Northern, Inc.

Consulting Engineers Environmental Scientists Geologists
Construction Materials Testing Geophysical Services

GEOLOGIC HAZARDS ASSESSMENT

VALHALLA HEIGHTS ADDITION PHASES 3 & 4
NORTHWEST TERMINUS OF W. GOODLANDER ROAD
SELAH, YAKIMA COUNTY, WASHINGTON

GNN PROJECT NO. 214-498

JULY 2014

Prepared for

NCW DEVELOPMENT, LLC
P.O. BOX 119
WENATCHEE, WA 98807

Prepared by

GN NORTHERN, INC
CONSULTING GEOTECHNICAL ENGINEERS
YAKIMA, WASHINGTON
(509) 248-9798

Common Sense Approach to Earth and Engineering
Since 1995

Yakima • Kennewick • Spokane Valley • Hermiston, OR • Hood River, OR

(509) 248-9798
www.gnnorthern.com
gnnorthern@gnnorthern.com

Northern, Inc.

At GN Northern our mission is to serve our clients in the most efficient, cost effective way using the best resources and tools available while maintaining professionalism on every level. Our philosophy is to satisfy our clients through hard work, dedication and extraordinary efforts from all of our valued employees working as an extension of the design and construction team.

GN Northern, Inc.

July 2, 2014

NCW Development
P.O. Box 119
Wenatchee, WA 98807

Attention: Mr. Gary Bates, Vice President

Subject: **Geologic Hazards Assessment**
Proposed Valhalla Heights Addition Phases 3 & 4 Residential Subdivision
Northwest Terminus of West Goodlander Road
Selah, Yakima County, Washington

GNN Project No. 214-498

Mr. Bates,

As requested, GN Northern, Inc. (GNN) has prepared this geologic hazards assessment report for the proposed Valhalla Heights Addition, Phases 3 & 4, residential subdivision generally located at the current northwest terminus of West Goodlander Road in the City of Selah, Yakima County, Washington.

Based on the finding of our evaluation, we conclude that any potential geologic hazards can be mitigated and that the site is suitable for the proposed development provided the recommendations contained in this report and any subsequent site-specific design-level geotechnical engineering evaluations are followed both during the design and construction phases.

The report, which follows, describes in detail our evaluation, summarizes our findings, and presents our recommendations. It is important that we provide consultation during the design and field-testing services during construction to review and monitor the implementation of our recommendations.

If you have any questions regarding this report, please contact us at 509-248-9798.

Respectfully submitted,
GN Northern, Inc.

Karl A. Harmon

Digitally signed by Karl A. Harmon
DN: cn=Karl A. Harmon, o=GN Northern, Inc., ou, email=kharmon@gnnorthern.com, c=US
Date: 2014.07.02 16:03:43 -07'00'

Karl Harmon, LEG, PE
Senior Geologist/Engineer

KARL A. HARMON
STATE OF WASHINGTON
41534
REGISTERED
PROFESSIONAL ENGINEER
Expires 08/02/2015

State of Washington
Engineering Geologist
2535
Licensed Geologist
Karl A. Harmon

Enclosures: Geologic Hazards Assessment (digital PDF copy)

TABLE OF CONTENTS

	Page No.
EXECUTIVE SUMMARY	**1**
INTRODUCTION	**2**
PROJECT DESCRIPTION	2
PURPOSE AND SCOPE OF SERVICES	2
METHODS OF EXPLORATION AND TESTING	**3**
TECHNICAL LITERATURE AND AERIAL PHOTO REVIEW	3
FIELD RECONNAISSANCE	4
FIELD EXPLORATION	4
LABORATORY TESTING	4
DISCUSSION	**5**
SITE DESCRIPTION	5
SOIL/BEDROCK CONDITIONS	6
GROUNDWATER	6
GEOLOGIC SETTING	7
GEOLOGIC HAZARDS	7
SEISMIC HAZARDS	7
SECONDARY SEISMIC HAZARDS	9
SLOPE STABILITY	9
FLOODING AND EROSION	10
SLOPE STABILITY ANALYSIS	10
CONCLUSIONS	**12**
GENERAL	12
GEOTECHNICAL CONSTRAINTS AND MITIGATION:	13
RECOMMENDATIONS	**14**
SITE DEVELOPMENT – GRADING	14
EXCAVATIONS	15
GRADED SLOPE CONSTRUCTION	15
FILL SLOPES (2:1 MAXIMUM GRADIENT)	16

CUT SLOPES (2:1 MAXIMUM GRADIENT) 17

SLOPE PROTECTION AND MAINTENANCE 17

LIMITATIONS AND ADDITIONAL SERVICES **19**

UNIFORMITY OF CONDITIONS AND LIMITATIONS 19

ADDITIONAL SERVICES 20

APPENDICES

- **Appendix I – Vicinity Map (Figure 1), Site & Exploration Maps (Figures 2A & 2B)**
- **Appendix II – Exploratory Test-Pit Logs, Key Chart (for Soil Classification)**
- **Appendix III – Laboratory Testing Results**
- **Appendix IV – Site Photos**
- **Appendix V – Slope Stability Analyses**
- **Appendix VI – Cut-Fill Transition Details (Figures 3A – 3D)**
- **Appendix VII – Miscellaneous Documents**
- **Appendix VIII – Washington Department of Ecology Well Logs**
- **Appendix IX – NRCS Soil Survey**
- **Appendix X – USGS Design Maps Summary**

EXECUTIVE SUMMARY

GN Northern, Inc. has prepared this executive summary solely to provide a general overview of the report. The report itself should be relied upon for information about the findings, conclusions, recommendations, and other concerns. The intent of this geologic hazards assessment report is to assess various geologic hazards that may impact the proposed development and provide recommendations for mitigation, as necessary.

The proposed Valhalla Height, Phases 3 & 4, residential subdivision project site is located at the northwest terminus of W. Goodlander Road in the City of Selah, Yakima County, Washington. The project site currently consists of approximately 24.6 acres of undeveloped hillside terrain with a moderate growth of native grasses and brush. Portions of the project site are relatively steep and surface soils are considered to be potentially erodible.

Our site assessment was performed to identify common geotechnical and geologic conditions in the project region, including general and site specific soil and bedrock conditions, groundwater, slopes, drainage, erosion, and geologic hazards. A review of selected information pertaining to the project site and surrounding region was performed that included published technical literature, published geologic maps, available aerial photographs, and previous geotechnical/geologic studies prepared for this and other sites in the vicinity. Site specific geologic and geotechnical data was obtained from our field exploration program consisting of eleven test-pit excavations to observe the subsurface soil conditions and obtain samples for laboratory testing.

Development on sloping ground poses an inherent risk related to global and local stability of site slopes. The proposed project site development will require careful design and construction including slope stabilization and drainage/erosion control measures to mitigate the observed geotechnical and geologic site constraints.

In our professional opinion, the proposed project may be constructed as planned, provided that the recommendations in this report are incorporated in the final design and construction. Based on our site evaluation and analysis, the existing native slope conditions are relatively stable however proposed cut and fill slopes for the planned development will require mitigation measures as recommended within this report to increase safety factors of the reconfigured slopes. In our professional opinion, proper development of the proposed project will not pose a threat to public health and safety.

INTRODUCTION

Project Description

This geologic hazards assessment has been prepared for the proposed Valhalla Height, Phases 3 & 4, residential subdivision project to be constructed at the northwest terminus of W. Goodlander Road, in the City of Selah, Washington (see Figure 1, Appendix I). We understand that the proposed residential development will include approximately 55 lots for future single-family residences. Roadway access to the development will be provided by the extension of W. Goodlander Road.

Site development will generally include clearing and grubbing of vegetation, site grading, roadway surface preparation, underground utility installation, construction of residential streets and sidewalks. Remedial site grading will be necessary to develop stable cut and fill slopes and provide uniform support for proposed structures, roadways, and infrastructure improvements.

Purpose and Scope of Services

The purpose of our services was to evaluate the surface and subsurface soil and bedrock conditions and potential geologic hazards as they relate to the proposed future residential development and provide professional opinions and recommendations for mitigations of any identified geotechnical and/or geologic constraints. The scope of work included the following:

- A general reconnaissance of the site.
- Subsurface exploration by excavating eleven exploratory test-pits to depths ranging from approximately 2 to 15 feet below existing grade.
- Laboratory testing of selected soil samples obtained from the exploratory test-pits.
- A review of selected published technical literature pertaining to the site and previous geotechnical/geologic reports prepared for similar projects in the vicinity.
- An engineering analysis and evaluation of the acquired data from the exploration and testing programs.
- Stability analysis of existing and proposed slopes.
- A summary of our findings and recommendations in this written report.

This report contains the following:

- Discussions on subsurface soil, bedrock and groundwater conditions.
- Discussions on regional and local geologic conditions.
- Discussions on geologic and seismic hazards.
- Graphic and tabulated results of laboratory tests and field studies.
- Preliminary recommendations regarding:
  - Site development and grading criteria including cut and fill slope construction.
  - Excavation conditions.
  - Seismic design parameters.

Not Contained in This Report: Although available through GN Northern, the current scope of our services does not include:

- Site-specific geotechnical engineering evaluation or recommendations for future proposed residential structures or improvements beyond the proposed subdivision infrastructure.
- An environmental assessment.
- An investigation for the presence or absence of wetlands, hazardous or toxic materials in the soil, surface water, groundwater, or air on, below, or adjacent to the subject property.

METHODS OF EXPLORATION AND TESTING

Technical Literature and Aerial Photo Review

A review of selected information pertaining to the site and surrounding area was performed that included published technical literature, published geologic maps, aerial photographs and previous geotechnical and geologic reports prepared for this and other sites in the vicinity. The review was performed to identify typical geotechnical and geologic constraints that may affect the proposed development, including soil and bedrock conditions, groundwater, slopes, drainage, erosion, and geologic hazards.

Field Reconnaissance

Field reconnaissance of the subject property was performed in conjunction with our subsurface exploration on June 23, 2014 to observe the on-site surficial geologic and geotechnical conditions and to confirm the data obtained from our technical literature review.

Field Exploration

Eleven exploratory test-pits were excavated to depths ranging from approximately 2 to 15 feet below the existing ground surface to observe the soil profile and to obtain samples for laboratory testing. The test-pits were excavated on June 23, 2014, using a track mounted CAT 315C excavator. Approximate test-pit locations are shown on the *Site & Exploration Maps*, Figures 2A & 2B, in Appendix I.

Selected representative samples were obtained from the test-pit spoils. Recovered soil samples were sealed in containers and returned to the laboratory. The final logs of the test-pits represent our interpretation of the contents of the field logs and the results of laboratory testing performed on the samples obtained during the subsurface exploration. The final logs are included in Appendix II of this report. The stratification lines represent the approximate boundaries between soil types, although the transitions may be gradational.

Laboratory Testing

Samples were reviewed along with field logs to select those that would be analyzed further. Those selected for laboratory testing include soils that would likely be exposed and used during grading and those deemed to be within the influence of proposed improvements. Test results are presented in graphic and tabular form in Appendix III of this report. The tests were conducted in general accordance with the procedures of the American Society for Testing and Materials (ASTM) or other standardized methods as referenced below. Our testing program consisted of particle size analysis to classify and evaluate soil composition. The gradation characteristics of selected samples were made by sieve analysis procedures.

DISCUSSION

Site Description

The proposed residential development is to be constructed on an irregular shaped property at the northwest terminus of W. Goodlander Road, in the City of Selah, Washington The project site currently consists of six (6) separate parcels identified as Assessor's Parcel Numbers: 18142714426 (1.67-acre), 18142741404 (9.79-acre), 18142744401 (6.67-acre), 18142633413 (0.6-acre), 18142633409 (0.52-acre) and portion of 18142633400 (12.97). The site location is shown on the *Vicinity Map* (Figure 1, Appendix I).

The project site currently consists of approximately 24.6 acres of undeveloped hillside terrain with a sparse growth of native grass and brush. Un-paved access roads exist at the project site generally from north to south, along with an access road for existing water tanks located in northeastern portion of the site. A minimum of two significant areas of apparent fill were noted during our site visit. An area along the northeastern site boundary was observed as artificial apparently placed during the construction of the water tanks sometime between 2008 and 2009 from our review of selected historic aerial imagery. The fill slope gradient was observed to descend at a slope angle greater than 2:1. Another area of fill north of the cul-de-sac for W. Goodlander Road was noted to be placed sometime between 2006 and 2008.

The subject site is located near the top of an elevated knob/hill in the Selah Heights area. Native slopes across the project site currently descend at gradients ranging from approximately 5 to 55%. Site elevations range from approximately 1,645 to 1,505 feet above MSL, for a total relief within the project boundaries of about 140 feet. Elevations are referenced from the topographic survey provided by Landline Surveying. However, the elevation data on the provided topographic survey pre-dates the construction of the water tanks and the placement of fill in the northern and eastern portions of the site.

The site is generally bounded to the north by Marisa Hill Road, to the northeast and northwest by single-family residences, to the southeast by W. Goodlander Road, and to the west, east and south by native undeveloped hillside property.

Soil/Bedrock Conditions

The field exploration indicates that native site soils consist primarily of Well-Graded Gravel with Silt and Sand (GW-GM), overlying Well-graded Gravel with Sand (GW). The upper 3 to 7 feet was observed to be medium dense to dense, overlying dense to very dense gravels. Slight to moderately cemented gravels were observed in test-pits TP-5, TP-6, TP-7, TP-8, and TP-9. Pockets of hard Clayey Silt were observed in test-pits TP-1 and TP-7. Soils observed in test-pit TP-11 consisted of very dense hardpan and the test-pit was therefore terminated from excavator refusal at 2 feet below ground surface (BGS). Although not encountered in our shallow test-pits, outcrops of sandstone beds were observed on the lower slopes below the project site.

Fill soils were observed in test-pits TP-3 and TP-10. Test-pit TP-3, located north of the cul-de-sac for W. Goodlander Road, consisted of loose Sandy Silt (ML) fill soils to at least 15 feet BGS. The fill soils also included buried organics with some miscellaneous trash and debris. Fill soils in test-pit TP-10, located along the northeastern site boundary, consisted of medium dense, Well-Graded Gravel with Silt and Sand (GW-GM) with organics, overlying medium dense Silty Sand with Gravel (SM) fill soils. Apparent native gravel soils were encountered at approximately 11 feet BGS. Test-pit logs in Appendix II include more detailed descriptions of the soils encountered.

Groundwater

Free groundwater was <u>not</u> encountered in any of the test-pits during exploration. No evidence of onsite surface ponding, springs or seeps was noted during our site reconnaissance. To assist in our evaluation, we have reviewed the Washington State Department of Ecology (DOE) database of nearby well logs to estimated groundwater levels in the vicinity. Based on our review of available data, groundwater levels are believed to be greater than 100 feet deep in the area; the well logs are included in Appendix VII.

Groundwater levels may fluctuate with precipitation, irrigation, drainage, regional pumping from wells, and site grading. Minor localized and seasonal perched groundwater conditions could occur beneath the site above less permeable underlying strata. Groundwater levels may fluctuate with precipitation, irrigation, drainage, and site grading, therefore, the absence of detected groundwater may not represent a permanent condition. Nevertheless, based on the currently available

information, groundwater is not expected to be a significant factor in design or construction at this site.

Geologic Setting

Regional Geology: The project site is located within the Selah Heights region of the Yakima Fold Belts sub-province, formed by north–south compression, within the vast Columbia Basin physiographic province of southeastern Washington. The uplifted Selah Heights are generally situated in the western portion of an east-west trending anticline ridge northwest of the confluence of the Naches and Yakima river valleys. This subject site is underlain by middle to upper Miocene continental sedimentary deposits and rock of the Ellensburg Formation. Overlying sediments include relatively thin surficial deposits consisting of Plio-Pleistocene loess, including silt and fine-grained sands.

Geologic Hazards

Geologic hazards that may affect the development include seismic hazards (ground shaking, surface fault rupture, soil liquefaction, and other secondary earthquake-related hazards), slope instability, flooding, ground subsidence, and erosion. A discussion follows on the specific hazards to this site.

Seismic Hazards

Surface Fault Rupture: For the purposes of this report, an active fault is defined as a fault that has had displacement within the Holocene epoch or last 11,000 years. Due to the lack of known active fault traces in the immediate site vicinity, surface fault rupture is unlikely to occur at the project site. While fault rupture would most likely occur along previously established fault traces, future fault rupture could occur at other locations.

Seismic Conditions: The Yakima region is generally not considered to be located within an area of high seismic activity. There are no confirmed major faults in the region capable of producing strong earthquakes. Anticipated ground motions in the region due to seismic activity along faults in other parts of the Northwest are relatively low.

The two largest crustal earthquakes felt in the state of Washington included the 1872, M 6.8 quake near Lake Chelan and the 1936, M 6.0 Walla Walla earthquake. The following list provides

information regarding historic earthquakes within the past 20 years for epicenters within 100 miles of Selah (city center), Washington (list courtesy of www.city-data.com) listed by magnitude:

Date of Event	Magnitude	Distance from Selah (miles)
April 29, 1965	6.6	96.5
February 14, 1981	5.5	74.0
May 3, 1996	5.5	99.6
October 8, 2006	4.7	52.3
June 18, 1994	4.3	75.4
May 20, 1995	4.2	68.5

While accurate earthquake predictions are not possible, various agencies have conducted statistical risk analyses. The United States Geological Survey [USGS] has completed probabilistic seismic hazard maps. We have used these maps in our evaluation of the seismic risk at the site. Based on limited data obtained during our site evaluation and Table 1613.5.2, Site Class Definitions of the 2012 International Building Code, the sites soil profile is estimated to conservatively classify with a Site Class determinations of "D". Additional geologic studies to obtain data from deeper stratum at the site could result in a reclassification to Site Class "C" due to the likely cemented nature of subsurface sediments.

Spectral response accelerations S_S and S_1 are the short and long period spectral response accelerations used for seismic design expressed in terms of gravity or "*g*". S_S and S_1 are defined as the 5 percent damped, spectral response acceleration at 0.2-second and 1.0-second period respectively, having a 2 percent chance of being exceeded in 50 years, referred to as the Maximum Considered Earthquake [MCE]. Probabilistic ground motions for the site were evaluated using the USGS web site. Based on our evaluation of the site geology and soil conditions encountered (Site Class "D"), we recommend the following IBC (2012) seismic design criteria:

Seismic Design Parameter	Value (units)
S_s	0.522 (g)
S_1	0.215 (g)
F_a	1.383 (unitless)
F_v	1.967 (unitless)
SM_s	0.722 (g)
SM_1	0.423 (g)
SD_s	0.481 (g)
SD_1	0.282 (g)

Secondary Seismic Hazards

Secondary seismic hazards related to ground shaking include soil liquefaction, ground subsidence, tsunamis, and seiches. The site is far inland, so the hazard from tsunamis is non-existent. The existing water storage tanks near the northeast portion of the site were constructed relatively recently (circa 2008-2009) and presumably engineered/constructed to resist seismic hazards. No other elevated water storage reservoirs are located in the immediate vicinity of the site. Therefore, hazards from seiches are considered low.

Soil Liquefaction: Liquefaction is the loss of soil strength from sudden shock (usually earthquake shaking), causing the soil to become a fluid mass. In general, for the effects of liquefaction to be manifested at the surface, groundwater levels must be within 50 feet of the ground surface and the soils within the saturated zone must also be susceptible to liquefaction. The potential for liquefaction to occur at this site is considered negligible because the following factors: relatively shallow sedimentary bedrock is present beneath the site; depth of groundwater beneath the site exceeds 50 feet; and low anticipated seismic accelerations in the region.

Slope Stability

The subject site is located near the top of an elevated knob/hill in the Selah Heights area. Native slopes across the project site currently descend at gradients ranging from approximately 5 to 55%. Site elevations range from approximately 1,645 to 1,505 feet above MSL, for a total relief within the project boundaries of about 140 feet.

A field reconnaissance of the project site was performed to observe site conditions and correlate the information gathered from our preliminary research. During our reconnaissance we looked for common geomorphic features of landslides as well as indications of possible signs demonstrating recent activity and instability of slide masses. Some slopes located below and outside the boundaries of the project site are notably steeper. No evidence of any significant slope instability within the native conditions was noted at the site.

We have performed slope stability analyses of the various slope conditions of the site, both existing and proposed (see Slope Stability Analysis below). Modeling of the slope configurations were based on our investigation and research. Based on our analyses, it appears that the native

slopes with gradients ranging from approximately 5 to 55% are considered grossly stable with relatively high factors of safety against movement. The existing native onsite vegetation serves to provide protection from shallow surficial instability and erosional forces.

Flooding and Erosion

Based on GIS data from the Yakima County website (Yakimap.com) the areas of proposed development at the project site are not mapped within designated FEMA 100 or 500-year flood plains. The project site is situated in an area where sheet flow and erosion may occur. The near surface site soils are known to exhibit a potential for erosion. The need for and design of flood control devices and erosion protection measures is within the purview of the design civil engineer. In general, erosion should be mitigated with best management practices (BMPs) consisting of proper drainage design including collecting and disposal (conveyance) of water to approved points of discharge in a non-erosive manner. Appropriate project design, construction, and maintenance will be necessary to mitigate the potential for site erosion hazards.

Slope Stability Analysis

Slope stability analyses were conducted on the existing slopes to evaluate their present state of stability as well as likely proposed re-graded slope configurations for the project site. The analyses were conducted using a generalized geologic cross section model developed from previously prepared topographic survey prepared by Landline Surveyors and data obtained our subsurface explorations. However, the elevation data on the provided topographic survey pre-dates the construction of the water tanks and the placement of fill in the northern and eastern portions of the site.

The slope stability analyses were conducted by a two-dimensional limit equilibrium stability analysis of selected trial failure surfaces using the computer program *STABL6* (Carpenter, 1986). Potential circular-arc failure surfaces were evaluated using the modified Bishop Method. The computer program searched for critical potential failure surfaces with low computed factors of safety.

The computed factor of safety (FS) against slope failure is simply the ratio of total resisting forces or moments (strength of the slope) to the total driving forces or moments for planar or circular

failure surfaces respectively. A slope with a factor of safety of 1.0 is in equilibrium, indicating that the disturbing forces driving the slope down are equal to its strength to resist failure. Simply put slope-failure result when the strength of the slope is overcome by gravity.

Although earthquakes are generally not a significant concern in the Yakima County region, and anticipated seismic accelerations are expected to be relatively low, the stability of the slopes have been analyzed under both static and seismic conditions. Our analysis used the pseudostatic method which modifies the limit equilibrium method by incorporating a horizontal static seismic force to simulate the potential inertial forces generated from earthquake ground accelerations.

For slope stability analyses under seismic loading, a pseudostatic seismic coefficient, k_h (horizontal component), expressed in terms of acceleration (units of *g*), is typically calculated as 50% of the horizontal peak ground acceleration (PGA). According to the International Building Code, the PGA may be taken as 2/3*Ss/2.5, this results in a pseudostatic seismic coefficient: k_h value = $0.5*2/3*0.52/2.5 = 0.07_g$.

The selection of unit weight and shear strength parameters for the various earth materials were based on judgment and data obtained during our field investigation, laboratory testing, review of previous studies, research and previous experience with similar materials in similar geotechnical and geologic settings. Engineering and geologic judgment must be applied to soil/rock strength parameters in order to consider lateral and vertical variations in the subsurface conditions, such as degree of cementation, fracturing, planes of weakness, and gradational characteristics. The following geotechnical strength parameters were used in our stability calculations:

Earth Material	Shear Strength Parameters		Unit Weight
	Friction Angle: ϕ	Cohesion: c (psf)	(pcf)
Surface Silty Sand / Sandy Silt (SM/ML)	30	0	110
Sandy Gravels (GM/GW)	40	250	140
Compacted Engineered Fill (derived from the native soils)	36	50	135

The results of the stability analyses, using the shear strength data as described above, are presented on the following table. The factor of safety of against slope failure was computed for existing and

proposed slope configurations (presumed to be a maximum of 2H:1V or 50%) as indicated on the attached table. The results of the slope stability analyses are attached to this report in Appendix VII and summarized below:

Slope Section	Slope Condition	Static Factor of Safety	Seismic Factor of Safety
Section A-A'	Native	3.84	2.95
Section B-B'	Native	2.05	1.72
Section C-C'	Native	2.17	1.82
Section D-D'	Native – Upper	2.20	1.89
Section D-D'	Native – Lower	1.28	1.13
2H:1V	Proposed	1.77	1.51

* the lower portion of cross-section D-D' is located outside of the project boundaries

GN Northern recommends that all site slopes be designed to meet a minimum factor of safety of 1.5 for the static condition and 1.1 under seismic loading. Based on our analysis, the existing site slopes within the proposed project boundaries meet these minimum factors of safety. Our analysis further indicates that the proposed graded slopes can be properly designed and constructed to meet or exceed these minimums.

CONCLUSIONS

The following is a summary of our conclusions and professional opinions based on the data obtained from a review of selected technical literature and the site evaluation.

General

- ***Based on our understanding of the proposed development and subsurface conditions, from a geotechnical and geologic perspective, it is our professional opinion that the site is suitable for the proposed development, provided the recommendations in this report and any subsequent site specific/design-level geotechnical evaluations are followed in the design and construction of this project.***

Geotechnical Constraints and Mitigation:

- The primary geologic hazards and site constraints are surface erosion and the potential for slope failures. However, based on our site evaluation, the potential risk of slope failure and erosion is relatively low. Engineered design and careful construction as recommended within this report can mitigate these geologic constraints and increase safety to allow development of potentially geologically hazardous areas.

- Development on sloping ground poses an inherent risk related to global and local stability of site slopes. The proposed project site development will require careful design and construction including proper re-grading of slopes and installation drainage/erosion control measures to mitigate any geotechnical and geologic site constraints.

- Other common geologic hazards, including fault rupture, liquefaction, and seismic shaking are considered low or negligible on this site.

- Adherence to the grading and structural recommendations in this report and any subsequent design-level geotechnical evaluation should reduce the potential hazard of slope failure, erosion and settlement problems.

- The soils are susceptible to wind and water erosion. Preventative measures to control runoff and reduce erosion should be incorporated into future site grading plans. Dust control should also be implemented during construction.

- Site grading for future development will require mitigation of undocumented fill(s).

- Future development plans should provide for appropriate setbacks from descending slopes.

- Permanent reconfigured slopes should be constructed at a maximum gradient of 2:1 (horizontal:vertical).

- ***In our professional opinion, proper development of the proposed project will not pose a threat to public health and safety.***

RECOMMENDATIONS

The recommendations in this report are indented to address any potential geologic hazards relative to general development of the proposed residential subdivision and infrastructure. Additional structure- and site-specific design-level geotechnical investigation(s) and recommendations will be necessary to address site constraints of future additional structures and improvements.

Site Development – Grading

A representative of GNN should observe site clearing, grading, and the bottoms of excavations before placing fill. Local variations in soil conditions may warrant increasing the depth of recompaction and over-excavation.

Clearing and Grubbing: At the start of site grading, areas of proposed improvements should be cleared of existing vegetation, trees, large roots, non-engineered fill, construction debris, trash, and abandoned underground utilities. The surface should be stripped of organic growth and removed from the construction area. Areas disturbed during clearing should be properly backfilled and compacted as described below.

Removal of existing vegetation should be carefully controlled and limited to only those areas of proposed improvements and associated grading. Native site vegetation and surface conditions should be maintained in their native condition to the greatest extent possible during construction. Areas disturbed during grading and construction should employ appropriate BMPs and be immediately protected and/or re-vegetated to control runoff and erosion.

Engineered (Structural) Fill: The native soil is suitable for use as engineered fill and utility trench backfill, provided it is free of significant organic or deleterious matter. The native soil should be placed in maximum 8-inch lifts (loose) and compacted to at least 95% relative compaction (ASTM D 1557) near its optimum moisture content. Compaction should be verified by testing. Rocks larger than 6 inches in greatest dimension should be removed from fill or backfill material.

Imported fill soils (if needed) should be non-expansive, granular soils meeting the USCS classifications of SM, GM, SP-SM, or SW-SM with a maximum rock size of 3 inches and 5 to 35% passing the No. 200 sieve. The geotechnical engineer should evaluate the import fill soils before hauling to the site. However, because of the potential variations within the borrow

source, import soil will not be prequalified by GNN. The imported fill should be placed in lifts no greater than 8 inches in loose thickness and compacted to at least 95% relative compaction (ASTM D 1557) near optimum moisture content.

Excavations

Excavations at the site should be made in accordance with requirements of Chapter 296-155, Part N of the Washington Administrative Code (WAC). Our site exploration and knowledge of the general area indicates there is a potential for caving of site excavations (utilities, footings, etc.). Excavations within sandy soil should be kept moist, but not saturated, to reduce the potential of caving or sloughing. Where excavations over 4 feet deep are planned, lateral bracing or appropriate cut slopes of 1.5:1 (horizontal:vertical) should be provided. No surcharge loads from stockpiled soils or construction materials should be allowed within a horizontal distance measured from the top of the excavation slope and equal to the depth of the excavation.

In accordance with the standards of WAC Ch. 296-155, Part N and the general soil information obtained during our field exploration, classification of the near surface on-site soils will likely be characterized as Type C. Actual classification of site specific soil type as they pertain to excavating, trenching, and shoring safety should be based on real-time observations and determinations of exposed soils by the Competent Person during grading and trenching operations.

Graded Slope Construction

Development on sloping ground poses an inherent risk related to global and local stability of site slopes. In order to mitigate the potential hazards of erosion and slope instability, site development will require careful design and construction and implementation of proper drainage/erosion control measures to mitigate the observed geotechnical and geologic site constraints.

Based on our slope stability analyses, properly re-constructed cut/fill slopes can be safely developed at gradients as steep as 2H:1V provided the recommendations in this report are followed during design and construction.

Fill slopes should be overfilled and trimmed back to competent material. Back-drains and seepage control measures are not expected to be required because of the relatively free draining nature of the native soils. The project engineering geologist should observe all construction cuts to inspect

for adverse geologic conditions and make appropriate recommendations based on the exposed conditions. Grading details for proper slope construction are included in Appendix VI attached to this report.

BMPs to control erosion on all graded slopes will be required. Landscaping should take into consideration the engineering characteristics of the slopes, especially with regards to the surficial stability of the slopes.

Fill Slopes (2:1 Maximum Gradient)

Fill slopes should be constructed at a maximum slope of 2H:1V (horizontal to vertical). Fill slopes should be constructed with suitable structural fill soil that has been properly moisture conditioned and compacted as recommended in this report. Fill slopes should be overfilled and trimmed back to uniformly compacted material. The final slope surface should be track-walked or grid rolled to improve the slope's resistance to erosion.

Where fill slopes are to be constructed on natural slopes steeper than 5:1, the fill should be keyed and benched into firm natural soil (see Appendix VI).

Slopes constructed as fill over cut will necessitate specific grading methods to provide bonding of the fill and to help mitigate the possibility of creating a weak plane between fill and cut which could potentially affect slope stability. Refer to Appendix VI for a graphic representation of the recommended fill over cut slope configuration.

Prior to placement of fill in fill over cut slopes, cut slopes should be visually observed by the engineering geologists, or their representatives, to check for adverse geologic features exposed within the slope face. The geotechnical consultant should monitor this remedial grading.

Keys for all slope reconstruction greater than 5 feet in height should be cut into firm natural soil. The minimum key dimensions are 10 feet horizontal and 2 feet vertical from the lowest adjacent soil grade. Before fill is placed, the key should be observed by the geotechnical engineer, or their representative, to observe compliance with the above recommendations and the possible need for bench drains or sub-drains, if required. A protective berm should be constructed and maintained at the top of all fill slopes to divert any runoff away from the slope face. It is recommended that the

project geotechnical engineer, or their representatives, be present during the fill construction to observe compliance with the above recommendations.

Cut Slopes (2:1 Maximum Gradient)

Cut slopes should be constructed at a maximum slope of 2H:1V (horizontal to vertical). Refer to Appendix VI for a graphic representation of the recommended cut slope construction detail. The engineering geologists, or their representatives, should monitor cut slopes during construction, to check for adverse geologic features exposed within the cut face. Although not anticipate, proposed slopes may require finished at a shallower gradient or reconstruction as buttressed slopes if adverse geologic conditions are exposed during construction.

If buttressing for stabilization is required, backcuts should be at an angle of 1:1 or flatter unless local conditions allow a steeper cut, where approved by the project engineering geologist. Localized areas of backcut failure should be anticipated.

Temporary backcuts for keyways and benches may be excavated vertical up to 5 feet in height. Backcut failures may occur during keyway and benching operations. Careful grading operations should be implemented when working adjacent to vertical backcuts. Where unstable conditions may exist, backcut slopes should be laid back to a 1:1 or flatter configuration as recommended by the project geologist or geotechnical engineer.

Slope Protection and Maintenance

Proper slope protection and maintenance should help minimize slope erosion and improve the stability of the project slopes. The project soils are potentially prone to erosion and will require appropriate protection and maintenance.

Positive drainage should be provided at the tops of all slopes to divert runoff away from the face. Swales constructed in native soils should be lined with gunite, concrete, or other suitable no-erosive material. Erosion protection should be provided, especially where concentrated runoff is anticipated.

A qualified Landscape Architect should provide recommendations for slope planting. As the exposed site soils are susceptible to erosion, it is required that erosion control measures, such as

planting, erosion control blankets or fabrics, sprayed tackifiers, or some combination of these, be utilized on all slopes within this project. Landscaping should take into consideration the engineering characteristics of the slopes, especially with regards to the surficial stability.

Periodic maintenance and repair of slopes and drainage structures should be performed. Drainage inlets, outlets, and spillways should be periodically inspected and cleaned of soils and debris. Slope plantings and irrigation systems should consider low water tolerant plants with drip irrigation and be well maintained. All slopes should be periodically inspected for evidence of cracking, erosion, and rodent infestation and any observed problems should be repaired.

LIMITATIONS AND ADDITIONAL SERVICES

Uniformity of Conditions and Limitations

Our findings and recommendations in this report are based on selected points of field exploration, laboratory testing, and our understanding of the proposed project. Furthermore, our findings and recommendations are based on the assumption that soil and rock conditions do not vary significantly from those found at specific exploratory locations. Variations in soil or groundwater conditions could exist between and beyond the exploration points. The nature and extent of these variations may not become evident until construction. Variations in soil or groundwater may require additional studies, consultation, and possible revisions to our recommendations.

Findings of this report are valid as of the issued date of the report. However, changes in conditions of a property can occur with passage of time, whether they are from natural processes or works of man, on this or adjoining properties. In addition, changes in applicable standards occur, whether they result from legislation or broadening of knowledge. Accordingly, findings of this report may be invalidated wholly or partially by changes outside our control. Therefore, this report should not be relied upon after a period of one year without subsequent review by GNN.

In the event that any changes in the nature, design, or location of structures are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report are modified or verified in writing.

This report is issued with the understanding that the owner or the owner's representative has the responsibility to bring the information and recommendations contained herein to the attention of the architect and engineers for the project so that they are incorporated into the plans and specifications for the project. The owner or the owner's representative also has the responsibility to verify that the general contractor and all subcontractors follow such recommendations. It is further understood that the owner or the owner's representative is responsible for submittal of this report to the appropriate governing agencies.

As the Geologist / Geotechnical Engineer of Record for this project, GN Northern (GNN) has striven to provide our services in accordance with generally accepted geologic / geotechnical

engineering practices in this locality at this time. No warranty or guarantee is express or implied. This report was prepared for the exclusive use of the Client and the Client's authorized agents.

GNN should be provided the opportunity for a general review of final design and specifications in order that earthwork recommendations may be properly interpreted and implemented in the design and specifications. If GNN is not accorded the privilege of making this recommended review, we can assume no responsibility for misinterpretation of our recommendations.

Although available through GNN, the current scope of our services does not include a design-level geotechnical engineering evaluation, environmental assessment, or an investigation for the presence or absence of wetlands, hazardous or toxic materials in the soil, surface water, groundwater, or air on, below, or adjacent to the subject property.

Additional Services

This report is based on the assumption that an adequate program of client consultation, construction monitoring, and testing will be performed during the final design and construction phases to check compliance with these recommendations. Maintaining GNN as the geologic/geotechnical consultant from beginning to end of the project will provide continuity of services. *The geotechnical engineering firm providing tests and observations shall assume the responsibility of Geotechnical Engineer of Record.*

Construction monitoring and testing would be additional services provided by our firm. The costs of these services are not included in our present fee arrangements, but can be obtained from our office. The recommended review, tests, and observations include, but are not necessarily limited to, the following:

- Consultation during the final design stages of the project.
- A review of the building and grading plans to observe that recommendations of our report have been properly implemented into the design.
- Observation and testing during site preparation, grading, and placement of engineered fill as required by local grading ordinances.
- Consultation as needed during construction.

APPENDICES

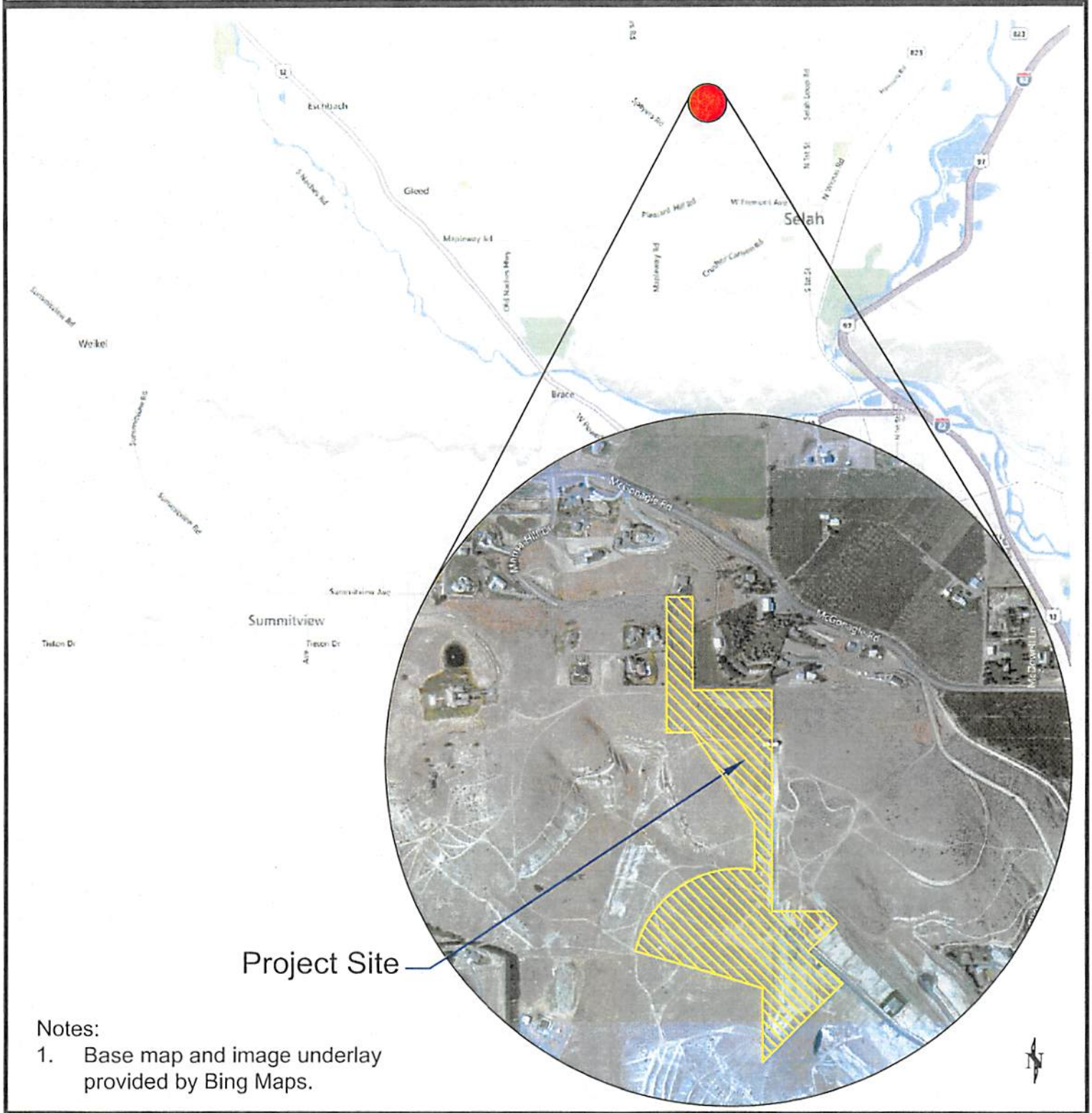
Appendix I

Vicinity Map (Fig. 1)

Site & Exploration Maps (Figs. 2A & 2B)

Northern, Inc.

Consulting Engineers Environmental Scientists Construction Materials Testing



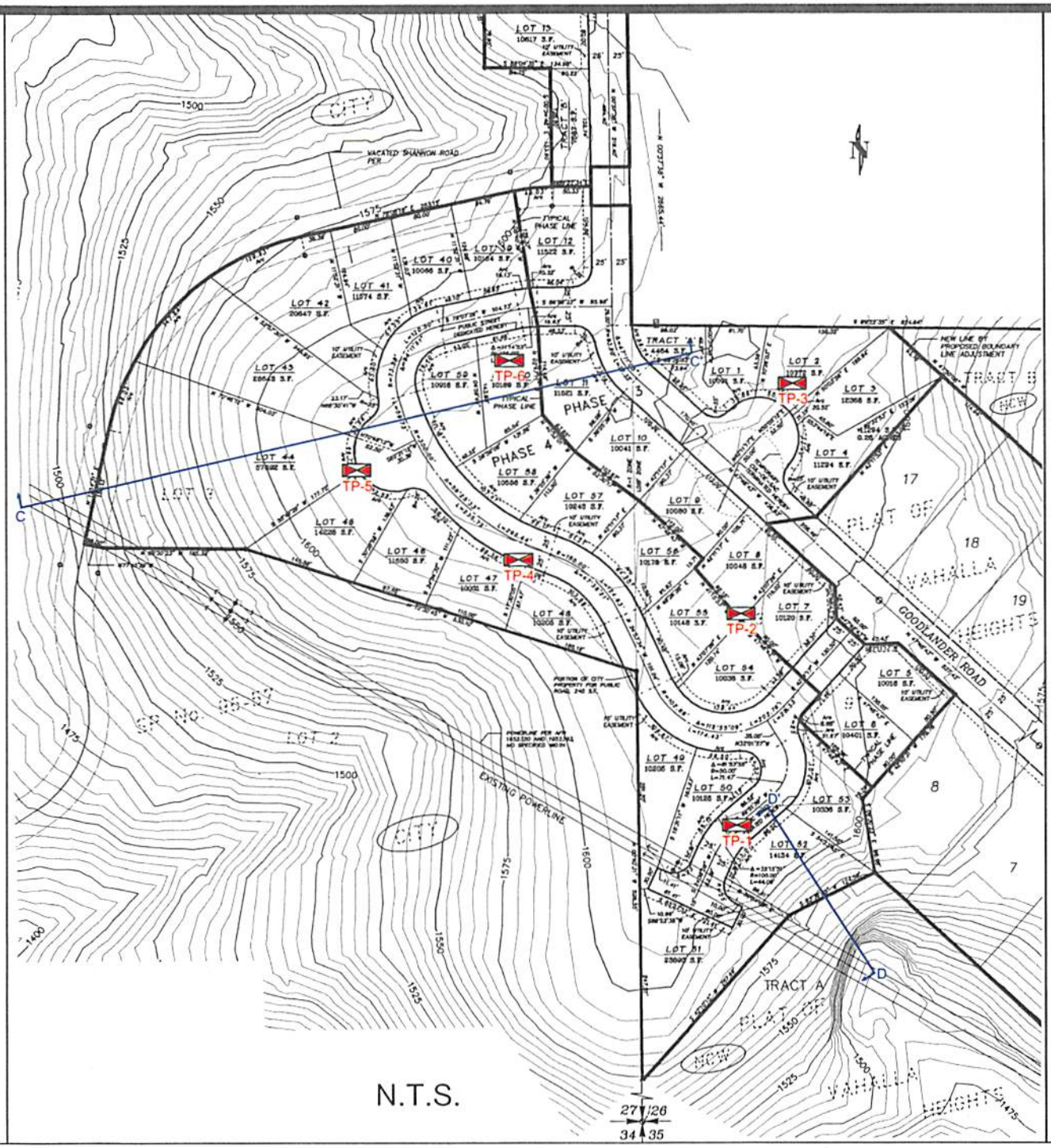
Notes:

1. Base map and image underlay provided by Bing Maps.

GN Northern, Inc. Job Number: 214-498	**Vicinity Map** Proposed Residential Development Valhalla Heights Addition Selah, Yakima County, Washington			
	Date 6/30/2014	Drawn By YM	Reviewed By KAH	Figure 1

Northern, Inc.

Consulting Engineers Environmental Scientists Construction Materials Testing



Notes:

Base map titled *Valhalla Heights Addition*, dated 6/7/14, prepared by *Landline Surveying*

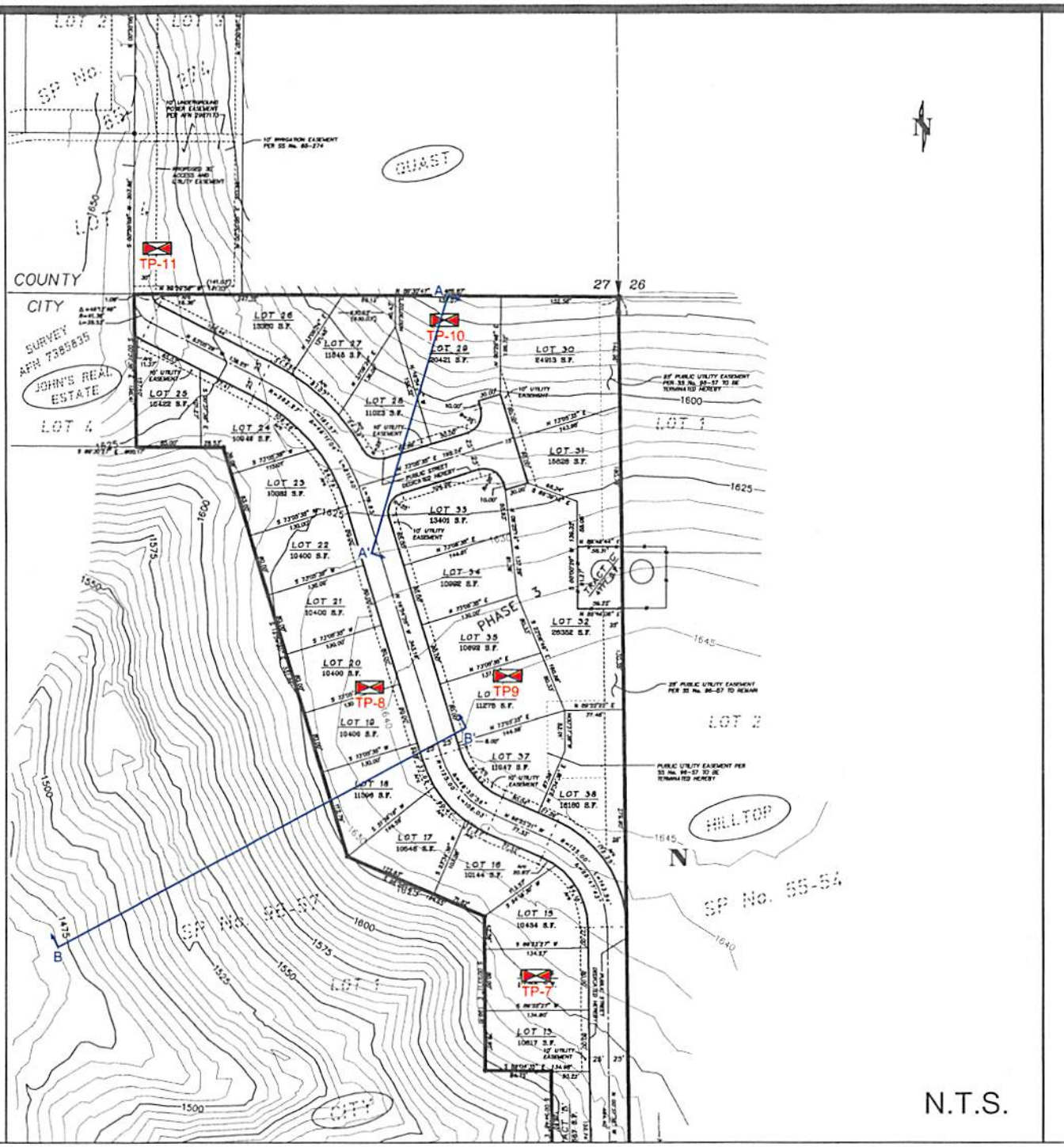
Legend:

Test-pit location

GN Northern, Inc. Job Number: 214-498	**Site & Exploration Map** Proposed Residential Development Valhalla Heights Addition Selah, Yakima County, Washington			
	Date 6/30/2014	Drawn By YM	Reviewed By KAH	Figure 2A

Northern, Inc.

Consulting Engineers Environmental Scientists Construction Materials Testing



Notes:
Base map titled *Valhalla Heights Addition*, dated 6/7/14, prepared by *Landline Surveying*

Legend:
Test-pit location

GN Northern, Inc. Job Number: 214-498	**Site & Exploration Map** Proposed Residential Development Valhalla Heights Addition Selah, Yakima County, Washington			
	Date 6/30/2014	Drawn By YM	Reviewed By KAH	Figure 2B

Appendix II

Exploratory Test-Pit Logs

Key Chart (for Soil Classification)

GN Northern
722 N. 16th Avenue, Suite 31
Yakima, WA 98902
Telephone: 509-248-9798
Fax: 509-248-4220

TEST PIT NUMBER TP-1

CLIENT NCW Development, LLC
PROJECT NAME Valhalla Heights Addition
PROJECT NUMBER 214-498
PROJECT LOCATION Selah, Washington
DATE STARTED 6/23/14 **COMPLETED** 6/23/14
GROUND ELEVATION 1616 ft **TEST PIT SIZE** 36 x 120 inches
EXCAVATION CONTRACTOR Calvert Excavating Inc
GROUND WATER LEVELS:
EXCAVATION METHOD Cat 315C Excavator
AT TIME OF EXCAVATION ---
LOGGED BY KH **CHECKED BY** KH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°40'1.92"N, 120°33'4.23"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0		GW-GM		WELL GRADED GRAVEL WITH SILT AND SAND, (GW-GM) tan, rounded, dry, medium dense to dense, with cobbles	
2.0					1614.0
2.5		GW		WELL GRADED GRAVEL WITH SAND, (GW) brown, rounded, dry to moist, medium dense to dense, with cobbles	
				- pocket of clayey silt, dark brown, hard	
5.0				- soil becomes dense to very dense	
7.5					
10.0					
11.5					1604.5

- Test-pit terminated at approximately 11.5 feet BGS, no groundwater at the time of excavation
- Referenced elevations are approximate and are based on topographic survey prepared by Landline Surveying

Bottom of test pit at 11.5 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 7/1/14 16:18 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\PROJECTS\214-498 VALHALLA HEIGHTS ADDITION, SELAH.GPJ

GN Northern
722 N. 16th Avenue, Suite 31
Yakima, WA 98902
Telephone: 509-248-9798
Fax: 509-248-4220

TEST PIT NUMBER TP-2

CLIENT NCW Development, LLC
PROJECT NAME Valhalla Heights Addition
PROJECT NUMBER 214-498
PROJECT LOCATION Selah, Washington
DATE STARTED 6/23/14 **COMPLETED** 6/23/14
GROUND ELEVATION 1613 ft **TEST PIT SIZE** 36 x 120 inches
EXCAVATION CONTRACTOR Calvert Excavating Inc
GROUND WATER LEVELS:
EXCAVATION METHOD Cat 315C Excavator
AT TIME OF EXCAVATION ---
LOGGED BY KH **CHECKED BY** KH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°40'4.52"N, 120°33'4.25"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			GW-GM		WELL GRADED GRAVEL WITH SILT AND SAND, (GW-GM) tan, rounded, dry, medium dense to dense, with cobbles
2.0					1611.0
2.5	GB	Fines = 1%	GW		WELL GRADED GRAVEL WITH SAND, (GW) brown, rounded, dry to moist, medium dense to dense, with cobbles
5.0					- soil becomes dense to very dense
7.5					
10.0					
11.5					1601.5

- Test-pit terminated at approximately 11.5 feet BGS, no groundwater at the time of excavation
- Referenced elevations are approximate and are based on topographic survey prepared by Landline Surveying

Bottom of test pit at 11.5 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 7/1/14 16:18 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\PROJECTS\214-498 VALHALLA HEIGHTS ADDITION, SELAH.GPJ

GN Northern
722 N. 16th Avenue, Suite 31
Yakima, WA 98902
Telephone: 509-248-9798
Fax: 509-248-4220

TEST PIT NUMBER TP-3

CLIENT NCW Development, LLC
PROJECT NAME Valhalla Heights Addition
PROJECT NUMBER 214-498
PROJECT LOCATION Selah, Washington
DATE STARTED 6/23/14 **COMPLETED** 6/23/14
GROUND ELEVATION 1607 ft **TEST PIT SIZE** 36 x 120 inches
EXCAVATION CONTRACTOR Calvert Excavating Inc
GROUND WATER LEVELS:
EXCAVATION METHOD Cat 315C Excavator
AT TIME OF EXCAVATION ---
LOGGED BY KH **CHECKED BY** KH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°40'7.44"N, 120°33'3.10"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0					FILL: SANDY SILT, (ML) tan, dry, loose, with buried organics and trash
2.5	GB	MC = 8% Fines = 49%			
5.0					- soil becomes loose to medium dense
7.5			ML		
10.0					
12.5					
15.0				15.0	1592.0

- Test-pit terminated at approximately 15 feet BGS, no groundwater at the time of excavation
- Referenced elevations are approximate and are based on topographic survey prepared by Landline Surveying

Bottom of test pit at 15.0 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 7/1/14 16:18 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\PROJECTS\214-498 VALHALLA HEIGHTS ADDITION, SELAH.GPJ

GN Northern
722 N. 16th Avenue, Suite 31
Yakima, WA 98902
Telephone: 509-248-9798
Fax: 509-248-4220

TEST PIT NUMBER TP-4

CLIENT NCW Development, LLC
PROJECT NAME Valhalla Heights Addition
PROJECT NUMBER 214-498
PROJECT LOCATION Selah, Washington
DATE STARTED 6/23/14 **COMPLETED** 6/23/14
GROUND ELEVATION 1618 ft **TEST PIT SIZE** 36 x 120 inches
EXCAVATION CONTRACTOR Calvert Excavating Inc
GROUND WATER LEVELS:
EXCAVATION METHOD Cat 315C Excavator
AT TIME OF EXCAVATION ---
LOGGED BY KH **CHECKED BY** KH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°40'5.23"N, 120°33'8.41"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0		GW-GM		WELL GRADED GRAVEL WITH SILT AND SAND, (GW-GM) tan, rounded, dry, medium dense to dense, with cobbles	
2.0					1616.0
2.5		GW		WELL GRADED GRAVEL WITH SAND, (GW) brown, rounded, dry to moist, medium dense to dense, with cobbles	
5.0					
7.5				- soil becomes dense to very dense	
10.0					1608.0

- Test-pit terminated at approximately 10 feet BGS, no groundwater at the time of excavation
- Referenced elevations are approximate and are based on topographic survey prepared by Landline Surveying

Bottom of test pit at 10.0 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 7/1/14 16:18 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\PROJECTS\214-498 VALHALLA HEIGHTS ADDITION, SELAH.GPJ

GN Northern
722 N. 16th Avenue, Suite 31
Yakima, WA 98902
Telephone: 509-248-9798
Fax: 509-248-4220

TEST PIT NUMBER TP-5

CLIENT NCW Development, LLC
PROJECT NAME Valhalla Heights Addition
PROJECT NUMBER 214-498
PROJECT LOCATION Selah, Washington
DATE STARTED 6/23/14 **COMPLETED** 6/23/14
GROUND ELEVATION 1615 ft **TEST PIT SIZE** 36 x 120 inches
EXCAVATION CONTRACTOR Calvert Excavating Inc
GROUND WATER LEVELS:
EXCAVATION METHOD Cat 315C Excavator
AT TIME OF EXCAVATION ---
LOGGED BY KH **CHECKED BY** KH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°40'6.37"N, 120°33'11.52"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0					
		GW-GM		WELL GRADED GRAVEL WITH SILT AND SAND, (GW-GM) tan, rounded, dry, medium dense to dense, with cobbles	
2.0					1613.0
2.5		GW		WELL GRADED GRAVEL WITH SAND, (GW) brown, rounded, dry to moist, medium dense to dense, with cobbles	
5.0					
7.5				- soil becomes dense to very dense, slightly cemented, trace boulder	
10.0					1605.0

- Test-pit terminated at approximately 10 feet BGS, no groundwater at the time of excavation
- Referenced elevations are approximate and are based on topographic survey prepared by Landline Surveying

Bottom of test pit at 10.0 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 7/1/14 16:18 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\PROJECTS\214-498 VALHALLA HEIGHTS ADDITION, SELAH.GPJ

GN Northern
722 N. 16th Avenue, Suite 31
Yakima, WA 98902
Telephone: 509-248-9798
Fax: 509-248-4220

TEST PIT NUMBER TP-6

CLIENT NCW Development, LLC
PROJECT NAME Valhalla Heights Addition
PROJECT NUMBER 214-498
PROJECT LOCATION Selah, Washington
DATE STARTED 6/23/14 **COMPLETED** 6/23/14
GROUND ELEVATION 1615 ft **TEST PIT SIZE** 36 x 120 inches
EXCAVATION CONTRACTOR Calvert Excavating Inc
GROUND WATER LEVELS:
EXCAVATION METHOD Cat 315C Excavator
AT TIME OF EXCAVATION ---
LOGGED BY KH **CHECKED BY** KH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°40'8.45"N, 120°33'9.30"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0					
		GW-GM		WELL GRADED GRAVEL WITH SILT AND SAND, (GW-GM) tan, rounded, dry, medium dense to dense, with cobbles	
				- lense of cemented soils, hardpan	
2.0					1613.0
2.5		GW		WELL GRADED GRAVEL WITH SAND, (GW) brown, rounded, dry to moist, medium dense to dense, with cobbles	
5.0					
7.5				- soil becomes dense to very dense, slightly cemented	
10.0				- soil becomes very dense, moderately cemented	
10.5					1604.5

- Test-pit terminated at approximately 10.5 feet BGS, no groundwater at the time of excavation
- Referenced elevations are approximate and are based on topographic survey prepared by Landline Surveying

Bottom of test pit at 10.5 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 7/1/14 16:18 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\PROJECTS\214-498 VALHALLA HEIGHTS ADDITION, SELAH.GPJ

GN Northern
722 N. 16th Avenue, Suite 31
Yakima, WA 98902
Telephone: 509-248-9798
Fax: 509-248-4220

TEST PIT NUMBER TP-7

CLIENT NCW Development, LLC
PROJECT NAME Valhalla Heights Addition
PROJECT NUMBER 214-498
PROJECT LOCATION Selah, Washington
DATE STARTED 6/23/14 **COMPLETED** 6/23/14
GROUND ELEVATION 1626 ft **TEST PIT SIZE** 36 x 120 inches
EXCAVATION CONTRACTOR Calvert Excavating Inc
GROUND WATER LEVELS:
EXCAVATION METHOD Cat 315C Excavator
AT TIME OF EXCAVATION ---
LOGGED BY KH **CHECKED BY** KH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°40'12.40"N, 120°33'7.86"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0		GW-GM		WELL GRADED GRAVEL WITH SILT AND SAND, (GW-GM) tan, rounded, dry, medium dense to dense, with cobbles	
2.0					1624.0
2.5		GW		WELL GRADED GRAVEL WITH SAND, (GW) brown, rounded, dry to moist, medium dense to dense, with cobbles, slightly cemented	
				- pockets of clayey silt, dark brown, hard	
5.0				- soil becomes dense to very dense, moderately cemented	
7.5					
8.0					1618.0

- Test-pit terminated at approximately 8 feet BGS, no groundwater at the time of excavation
- Referenced elevations are approximate and are based on topographic survey prepared by Landline Surveying

Bottom of test pit at 8.0 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 7/1/14 16:18 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\PROJECTS\214-498 VALHALLA HEIGHTS ADDITION, SELAH.GPJ

GN Northern
722 N. 16th Avenue, Suite 31
Yakima, WA 98902
Telephone: 509-248-9798
Fax: 509-248-4220

TEST PIT NUMBER TP-8

CLIENT NCW Development, LLC
PROJECT NAME Valhalla Heights Addition
PROJECT NUMBER 214-498
PROJECT LOCATION Selah, Washington
DATE STARTED 6/23/14 **COMPLETED** 6/23/14
GROUND ELEVATION 1638 ft **TEST PIT SIZE** 36 x 120 inches
EXCAVATION CONTRACTOR Calvert Excavating Inc
GROUND WATER LEVELS:
EXCAVATION METHOD Cat 315C Excavator
AT TIME OF EXCAVATION ---
LOGGED BY KH **CHECKED BY** KH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°40'16.03"N, 120°33'11.05"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0		GW-GM		WELL GRADED GRAVEL WITH SILT AND SAND, (GW-GM) tan, rounded, dry, medium dense to dense, with cobbles	
2.0					1636.0
2.5		GW		WELL GRADED GRAVEL WITH SAND, (GW) brown, rounded, dry to moist, medium dense to dense, with cobbles, slightly cemented - soil becomes dense to very dense, moderately cemented	
5.0					
7.5					
8.0					1630.0

- Test-pit terminated at approximately 8 feet BGS, no groundwater at the time of excavation
- Referenced elevations are approximate and are based on topographic survey prepared by Landline Surveying

Bottom of test pit at 8.0 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 7/1/14 16:18 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\PROJECTS\214-498 VALHALLA HEIGHTS ADDITION, SELAH.GPJ

GN Northern
722 N. 16th Avenue, Suite 31
Yakima, WA 98902
Telephone: 509-248-9798
Fax: 509-248-4220

TEST PIT NUMBER TP-9

CLIENT NCW Development, LLC
PROJECT NAME Valhalla Heights Addition
PROJECT NUMBER 214-498
PROJECT LOCATION Selah, Washington
DATE STARTED 6/23/14 **COMPLETED** 6/23/14
GROUND ELEVATION 1645 ft **TEST PIT SIZE** 36 x 120 inches
EXCAVATION CONTRACTOR Calvert Excavating Inc
GROUND WATER LEVELS:
EXCAVATION METHOD Cat 315C Excavator
AT TIME OF EXCAVATION ---
LOGGED BY KH **CHECKED BY** KH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°40'16.11"N, 120°33'8.35"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0		GW-GM		WELL GRADED GRAVEL WITH SILT AND SAND, (GW-GM) tan, rounded, dry, medium dense to dense, with cobbles	
2.0					1643.0
2.5		GW		WELL GRADED GRAVEL WITH SAND, (GW) brown, rounded, dry to moist, medium dense to dense, with cobbles, slightly cemented	
5.0				- soil becomes dense to very dense, moderately cemented	
7.5					
8.0					1637.0

- Test-pit terminated at approximately 8 feet BGS, no groundwater at the time of excavation
- Referenced elevations are approximate and are based on topographic survey prepared by Landline Surveying

Bottom of test pit at 8.0 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 7/1/14 16:18 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\PROJECTS\214-498 VALHALLA HEIGHTS ADDITION, SELAH.GPJ

GN Northern
722 N. 16th Avenue, Suite 31
Yakima, WA 98902
Telephone: 509-248-9798
Fax: 509-248-4220

TEST PIT NUMBER TP-10

CLIENT NCW Development, LLC
PROJECT NAME Valhalla Heights Addition
PROJECT NUMBER 214-498
PROJECT LOCATION Selah, Washington
DATE STARTED 6/23/14 **COMPLETED** 6/23/14
GROUND ELEVATION 1577 ft **TEST PIT SIZE** 36 x 120 inches
EXCAVATION CONTRACTOR Calvert Excavating Inc
GROUND WATER LEVELS:
EXCAVATION METHOD Cat 315C Excavator
AT TIME OF EXCAVATION ---
LOGGED BY KH **CHECKED BY** KH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°40'20.52"N, 120°33'9.58"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0					FILL: WELL GRADED GRAVEL WITH SILT AND SAND, (GW-GM) tan, rounded, dry, medium dense, with cobbles, with organics	
2.5		Fines = 6%	GW-GM			
5.0						
7.5				7.5		1569.5
			SM		FILL: SILTY SAND WITH GRAVEL, (SM) brown, moist, medium dense	
10.0						
				11.0		1566.0
			GW		WELL GRADED GRAVEL WITH SAND, (GW) brown, rounded, dry to moist, medium dense to dense, with cobbles, (APPARENT NATIVE)	
12.5				12.5		1564.5

- Test-pit terminated at approximately 12.5 feet BGS, no groundwater at the time of excavation
- Referenced elevations are approximate and are based on topographic survey prepared by Landline Surveying

Bottom of test pit at 12.5 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 7/1/14 16:18 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\PROJECTS\214-498 VALHALLA HEIGHTS ADDITION_SELAH.GPJ

GN Northern
722 N. 16th Avenue, Suite 31
Yakima, WA 98902
Telephone: 509-248-9798
Fax: 509-248-4220

TEST PIT NUMBER TP-11

CLIENT NCW Development, LLC
PROJECT NAME Valhalla Heights Addition
PROJECT NUMBER 214-498
PROJECT LOCATION Selah, Washington
DATE STARTED 6/23/14 **COMPLETED** 6/23/14
GROUND ELEVATION 1635 ft **TEST PIT SIZE** 36 x 120 inches
EXCAVATION CONTRACTOR Calvert Excavating Inc
GROUND WATER LEVELS:
EXCAVATION METHOD Cat 315C Excavator
AT TIME OF EXCAVATION ---
LOGGED BY KH **CHECKED BY** KH
AT END OF EXCAVATION ---
NOTES Approx. GPS Coords.: 46°40'21.86"N, 120°33'15.19"W
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0				
			0.3 Organic rich topsoil	1634.8
			HARDPAN, highly cemented soils, very dense	
			2.0	1633.0

- Test-pit terminated at approximately 2 feet BGS, no groundwater at the time of excavation
- Referenced elevations are approximate and are based on topographic survey prepared by Landline Surveying

Bottom of test pit at 2.0 feet.

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 7/1/14 16:18 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\PROJECTS\214-498 VALHALLA HEIGHTS ADDITION, SELAH.GPJ

Northern, Inc.
Kennewick, Yakima, Spokane, Hermiston (OR)

KEY CHART

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE

COARSE-GRAINED SOILS			FINE-GRAINED SOILS		
DENSITY	N (BLOWS/FT)	FIELD TEST	CONSISTENCY	N (BLOWS/FT)	FIELD TEST
Very Loose	0 – 4	Easily penetrated with ½-inch reinforcing rod pushed by hand	Very Soft	0 – 2	Easily penetrated several inches by thumb
Loose	4 – 10	Difficult to penetrate with ½-inch reinforcing rod pushed by hand	Soft	2 – 4	Easily penetrated one inch by thumb
Medium -Dense	10 – 30	Easily penetrated with ½-inch rod driven with a 5-lb hammer	Medium-Stiff	4 – 8	Penetrated over ½-inch by thumb with moderate effort
Dense	30 – 50	Difficult to penetrate with ½-inch rod driven with a 5-lb hammer	Stiff	8 – 15	Indented about ½-inch by thumb but penetrated with great effort
Very Dense	> 50	penetrated only a few inches with ½-inch rod driven with a 5-lb hammer	Very Stiff	15 – 30	Readily indented by thumb
			Hard	> 30	Indented with difficulty by thumbnail

USCS SOIL CLASSIFICATION

MAJOR DIVISIONS			GROUP DESCRIPTION	
Coarse-Grained Soils <50% passes #200 sieve	**Gravel** and **Gravelly Soils** <50% coarse fraction passes #4 sieve	**Gravel** (with little or no fines)	GW	Well-graded **Gravel**
			GP	Poorly Graded **Gravel**
		Gravel (with >12% fines)	GM	Silty **Gravel**
			GC	Clayey **Gravel**
	Sand and **Sandy Soils** >50% coarse fraction passes #4 sieve	**Sand** (with little or no fines)	SW	Well-graded **Sand**
			SP	Poorly graded **Sand**
		Sand (with >12% fines)	SM	Silty **Sand**
			SC	Clayey **Sand**
Fine-Grained Soils >50% passes #200 sieve	**Silt** and **Clay** Liquid Limit < 50		ML	**Silt**
			CL	Lean **Clay**
			OL	Organic **Silt** and **Clay** (low plasticity)
	Silt and **Clay** Liquid Limit > 50		MH	Inorganic **Silt**
			CH	Inorganic **Clay**
			OH	Organic **Clay** and **Silt** (med. to high plasticity)
Highly Organic Soils			PT	**Peat**
				Top Soil

LOG SYMBOLS

	2S	2" OD Split Spoon (SPT)
	3S	3" OD Split Spoon
	NS	Non-Standard Split Spoon
	ST	Shelby Tube
	CR	Core Run
	BG	Bag Sample
	TV	Torvane Reading
	PP	Penetrometer Reading
	NR	No Recovery
	GW	Groundwater Table

MODIFIERS

DESCRIPTION	RANGE
Trace	<5%
Little	5% – 12%
Some	>12%

MOISTURE CONTENT

DESCRIPTION	FIELD OBSERVATION
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but not visible water
Wet	Visible free water

SOIL CLASSIFICATION INCLUDES

1. Group Name
2. Group Symbol
3. Color
4. Moisture content
5. Density / consistency
6. Cementation
7. Particle size (if applicable)
8. Odor (if present)
9. Comments

MAJOR DIVISIONS WITH GRAIN SIZE

SIEVE SIZE						
12"	3"	3/4"	4	10	40	200
GRAIN SIZE (INCHES)						
12	3	0.75	0.19	0.079	0.0171	0.0029

Boulders	Cobbles	Gravel		Sand			Silt and Clay
		Coarse	Fine	Coarse	Medium	Fine	

Conditions shown on boring and testpit logs represent our observations at the time and location of the fieldwork, modifications based on lab test, analysis, and geological and engineering judgment. These conditions may not exist at other times and locations, even in close proximity thereof. This information was gathered as part of our investigation, and we are not responsible for any use or interpretation of the information by others.

Appendix III
Laboratory Testing Results

GN Northern
722 N. 16th Avenue, Suite 31
Yakima, WA 98902
Telephone: 509-248-9798
Fax: 509-248-4220

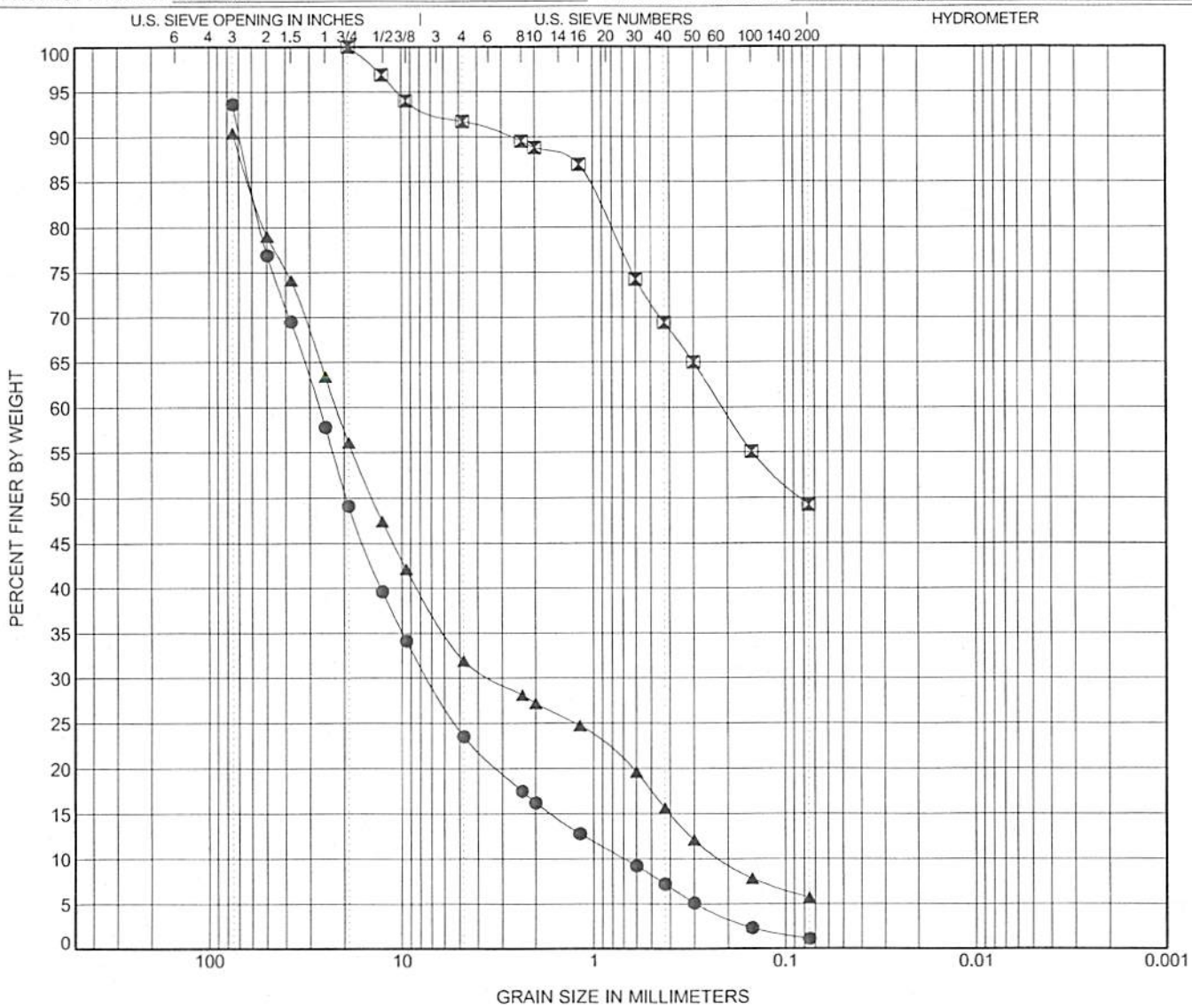
GRAIN SIZE DISTRIBUTION

CLIENT NCW Development, LLC

PROJECT NAME Valhalla Heights Addition

PROJECT NUMBER 214-498

PROJECT LOCATION Selah, Washington



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	TP-2	2.5	WELL-GRADED GRAVEL with SAND(GW)				2.81	38.69
⧗	TP-3	3.0	SANDY SILT(ML)					
▲	TP-10	3.0	WELL-GRADED GRAVEL with SILT and SAND(GW-GM)				2.38	102.88

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-2	2.5	75	26.981	7.266	0.697	70.1	22.4	1.1	
⧗	TP-3	3.0	19	0.211			8.3	42.5	49.2	
▲	TP-10	3.0	75	22	3.348	0.214	58.5	26.2	5.7	

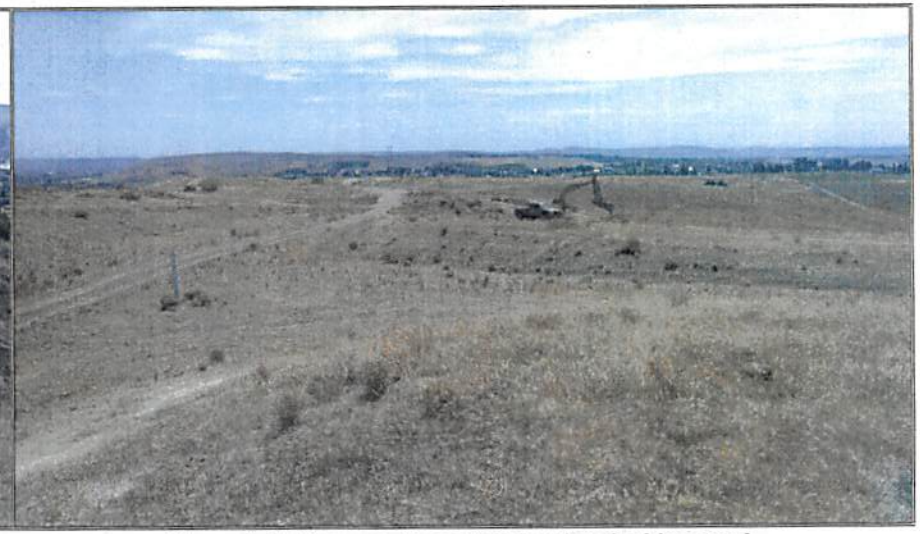
GRAIN SIZE - GINT STD US LAB.GDT - 6/28/14 14:45 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\PROJECTS\214-498 VALHALLA HEIGHTS ADDITION, SELAH.GPJ

Appendix IV
Site Photos

View of site from along southwestern slope, looking northeast

View of southwestern slope, looking northwest

View of site from central portion, looking southeast



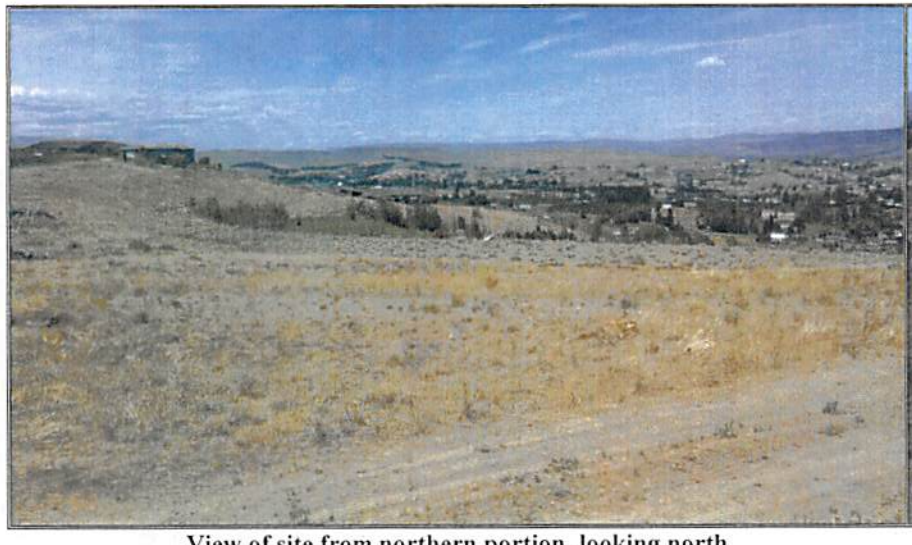
View of site from north-central portion, looking south

Northern, Inc.

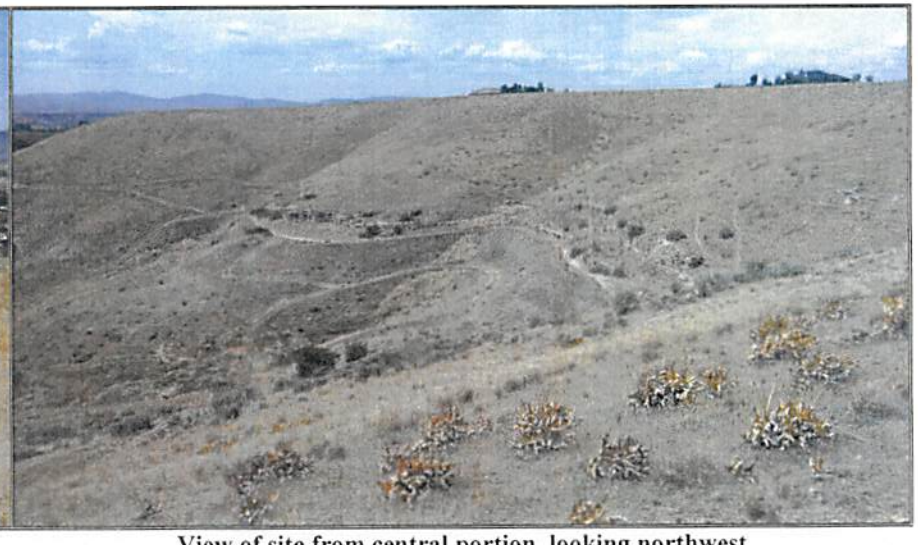
Job Number: 214-498

Site Photos
Proposed Residential Development
Valhalla Heights Addition
Selah, Yakima County, Washington

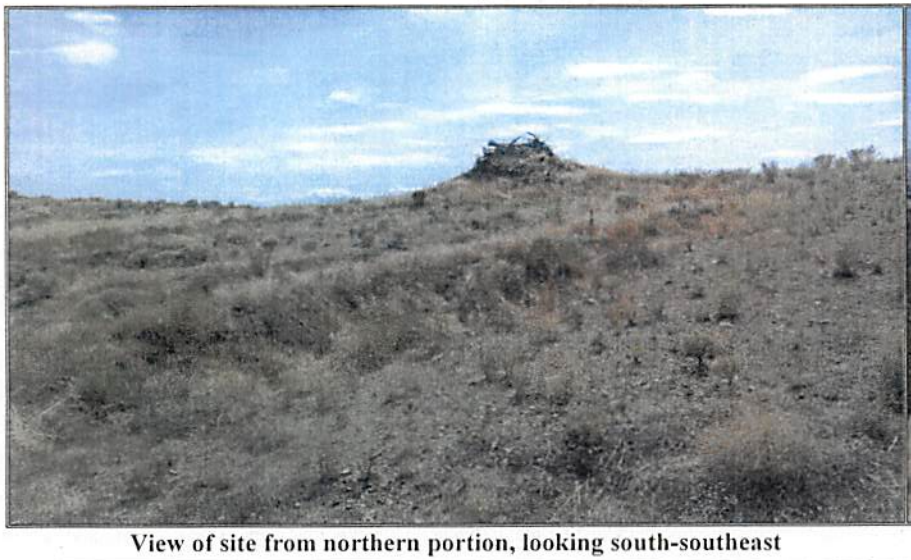
Date	Mounted By:	Reviewed By:	Plate
6/30/2014	YM	KAH	1



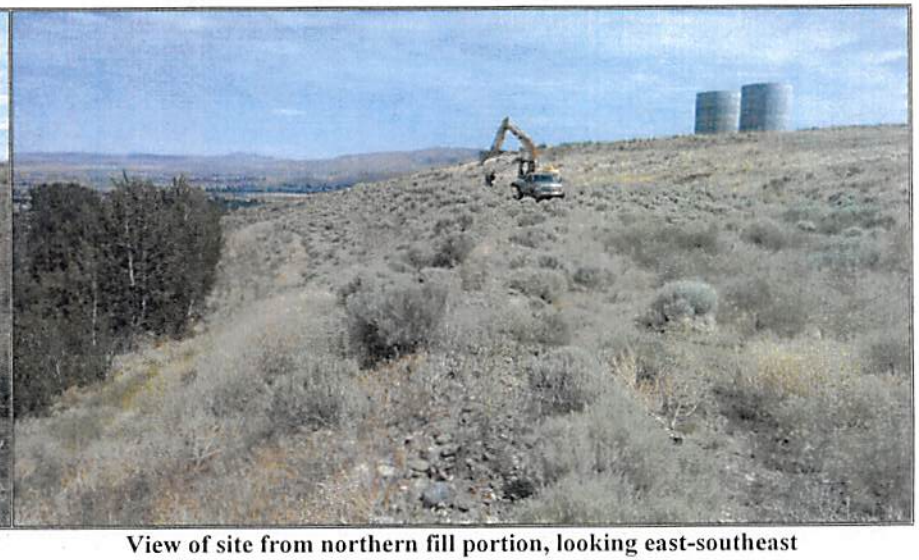
View of site from northern portion, looking north



View of site from central portion, looking northwest



View of site from northern portion, looking south-southeast



View of site from northern fill portion, looking east-southeast

Northern, Inc.

Job Number: 214-498

Site Photos
Proposed Residential Development
Valhalla Heights Addition
Selah, Yakima County, Washington

Date	Mounted By:	Reviewed By:	Plate
6/30/2014	YM	KAH	2

Soil profile inside test-pit TP-1

Soil profile inside test-pit TP-3

Soil profile inside test-pit TP-10

Very hard excavating at test-pit TP-11

Northern, Inc.

Job Number: 214-498

Site Photos
Proposed Residential Development
Valhalla Heights Addition
Selah, Yakima County, Washington

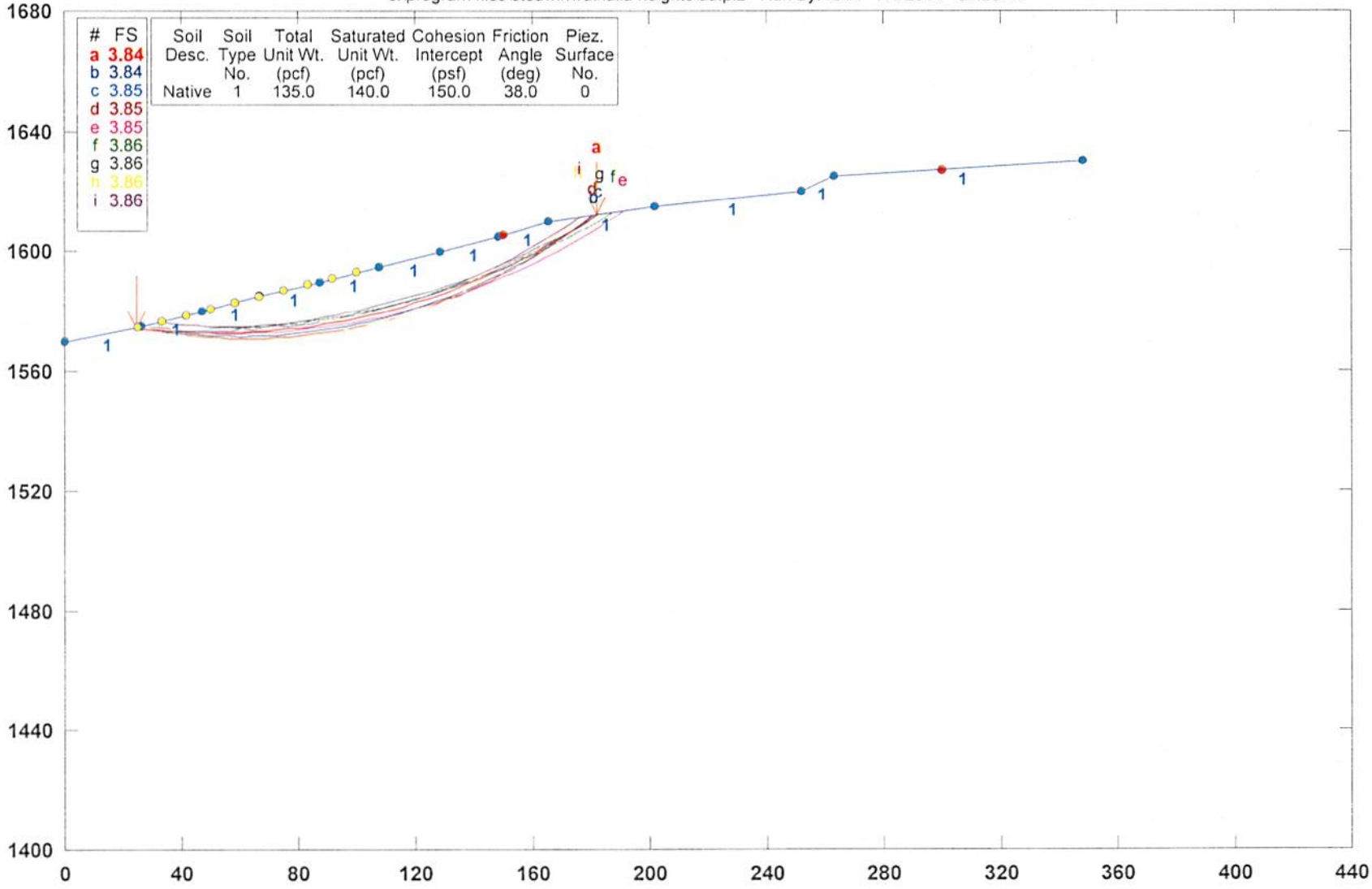
Date	Mounted By:	Reviewed By:	Plate
6/30/2014	YM	KAH	3

Appendix V

Slope Stability Analyses

Valhalla Heights - Phase 3 & 4 - Section- A-A' - Static (See Figure 2B)

c:\program files\stedwin\valhalla heights\aa.pl2 Run By: KAH 7/1/2014 04:25PM



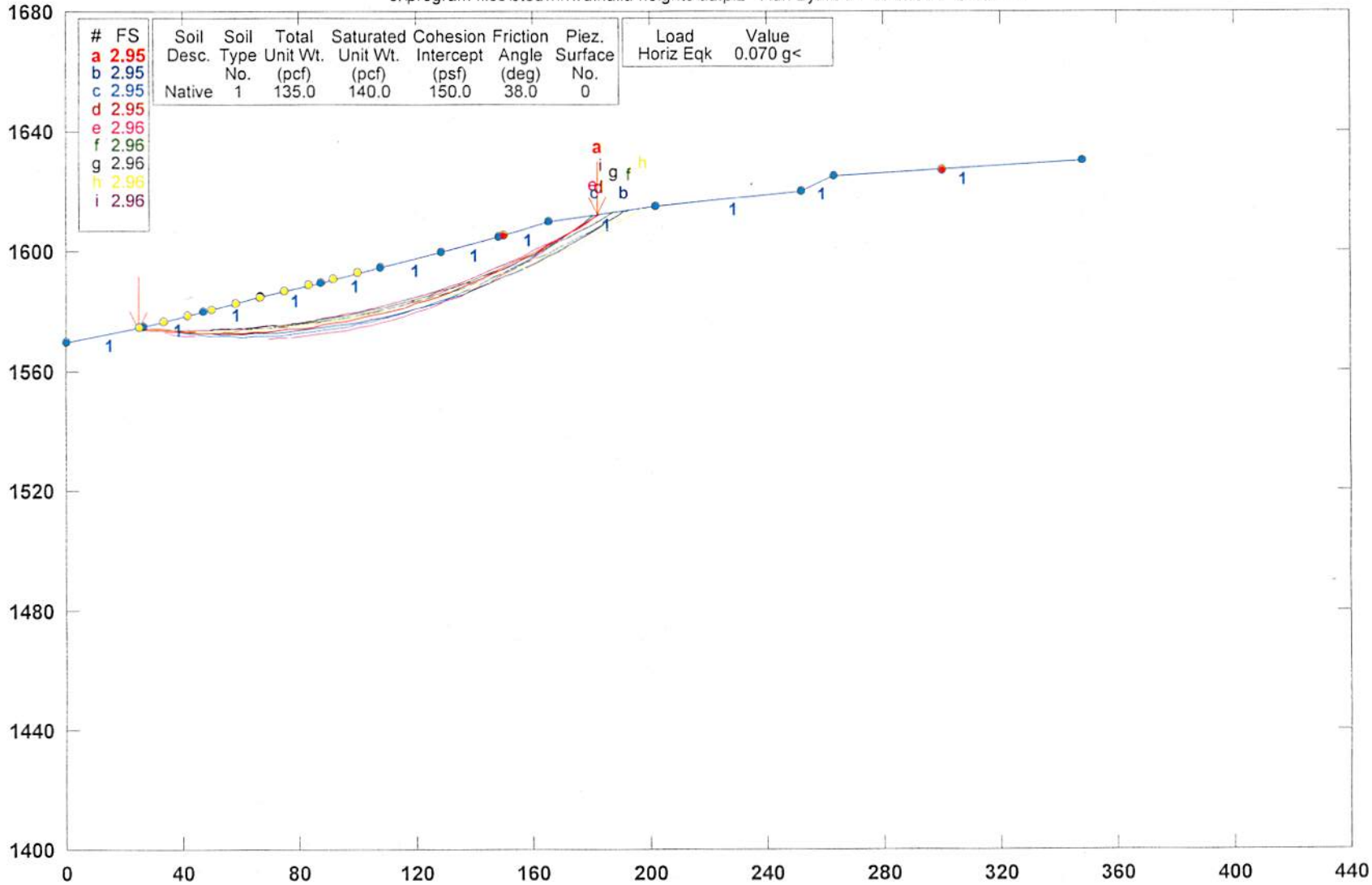
STABL6H FSmin=3.84

Safety Factors Are Calculated By The Modified Bishop Method

STED

Valhalla Heights - Phase 3 & 4 - Section- A-A' - Seismic (See Figure 2B)

c:\program files\stedwin\valhalla heights\aa.pl2 Run By: KAH 7/1/2014 04:31PM



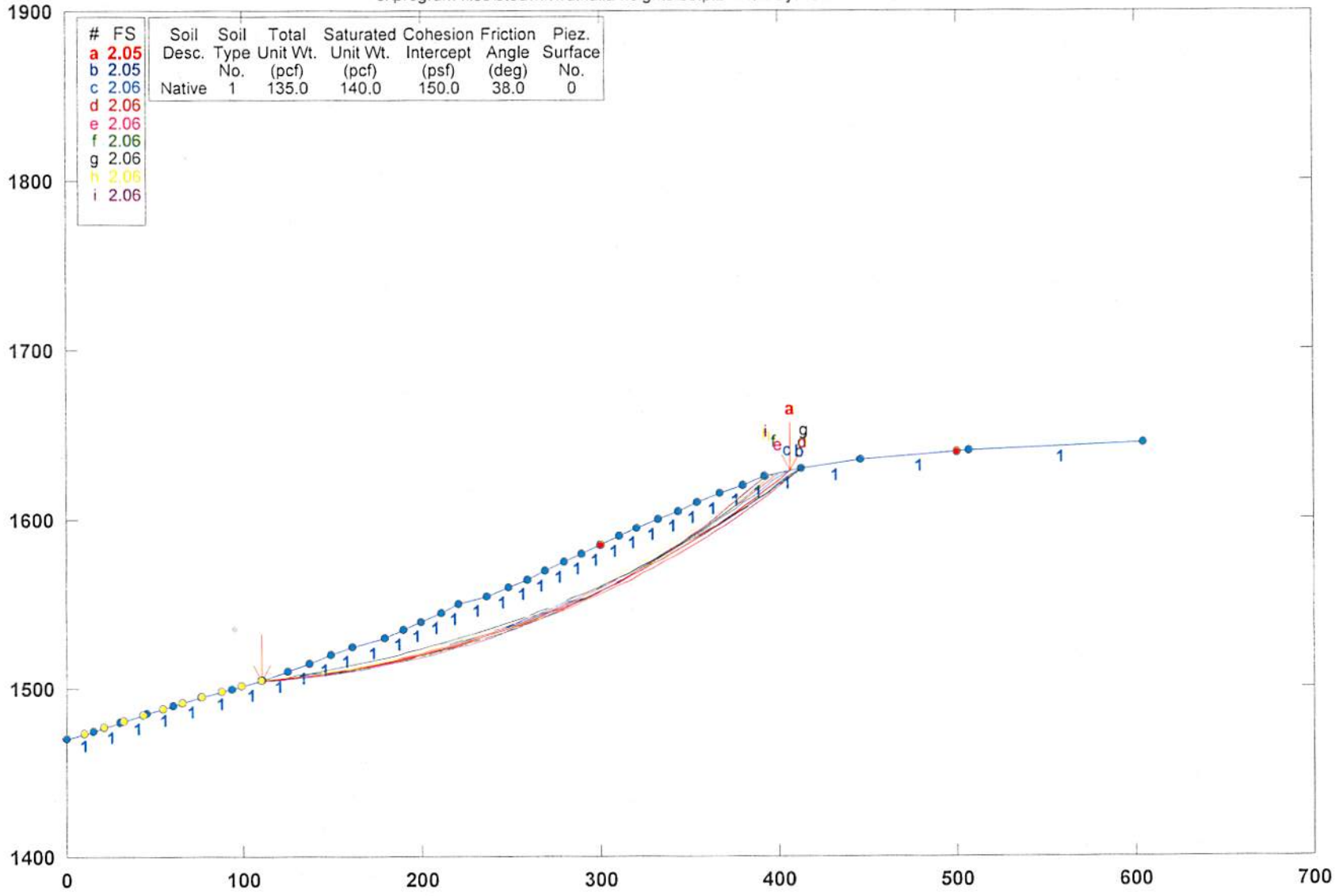
STABL6H FSmin=2.95

Safety Factors Are Calculated By The Modified Bishop Method

STED

Valhalla Height - Phase 3 & 4 - Section - B-B' - Static (See Figure 2B)

c:\program files\stedwin\valhalla heights\bb.pl2 Run By: KAH 7/1/2014 04:49PM



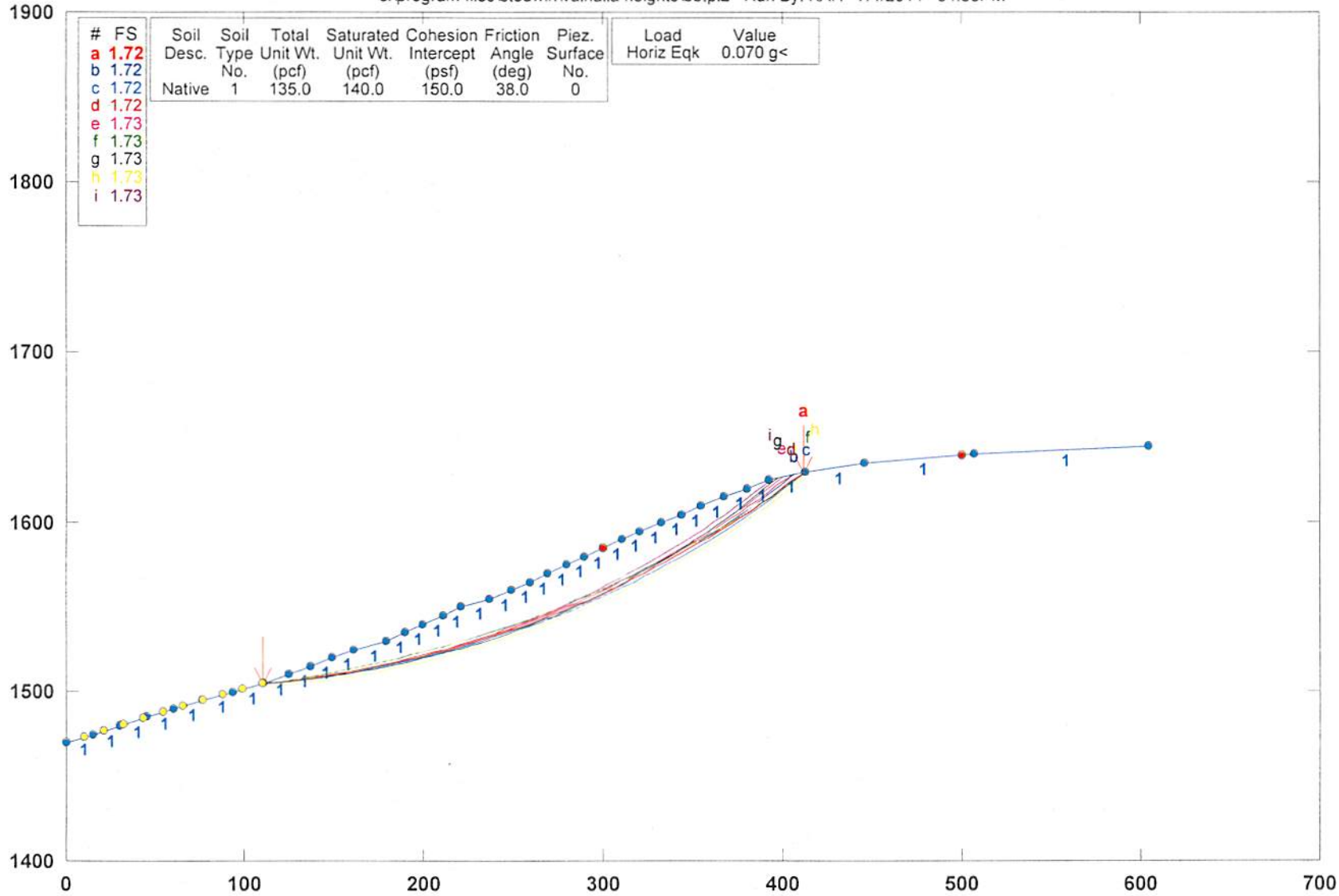
STABL6H FSmin=2.05

Safety Factors Are Calculated By The Modified Bishop Method

STED

Valhalla Height - Phase 3 & 4 - Section - B-B' - Seismic (See Figure 2B)

c:\program files\stedwin\valhalla heights\bb.pl2 Run By: KAH 7/1/2014 04:50PM



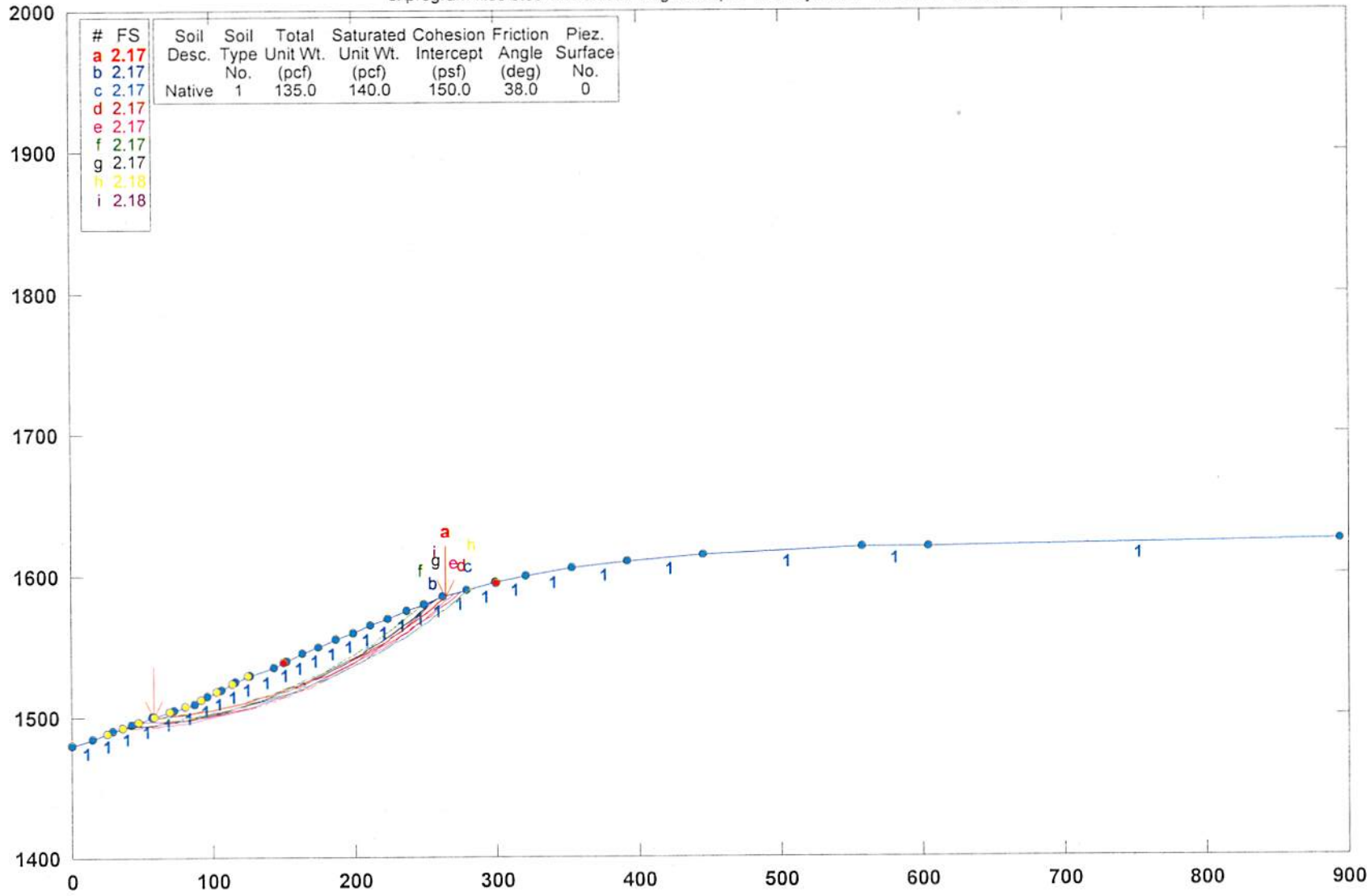
STABL6H FSmin=1.72

Safety Factors Are Calculated By The Modified Bishop Method

STED

Valhalla Heights - Phase 3 & 4 - Section- C-C' Static (See Figure 2A)

c:\program files\stedwin\valhalla heights\cc.pl2 Run By: KAH 7/1/2014 04:52PM



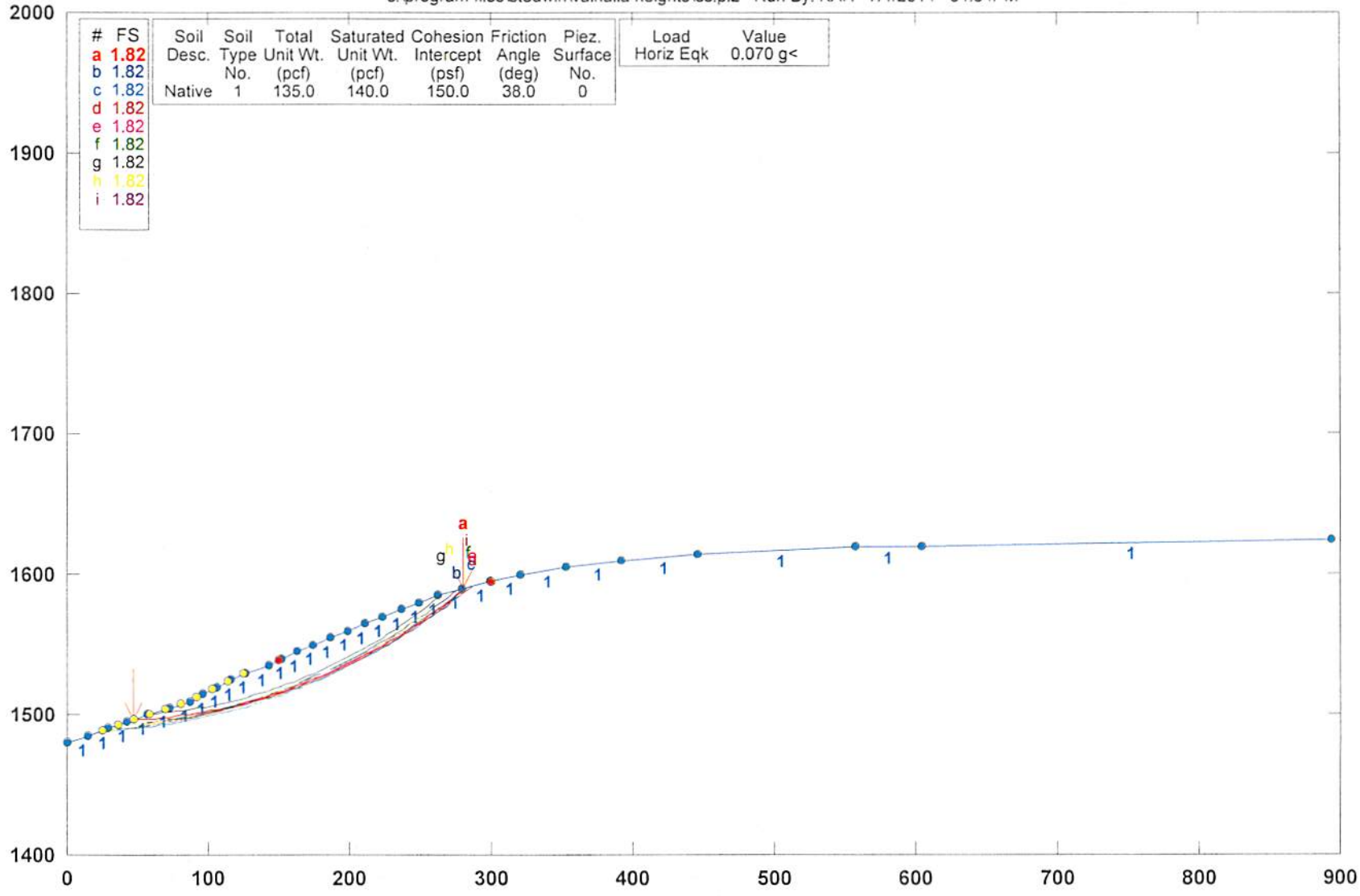
STABL6H FSmin=2.17

Safety Factors Are Calculated By The Modified Bishop Method

STED

Valhalla Heights - Phase 3 & 4 - Section- C-C' Seismic (See Figure 2A)

c:\program files\stedwin\valhalla heights\cc.pl2 Run By: KAH 7/1/2014 04:54PM



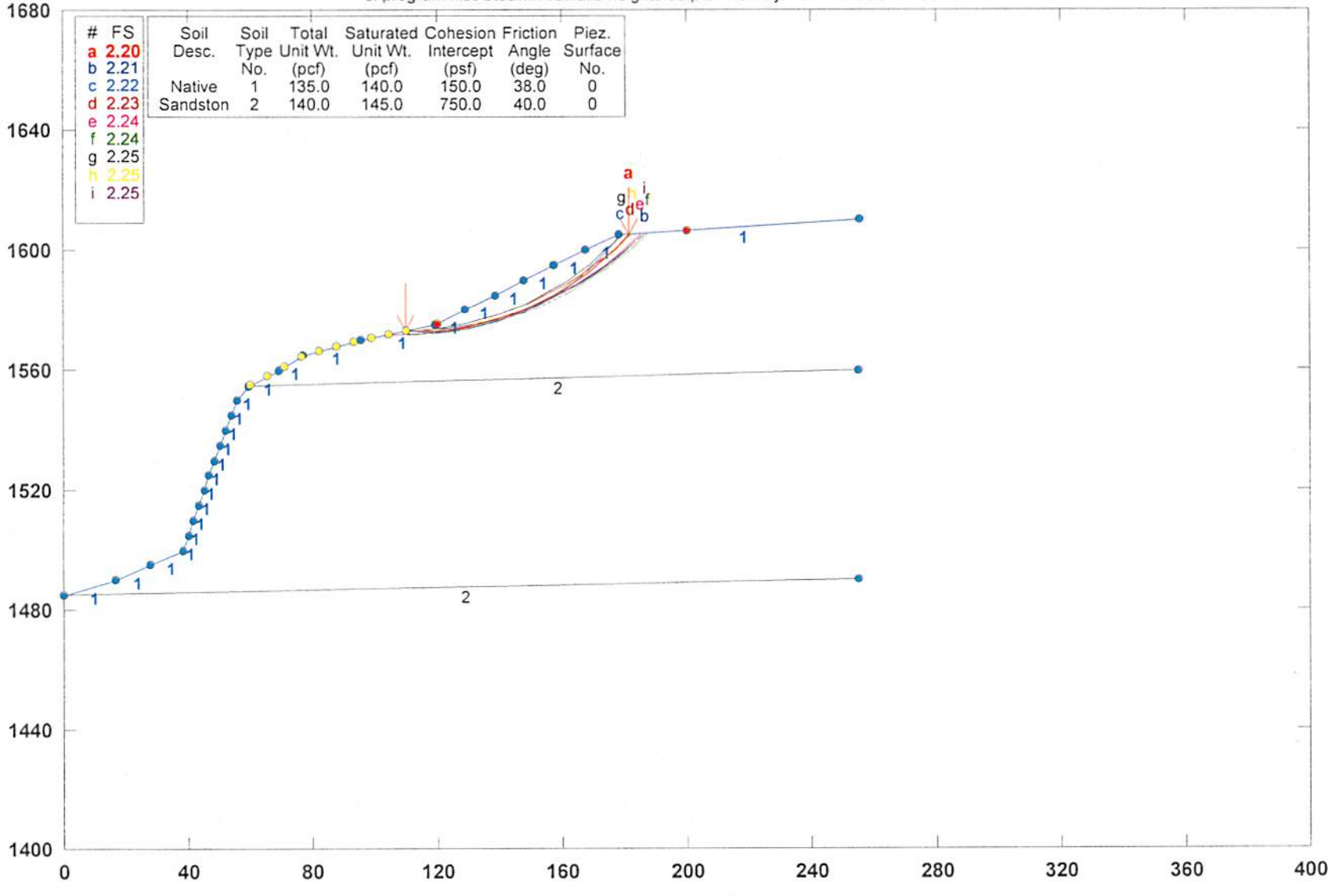
STABL6H FSmin=1.82

Safety Factors Are Calculated By The Modified Bishop Method

STED

Valhalla Heights - Phase 3 & 4 - Section D-D' Upper - Static (See Figure 2A)

c:\program files\stedwin\valhalla heights\dd.pl2 Run By: KAH 7/2/2014 09:10AM



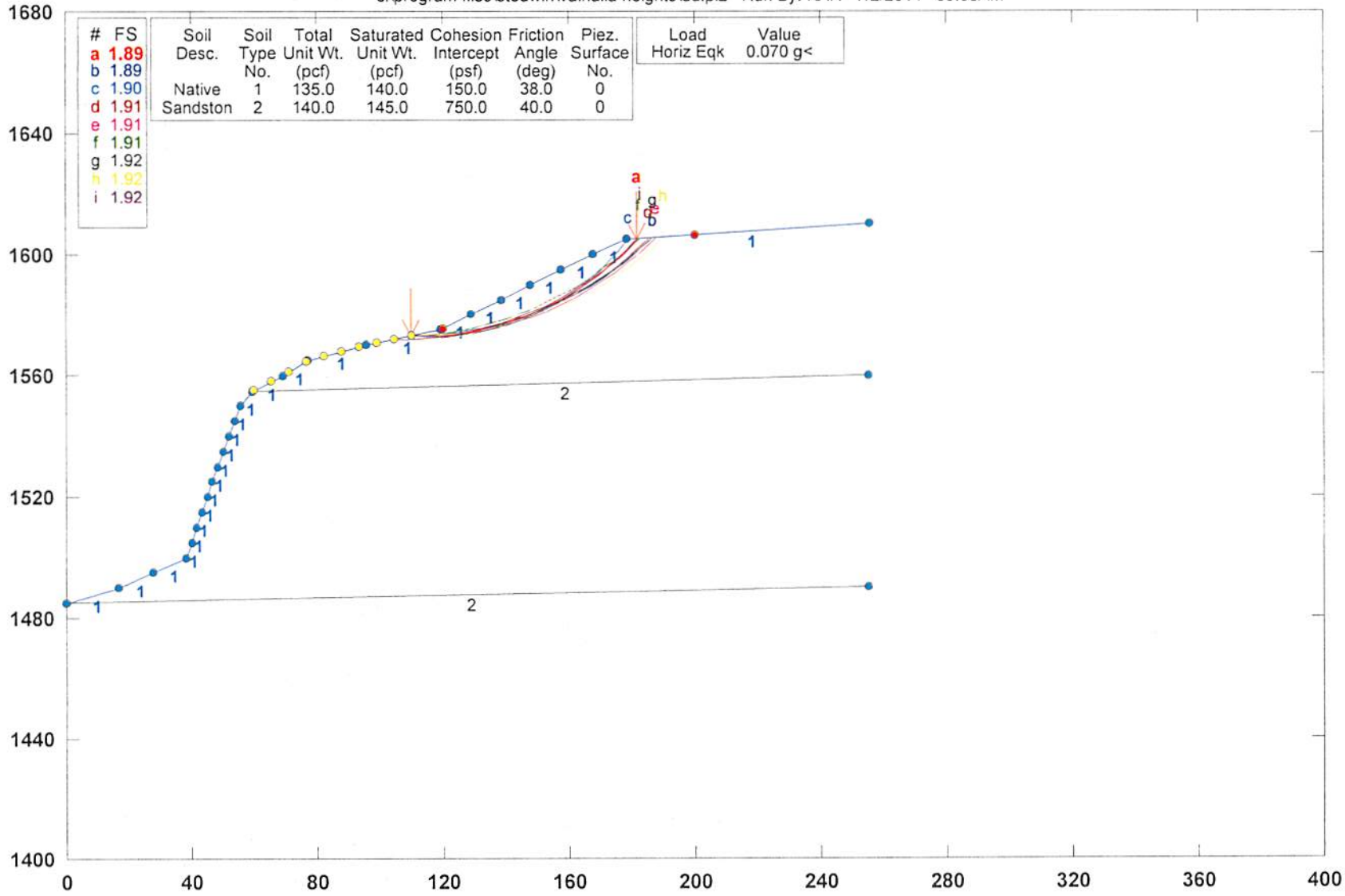
STABL6H FSmin=2.20

Safety Factors Are Calculated By The Modified Bishop Method

STED

Valhalla Heights - Phase 3 & 4 - Section D-D' Upper - Seismic (See Figure 2A)

c:\program files\stedwin\valhalla heights\dd.pl2 Run By: KAH 7/2/2014 09:08AM



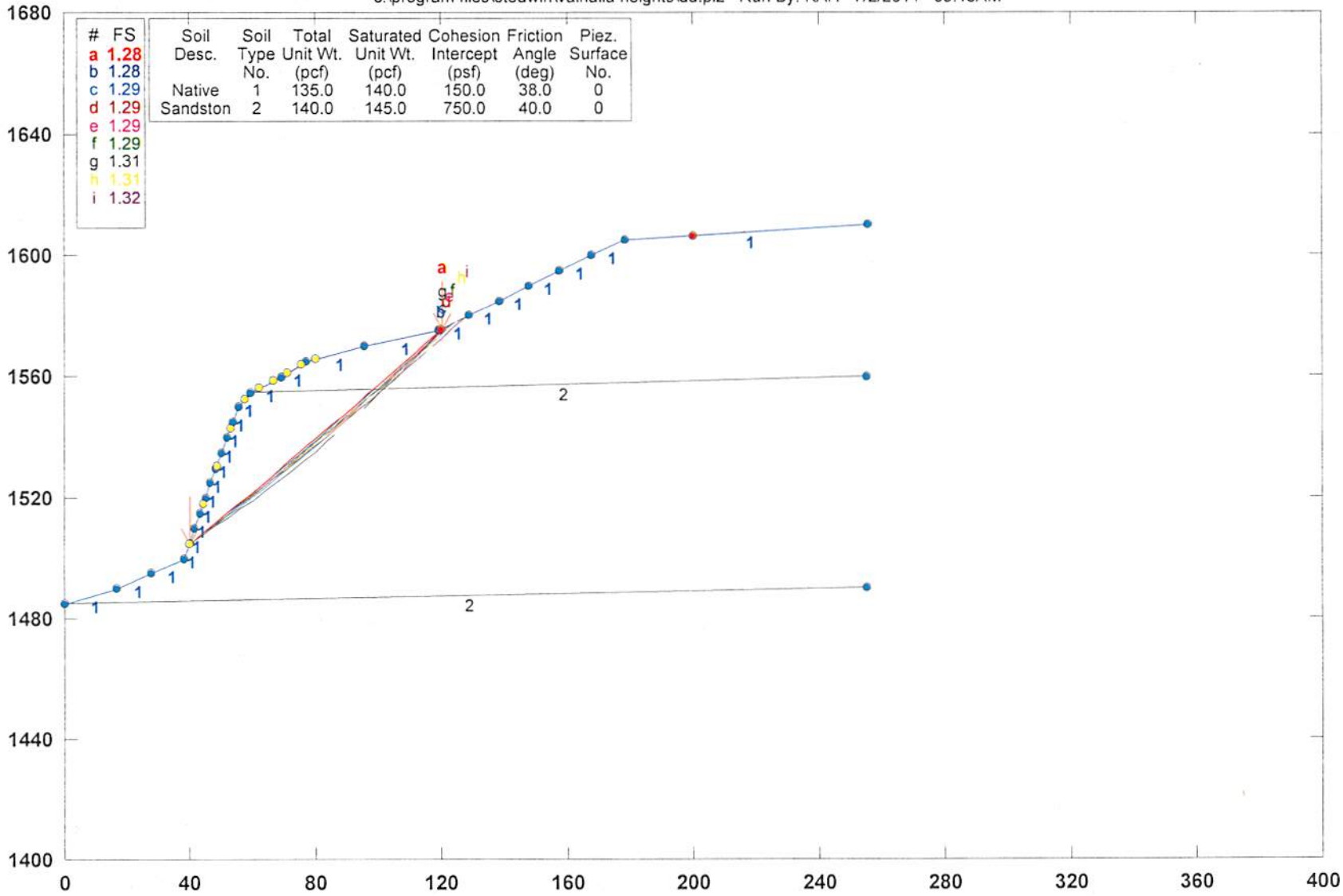
STABL6H FSmin=1.89

Safety Factors Are Calculated By The Modified Bishop Method

STED

Valhalla Heights - Phase 3 & 4 - Section D-D' Lower - Static (See Figure 2A)

c:\program files\stedwin\valhalla heights\dd.pl2 Run By: KAH 7/2/2014 09:13AM



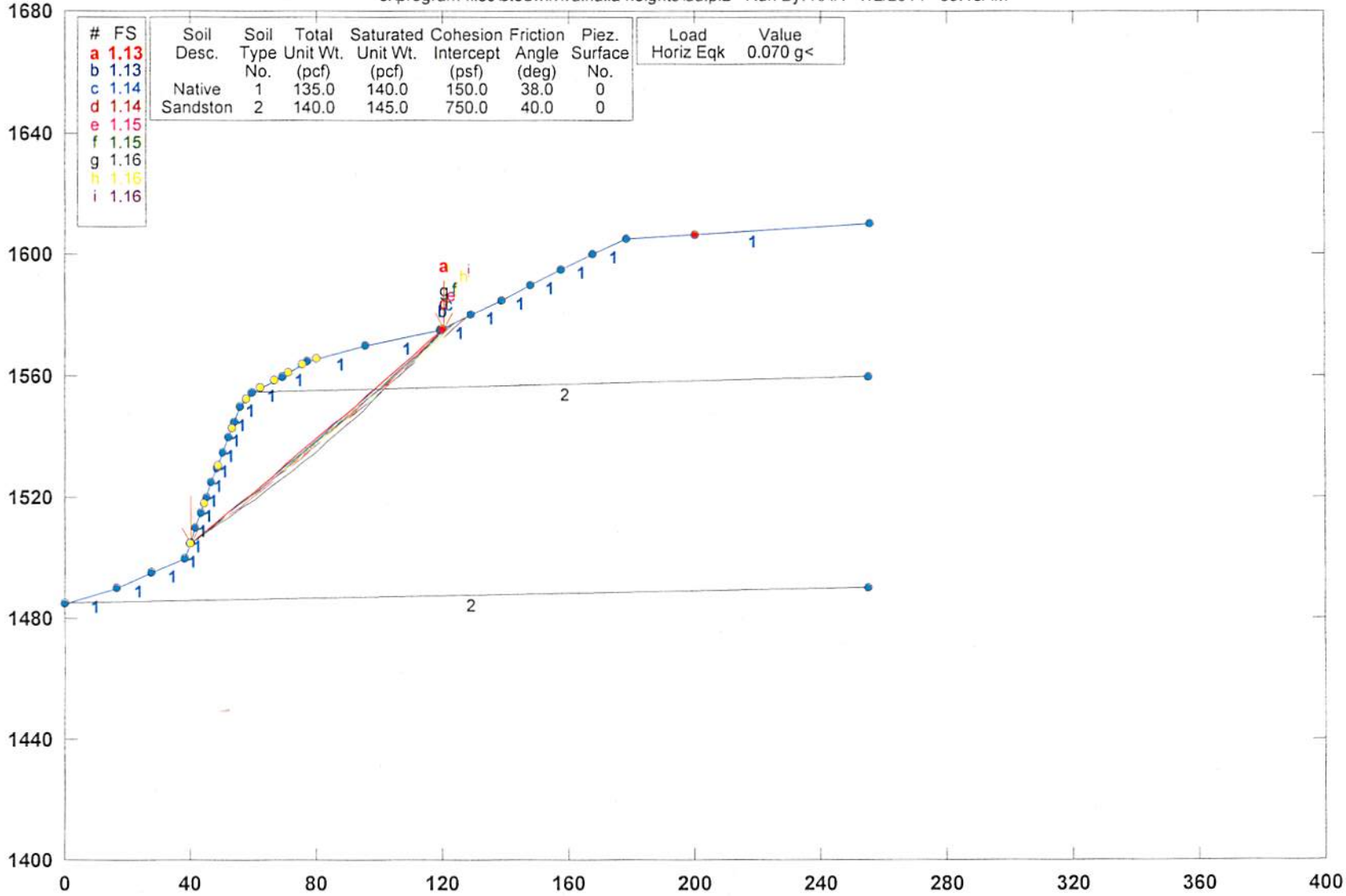
STABL6H FSmin=1.28

Safety Factors Are Calculated By The Modified Bishop Method

STED

Valhalla Heights - Phase 3 & 4 - Section D-D' Lower - Seismic (See Figure 2A)

c:\program files\stedwin\valhalla heights\dd.pl2 Run By: KAH 7/2/2014 09:18AM



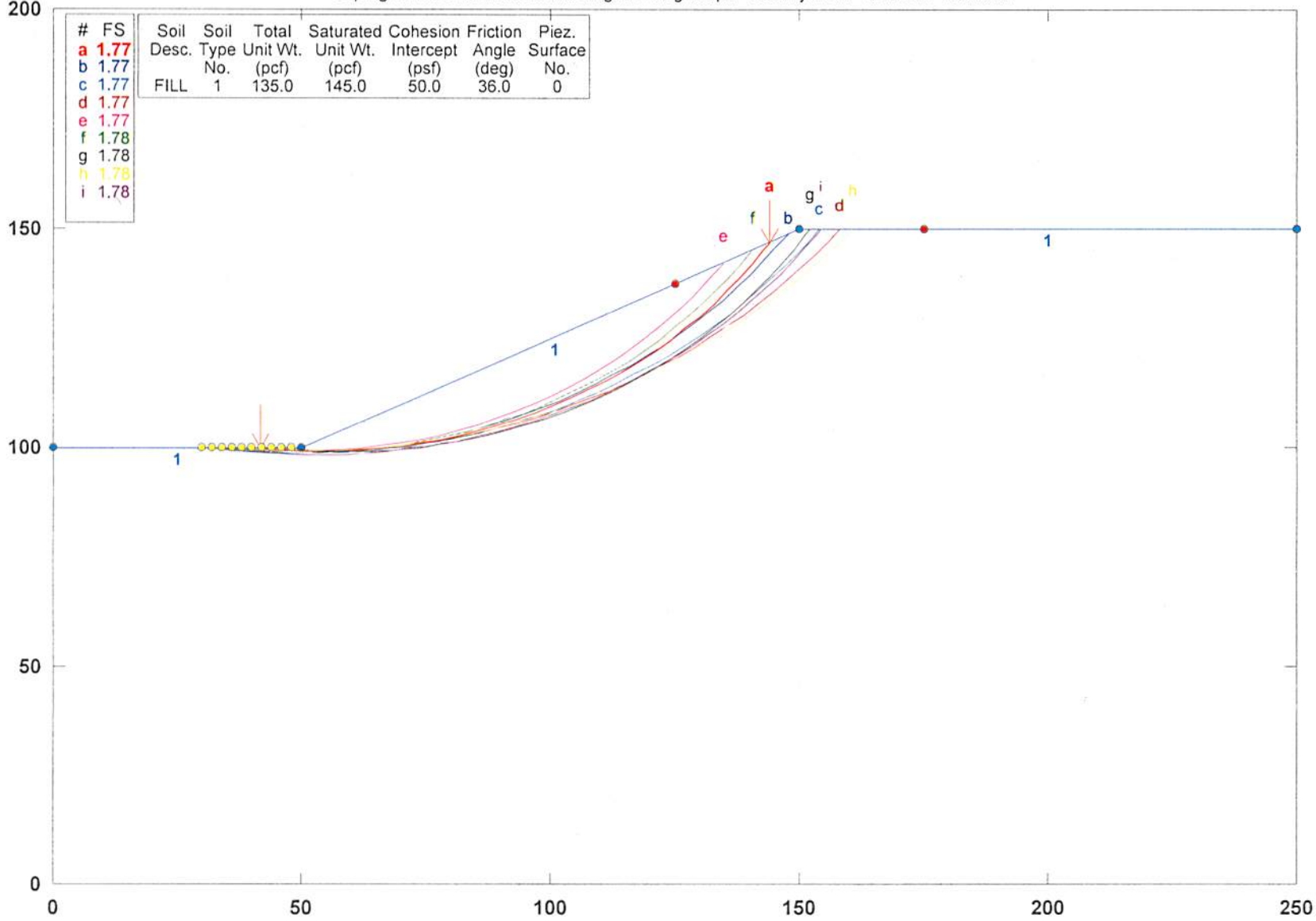
STABL6H FSmin=1.13

Safety Factors Are Calculated By The Modified Bishop Method

STED

Valhalla Heights - Phase 3 & 4 - Regraded 2H:1V Slope - Static

c:\program files\stedwin\valhalla heights\2to1gene.pl2 Run By: KAH 7/2/2014 09:05AM



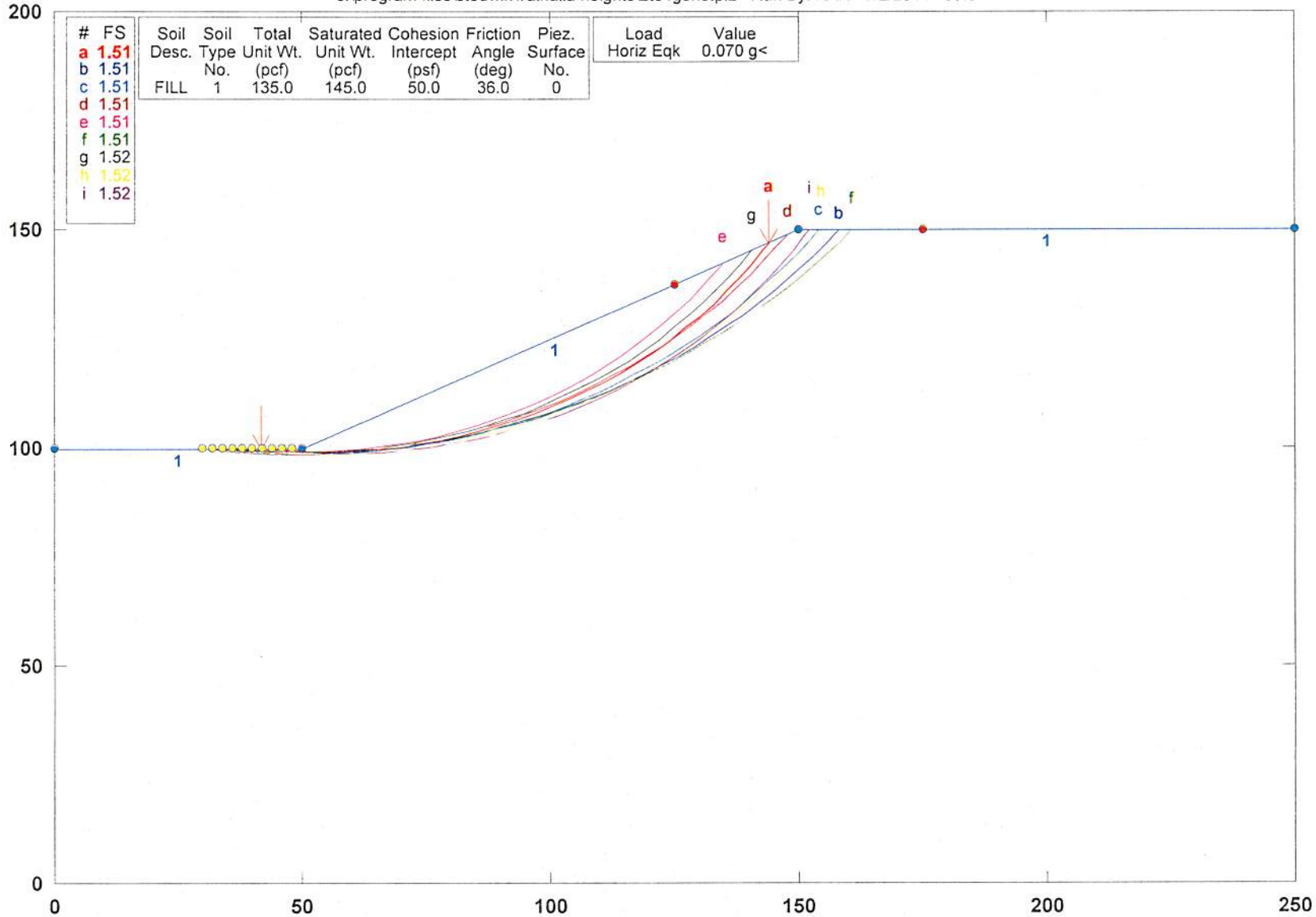
STABL6H FSmin=1.77

Safety Factors Are Calculated By The Modified Bishop Method

STED

Valhalla Heights - Phase 3 & 4 - Regraded 2H:1V Slope - Seismic

c:\program files\stedwin\valhalla heights\2to1gene.pl2 Run By: KAH 7/2/2014 09:07AM



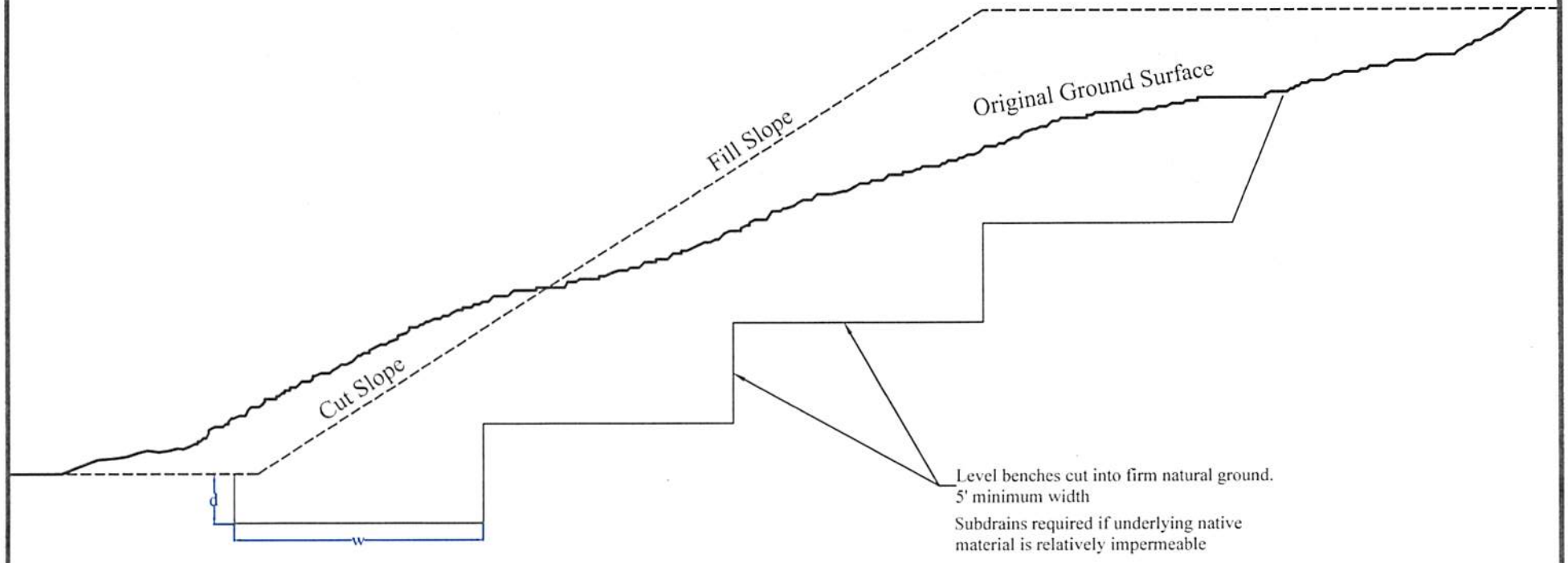
STABL6H FSmin=1.51

Safety Factors Are Calculated By The Modified Bishop Method

STED

Appendix VI

Cut-Fill Transition Details (Fig. 3A to 3D)

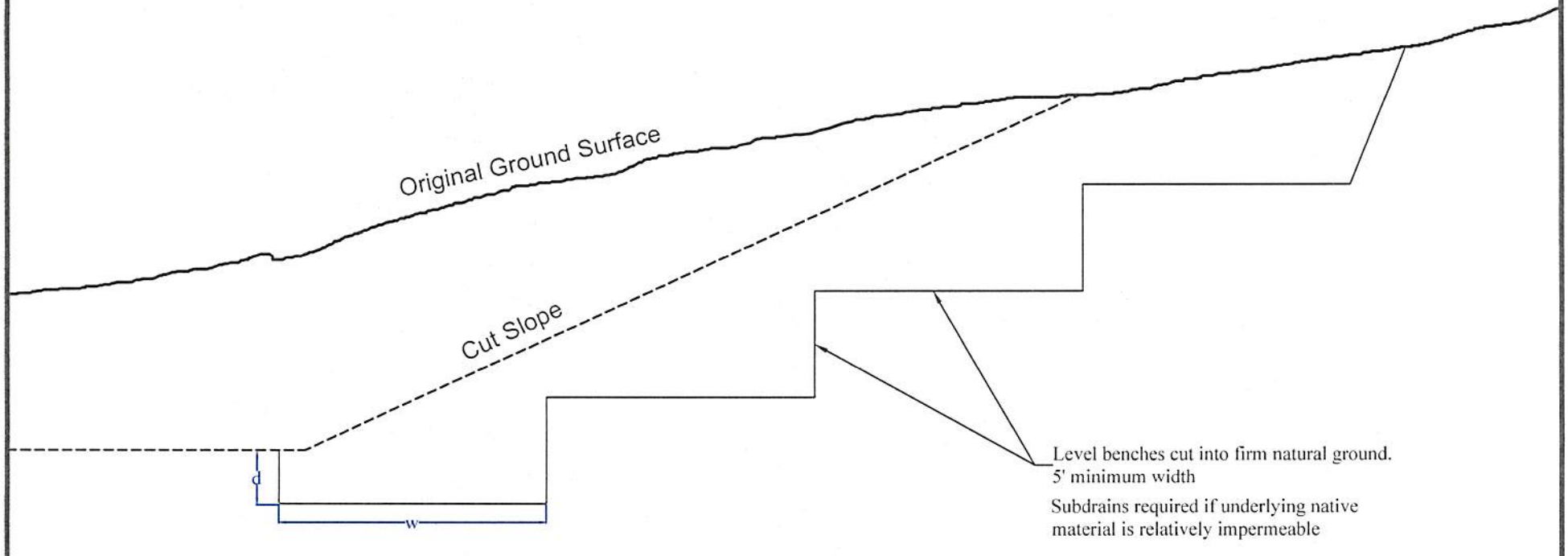


Notes:
d = minimum downslope key depth into dense natural ground approved by the project engineering geologist or geotechnical engineer.

w = Width of keyway: Half the slope height or 10' minimum

N.T.S.

Northern, Inc. • Consulting Engineers • Environmental Scientists • Geologists • Construction Materials Testing	GN Northern, Inc. Project No. 214-498	**Cut/ Fill Detail: Fill Over Cut Condition** Valhalla Heights Addition Selah, Washington			
		Date 6/30/2014	Drawn By YM	Reviewed By KAH	Figure 3A

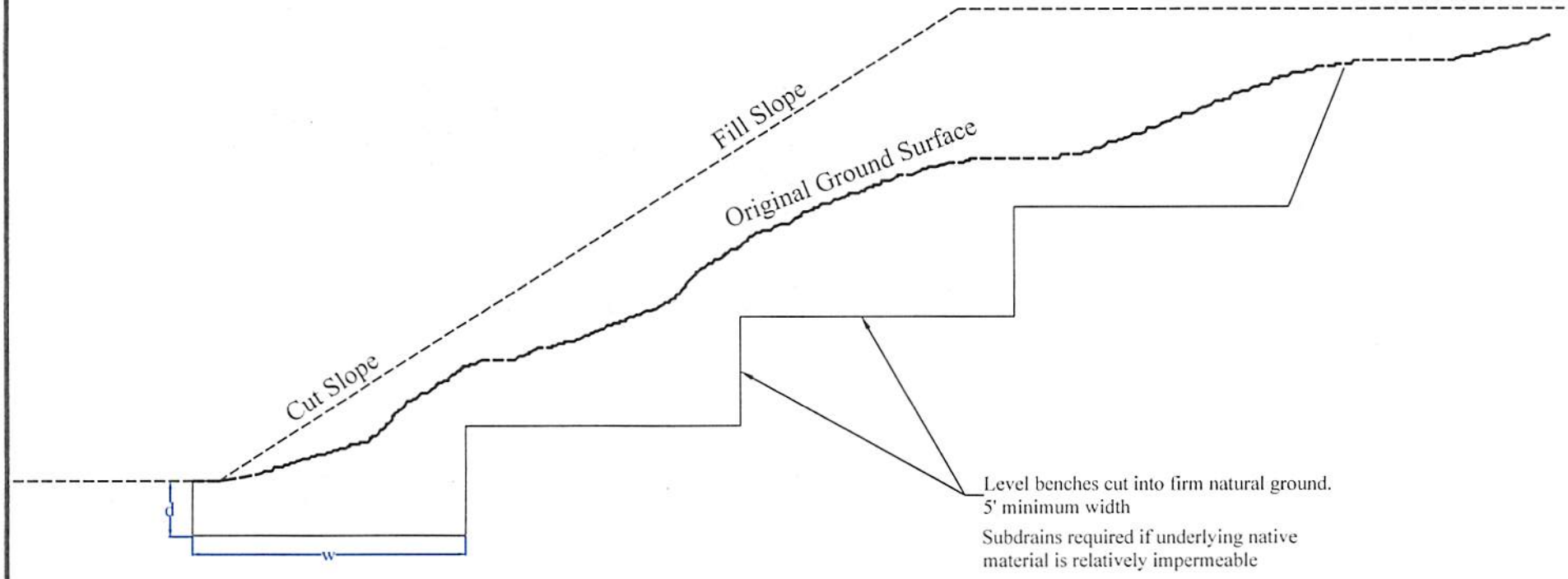


Notes:
d = minimum downslope key depth into dense natural ground approved by the project engineering geologist or geotechnical engineer.

w = Width of keyway: Half the slope height or 10' minimum

N.T.S.

Northern, Inc. * Consulting Engineers * Environmental Scientists * Geologists * Construction Materials Testing	GN Northern, Inc. Project No. 214-498	**Cut/ Fill Detail: Reconstructed Cut Slope** Valhalla Heights Addition Selah, Washington			
		Date 6/30/2014	Drawn By YM	Reviewed By KAH	Figure 3B

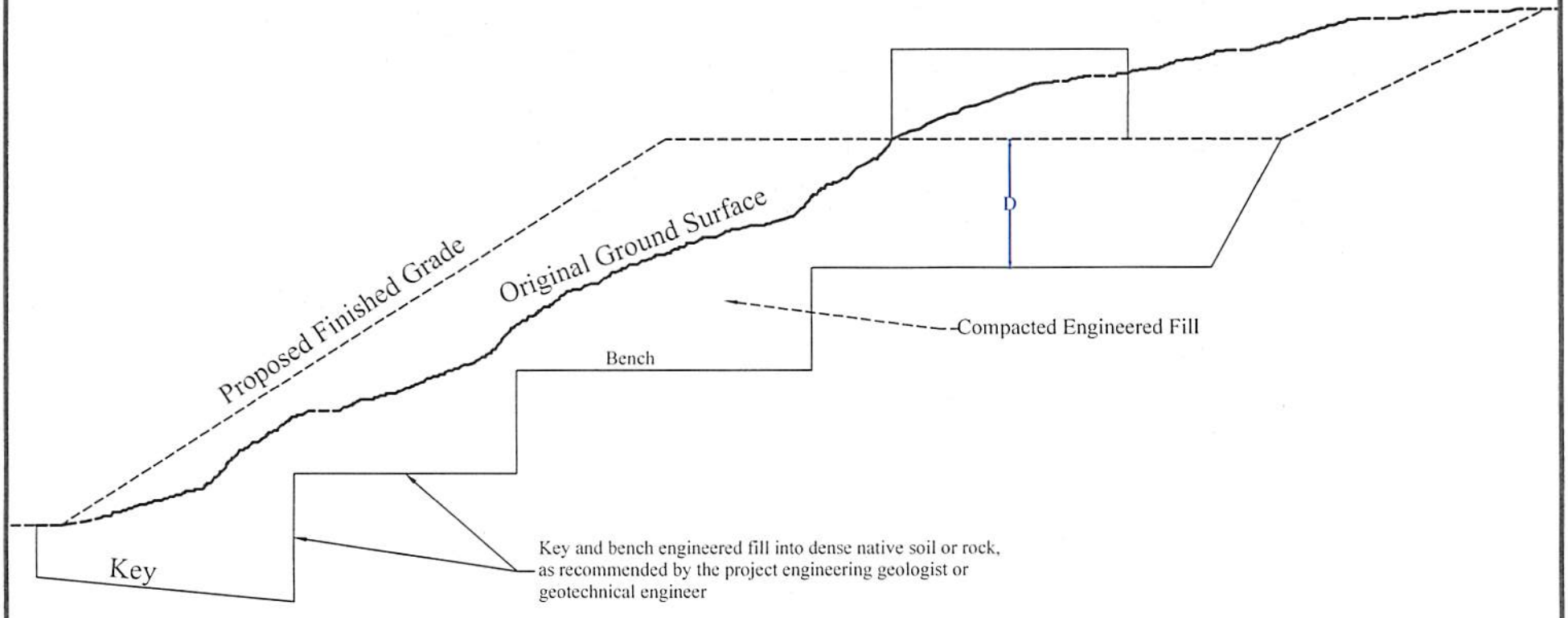


Notes:
d = minimum downslope key depth into dense natural ground approved by the project engineering geologist or geotechnical engineer. 2' Minimum

w = Width of keyway: Half the slope height or 10' minimum

N.T.S.

Northern, Inc. * Consulting Engineers * Environmental Scientists * Geologists * Construction Materials Testing	GN Northern, Inc. Project No. 214-498	**Cut/ Fill Detail: Fill Over Native Condition** Valhalla Heights Addition Selah, Washington			
		Date 6/30/2014	Drawn By YM	Reviewed By KAH	Figure 3C



Notes:
D = Depth of over-excavation and re-compaction as recommended in report. Minimum depth of fill under structure is 5'. maximum fill thickness differential ratio under structure is 3:1

N.T.S.

Northern, Inc. * Consulting Engineers * Environmental Scientists * Geologists * Construction Materials Testing	GN Northern, Inc. Project No. 214-498	**Over-Excavation Detail: Transition Condition** Valhalla Heights Addition Selah, Washington			
		Date 6/30/2014	Drawn By YM	Reviewed By KAH	Figure 3D

Appendix VII
Miscellaneous Documents

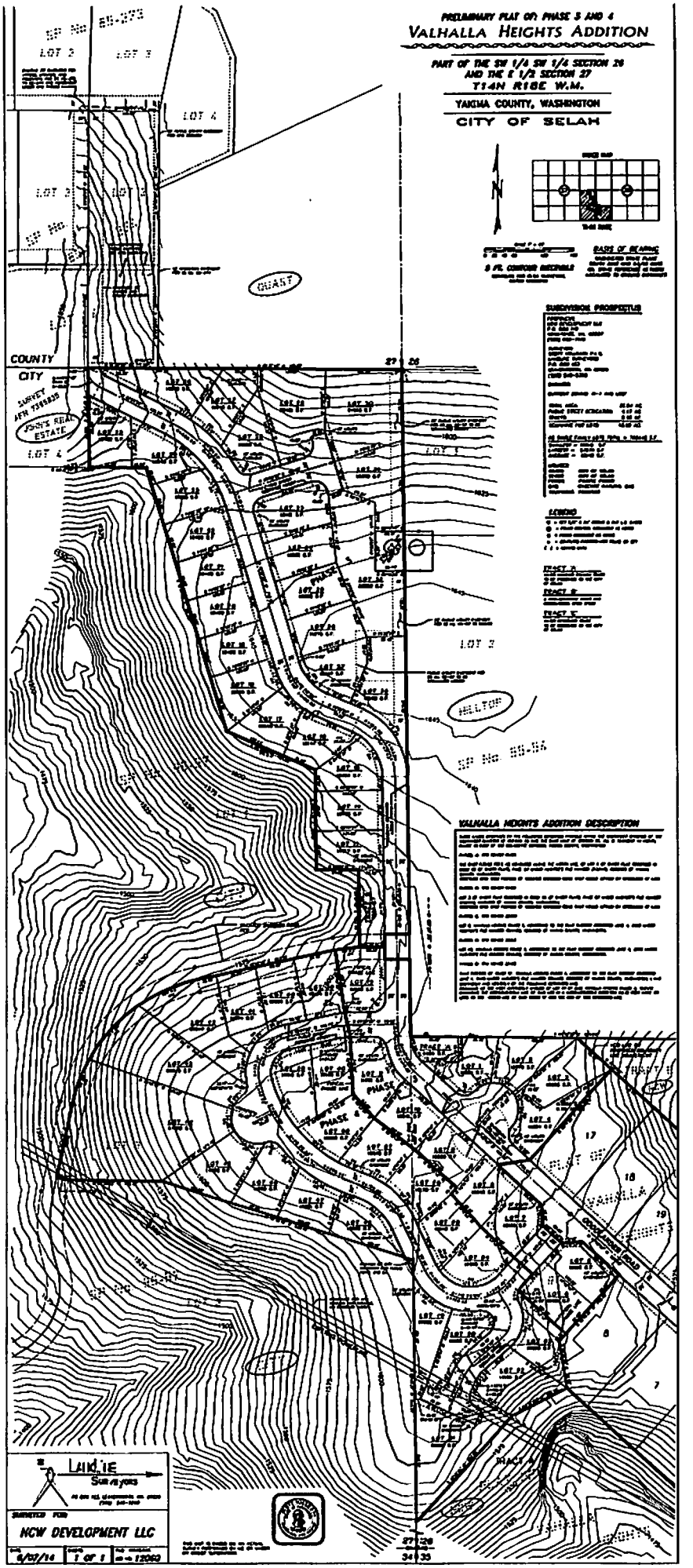
PRELIMINARY PLAT OF: PHASE 3 AND 4

VALHALLA HEIGHTS ADDITION

PART OF THE SW 1/4 SW 1/4 SECTION 26
AND THE E 1/2 SECTION 27
T14N R18E W.M.

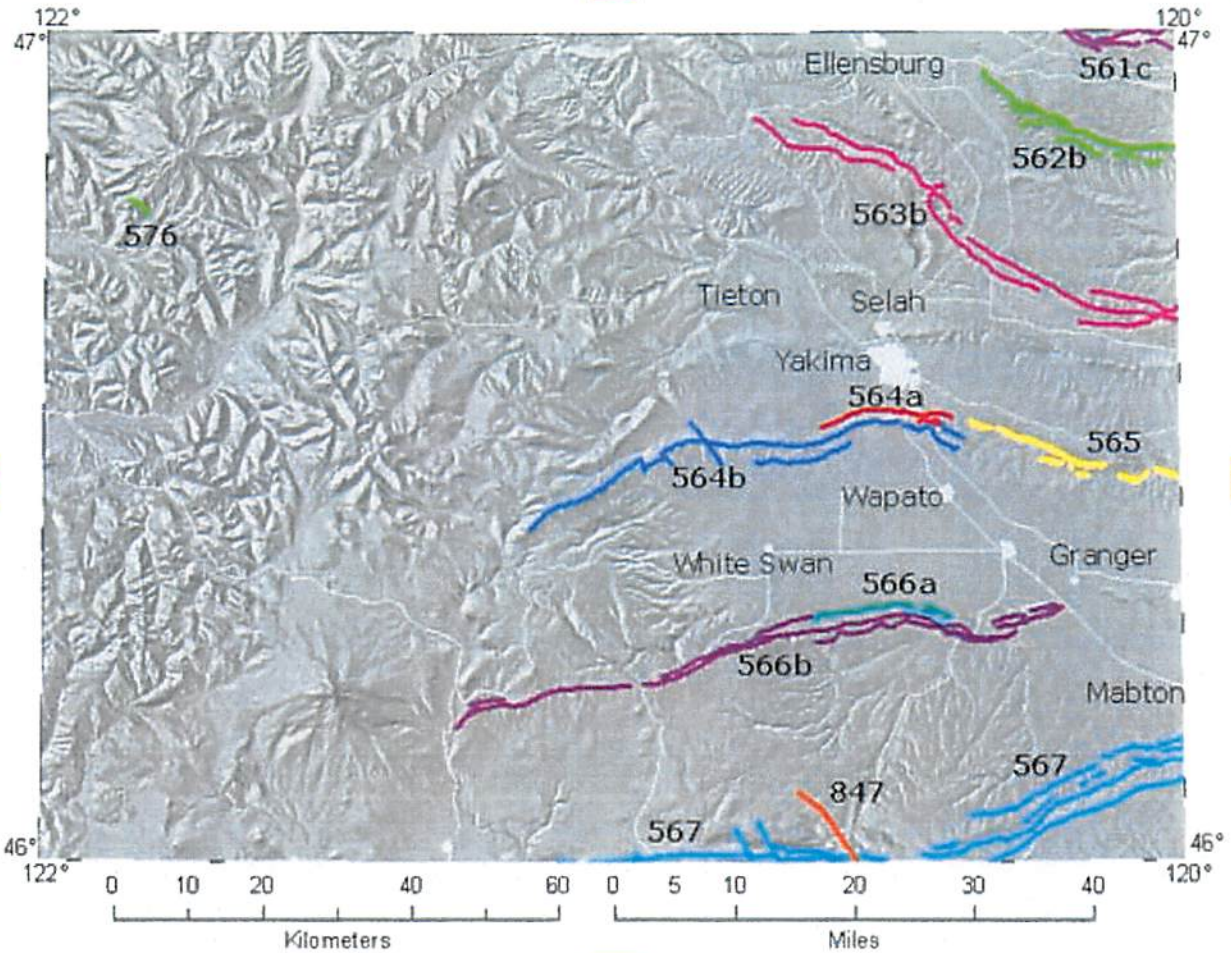
YAKIMA COUNTY, WASHINGTON

CITY OF SELAH



USGS
Quaternary Fault and Fold Database for the United States

Yakima 1° x 2° Sheet



Use the number and/or name in the Database Search to get more information about a fault.

Number	Name
561c	Frenchman Hills structure, folds and other faults of the Frenchman Hills uplift
562b	Saddle Mountain structures, folds and other faults of the Saddle Mountains
563b	Umtanum Ridge structures, folds and other faults of the Umtanum Ridge-Gable
564a	Ahtanum Ridge structures, Ahtanum Creek fault
564b	Ahtanum Ridge structures, folds and other faults of the Ahtanum Ridge uplift
565	Rattlesnake Hills structures

566a	Toppenish Ridge structures, Mill Creek fault
566b	Toppenish Ridge structures, folds and other faults of the Toppenish Ridge uplift
567	Horse Heaven Hills structures
576	Devils Dream fault
847	Arlington-Shutler Butte fault

Last modified December 19, 2005
URL http://earthquake.usgs.gov/regional/qfaults/wa/yak.html

Appendix VIII

Washington Department of Ecology Well Logs

File Original and First Copy with Department of Ecology
Second Copy - Owner's Copy
Third Copy - Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. .....
Permit No. .....

(1) OWNER: Name Robert Hull Address Rt. 2 Selah, Wn.

(2) LOCATION OF WELL: County Yakima, Wn. — SW ¼ NW ¼ Sec. 26 T. 14 N., R. 18 W.M.

Bearing and distance from section or subdivision corner 500 ft N. and 470 E. of S.W. (See back)

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) .....
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 215 ft. Depth of completed well 211 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam. from 0 ft. to 211 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☒ No ☐
Type of perforator used 1/8
SIZE of perforations in. by 3 in.
perforations from 171 ft. to 211 ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 20 ft.
Material used in seal
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ..... ft.
Static level 165 ft. below top of well Date 3-3-82
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 15 gal./min. with 30 ft. drawdown after 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Top Soil Black	0	3
Hardpan Sandy "hite	3	12
Clay Brown Fine	12	35
Clay Brown Sandy	35	72
Packed Sandy Coarse	72	102
Clay Brown Fine	102	165
Clay Sandy Brown Fine	165	190
Clay Red Coarse Water Barring	190	211

APR - 1 -

Work started 2-22, 1982. Completed 3-3, 1982.

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME HULL DRILLING (Person, firm, or corporation) (Type or print)

Address RT. 2 Box 2265 Selah, Wn. 98942

[Signed] Robert V Hull (Well Driller)

License No. 0208 Date 3-20, 1982

(USE ADDITIONAL SHEETS IF NECESSARY)

EP 4-21-82

ECY 050-1-20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

E

STATE OF WASHINGTON

Application No. .....

Permit No. .....

(1) OWNER: Name Larry D. Hull Address 771 Parish Rd - Selah, Wa. 98942

(2) LOCATION OF WELL: County Yakima ¼ NW ¼ Sec. 26 T. 14 N. R. 18 W.M.

Bearing and distance from section or subdivision corner 40 Ft South + 30 ft. East of N.E. corner of Lot 2 of Short Plat 85-180

(3) PROPOSED USE: Domestic ■ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) .....
New well ■ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ■ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 248 ft. Depth of completed well 246 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from +1 ft. to 246 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ■ " Diam. from ft. to ft.

Perforations: Yes ■ No ☐
Type of perforator used .....
SIZE of perforations ⅛ in. by 3 in.
256 perforations from 256 ft. to 242 ft.
..... perforations from ft. to ft.
..... perforations from ft. to ft.

Screens: Yes ☐ No ■
Manufacturer's Name .....
Type ..... Model No. .....
Diam. ..... Slot size ..... from ft. to ft.
Diam. ..... Slot size ..... from ft. to ft.

Gravel packed: Yes ☐ No ■ Size of gravel: .....
Gravel placed from ft. to ft.

Surface seal: Yes ■ No ☐ To what depth? 22 ft.
Material used in seal Bentonite, Cement
Did any strata contain unusable water? Yes ☐ No ■
Type of water? ..... Depth of strata .....
Method of sealing strata off .....

(7) PUMP: Manufacturer's Name .....
Type: ..... H.P. .....

(8) WATER LEVELS: Land-surface elevation above mean sea level ..... ft.
Static level 108 ft. below top of well Date 6-9-88
Artesian pressure ..... lbs. per square inch Date .....
Artesian water is controlled by ..... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom? .....
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" Pumped by air 250 psi "
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test .....
Bailer test ..... gal./min. with ..... ft. drawdown after ..... hrs.
Artesian flow ..... g.p.m. Date .....
Temperature of water ..... Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG: Short Plat 85-180

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Top Soil	0	4
Conglomerate	5	7
Brown sandy clay	8	15
Brown clay	16	95
White clay	96	141
Brown clay	142	159
Blue clay	160	202
White clay	203	219
Brown clay	220	259
Sand stone water Bearing	260	298

RECEIVED
JUL 7 1988
DEPARTMENT OF ECOLOGY
CENTRAL REGION OFFICE

Work started 6-3-, 1988. Completed 6-9-, 1988

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Hull Drilling

NAME Larry D. Hull (Person, firm, or corporation) (Type or print)

Address 771 Parish Rd 98942

[Signed] Larry Hull (Well Driller)

License No. 1498 Date 7-4-, 1988

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

007608 007608

Application No. E

Permit No.

(1) OWNER: Name Bob Monson Address Rt. 4 Box 4164 Selah

(2) LOCATION OF WELL: County Yakima — SW ¼ NW ¼ Sec. 26 T. 14 N., R. 18 W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☑ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)

New well ☑ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☑ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 204 ft. Depth of completed well 204 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from +2 ft. to 197 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☐ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☑
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☑
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☑ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☑ No ☐ To what depth? 18 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 110 ft. below top of well Date
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom?
Yield: 20 gal./min. with ft. drawdown after hrs.
" " Air Lift "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Sandstone & clay layers	0	115
Clay tan	115	197
Sandstone & conglomerate	197	204

RECEIVED NOV 2 1987 DEPARTMENT OF ECOLOGY REGIONAL OFFICE

Work started 10/27, 19 87 Completed 10/29, 19 87

WELL DRILLER'S STATEMENT:

This well was drilled under my supervision and this report is true to the best of my knowledge and belief.

ENTERED

NAME Rick Poulin Drilling (Person, firm, or corporation) (Type or print)

Address 2 Nth 1st Selah

[Signed] Rick Poulin (Well Driller)

License No. 142 Date 10/29, 19 87

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. ____

Permit No. ____

(1) OWNER: Name Ken Hooderson Address Rt. 2 Selah, Wn. 98942

(2) LOCATION OF WELL: County Selah, county-Yakima — SW¼ N.W.¼ Sec. 26 T. 14 N., R. 18 W.M. E

Bearing and distance from section or subdivision corner see attached paper

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) ____

New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well ____ inches.
Drilled ____ ft. Depth of completed well ____ ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam. from 0 ft. to 195 ft.
Threaded ☐ ____ " Diam. from ____ ft. to ____ ft.
Welded ☒ ____ " Diam. from ____ ft. to ____ ft.

Perforations: Yes ☒ No ☐
Type of perforator used ____
SIZE of perforations 1/8" in. by 4 in.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.

Screens: Yes ☐ No ☐
Manufacturer's Name ____
Type ____ Model No. ____
Diam. ____ Slot size ____ from ____ ft. to ____ ft.
Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: ____
Gravel placed from ____ ft. to ____ ft.

Surface seal: Yes ☒ No ☐ To what depth? 20 ft.
Material used in seal grout
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? ____ Depth of strata ____
Method of sealing strata off ____

(7) PUMP: Manufacturer's Name ____
Type: ____ H.P. ____

(8) WATER LEVELS: Land-surface elevation above mean sea level .... ____ ft.
Static level 168 ft. below top of well Date 3-29-77
Artesian pressure ____ lbs. per square inch Date ____
Artesian water is controlled by ____ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom? ____
Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ____
Bailer test 15 gal./min. with 5 ft. drawdown after 1 hrs.
Artesian flow ____ g.p.m. Date ____
Temperature of water ____ Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Topsoil Black, fine	0	4
Clay Brown, fine	4	96
Sandstone gray medbrown	96	112
clay [illegible] fine	112	184
Sand grey coarse	184	195
Water bearing		

RECEIVED
APR 5 1977
DEPARTMENT OF ECOLOGY
CENTRAL REGIONAL OFFICE

Work started 3-24 19 77 Completed 3-29 19 77

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME HULL DRILLING CO (Person, firm, or corporation) (Type or print)

Address Rt. 2 box 2265 Selah, Wn. 98942

[Signed] [signature] (Well Driller)

License No. 0208 Date 4-4- 19 77

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7356—OS—(Rev. 4-71)
ECY-070-28

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

Appendix IX
NRCS Soil Survey

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Yakima County Area, Washington

Valhalla Heights Addition

June 28, 2014

120° 33' 27" W
120° 32' 47" W
46° 40' 29" N
46° 39' 53" N
686900
687000
687100
687200
687300
687400
687500
687600
5171900
5171800
5171700
5171600
5171500
5171400
5171300
5171200
5171100
5171000
5170900
129
Mcgonagle Rd
111
102
114
Map Scale: 1:5,440 if printed on A portrait (8.5" x 11") sheet.
Meters
0 50 100 200 300
Feet
0 250 500 1000 1500
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

Map Unit Legend

Yakima County Area, Washington (WA677)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
102	Ritzville silt loam, 15 to 30 percent slopes	24.0	21.0%
111	Roza clay loam, 5 to 8 percent slopes	0.6	0.5%
114	Roza clay loam, 30 to 60 percent slopes	89.5	78.4%
129	Selah silt loam, 5 to 8 percent slopes	0.2	0.1%
Totals for Area of Interest		114.2	100.0%

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic

classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Yakima County Area, Washington

102—Ritzville silt loam, 15 to 30 percent slopes

Map Unit Setting

Elevation: 800 to 3,000 feet
Mean annual precipitation: 9 to 12 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 100 to 180 days

Map Unit Composition

Ritzville and similar soils: 100 percent

Description of Ritzville

Setting

Landform: Hillslopes
Parent material: Loess

Typical profile

H1 - 0 to 7 inches: neutral, silt loam
H2 - 7 to 37 inches: neutral, silt loam
H3 - 37 to 60 inches: strongly alkaline, silt loam

Properties and qualities

Slope: 15 to 30 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 12.0 inches)

Interpretive groups

Farmland classification: Farmland of unique importance
Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: LOAMY 10-16 PZ (R008XY102WA)

111—Roza clay loam, 5 to 8 percent slopes

Map Unit Setting

Elevation: 1,100 to 4,600 feet
Mean annual precipitation: 8 to 12 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 110 to 165 days

Map Unit Composition
Roza and similar soils: 100 percent

Description of Roza

Setting
Parent material: Alluvium and/or residuum derived from fine textured sediments

Typical profile
H1 - 0 to 2 inches: slightly alkaline, clay loam
H2 - 2 to 19 inches: slightly alkaline, silty clay
H3 - 19 to 60 inches: slightly alkaline, clay loam

Properties and qualities
Slope: 5 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 20 percent
Available water storage in profile: High (about 9.7 inches)

Interpretive groups
Farmland classification: Farmland of statewide importance
Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: CALCAREOUS LOAM 10-16" pz (R008XY701WA)

114—Roza clay loam, 30 to 60 percent slopes

Map Unit Setting
Elevation: 1,100 to 4,600 feet
Mean annual precipitation: 8 to 12 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 110 to 165 days

Map Unit Composition
Roza and similar soils: 100 percent

Description of Roza

Setting
Parent material: Alluvium and/or residuum derived from fine textured sediments

Typical profile
H1 - 0 to 2 inches: slightly alkaline, clay loam
H2 - 2 to 19 inches: slightly alkaline, silty clay
H3 - 19 to 60 inches: slightly alkaline, clay loam

Properties and qualities

Slope: 30 to 60 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 20 percent
Available water storage in profile: High (about 9.7 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: CALCAREOUS LOAM 10-16" pz (R008XY701WA)

129—Selah silt loam, 5 to 8 percent slopes

Map Unit Setting

Elevation: 1,100 to 2,900 feet
Mean annual precipitation: 8 to 15 inches
Mean annual air temperature: 48 to 55 degrees F
Frost-free period: 130 to 180 days

Map Unit Composition

Selah and similar soils: 100 percent

Description of Selah

Setting

Landform: Terraces
Parent material: Loess and old alluvium

Typical profile

H1 - 0 to 7 inches: neutral, silt loam
H2 - 7 to 29 inches: slightly alkaline, silt loam
H3 - 29 to 34 inches: slightly alkaline, clay loam
H4 - 34 to 38 inches: , cemented material

Properties and qualities

Slope: 5 to 8 percent
Depth to restrictive feature: 20 to 40 inches to duripan
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent

Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 6.5 inches)

Interpretive groups

Farmland classification: Farmland of statewide importance
Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: LOAMY 10-16 PZ (R008XY102WA)

Appendix X

USGS Design Maps Summary

USGS Design Maps Summary Report

User-Specified Input

Report Title Valhalla Heights Addition

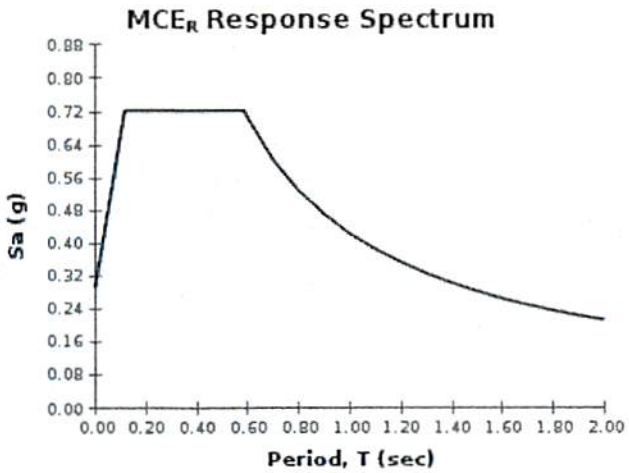
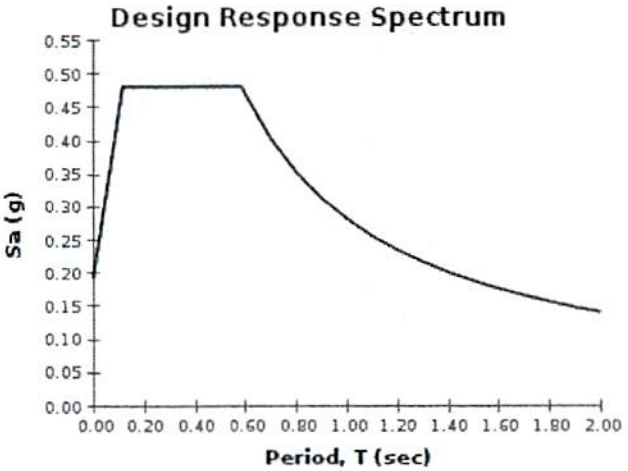
Building Code Reference Document 2012 International Building Code

Site Coordinates 46.67011°N, 120.55218°W

Site Soil Classification Site Class D – "Stiff Soil"

Risk Category I/II/III

USGS-Provided Output

S_S =	0.522 g	S_{MS} =	0.722 g	S_{DS} =	0.481 g
S_1 =	0.215 g	S_{M1} =	0.423 g	S_{D1} =	0.282 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.