150
77	-141	134	-275	-184	89	-273	2	0.0144
79	-12	7	-19	-59	-41	-18	1	0.0132
81	27	-25	52	-23	-76	53	1	0.0126
83	-51	52	-103	-105	3	-108	-5	0.0120

Depth (ft)	Initial B0	Initial B180	Initial Incr. Dev. (Diff)	Current B0	Current B180	Current Incr. Dev. (Diff)	Incr. Disp. (Change)	Cum. Disp. (in)
85	-102	98	-200	-147	54	-201	-1	0.0150
87	-70	74	-144	-116	24	-140	4	0.0156
89	-122	126	-248	-170	78	-248	0	0.0132
91	-211	213	-424	-258	166	-424	0	0.0132
93	-249	253	-502	-291	197	-488	14	0.0132
95	-200	188	-388	-245	143	-388	0	0.0048
97	-99	95	-194	-146	49	-195	-1	0.0048
99	-157	150	-307	-204	105	-309	-2	0.0054
101	-119	115	-234	-165	71	-236	-2	0.0066
103	-119	121	-240	-162	69	-231	9	0.0078
105	-90	84	-174	-134	39	-173	1	0.0024
107	-42	35	-77	-89	-11	-78	-1	0.0018
109	79	-84	163	31	-133	164	1	0.0024
111	203	-205	408	153	-249	402	-6	0.0018
113	101	-103	204	53	-151	204	0	0.0054
115	-35	33	-68	-81	-14	-67	1	0.0054
117	-121	120	-241	-168	71	-239	2	0.0048
119	-296	298	-594	-342	246	-588	6	0.0036
121	0	0	0	0	0	0	0	0.0000

APPENDIX C: REPORTING COMPLETED BY OTHERS

Foundations

File Landslide

January 6, 1959

Mr. Carl E. Minor
Materials & Research Engineer
318 State Avenue
Olympia, Washington

Dear Sir:

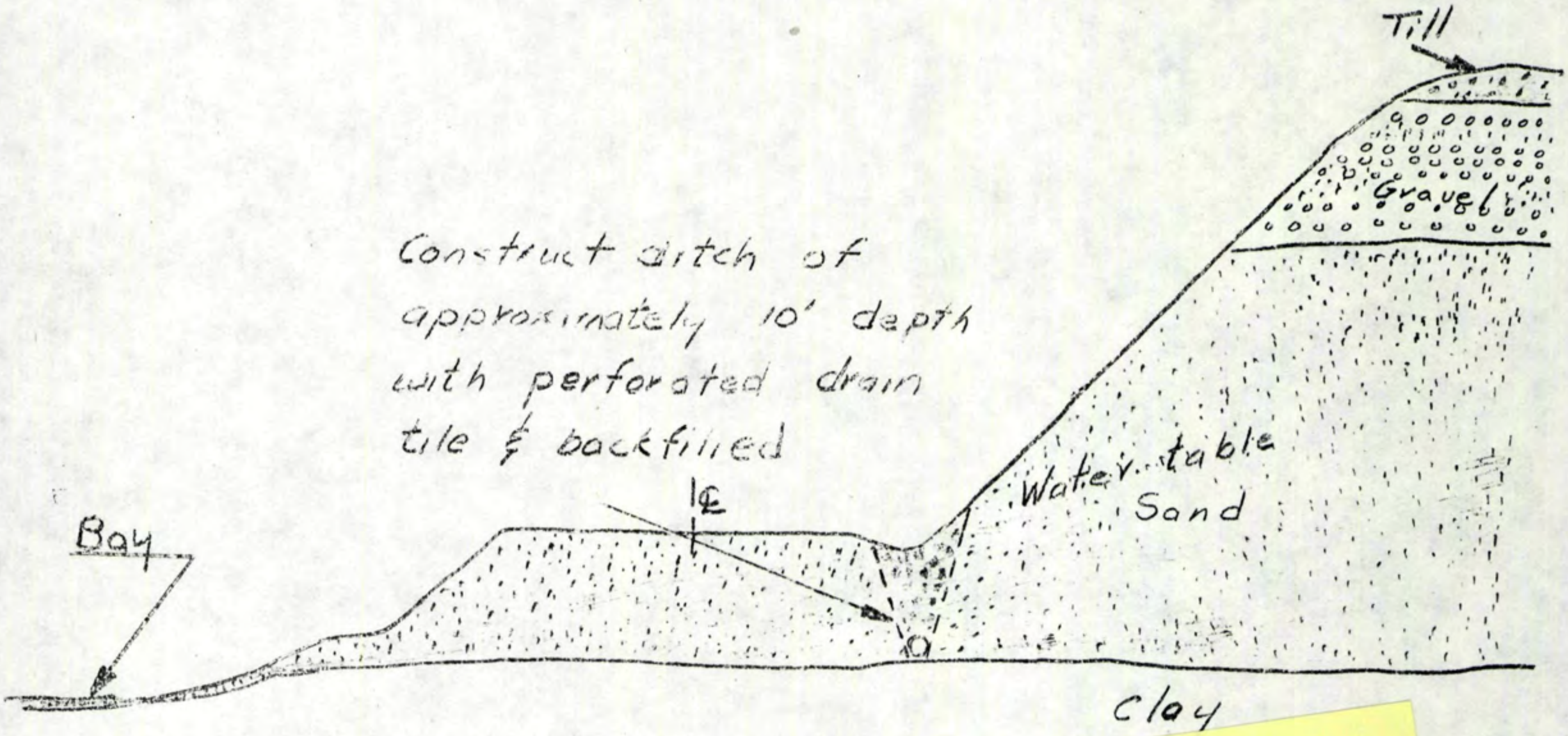
Attached you will find a diagrammatic sketch showing a procedure for the correction of a landslide one and one-quarter mile south of Victor on SSH #14-A. This landslide has caused a constant maintenance problem in the past, and will continue to do so until a correction is made.

The landslide is caused by subsurface water flowing through sand beds that are overlying an impervious glacial clay. The correction for this landslide would be to cut off this flow of water from the roadway section. It is felt that this correction could be accomplished by excavating a 10' ditch in the present ditch line and placing a perforated pipe in this ditch. This constructed ditch should be backfilled ~~by~~ with a free-draining material.

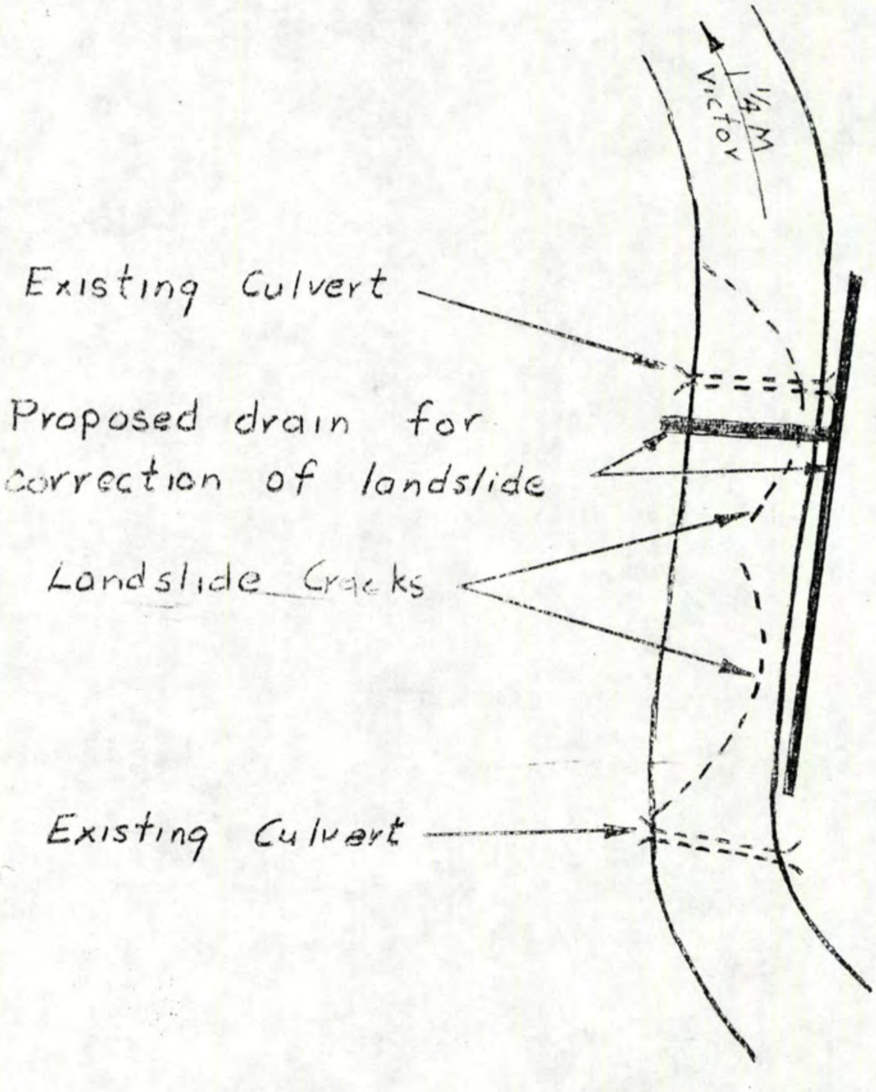
Yours very truly,

ARTHUR M. RITCHIE & JOE B. CASHMAN
Geologists

JBC:MMK
Attach.



↑ does not exist



DIAGRAMATIC SKETCH OF LANDSLIDE NEAR VICTOR

FORM 700-008
REVISED 3/72

DEPARTMENT OF HIGHWAYS

DATE: July 9, 1976

INTRA-DEPARTMENTAL COMMUNICATION

FROM: H. Frankmoelle

SUBJECT: C.S. 2332, SR 302, Victor Vicinity - Settlement

TO: R. McCoy

For many years - thirty or more according to one now retired employee - SR 302 in the vicinity of Victor has been settling. Maintenance forces have been placing layer after layer of asphalt concrete and sand and gravel (usually pit run) to bring the pavement back to its original level. In December 1971 a section about 50 feet long and extending across 3/4 of the traveled portion of the highway slid out into the bay exposing many layers of asphalt for a depth of about ten feet. In some areas this may actually reach a depth of 15 feet or more.

The soils conditions are approximately as shown on the attached drawing, with fine silty sand overlaying blue clay. The fines are easily liquified with even a minor amount of water. Upland run-off of surface drainage penetrates top soil and underlying sandy soil, eventually seeping out on the water side of the highway. Drainage facilities in the area are very marginal and difficult to maintain due to the soils conditions. Piping

There seem to be three major factors that cause the settlement of the roadway. One is of course water penetration from the high ground east of the highway. The additional weight from the many layers of asphalt materials is certainly another reason for the present problems. Also the water is trapped between the layers and carries fines to the water side of the fill.

The third reason seems to be the action of the tide on the wter side of the highway. The shoreline in this area is exposed to wind and wave action from the Southwest which is considerable at times. The water pressure during high tides apparently stops the drainage run-off through the soil above the clay layers and causes a pressure build-up which is released at low tide, causing fine materials to be squeezed out from under the heavy roadway fill. These materials are carried out into the bay with the receding water. Piping

This theory seems to be born out by the fact that we have experienced more rapid settling of the roadway after extreme high tides which usually occur in December, January and February, at the rate of about 3 or 4 per year. Rapid Drawdown

We were able to place some riprap on the water side in the worst areas of settlement. This has reduced the problem considerably. In the winter of 71-72 and again 72-73 we experienced settlement of 8 - 12 inches, while the total settlement for the next two winters after the rock had been placed amounted to less than half of that with an average of about 4 inches.

Because of a lack of funds and limitations of maintenance operations the rock placement was less than necessary for a more permanent correction of the problem. Drainage facilities need improvements and the practice of adding asphalt concrete will have to be stopped.

HWY FORM 700-008
REVISED 3/72

DEPARTMENT OF HIGHWAYS

INTRA-DEPARTMENTAL COMMUNICATION

DATE: July 9, 1976

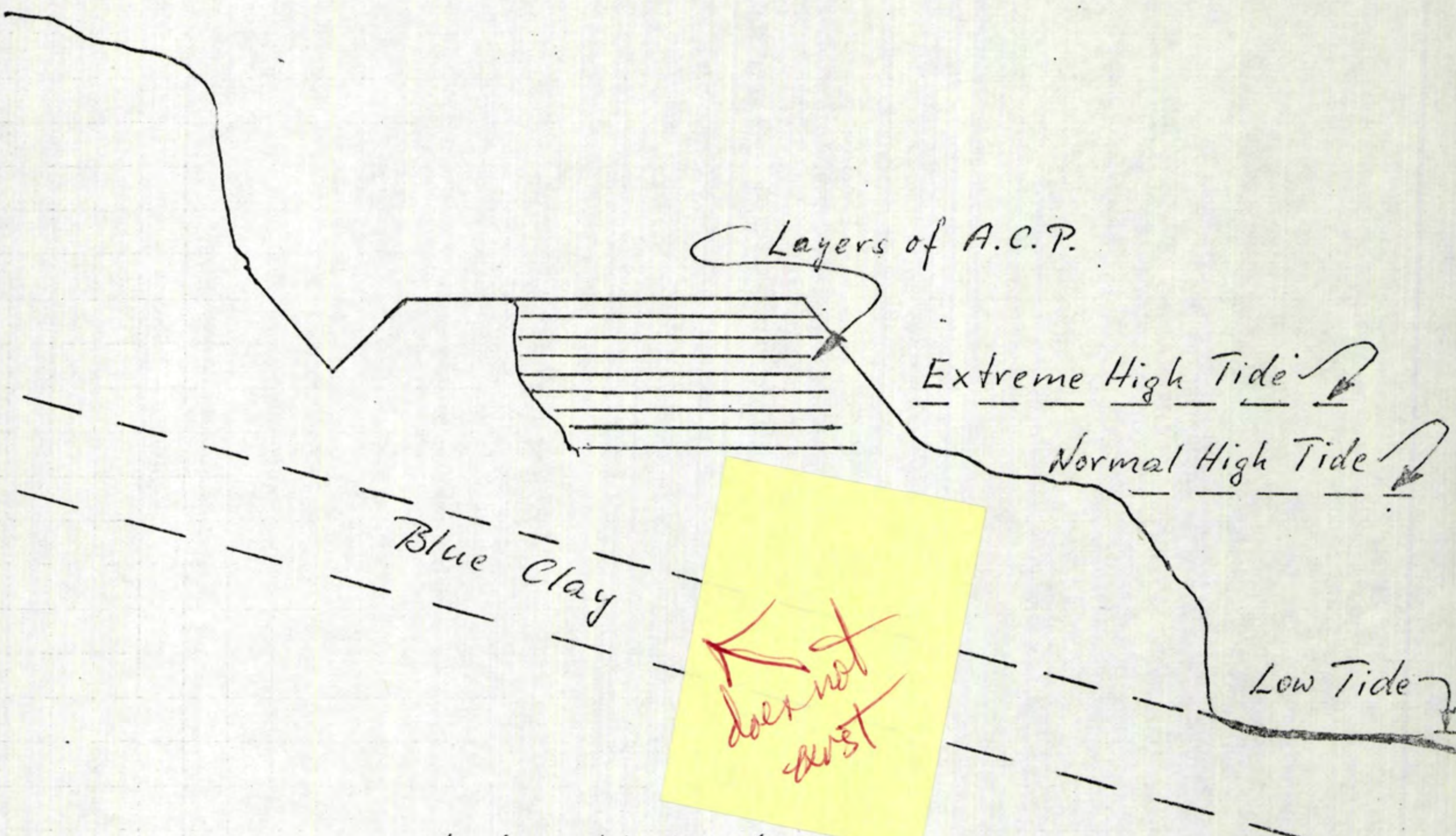
FROM: H. Frankmoelle

SUBJECT: (continued)

TO: R. McCoy

Any excavation along the upland (east) side of the highway will cause settlements and slides on the adjacent higher ground and could cause considerable damage to private property, including one or two homes located in this area. We did experience minor problems of this type when we attempted to improve the drainage by installing seepage basins at the entrance ends of cross-culverts.

REC...



SR 302, Victor Vicinity -

Settlement Area

HWY FORM 700-008 REVISED 3/72

Foundations

DEPARTMENT OF HIGHWAYS

INTRA-DEPARTMENTAL COMMUNICATION

DATE: April 1, 1977

FROM: R. V. LeClerc/A. P. Kilian
Scan 234-7111

SUBJECT: SR-302, CS 2332, L-5013
VICTOR VICINITY SLIDE

TO: J. D. Zirkle/R. Minsch

The following IDC will serve as our report on the Victor Slide, Vicinity MP 5.5. It summarizes the conditions in the field, the investigations performed, and possible remedial actions for stabilization of the slide.

The subject slide area extends from the uphill ditch line to a point approximately 80 ft down the beach from the toe of the existing rock berm. Three test holes were drilled by district forces to determine the depth of the slide and the soil conditions involved. The soil stratification in the slide area is depicted on the attached cross-section, figure 1. In general, the foundation material consists of dense to very dense fine sand overlain by 8 to 30 ft of very loose fine sand containing some gravel and organic matter. It should be noted that clay is not present at or near the slide surface as reported some years ago.

A slope inclinometer was installed in hole B-1 to monitor slide movement. A plot of deflection versus depth is shown on the soil cross-section, figure 1. Although the magnitude of delfection is small, it is definite that failure is occuring at the contact between the very loose sand and the very dense sand. As noted above, the toe of the slide is 80 ft down the beach, as measured from the existing rock berm. It is now apparent that the slide in question is a deep seated flow slide. Although piping of sand through the existing rock berm and erosion of the sand by wave action, as reported in our June 11, 1976 IDC, are still considered as potential problems, they are minor compared to the overall slide instability. The slope inclonometer data and our field review indicate that the slide is marginally stable, with an actual factor of safety approximating unity.

The history of this slide, as reported by your maintenance people, indicates major movement during the winter, associated with high tides and storm action. This information is consistent with the known slide configuration. High tides would saturate the soil above the normal water level, adding weight to the head of the slide and simulating a rapid drawdown condition. Considering the very loose nature of the sand, once an unstable condition is reached liquefaction in the sand occurs and relatively large deflections, of as much as a foot, could occur.

In general, those things which will improve slide stability are as follows: reduce the seepage forces acting from uphill on the embankment, reduce the weight at the head of the slide, construct a stabilizing berm at the slide toe, and increase the shear strength on the failure plane. Attached is a step by step summary of our analysis of the slide. The various arcs analyzed are identified on figure 2. The stability analysis was performed using the Bell slope stability program. It is common practice to design embankment slopes and slide corrections for a factor of safety of 1.25. Because of the very low shear strength of the soil, the fact the slide toe

Dave Belling, Joe Michael, Gene, Al Kilian 1-5-78
a) with adjudust, keep detour profile as low as possible to not load existing buttress to failure, b) their drainage looks good (Herming) c) Choke Existing buttress to prevent piping. APK

is below water much of the time, and due to construction difficulties in lowering the water level more than 8 ft at the ditch line, a design with a minimum factor of safety of 1.25 using dewatering and a berm is for all practical purposes unattainable. Lowering the water level 8 ft at the ditch line increases the factor of safety from 1.00 to about 1.09. Widening the existing rock berm by 10 ft with a 2.1 sideslope, as shown in figure 2, further increases the safety factor to 1.13. Obviously dewatering helps the most, while a berm has limited effect. A shallow, very wide, and costly berm would be needed to be of much benefit.

Considering that we have relatively good data to analyze and assuming we are willing to accept some greater risk, the marginal design described above, i.e., lowering the water level and widening the rock berm, may be acceptable. Use of a longitudinal drain to lower the water level 8 ft at the ditch line is questionable since construction would likely cause a slide in the uphill cut face, unless well points are driven and the water level lowered 8 ft by pumping first. A more effective alternate which may cause problems in maintaining traffic is to construct cross drains at 40-ft intervals along line. The drains would be constructed by trenching across the roadway, lining the trench with filter cloth, laying a 6 inch drain pipe, backfilling with clean granular material, and lapping the filter cloth. This type of drain system should be effective in minimizing the influence of tides and storms as it should give up water rapidly. However, in order to maintain at least one way traffic, a detour may need to be constructed to the beach side of the existing roadway. When the rock berm is widened, the existing face should be choked with a well graded granular material to prevent piping of the sand through the rock berm.

Vibro-replacement was reviewed as a possible means of increasing the shear strength along the failure plane. However, to be a positive solution it appears all of the fill above the beach would have to be treated with stone columns. For rough estimating purposes, the columns would be on roughly 6-ft centers with an average length of 25 ft, and at a cost of $8 per lineal foot. If you are interested in looking into this system we will supply further information. The system is patented and the patent holder works out of the midwest.

A more obvious positive solution is to shift the alignment into the existing hill, getting the roadway section out of the slide area. This would necessitate roughly a 30-ft cut.

The final solution that we considered is reduction of the weight at the head of the slide by removing the built up pavement section to a depth of 8 ft and backfilling with sawdust. In order to construct this option, the water level must be lowered 8 ft as previously discussed. A possible sequence of construction would be:

1) Drive well points in the uphill ditch and pump the water level down 8 ft.

2) Construct cross drains from the existing rock berm to existing roadway.

3) Construct a detour to the beach side of the existing roadway.

4) Remove the old roadway to an 8-ft depth.

5) Extend the cross drains to the uphill ditch.

6) Build the sawdust fill.

7) Remove the detour.

This alternative does provide a positive solution with a factor of safety of 1.30; however, leachate may be a problem.

An additional concern that we feel obligated to comment on is that the beach has private property signs on it and approaches have been constructed for access. It would seem prudent to advise the county that this is a slide area and, for safety reasons, house construction should be discouraged or prohibited. An earthquake could cause liquefaction of the sand into a massive flow slide.

RVL:ksj
APK

Attach.

VICTOR SLIDE

Stability Analysis Summary:

(1) Failure surface A-A
Fine sand ϕ = varies
c = 50 psf
γ wet = 120 pcf (Sat.)
γ wet = 110 pcf (above W.T.)
γ dry ~ 90 pcf
γ pav't ~ 145 pcf

Using wet unit weights and pore pressure effect run search for Factor of Safety. (Low Tide)

ϕ = 9°15' for F.S. = 1.00
Tan ϕ = 0.163

(2) Using A-A from "(1)" but with high tide, tan ϕ = 0.163

F.S. = 0.97

(3) Using A-A from "(1)" with low tide, ϕ = 9°15', and lowered uphill W.T. by 8' at ditch.

F.S. = 1.11

(4) Using A-A from "(1)" with low tide, ϕ = 9°15', and adding a rock berm

F.S. = 1.70

(5) Repeating step "(4)" but with high tide

F.S. = 1.62

(6) Using arc B-D-B, which goes under rock berm from step (5),
a) ϕ = 9°15'
b) High tide

F.S. = 1.51

(7) Using arc B-D-C, with a toe further out the beach and under rock berm from step (5),
a) ϕ = 9°15'
b) high tide

F.S. = 1.14

(8) Using arc D-D-D which goes further out the beach and deeper
a) ϕ = 9°15'
b) high tide
c) rock berm from step (4)

F.S. = 0.76

-X- (Additional field review confirms arc D-D-D most nearly approximates slide.)

(9) Using arc D-D-D with no berm added
  a) existing W.T. as in step (1)
  b) low tide
  c) F.S. = 1 search for Ø

for F.S. 1.00 Ø = 13°46'
(F.S. = 0.995/tan Ø = 0.245)

(10) Using arc D-D-D with a berm added
  a) existing W.T. as in step (1)
  b) low tide
  c) tan Ø = 0.245

F.S. = 1.102

(11) Using arc D-D-D with berm added
  a) lowered W.T. 8'
  b) low tide
  c) tan Ø = 0.245

F.S. = 1.19

(12) Arc W-W check stability of berm
  a) uniform friction tan Ø = 0.245
  b) low tide
  c) existing W.T.

F.S. = 0.87

(13) Smaller berm section redo step (12)

F.S. = 1.02

high tide would reduce driving forces, increasing factor of safety water level @ beach groundline worst condition.

Upper 10 to 15 ft of slide material is coarser grained soil and should possess greater shear strength than occurs at the slide failure surface. Visual observation indicates existing berm in good condition. Friction angle, "Ø" of 20° to 30° should be reasonable where shear plane not already extablished.

(If Ø = 20° F.S. = 1.38 for smaller berm.)

(14) With smaller berm from step 13 recheck slide stability as in step 11.

F.S. = 1.13

Smaller berm half as effective as larger berm. Adds about 0.05 to factor of safety.

* Need small berm with lowered water level to achieve a marginally acceptable design. Using cross drains @ 40 ft intervals to lower water level, tidal flucuations should not produce a rapid drawdown condition.

(15) If vibro-replacement used to increase stability of the portion of slide directly below the roadway:

a) friction intreated zone increased to an average = 25°
b) same criteria as step 9 tan ϕ = 0.245 or ϕ = 13°46'

F.S. = 1.10

if spacing of stone columns decreased thus increasing average friction to ϕ = 30°

F.S. = 1.15

Vibro — replacement does not appear to be a positive solution unless carried horizontally out to existing rock berm. All fill above beach would then be on rock columns. Expen e prohibitive.

(16) If existing roadway section replaced with sawdust to 8 ft depth

a) friction remains the same as existing on the slide surface
b) weight @ head of slide decreased
c) to construct sawdust water level will have to be lowered 8 ft as investigated before.

F.S. = 1.30 (EQK = 0.025 F.S. = 1.12)

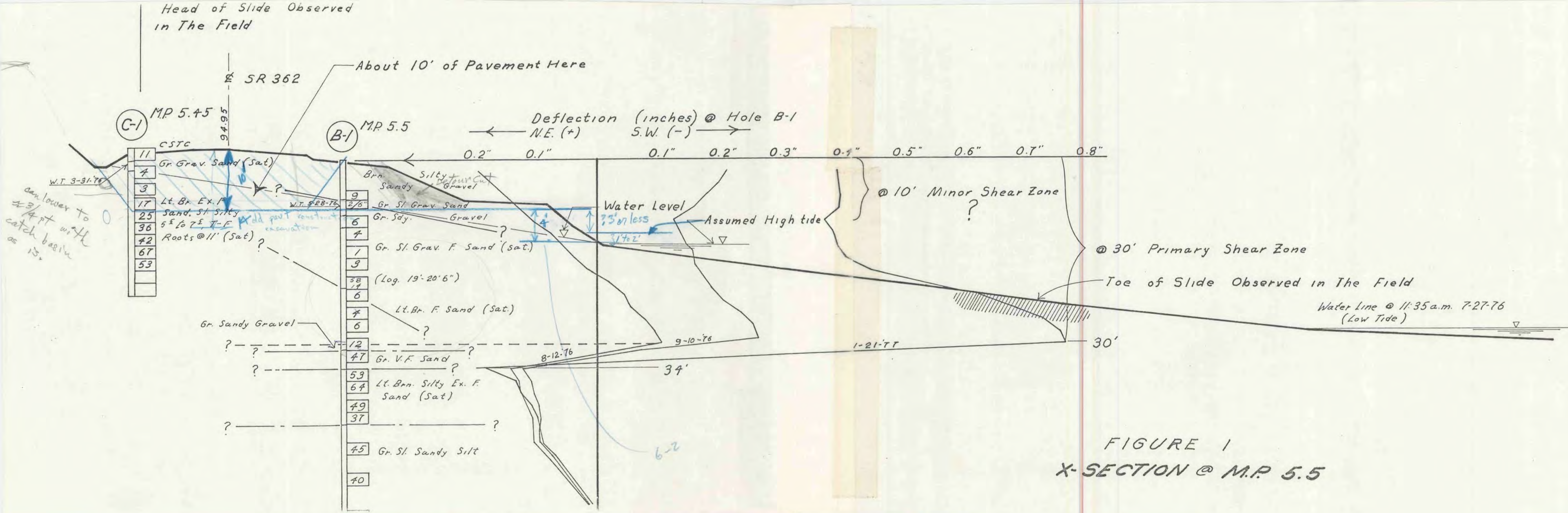


FIGURE 1

X-SECTION @ M.P. 5.5

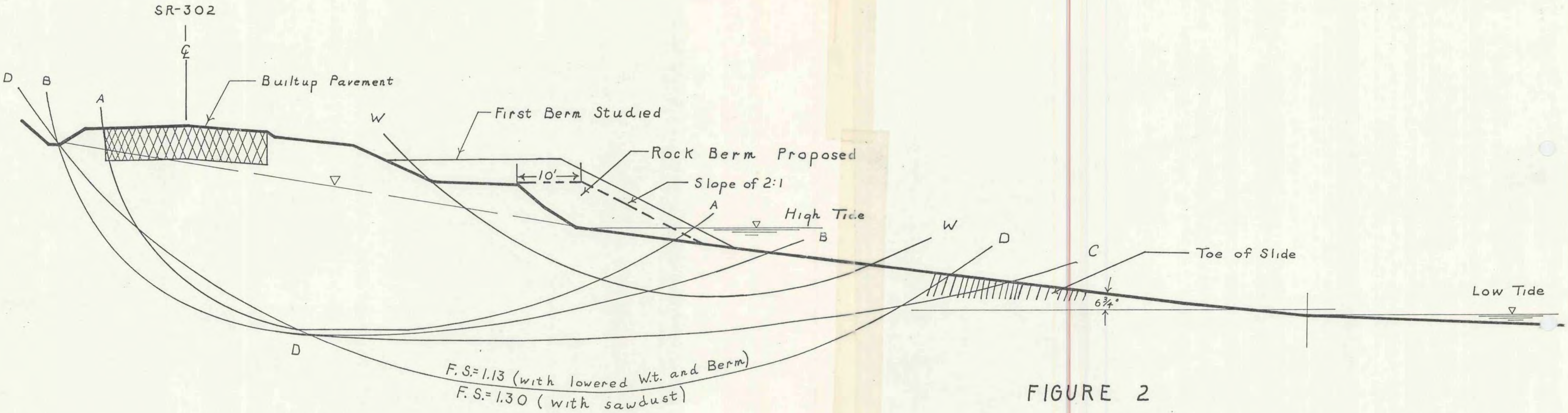

SR-302
℄
D
B
A
Builtup Pavement
W
First Berm Studied
Rock Berm Proposed
10'
Slope of 2:1
A
High Tide
W
B
D
C
Toe of Slide
6¾°
Low Tide
D
F.S.=1.13 (with lowered W.t. and Berm)
F.S.=1.30 (with sawdust)

FIGURE 2

S O I L S   R E P O R T

C.S. 2332 & 2737 | SR 302 | L-5574

COULTER ROAD TO VICTOR VICINITY

&

ELGIN - CLIFTON ROAD TO GOODRICH DRIVE VICINITY

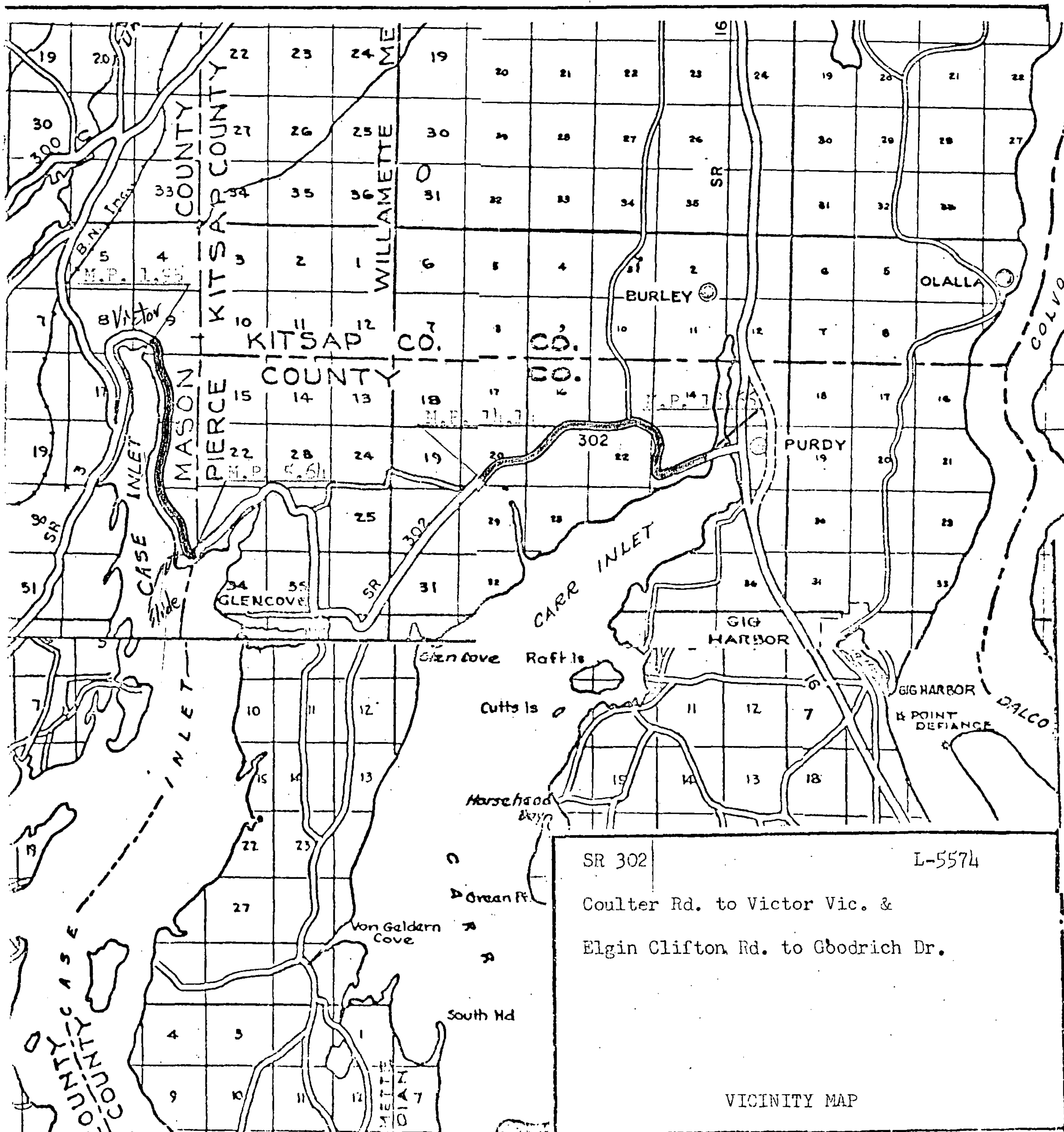
January 13, 1978

Mr. J. D. Zirkle
District Engineer

Mr. R. E. Bockstruck
District Location Engineer

Prepared By:
J. D. Belling
District Materials Engineer

TABLE OF CONTENTS



SR 302 L-5574

Coulter Rd. to Victor Vic. &

Elgin Clifton Rd. to Goodrich Dr.

VICINITY MAP

Mr. J. D. Zirkle
District Engineer
Attention: R. E. Bockstruck
District Location Engineer

C. S. 2332 & 2737 SR 302 L-5574
Coulter Road to Victor Vicinity &
Elgin-Clifton Road to Goodrich Drive
Vicinity
Soils Report

I. GENERAL

This is the District soils report of the recently completed soils investigation on SR 302 from Coulter Road to Victor Vicinity, SR M.P. 1.95 to M.P. 5.64 and from Elgin Clifton Road to Goodrich Drive Vicinity, SR M.P. 14.14 to 18.66. SR 302 is a collector class highway having restricted passing site distance due to its sharp curves and rolling terrain. It is the intent of the proposed project to widen and resurface the existing roadway to two 11 foot lanes with 3' shoulders.

A soils report on the Victor slide, SR M.P. 5.37 to M.P. 5.46, has been made and Headquarters Materials has responded by their letter dated April 1, 1977. This eight page letter is included in the appendix. The letter contains the summary of the conditions in the field, the investigation performed and possible remedial actions for stabilization of this slide. The District has decided to proceed with the lightweight fill method to correct this slide and the proposed cross section is included on the attached soils profile.

This highway was originally built by the respective Counties and very little contract work has been done since this highway has been on the State system. The only records we have, indicate these two sections received a non-skid seal treatment in the late 1940's.

Since then, State Maintenance forces have done extensive paving and patching on much of the roadway. Other than the Victor slide area and a smaller section at M.P. 5.1, the roadway is in good enough condition to overlay and widen as proposed.

The summers are generally cool and dry and the winters moist and comparatively mild with an average annual rainfall of 55 inches. The prevailing westerly winds from the Pacific Ocean and the nearness of Puget Sound cause the characteristic marine climate of the area.

II. SUBSIDIANCE AT M.P. 5.1

A large portion of the roadway from M.P. 5.06 to M.P. 5.10 has recently dropped about 0.3' to 0.4'. The right side of the roadway and fill have subsided toward the bay which is at the toe of the fill.

There are two factors that have contributed to this failure. One is, water is ponding in the left (uphill) ditch which is very wide and long and this water is running thru the fill. The existing situation here is very bad. The other factor is, the high tide and wind combination is eroding the toe of the fill.

The recommended solution for this failure is:

(1) Clean out the debris from within and around the ditch.

(2) Regrade the ditch to provide an adequate slope toward the inlet of the cross pipe.

(3) Lower the inlet end of the existing 18" corrugated metal cross culvert pipe (about 2.5' - 3') to the bottom of the regraded ditch and provide a beveled or flarred end section on the inlet end.

(4) Construct a rock buttress--bulkhead, similar to that at M.P. 5.10, for the total length of the failed section.

III. SOILS

Nine sack samples of materials encountered within the Coulter Road to Victor section and four samples within the Elgin-Clifton Road to Goodrich Drive Vicinity section, have been transmitted to the Headquarters Materials for their analysis. These samples were encountered in a total of 35 test holes and were classified and graphically plotted on the soils profile in the appendix.

IV. RECOMMENDATIONS

(1) Correct the failure at M.P. 5.1 as outlined in Section II of this report.

(2) Taper the depth of the sawdust fill at both ends to mitigate differential settlement of sawdust vs earth fill.

(3) It is requested the Materials Laboratory make recommendations on the structural requirements for this project. Please comment on the proposed "daylighting" of the lightweight fill at the ditch on the left and on the slope on the right.

JDB:ws
cc: Materials Laboratory
Design
J. H. Michel
File: L-5574 Materials

DOT FORM 700-008 REVISED 11/77

RECEIVED APR 22 1983 MATERIALS LAB

DEPARTMENT OF TRANSPORTATION
INTRA-DEPARTMENTAL COMMUNICATION

DATE: April 21, 1983

FROM: D. D. Rude DR
Phone: 3-7253

SUBJECT: Contract 1259 SR 302
Victor Slide

To: ~~B. Dugan~~ Kilian/Zimmerman ZM-21

As requested, I have investigated the lightweight fill to see if the cause for the recent settlement could be determined. Initially, it was felt the lightweight fill material may be consolidating and causing the present problems, but further investigation by Tom Zimmerman has shown that the slide mass is once again moving. This is detected by the presence of tension cracks in the pavement and several scarp faces showing in the material between the roadway fill and the beach. Now that the mass is unstable, it can be expected there will be movement at the present rate or greater since the needed patching will add weight to the fill and thus reduce the stability. The drainage system that was installed in the lightweight fill will eventually fail as movement continues and this will also reduce the stability of the slide.

Several factors are contributing to the renewed movement. The high water level in the sawdust backfill is adding weight to the fill as well as creating a saturated material between the roadway and the beach. The special underdrain system is drawing out some of the water but the leachate seepage at the toe of the fill and the amount of water flowing from the sawdust fill and appearing on the beach at several different locations is also a considerable volume. In 1979, groundwater flow was roughly estimated to be about 150 gallons per day per lineal foot of roadway. Another factor is the high tides which saturate the soil above the normal water level and due to the very loose nature of the soil, the rapid drawdown causes movement. The riprap at the beach has suffered due to both the past slide movement and erosion of the supporting soil.

The soils investigation and slope inclinometer monitoring prior to the placement of the lightweight fill disclosed two shear zones with a minor zone appearing at a 10 foot depth and the primary zone appearing at a 30 foot depth. The test hole that was monitored was 18 feet right of center line and would have been disturbed or destroyed during the lightweight fill construction. The present movement is probably also occurring at the same depths but this cannot be determined with any reliability unless new test holes are drilled to ascertain the water level in the sawdust fill, the density of the underlying material and the location of the shear zone.

There are several measures that may be effective for increasing the factor of safety and are outlined in a letter from LeClerc/Kilian dated October 10, 1979. Due to the cost for the various methods to lower the water level in the lightweight fill and since it was felt the roadway was marginally stable, it was determined at that time to be cost effective to allow the leachate and groundwater to dissipate. The preferred method of correction before this movement was to lower the uphill perforated underdrain to an elevation approximately

2 feet below the bottom of the lightweight fill at an estimated cost of $60,000. Another method called for installing horizontal drains at an approximate cost of $35,000 to $44,000 and would require access from the beach and would be outside our R/W. A third method would be to construct underdrains every 50 feet to carry drainage from the gravel blanket under the lightweight fill and drain to the beach. This third method would cost about $30,000 and would require work outside the R/W.

If funding for this slide correction seems probable, Headquarters Materials recommends that two test holes be drilled to determine the existing conditions. These holes would need to go through the lightweight fill material and to a depth about 10 feet below the beach level.

If further information or a soils investigation is needed, please advise.

DDR:pk
cc: Kilian/Zimmerman w/attach.
Barclay w/attach.
Darnell w/attach.
Materials Cont. 1259
Serial File 83-97
Attach.

FOUNDATIONS COPY

Washington State
Department of Transportation

Intra-Departmental Communication

Date: September 19, 1991

From: R. G. Finkle/A. P. Kilian
HQ Mats Lab/Geotechnical
QM-21

Subject: SR-302, C.S.2332, L-0942
Victor Vicinity Landslide

To: G. F. Demich/M. W. Hortin
District 3, KT-11, 7440

Attn: Mel Hitzke

Continued movement of the Victor Landslide has resulted in field investigations of unstable slopes in the Victor area. The "Victor Landslide" indicated on Figure 1 has experienced continued movement over the years. Nearby areas to the north, shown on the figure as areas "Beach Instability", "Active Slide", and "Old Slide", have experienced more recent movement.

The current field investigation has consisted of geologic mapping and the drilling of four test holes by District Materials. The geologic mapping has defined the limits of the Victor Slide to be the same as the historical Victor Slide. Further to the north below the roadway is an approximately 1200 foot long area of beach instability. In some locations this instability has enlarged into the travelled lane. Roughly in the middle of the beach erosion area is an old landslide that is present on both sides of the roadway. The slide extends roughly 300 feet upslope. Within the large slide is a smaller active slide about 100 feet across that is damaging the roadway.

At this point in time the "Beach Instability" area is considered somewhat active but not a major threat to the existing highway. Local slope failures could happen at any time. The Old Slide area is considered marginally stable. Recent instrumentation installed has not indicated the nature or extent of any instability. Any consideration of earthwork construction in this area would have to be assumed to worsen slope stability.

The "Active Slide" area is indicating recent slope movement has occurred. Continued movement is expected requiring correction. The instrumentation to date has not identified the depth of movement. It is expected that continued monitoring will be needed through the winter to define the extent of the slide and to provide necessary input to develop a realistic correction. No earthwork activities should be planned for this area until the nature and extent of the unstable slopes is defined as the earthwork could worsen local stability and possibly activate the Old Slide.

Two test holes were drilled in the Victor Slide to evaluate the effectiveness of the wood fibre/drainage correction, and further define the extent of the slide. Figure 2 is a profile of the soil conditions along the right shoulder of the roadway. Test holes C-4 and TH-3 are the recently drilled test holes. The exploration found the extent of the slide, as shown on the soil profile, to be as previously known. Figure 3 provides a cross-section of the landslide. The wood fibre was found to be somewhat decayed, more so than found during research of other wood fibre corrections. The groundwater was found to be high indicating failure of the drainage system.

An additional technical issue has come to light in recent years that may be relative to the Victor instability. Published research (Kramer and Seed, 1988) has identified the potential for static liquefaction in saturated loose sands similar to this site. Such an occurrence at this site would render any solution other than insitu strengthening of the very loose saturated soil ineffective. We are currently researching this issue to determine an appropriate corrective design.

Conceptually, at this time, remedial action for the Victor Slide could include realignment, insitu ground improvement with stone columns, bridging the slide area with partial removal of the slide, and complete removal of the slide. Realignment in concept would consist of moving the alignment to the south off of the landslide area. The shift would need to move the roadway a minimum 20 feet south of the existing top of cut in the existing Victor slide area. The new alignment would need to tie in south of the "Old Slide" so as not to worsen stability in that area.

The second option is to improve the ground using stone columns. Stone columns is a vibro-replacement technique where a vibrating probe is pushed into the ground densifying the soil. Crushed stone is then poured into the annulus formed around the vibrator and then compacted to form a stone column. Figure 4 presents a cross-section of the concept. A rough estimate for the stone columns needed for this project is 469 columns at an average length 25 feet, or 11,725 LF. At a cost of $35/LF the cost of the stone columns would be $410,375. It is uncertain at this time whether the vibrator probe can penetrate the wood fibre. Consequently a rough cost estimate should include 7,035 feet of preboring. At a cost of $8/LF this adds $57,280 to the estimate. The stone columns can be installed from the existing roadway, one lane at a time.

A third option is to construct a bridge across the slide area. The bridge would need to be pile supported as indicated in the sketch in Figure 5. The piling would either need to be designed for the lateral loads imposed by slide movement, or the top of the slide would need to be removed down to beach level to prevent any slide movement. Assuming a 400 ft long bridge at $60/SF bridge costs would be roughly $860,000. Bridge and Structures can provide more accurate cost data for a conceptual design. Added to this would be the removal and wasting of about 200,000 CY of soil and wood fibre.

During brain storming sessions full depth removal of the slide has been proposed as a fourth option. Removal would have to extend to the depth and extent shown on Figure 6 and for the full length as shown on Figure 2. Removal to the depths shown would require a shoring wall to prevent encroachment of the bay waters into the excavation and "flow" of sands into the excavation.

Unless directed otherwise we will continue to pursue the evaluation and design for static liquefaction and the design of a stone column correction.

APK
CC: Dave Ericson, D-3, KT-11
Karl Kirker, Br. & Struc., KF-01

Victor Slide
Profile Right Shoulder

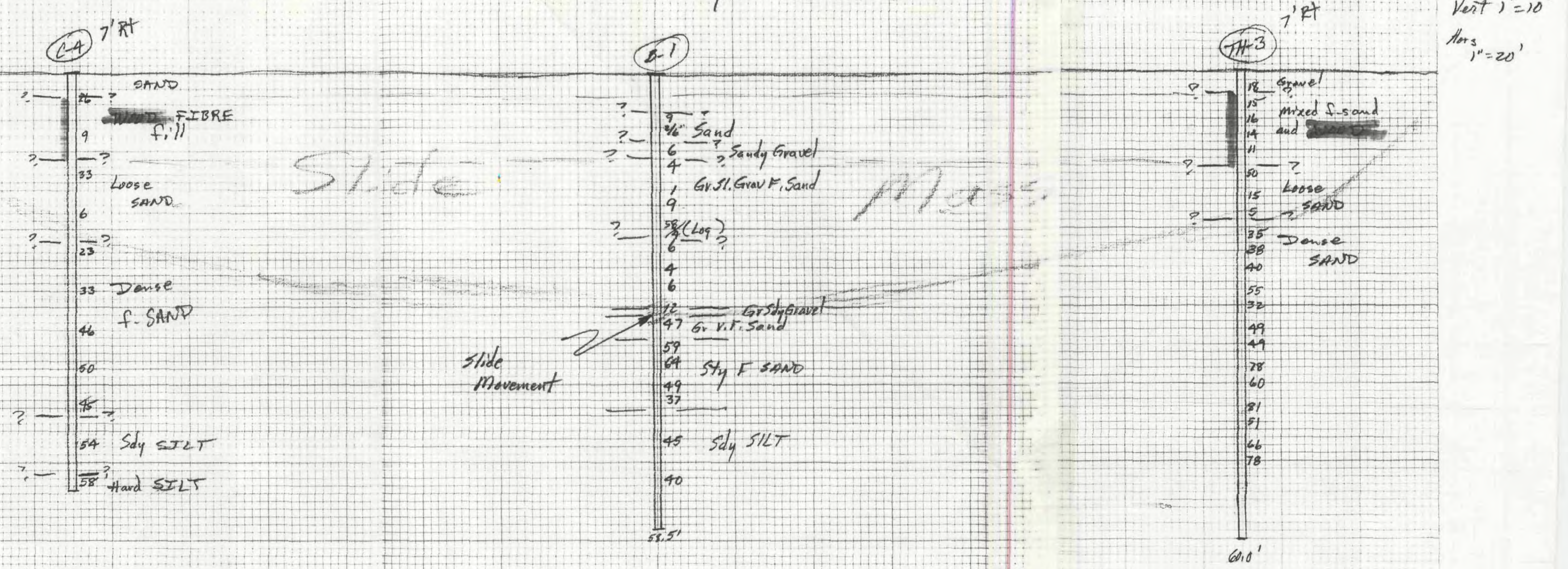


Figure 2

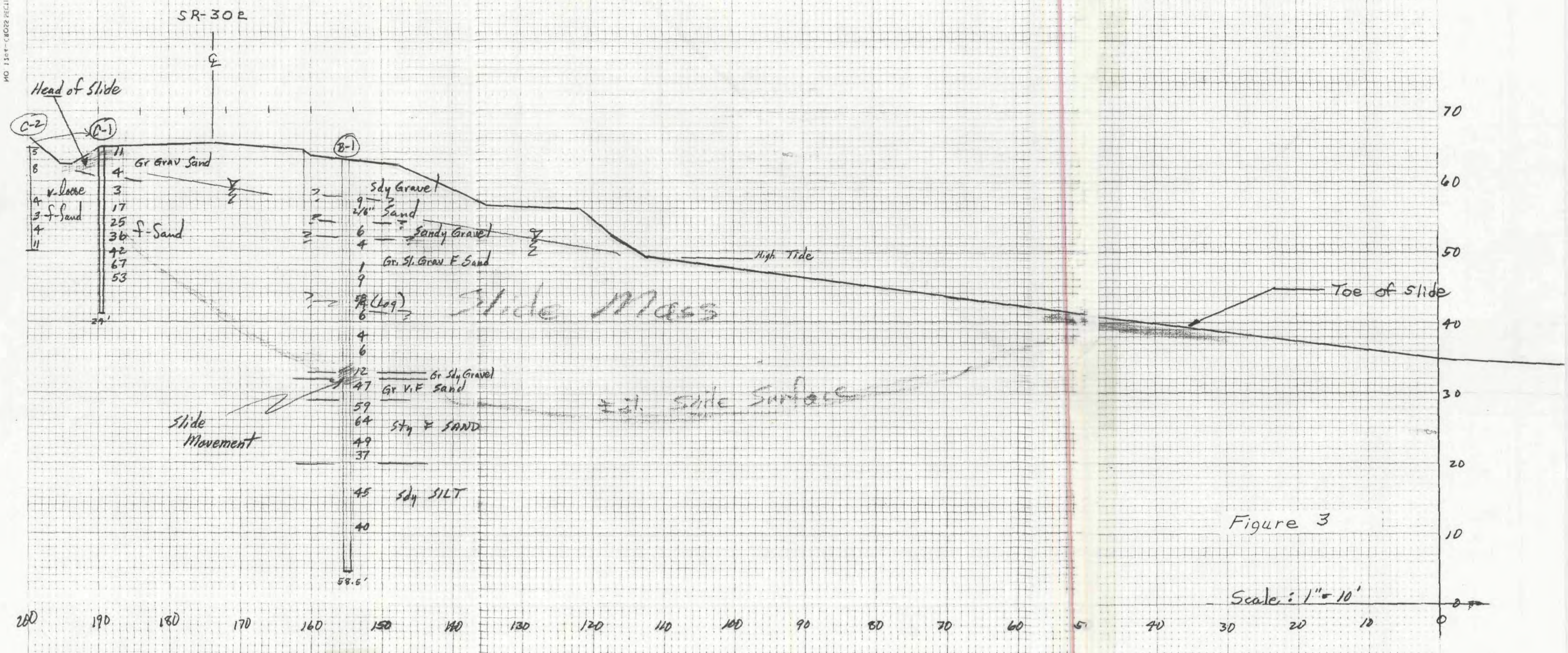

SR-302
Head of Slide
C-2
C-1
B-1
Gr Grav Sand
v-loose
f-Sand
f-Sand
29'
Sdy Gravel
Sand
Sandy Gravel
Gr. Sl. Grav F Sand
(Log)
High Tide
Slide Mass
Toe of Slide
Gr Sdy Gravel
Gr. V.F Sand
Sty F SAND
Slide Movement
Est. Slide Surface
Sdy SILT
58.5'
Scale: 1" = 10'

Figure 3

Stone Columns

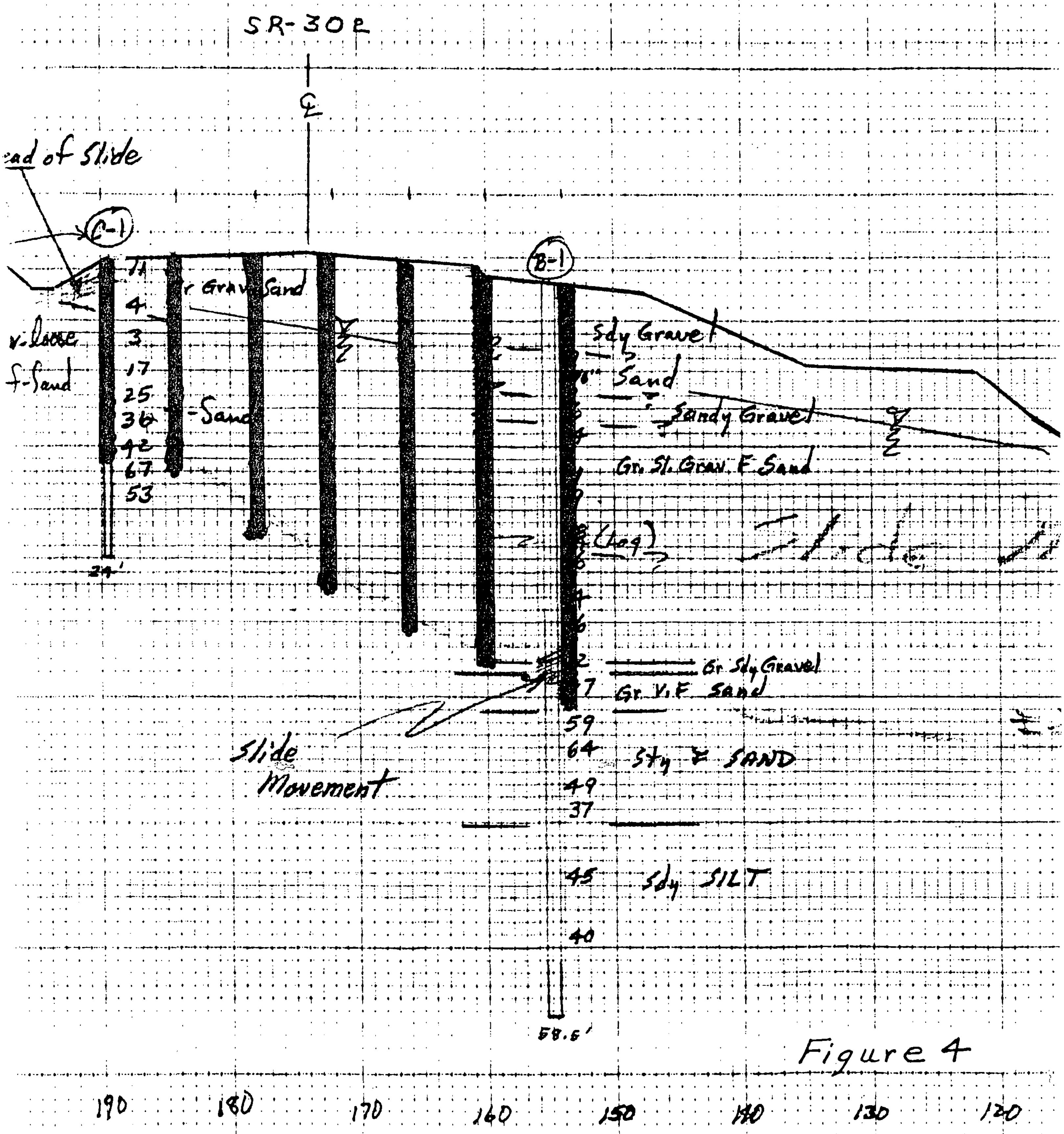
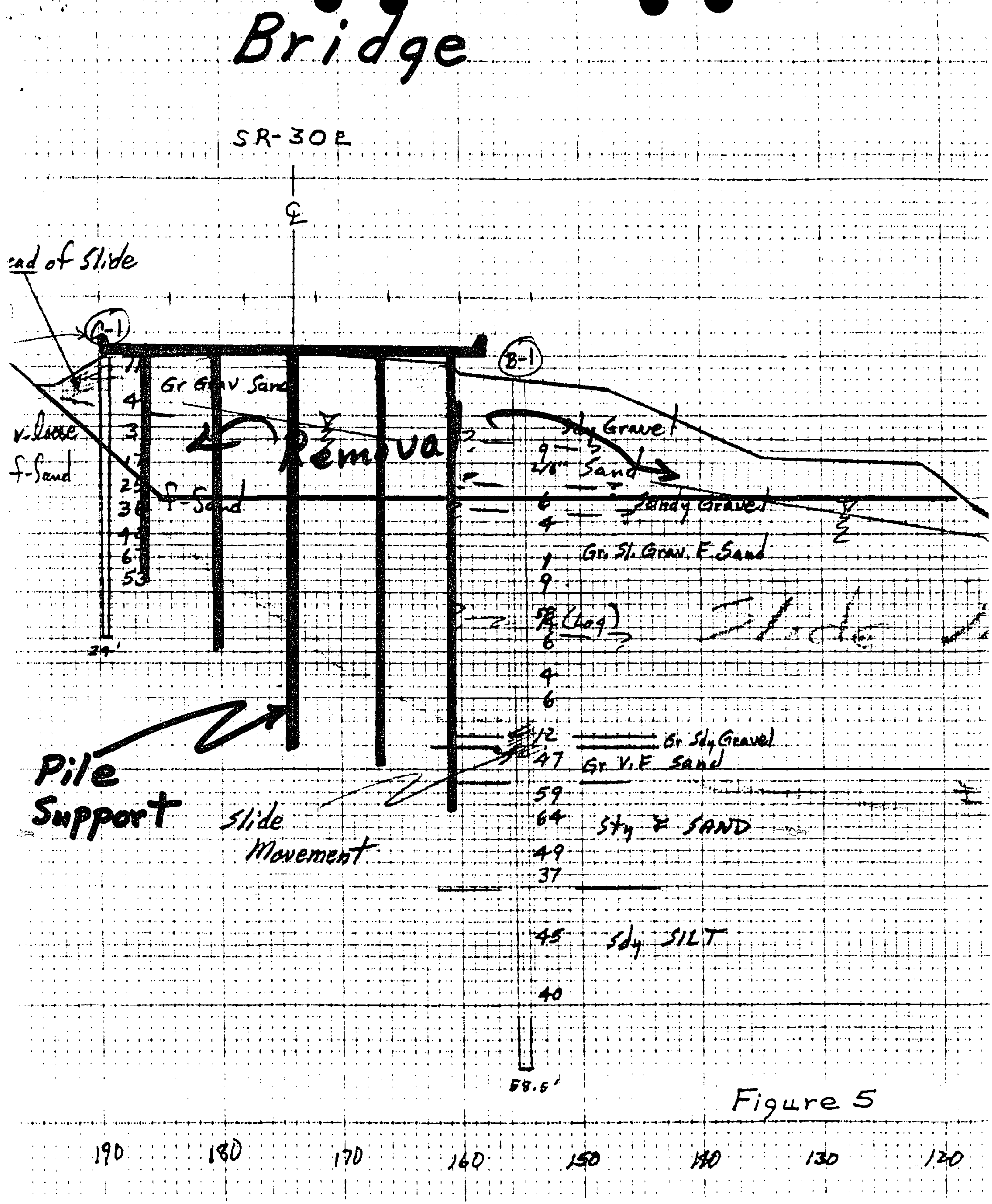


Figure 4



Bridge
SR-302
℄
ead of Slide
C-1
B-1
v-loose
f-Sand
Gr Grav Sand
f-Sand
Removal
Sdy Gravel
Sand
Sandy Gravel
Gr. Sl. Grav. F Sand
Gr Sdy Gravel
Gr. V.F Sand
Sty F SAND
Sdy SILT
Pile Support
Slide Movement
24'
58.5'
190
180
170
160
150
140
130
120

Figure 5

Removal and Backfill

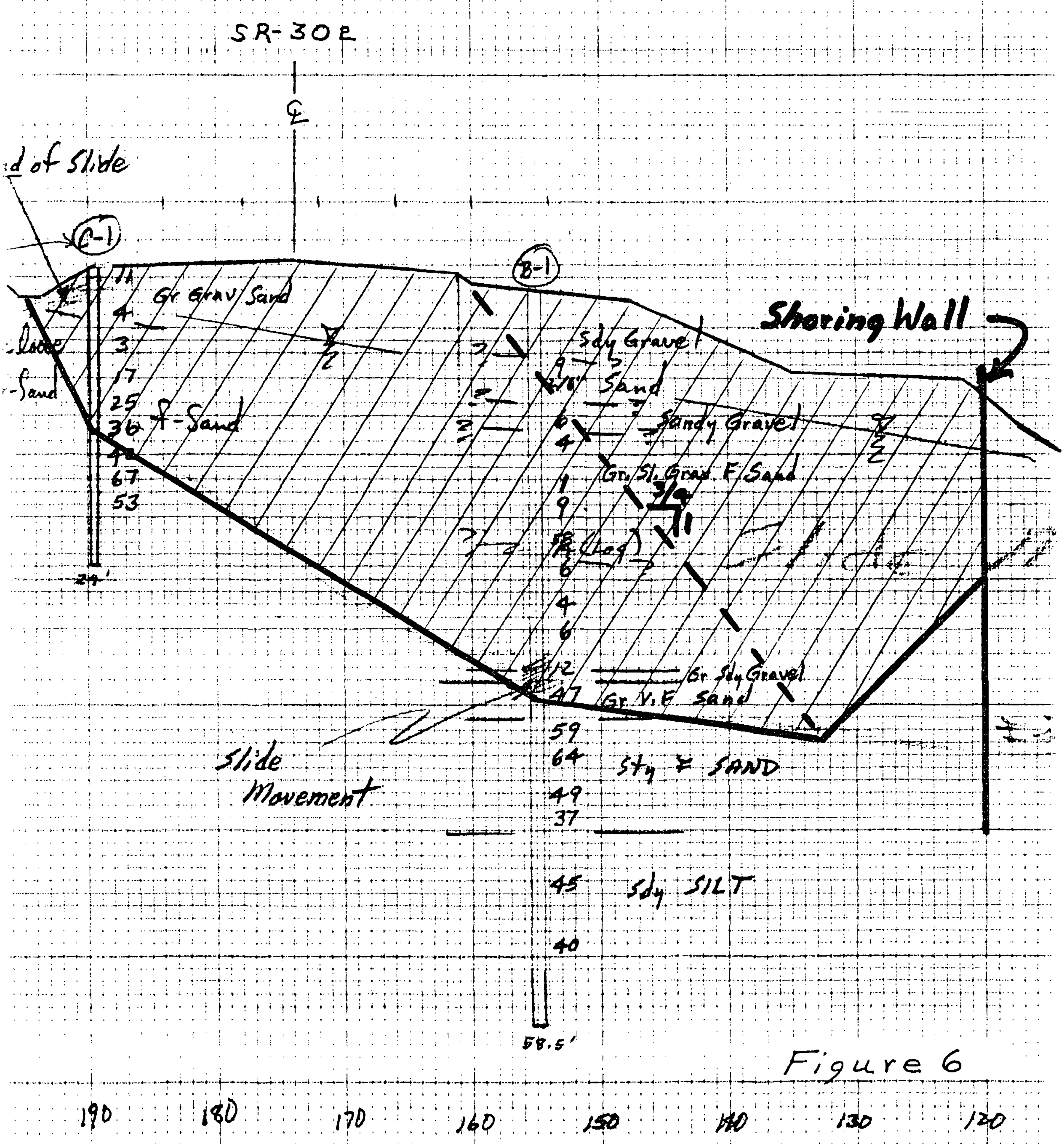


Figure 6

Washington State
Department of Transportation

Memorandum

March 21, 2001

TO: File DMC041-01
Emergency Response and Repair
SR-302 Victor Landslide Earthquake Failure

FROM: J.R. Struthers
OSC Materials Laboratory MS: 47365
Geotechnical Services Branch
Fax (360)709-5585

SUBJECT: SR-302 Victor Landslide
Historical Review

INTRODUCTION

During the February 28, 2001 Nisqually Earthquake, the roadway in the vicinity of SR-302 MP5.5 failed. Initial observations of the approximately 2,500 linear foot failed roadway section revealed tension cracking and arcuate scarps extending across both lanes of traffic and at least 75 feet upslope of the roadway (locally). Maximum observed displacements across tension cracks in the roadway was approximately 0.25 feet lateral and about 2.5 feet vertical the day after the earthquake. Following the earthquake deformation within the failed roadway continued for several days.

Review of WSDOT files indicates that roadway failures in this section of roadway are a long-lived phenomenon; with failures documented to the 1950's and anecdotal evidence that failure of the roadway has been an issue as far back as the late 1930's. The purpose of this memorandum is to provide a summary of information contained in WSDOT files with commentary.

1959 LANDSLIDE REPAIR

A letter dated January 6, 1959 by A. M. Ritchie and J. B. Cashman (geologists) documents a recommended repair for a landslide about 1 ¼ mile south of Victor. The letter states that the cause of the landslide was subsurface water flowing through sand beds that overlie a glacial clay. The recommended repair was installation of a 10 foot deep and 400 foot long drainage in the upslope ditch to relieve elevated groundwater conditions. No subsurface investigation was performed for this design and repair.

1971 FAILURE

In December 1971, a 50 foot section of the roadway failed out into the bay. This failure was regraded and paved and a more "permanent" fix was not built until 1976. This failure is documented in a July 9, 1976 letter by H. Frankmoelle. This letter documents the placement of riprap outboard of the failure to mitigate potential piping failure at the toe due to tide and wave action. Settlement in the road section were reported as about 8 to 12 inches during the winters of 71-72 and 72-72. At this time, piping of soils was still thought to be the principle mechanism of failure.

1977 SAWDUST FILL

In Spring of 1976, the Geotehnical Branch was requested to provide correction to the Victor Slide at MP 5.5 prior to planned summer paving of the section. In a June 11, 1976 letter, T.V. Zimmerman proposed 1) drainage improvement by French drain, or 2) drainage improvement by butress reconstruction with a filter course. Both of these recommendations were based on the concept that the slide was a piping failure and were not implemented.

In 1976, two borings (B-1 and C1) were installed in the failed section. Boring B-1, which was equipped with an inclinometer, documented 0.75 inches of displacement at a depth of abut 30 feet between spring of 1976 (date unknown) and 1/21/77. These borings allowed construction of the first data supported subsurface model for the project; dense sands at depth overlain by 8 to30 feet of loose sands. No clay layer was documented. During field reconnaissance, the toe of the failure was observed about 80 feet down-slope of the roadway embankment (in the bay). Note that both of these holes were drilled with auger; making SPT values collected suspect.

The slide was characterized as a flow slide with displacement occurring between the loose and dense sands at about 30 feet bgs. Slide movement was attributed to draw-down induced liquefaction of subsurface soils in response to tidal drawdown and the mechanism of piping was debunked in an April 1977 letter by A. Kilian. Many repair options were reviewed during this investigation, including stone column-reinforement, wall-system repairs, dewatering, berm widening, realignment, and lightweight fill. Additional recommendations included designation of the area by the county as a slide area. The sawdust fill was constructed and experienced drainage problems within a relatively short period of time.

1979 SAWDUST DRAINAGE EPISODE

In 1979, the DOE fined WSDOT for the leachate discharge from the wood-fill embankment area. At this time, design work was conducted to improve the drainage below the wood-waste fill and keep groundwater below the elevation of the fill; reducing leachate problems. Both trench and horizontal drains were examined. No drainage measures were ever implemented, due to cost of installation.

1983 REACTIVATION OF FAILURE

In April, 1983, Rich Darnell notified the Geotechnical Branch that the area between MP 5.37 and 5.46 had settled about 10 inches in a 60 day period. A. Kilian recommended investigation of the lighweight fill area and installation of the drainage provisions originally recommended in 1979. No action was apparently taken until 1991.

1991 INVESTIGATION

In 1991, approval was received to install two holes in the wood waste fill area for subdrain design. During this investigation, two other areas of failure about 100 and 300 feet in length were noted to the north of the wood-waste area. Two additional holes were drilled; one in each of these failure areas and geologic mapping of the area was performed.

During this investigation, a 1200 foot long zone of beach instability was noted in the northern part of the current failed section, and an ancient landslide extending about 300 feet upslope was delimited. A September 19, 1991 letter from A. Killiam to G. Demich summarizes these findings and presents bridging, realignment, and stone-column reinforcement as conceptual design approaches.

1996 to 2000 MISCELLANEOUS

The Victor Slide was visited on at lease 2 more occasions by OSC geologists during this period. In 1996, Nancy Boyd visited the site and described failure features in both the roadway and upslope in two sections: 1) settlement in southern lightweight fill area, 2) several inches of movement per day of cracking and movement in the central portion of the slide (following storm). Evidence of past landslide activity was noted, upslope of this cracking.

In 1997, Jim Alexander of Hong-West Associates made contact regarding the siting of a sewer throught this area. This project is currently halted on the north side of the slide.

On February 22, 2000, an unknown geologist made a site visit in response to maintenance reports of pervasive uplift in the slide area. At this time cracking of pavement, tilting of utility poles was noted. No further action is documented.

Also of note is an attempt to develop the slopes in the central portion of the slide, which anectdotal evidence (conversations with locals) indicates took place in 1995 to 1997. Apparently, development got as far as utility installation and mass grading prior to reactivating the landslide. In the area of development, several prominent scarps are evident and a concrete-paved road shows signs of extensive disruption.

JRS

FILE

Washington State
Department of Transportation

Memorandum

June 20, 2001

TO: A. Trowbridge / S. Vanderstaay
Olympic Region Design Office, Port Orchard WB-18

FROM: T.M. Allen / J.R. Struthers
OSC Materials Laboratory MS: 47365
Geotechnical Services Branch
Fax (360)709-5585

SUBJECT: SR-302, MP 5.5, DMC-041
Estimated Costs for Geotechnical Investigation and Analysis
Victor Landslide Failures

This memorandum summarizes scope of work and estimated fees to complete geotechnical investigation, analysis, and design of drainage provisions to improve the stability of the two landslide failures between approximately MP 4.4 and 4.8 of SR 302. These two landslide failures experienced sudden, large-scale movement during the February 2001 Nisqually Earthquake.

Estimated Costs for Project Completion

Based on previous analysis of landslide failures at these two locations, discussions with the Region Design Office, and recently collected data, positive repair of the failures using options such as buttresses, walls, or ground improvement (eg. vibrofloat stone columns) may not be economically feasible. Accordingly, our currently proposed conceptual mitigation option involves construction of horizontal and cutoff drains to increase the stability of the roadway section. The increase in stability should result in decreased annual movement of the failures and a corresponding decrease in annual maintenance costs.

Due to the lack of existing information regarding groundwater conditions in the area upslope of the roadway, we are unable to provide a reliable estimate for project completion at this time. If information from the investigation reveals that drainage improvements will not produce an acceptable increase in stability, we will appraise the Regional Design Office so that decisions on an appropriate course of action can be made.

Estimated Fees for Geotechnical Investigation, Analysis, and Design

Geotechnical investigation for the project will consist of drilling 4 borings to depths ranging between 50 and 120 feet in depth and installing instrumentation for monitoring of groundwater conditions during the fall to winter of 2001. The location of these boring is summarized in our *Phase II Exploration Plan* for the project (attached). Please note the vibrating-wire piezometers with data loggers will be installed in the three standpipe piezometer locations and that one vibrating wire transducer will be grouted in-place at Boring H-4-01.

Analysis, design, and monitoring will continue through the winter of 2001 / 2002, ending with production of a geotechnical report containing design recommendations in early Spring of 2002. Tables 1 and 2 provide a breakdown of anticipated investigation and analysis costs by task. Note that these tables present estimates only and that actual fees for the project will be billed on a time and materials basis. In addition, due to the possibility that supplemental borings may be required for the north area failure, we recommend that a contingency of 5% in addition to the estimated fees be allocated to perform this additional work, if required.

Table 1
Estimated Fees For Geotechnical Investigation, Anaysis, and Design SR 302 Victor Landslide Phase II

Driller Coordination	15	84.71	$	1,271
Survey Coordination	4	84.71	$	339
Field Visits (2)	20	84.71	$	1,694
Geophysics Subcontractor	NA		$	17,981
Drilling Estimate (time and materials)	NA		*$*	*31,142*
	Subtotal		**$**	**53,274**
Task 3 - Laboratory Analysis				
Sample Receipt/tracking (100 samples)	NA		*$*	*300*
Laboratory Testing	NA		*$*	*4,897*
Laboratory Assignment/Coordination	10	84.71	$	847
	Subtotal		**$**	**6,044**
Task 4 - Instrumentation and Monitoring				
Set-up / Baseline Readings	10	84.71	$	847
Piezometer Equipment (4 transducer / loggers)	NA		$	6,000
Monitoring (7 months)	65	84.71	$	5,506
Data Processing/Receipt	35	84.71	$	2,965
	Subtotal		**$**	**15,318**
Task 5 - Geotechnical Analysis				
Data Compilation	20	84.71	$	1,694
Geology/Model Development	30	84.71	$	2,541
Slide Analysis	40	84.71	$	3,388
Repair Analysis	20	84.71	$	1,694
	Subtotal		**$**	**9,318**
Task 6 - Report Preparation				
Drafting/Log Preparation	60	77.2	$	4,632
Report Writing	40	84.71	$	3,388
Review/Revision	15	84.71	$	1,271
Report Production/Distribution	8	77.2	$	618
	Subtotal		**$**	**9,909**
	Estimated Total Fees		**$**	**94,625**

Table 2
Estimated Fees For Geotechnical Laboratory Testing
SR 302 Victor Landslide Phase II

Moisture Content	40	$ 25.17	$	1,007
Unconfined Compression		$ 114.41	$	-
Triaxial Compression (UU) per point		$ 305.08	$	-
Triaxial Compression (CU) per point		$ 610.16	$	-
Triaxial Compression (Drained) per point		$ 610.16	$	-
Direct Shear (Remolded)		$ 686.43	$	-
Direct Shear (Consolidated, drained)	2	$ 610.16	$	1,220
Consolidation (5 loads)		$ 610.16	$	-
Consolidation (5 loads with rebound)			$	-
Atterberg Limits	10	$ 76.27	$	763
Soil Identification		$ 25.17	$	-
Gradation		$ 76.27	$	-
Gradation and Identification	20	$ 95.34	$	1,907
Rock				
Compressive Strength Prep		$ 57.20		
Point Load		$ 19.07		
Direct Shear		$ 305.08		
Core Photography and Processing		$ 38.14		
		Estimated Total Laboratory Fees	**$**	**4,897**

Geotech Branch Engineers and Tech Phone Nos. (360) 709-xxxx Office Assist. Kristi (360) 709-5453

Tony	Matt	Don C	Bryan	Jim C	Don W	Nabil	Bahi	Dale	Bill	Bob G
5452	5463	5456	5458	5452	5457	5469	5459	5466	5465	5468

FIELD EXPLORATION REQUEST

DATE: May 14, 2001 **REVIEWED BY:** SHL

REGION: Olympic **SR:** 302 **C.S.:** ______ **JOB No.:** DM041

PROJECT NAME: Victor Landslide Investigation – Phase 2

PROJ. CONTACT: James Struthers **PHONE:** (360) 709-5409

PROJECT TYPE:

[ ] **CENTERLINE** [ ] **STRUCTURE** [X] **LANDSLIDE** [ ] **PIT/QUARRY**

NUMBER OF TEST BORINGS: 4

ESTIMATED DRILL FOOTAGE: 325 to 350

TYPE OF TEST HOLE:

- [X] **STANDARD TEST HOLE**
- [ ] **CPT**
- [ ] **STANDARD TEST HOLE AND CPT**
- [ ] **OTHER** ______

INSITU TESTING: / **FREQUENCY OF TESTING:**

- [ ] **VANE SHEAR** ______
- [ ] **CPT PORE PRESSURE DISAPATION** ______
- [ ] **CPT SEISMIC VELOCITY** ______
- [ ] **OTHER** ______

INSTRUMENTATION:

- [X] **OPEN STANDPIPE PIEZO**
- [ ] **SLOPE INCLINOMETER**
- [X] **PNEUMATIC PIEZO**
- [X] **OTHER** TDR cable

SAMPLING FREQUENCY:

- [X] **STANDARD SPT AT 5 FOOT INTERVALS**
- [X] **WSDOT UNDISTURBED SAMPLES**
- [ ] **SHELBY TUBE UNDISTURBED SAMPLES**
- [ ] **LONGYEAR UNDISTURBED SAMPLES**
- [ ] **PISTON SAMPLER UNDISTURBED SAMPLES**
- [ ] **CONTINUOUS SAMPLING**
- [ ] **OTHER** ______

Geotech Branch Engineering Geologist Phone Nos. (360) 709-xxxx Office Assist. Kristi (360) 709-5453

Steve	Tom	Lynn	Dave	Doug
5460	5461	5462	5455	5427

SPECIAL INSTRUCTIONS:

What are we looking for?

This section of road has had problems in two separate areas since about the 1930's or 1940's. The two areas are shown on the photos (north area and south area).

The south area has been the site of an embankment failure that WSDOT has tried to repair two times; once with drain improvements in 1959 and once with a light-weight fill in 1977. Neither fix really performed very well and this area settles sometimes up to 10 inches per year. Maintenance seems to think that this settlement is greatest in response to large tide fluctuations and big storm events.

In the north area, the roadway has been failing since at least 1991. This failure is part of a larger landslide that hasn't been extensively studied, but appears to extend 275 feet upslope of the roadway. In 1996 to 1997, a developer did some utility installation and grading in this area and kicked loose a pretty big slide that is responsible for some of the scarps that you can see upslope of the roadway.

Recently, during the Nisqually Quake, this area broke loose and failed over the length of both areas, producing vertical offsets in the roadway on the order of about 1 to 3 feet and closing the roadway. Maintenance ground the damaged pavement down, installed some trench drains and graveled the road to open it.

We currently have 3 borings at the locations noted; all with piezometers and inclinometers. The plan is to design a drainage fix that will improve the stability of the slide areas. We aren't currently planning to do a structural fix like a buttress or a wall system due to large cost of these items.

Investigation for design of the drainage fix will be in several phases. This first phase will be four borings with both piezometers and time-domain reflectometry cables (like an electrical slope inclinometer). The purpose of these holes is to define two critical cross-sections in the slides and get enough information on groundwater upslope of the roadway to site more borings (if needed), or design drainage systems. The attached map shows the locations of the proposed borings H-4-01 through H-7-01.

Expected Conditions

The three borings that have been drilled at the site encountered deposits consisting of interlayered, silt, silty sand, and clay. This package of sediment is at least 60 feet thick at the roadway and is underlain by very dense glacial till. In borings further upslope, expect to hit a layer of till that overlies the sand deposits.

Borings

Note: all of the depths for borings listed below are estimated. Check with me prior to drilling to confirm them; I will have survey data at that time.

H-4-01 – This boring is located on the bench immediately downslope of the roadway. Expect to find about 10 to 12 feet of silty sand fill underlain by interbedded silt and silty sand deposits. Total depth of the boring will be about 50 to 60 feet. We are looking for a hard package of sandy silt (N value >40) that underlies the slide material. Sample at about 5 foot intervals with

SPT sampler and collect representative WSDOT undisturbed samples of fine-grained soils encountered.

Call before you TD the hole. For the install, we want a vibrating-wire piezometer set at the anticipated failure surface. Based on the data from historical borings and Boring H-3-01, the failure plane is at about 30 to 35 foot depth. In addition, this hole will have coaxial cable to depth for TDR measurements. We will sort out the details of this install prior to starting the job. **Call before you start the install to confirm conditions.**

H-5-01 – This boring is located on the bluff upslope of the roadway. Expect to find interbedded sands and silty sands to the elevation of the roadway. Total depth of the hole is estimated at about 70 to 80 feet. The purpose of the hole is to provide information on groundwater in the slope above the roadway.

Call before you TD the hole. For the install, we want a standpipe piezometer with screen from about 20 to 40 feet (estimated). Put a 2 foot sump of blank PVC on the bottom of the piezo. Also install a TDR cable to depth. **Call before you start the install to confirm conditions.**

H-6-01 – This boring is located on a topographic bench to the north of an access road for the former subdivision. It is in the middle portion of the northern landslide. The boring will be used to monitoring movement in this slide block, so it needs to get below the slide plane. It will also give us information on groundwater in the middle of the slide mass. The estimated depth of this boring is 70 to 80 feet.

Call before you TD the hole. For the install, we want a standpipe piezometer with screen to be determined following drilling. The boring will also have a cable fro TDR. **Call before you start the install to confirm conditions.**

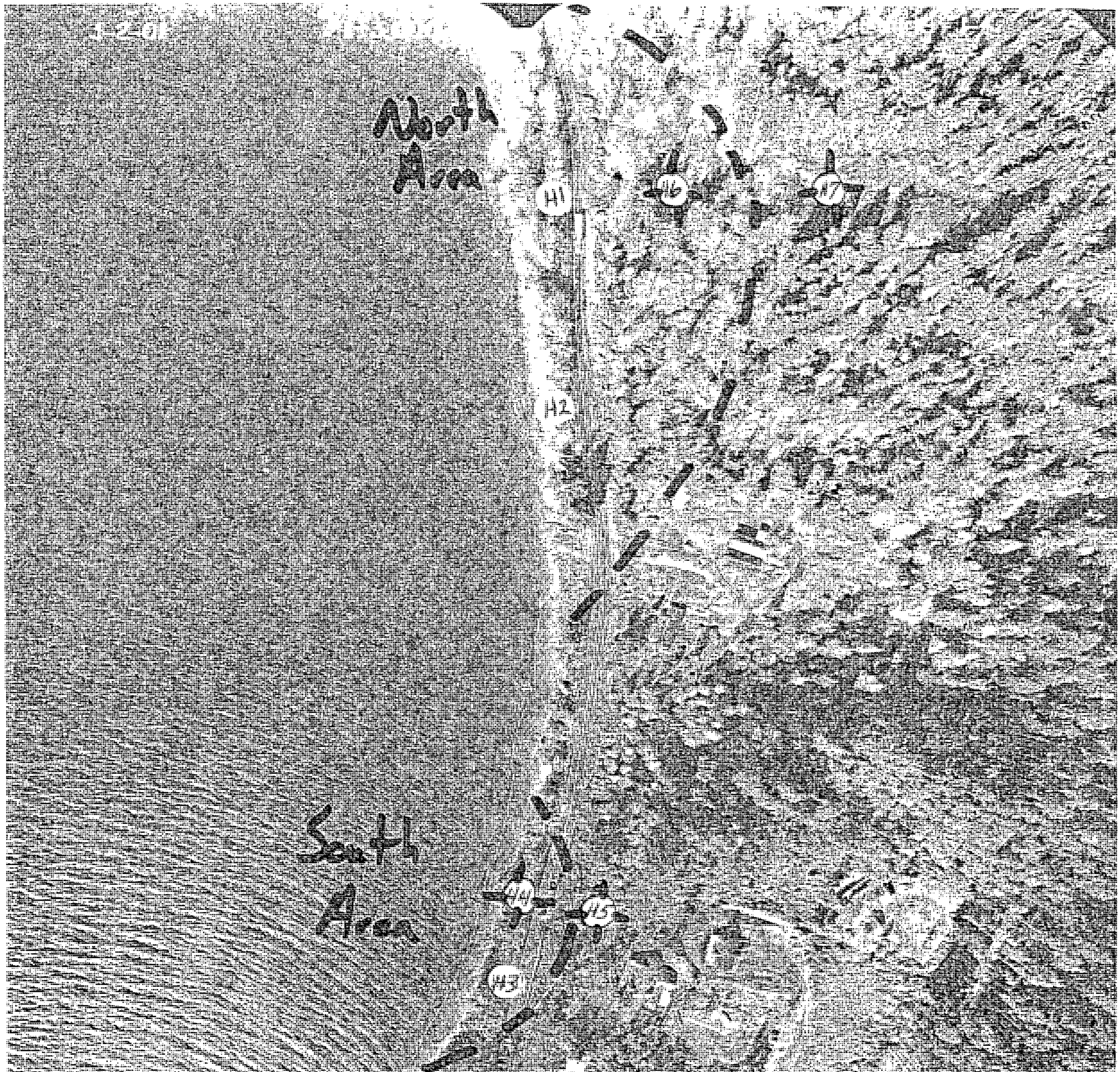
H-7-01 – This boring is located upslope of the north area slide main scarp and will give us background data on stratigraphy and upslope groundwater conditions. Because of its high elevation, this will probably be the deepest hole on the job. The upper portion of the hole will be drilled through a glacial till that overlies the sand and gravel units that you see lower on the slope. Total depth of this boring is estimated at between 100 and 125 feet.

Call before you TD the hole. This hole will have a standpipe piezometer with screen to be selected based on drilling conditions. It will also have a cable installed for TDR. **Call before you start the install to confirm conditions.**

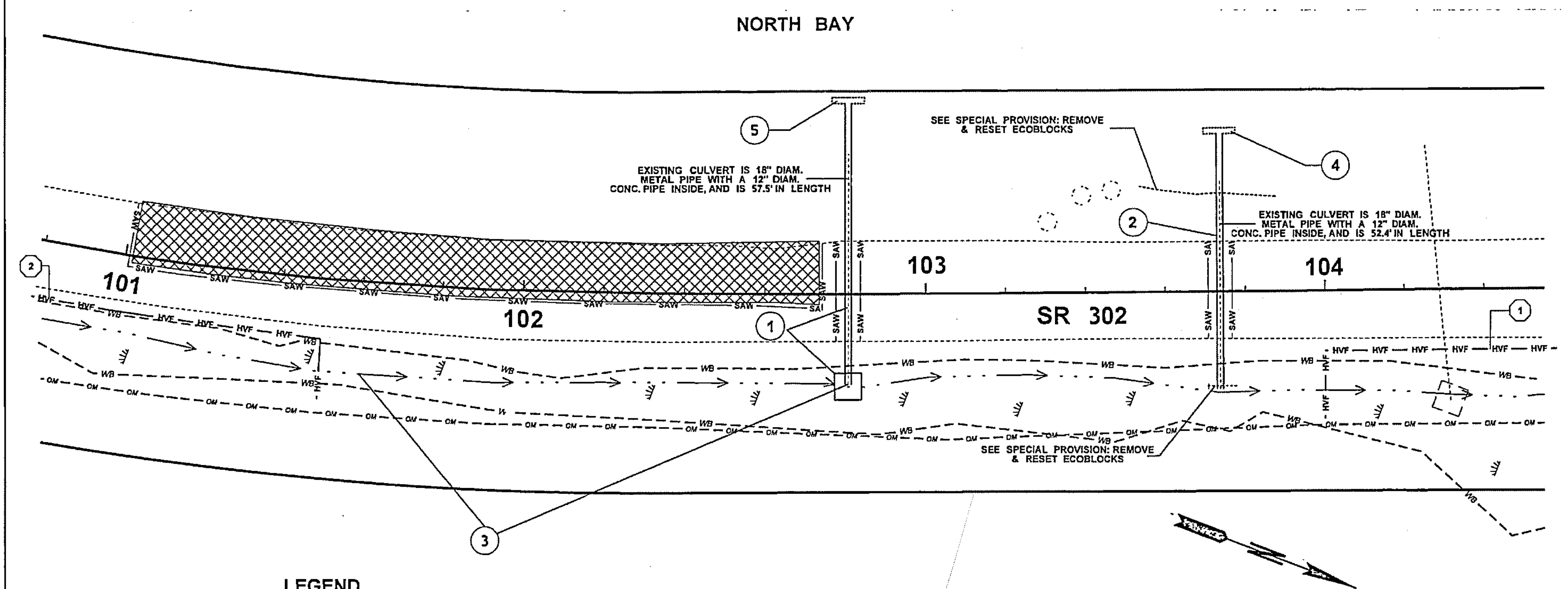
If you have any questions, feel free to call me at any time (doesn't matter how late or early). You can get me at a variety of places:

Office	(360) 709-5409
Cell	(360) 481-2069
Home	(360) 274-2330
Message	(503) 263-7762

Victor Landslide
Phase 2 Investigation
5/10/01



Note: H1-01 through H3-01 Already installed.



LEGEND

	EXISTING CATCH BASIN		PIEZIOMETER CASING
	NEW CATCH BASIN		
	EXISTING CULVERT PIPE		ECOLOGY BLOCK RETAINING WALL
	NEW CULVERT PIPE		EXISTING RIGHT OF WAY
	EXISTING DITCH		EXISTING EDGE OF PAVEMENT
104	ALIGNMENT & STATION	SAW	SAW CUT
OM — OM	OVERHEAD UTILITIES		LIMITS OF CELLULAR LIGHT WEIGHT CONCRETE
HVF — HVF	HIGH VISIBILITY FENCE		
WB	WETLAND BOUNDARY		WETLAND AREA

HIGH VISIBILITY FENCE SEE STANDARD PLAN 1-10.10-01		
CODE	LOCATION	QUANTITY
1	STA. 104+80 15' RT.STA. 104+02 15' RT. TO 30' RT.	95 L.F.
2	101+50 15' RT. TO STA. 100+03 15' RT. TO 26' RT.	65 L.F.
	TOTAL	160 L.F.

0 25 50
SCALE IN FEET

NOTES:

1. CULVERT AT 103+74 HAS ECOLOGY BLOCK RETAINING WALLS AT INLET AND OUTLET. SEE THE SPECIAL PROVISION "REMOVE AND RESET ECOBLOCKS".
2. THE OVERHEAD UTILITIES HAVE POWER AND COMMUNICATION CABLES.
3 SEE SHEET DD1 FOR STRUCTURE NOTES 1-5.
4. SEE SHEET DD2 FOR TEE-DIFFUSER DETAIL

FILE NAME	G:\2DesignPS&E\SR302 XL-4651 N. of E Victor Rd--Culvert Replacement\7.00-Design\7.02-InRoads\XLXXXX\Survey\SP-VictorWorking_2-D_tw.dgn			
TIME	7:09:54 AM			
DATE	7/1/2016			
PLOTTED BY	SchlecB			
DESIGNED BY	T. WILSON			
ENTERED BY	T. WILSON			
CHECKED BY	A. AMOS			
PROJ. ENGR.	M. BRITTON			
REGIONAL ADM.	K. DAYTON	REVISION	DATE	BY

REGION NO: 10 | STATE: WASH | FED.AID PROJ.NO.
JOB NUMBER: 16C516
CONTRACT NO.
LOCATION NO: XL4651

P.E. STAMP BOX DATE
P.E. STAMP BOX DATE 7-6-16

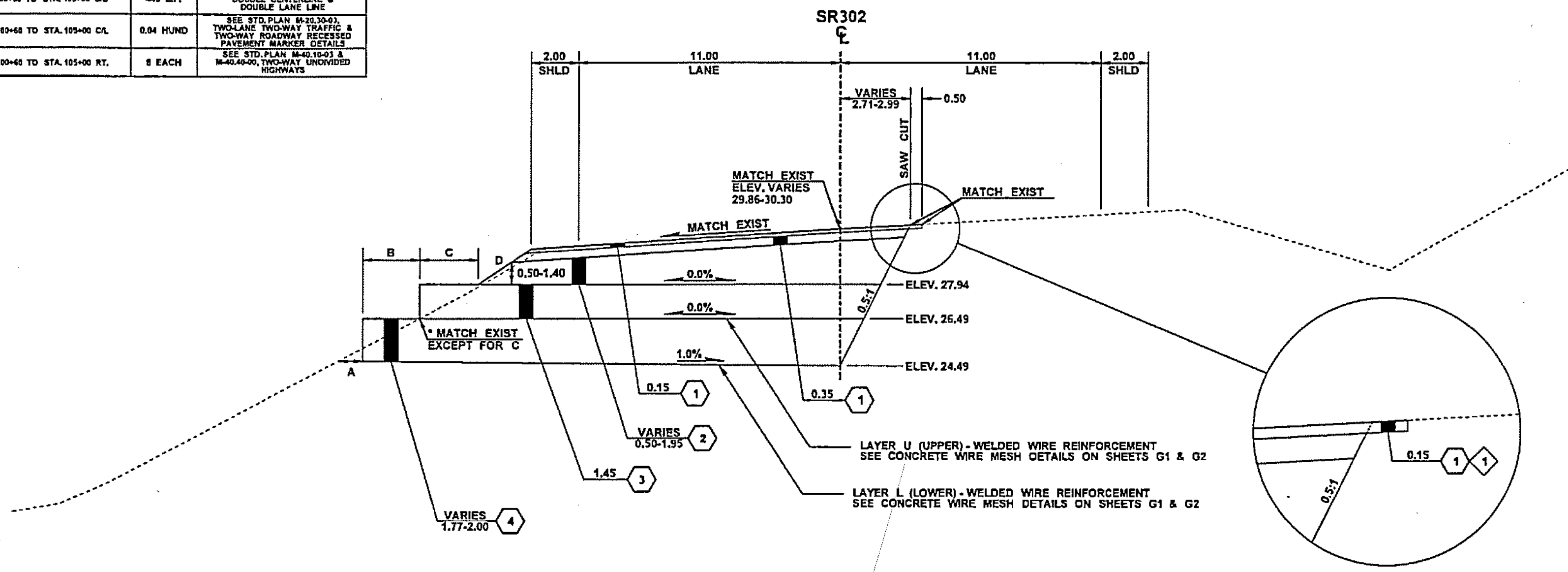
Washington State Department of Transportation

SR 302
1.15 MILES S OF E VICTOR RD
MAJOR DRAINAGE
SITE PREP / EXISTING UTILITIES

PLAN REF NO: SP1
SHEET 5 OF 15 SHEETS

TRAFFIC ITEMS

ITEM	LOCATION	QUANTITY	NOTES
PAINTED WHITE EDGE LINE	STA. 100+60 TO STA. 105+00 LT. AND RT.	880 L.F.	SEE STD. PLAN M-20.10-02, EDGE LINE & SOLID LANE LINE
PAINTED DOUBLE YELLOW CENTERLINE	STA. 100+60 TO STA. 105+00 C/L	440 L.F.	SEE STD. PLAN M-20.10-02, DOUBLE CENTERLINE & DOUBLE LANE LINE
TYPE 2YY - RECESSED PAVEMENT MARKERS	STA. 100+60 TO STA. 105+00 C/L	0.04 HUND	SEE STD. PLAN M-20.30-03, TWO-LANE TWO-WAY TRAFFIC & TWO-WAY ROADWAY RECESSED PAVEMENT MARKER DETAILS
TYPE WW - FLEXIBLE GUIDE POST	STA. 100+60 TO STA. 105+00 RT.	8 EACH	SEE STD. PLAN M-40.10-03 & M-40.40-00, TWO-WAY UNDIVIDED HIGHWAYS



PLANING DETAIL

SURFACING LEGEND:

(1) HMA CL. ½ IN. PG 64 - 22

(2) CRUSHED SURFACING BASE COURSE

(3) REINFORCED LIGHTWEIGHT CELLULAR CONCRETE CLASS IV

(4) REINFORCED LIGHTWEIGHT CELLULAR CONCRETE CLASS II OR CLASS IV

PLANING LEGEND:

◇1 PLANING BITUMINOUS PAVEMENT

NOTES:

1. ALL DIMENSIONS SHOWN IN FEET UNLESS OTHERWISE NOTED.
2. ALL DEPTHS SHOWN ARE FINAL COMPACTED DEPTHS. SEE STANDARD SPECIFICATIONS FOR MAXIMUM LIFT DEPTHS.
3. ONLY STATIC ROLLING WILL BE ALLOWED FOR CSBC AND HMA PLACED ON THE REINFORCED LIGHTWEIGHT CONCRETE REPAIR SECTION; SEE CELLULAR CONCRETE SPECIAL PROVISION

REINFORCED LIGHTWEIGHT CONC. REPAIR SECTION

LINE	STATION	TO	STATION	A	B	C	D
SR302	101+00.00		101+33.00	1.00	USE A	* VARIES 3.95-3.10	MATCH EXIST
SR302	101+33.00		101+85.00	1.00	USE A	* VARIES 3.10-1.70	1.5:1
SR302	101+85.00		102+25.00	1.00	USE A	* VARIES 1.70-2.45	1.5:1
SR302	102+25.00		102+53.00	1.00	USE A	* VARIES 2.45-0.54	1.5:1
SR302	102+53.00		102+54.00	1.00	USE A	0.54-0.52	1.5:1
SR302	102+54.00		102+56.00	USE B	1.08-0.49	0.52-0.48	1.5:1
SR302	102+56.00		102+59.00	0.00	USE A	0.48-0.41	1.5:1
SR302	102+59.00		102+62.00	USE B	0.23-0.81	0.41-0.34	1.5:1
SR302	102+62.00		102+64.00	1.00	USE A	0.34-0.30	1.5:1
SR302	102+64.00		102+70.00	1.00	USE A	* VARIES 0.30-2.53	1.5:1

NOT TO SCALE

FILE NAME	G:\2DesignPS&E\SR302 XL-4651 N. of E Victor Rd--Culvert Replacement\8.00-PSE\PS&ESheets\XL4651_DE_RS.dgn
TIME	9:06:34 AM
DATE	7/8/2016
PLOTTED BY	SchlecB
DESIGNED BY	B. SCHLECHTEN
ENTERED BY	B. SCHLECHTEN
CHECKED BY	A. AMOS
PROJ. ENGR.	M. BRITTON
REGIONAL ADM.	K. DAYTON

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED. AID PROJ. NO.

JOB NUMBER 16C516

CONTRACT NO. | LOCATION NO. XL4651

P.E. STAMP BOX | DATE | P.E. STAMP BOX | DATE

7-8-16

Washington State Department of Transportation

SR 302
1.15 MILES S OF E VICTOR RD
MAJOR DRAINAGE

ROADWAY SECTION

PLAN REF NO RS1

SHEET 3 OF 15 SHEETS

Contract 008958

Sent:e Thursday, January 14, 2021 4:47 PM

Subject:eSR 302 vicinity MP 4.5 Embankment Failure/Landslide - Geotechnical Office Response

Rich,

Per your request, on Wednesday, January 13th, 2021, I met you at the site of a reported embankment failure/landslide on SR 302, at approximately MP 4.5 (Figure 1). This location is within the limits of a slope in our Unstable Slope Management System (USMS) as slope 177 and has a rating of 402 (MP 4.39 to 4.63). Reportedly, this section of the highway failed during the 2001 Nisqually earthquake. It was mitigated following the earthquake and Maintenance indicated this section did not show signs of instability until approximately 6 to 7 years ago, when cracks began developing in both lanes of the highway. The site is within an area of known instability, locally referred to as the "Victor Slide". Our assessment included reviewing selected available geologic and geotechnical literature/maps, conducting Region interviews, taking site photographs, observing site geomorphology and generating a field-developed cross section.

At the time of our visit, both lanes of the highway were closed to traffic. The current deformation affects approximately 210 feet of the highway, with cracks affecting both lanes and shoulders (Figure 2). The asphalt is separated from the soil for an additional 70 feet on the southbound side of the highway and a small section of the northbound side has minor separation (Figure 3). While I was on site, I noticed that cracks were open 2 to 3 inches with up to 5 to 6 inches of vertical offset, in places (Figure 4). I spray-painted the ends of several cracks so we can measure any future extension of the cracks. Maintenance states that the cracks are in approximately the same locations as past failures and that they typically fill the voids with gravel and patch this section of highway; however, new cracks have developed on the south end of the deformation area (see Figure 2), reportedly extending the limits of the familiar failure zone. I walked upslope and did not notice any fresh signs of instability (cracks, slumping, etc.); however, I did notice ponded water immediately above the cutslope and in the upslope/northbound ditch, immediately adjacent to the area of pavement cracks (Figures 5 and 6). I walked downslope and did not observe fresh signs of instability. I did not observe any seepage downslope of the highway; however, the slope was covered with vegetation. It appears that the current failure is occurring on or near the fill/native contact; however, we are unable to verify the depth of the failure without a subsurface investigation.

The Region proposed to fill the voids with gravel and level it with hot or cold mix. I called Marc Fish and Eric Smith (Geotechnical Office) to discuss and we agree that their proposal is reasonable. I also discussed, with Maintenance, that another option would be to fill the voids with gravel and level the highway with gravel for a temporary fix. I stressed that the landslide may still be active, and that the cracks may reappear during the next rain cycle. We also recommend that the upslope ditch be cleaned out to promote positive drainage to the nearby culvert.

Maintenance should continue to closely monitor this area during the remaining wet season and contact our office if the problem reoccurs. Our office will update the USMS with this new landslide event.

We hope the above provides the information you need at this time. If you have any questions, please call me at the number below or Eric Smith at 360-280-5041.

Thank you.

Michael Mulhern
Geotechnical Specialist
State Materials Laboratory – Geotechnical Office

Will Rosso

From:	Newman, Stephen
Sent:	Thursday, January 13, 2022 8:09 AM
Subject:	Geotechnical site visit report, 2022-01-11 – Victor Slide, SR 302, MP 4.5
Attachments:	AnnotatedPhotos_SR302_MP4-5_DMC268.pdf; Fig1_SiteVicinityMap_SR302_MP4-5_DMC268.pdf; Fig2_GeotechnicalObservMap_SR302_MP4-5_DMC268.pdf

Good morning,

On Tuesday, January 11th, 2021, at the request of your office, we visited the site of recent embankment settlement at SR 302, MP 4.5 (the project site). The project site has experienced several previous episodes of subsidence and/or slope displacement, including during the 2001 Nisqually earthquake. The site was mitigated following the earthquake and, according to conversations with Olympic Region Maintenance, did not show signs of instability until approximately 7 or 8 years ago, when cracks began developing in both lanes of the highway. The site is within an area of known instability, locally referred to as the "Victor Slide", and is included in our Unstable Slope Management System (USMS) as USMS slope #177.

We understand that the site experienced significant rainfall and snow melt in the weeks prior to the most recent episode of embankment settlement, leading to elevated groundwater levels and increased surface runoff. We also understand that one or more anomalously high 'king' tides have occurred in recent weeks at the project site, which have likely exacerbated the already high groundwater levels in the embankment, and have also likely increased coastal erosion along the toe of the embankment. These factors have likely combined to trigger the recent episode of embankment settlement. Below, we present our field observations, conclusions and geotechnical recommendations. Attached, please find selected and annotated photographs from our visit, a site vicinity map, and a preliminary map showing the locations of observed ground cracks.

We arrived on site at approximately 12:30 pm and departed the site at approximately 5:00 pm. Upon our arrival we observed two areas where ground cracks extended into the SR 302 travel lanes, one area near MP 4.45, and another more significant area between approximately MP 4.50 and 4.55 (see attached Figure 1). We also observed a third area of ground cracking that was limited to the eastbound (EB) SR 302 shoulder and embankment slope, near MP 4.57. We did not observe any ground cracks or subsidence in the vicinity of the rebuilt section of embankment between approximately MP 4.59 and MP 4.63.

Ground crack near MP 4.45

We observed a single ground crack near MP 4.45, which was limited to the EB SR 302 travel lane and shoulder. This crack was previously observed and photographed during a site visit by our office in June 2019. The extent of the crack does not appear to have changed since our 2019 site visit, but the crack aperture appears to have increased from approximately 0.25 to 0.75 inches across. No vertical offset is apparent along this crack. Based on the ground stakes that we observed at this location, an 18-inch-diameter, 60-foot-long culvert is apparently slated to be installed at this location.

Ground cracks and subsidence between approximately MP 4.50 and MP 4.55

We observed a series of interconnected ground cracks between approximately MP 4.50 and MP 4.55, which begin along the EB shoulder, extend across both travel lanes to the WB shoulder, and then cross back over to terminate in the EB travel lane. These cracks form a half-moon shape in plan view, open to the west. They are vertically offset between <1 and 3 inches, with the west side of the crack subsiding relative to the east side. The cracks are locally horizontally offset by up to 2 inches. The subsided portion of the embankment appears to have rotated backwards, such that the EB shoulder is now superelevated, and the asphalt pavement tilts gently to the east, toward the ground cracks. We observed significant surface water ponding on the pavement, especially in the WB lane, and the ponded water appears to be draining into the open ground cracks.

During site visits by our office in June 2019 and January 2021, we documented similar patterns of ground cracks between approximately MP 4.50 and 4.55. Based on our records and field observations, we understand that a new layer of asphalt pavement was subsequently added to restore the grade at this location in both 2019 and 2021, prior to this latest episode of cracking and subsidence.

Ground cracks and subsidence near MP 4.57

Near MP 4.57, we observed multiple arcuate ground cracks in the EB SR 109 shoulder and embankment slope. Based on photographs of this location taken by our office during a site visit in July 2017, this portion of the embankment underwent previous mitigation that included placement of quarry spalls, rip rap and geotextile. The observed ground cracks exhibit at least 6 inches of vertical displacement, and locally exhibit more than 1 foot of vertical displacement.

Two mature cedar trees are present near the base of the embankment, to the immediate south of the observed ground cracks, and are visible in the July 2017 photographs. Relative to our recent observations and photographs (see attached exhibits), these trees have undergone significant forward tilting since 2017.

We observed a steel standpipe casing protruding from the toe of the embankment slope at this location, with a red inclinometer casing grouted inside the steel casing. Both the steel outer casing and the red plastic inclinometer casing were tilted forward at least 50 degrees from vertical, indicative of forward rotation of the embankment toe. We also observed a conspicuous lack of armoring at beach level along this portion of the embankment toe.

Field observations up slope from SR 302

We traversed the terrain up slope from the project site to look for evidence of accelerated deep-seated landslide displacement, relative to recent years of relatively slow landslide creep-type displacement. Based on our observations of lidar hillshade maps, and based on past field observations by our office, we classify the terrain immediately east and upslope from the highway as a historically active deep-seated landslide. We compared field photographs taken by our office in 2019 with our recently acquired field photographs, and did not observe any significant differences in the landslide topography or vegetation. Existing indicators of historic landslide displacement, such as through-going cracks in the concrete driveway that align with the landslide head scarp, did not appear to have accrued significant offset relative to that observed in 2019.

Surface water observations

In addition to the previously mentioned surface water ponding in the travel lanes and draining through open ground cracks, we also observed poorly functioning ditches and culverts at the project site. At several locations along the WB SR 302 ditch, we observed masses of soil in the ditch that are preventing water from flowing to the culvert inlets. We observed thick mats of vegetation at several other locations in the ditch and around culvert inlets, which may also be contributing to poor ditch and culvert performance.

In the vicinity of MP 4.47, we observed the outlet of a 12-inch-diameter corrugated plastic pipe culvert. We could not locate the culvert inlet due to significant vegetation and soil obscuring the culvert inlet. No water was observed flowing through this culvert, despite the extremely wet weather conditions during and preceding our site visit.

Geotechnical Recommendations

We recommend reestablishing the WB SR 302 ditch between approximately MP 4.4 and 4.6 by removing vegetation and debris that may be partially or fully obstructing flow. We also recommend clearing any debris or vegetation that may be partially or fully blocking the culvert inlets in the WB ditch. We recommend sealing the ground cracks in the pavement at MP 4.45. Between approximately MP 4.50 and MP 4.55, we recommend sealing the ground cracks in the pavement (and in the shoulders, if possible); we also recommend directing surface water away from the cracks.

Once the above mitigation efforts have been completed, and once the current episode of ground movement ends, we strongly recommend repaving the travel lanes in the vicinity of MP 4.50 and 4.55 (where the travel lanes have subsided/rotated) and reestablishing the highway grade.

We understand that the above recommendations are not a permanent fix, and that the project site will very likely undergo additional ground cracking and subsidence in the near future. During our site visit, we collected a large volume of geotechnical field data. We would be happy to entertain more robust, long-term solutions to stabilize this section of SR 302, but such solutions will require significant additional time and funding.

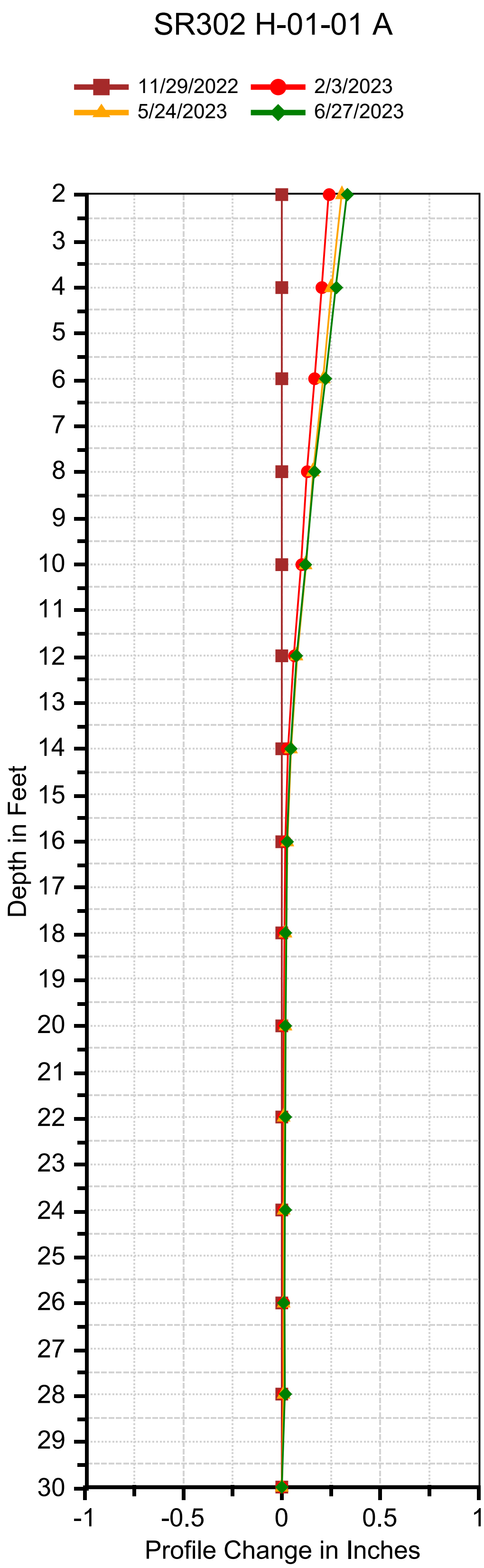
If you have any questions or concerns, please contact me at 360-764-0195.

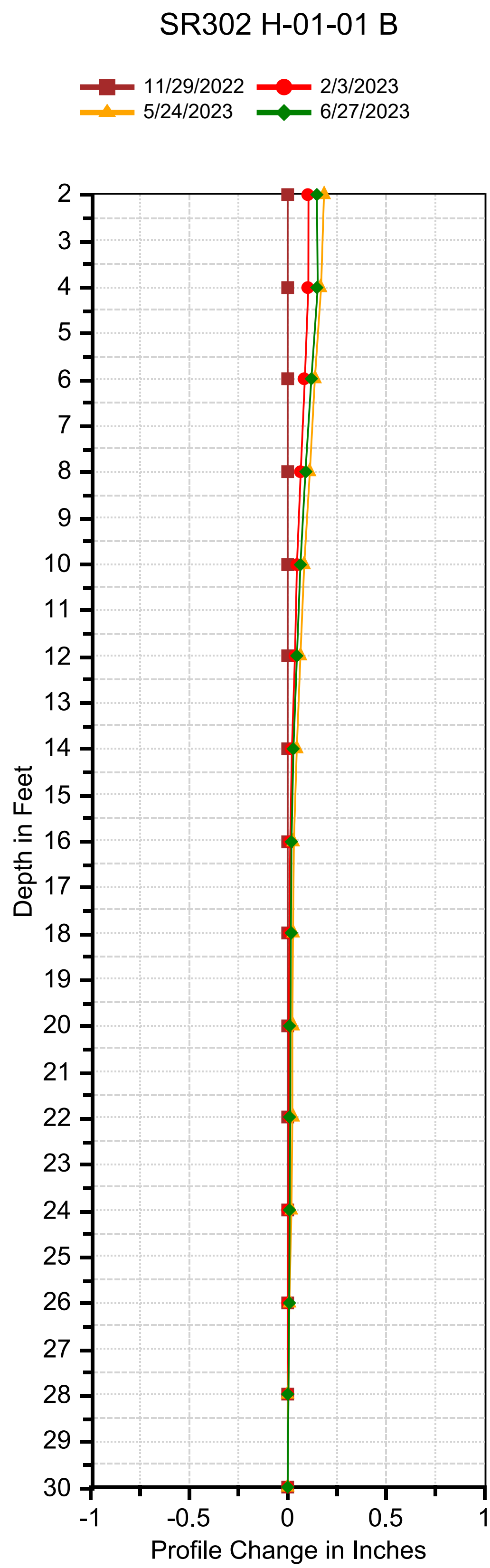
Regards,

Stephen D. Newman, LEG
WSDOT Geotechnical Office

APPENDIX D

INSTRUMENTATION DATA
(CURRENT STUDY)





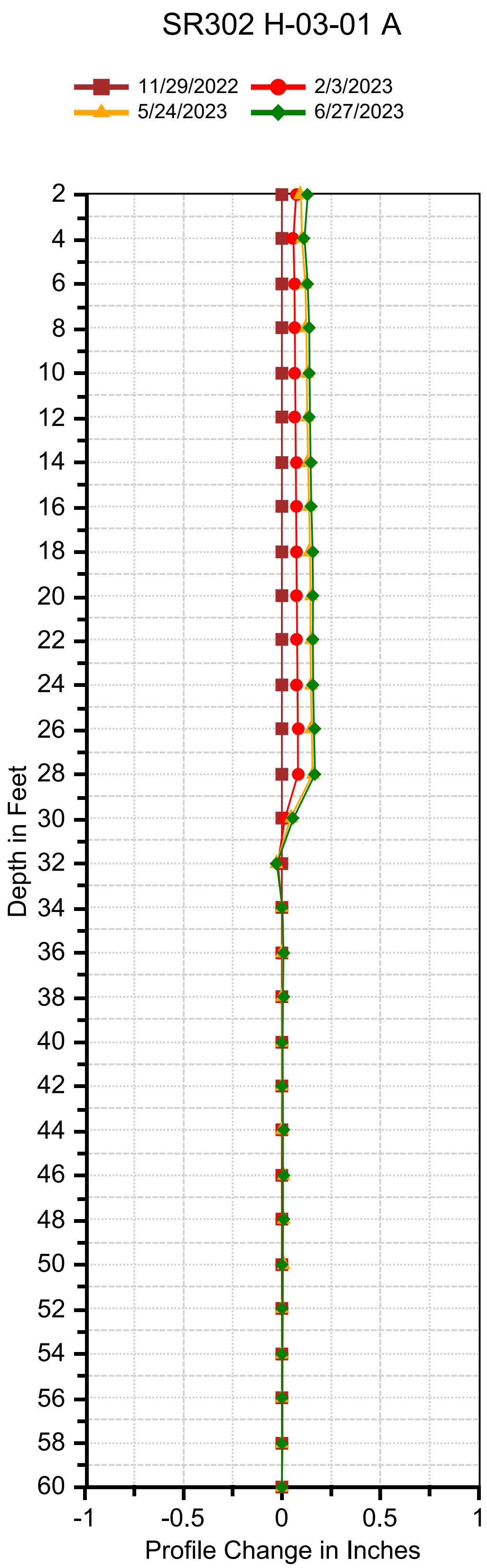
HWA GEOSCIENCES INC.
DBE/MWBE

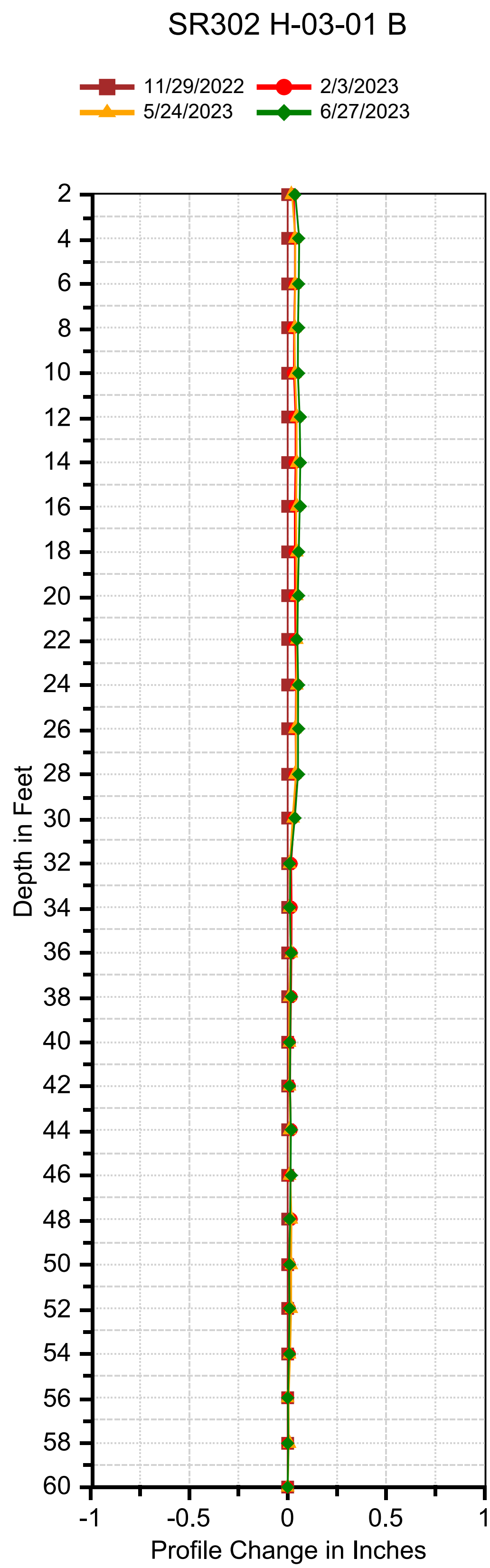
APPENDIX D

H-01-01
SR 302 Victor Area Study
Mason County, Washington

FIGURE NO.
D1

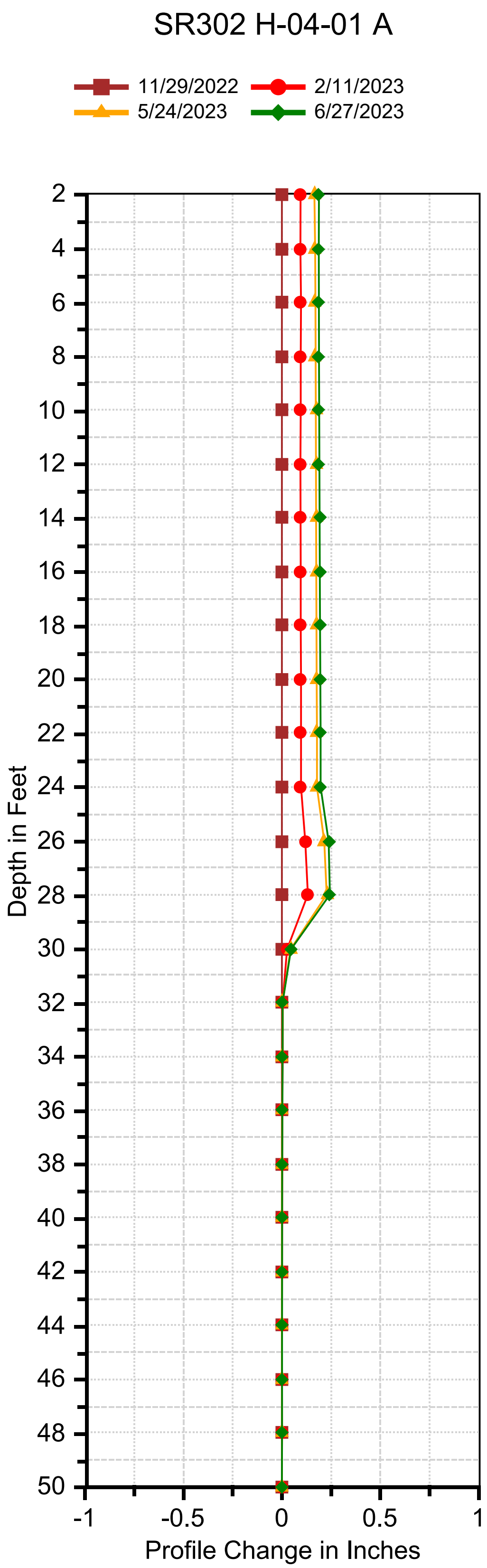
PROJECT NO.
2022-043

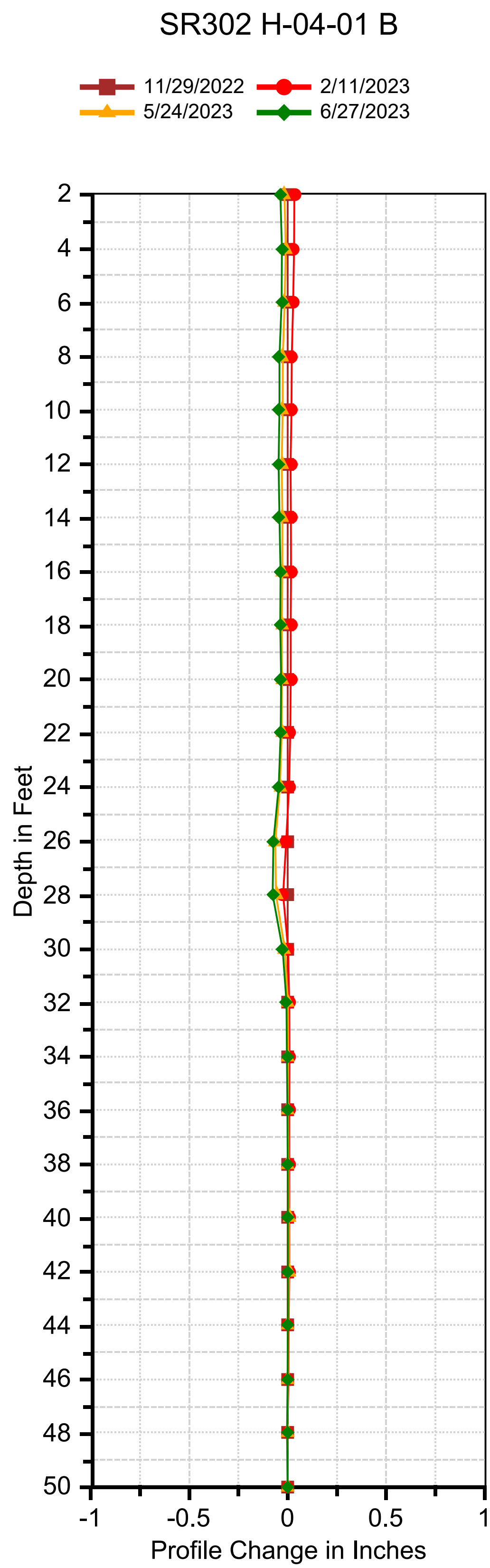




HWA GEOSCIENCES INC.
DBE/MWBE

APPENDIX D	FIGURE NO. D2
H-03-01 SR 302 Victor Area Study Mason County, Washington	PROJECT NO. 2022-043





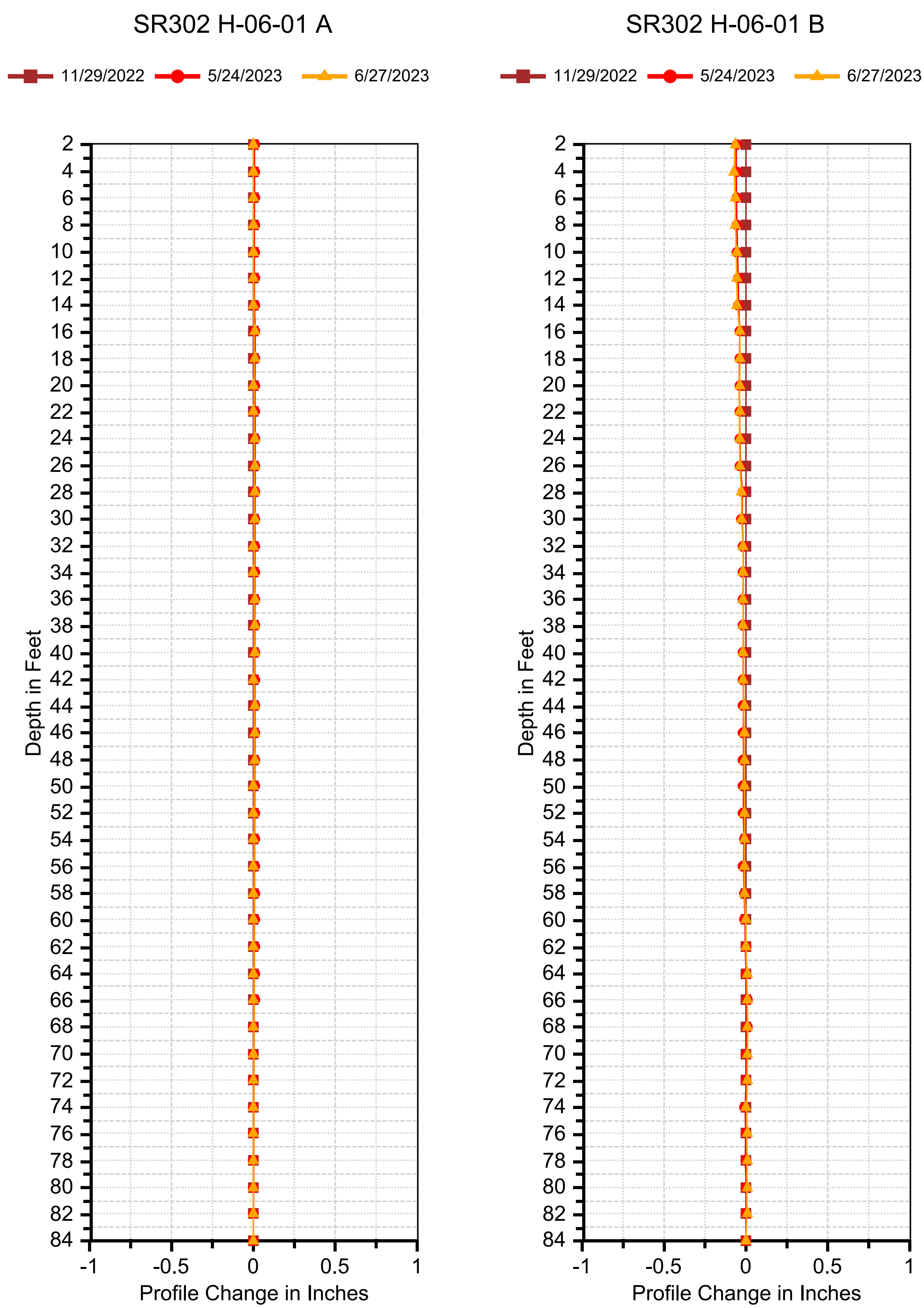
HWA GEOSCIENCES INC.
DBE/MWBE

APPENDIX D

H-04-01
SR 302 Victor Area Study
Mason County, Washington

FIGURE NO.
D3

PROJECT NO.
2022-043



HWA GEOSCIENCES INC.
DBE/MWBE

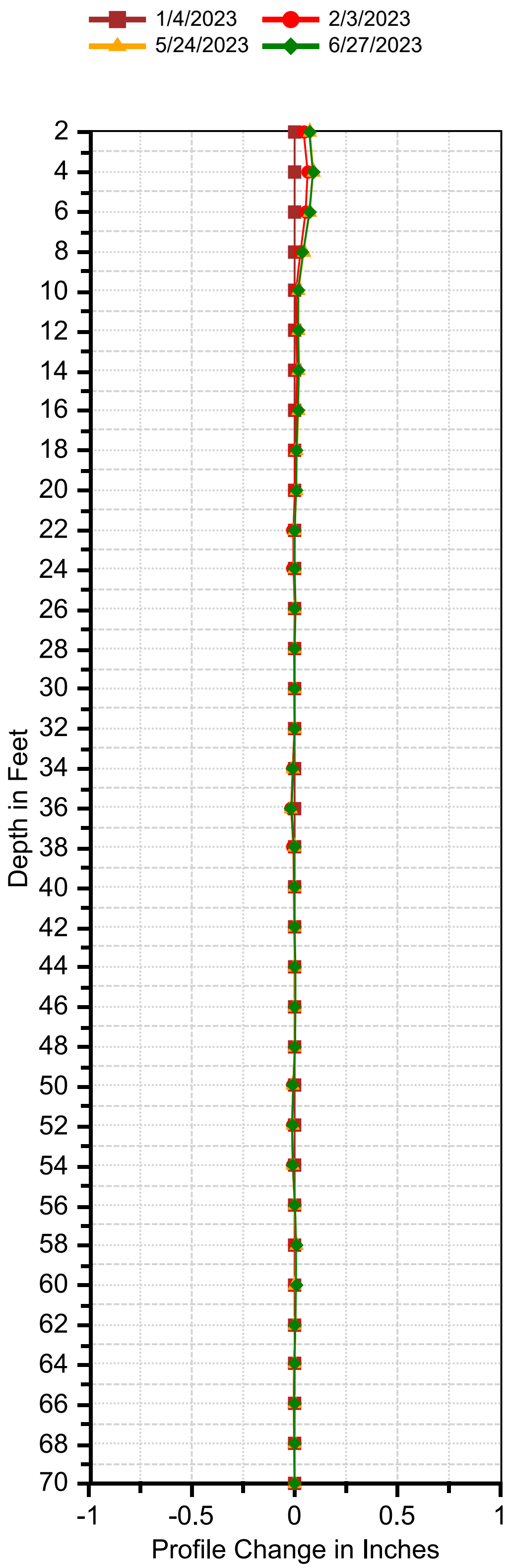
APPENDIX D

H-06-01
SR 302 Victor Area Study
Mason County, Washington

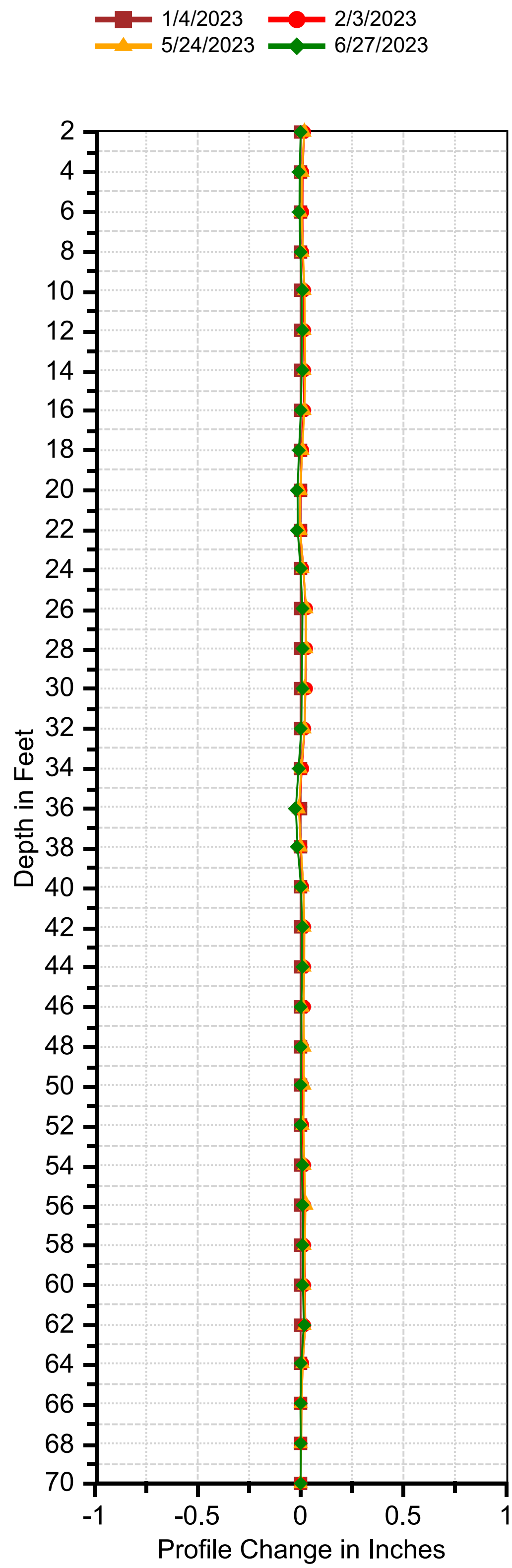
FIGURE NO.
D4

PROJECT NO.
2022-043

SR302 HWA-2Si-22 A



SR302 HWA-2Si-22 B



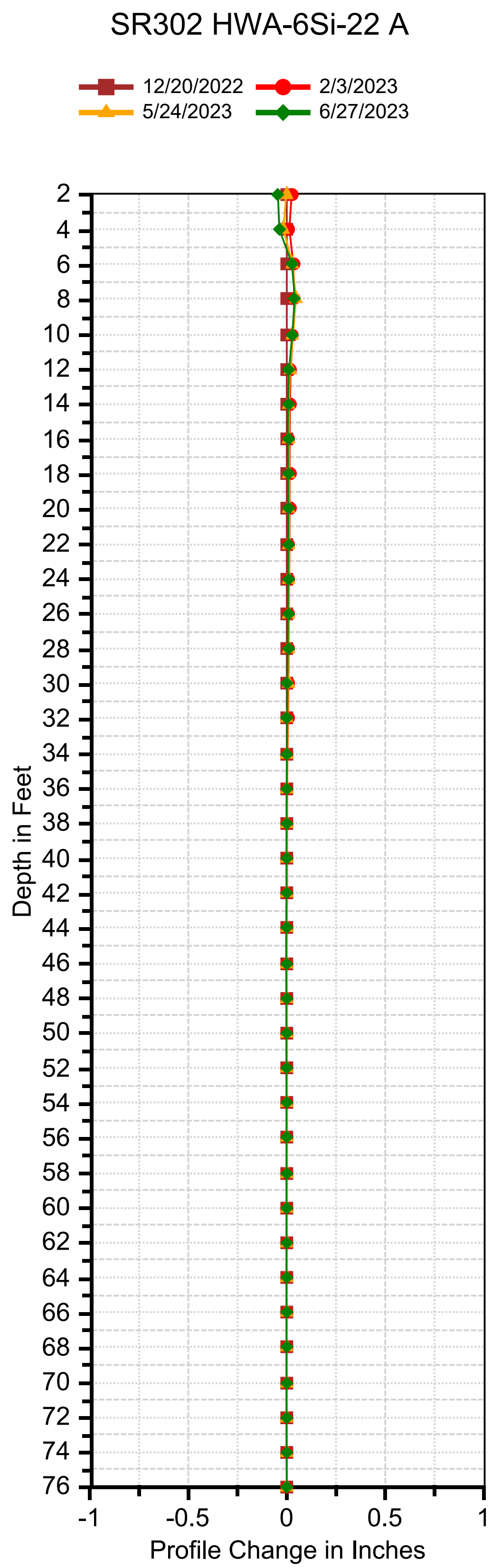
HWA GEOSCIENCES INC.
DBE/MWBE

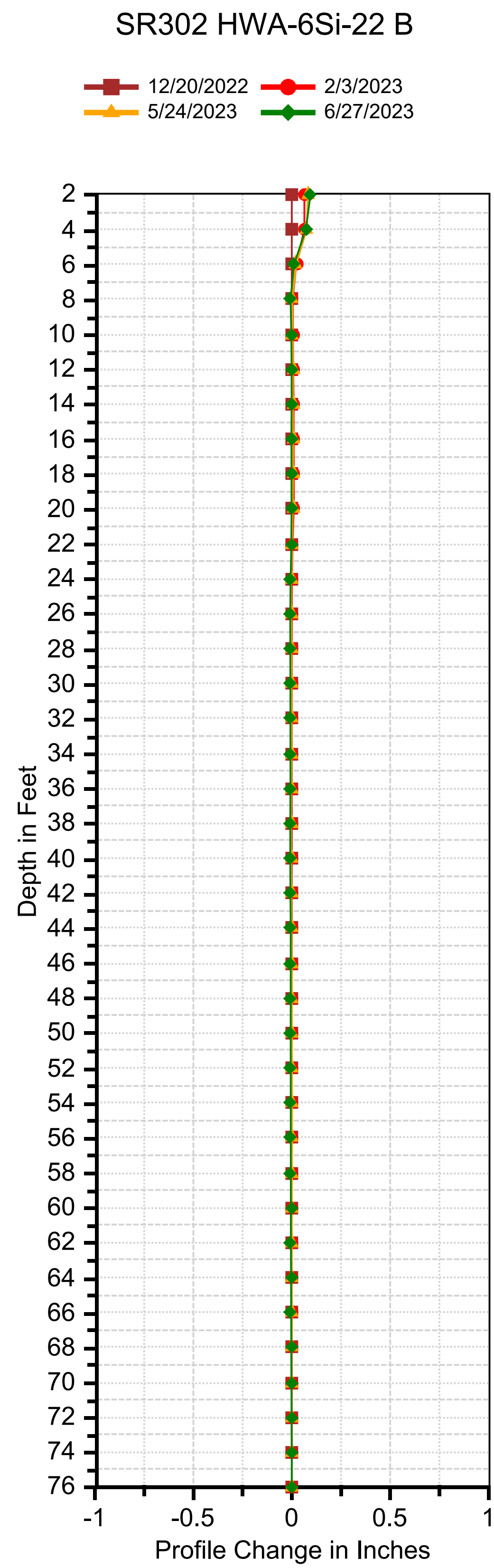
APPENDIX D

HWA-2Si-23
SR 302 Victor Area Study
Mason County, Washington

FIGURE NO.
D5

PROJECT NO.
2022-043





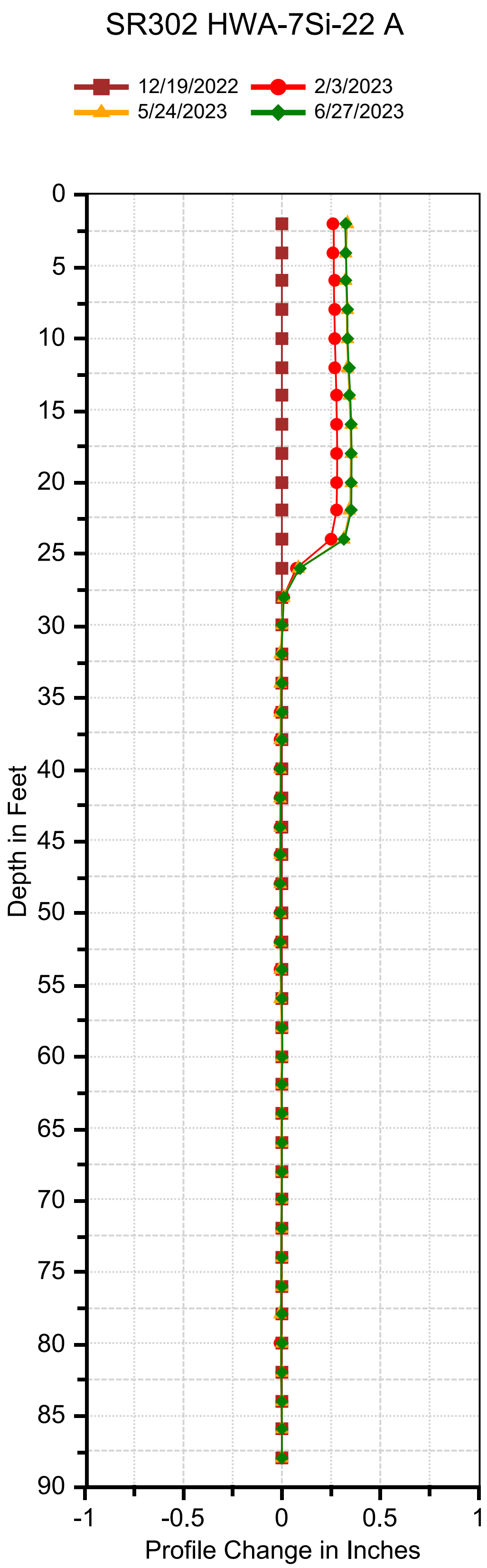
HWA GEOSCIENCES INC.
DBE/MWBE

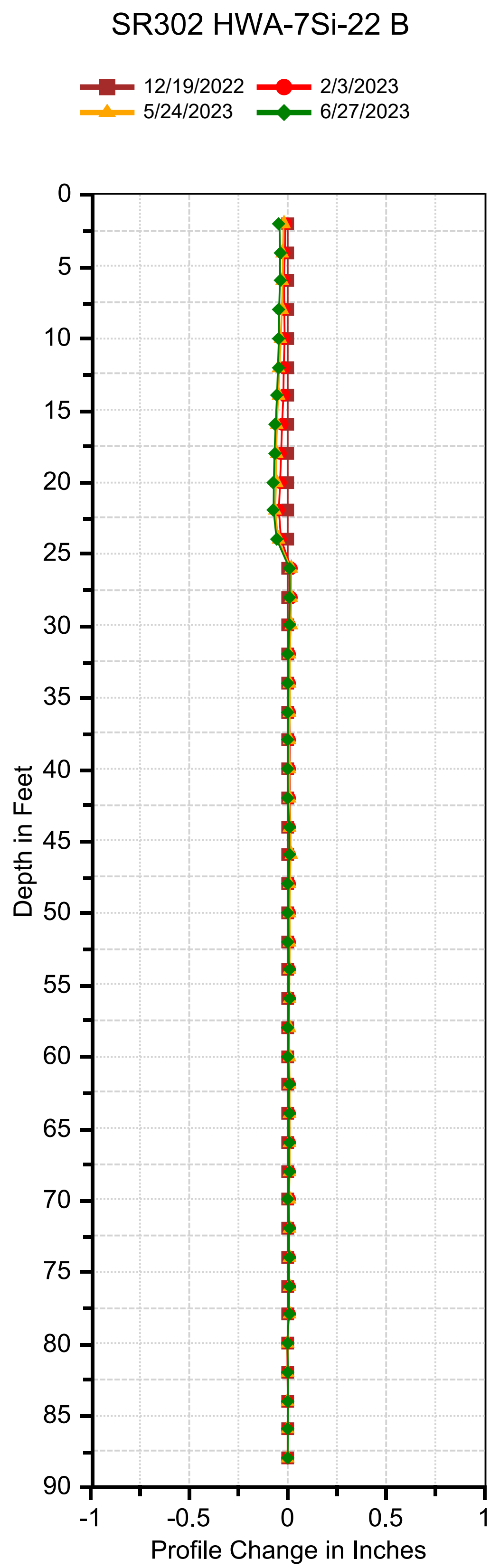
APPENDIX D

HWA-6Si-23
SR 302 Victor Area Study
Mason County, Washington

FIGURE NO.
D6

PROJECT NO.
2022-043





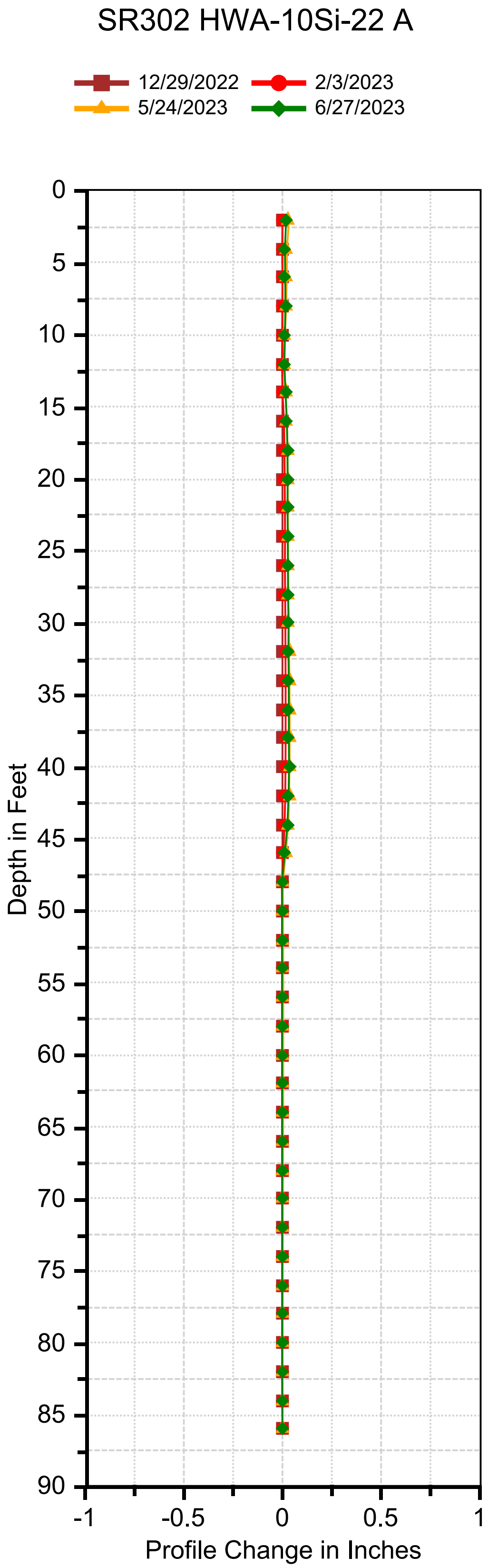
HWA GEOSCIENCES INC.
DBE/MWBE

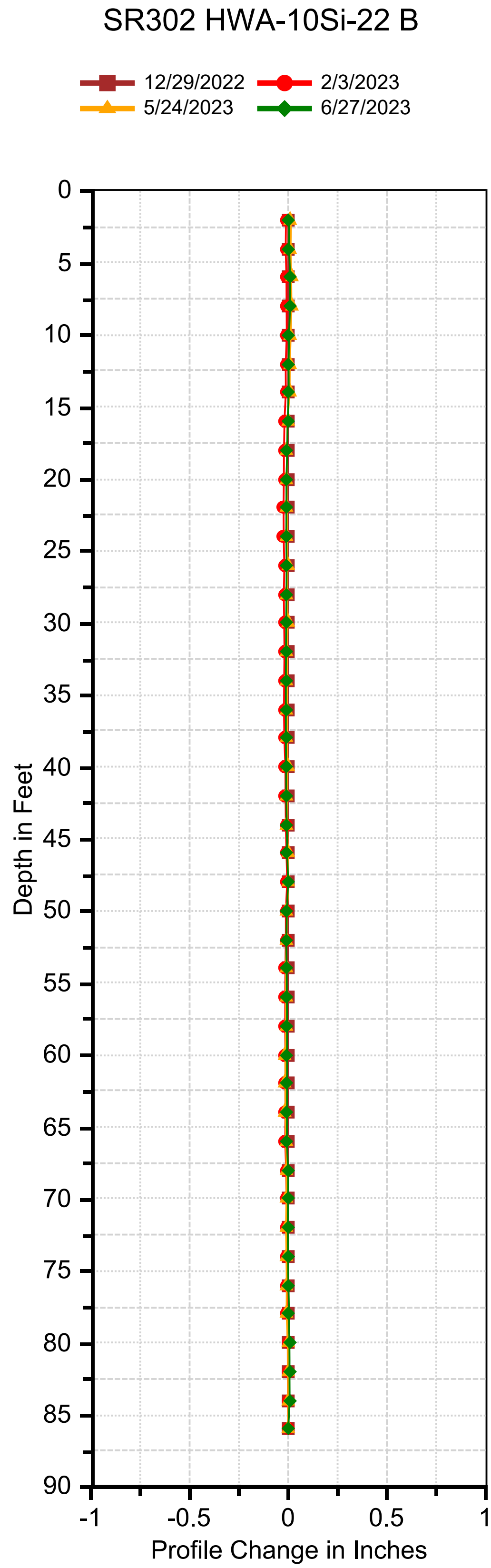
APPENDIX D

HWA-7Si-23
SR 302 Victor Area Study
Mason County, Washington

FIGURE NO.
D7

PROJECT NO.
2022-043





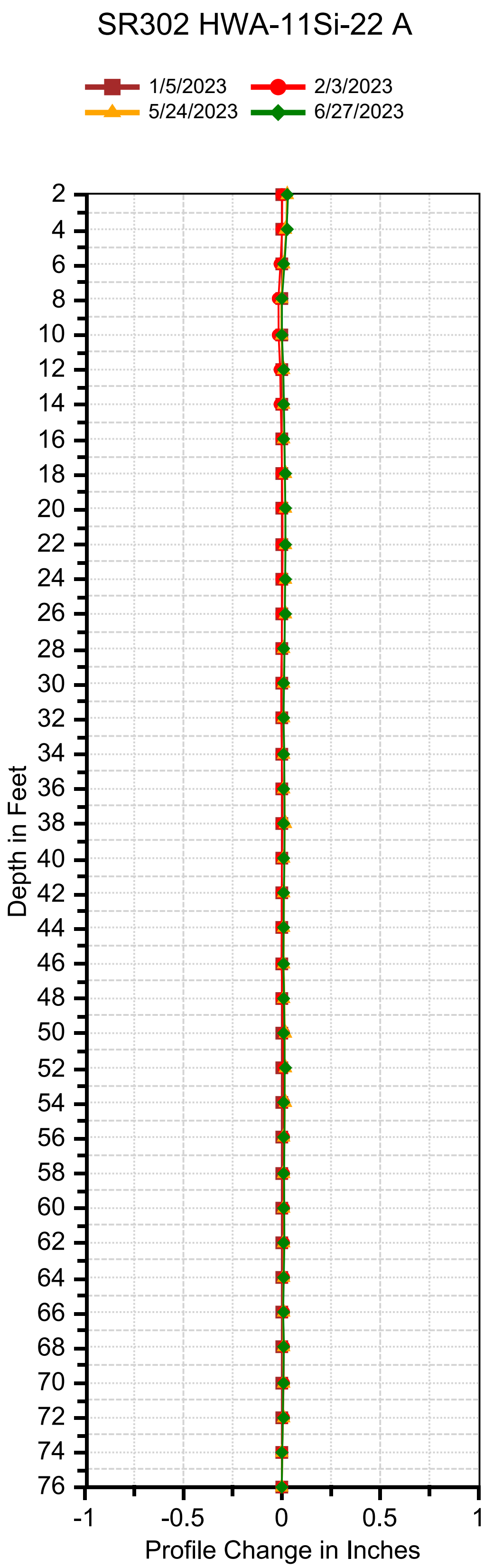
HWA GEOSCIENCES INC.
DBE/MWBE

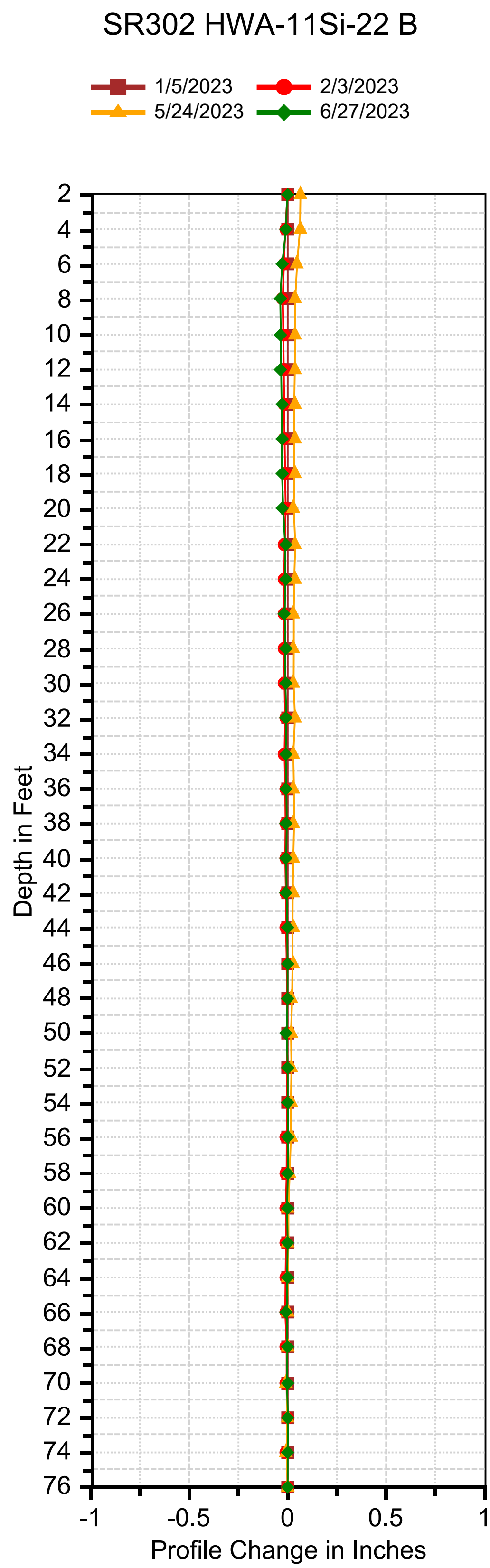
APPENDIX D

HWA-10Si-23
SR 302 Victor Area Study
Mason County, Washington

FIGURE NO.
D8

PROJECT NO.
2022-043





HWA GEOSCIENCES INC.
DBE/MWBE

APPENDIX D

HWA-11Si-23
SR 302 Victor Area Study
Mason County, Washington

FIGURE NO.
D9

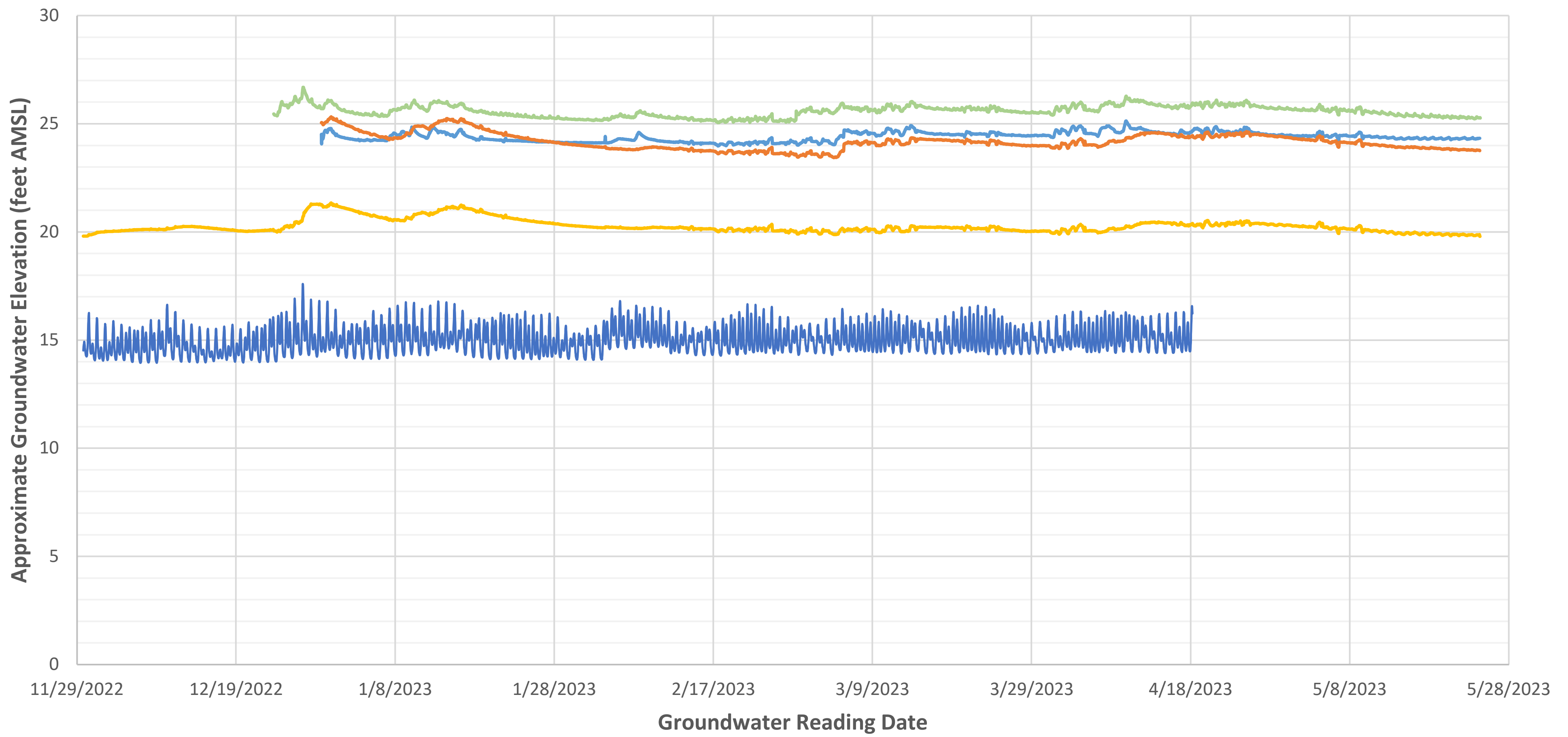
PROJECT NO.
2022-043

Date	May 24, 2023
Job No.	2022-043-21
Project	SR 302 Victor Area Study Mason County, Washington

Figure - D10
Piezometer Report

HWA GEOSCIENCES INC.
DBE/MWBE

	Boring	Ground Elevation (ft)*	Shallowest Water Elevation (ft)	Deepest Water Elevation (ft)	First Reading	Last Reading	Latitude	Longitude	Datum	Collector
	HWA-1P-22	33.7	25.1	24.0	12/29/2022	5/24/2023	47.36542	-122.80802	WGS84	W. Rosso
	HWA-3P-22	34.6	25.3	23.4	12/27/2022	5/24/2023	47.36465	-122.80747	WGS84	W. Rosso
	HWA-8P-22	35.6	26.7	25.1	12/19/2022	5/24/2023	47.36405	-122.80720	WGS84	W. Rosso
	H-1-01	31.4	21.3	19.8	11/29/2022	5/24/2023	47.36471	-122.80765	WGS84	W. Rosso
	H-3-01	18.7	17.6	14.0	11/29/2022	4/18/2023	47.36121	-122.80645	WGS84	W. Rosso



Date May 24, 2023

Job No. 2022-043-21

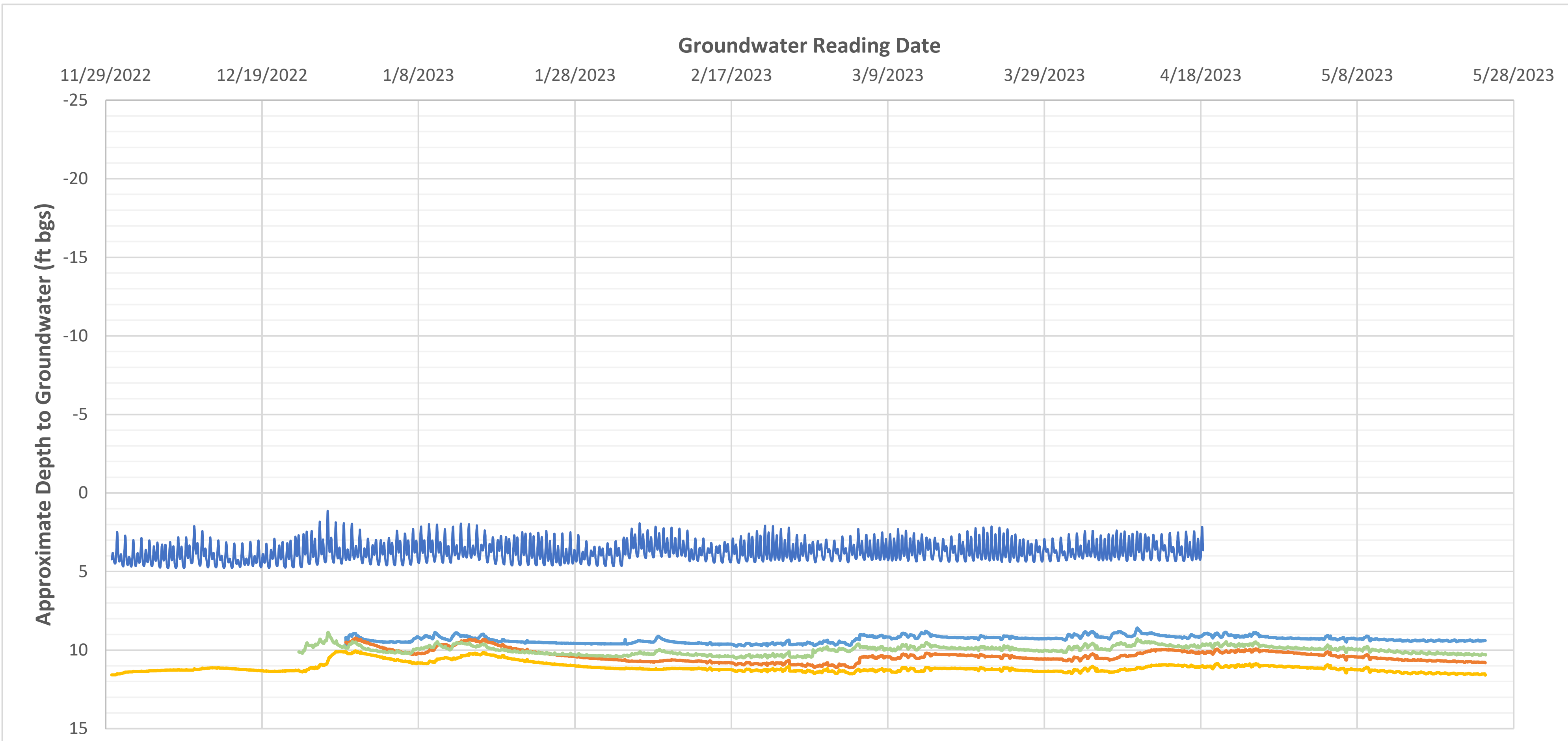
Project SR 302 Victor Area Study

Mason County, Washington

Figure - D11
Piezometer Report

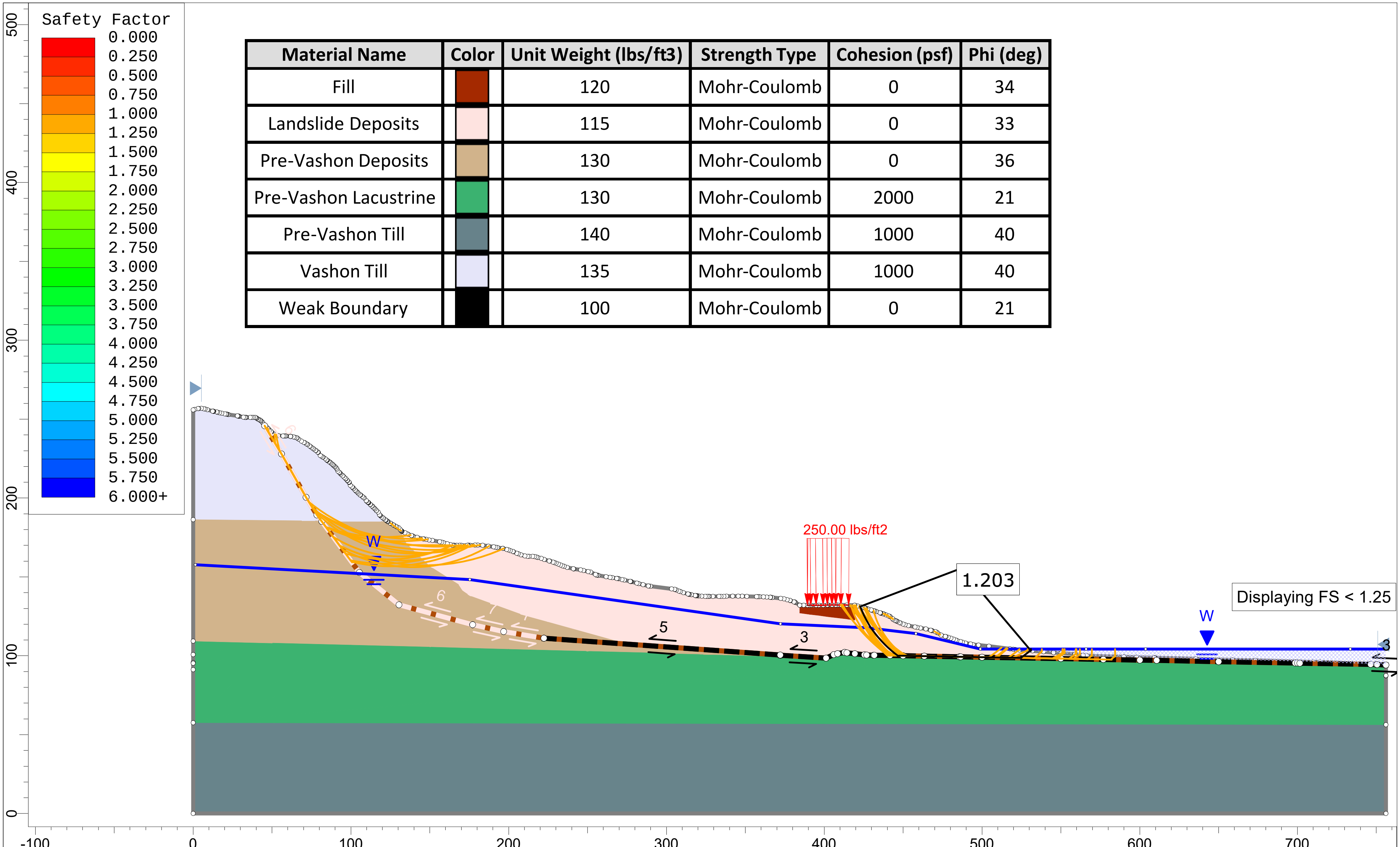
HWA GEOSCIENCES INC. DBE/MWBE

	Boring	Ground Elevation (ft)*	Shallowest Water Depth (ft bgs)	Deepest Water Depth (ft bgs)	First Reading	Last Reading	Latitude	Longitude	Datum	Collector
	HWA-1P-22	33.7	8.6	9.7	12/29/2022	5/24/2023	47.36542	-122.80802	WGS84	W. Rosso
	HWA-3P-22	34.6	9.2	11.1	12/27/2022	5/24/2023	47.36465	-122.80747	WGS84	W. Rosso
	HWA-8P-22	35.6	8.9	10.5	12/19/2022	5/24/2023	47.36405	-122.80720	WGS84	W. Rosso
	H-1-01	31.4	10.0	11.6	11/29/2022	5/24/2023	47.36471	-122.80765	WGS84	W. Rosso
	H-3-01	18.7	1.1	4.8	11/29/2022	4/18/2023	47.36121	-122.80645	WGS84	W. Rosso



APPENDIX E

SLOPE STABILITY MODELING FIGURES



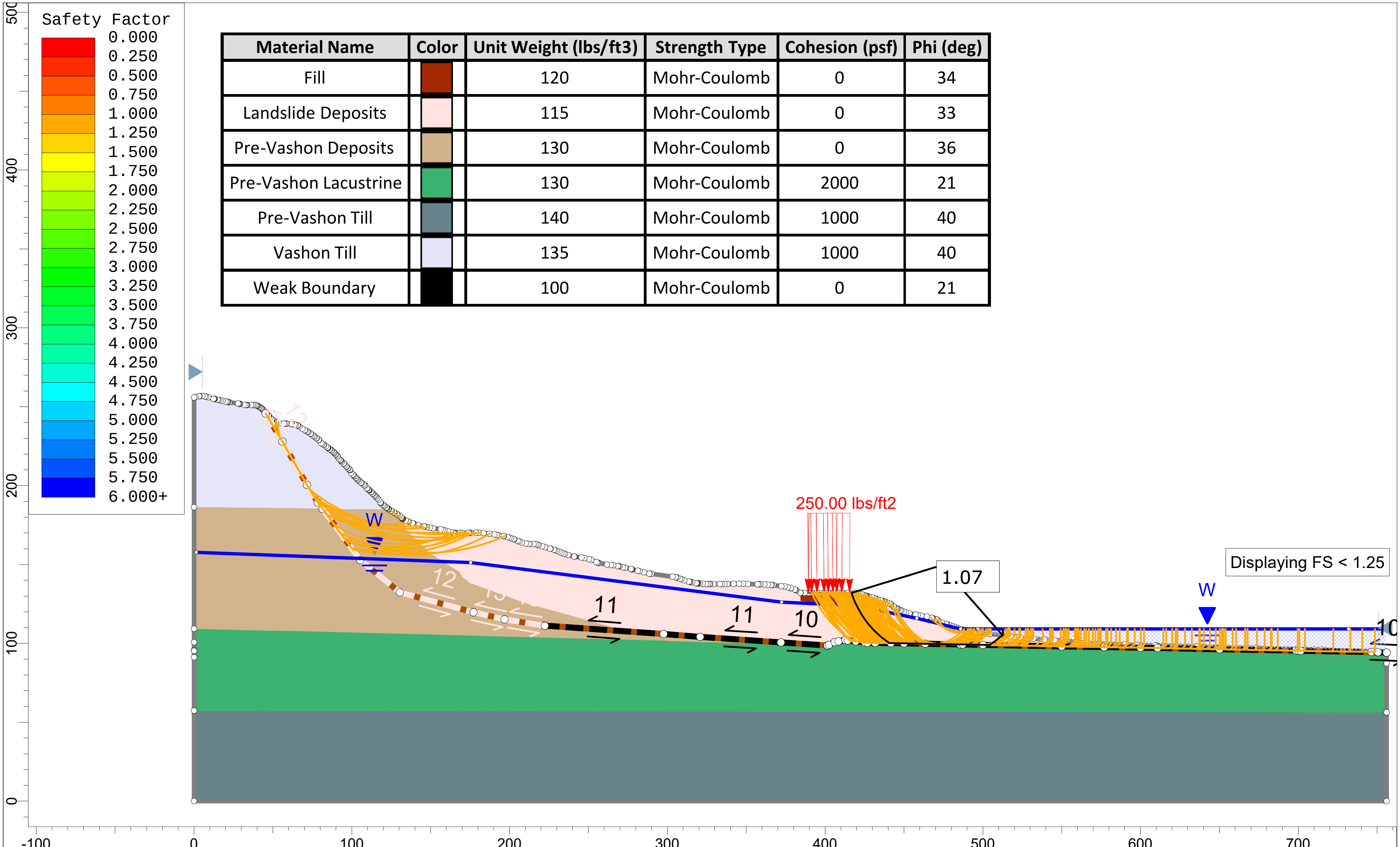
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	Mohr-Coulomb	0	34
Landslide Deposits		115	Mohr-Coulomb	0	33
Pre-Vashon Deposits		130	Mohr-Coulomb	0	36
Pre-Vashon Lacustrine		130	Mohr-Coulomb	2000	21
Pre-Vashon Till		140	Mohr-Coulomb	1000	40
Vashon Till		135	Mohr-Coulomb	1000	40
Weak Boundary		100	Mohr-Coulomb	0	21

rocscience

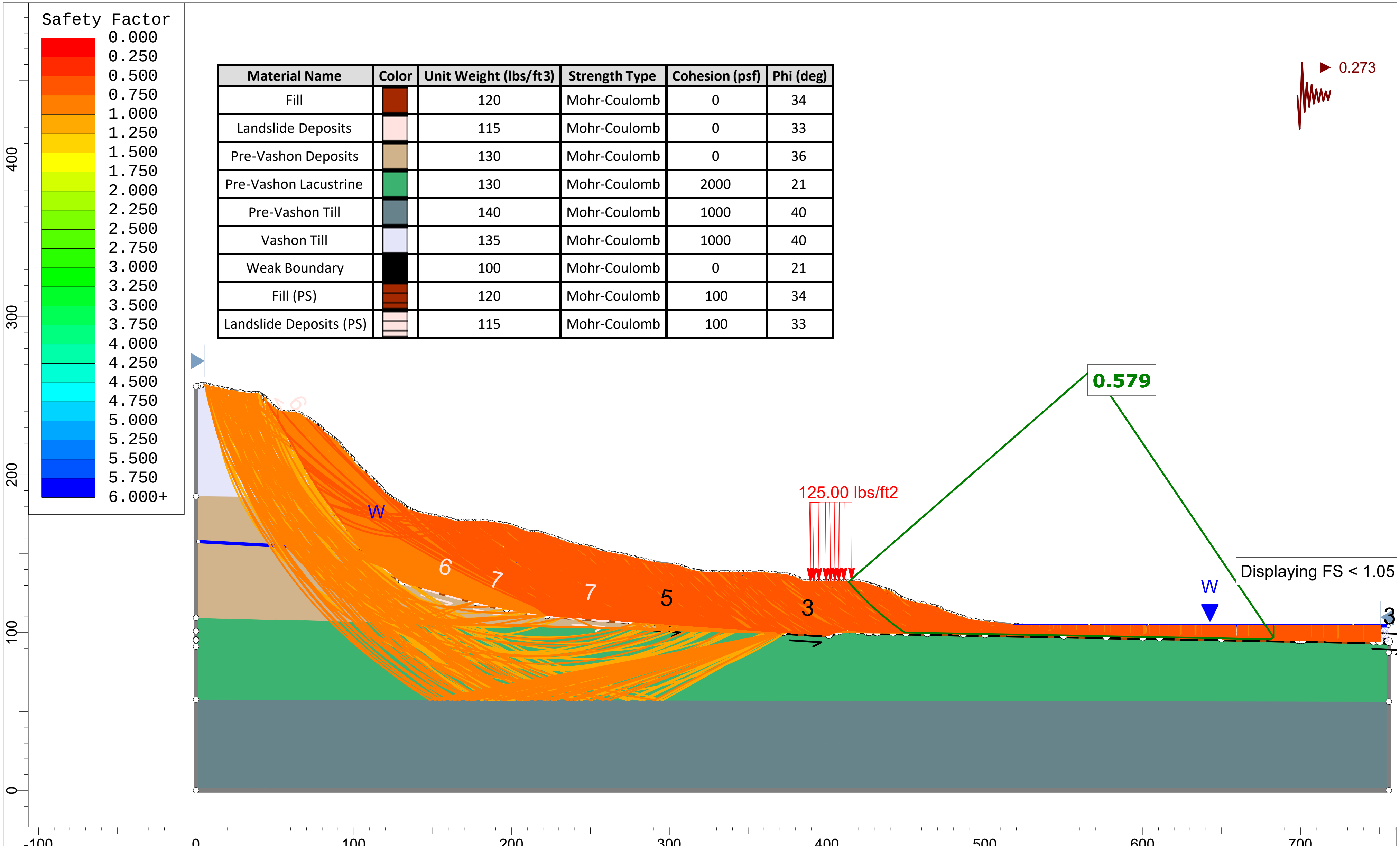
SLIDEINTERPRET 9.023

Project	SR 302 Victor Area Study		
Group	SR 302, MP 4.5	*Scenario*	Figure E-1 - Static Conditions (SC)
Drawn By	WRR	*Company*	HWA GeoSciences
Date	4/2/2023, 6:43:01 PM	*File Name*	Profile A (Center of Slide) 4.19.23.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	Mohr-Coulomb	0	34
Landslide Deposits		115	Mohr-Coulomb	0	33
Pre-Vashon Deposits		130	Mohr-Coulomb	0	36
Pre-Vashon Lacustrine		130	Mohr-Coulomb	2000	21
Pre-Vashon Till		140	Mohr-Coulomb	1000	40
Vashon Till		135	Mohr-Coulomb	1000	40
Weak Boundary		100	Mohr-Coulomb	0	21



rocscience	Project	SR 302 Victor Area Study	
	Group	SR 302, MP 4.5	Scenario: Figure E-2 - High Groundwater Conditions (HGW)
	Drawn By	WRR	Company: HWA GeoSciences
SLIDEINTERPRET 9.023	Date	4/2/2023, 6:43:01 PM	File Name: Profile A (Center of Slide) 4.19.23.slmd



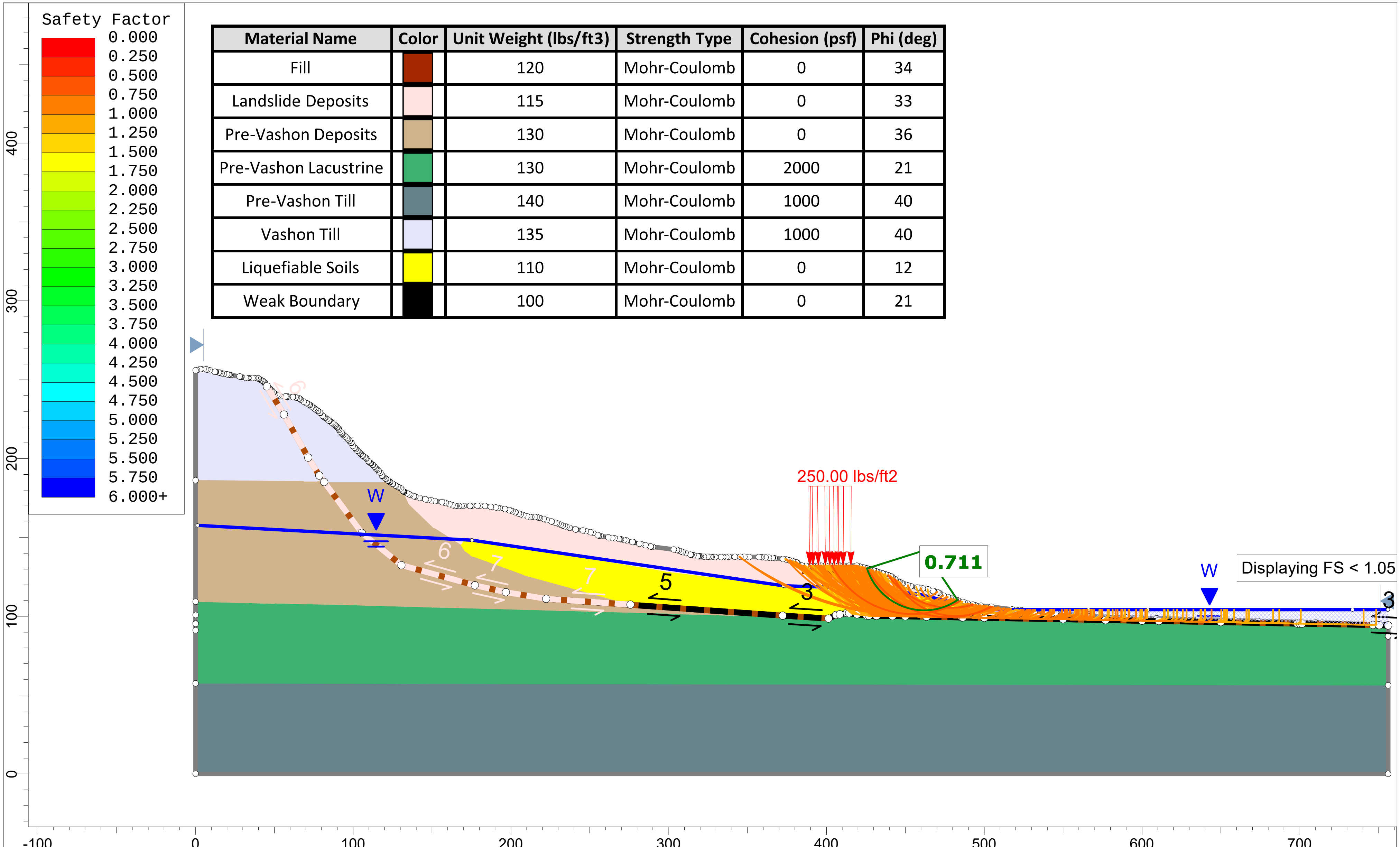
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	Mohr-Coulomb	0	34
Landslide Deposits		115	Mohr-Coulomb	0	33
Pre-Vashon Deposits		130	Mohr-Coulomb	0	36
Pre-Vashon Lacustrine		130	Mohr-Coulomb	2000	21
Pre-Vashon Till		140	Mohr-Coulomb	1000	40
Vashon Till		135	Mohr-Coulomb	1000	40
Weak Boundary		100	Mohr-Coulomb	0	21
Fill (PS)		120	Mohr-Coulomb	100	34
Landslide Deposits (PS)		115	Mohr-Coulomb	100	33

rocscience

SLIDEINTERPRET 9.023

Project	SR 302 Victor Area Study		
Group	SR 302, MP 4.5	*Scenario*	Figure E-3 - Pseudo Static Conditions (PS)
Drawn By	WRR	*Company*	HWA GeoSciences
Date	4/2/2023, 6:43:01 PM	*File Name*	Profile A (Center of Slide) 4.19.23.slmd

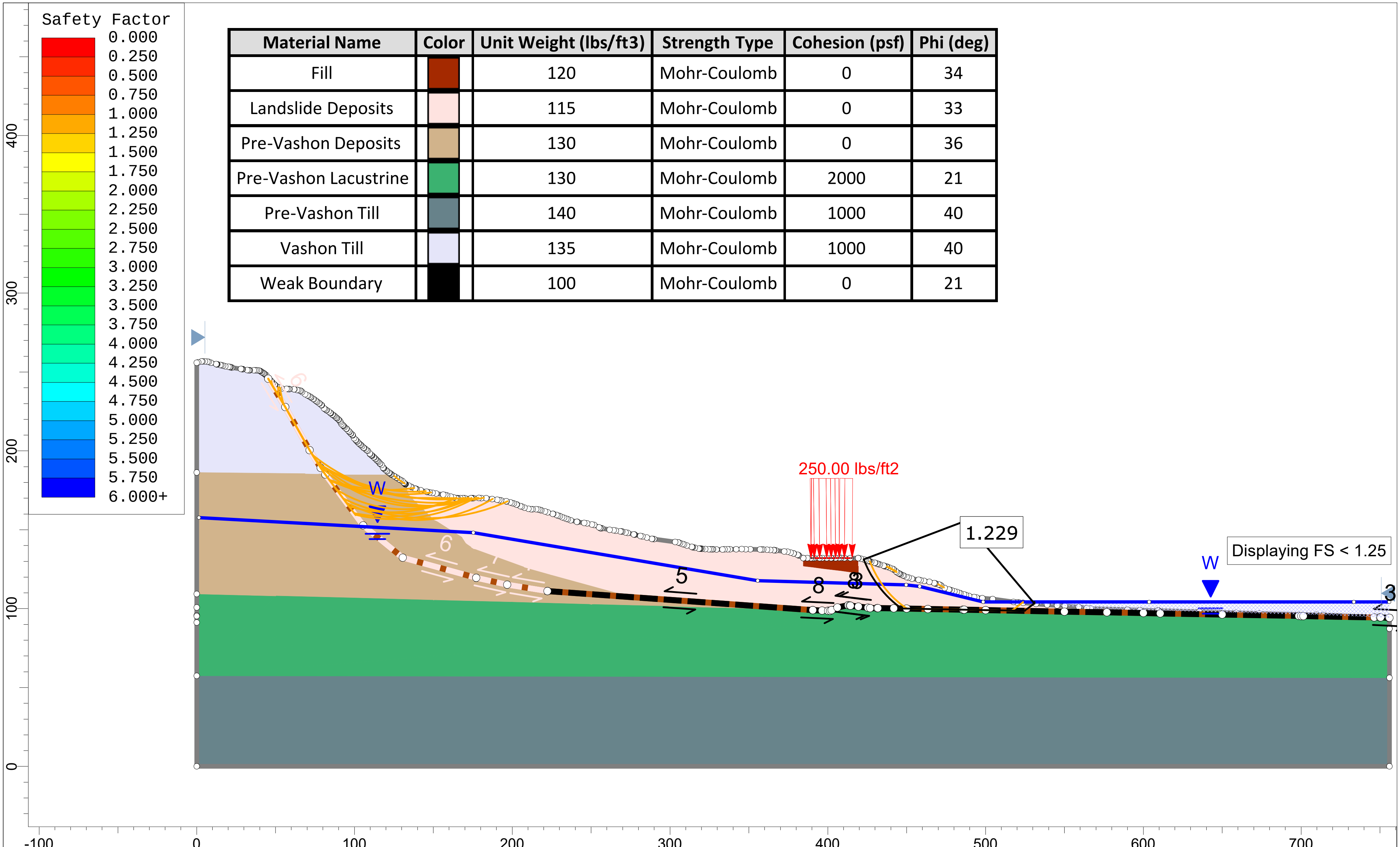
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	Mohr-Coulomb	0	34
Landslide Deposits		115	Mohr-Coulomb	0	33
Pre-Vashon Deposits		130	Mohr-Coulomb	0	36
Pre-Vashon Lacustrine		130	Mohr-Coulomb	2000	21
Pre-Vashon Till		140	Mohr-Coulomb	1000	40
Vashon Till		135	Mohr-Coulomb	1000	40
Liquefiable Soils		110	Mohr-Coulomb	0	12
Weak Boundary		100	Mohr-Coulomb	0	21



rocscience

SLIDEINTERPRET 9.023

Project	SR 302 Victor Area Study		
Group	SR 302, MP 4.5	*Scenario*	Figure E-4 - Post Liquefaction Conditions (PL)
Drawn By	WRR	*Company*	HWA GeoSciences
Date	4/2/2023, 6:43:01 PM	*File Name*	Profile A (Center of Slide) 4.19.23.slmd

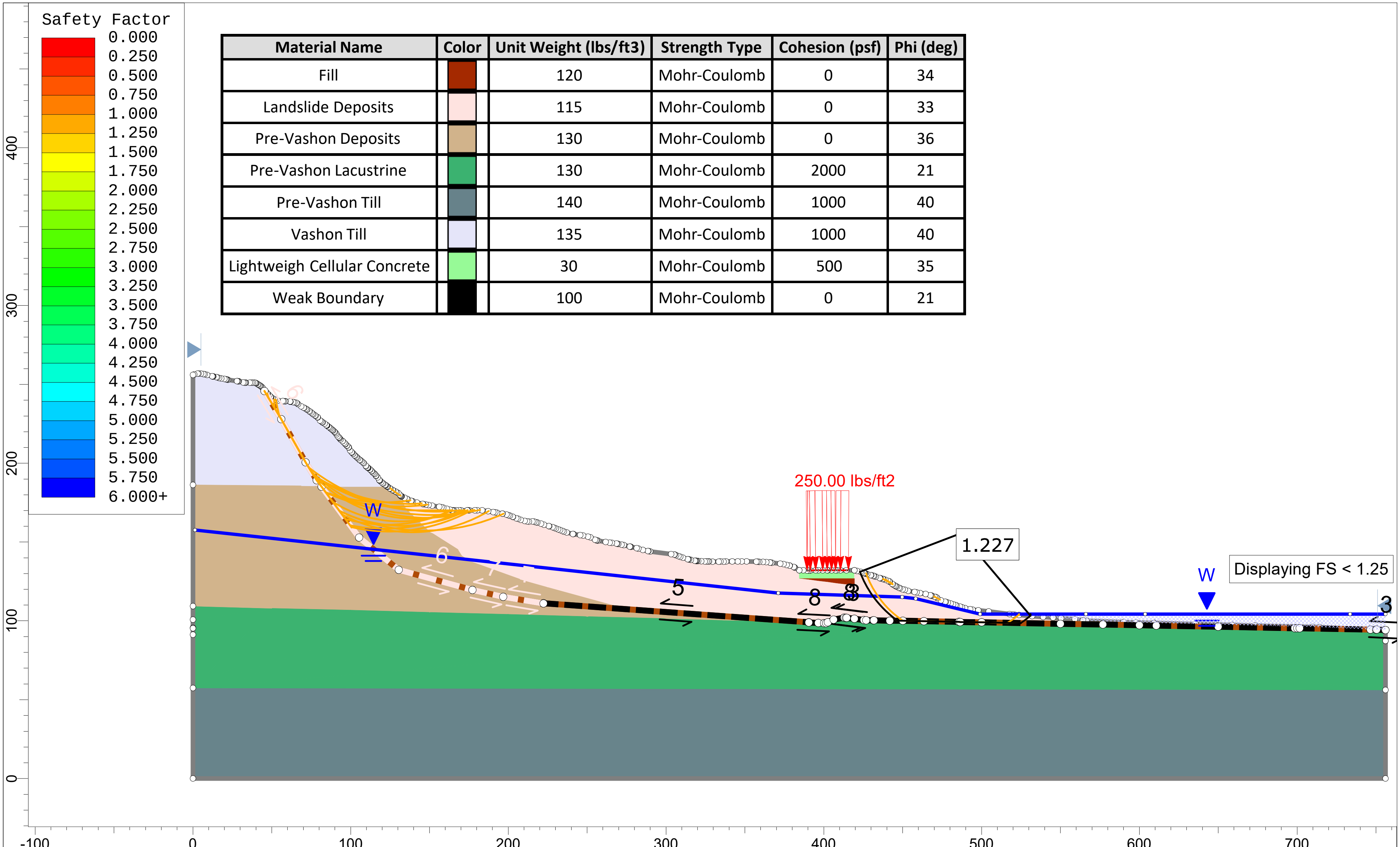


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	Mohr-Coulomb	0	34
Landslide Deposits		115	Mohr-Coulomb	0	33
Pre-Vashon Deposits		130	Mohr-Coulomb	0	36
Pre-Vashon Lacustrine		130	Mohr-Coulomb	2000	21
Pre-Vashon Till		140	Mohr-Coulomb	1000	40
Vashon Till		135	Mohr-Coulomb	1000	40
Weak Boundary		100	Mohr-Coulomb	0	21

rocscience

SLIDEINTERPRET 9.023

Project	SR 302 Victor Area Study		
Group	SR 302, MP 4.5	*Scenario*	Figure E-5 - Horizontal Drains 2' above MMHW (SC)
Drawn By	WRR	*Company*	HWA GeoSciences
Date	4/2/2023, 6:43:01 PM	*File Name*	Profile A (Center of Slide) 4.19.23.slmd

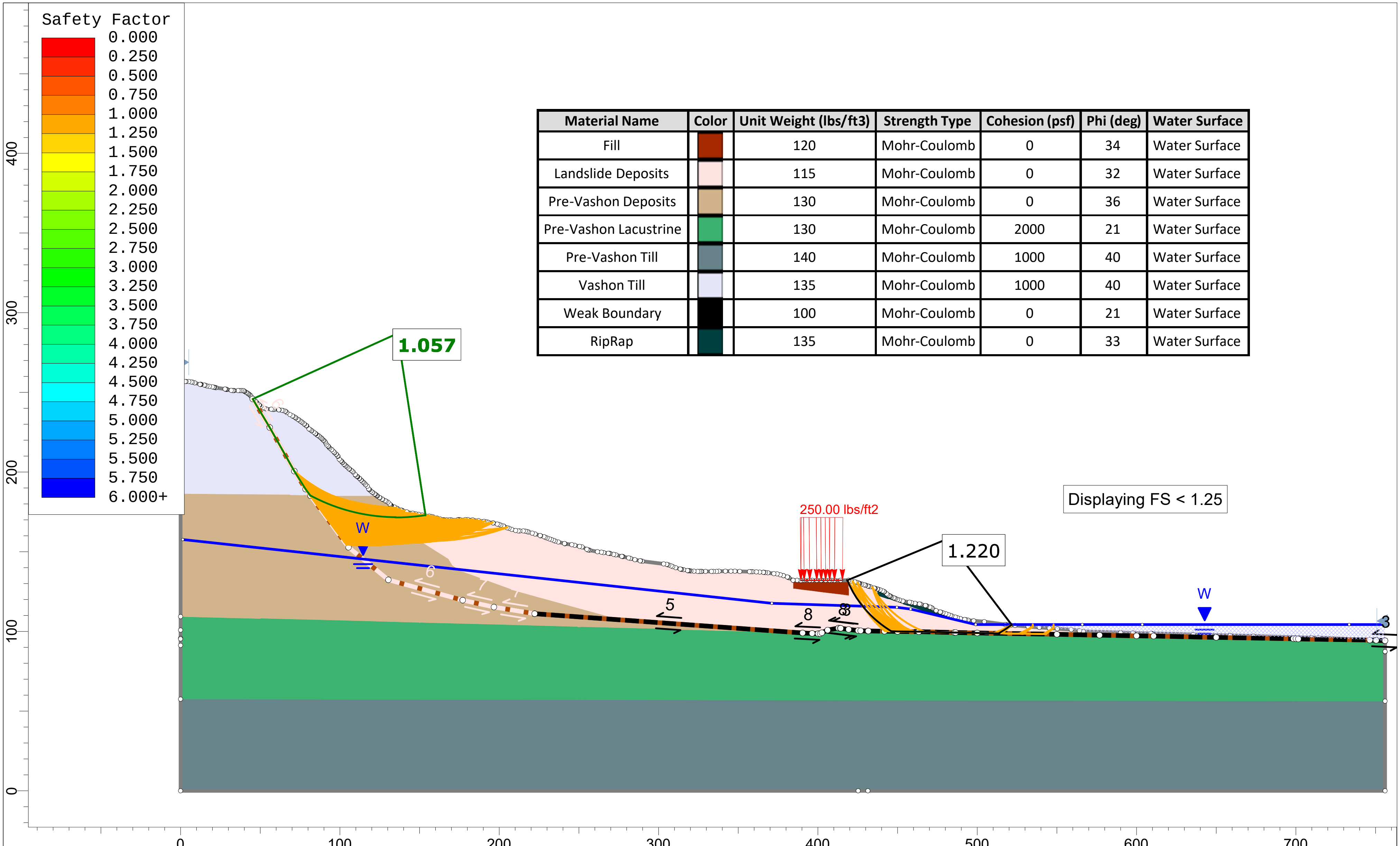


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	Mohr-Coulomb	0	34
Landslide Deposits		115	Mohr-Coulomb	0	33
Pre-Vashon Deposits		130	Mohr-Coulomb	0	36
Pre-Vashon Lacustrine		130	Mohr-Coulomb	2000	21
Pre-Vashon Till		140	Mohr-Coulomb	1000	40
Vashon Till		135	Mohr-Coulomb	1000	40
Lightweigh Cellular Concrete		30	Mohr-Coulomb	500	35
Weak Boundary		100	Mohr-Coulomb	0	21

rocscience

SLIDEINTERPRET 9.023

Project	SR 302 Victor Area Study		
Group	SR 302, MP 4.5	*Scenario*	Figure E-6 - 5' of LCC with Horizontal Drains (SC)
Drawn By	WRR	*Company*	HWA GeoSciences
Date	4/2/2023, 6:43:01 PM	*File Name*	Profile A (Center of Slide) 4.19.23.slmd

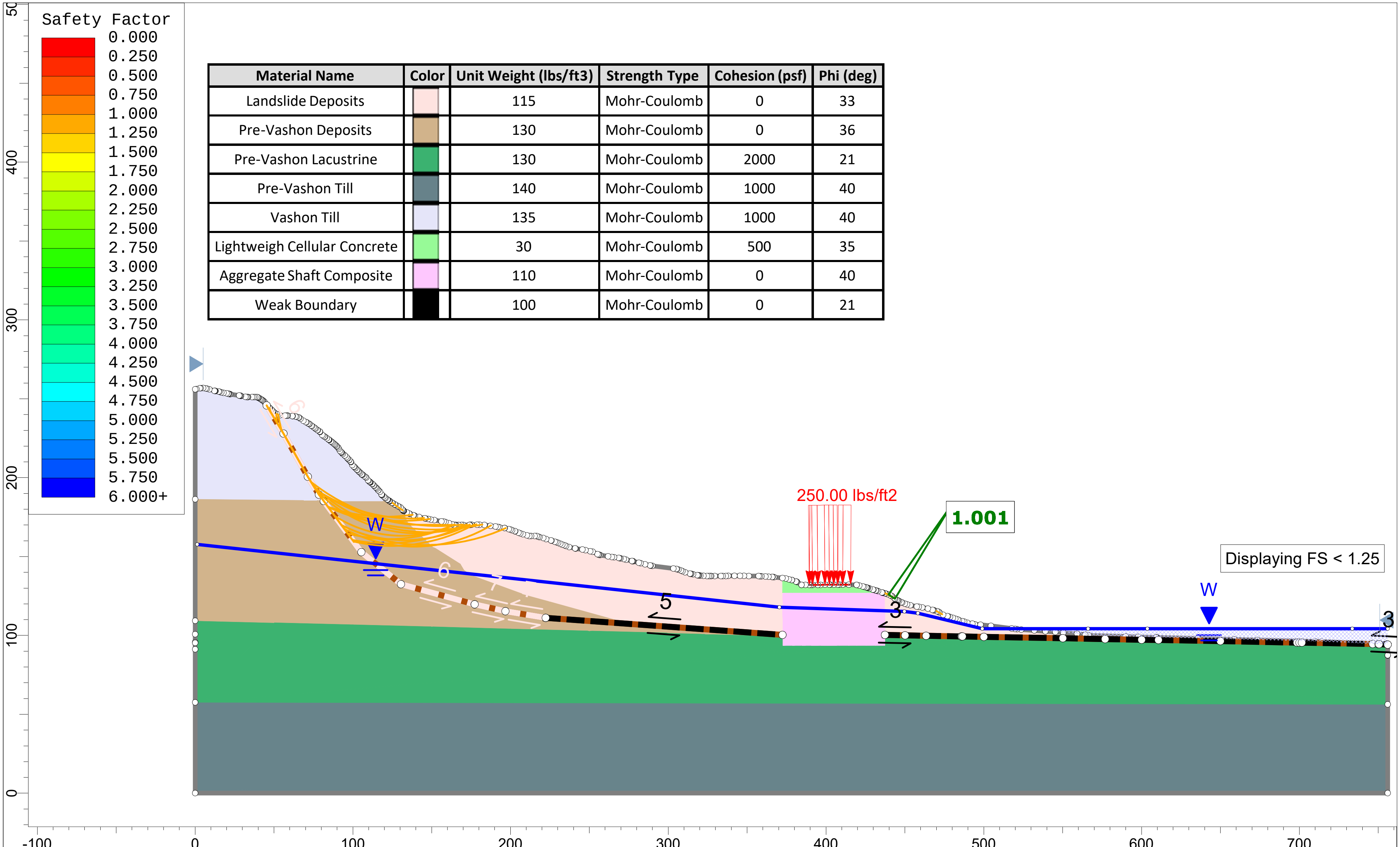


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Fill		120	Mohr-Coulomb	0	34	Water Surface
Landslide Deposits		115	Mohr-Coulomb	0	32	Water Surface
Pre-Vashon Deposits		130	Mohr-Coulomb	0	36	Water Surface
Pre-Vashon Lacustrine		130	Mohr-Coulomb	2000	21	Water Surface
Pre-Vashon Till		140	Mohr-Coulomb	1000	40	Water Surface
Vashon Till		135	Mohr-Coulomb	1000	40	Water Surface
Weak Boundary		100	Mohr-Coulomb	0	21	Water Surface
RipRap		135	Mohr-Coulomb	0	33	Water Surface

rocscience

SLIDEINTERPRET 9.023

Project	SR 302 Victor Area Study		
Group	SR 302, MP 4.5	*Scenario*	Figure E-7 - 3' Shoreline Armor (SC)
Drawn By	WRR	*Company*	HWA GeoSciences
Date	4/2/2023, 6:43:01 PM	*File Name*	Profile A (Center of Slide) 6.4.23.slmd

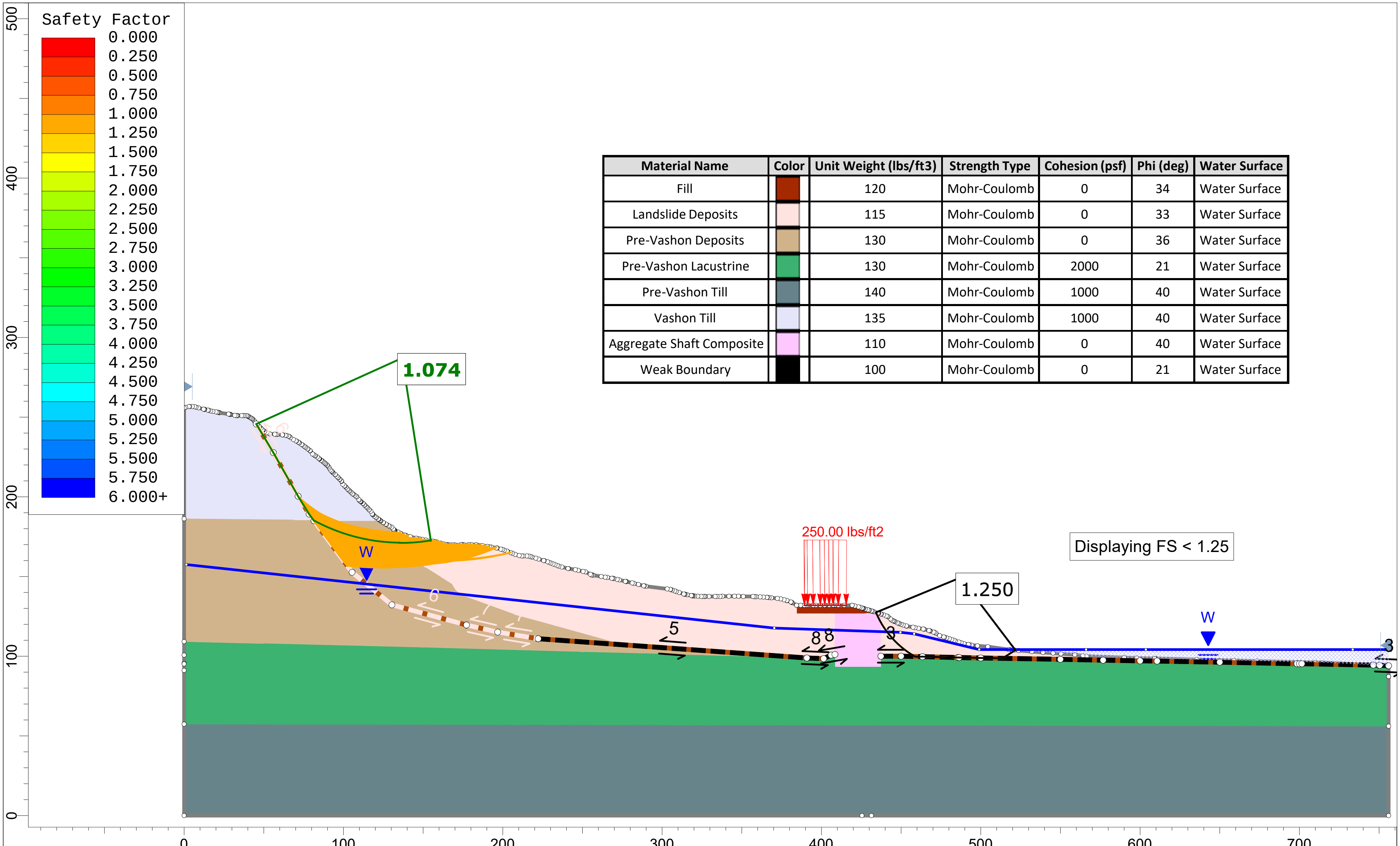


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Landslide Deposits		115	Mohr-Coulomb	0	33
Pre-Vashon Deposits		130	Mohr-Coulomb	0	36
Pre-Vashon Lacustrine		130	Mohr-Coulomb	2000	21
Pre-Vashon Till		140	Mohr-Coulomb	1000	40
Vashon Till		135	Mohr-Coulomb	1000	40
Lightweigh Cellular Concrete		30	Mohr-Coulomb	500	35
Aggregate Shaft Composite		110	Mohr-Coulomb	0	40
Weak Boundary		100	Mohr-Coulomb	0	21

rocscience

SLIDEINTERPRET 9.023

Project	SR 302 Victor Area Study		
Group	SR 302, MP 4.5	*Scenario*	Figure E-8 - Aggregate Shafts w/ LCC & Drains (SC)
Drawn By	WRR	*Company*	HWA GeoSciences
Date	4/2/2023, 6:43:01 PM	*File Name*	Profile A (Center of Slide) 4.19.23.slmd

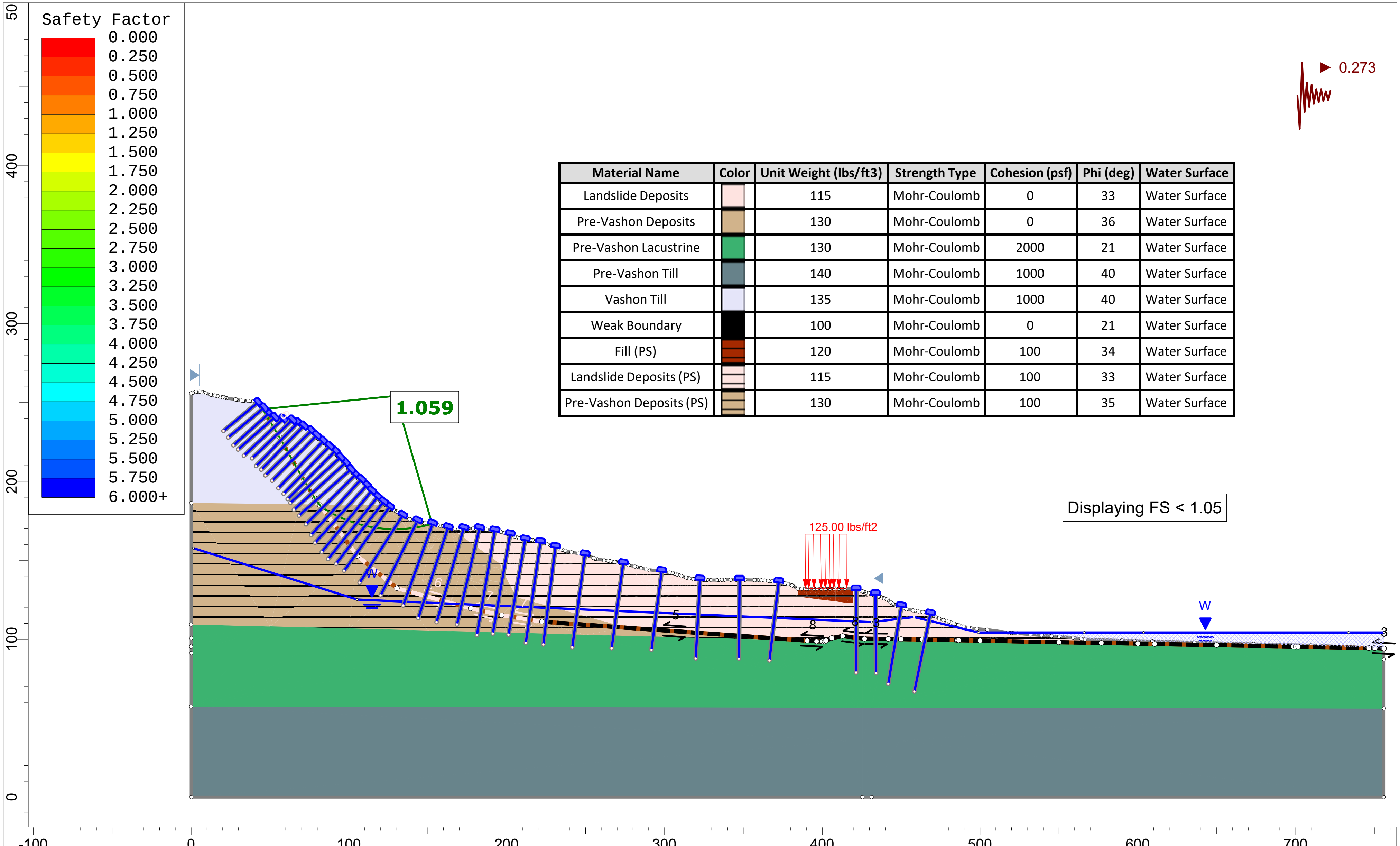


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Fill		120	Mohr-Coulomb	0	34	Water Surface
Landslide Deposits		115	Mohr-Coulomb	0	33	Water Surface
Pre-Vashon Deposits		130	Mohr-Coulomb	0	36	Water Surface
Pre-Vashon Lacustrine		130	Mohr-Coulomb	2000	21	Water Surface
Pre-Vashon Till		140	Mohr-Coulomb	1000	40	Water Surface
Vashon Till		135	Mohr-Coulomb	1000	40	Water Surface
Aggregate Shaft Composite		110	Mohr-Coulomb	0	40	Water Surface
Weak Boundary		100	Mohr-Coulomb	0	21	Water Surface

rocscience

SLIDEINTERPRET 9.023

Project	SR 302 Victor Area Study
Group	SR 302, MP 4.5
Scenario	Figure E-9 Aggregate Shafts w/ LCC & Drains (SC)
Drawn By	WRR
Company	HWA GeoSciences
Date	4/2/2023, 6:43:01 PM
File Name	Profile A (Center of Slide) 6.4.23.slmd

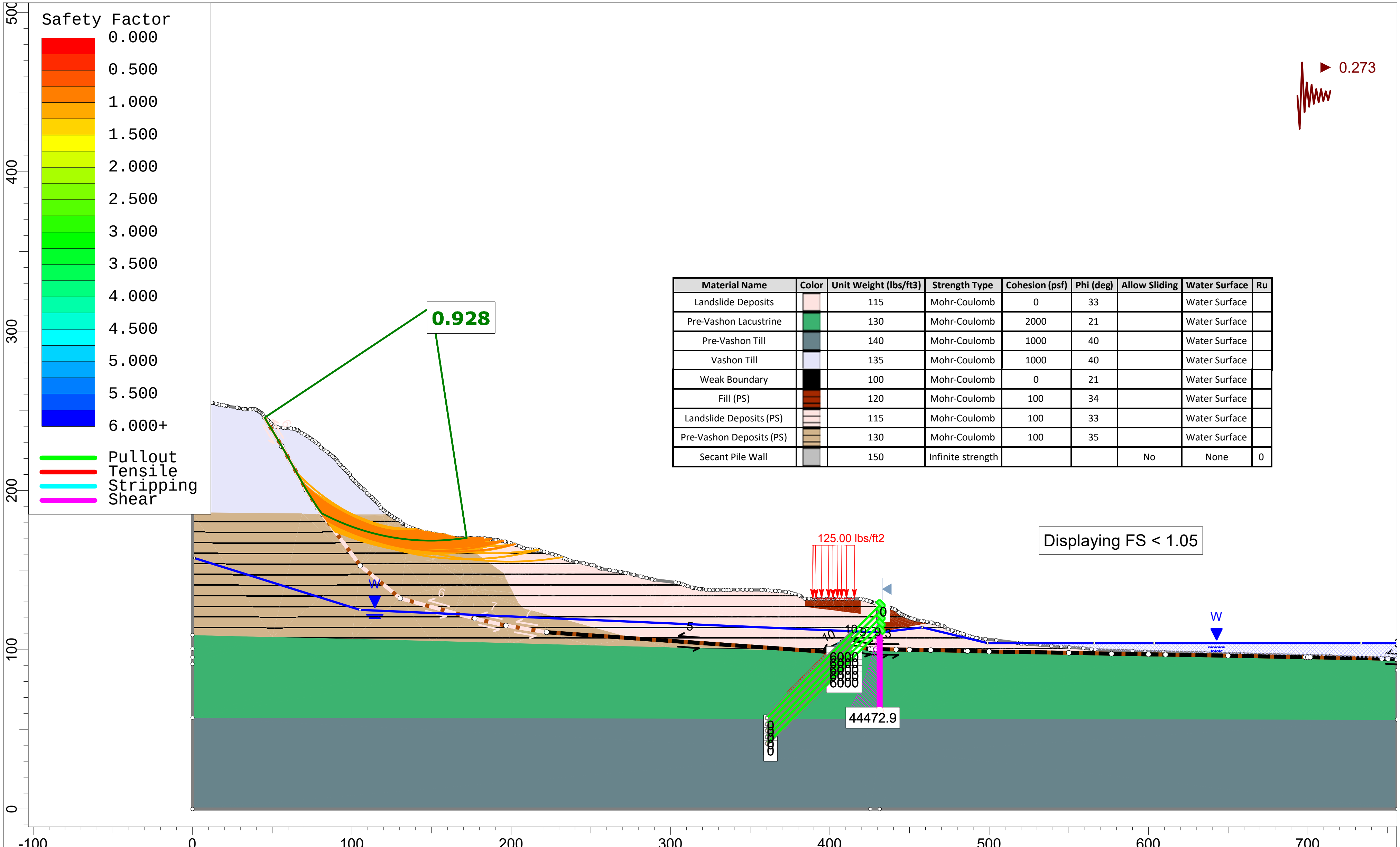


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Landslide Deposits		115	Mohr-Coulomb	0	33	Water Surface
Pre-Vashon Deposits		130	Mohr-Coulomb	0	36	Water Surface
Pre-Vashon Lacustrine		130	Mohr-Coulomb	2000	21	Water Surface
Pre-Vashon Till		140	Mohr-Coulomb	1000	40	Water Surface
Vashon Till		135	Mohr-Coulomb	1000	40	Water Surface
Weak Boundary		100	Mohr-Coulomb	0	21	Water Surface
Fill (PS)		120	Mohr-Coulomb	100	34	Water Surface
Landslide Deposits (PS)		115	Mohr-Coulomb	100	33	Water Surface
Pre-Vashon Deposits (PS)		130	Mohr-Coulomb	100	35	Water Surface

rocscience

SLIDEINTERPRET 9.023

Project	SR 302 Victor Area Study		
Group	SR 302, MP 4.5	*Scenario*	Figure E-11 Anchored Slope (PS)
Drawn By	WRR	*Company*	HWA GeoSciences
Date	4/2/2023, 6:43:01 PM	*File Name*	Profile A (Center of Slide) 4.19.23.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding	Water Surface	Ru
Landslide Deposits		115	Mohr-Coulomb	0	33		Water Surface	
Pre-Vashon Lacustrine		130	Mohr-Coulomb	2000	21		Water Surface	
Pre-Vashon Till		140	Mohr-Coulomb	1000	40		Water Surface	
Vashon Till		135	Mohr-Coulomb	1000	40		Water Surface	
Weak Boundary		100	Mohr-Coulomb	0	21		Water Surface	
Fill (PS)		120	Mohr-Coulomb	100	34		Water Surface	
Landslide Deposits (PS)		115	Mohr-Coulomb	100	33		Water Surface	
Pre-Vashon Deposits (PS)		130	Mohr-Coulomb	100	35		Water Surface	
Secant Pile Wall		150	Infinite strength			No	None	0

rocscience

SLIDEINTERPRET 9.023

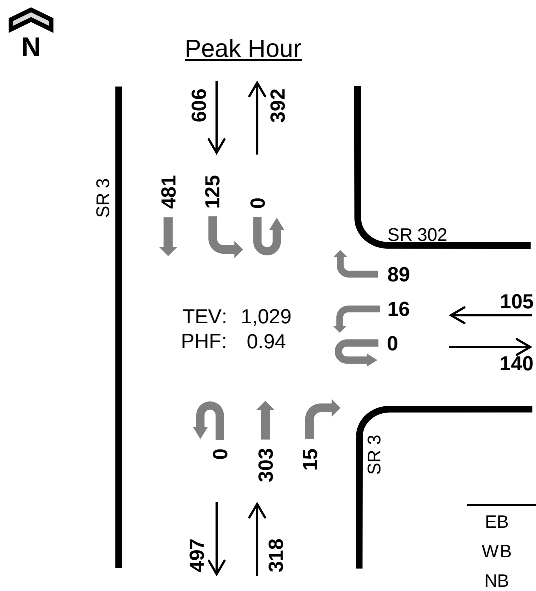
Project	SR 302 Victor Area Study
Group	SR 302, MP 4.5
Scenario	Figure E-11 - Retaining Wall w/ Drainage
Drawn By	WRR
Company	HWA GeoSciences
Date	4/2/2023, 6:43:01 PM
File Name	Profile A (Center of Slide) 6.4.23.slmd

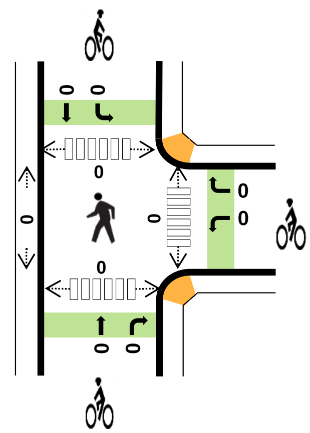
Appendix C

Turning Movement Counts

SR 3
SR 302

Date: 11/15/2022
Count Period: 3:00 PM to 5:00 PM
Peak Hour: 4:00 PM to 5:00 PM





	HV %:	PHF
EB	-	-
WB	1.0%	0.58
NB	3.1%	0.88
SB	4.8%	0.89
TOTAL	3.9%	0.94

Two-Hour Count Summaries

Interval Start	0 Eastbound UT	LT	TH	RT	SR 302 Westbound UT	LT	TH	RT	SR 3 Northbound UT	LT	TH	RT	SR 3 Southbound UT	LT	TH	RT	15-min Total	Rolling One Hour
3:00 PM	0	0	0	0	0	7	0	35	0	0	71	1	0	24	125	0	263	0
3:15 PM	0	0	0	0	0	2	0	22	0	0	74	1	0	13	140	0	252	0
3:30 PM	0	0	0	0	0	3	0	20	0	0	83	4	0	19	137	0	266	0
3:45 PM	0	0	0	0	0	1	0	18	0	0	74	3	0	24	104	0	224	1,005
4:00 PM	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**11**	**0**	**0**	**90**	**0**	**0**	**23**	**109**	**0**	**234**	976
4:15 PM	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**21**	**0**	**0**	**75**	**5**	**0**	**34**	**136**	**0**	**275**	999
4:30 PM	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**18**	**0**	**0**	**63**	**4**	**0**	**31**	**138**	**0**	**259**	992
4:45 PM	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**39**	**0**	**0**	**75**	**6**	**0**	**37**	**98**	**0**	**261**	**1,029**
Count Total	0	0	0	0	0	29	0	184	0	0	605	24	0	205	987	0	2,034	0
Peak Hour All	**0**	**0**	**0**	**0**	**0**	**16**	**0**	**89**	**0**	**0**	**303**	**15**	**0**	**125**	**481**	**0**	**1,029**	**0**
Peak Hour HV	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**10**	**0**	**0**	**8**	**21**	**0**	**40**	**0**
Peak Hour HV%	**-**	**-**	**-**	**-**	**-**	**0%**	**-**	**1%**	**-**	**-**	**3%**	**0%**	**-**	**6%**	**4%**	**-**	**4%**	**0**

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals EB	WB	NB	SB	Total	Bicycles EB	WB	NB	SB	Total	Pedestrians (Crossing Leg) East	West	North	South	Total
3:00 PM	0	1	6	13	*20*	0	0	0	0	*0*	0	0	0	0	*0*
3:15 PM	0	2	6	7	*15*	0	0	0	0	*0*	0	0	0	0	*0*
3:30 PM	0	0	6	9	*15*	0	0	0	0	*0*	0	0	0	0	*0*
3:45 PM	0	1	7	0	*8*	0	0	0	0	*0*	0	0	0	0	*0*
4:00 PM	**0**	**0**	**4**	**4**	***8***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:15 PM	**0**	**0**	**2**	**6**	***8***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:30 PM	**0**	**0**	**2**	**11**	***13***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:45 PM	**0**	**1**	**2**	**8**	***11***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***
Count Total	0	5	35	58	*98*	0	0	0	0	*0*	0	0	0	0	*0*
Peak Hr	**0**	**1**	**10**	**29**	***40***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***

project.manager.wa@idaxdata.com

Two-Hour Count Summaries - Heavy Vehicles

Interval Start	0				SR 302				SR 3				SR 3				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	0	1	0	0	6	0	0	2	11	0	20	0
3:15 PM	0	0	0	0	0	0	0	2	0	0	6	0	0	1	6	0	15	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	6	0	0	2	7	0	15	0
3:45 PM	0	0	0	0	0	0	0	1	0	0	6	1	0	0	0	0	8	58
4:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**0**	**0**	**4**	**0**	**8**	46
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**3**	**3**	**0**	**8**	39
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**2**	**9**	**0**	**13**	37
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**2**	**0**	**0**	**3**	**5**	**0**	**11**	**40**
Count Total	0	0	0	0	0	0	0	5	0	0	34	1	0	13	45	0	98	0
Peak Hour	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**10**	**0**	**0**	**8**	**21**	**0**	**40**	**0**

Two-Hour Count Summaries - Bikes

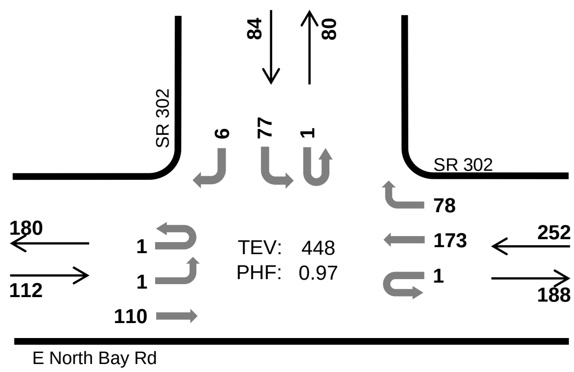
Interval Start	0			SR 302			SR 3			SR 3			15-min Total	Rolling One Hour
	Eastbound			Westbound			Northbound			Southbound				
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak Hour	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

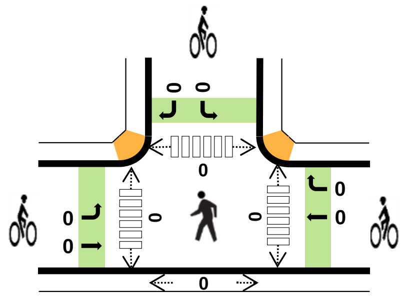
Note: U-Turn volumes for bikes are included in Left-Turn, if any.

SR 302
E North Bay Rd

Date: 11/15/2022
Count Period: 3:00 PM to 5:00 PM
Peak Hour: 4:00 PM to 5:00 PM

Peak Hour





	HV %:	PHF
EB	6.3%	0.76
WB	0.8%	0.89
NB	-	-
SB	3.6%	0.84
TOTAL	2.7%	0.97

Two-Hour Count Summaries

Interval Start		E North Bay Rd Eastbound UT	LT	TH	RT	SR 302 Westbound UT	LT	TH	RT	0 Northbound UT	LT	TH	RT	SR 302 Southbound UT	LT	TH	RT	15-min Total	Rolling One Hour
3:00 PM		0	0	25	0	0	0	46	15	0	0	0	0	0	20	0	3	109	0
3:15 PM		0	0	29	0	0	0	30	21	0	0	0	0	0	11	0	2	93	0
3:30 PM		0	2	22	0	0	0	42	24	0	0	0	0	0	17	0	0	107	0
3:45 PM		0	0	24	0	0	0	34	15	0	0	0	0	0	19	0	0	92	401
4:00 PM		**0**	**0**	**37**	**0**	**0**	**0**	**45**	**10**	**0**	**0**	**0**	**0**	**0**	**18**	**0**	**1**	**111**	403
4:15 PM		**0**	**1**	**23**	**0**	**1**	**0**	**39**	**19**	**0**	**0**	**0**	**0**	**0**	**23**	**0**	**2**	**108**	418
4:30 PM		**0**	**0**	**24**	**0**	**0**	**0**	**49**	**18**	**0**	**0**	**0**	**0**	**1**	**22**	**0**	**0**	**114**	425
4:45 PM		**1**	**0**	**26**	**0**	**0**	**0**	**40**	**31**	**0**	**0**	**0**	**0**	**0**	**14**	**0**	**3**	**115**	**448**
Count Total		1	3	210	0	1	0	325	153	0	0	0	0	1	144	0	11	849	0
Peak Hour	**All**	**1**	**1**	**110**	**0**	**1**	**0**	**173**	**78**	**0**	**0**	**0**	**0**	**1**	**77**	**0**	**6**	**448**	**0**
	HV	**0**	**0**	**7**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**1**	**12**	**0**
	HV%	**0%**	**0%**	**6%**	**-**	**0%**	**-**	**1%**	**1%**	**-**	**-**	**-**	**-**	**0%**	**3%**	**-**	**17%**	**3%**	**0**

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals EB	WB	NB	SB	Total	Bicycles EB	WB	NB	SB	Total	Pedestrians (Crossing Leg) East	West	North	South	Total
3:00 PM	1	2	0	2	*5*	0	0	0	0	*0*	0	0	0	0	*0*
3:15 PM	1	1	0	1	*3*	0	0	0	0	*0*	0	0	0	0	*0*
3:30 PM	1	3	0	1	*5*	0	0	0	0	*0*	0	0	0	0	*0*
3:45 PM	0	2	0	0	*2*	0	0	0	0	*0*	0	0	0	0	*0*
4:00 PM	**3**	**0**	**0**	**0**	***3***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:15 PM	**2**	**1**	**0**	**1**	***4***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:30 PM	**1**	**0**	**0**	**1**	***2***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:45 PM	**1**	**1**	**0**	**1**	***3***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***
Count Total	10	10	0	7	*27*	0	0	0	0	*0*	0	0	0	0	*0*
Peak Hr	**7**	**2**	**0**	**3**	***12***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***

Two-Hour Count Summaries - Heavy Vehicles

Interval Start	E North Bay Rd				SR 302				0				SR 302				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
3:00 PM	0	0	1	0	0	0	2	0	0	0	0	0	0	2	0	0	5	0
3:15 PM	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	3	0
3:30 PM	0	0	1	0	0	0	3	0	0	0	0	0	0	1	0	0	5	0
3:45 PM	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2	15
4:00 PM	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	13
4:15 PM	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**4**	14
4:30 PM	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**2**	11
4:45 PM	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**3**	**12**
Count Total	0	0	10	0	0	0	7	3	0	0	0	0	0	6	0	1	27	0
Peak Hour	**0**	**0**	**7**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**1**	**12**	**0**

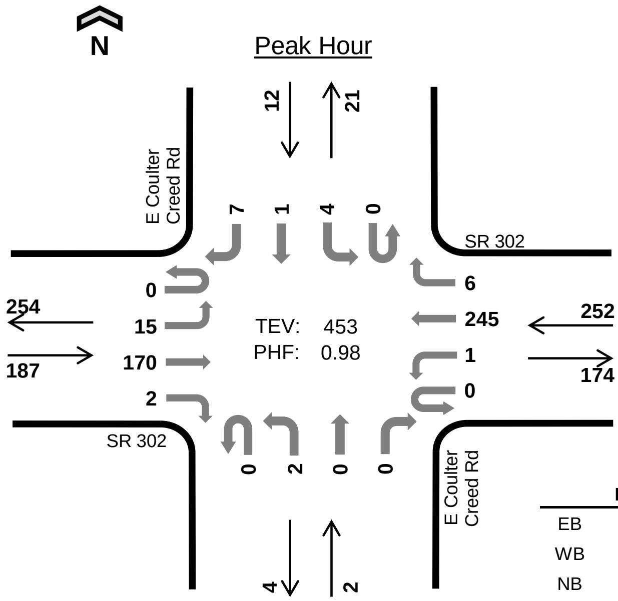
Two-Hour Count Summaries - Bikes

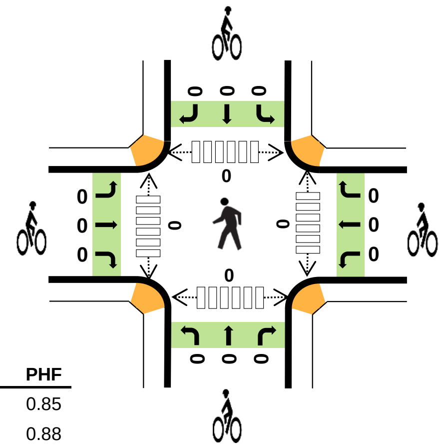
Interval Start	E North Bay Rd			SR 302			0			SR 302			15-min Total	Rolling One Hour
	Eastbound			Westbound			Northbound			Southbound				
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak Hour	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

E Coulter Creed Rd
SR 302

Date: 11/15/2022
Count Period: 3:00 PM to 5:00 PM
Peak Hour: 4:00 PM to 5:00 PM





	HV %:	PHF
EB	4.8%	0.85
WB	1.2%	0.88
NB	0.0%	0.50
SB	8.3%	0.60
TOTAL	2.9%	0.98

Two-Hour Count Summaries

Interval Start	SR 302 Eastbound				SR 302 Westbound				E Coulter Creed Rd Northbound				E Coulter Creed Rd Southbound				15-min Total	Rolling One Hour
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
3:00 PM	0	5	37	3	0	0	57	2	0	0	0	0	0	2	0	1	107	0
3:15 PM	0	1	41	0	0	0	49	0	0	0	0	0	0	0	0	4	95	0
3:30 PM	0	1	37	0	0	0	63	0	0	0	0	0	0	0	0	2	103	0
3:45 PM	0	5	39	0	0	0	46	2	0	1	0	0	0	1	0	3	97	402
4:00 PM	**0**	**3**	**51**	**1**	**0**	**1**	**51**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**112**	407
4:15 PM	**0**	**6**	**42**	**0**	**0**	**0**	**55**	**4**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**3**	**112**	424
4:30 PM	**0**	**3**	**42**	**1**	**0**	**0**	**67**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**0**	**116**	437
4:45 PM	**0**	**3**	**35**	**0**	**0**	**0**	**72**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**1**	**113**	**453**
Count Total	0	27	324	5	0	1	460	10	0	3	0	0	0	7	1	17	855	0
Peak Hour All	**0**	**15**	**170**	**2**	**0**	**1**	**245**	**6**	**0**	**2**	**0**	**0**	**0**	**4**	**1**	**7**	**453**	**0**
Peak Hour HV	**0**	**1**	**8**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**13**	**0**
Peak Hour HV%	**-**	**7%**	**5%**	**0%**	**-**	**0%**	**1%**	**0%**	**-**	**0%**	**-**	**-**	**-**	**25%**	**0%**	**0%**	**3%**	**0**

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
3:00 PM	3	3	0	1	*7*	0	0	0	0	*0*	0	0	0	1	*1*
3:15 PM	1	1	0	0	*2*	0	0	0	0	*0*	0	0	0	0	*0*
3:30 PM	2	2	0	0	*4*	0	0	0	0	*0*	0	0	0	0	*0*
3:45 PM	2	1	0	0	*3*	0	0	0	0	*0*	0	0	0	0	*0*
4:00 PM	**3**	**0**	**0**	**0**	***3***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:15 PM	**2**	**1**	**0**	**0**	***3***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:30 PM	**2**	**1**	**0**	**0**	***3***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:45 PM	**2**	**1**	**0**	**1**	***4***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***
Count Total	17	10	0	2	*29*	0	0	0	0	*0*	0	0	0	1	*1*
Peak Hour	**9**	**3**	**0**	**1**	***13***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***

Two-Hour Count Summaries - Heavy Vehicles

Interval Start	SR 302				SR 302				E Coulter Creed Rd				E Coulter Creed Rd				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
3:00 PM	0	1	2	0	0	0	3	0	0	0	0	0	0	1	0	0	7	0
3:15 PM	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0
3:30 PM	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	4	0
3:45 PM	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	3	16
4:00 PM	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	12
4:15 PM	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	13
4:30 PM	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	12
4:45 PM	**0**	**0**	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**4**	**13**
Count Total	0	2	15	0	0	0	10	0	0	0	0	0	0	2	0	0	29	0
Peak Hour	**0**	**1**	**8**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**13**	**0**

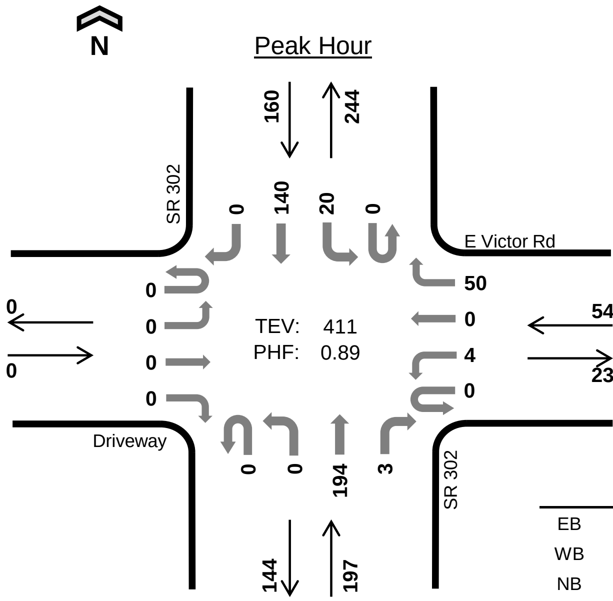
Two-Hour Count Summaries - Bikes

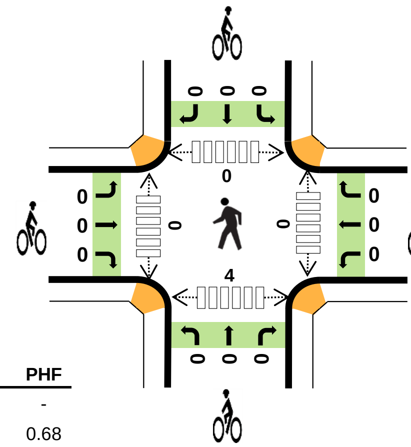
Interval Start	SR 302			SR 302			E Coulter Creed Rd			E Coulter Creed Rd			15-min Total	Rolling One Hour
	Eastbound			Westbound			Northbound			Southbound				
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak Hour	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

SR 302
E Victor Rd

Date: 11/15/2022
Count Period: 3:00 PM to 5:00 PM
Peak Hour: 4:00 PM to 5:00 PM





	HV %:	PHF
EB	-	-
WB	0.0%	0.68
NB	0.5%	0.79
SB	5.6%	0.89
TOTAL	2.4%	0.89

Two-Hour Count Summaries

Interval Start		Driveway Eastbound UT	LT	TH	RT	E Victor Rd Westbound UT	LT	TH	RT	SR 302 Northbound UT	LT	TH	RT	SR 302 Southbound UT	LT	TH	RT	15-min Total	Rolling One Hour
3:00 PM		0	0	0	0	0	0	0	2	0	0	56	2	0	2	35	0	97	0
3:15 PM		0	0	0	0	0	1	0	4	0	0	44	0	0	3	38	0	90	0
3:30 PM		0	0	0	0	0	1	0	6	0	0	59	2	0	3	36	0	107	0
3:45 PM		0	0	0	0	0	0	0	1	0	0	51	0	0	4	29	1	86	380
4:00 PM		**0**	**0**	**0**	**0**	**0**	**1**	**0**	**9**	**0**	**0**	**39**	**2**	**0**	**5**	**40**	**0**	**96**	379
4:15 PM		**0**	**0**	**0**	**0**	**0**	**1**	**0**	**19**	**0**	**0**	**40**	**0**	**0**	**5**	**33**	**0**	**98**	387
4:30 PM		**0**	**0**	**0**	**0**	**0**	**2**	**0**	**12**	**0**	**0**	**61**	**1**	**0**	**6**	**33**	**0**	**115**	395
4:45 PM		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**0**	**0**	**54**	**0**	**0**	**4**	**34**	**0**	**102**	**411**
Count Total		0	0	0	0	0	6	0	63	0	0	404	7	0	32	278	1	791	0
Peak Hour	**All**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**50**	**0**	**0**	**194**	**3**	**0**	**20**	**140**	**0**	**411**	**0**
	HV	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**8**	**0**	**10**	**0**
	HV%	**-**	**-**	**-**	**-**	**-**	**0%**	**-**	**0%**	**-**	**-**	**1%**	**0%**	**-**	**5%**	**6%**	**-**	**2%**	**0**

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals EB	WB	NB	SB	Total	Bicycles EB	WB	NB	SB	Total	Pedestrians (Crossing Leg) East	West	North	South	Total
3:00 PM	0	0	1	2	*3*	0	0	0	0	*0*	0	0	0	0	*0*
3:15 PM	0	0	0	3	*3*	0	0	0	0	*0*	0	0	0	0	*0*
3:30 PM	0	0	2	3	*5*	0	0	0	0	*0*	0	0	0	0	*0*
3:45 PM	0	0	1	2	*3*	0	0	0	0	*0*	0	0	0	0	*0*
4:00 PM	**0**	**0**	**0**	**4**	***4***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**4**	*4*
4:15 PM	**0**	**0**	**1**	**2**	***3***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:30 PM	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:45 PM	**0**	**0**	**0**	**3**	***3***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***
Count Total	0	0	5	19	*24*	0	0	0	0	*0*	0	0	0	4	*4*
Peak Hour	**0**	**0**	**1**	**9**	***10***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**4**	***4***

Two-Hour Count Summaries - Heavy Vehicles

Interval Start	Driveway				E Victor Rd				SR 302				SR 302				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	3	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	3	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3	0	5	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	3	14
4:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**4**	15
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**0**	**3**	15
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	10
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**0**	**3**	**10**
Count Total	0	0	0	0	0	0	0	0	0	0	5	0	0	2	17	0	24	0
Peak Hour	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**8**	**0**	**10**	**0**

Two-Hour Count Summaries - Bikes

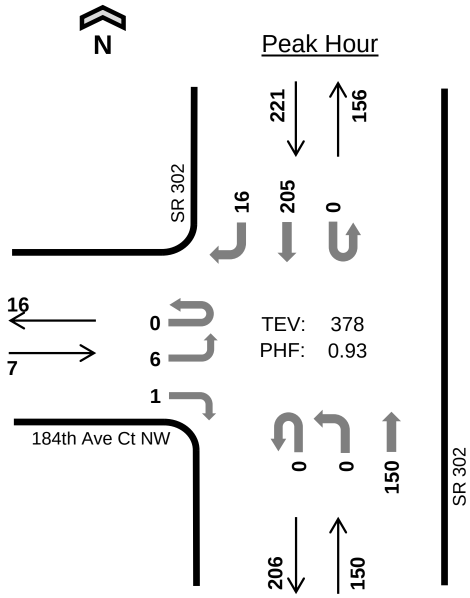
Interval Start	Driveway			E Victor Rd			SR 302			SR 302			15-min Total	Rolling One Hour
	Eastbound			Westbound			Northbound			Southbound				
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak Hour	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

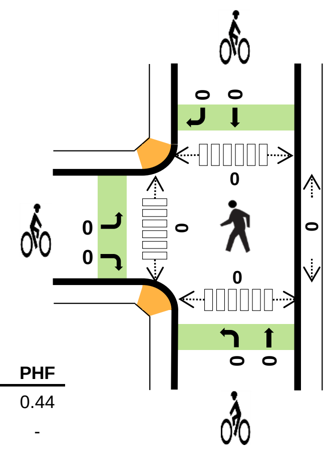
Note: U-Turn volumes for bikes are included in Left-Turn, if any.

www.idaxdata.com

SR 302
184th Ave Ct NW

Date: 11/15/2022
Count Period: 3:00 PM to 5:00 PM
Peak Hour: 4:00 PM to 5:00 PM





	HV %:	PHF
EB	0.0%	0.44
WB	-	-
NB	7.3%	0.83
SB	1.4%	0.92
TOTAL	3.7%	0.93

Two-Hour Count Summaries

Interval Start		184th Ave Ct NW				0				SR 302				SR 302				15-min Total	Rolling One Hour
		Eastbound				Westbound				Northbound				Southbound					
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
3:00 PM		0	0	0	0	0	0	0	0	0	0	26	0	0	0	54	1	81	0
3:15 PM		0	0	0	0	0	0	0	0	0	1	44	0	0	0	44	3	92	0
3:30 PM		0	2	0	0	0	0	0	0	0	1	40	0	0	0	61	0	104	0
3:45 PM		0	1	0	0	0	0	0	0	0	1	18	0	1	0	48	6	75	352
4:00 PM		**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**45**	**0**	**0**	**0**	**44**	**4**	**95**	366
4:15 PM		**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**34**	**0**	**0**	**0**	**51**	**3**	**89**	363
4:30 PM		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**32**	**0**	**0**	**0**	**55**	**5**	**92**	351
4:45 PM		**0**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**39**	**0**	**0**	**0**	**55**	**4**	**102**	**378**
Count Total		0	9	0	1	0	0	0	0	0	3	278	0	1	0	412	26	730	0
Peak Hour	**All**	**0**	**6**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**150**	**0**	**0**	**0**	**205**	**16**	**378**	**0**
	HV	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**11**	**0**	**0**	**0**	**3**	**0**	**14**	**0**
	HV%	**-**	**0%**	**-**	**0%**	**-**	**-**	**-**	**-**	**-**	**-**	**7%**	**-**	**-**	**-**	**1%**	**0%**	**4%**	**0**

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
3:00 PM	0	0	1	1	*2*	0	0	0	0	*0*	0	0	0	0	*0*
3:15 PM	0	0	1	1	*2*	0	0	0	0	*0*	0	0	0	0	*0*
3:30 PM	0	0	6	1	*7*	0	0	0	0	*0*	0	0	0	0	*0*
3:45 PM	0	0	0	3	*3*	0	0	0	0	*0*	0	0	0	0	*0*
4:00 PM	**0**	**0**	**5**	**0**	***5***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:15 PM	**0**	**0**	**4**	**1**	***5***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:30 PM	**0**	**0**	**1**	**1**	***2***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:45 PM	**0**	**0**	**1**	**1**	***2***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***
Count Total	0	0	19	9	*28*	0	0	0	0	*0*	0	0	0	0	*0*
Peak Hr	**0**	**0**	**11**	**3**	***14***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***

Two-Hour Count Summaries - Heavy Vehicles

Interval Start	184th Ave Ct NW				0				SR 302				SR 302				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	6	0	0	0	1	0	7	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	3	14
4:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**5**	17
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**0**	**0**	**1**	**0**	**5**	20
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**2**	15
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**2**	**14**
Count Total	0	0	0	0	0	0	0	0	0	0	19	0	1	0	8	0	28	0
Peak Hour	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**11**	**0**	**0**	**0**	**3**	**0**	**14**	**0**

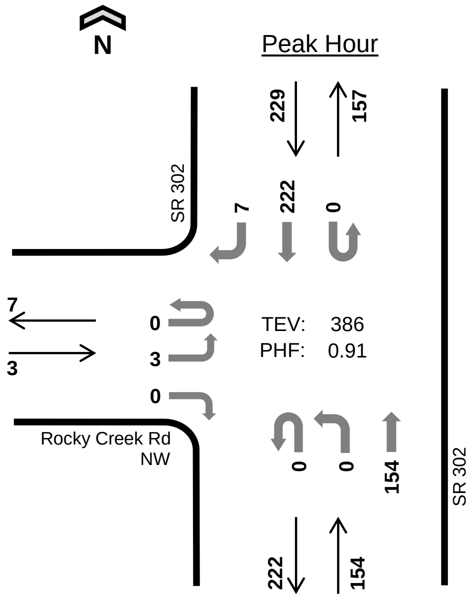
Two-Hour Count Summaries - Bikes

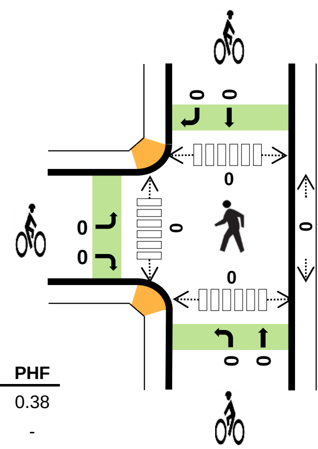
Interval Start	184th Ave Ct NW			0			SR 302			SR 302			15-min Total	Rolling One Hour
	Eastbound			Westbound			Northbound			Southbound				
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak Hour	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

SR 302
Rocky Creek Rd NW

Date: 11/15/2022
Count Period: 3:00 PM to 5:00 PM
Peak Hour: 4:00 PM to 5:00 PM





	HV %:	PHF
EB	33.3%	0.38
WB	-	-
NB	6.5%	0.84
SB	1.3%	0.91
TOTAL	3.6%	0.91

Two-Hour Count Summaries

Interval Start	Rocky Creek Rd NW				0				SR 302				SR 302				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
3:00 PM	0	1	0	1	0	0	0	0	0	0	28	0	0	0	54	1	85	0
3:15 PM	0	1	0	1	0	0	0	0	0	0	44	0	0	0	45	1	92	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	41	0	0	0	61	1	103	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	22	0	0	0	56	2	80	360
4:00 PM	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**46**	**0**	**0**	**0**	**48**	**1**	**96**	371
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**33**	**0**	**0**	**0**	**57**	**1**	**91**	370
4:30 PM	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**32**	**0**	**0**	**0**	**58**	**1**	**93**	360
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**43**	**0**	**0**	**0**	**59**	**4**	**106**	**386**
Count Total	0	5	0	2	0	0	0	0	0	0	289	0	0	0	438	12	746	0
Peak Hour All	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**154**	**0**	**0**	**0**	**222**	**7**	**386**	**0**
Peak Hour HV	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**0**	**0**	**0**	**3**	**0**	**14**	**0**
Peak Hour HV%	**-**	**33%**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**6%**	**-**	**-**	**-**	**1%**	**0%**	**4%**	**0**

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
3:00 PM	0	0	2	0	*2*	0	0	0	0	*0*	0	0	0	0	*0*
3:15 PM	2	0	1	0	*3*	0	0	0	0	*0*	0	0	0	0	*0*
3:30 PM	0	0	5	1	*6*	0	0	0	0	*0*	0	0	0	0	*0*
3:45 PM	0	0	1	3	*4*	0	0	0	0	*0*	0	0	0	0	*0*
4:00 PM	**1**	**0**	**5**	**0**	***6***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:15 PM	**0**	**0**	**3**	**1**	***4***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:30 PM	**0**	**0**	**1**	**1**	***2***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:45 PM	**0**	**0**	**1**	**1**	***2***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***
Count Total	3	0	19	7	*29*	0	0	0	0	*0*	0	0	0	0	*0*
Peak Hr	**1**	**0**	**10**	**3**	***14***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***

Two-Hour Count Summaries - Heavy Vehicles

Interval Start	Rocky Creek Rd NW				0				SR 302				SR 302				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0
3:15 PM	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	3	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	6	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	4	15
4:00 PM	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**6**	19
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**1**	**0**	**4**	20
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**2**	16
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**2**	**14**
Count Total	0	2	0	1	0	0	0	0	0	0	19	0	0	0	7	0	29	0
Peak Hour	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**0**	**0**	**0**	**3**	**0**	**14**	**0**

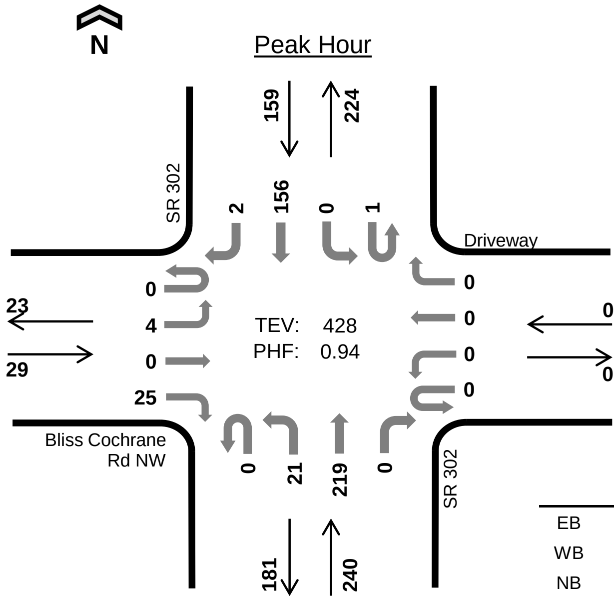
Two-Hour Count Summaries - Bikes

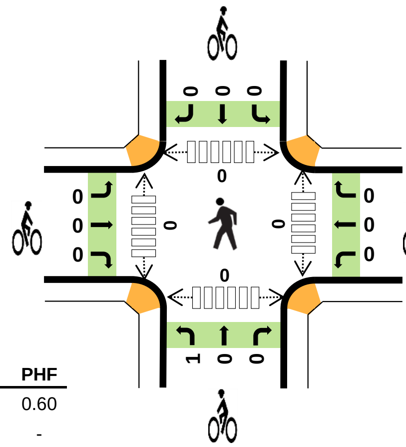
Interval Start	Rocky Creek Rd NW			0			SR 302			SR 302			15-min Total	Rolling One Hour
	Eastbound			Westbound			Northbound			Southbound				
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak Hour	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Note: U-Turn volumes for bikes are included in Left-Turn, if any.

SR 302
Bliss Cochrane Rd NW

Date: 11/15/2022
Count Period: 3:00 PM to 5:00 PM
Peak Hour: 4:00 PM to 5:00 PM





	HV %:	PHF
EB	17.2%	0.60
WB	-	-
NB	1.3%	0.83
SB	6.3%	0.90
TOTAL	4.2%	0.94

Two-Hour Count Summaries

Interval Start		Bliss Cochrane Rd NW Eastbound UT	LT	TH	RT	Driveway Westbound UT	LT	TH	RT	SR 302 Northbound UT	LT	TH	RT	SR 302 Southbound UT	LT	TH	RT	15-min Total	Rolling One Hour
3:00 PM		0	1	0	4	0	0	0	0	0	10	54	0	0	0	29	1	99	0
3:15 PM		0	2	0	9	0	0	0	0	0	8	50	0	0	0	43	0	112	0
3:30 PM		0	1	0	5	0	0	0	0	0	7	55	0	0	0	37	0	105	0
3:45 PM		0	1	0	3	0	0	0	0	0	7	60	0	0	0	26	0	97	413
4:00 PM		**0**	**1**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**6**	**48**	**0**	**0**	**0**	**44**	**0**	**103**	417
4:15 PM		**0**	**2**	**0**	**10**	**0**	**0**	**0**	**0**	**0**	**2**	**53**	**0**	**1**	**0**	**37**	**0**	**105**	410
4:30 PM		**0**	**1**	**0**	**6**	**0**	**0**	**0**	**0**	**0**	**9**	**63**	**0**	**0**	**0**	**33**	**2**	**114**	419
4:45 PM		**0**	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**4**	**55**	**0**	**0**	**0**	**42**	**0**	**106**	**428**
Count Total		0	9	0	46	0	0	0	0	0	53	438	0	1	0	291	3	841	0
Peak Hour	**All**	**0**	**4**	**0**	**25**	**0**	**0**	**0**	**0**	**0**	**21**	**219**	**0**	**1**	**0**	**156**	**2**	**428**	**0**
	HV	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**10**	**0**	**18**	**0**
	HV%	**-**	**0%**	**-**	**20%**	**-**	**-**	**-**	**-**	**-**	**0%**	**1%**	**-**	**0%**	**-**	**6%**	**0%**	**4%**	**0**

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals EB	WB	NB	SB	Total	Bicycles EB	WB	NB	SB	Total	Pedestrians (Crossing Leg) East	West	North	South	Total
3:00 PM	0	0	2	2	*4*	0	0	0	0	*0*	0	0	0	0	*0*
3:15 PM	1	0	2	2	*5*	0	0	0	0	*0*	0	0	0	0	*0*
3:30 PM	0	0	0	5	*5*	0	0	0	0	*0*	0	0	0	0	*0*
3:45 PM	1	0	3	1	*5*	0	0	0	0	*0*	0	0	0	0	*0*
4:00 PM	**0**	**0**	**1**	**7**	***8***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:15 PM	**3**	**0**	**0**	**3**	***6***	**0**	**0**	**1**	**0**	***1***	**0**	**0**	**0**	**0**	*0*
4:30 PM	**0**	**0**	**1**	**0**	***1***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:45 PM	**2**	**0**	**1**	**0**	***3***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***
Count Total	7	0	10	20	*37*	0	0	1	0	*1*	0	0	0	0	*0*
Peak Hour	**5**	**0**	**3**	**10**	***18***	**0**	**0**	**1**	**0**	***1***	**0**	**0**	**0**	**0**	***0***

Two-Hour Count Summaries - Heavy Vehicles

Interval Start	Bliss Cochrane Rd NW				Driveway				SR 302				SR 302				15-min Total	Rolling One Hour
	Eastbound				Westbound				Northbound				Southbound					
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	4	0
3:15 PM	0	0	0	1	0	0	0	0	0	1	1	0	0	0	2	0	5	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5	0
3:45 PM	0	1	0	0	0	0	0	0	0	1	2	0	0	0	1	0	5	19
4:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**7**	**0**	**8**	23
4:15 PM	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**6**	24
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	20
4:45 PM	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**3**	**18**
Count Total	0	1	0	6	0	0	0	0	0	4	6	0	0	0	20	0	37	0
Peak Hour	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**10**	**0**	**18**	**0**

Two-Hour Count Summaries - Bikes

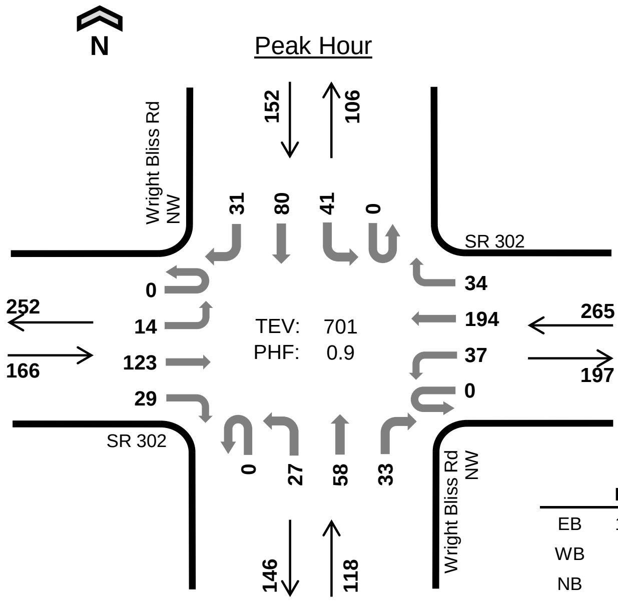
Interval Start	Bliss Cochrane Rd NW			Driveway			SR 302			SR 302			15-min Total	Rolling One Hour
	Eastbound			Westbound			Northbound			Southbound				
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	1
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	1
4:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Count Total	0	0	0	0	0	0	1	0	0	0	0	0	1	0
Peak Hour	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**

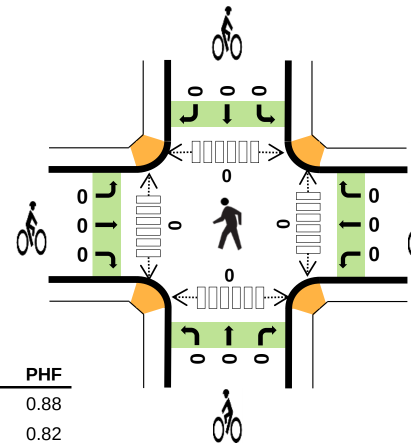
Note: U-Turn volumes for bikes are included in Left-Turn, if any.

Wright Bliss Rd NW
SR 302

idax

Date: 11/15/2022
Count Period: 3:00 PM to 5:00 PM
Peak Hour: 3:45 PM to 4:45 PM





	HV %:	PHF
EB	10.2%	0.88
WB	0.8%	0.82
NB	5.9%	0.64
SB	3.9%	0.86
TOTAL	4.6%	0.90

Two-Hour Count Summaries

Interval Start		SR 302 Eastbound				SR 302 Westbound				Wright Bliss Rd NW Northbound				Wright Bliss Rd NW Southbound				15-min Total	Rolling One Hour
		UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
3:00 PM		0	5	20	6	0	9	53	5	0	10	8	13	0	8	22	3	162	0
3:15 PM		0	3	37	11	0	12	34	10	0	9	12	1	0	9	22	11	171	0
3:30 PM		0	5	31	9	0	10	50	8	0	8	15	5	0	12	18	6	177	0
3:45 PM		**0**	**7**	**18**	**5**	**0**	**6**	**52**	**8**	**0**	**9**	**20**	**17**	**0**	**9**	**20**	**6**	**177**	687
4:00 PM		**0**	**1**	**30**	**13**	**0**	**10**	**40**	**8**	**0**	**6**	**10**	**5**	**0**	**7**	**16**	**10**	**156**	681
4:15 PM		**0**	**3**	**41**	**3**	**0**	**10**	**42**	**8**	**0**	**7**	**10**	**6**	**0**	**15**	**20**	**9**	**174**	684
4:30 PM		**0**	**3**	**34**	**8**	**0**	**11**	**60**	**10**	**0**	**5**	**18**	**5**	**0**	**10**	**24**	**6**	**194**	**701**
4:45 PM		0	1	36	10	0	16	46	5	0	8	11	5	0	7	22	7	174	698
Count Total		0	28	247	65	0	84	377	62	0	62	104	57	0	77	164	58	1,385	0
Peak Hour	**All**	**0**	**14**	**123**	**29**	**0**	**37**	**194**	**34**	**0**	**27**	**58**	**33**	**0**	**41**	**80**	**31**	**701**	**0**
	HV	**0**	**2**	**14**	**1**	**0**	**1**	**0**	**1**	**0**	**3**	**2**	**2**	**0**	**1**	**3**	**2**	**32**	**0**
	HV%	**-**	**14%**	**11%**	**3%**	**-**	**3%**	**0%**	**3%**	**-**	**11%**	**3%**	**6%**	**-**	**2%**	**4%**	**6%**	**5%**	**0**

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
3:00 PM	0	1	5	0	*6*	0	0	0	0	*0*	0	0	0	0	*0*
3:15 PM	3	1	0	1	*5*	0	0	0	0	*0*	0	0	0	0	*0*
3:30 PM	4	2	2	1	*9*	0	0	0	0	*0*	0	0	0	0	*0*
3:45 PM	**2**	**0**	**3**	**1**	***6***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:00 PM	**4**	**1**	**0**	**1**	***6***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:15 PM	**6**	**1**	**1**	**4**	***12***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	*0*
4:30 PM	**5**	**0**	**3**	**0**	***8***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***
4:45 PM	2	1	4	0	*7*	0	0	0	0	*0*	0	0	0	0	*0*
Count Total	26	7	18	8	*59*	0	0	0	0	*0*	0	0	0	0	*0*
Peak Hour	**17**	**2**	**7**	**6**	***32***	**0**	**0**	**0**	**0**	***0***	**0**	**0**	**0**	**0**	***0***

project.manager.wa@idaxdata.com

Two-Hour Count Summaries - Heavy Vehicles

Interval Start	SR 302 Eastbound				SR 302 Westbound				Wright Bliss Rd NW Northbound				Wright Bliss Rd NW Southbound				15-min Total	Rolling One Hour
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	1	0	0	1	2	2	0	0	0	0	6	0
3:15 PM	0	0	2	1	0	0	1	0	0	0	0	0	0	0	1	0	5	0
3:30 PM	0	2	2	0	0	1	1	0	0	0	1	1	0	1	0	0	9	0
3:45 PM	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**1**	**0**	**1**	**0**	**0**	**6**	26
4:00 PM	**0**	**0**	**3**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**6**	26
4:15 PM	**0**	**1**	**5**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**3**	**1**	**12**	33
4:30 PM	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**8**	**32**
4:45 PM	0	0	2	0	0	0	1	0	0	1	1	2	0	0	0	0	7	33
Count Total	0	4	20	2	0	2	4	1	0	5	6	7	0	2	4	2	59	0
Peak Hour	**0**	**2**	**14**	**1**	**0**	**1**	**0**	**1**	**0**	**3**	**2**	**2**	**0**	**1**	**3**	**2**	**32**	**0**

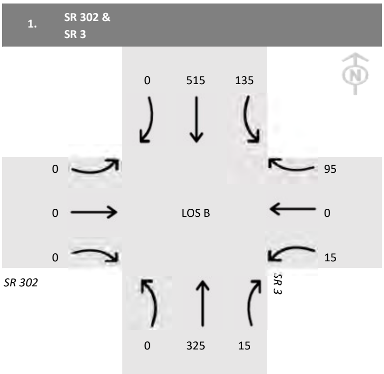
Two-Hour Count Summaries - Bikes

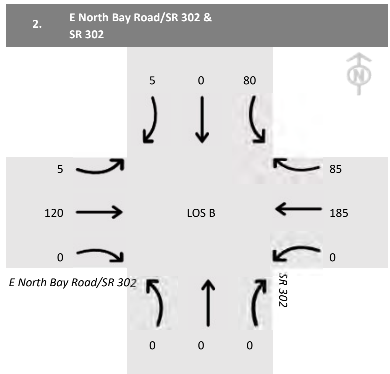
Interval Start	SR 302 Eastbound			SR 302 Westbound			Wright Bliss Rd NW Northbound			Wright Bliss Rd NW Southbound			15-min Total	Rolling One Hour
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT		
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:15 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
4:30 PM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Count Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak Hour	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

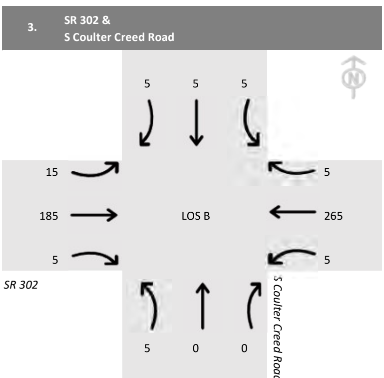
Note: U-Turn volumes for bikes are included in Left-Turn, if any.

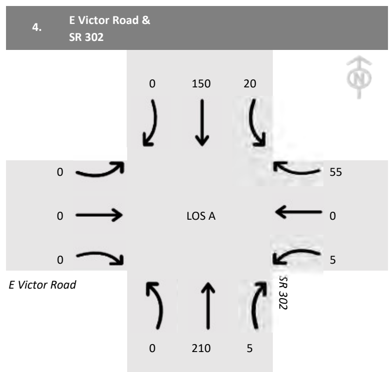
Appendix D

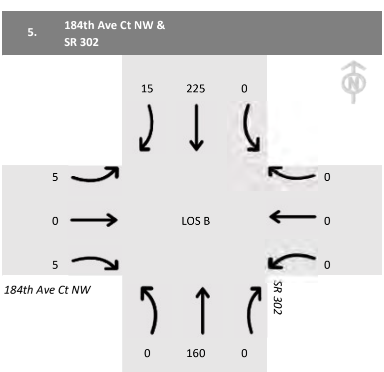
Intersection Traffic Volumes

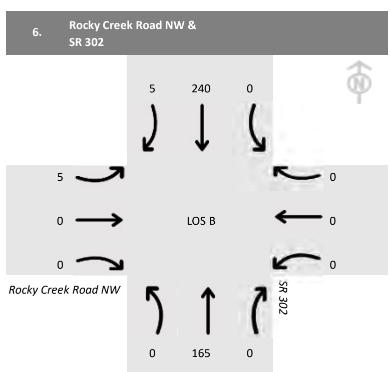

1.
SR 302 &
SR 3
0
515
135
0
95
0
LOS B
0
0
15
SR 302
SR 3
0
325
15

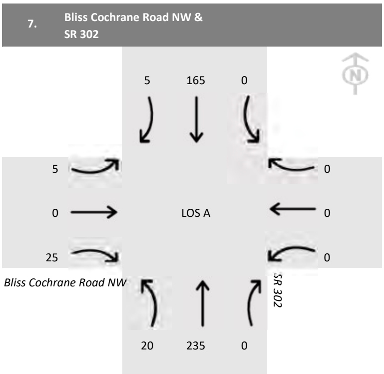

2.
E North Bay Road/SR 302 &
SR 302
5
0
80
5
85
120
LOS B
185
0
0
E North Bay Road/SR 302
SR 302
0
0
0

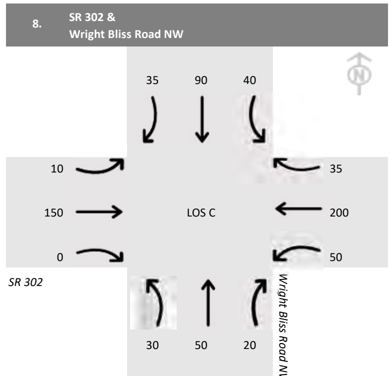

3.
SR 302 &
S Coulter Creed Road
5
5
5
15
5
185
LOS B
265
5
5
SR 302
S Coulter Creed Road
5
0
0


4.
E Victor Road &
SR 302
0
150
20
0
55
0
LOS A
0
0
5
E Victor Road
SR 302
0
210
5


5.
184th Ave Ct NW &
SR 302
15
225
0
5
0
0
LOS B
0
5
0
184th Ave Ct NW
SR 302
0
160
0

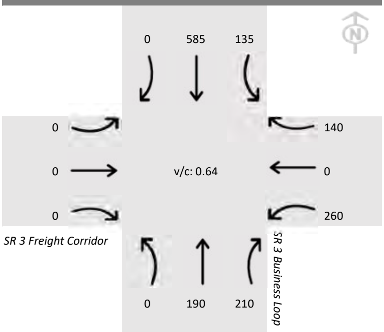

6.
Rocky Creek Road NW &
SR 302
5
240
0
5
0
0
LOS B
0
0
0
Rocky Creek Road NW
SR 302
0
165
0


7.
Bliss Cochrane Road NW &
SR 302
5
165
0
5
0
25
LOS A
0
0
0
Bliss Cochrane Road NW
SR 302
20
235
0

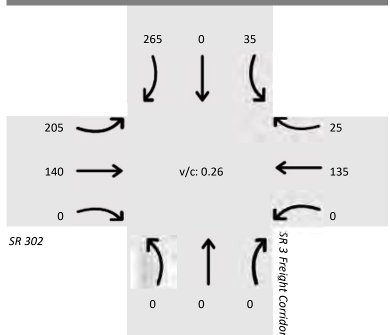

8.
SR 302 &
Wright Bliss Road NW
35
90
40
10
150
0
LOS C
35
200
50
SR 302
Wright Bliss Road NV
30
50
20

PM Peak Hour

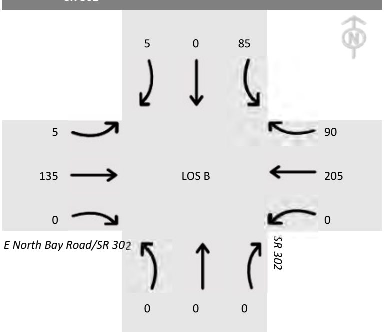
1a. SR 3 Freight Corridor & SR 3 Business Loop



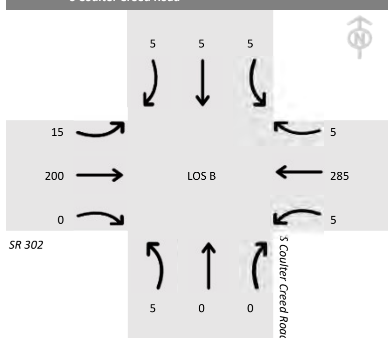
1b. SR 302 & SR 3 Freight Corridor



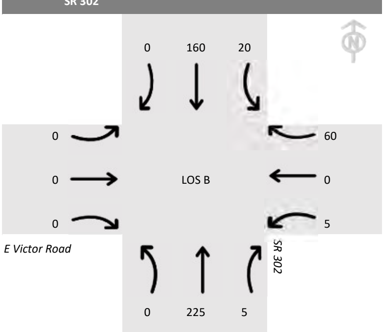
2. E North Bay Road/SR 302 & SR 302



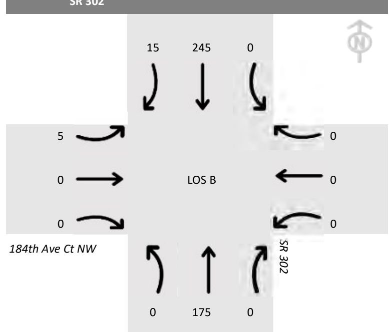
3. SR 302 & S Coulter Creed Road



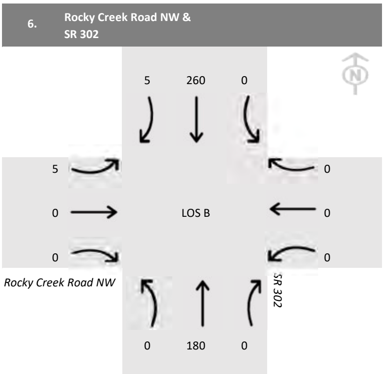
4. E Victor Road & SR 302

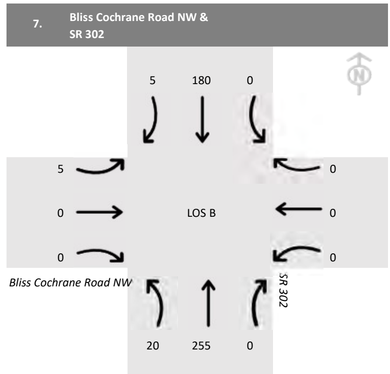


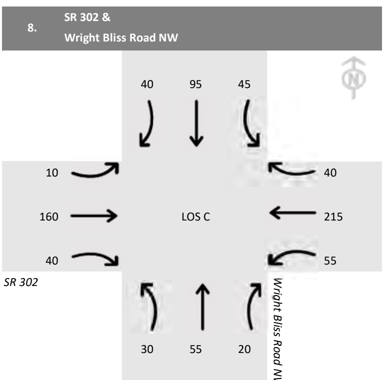
5. 184th Ave Ct NW & SR 302



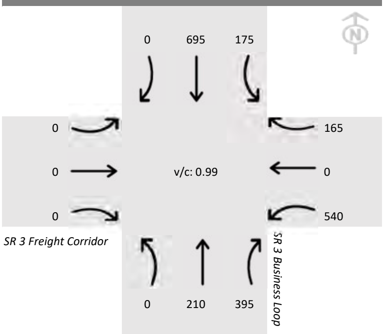
PM Peak Hour


6.
Rocky Creek Road NW &
SR 302
5
260
0
5
0
0
LOS B
0
0
0
Rocky Creek Road NW
SR 302
0
180
0

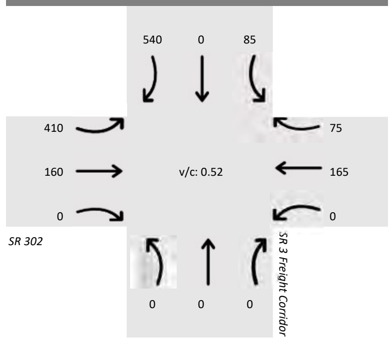

7.
Bliss Cochrane Road NW &
SR 302
5
180
0
5
0
0
LOS B
0
0
0
Bliss Cochrane Road NW
SR 302
20
255
0


8.
SR 302 &
Wright Bliss Road NW
40
95
45
10
160
40
LOS C
40
215
55
SR 302
Wright Bliss Road NV
30
55
20

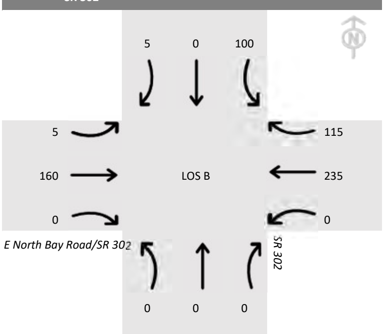
1a. **SR 3 Freight Corridor & SR 3 Business Loop**



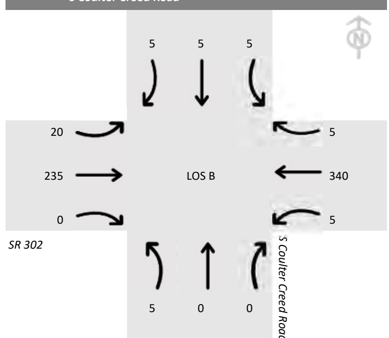
1b. **SR 302 & SR 3 Freight Corridor**



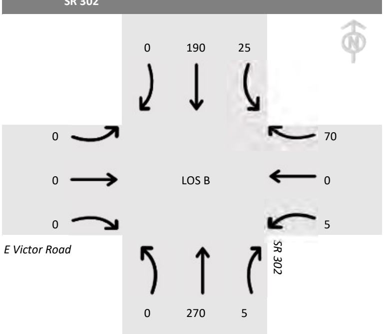
2. **E North Bay Road/SR 302 & SR 302**



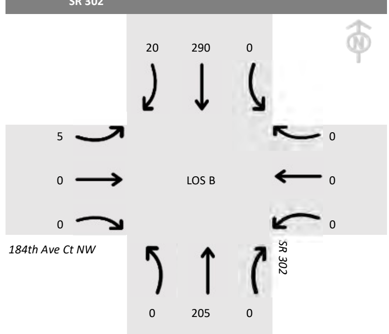
3. **SR 302 & S Coulter Creed Road**



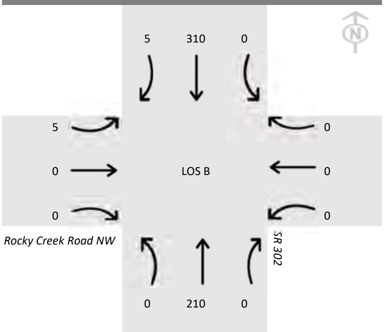
4. **E Victor Road & SR 302**



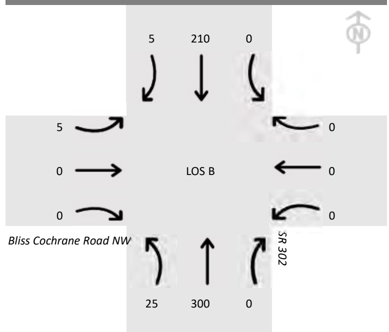
5. **184th Ave Ct NW & SR 302**



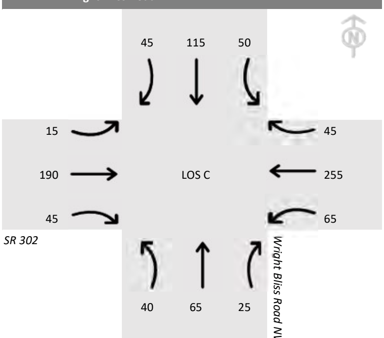
6. **Rocky Creek Road NW & SR 302**



7. **Bliss Cochrane Road NW & SR 302**



8. **SR 302 & Wright Bliss Road NW**



Appendix E

Traffic Analysis (Synchro and Sidra) Results

Intersection						
Int Delay, s/veh	2.5					

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	15	95	315	15	135	515
Future Vol, veh/h	15	95	315	15	135	515
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	1	1	3	3	5	5
Mvmt Flow	16	101	335	16	144	548

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1179	343	0	0	351	0
Stage 1	343	-	-	-	-	-
Stage 2	836	-	-	-	-	-
Critical Hdwy	6.41	6.21	-	-	4.15	-
Critical Hdwy Stg 1	5.41	-	-	-	-	-
Critical Hdwy Stg 2	5.41	-	-	-	-	-
Follow-up Hdwy	3.509	3.309	-	-	2.245	-
Pot Cap-1 Maneuver	212	702	-	-	1191	-
Stage 1	721	-	-	-	-	-
Stage 2	427	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	175	702	-	-	1191	-
Mov Cap-2 Maneuver	175	-	-	-	-	-
Stage 1	721	-	-	-	-	-
Stage 2	353	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	14.4	0	1.8
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	498	1191	-
HCM Lane V/C Ratio	-	-	0.235	0.121	-
HCM Control Delay (s)	-	-	14.4	8.4	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.9	0.4	-

Intersection						
Int Delay, s/veh	2.1					

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	5	120	185	85	80	5
Future Vol, veh/h	5	120	185	85	80	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	6	6	1	1	4	4
Mvmt Flow	5	124	191	88	82	5

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	279	0	-	0	369	235
Stage 1	-	-	-	-	235	-
Stage 2	-	-	-	-	134	-
Critical Hdwy	4.16	-	-	-	6.44	6.24
Critical Hdwy Stg 1	-	-	-	-	5.44	-
Critical Hdwy Stg 2	-	-	-	-	5.44	-
Follow-up Hdwy	2.254	-	-	-	3.536	3.336
Pot Cap-1 Maneuver	1261	-	-	-	627	799
Stage 1	-	-	-	-	799	-
Stage 2	-	-	-	-	887	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1261	-	-	-	624	799
Mov Cap-2 Maneuver	-	-	-	-	624	-
Stage 1	-	-	-	-	796	-
Stage 2	-	-	-	-	887	-

Approach	EB	WB	SB
HCM Control Delay, s	0.3	0	11.6
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1261	-	-	-	632
HCM Lane V/C Ratio	0.004	-	-	-	0.139
HCM Control Delay (s)	7.9	0	-	-	11.6
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0.5

Intersection	
Int Delay, s/veh	0.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Traffic Vol, veh/h	15	180	5	5	260	5	5	0	0	5	5	5
Future Vol, veh/h	15	180	5	5	260	5	5	0	0	5	5	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	98	98	98	98	98	98	98	98	98	98	98	98
Heavy Vehicles, %	5	5	5	1	1	1	0	0	0	8	8	8
Mvmt Flow	15	184	5	5	265	5	5	0	0	5	5	5

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	270	0	0	189	0	0	500	497	187	495	497	268
Stage 1	-	-	-	-	-	-	217	217	-	278	278	-
Stage 2	-	-	-	-	-	-	283	280	-	217	219	-
Critical Hdwy	4.15	-	-	4.11	-	-	7.1	6.5	6.2	7.18	6.58	6.28
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.18	5.58	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.18	5.58	-
Follow-up Hdwy	2.245	-	-	2.209	-	-	3.5	4	3.3	3.572	4.072	3.372
Pot Cap-1 Maneuver	1276	-	-	1391	-	-	484	477	860	475	466	756
Stage 1	-	-	-	-	-	-	790	727	-	716	670	-
Stage 2	-	-	-	-	-	-	728	683	-	772	711	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1276	-	-	1391	-	-	470	469	860	469	458	756
Mov Cap-2 Maneuver	-	-	-	-	-	-	470	469	-	469	458	-
Stage 1	-	-	-	-	-	-	780	718	-	707	667	-
Stage 2	-	-	-	-	-	-	715	680	-	762	702	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.6	0.1	12.7	12
HCM LOS			B	B

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	470	1276	-	-	1391	-	-	532
HCM Lane V/C Ratio	0.011	0.012	-	-	0.004	-	-	0.029
HCM Control Delay (s)	12.7	7.9	0	-	7.6	0	-	12
HCM Lane LOS	B	A	A	-	A	A	-	B
HCM 95th %tile Q(veh)	0	0	-	-	0	-	-	0.1

Intersection						
Int Delay, s/veh	1.7					

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	5	55	210	5	20	150
Future Vol, veh/h	5	55	210	5	20	150
Conflicting Peds, #/hr	4	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	89	89	89	89	89	89
Heavy Vehicles, %	0	0	1	1	6	6
Mvmt Flow	6	62	236	6	22	169

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	456	239	0	0	242	0
Stage 1	239	-	-	-	-	-
Stage 2	217	-	-	-	-	-
Critical Hdwy	6.4	6.2	-	-	4.16	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	-	-	2.254	-
Pot Cap-1 Maneuver	566	805	-	-	1301	-
Stage 1	805	-	-	-	-	-
Stage 2	824	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	554	805	-	-	1301	-
Mov Cap-2 Maneuver	554	-	-	-	-	-
Stage 1	805	-	-	-	-	-
Stage 2	806	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	10.1	0	0.9
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	776	1301	-
HCM Lane V/C Ratio	-	-	0.087	0.017	-
HCM Control Delay (s)	-	-	10.1	7.8	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.3	0.1	-

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	5	5	0	160	225	15
Future Vol, veh/h	5	5	0	160	225	15
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	93	93	93	93	93	93
Heavy Vehicles, %	0	0	2	2	1	2
Mvmt Flow	5	5	0	172	242	16

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	422	250	258	0	-	0
Stage 1	250	-	-	-	-	-
Stage 2	172	-	-	-	-	-
Critical Hdwy	6.4	6.2	4.12	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.218	-	-	-
Pot Cap-1 Maneuver	592	794	1307	-	-	-
Stage 1	796	-	-	-	-	-
Stage 2	863	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	592	794	1307	-	-	-
Mov Cap-2 Maneuver	592	-	-	-	-	-
Stage 1	796	-	-	-	-	-
Stage 2	863	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	10.4	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1307	-	678	-	-
HCM Lane V/C Ratio	-	-	0.016	-	-
HCM Control Delay (s)	0	-	10.4	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection						
Int Delay, s/veh	0.1					

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	5	0	0	165	240	5
Future Vol, veh/h	5	0	0	165	240	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	91	91	91	91	91	91
Heavy Vehicles, %	33	33	6	6	1	1
Mvmt Flow	5	0	0	181	264	5

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	448	267	269	0	-	0
Stage 1	267	-	-	-	-	-
Stage 2	181	-	-	-	-	-
Critical Hdwy	6.73	6.53	4.16	-	-	-
Critical Hdwy Stg 1	5.73	-	-	-	-	-
Critical Hdwy Stg 2	5.73	-	-	-	-	-
Follow-up Hdwy	3.797	3.597	2.254	-	-	-
Pot Cap-1 Maneuver	515	703	1272	-	-	-
Stage 1	711	-	-	-	-	-
Stage 2	781	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	515	703	1272	-	-	-
Mov Cap-2 Maneuver	515	-	-	-	-	-
Stage 1	711	-	-	-	-	-
Stage 2	781	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	12.1	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1272	-	515	-	-
HCM Lane V/C Ratio	-	-	0.011	-	-
HCM Control Delay (s)	0	-	12.1	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection						
Int Delay, s/veh	1					

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	5	25	20	235	165	5
Future Vol, veh/h	5	25	20	235	165	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	17	17	1	1	6	6
Mvmt Flow	5	27	21	250	176	5

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	471	179	181	0	-	0
Stage 1	179	-	-	-	-	-
Stage 2	292	-	-	-	-	-
Critical Hdwy	6.57	6.37	4.11	-	-	-
Critical Hdwy Stg 1	5.57	-	-	-	-	-
Critical Hdwy Stg 2	5.57	-	-	-	-	-
Follow-up Hdwy	3.653	3.453	2.209	-	-	-
Pot Cap-1 Maneuver	525	827	1400	-	-	-
Stage 1	817	-	-	-	-	-
Stage 2	725	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	516	827	1400	-	-	-
Mov Cap-2 Maneuver	516	-	-	-	-	-
Stage 1	803	-	-	-	-	-
Stage 2	725	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	10	0.6	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1400	-	752	-	-
HCM Lane V/C Ratio	0.015	-	0.042	-	-
HCM Control Delay (s)	7.6	0	10	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.1	-	-

Intersection												
Int Delay, s/veh	7.1											

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	10	150	35	50	200	35	30	50	20	40	90	35
Future Vol, veh/h	10	150	35	50	200	35	30	50	20	40	90	35
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	Yield	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	9	9	9	1	1	1	8	8	8	3	3	3
Mvmt Flow	11	167	39	56	222	39	33	56	22	44	100	39

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	261	0	0	167	0	0	632	582	187	582	543	242
Stage 1	-	-	-	-	-	-	209	209	-	354	354	-
Stage 2	-	-	-	-	-	-	423	373	-	228	189	-
Critical Hdwy	4.19	-	-	4.11	-	-	7.18	6.58	6.28	7.13	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	6.18	5.58	-	6.13	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.18	5.58	-	6.13	5.53	-
Follow-up Hdwy	2.281	-	-	2.209	-	-	3.572	4.072	3.372	3.527	4.027	3.327
Pot Cap-1 Maneuver	1264	-	-	1417	-	-	385	417	840	423	445	794
Stage 1	-	-	-	-	-	-	780	718	-	661	629	-
Stage 2	-	-	-	-	-	-	597	608	-	772	742	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1264	-	-	1417	-	-	287	394	840	352	420	794
Mov Cap-2 Maneuver	-	-	-	-	-	-	287	394	-	352	420	-
Stage 1	-	-	-	-	-	-	772	711	-	654	600	-
Stage 2	-	-	-	-	-	-	451	580	-	686	735	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.4	1.3	17.8	18.7
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	392	1264	-	-	1417	-	-	444
HCM Lane V/C Ratio	0.283	0.009	-	-	0.039	-	-	0.413
HCM Control Delay (s)	17.8	7.9	0	-	7.6	0	-	18.7
HCM Lane LOS	C	A	A	-	A	A	-	C
HCM 95th %tile Q(veh)	1.1	0	-	-	0.1	-	-	2

MOVEMENT SUMMARY

Site: 200 [SR 3 Business Loop/SR 3 Freight Corridor - 2030 PM]

Network: N101 [2030 PM]

No Build - 2030 PM Peak Hour
Site Category: -
Roundabout

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Arrival Flows Total veh/h	Arrival Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
Movement Performance Vehicles														
South: SR 3 Business Loop														
8	T1	190	3.0	190	3.0	0.319	4.7	LOS A	2.0	51.8	0.37	0.49	0.37	36.7
18	R2	210	3.0	210	3.0	0.319	4.7	LOS A	2.0	51.8	0.37	0.49	0.37	33.2
Approach		400	3.0	400	3.0	0.319	4.7	LOS A	2.0	51.8	0.37	0.49	0.37	35.3
East: SR 3 Freight Corridor														
1	L2	260	4.0	260	4.0	0.332	10.6	LOS B	2.0	50.5	0.41	0.63	0.41	32.7
16	R2	140	4.0	140	4.0	0.332	5.0	LOS A	2.0	50.5	0.41	0.63	0.41	31.5
Approach		400	4.0	400	4.0	0.332	8.7	LOS A	2.0	50.5	0.41	0.63	0.41	32.3
North: SR 3 Business Loop														
7	L2	135	5.0	135	5.0	0.637	12.2	LOS B	5.8	150.9	0.67	0.69	0.71	30.8
4	T1	585	5.0	585	5.0	0.637	6.6	LOS A	5.8	150.9	0.67	0.69	0.71	35.0
Approach		720	5.0	720	5.0	0.637	7.6	LOS A	5.8	150.9	0.67	0.69	0.71	34.5
All Vehicles		1520	4.2	1520	4.2	0.637	7.1	LOS A	5.8	150.9	0.52	0.62	0.54	34.2

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Network Data dialog (Network tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 222 [SR 3 Freight Corridor/SR 302 - 2030 PM] **Network: N101 [2030 PM]**

No Build - 2030 PM Peak Hour
Site Category: -
Roundabout

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Arrival Flows Total veh/h	Arrival Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
East: SR 302														
6	T1	135	1.0	135	1.0	0.129	4.8	LOS A	0.6	15.1	0.34	0.47	0.34	33.2
16	R2	25	1.0	25	1.0	0.129	4.8	LOS A	0.6	15.1	0.34	0.47	0.34	35.6
Approach		160	1.0	160	1.0	0.129	4.8	LOS A	0.6	15.1	0.34	0.47	0.34	33.8
North: SR 3 Freight Corridor														
7	L2	35	5.0	35	5.0	0.240	10.3	LOS B	1.3	33.4	0.31	0.52	0.31	36.6
14	R2	265	5.0	265	5.0	0.240	4.6	LOS A	1.3	33.4	0.31	0.52	0.31	33.1
Approach		300	5.0	300	5.0	0.240	5.3	LOS A	1.3	33.4	0.31	0.52	0.31	33.8
West: SR 3 Freight Corridor														
5	L2	205	4.0	205	4.0	0.255	9.9	LOS A	1.6	40.9	0.18	0.55	0.18	33.6
2	T1	140	4.0	140	4.0	0.255	4.2	LOS A	1.6	40.9	0.18	0.55	0.18	33.6
Approach		345	4.0	345	4.0	0.255	7.6	LOS A	1.6	40.9	0.18	0.55	0.18	33.6
All Vehicles		805	3.8	805	3.8	0.255	6.2	LOS A	1.6	40.9	0.26	0.53	0.26	33.7

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Network Data dialog (Network tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Intersection						
Int Delay, s/veh	2.2					

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	5	135	205	90	85	5
Future Vol, veh/h	5	135	205	90	85	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	6	6	1	1	4	4
Mvmt Flow	5	139	211	93	88	5

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	304	0	-	0	407	258
Stage 1	-	-	-	-	258	-
Stage 2	-	-	-	-	149	-
Critical Hdwy	4.16	-	-	-	6.44	6.24
Critical Hdwy Stg 1	-	-	-	-	5.44	-
Critical Hdwy Stg 2	-	-	-	-	5.44	-
Follow-up Hdwy	2.254	-	-	-	3.536	3.336
Pot Cap-1 Maneuver	1234	-	-	-	596	776
Stage 1	-	-	-	-	780	-
Stage 2	-	-	-	-	874	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1234	-	-	-	594	776
Mov Cap-2 Maneuver	-	-	-	-	594	-
Stage 1	-	-	-	-	777	-
Stage 2	-	-	-	-	874	-

Approach	EB	WB	SB
HCM Control Delay, s	0.3	0	12.1
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1234	-	-	-	602
HCM Lane V/C Ratio	0.004	-	-	-	0.154
HCM Control Delay (s)	7.9	0	-	-	12.1
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0.5

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	15	200	5	5	285	5	5	0	0	5	5	5
Future Vol, veh/h	15	200	5	5	285	5	5	0	0	5	5	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	98	98	98	98	98	98	98	98	98	98	98	98
Heavy Vehicles, %	5	5	5	1	1	1	0	0	0	8	8	8
Mvmt Flow	15	204	5	5	291	5	5	0	0	5	5	5

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	296	0	0	209	0	0	546	543	207	541	543	294
Stage 1	-	-	-	-	-	-	237	237	-	304	304	-
Stage 2	-	-	-	-	-	-	309	306	-	237	239	-
Critical Hdwy	4.15	-	-	4.11	-	-	7.1	6.5	6.2	7.18	6.58	6.28
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.18	5.58	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.18	5.58	-
Follow-up Hdwy	2.245	-	-	2.209	-	-	3.5	4	3.3	3.572	4.072	3.372
Pot Cap-1 Maneuver	1248	-	-	1368	-	-	452	450	839	443	439	731
Stage 1	-	-	-	-	-	-	771	713	-	693	652	-
Stage 2	-	-	-	-	-	-	705	665	-	753	697	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1248	-	-	1368	-	-	439	442	839	437	431	731
Mov Cap-2 Maneuver	-	-	-	-	-	-	439	442	-	437	431	-
Stage 1	-	-	-	-	-	-	760	703	-	683	649	-
Stage 2	-	-	-	-	-	-	692	662	-	742	687	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.5	0.1	13.3	12.4
HCM LOS			B	B

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	439	1248	-	-	1368	-	-	502
HCM Lane V/C Ratio	0.012	0.012	-	-	0.004	-	-	0.03
HCM Control Delay (s)	13.3	7.9	0	-	7.6	0	-	12.4
HCM Lane LOS	B	A	A	-	A	A	-	B
HCM 95th %tile Q(veh)	0	0	-	-	0	-	-	0.1

Intersection	
Int Delay, s/veh	1.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	5	60	225	5	20	160
Future Vol, veh/h	5	60	225	5	20	160
Conflicting Peds, #/hr	4	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	0	0	1	1	6	6
Mvmt Flow	5	63	237	5	21	168

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	454	240	0	0	242	0
Stage 1	240	-	-	-	-	-
Stage 2	214	-	-	-	-	-
Critical Hdwy	6.4	6.2	-	-	4.16	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	-	-	2.254	-
Pot Cap-1 Maneuver	568	804	-	-	1301	-
Stage 1	805	-	-	-	-	-
Stage 2	826	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	556	804	-	-	1301	-
Mov Cap-2 Maneuver	556	-	-	-	-	-
Stage 1	805	-	-	-	-	-
Stage 2	809	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	10.1	0	0.9
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	777	1301	-
HCM Lane V/C Ratio	-	-	0.088	0.016	-
HCM Control Delay (s)	-	-	10.1	7.8	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.3	0	-

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	Y			↰	↱	
Traffic Vol, veh/h	5	5	0	175	245	15
Future Vol, veh/h	5	5	0	175	245	15
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	0	0	2	2	1	2
Mvmt Flow	5	5	0	184	258	16

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	450	266	274	0	-	0
Stage 1	266	-	-	-	-	-
Stage 2	184	-	-	-	-	-
Critical Hdwy	6.4	6.2	4.12	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.218	-	-	-
Pot Cap-1 Maneuver	571	778	1289	-	-	-
Stage 1	783	-	-	-	-	-
Stage 2	852	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	571	778	1289	-	-	-
Mov Cap-2 Maneuver	571	-	-	-	-	-
Stage 1	783	-	-	-	-	-
Stage 2	852	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	10.6	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1289	-	659	-	-
HCM Lane V/C Ratio	-	-	0.016	-	-
HCM Control Delay (s)	0	-	10.6	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection						
Int Delay, s/veh	0.1					

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	5	0	0	180	260	5
Future Vol, veh/h	5	0	0	180	260	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	33	33	6	6	1	1
Mvmt Flow	5	0	0	189	274	5

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	466	277	279	0	-	0
Stage 1	277	-	-	-	-	-
Stage 2	189	-	-	-	-	-
Critical Hdwy	6.73	6.53	4.16	-	-	-
Critical Hdwy Stg 1	5.73	-	-	-	-	-
Critical Hdwy Stg 2	5.73	-	-	-	-	-
Follow-up Hdwy	3.797	3.597	2.254	-	-	-
Pot Cap-1 Maneuver	502	693	1261	-	-	-
Stage 1	704	-	-	-	-	-
Stage 2	774	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	502	693	1261	-	-	-
Mov Cap-2 Maneuver	502	-	-	-	-	-
Stage 1	704	-	-	-	-	-
Stage 2	774	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	12.2	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1261	-	502	-	-
HCM Lane V/C Ratio	-	-	0.01	-	-
HCM Control Delay (s)	0	-	12.2	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection	
Int Delay, s/veh	1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	5	25	20	255	180	5
Future Vol, veh/h	5	25	20	255	180	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	17	17	1	1	6	6
Mvmt Flow	5	26	21	268	189	5

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	502	192	194	0	-	0
Stage 1	192	-	-	-	-	-
Stage 2	310	-	-	-	-	-
Critical Hdwy	6.57	6.37	4.11	-	-	-
Critical Hdwy Stg 1	5.57	-	-	-	-	-
Critical Hdwy Stg 2	5.57	-	-	-	-	-
Follow-up Hdwy	3.653	3.453	2.209	-	-	-
Pot Cap-1 Maneuver	503	813	1385	-	-	-
Stage 1	806	-	-	-	-	-
Stage 2	711	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	494	813	1385	-	-	-
Mov Cap-2 Maneuver	494	-	-	-	-	-
Stage 1	791	-	-	-	-	-
Stage 2	711	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	10.1	0.6	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1385	-	734	-	-
HCM Lane V/C Ratio	0.015	-	0.043	-	-
HCM Control Delay (s)	7.6	0	10.1	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.1	-	-

Intersection	
Int Delay, s/veh	7.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	10	160	40	55	215	40	30	55	20	45	95	40
Future Vol, veh/h	10	160	40	55	215	40	30	55	20	45	95	40
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	Yield	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	95	95	95	95	95	95	95	95	95	95	95	95
Heavy Vehicles, %	9	9	9	1	1	1	8	8	8	3	3	3
Mvmt Flow	11	168	42	58	226	42	32	58	21	47	100	42

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	268	0	0	168	0	0	645	595	189	593	553	247
Stage 1	-	-	-	-	-	-	211	211	-	363	363	-
Stage 2	-	-	-	-	-	-	434	384	-	230	190	-
Critical Hdwy	4.19	-	-	4.11	-	-	7.18	6.58	6.28	7.13	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	6.18	5.58	-	6.13	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.18	5.58	-	6.13	5.53	-
Follow-up Hdwy	2.281	-	-	2.209	-	-	3.572	4.072	3.372	3.527	4.027	3.327
Pot Cap-1 Maneuver	1256	-	-	1416	-	-	377	409	838	416	440	789
Stage 1	-	-	-	-	-	-	778	717	-	654	623	-
Stage 2	-	-	-	-	-	-	589	601	-	771	741	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1256	-	-	1416	-	-	278	385	838	343	414	789
Mov Cap-2 Maneuver	-	-	-	-	-	-	278	385	-	343	414	-
Stage 1	-	-	-	-	-	-	770	710	-	647	593	-
Stage 2	-	-	-	-	-	-	441	572	-	683	734	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.4	1.4	18.2	19.3
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	382	1256	-	-	1416	-	-	438
HCM Lane V/C Ratio	0.289	0.008	-	-	0.041	-	-	0.433
HCM Control Delay (s)	18.2	7.9	0	-	7.7	0	-	19.3
HCM Lane LOS	C	A	A	-	A	A	-	C
HCM 95th %tile Q(veh)	1.2	0	-	-	0.1	-	-	2.1

Intersection						
Int Delay, s/veh	2.3					

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	5	160	235	115	100	5
Future Vol, veh/h	5	160	235	115	100	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	6	6	1	1	4	4
Mvmt Flow	5	160	235	115	100	5

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	350	0	-	0	463	293
Stage 1	-	-	-	-	293	-
Stage 2	-	-	-	-	170	-
Critical Hdwy	4.16	-	-	-	6.44	6.24
Critical Hdwy Stg 1	-	-	-	-	5.44	-
Critical Hdwy Stg 2	-	-	-	-	5.44	-
Follow-up Hdwy	2.254	-	-	-	3.536	3.336
Pot Cap-1 Maneuver	1187	-	-	-	553	742
Stage 1	-	-	-	-	752	-
Stage 2	-	-	-	-	855	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1187	-	-	-	550	742
Mov Cap-2 Maneuver	-	-	-	-	550	-
Stage 1	-	-	-	-	748	-
Stage 2	-	-	-	-	855	-

Approach	EB	WB	SB
HCM Control Delay, s	0.2	0	13
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1187	-	-	-	557
HCM Lane V/C Ratio	0.004	-	-	-	0.189
HCM Control Delay (s)	8	0	-	-	13
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0.7

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	20	235	5	5	340	5	5	0	0	5	5	5
Future Vol, veh/h	20	235	5	5	340	5	5	0	0	5	5	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	5	5	5	1	1	1	0	0	0	8	8	8
Mvmt Flow	20	235	5	5	340	5	5	0	0	5	5	5

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	345	0	0	240	0	0	636	633	238	631	633	343
Stage 1	-	-	-	-	-	-	278	278	-	353	353	-
Stage 2	-	-	-	-	-	-	358	355	-	278	280	-
Critical Hdwy	4.15	-	-	4.11	-	-	7.1	6.5	6.2	7.18	6.58	6.28
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.18	5.58	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.18	5.58	-
Follow-up Hdwy	2.245	-	-	2.209	-	-	3.5	4	3.3	3.572	4.072	3.372
Pot Cap-1 Maneuver	1197	-	-	1333	-	-	393	400	806	385	389	686
Stage 1	-	-	-	-	-	-	733	684	-	652	620	-
Stage 2	-	-	-	-	-	-	664	633	-	716	668	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1197	-	-	1333	-	-	379	390	806	378	380	686
Mov Cap-2 Maneuver	-	-	-	-	-	-	379	390	-	378	380	-
Stage 1	-	-	-	-	-	-	719	671	-	640	617	-
Stage 2	-	-	-	-	-	-	651	630	-	702	655	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.6	0.1	14.6	13.4
HCM LOS			B	B

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	379	1197	-	-	1333	-	-	445
HCM Lane V/C Ratio	0.013	0.017	-	-	0.004	-	-	0.034
HCM Control Delay (s)	14.6	8.1	0	-	7.7	0	-	13.4
HCM Lane LOS	B	A	A	-	A	A	-	B
HCM 95th %tile Q(veh)	0	0.1	-	-	0	-	-	0.1

Intersection	
Int Delay, s/veh	1.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	5	70	270	5	25	190
Future Vol, veh/h	5	70	270	5	25	190
Conflicting Peds, #/hr	4	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	0	0	1	1	6	6
Mvmt Flow	5	70	270	5	25	190

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	517	273	0	0	275	0
Stage 1	273	-	-	-	-	-
Stage 2	244	-	-	-	-	-
Critical Hdwy	6.4	6.2	-	-	4.16	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	-	-	2.254	-
Pot Cap-1 Maneuver	522	771	-	-	1265	-
Stage 1	778	-	-	-	-	-
Stage 2	801	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	509	771	-	-	1265	-
Mov Cap-2 Maneuver	509	-	-	-	-	-
Stage 1	778	-	-	-	-	-
Stage 2	781	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	10.4	0	0.9
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	745	1265	-
HCM Lane V/C Ratio	-	-	0.101	0.02	-
HCM Control Delay (s)	-	-	10.4	7.9	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.3	0.1	-

Intersection						
Int Delay, s/veh	0.2					

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	5	5	0	205	290	20
Future Vol, veh/h	5	5	0	205	290	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	0	0	2	2	1	2
Mvmt Flow	5	5	0	205	290	20

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	505	300	310	0	-	0
Stage 1	300	-	-	-	-	-
Stage 2	205	-	-	-	-	-
Critical Hdwy	6.4	6.2	4.12	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.218	-	-	-
Pot Cap-1 Maneuver	530	744	1250	-	-	-
Stage 1	756	-	-	-	-	-
Stage 2	834	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	530	744	1250	-	-	-
Mov Cap-2 Maneuver	530	-	-	-	-	-
Stage 1	756	-	-	-	-	-
Stage 2	834	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	10.9	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1250	-	619	-	-
HCM Lane V/C Ratio	-	-	0.016	-	-
HCM Control Delay (s)	0	-	10.9	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection						
Int Delay, s/veh	0.1					

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	5	0	0	210	310	5
Future Vol, veh/h	5	0	0	210	310	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	33	33	6	6	1	1
Mvmt Flow	5	0	0	210	310	5

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	523	313	315	0	-	0
Stage 1	313	-	-	-	-	-
Stage 2	210	-	-	-	-	-
Critical Hdwy	6.73	6.53	4.16	-	-	-
Critical Hdwy Stg 1	5.73	-	-	-	-	-
Critical Hdwy Stg 2	5.73	-	-	-	-	-
Follow-up Hdwy	3.797	3.597	2.254	-	-	-
Pot Cap-1 Maneuver	464	661	1223	-	-	-
Stage 1	676	-	-	-	-	-
Stage 2	757	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	464	661	1223	-	-	-
Mov Cap-2 Maneuver	464	-	-	-	-	-
Stage 1	676	-	-	-	-	-
Stage 2	757	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	12.8	0	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1223	-	464	-	-
HCM Lane V/C Ratio	-	-	0.011	-	-
HCM Control Delay (s)	0	-	12.8	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection						
Int Delay, s/veh	1					

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	Y			↰↑	↑↱	
Traffic Vol, veh/h	5	30	25	300	210	5
Future Vol, veh/h	5	30	25	300	210	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	17	17	1	1	6	6
Mvmt Flow	5	30	25	300	210	5

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	563	213	215	0	-	0
Stage 1	213	-	-	-	-	-
Stage 2	350	-	-	-	-	-
Critical Hdwy	6.57	6.37	4.11	-	-	-
Critical Hdwy Stg 1	5.57	-	-	-	-	-
Critical Hdwy Stg 2	5.57	-	-	-	-	-
Follow-up Hdwy	3.653	3.453	2.209	-	-	-
Pot Cap-1 Maneuver	463	791	1361	-	-	-
Stage 1	788	-	-	-	-	-
Stage 2	681	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	453	791	1361	-	-	-
Mov Cap-2 Maneuver	453	-	-	-	-	-
Stage 1	771	-	-	-	-	-
Stage 2	681	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	10.3	0.6	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1361	-	715	-	-
HCM Lane V/C Ratio	0.018	-	0.049	-	-
HCM Control Delay (s)	7.7	0	10.3	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0.1	-	0.2	-	-

Intersection	
Int Delay, s/veh	9.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	15	190	45	65	255	45	40	65	25	50	115	45
Future Vol, veh/h	15	190	45	65	255	45	40	65	25	50	115	45
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	Yield	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	9	9	9	1	1	1	8	8	8	3	3	3
Mvmt Flow	15	190	45	65	255	45	40	65	25	50	115	45

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	300	0	0	190	0	0	731	673	213	673	628	278
Stage 1	-	-	-	-	-	-	243	243	-	408	408	-
Stage 2	-	-	-	-	-	-	488	430	-	265	220	-
Critical Hdwy	4.19	-	-	4.11	-	-	7.18	6.58	6.28	7.13	6.53	6.23
Critical Hdwy Stg 1	-	-	-	-	-	-	6.18	5.58	-	6.13	5.53	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.18	5.58	-	6.13	5.53	-
Follow-up Hdwy	2.281	-	-	2.209	-	-	3.572	4.072	3.372	3.527	4.027	3.327
Pot Cap-1 Maneuver	1222	-	-	1390	-	-	330	369	812	368	398	758
Stage 1	-	-	-	-	-	-	747	694	-	618	595	-
Stage 2	-	-	-	-	-	-	550	573	-	738	719	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1222	-	-	1390	-	-	224	344	812	289	371	758
Mov Cap-2 Maneuver	-	-	-	-	-	-	224	344	-	289	371	-
Stage 1	-	-	-	-	-	-	737	684	-	609	562	-
Stage 2	-	-	-	-	-	-	388	541	-	638	709	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.5	1.4	23.2	24.8
HCM LOS			C	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	326	1222	-	-	1390	-	-	387
HCM Lane V/C Ratio	0.399	0.012	-	-	0.047	-	-	0.543
HCM Control Delay (s)	23.2	8	0	-	7.7	0	-	24.8
HCM Lane LOS	C	A	A	-	A	A	-	C
HCM 95th %tile Q(veh)	1.9	0	-	-	0.1	-	-	3.1

MOVEMENT SUMMARY

Site: 200 [SR 3 Business Loop/SR 3 Freight Corridor - 2050 PM]

Network: N101 [2050 PM]

No Build - 2050 PM Peak Hour
Site Category: -
Roundabout

Movement Performance Vehicles															
Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Arrival Flows Total veh/h	Arrival Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: SR 3 Business Loop														
8	T1	210	3.0	210	3.0	0.509	5.2	LOS A	4.2	108.0	0.55	0.55	0.55	36.2
18	R2	395	3.0	395	3.0	0.509	5.1	LOS A	4.2	108.0	0.55	0.55	0.55	32.4
Approach		605	3.0	605	3.0	0.509	5.2	LOS A	4.2	108.0	0.55	0.55	0.55	34.2
East: SR 3 Freight Corridor														
1	L2	540	4.0	540	4.0	0.602	11.2	LOS B	5.0	129.8	0.61	0.68	0.61	31.7
16	R2	165	4.0	165	4.0	0.602	5.6	LOS A	5.0	129.8	0.61	0.68	0.61	30.6
Approach		705	4.0	705	4.0	0.602	9.9	LOS A	5.0	129.8	0.61	0.68	0.61	31.4
North: SR 3 Business Loop														
7	L2	175	5.0	175	5.0	0.989	40.1	LOS D	29.5	766.1	1.00	1.66	2.64	18.2
4	T1	695	5.0	695	5.0	0.989	34.5	LOS C	29.5	766.1	1.00	1.66	2.64	24.8
Approach		870	5.0	870	5.0	0.989	35.6	LOS D	29.5	766.1	1.00	1.66	2.64	23.8
All Vehicles		2180	4.1	2180	4.1	0.989	18.8	LOS B	29.5	766.1	0.75	1.04	1.40	27.8

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Network Data dialog (Network tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 222 [SR 3 Freight Corridor/SR 302 - 2050 PM]

Network: N101 [2050 PM]

No Build - 2050 PM Peak Hour
Site Category: -
Roundabout

Movement Performance Vehicles														
Mov ID	Turn	Demand Flows Total	HV	Arrival Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		veh/h	%	veh/h	%	v/c	sec		veh	ft				mph
East: SR 302														
6	T1	165	4.0	165	4.0	0.234	6.0	LOS A	1.3	33.6	0.55	0.61	0.55	32.2
16	R2	75	4.0	75	4.0	0.234	6.0	LOS A	1.3	33.6	0.55	0.61	0.55	35.0
Approach		240	4.0	240	4.0	0.234	6.0	LOS A	1.3	33.6	0.55	0.61	0.55	33.4
North: SR 3 Freight Corridor														
7	L2	85	5.0	85	5.0	0.520	10.8	LOS B	4.0	103.7	0.50	0.58	0.50	36.0
14	R2	540	5.0	540	5.0	0.520	5.2	LOS A	4.0	103.7	0.50	0.58	0.50	32.3
Approach		625	5.0	625	5.0	0.520	5.9	LOS A	4.0	103.7	0.50	0.58	0.50	33.1
West: SR 3 Freight Corridor														
5	L2	410	4.0	410	4.0	0.445	10.3	LOS B	3.6	92.3	0.37	0.58	0.37	32.6
2	T1	160	4.0	160	4.0	0.445	4.7	LOS A	3.6	92.3	0.37	0.58	0.37	32.6
Approach		570	4.0	570	4.0	0.445	8.7	LOS A	3.6	92.3	0.37	0.58	0.37	32.6
All Vehicles		1435	4.4	1435	4.4	0.520	7.1	LOS A	4.0	103.7	0.46	0.59	0.46	32.9

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Network Data dialog (Network tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Appendix F

Crash Analysis

Parametrix
ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES
719 2ND AVENUE, SUITE 200 | SEATTLE, WA 98104 | P 206.394.3700

TECHNICAL MEMORANDUM

DATE:	May 19, 2023
TO:	Ashley Carle, Roger Baugh, Nazmul Alam - WSDOT
FROM:	Kate Bradbury, PE - Parametrix
SUBJECT:	SR 302 Corridor Crash Analysis
CC:	Alex Atchison, PE - Parametrix
PROJECT NUMBER:	554-1631-164
PROJECT NAME:	SR 302 Victor Area Corridor Study

INTRODUCTION

One component of the legislative proviso was to recommend safety improvements along SR 302 in the Victor Area. Following WSDOT Safety Guidance for Corridor Planning (WSDOT 2015), and discussions with staff in the WSDOT Olympic Region Traffic office, an intermediate analysis level was selected for this study. This includes an assessment of the observed crash history to identify any trends as well as identification and evaluation of countermeasures to address the contributing factors.

CRASH ANALYSIS

Collision data were obtained from WSDOT between January 1, 2017, and December 31, 2021[1]. During the analysis period, 131 total crashes occurred on the corridor between SR 3 and Wright Bliss Road NW. This included one fatal crash and two serious injury crashes, although about 70% of crashes were crashes that had property damage only. Figure 1 shows the locations, severity, and density of crashes along the corridor. Over 28% of crashes (37 crashes) were intersection related and about 8% were driveway related (11 crashes). There were no crashes that involved a pedestrian or bicyclist.

The majority of crashes (34%) were fixed object crashes followed by angle crashes (22%) and non-collision crashes (21%). The fixed object crashes and non-collision[2] crashes suggest a trend in the occurrence of run off-the-road crashes along the corridor, many of which are clustered in or near horizontal curves (see Figure 2). The angle crashes on the corridor occurred primarily at intersections or driveways. Table 1 summarizes the observed crashes for the study period by severity and crash type.

[1] Under 23 U.S. Code § 148 and 23 U.S. Code § 407, safety data, reports, surveys, schedules, lists compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential crash sites, hazardous roadway conditions, or railway-highway crossings are not subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

[2] A non-collision crash is a collision where the first harmful event is not a collision with a fixed or non-fixed object or another vehicle (e.g., overturn, jackknife, etc.)

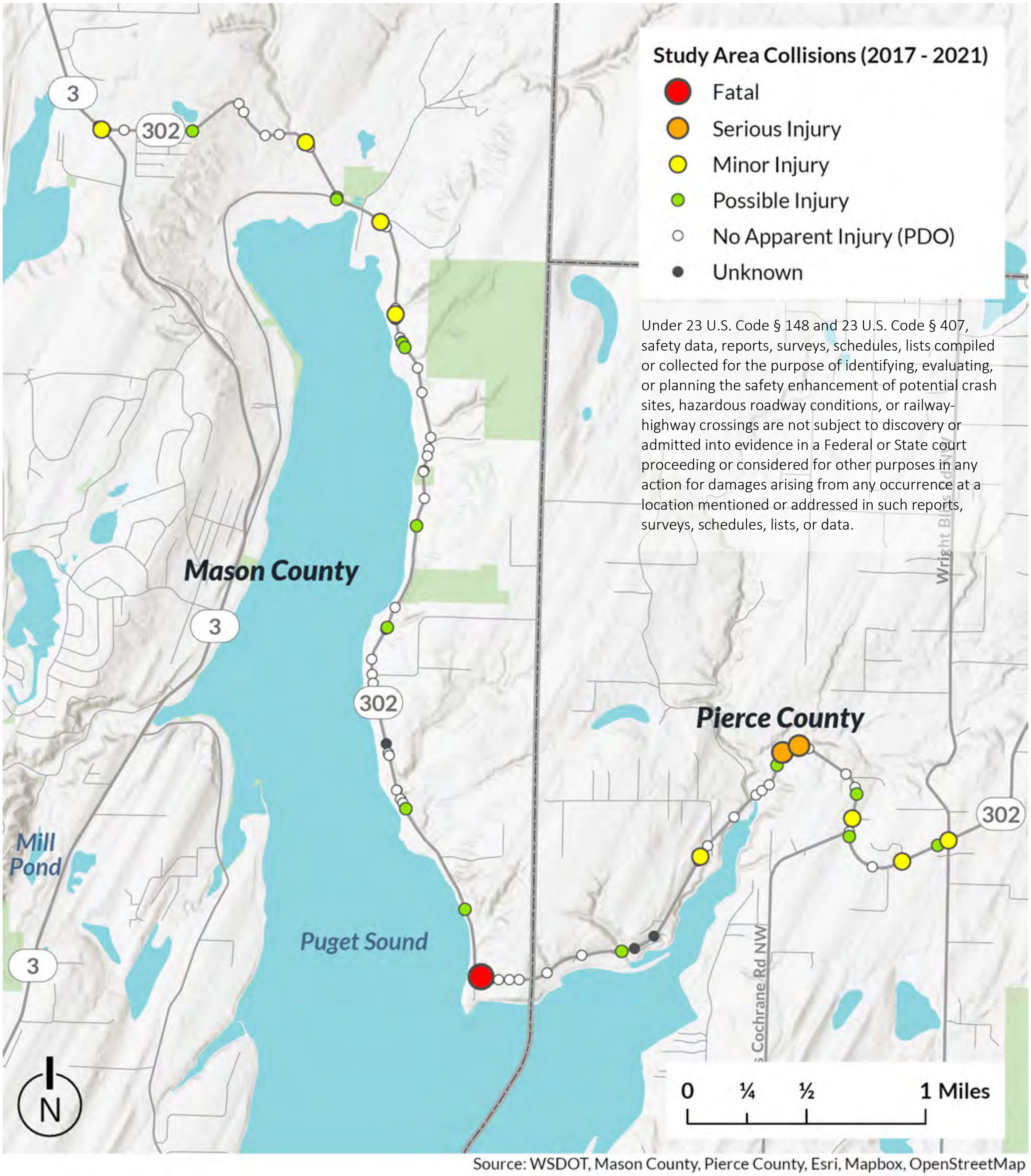
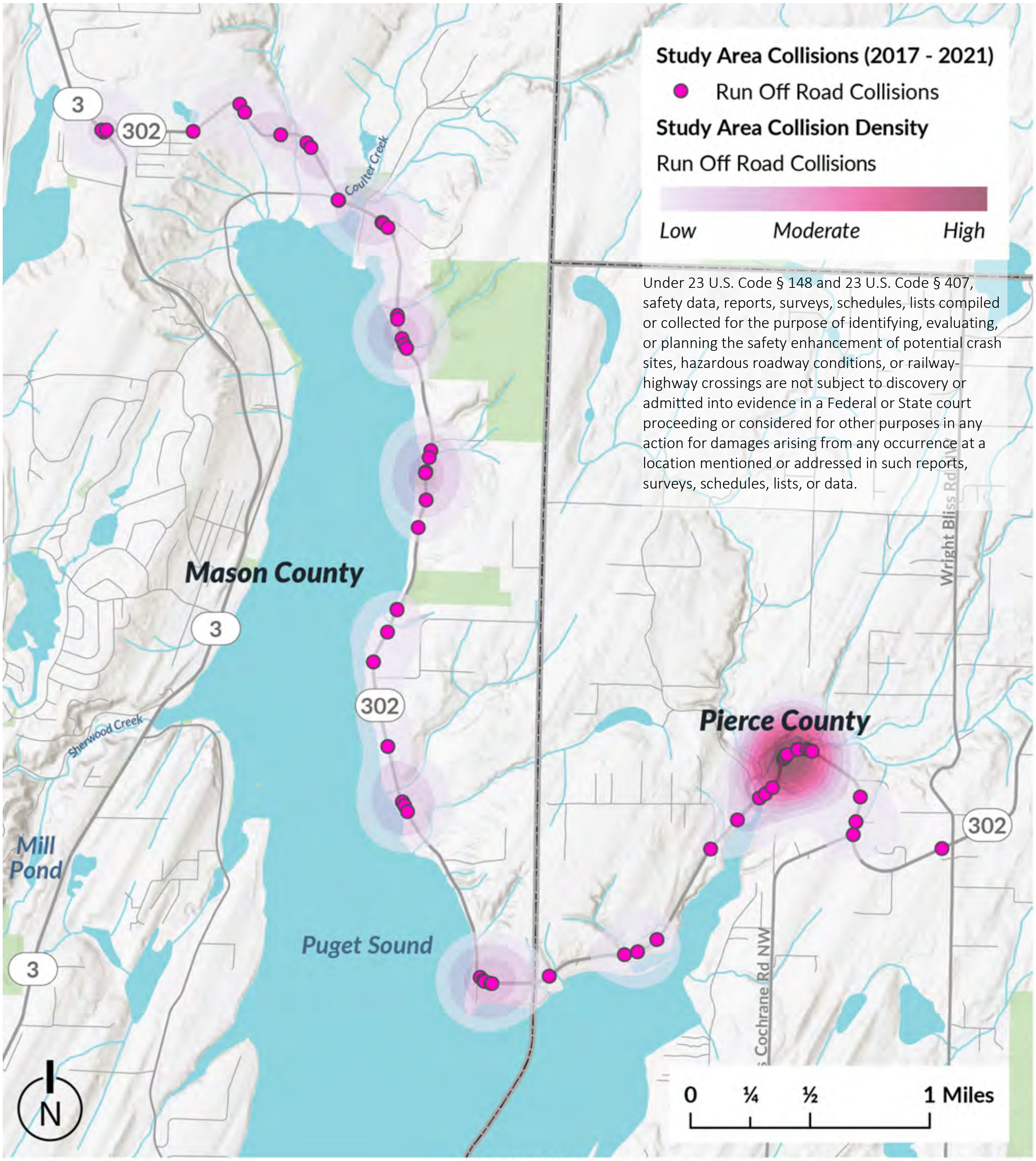


Figure 1. Total Crashes by Location and Severity (2017-2021)



Source: WSDOT, Mason County, Pierce County, Esri, Mapbox, OpenStreetMap

Figure 2. Run-off-the-Road Crashes (2017-2021)

Table 1. 2017–2021 Crash History by Severity and Crash Type

Crash Type	Fatal Crash Frequency	Serious Injury Crash Frequency	Minor Injury Crash Frequency	Possible Injury Crash Frequency	No Apparent Injury Crash Frequency	Total Crashes
Fixed Object	0	1	2	7	35	**45**
Angle	0	0	3	7	19	**29**
Non-collision	0	0	3	6	19	**28**
Rear End	0	0	1	3	14	**18**
Head-On/ Sideswipe, Opposite Direction	1	1	1	3	2	**8**
Sideswipe, Same Direction	0	0	0	1	1	**2**
Animal	0	0	0	0	1	**1**
Total Crashes	**1**	**2**	**10**	**27**	**87**	**131**

Under 23 U.S. Code § 148 and 23 U.S. Code § 407, safety data, reports, surveys, schedules, lists compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential crash sites, hazardous roadway conditions, or railway-highway crossings are not subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

Consideration of the primary contributing factors of the crashes can also help to highlight potential trends and opportunities for improvements along the corridor. Table 2 summarizes the primary contributing factors for the crashes within the study area.

Table 2. 2017–2021 Crashes by Primary Contributing Factor

Primary Contributing Factor	Crash Frequency	Percent of Total Crashes
Exceeding a Reasonably Safe Speed	30	23%
Other or None	27	21%
Inattention	17	13%
Distracted Driving	11	8%
Did Not Grant Right-of-Way to Vehicle	10	8%
Following Too Closely	10	8%
Under the Influence of Alcohol	9	7%
Improper Maneuver	7	5%
Asleep, Fatigued, or Ill	7	5%
Disregarded Traffic Control	3	2%

Under 23 U.S. Code § 148 and 23 U.S. Code § 407, safety data, reports, surveys, schedules, lists compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential crash sites, hazardous roadway conditions, or railway-highway crossings are not subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

The most common contributing factor was exceeding a reasonably safe speed, the primary factor in almost a quarter of the corridor's crashes. Many of these crashes were located in or near horizontal curves on the corridor.

About 20% of crashes had either no contributing factor or a variety of other factors, such as driver not distracted, operating defective equipment, or other contributing circumstance not listed. Inattention and distracted driving also collectively accounted for about 20% of crashes.

Environmental factors, such as weather and lighting conditions, can also be a contributing factor in crashes. The majority of crashes (56%) occurred during clear or partly cloudy conditions, but about 28% of crashes occurred during rainy conditions. Additionally, the majority of crashes (63%) occurred during daylight conditions, with about 25% of crashes occurring under dark, without street light conditions.

Overall, the key trends along the corridor include run-off-the-road crashes, the intersections at either end of the study corridor, speeding, lighting conditions, and a few key horizontal curve locations (around MP 2, MP 4, MP 4.8, and MP 6.6).

Appendix G

Level 1 Screening Results

SR 302 Victor Area Study - Level 1 Screening

Problem Statement: SR 302 in the Victor area of Mason County is at high risk of roadway closure due to flooding and landslides, causing resiliency and infrastructure issues. Landslides cause frequent damage to the roadway, requiring long detours due to lack of alternative routes in the area. SR 302 in the study area also lacks complete active transportation facilities that hinders mobility.

Purpose of the Study: The SR 302 Victor Area Study is intended to study the cause of landslides and identify potential solutions. In addition, the study will evaluate SR 302 from SR 3 to Wright Bliss Road to look at safety and infrastructure improvements to the highway, including improvements for active transportation.

Level 1 Screening	Measures
Study Needs	Is the strategy compatible with proposed geotechnical solutions, and meet the vision, goals and objectives for the study area?
Safety	Does the strategy have the potential to improve safety for active transportation users?
Multimodal Mobility	Does the strategy likely support the multimodal transportation network and improve mobility?
Environment	Is the strategy likely able to mitigate any potential significant environmental impacts?
Resilience	Does the strategy produce a more resilient transportation system?

Segment 1:	SR 3 to E North Bay Road	30 mph
Segment 2:	E North Bay Road to 192nd Ave Ct NW	40 mph
Segment 3:	192nd Ave Ct NW to Wright Bliss Road	45 mph

Category	Segment	ID#	Strategy Description	Study Needs	Safety	Multimodal Mobility	Environment	Resilience	Passes Level 1?	*Notes*
Active Transportation	1	AT1	Shared-use path along non-shoreline side of the roadway	Yes	Yes	Yes	Yes	Yes	PASS	*Shared-use path will be evaluated for both the shoreline and non-shoreline sides*
Active Transportation	1	AT1	Shared-use path along shoreline side of the roadway	Yes	Yes	Yes	Yes	Yes	PASS	*Shared-use path will be evaluated for both the shoreline and non-shoreline sides. Widening on the water side could have impacts to shoreline that would be extremely difficult to mitigate given environmental regulations. Widening on shoreline side would require maintaining existing edge of pavement on shoreline side and shifting roadway centerline to the north/east*
Active Transportation	1	AT2	Increase paved shoulder width to achieve lower LTS	Yes	Yes	Yes	Yes	Yes	PASS	
Active Transportation	1	AT3	Install flexible delineators or barriers where paved shoulder is implemented for peds/bikes	Yes	Yes	Yes	Yes	Yes	PASS	
Active Transportation	2	AT1	Shared-use path along non-shoreline side of the roadway	Yes	Yes	Yes	Yes	Yes	PASS	*Shared-use path will be evaluated for both the shoreline and non-shoreline sides*
Active Transportation	2	AT1	Shared-use path along shoreline side of the roadway	Yes	Yes	Yes	Yes	Yes	PASS	*Shared-use path will be evaluated for both the shoreline and non-shoreline sides. Widening on the water side could have impacts to shoreline that would be extremely difficult to mitigate given environmental regulations. Widening on shoreline side would require maintaining existing edge of pavement on shoreline side and shifting roadway centerline to the north/east*
Active Transportation	2	AT2	Increase paved shoulder width to achieve lower LTS	Yes	Yes	Yes	Yes	Yes	PASS	
Active Transportation	2	AT3	Install flexible delineators or barriers where paved shoulder is implemented for peds/bikes	Yes	Yes	Yes	Yes	Yes	PASS	
Active Transportation	3	AT1	Shared-use path along non-shoreline side of the roadway	Yes	Yes	Yes	Yes	Yes	PASS	*Shared-use path will be evaluated for both the shoreline and non-shoreline sides*
Active Transportation	3	AT1	Shared-use path along shoreline side of the roadway	Yes	Yes	Yes	Yes	Yes	PASS	*Shared-use path will be evaluated for both the shoreline and non-shoreline sides. Widening on the water side could have impacts to shoreline that would be extremely difficult to mitigate given environmental regulations. Widening on shoreline side would require maintaining existing edge of pavement on shoreline side and shifting roadway centerline to the north/east*
Active Transportation	3	AT2	Increase paved shoulder width to achieve lower LTS	Yes	Yes	Yes	Yes	Yes	PASS	
Active Transportation	3	AT3	Install flexible delineators or barriers where paved shoulder is implemented for peds/bikes	Yes	Yes	Yes	Yes	Yes	PASS	
Traffic	1	T1	Build new roadway in alternate location	No	Yes	Yes	Yes	Yes	FAIL	*New roadway alignment does not address the purpose of studying potential solutions for the existing SR 302 corridor between SR 3 and Wright Bliss Rd*
Traffic	1	T2	Freight restrictions	Yes	Yes	No	Yes	Yes	FAIL	*Restricting freight would require heavy vehicles to detour 22 miles along SR 16 and SR 3 and through the Gorst area. Freight is up to 10% of total traffic during the PM peak hour and restricting these vehicles would worsen their mobility. Additionally, this suggestion from the online open hour was meant to reduce noise pollution, reduce speeding to get around trucks, and reduce stress and cracks in the road. Vehicle weight (heavy trucks) does not correlate with roadway cracks.*
Traffic	1	T3	Floating road grid (floating bridge)	No	Yes	Yes	Yes	Yes	FAIL	*Similar to building a new roadway in an alternate location, any new roadway structures or new alignments on the water would have to happen in tandem with improvements to the existing roadway*
Traffic	1	T4	Additional lanes or turn lanes at intersections	Yes	Yes	No	Yes	Yes	FAIL	*All study intersections currently operate within LOS standards, so additional lanes are not needed for traffic operations*
Traffic	1	T5	Improved communication about road closures	Yes	Yes	Yes	Yes	Yes	PASS	
Traffic	2	T1	Build new roadway in alternate location	No	Yes	Yes	Yes	Yes	FAIL	*New roadway alignment does not address the purpose of studying potential solutions for the existing SR 302 corridor between SR 3 and Wright Bliss Rd*

SR 302 Victor Area Study - Level 1 Screening

Problem Statement: SR 302 in the Victor area of Mason County is at high risk of roadway closure due to flooding and landslides, causing resiliency and infrastructure issues. Landslides cause frequent damage to the roadway, requiring long detours due to lack of alternative routes in the area. SR 302 in the study area also lacks complete active transportation facilities that hinders mobility.

Purpose of the Study: The SR 302 Victor Area Study is intended to study the cause of landslides and identify potential solutions. In addition, the study will evaluate SR 302 from SR 3 to Wright Bliss Road to look at safety and infrastructure improvements to the highway, including improvements for active transportation.

Level 1 Screening	Measures
Study Needs	Is the strategy compatible with proposed geotechnical solutions, and meet the vision, goals and objectives for the study area?
Safety	Does the strategy have the potential to improve safety for active transportation users?
Multimodal Mobility	Does the strategy likely support the multimodal transportation network and improve mobility?
Environment	Is the strategy likely able to mitigate any potential significant environmental impacts?
Resilience	Does the strategy produce a more resilient transportation system?

Segment 1:	SR 3 to E North Bay Road	30 mph
Segment 2:	E North Bay Road to 192nd Ave Ct NW	40 mph
Segment 3:	192nd Ave Ct NW to Wright Bliss Road	45 mph

Category	Segment	ID#	Strategy Description	Study Needs	Safety	Multimodal Mobility	Environment	Resilience	Passes Level 1?	*Notes*
Traffic	1	T2	Freight restrictions	Yes	Yes	No	Yes	Yes	FAIL	*Restricting freight would require heavy vehicles to detour 22 miles along SR 16 and SR 3 and through the Gorst area. Freight is up to 10% of total traffic during the PM peak hour and restricting these vehicles would worsen their mobility. Additionally, this suggestion from the online open hour was meant to reduce noise pollution, reduce speeding to get around trucks, and reduce stress and cracks in the road. Vehicle weight (heavy trucks) does not correlate with roadway cracks.*
Traffic	2	T3	Floating road grid (floating bridge)	No	Yes	Yes	Yes	Yes	FAIL	*Similar to building a new roadway in an alternate location, any new roadway structures or new alignments on the water would have to happen in tandem with improvements to the existing roadway*
Traffic	2	T4	Additional lanes or turn lanes at intersections	Yes	Yes	No	Yes	Yes	FAIL	*All study intersections currently operate within LOS standards, so additional lanes are not needed for traffic operations*
Traffic	1	T5	Improved communication about road closures	Yes	Yes	Yes	Yes	Yes	PASS	
Traffic	3	T1	Build new roadway in alternate location	No	Yes	Yes	Yes	Yes	FAIL	*New roadway alignment does not address the purpose of studying potential solutions for the existing SR 302 corridor between SR 3 and Wright Bliss Rd*
Traffic	1	T2	Freight restrictions	Yes	Yes	No	Yes	Yes	FAIL	*Restricting freight would require heavy vehicles to detour 22 miles along SR 16 and SR 3 and through the Gorst area. Freight is up to 10% of total traffic during the PM peak hour and restricting these vehicles would worsen their mobility. Additionally, this suggestion from the online open hour was meant to reduce noise pollution, reduce speeding to get around trucks, and reduce stress and cracks in the road. Vehicle weight (heavy trucks) does not correlate with roadway cracks.*
Traffic	3	T3	Floating road grid (floating bridge)	No	Yes	Yes	Yes	Yes	FAIL	*Similar to building a new roadway in an alternate location, any new roadway structures or new alignments on the water would have to happen in tandem with improvements to the existing roadway*
Traffic	3	T4	Additional lanes or turn lanes at intersections	Yes	Yes	No	Yes	Yes	FAIL	*All study intersections currently operate within LOS standards, so additional lanes are not needed for traffic operations*
Traffic	1	T5	Improved communication about road closures	Yes	Yes	Yes	Yes	Yes	PASS	

Appendix H

Level 2 Screening Results

SR 302 Victor Area Study - Level 2 Screening

Problem Statement: SR 302 in the Victor area of Mason County is at high risk of roadway closure due to flooding and landslides, causing resiliency and infrastructure issues. Landslides cause frequent damage to the roadway, requiring long detours due to lack of alternative routes in the area. SR 302 in the study area also lacks complete active transportation facilities that hinders mobility.

Segment 1:	SR 3 to E North Bay Road
Segment 2:	E North Bay Road to 192nd Ave Ct NW
Segment 3:	192nd Ave Ct NW to Wrigth Bliss Road

Purpose of the Study:

The SR 302 Victor Area Study is intended to study the cause of landslides and identify potential solutions. In addition, the study will evaluate SR 302 from SR 3 to Wright Bliss Road to look at safety and infrastructure improvements to the highway, including improvements for active transportation.

Category	Description	Measure	Metric	Scoring
Safety	Encourage and support active transportation use by improving active transportation user safety and experience	Active Transportation User Safety	Potential to improve active transportation user safety	1 – Potential to worsen active transportation user safety 2 – Active transportation user safety likely to remain the same 3 – Potential to improve active transportation user safety
	The implementation of design characteristics to improve safety at access points along the highway.	Conflict points	Number of driveway/roadway crossings, length of exposure to driveways & roadways	1 – Increases the number of conflict points 2 – No change to the number of conflict points 3 – Reduces the number of conflict points
Multimodal Mobility	The ease of reaching major destinations (e.g., jobs, services, schools, ports) from a specific location by different travel modes.	Motorist Quality of service	Travel times Level of service at intersections	1 – Maintains LOS and travel times 2 – Improves LOS (meets LOS standards) and/or travel times 3 – Improves LOS (meets LOS standards) and travel times
		Ped / Bike Quality of service	Bicycle level of traffic stress (BLTS)	1 – BLTS 3 or higher 2 – BLTS 2 3 – BLTS 1
			Pedestrian level of traffic stress (PLTS)	1 – PLTS 3 or higher 2 – PLTS 2 3 – PLTS 1
		Connectivity	Improves connections to active transportation destinations (e.g., schools, hospitals, etc.) and/or helps complete future active transportation network (consistent with local plans).	1 – Does not maintain or improve connections to active transportation destinations 2 – Maintains connections to active transportation destinations consistent with local plans 3 – Improves connections to active transportation destinations consistent with local plans
Social Equity and Environmental Justice	The improvement and protection of health, safety, and accessibility outcomes for vulnerable populations, especially in low-income communities and communities that spend more, and longer, to get where they need to go.	Historically disadvantaged communities	Impacts in communities with economic or equity disadvantages	1 – Some impacts or displacements for residential or business areas identified with economic or equity disadvantages 2 – Minimal impacts or displacements for residential or business areas identified with economic or equity disadvantages 3 – No impacts or displacements for residential or business areas identified with economic or equity disadvantages
		Accessibility	Improves connectivity in transportation disadvantaged communities	1 – Does not improve transportation connections for transportation disadvantaged communities. 2 – May improve transportation connections for transportation disadvantaged communities. 3 – Provides improved transportation connections for transportation disadvantaged communities.
Environment	The impact of disturbing sensitive areas (wetlands, cultural areas, flood hazards, wildlife habitat, etc.) on the environment, and potential mitigations or improvements to protect and restore the environment.	Improves the natural environment	Improves fish passage, wetland habitat, habitat connectivity; maintains environmental compliance; reduces impacts to fish at chronic environmental deficiency sites	1 – Minimal or no improvement 2 – Improves one sensitive area 3 – Improves 2 or more sensitive areas
		Improves stormwater management	Number of acres of previously untreated existing pavement now treated	1 – Less than 30% improvement 2 – 30-70% improvement 3 – >70% improvement
Network Resiliency	Strengthening transportation elements vulnerable to natural disaster, extreme weather, and climate impacts.	Resiliency	Strategy would increase resiliency to natural disasters, extreme weather, and climate impacts	1 – Maintains current CIVA category 2 – Improves short-term resiliency 3 – Improves long-term resiliency
Cost and Implementation	Planning level costs, including potential right of way (ROW) acquisition. Incremental, phased solutions should be considered, especially for solutions with high costs and complex implementation.	Cost	Planning-level cost estimate	1 – > $5,000,000 2 – $1,000,000 to $5,000,000 3 – < $1,000,000
		Detours/Delays during construction	Estimated hours of additional delay during construction	1 – Large impacts during construction 2 – Moderate impacts during construction 3 – Minimal to no impact during construction

SR 302 Victor Area Study - Level 2 Screening

Year 2050

Legend: 1 | 2 | 3

Category	Measure	Metric	Scoring	No Build Score Seg 1	No Build Score Seg 2	No Build Score Seg 3	#1 Improved Shoulder Score Seg 1	#1 Improved Shoulder Score Seg 2	#1 Improved Shoulder Score Seg 3	#1 Improved Shoulder Notes	#2 Shared Use Path Score Seg 1	#2 Shared Use Path Score Seg 2	#2 Shared Use Path Score Seg 3	#2 Shared Use Path Notes
Safety	Active Transportation User Safety	Potential to improve active transportation user safety	1 – Potential to worsen active transportation user safety 2 – Active transportation user safety likely to remain the same 3 – Potential to improve active transportation user safety	2	2	2	2	3	3	*Segment 1 likely to be similar to existing conditions, even with buffered bike lane Segments 2 and 3: Bike lane provides some improvement over existing shoulder and substantial barrier is likely to improve bike safety.*	3	3	3	*Adding a shared-use path improves pedestrian/bicycle safety by providing a buffer between vehicles and active transportation users*
	Conflict points	Number of driveway/roadway crossings, length of exposure to driveways & roadways	1 – Increases the number of conflict points 2 – No change to the number of conflict points 3 – Reduces the number of conflict points	2	2	2	1	1	1	*Adding bike lane on both sides of the roadway would increase conflict points with driveways on the shoreline side*	1	1	1	*Adding a shared-use path on shoreline side would increase conflict points with driveways and adding a shared-use path on non-shoreline side would increase conflict points with peds and bikes crossing the roadway to access the shared-use path*
Multimodal Mobility	Motorist Quality of service	Travel times Level of service at intersections	1 – Maintains LOS and travel times 2 – Improves LOS (meets LOS standards) and/or travel times 3 – Improves LOS (meets LOS standards) and travel times	1	1	1	1	1	1	*No change to intersection LOS or travel time*	1	1	1	*No change to intersection LOS or travel time*
	Ped / Bike Quality of service	Bicycle level of traffic stress (BLTS)	1 – BLTS 3 or higher 2 – BLTS 2 3 – BLTS 1	1	1	1	2	2	2	*Segment 1: LTS 2 (30 mph without separation) Segment 2: LTS 2 (40 mph with concrete barrier) Segment 3: LTS 2 (45 mph with concrete barrier)*	2	2	2	*Segment 1: LTS 2 (planted buffer barrier) Segment 2: LTS 2 (concrete barrier) Segment 3: LTS 2 (concrete barrier)*
		Pedestrian level of traffic stress (PLTS)	1 – PLTS 3 or higher 2 – PLTS 2 3 – PLTS 1	1	1	1	1	1	1	*No change to PLTS Segment 1: LTS 3 Segment 2: LTS 4 Segment 3: LTS 4*	2	2	2	*Segment 1: LTS 2 (robust barrier) Segment 2: LTS 2 (robust barrier) Segment 3: LTS 2 (robust barrier)*
	Active Transportation Connectivity	Improves connections to active transportation destinations (e.g., schools, hospitals, etc.) and/or helps complete future active transportation network (consistent with local plans).	1 – Does not maintain or improve connections to active transportation destinations 2 – Maintains connections to active transportation destinations consistent with local plans 3 – Improves connections to active transportation destinations consistent with local plans	1	1	1	3	2	3	*Segment 1: Improved access to back entrance of schools Segment 2: Improvements reflect multimodal suitability desired in local plans; no AT destinations along east side of segment with improved connections Segment 3: Improvements reflect multimodal suitability desired in local plans; improved access to grocery store with food*	3	2	3	*Segment 1: Improved access to back entrance of schools Segment 2: Improvements reflect multimodal suitability desired in local plans; no AT destinations along east side of segment with improved connections Segment 3: Improvements reflect multimodal suitability desired in local plans; improved access to grocery store with food*
Social Equity and Environmental Justice	Historically disadvantaged communities	Impacts in communities with economic or equity disadvantages	1 – Some impacts or displacements for residential or business areas identified with economic or equity disadvantages 2 – Minimal impacts or displacements for residential or business areas identified with economic or equity disadvantages 3 – No impacts or displacements for residential or business areas identified with economic or equity disadvantages	3	3	3	3	3	3	*Segments 1-2: No impacts to residential property expected Segment 3: Not in an area identified as economic or equity disadvantaged*	2	2	3	*Segments 1-2: Minimal impacts impacts to residential property expected Segment 3: Not in an area identified as economic or equity disadvantaged*
	Accessibility	Improves connectivity in transportation disadvantaged communities	1 – Does not improve transportation connections for transportation disadvantaged communities. 2 – May improve transportation connections for transportation disadvantaged communities. 3 – Provides improved transportation connections for transportation disadvantaged communities.	1	1	1	2	2	2	*Proposed bike facilities provide additional transportation connections (all segments labeled transportation access disadvantaged) but do not provide as safe a biking environment as a shared use path*	3	3	3	*Proposed bike facilities provide additional transportation connections (all segments labeled transportation access disadvantaged)*
Environment	Improves the natural environment	Improves fish passage, wetland habitat, habitat connectivity; maintains environmental compliance; reduces impacts to fish at chronic environmental deficiency sites	1 – Minimal or no improvement 2 – Improves one sensitive area 3 – Improves 2 or more sensitive areas	1	1	1	2	3	1	*Assume widening will impact sensitive areas that will be mitigated with improvements. Segment 1: Improves 2 fish passages Segment 2: Improves 3 high priority sensitive areas, 2 medium priority sensitive areas, and 7 fish passage barriers; Segment 3: Improves 1 high priority sensitive area and 1 medium priority sensitive area*	2	3	1	*Assume widening will impact sensitive areas that will be mitigated with improvements. Segment 1: Improves 2 fish passages Segment 2: Improves 3 high priority sensitive areas, 2 medium priority sensitive areas, and 7 fish passage barriers; Segment 3: Improves 1 high priority sensitive area and 1 medium priority sensitive area*
	Improves stormwater management	Number of acres of previously untreated existing pavement now treated	1 – Less than 30% improvement 2 – 30-70% improvement 3 – >70% improvement	1	1	1	2	2	2	*Stormwater treatment will be added for additional pavement due to widening and existing pavement draining towards widened area*	2	2	2	*Stormwater treatment will be added for additional pavement due to widening and existing pavement draining towards widened area*
Network Resiliency	Resiliency	Strategy would increase resiliency to natural disasters, extreme weather, and climate impacts	1 – Maintains current CIVA category 2 – Improves short-term resiliency 3 – Improves long-term resiliency	1	1	1	2	2	2	*2022 landslide event closed SR 302 which would be considered a medium impact. Strategy would improve future potential impacts from similar events, improving short-term resiliency. Assessment based on 1. criticality (how critical corridor is to overall transportation operations and public safety) and 2. impact (potential climate change impacts to corridor operations)*	2	2	2	*2022 landslide event closed SR 302 which would be considered a medium impact. Strategy would improve future potential impacts from similar events, improving short-term resiliency. Assessment based on 1. criticality (how critical corridor is to overall transportation operations and public safety) and 2. impact (potential climate change impacts to corridor operations)*
Cost/Implementation	Cost	Planning-level cost estimate	1 – > $5,000,000 2 – $1,000,000 to $5,000,000 3 – < $1,000,000	3	3	3	2	1	1	*Cost estimate does not include improvements to environmentally sensitive areas.*	2	1	1	*Cost estimate does not include improvements to environmentally sensitive areas.*
	Detours/Delays during construction	Estimated hours of additional delay during construction	1 – Large impacts during construction 2 – Moderate impacts during construction 3 – Minimal to no impact during construction	3	3	3	2	1	1	*Construction impacts are closely correlated to construction cost, so the scoring is identical to the "Planning-level cost estimate" metric*	2	1	1	*Construction impacts are closely correlated to construction cost, so the scoring is identical to the "Planning-level cost estimate" metric*
			TOTAL	**21**	**21**	**21**	**25**	**24**	**23**		**27**	**25**	**25**	
			SEGMENT AVERAGE	**21**			**24**				**26**			