Staff Report for Administrative Hillside Review Approval

Weber County Planning Division

Synopsis

Application Information

Application Request:	Consideration and action on a Hillside Review Application for 6682 Chaparral Road, Huntsville.
Type of Decision:	Administrative
Applicant:	George Haley
File Number:	HSR 2021-01

Property Information

Project Area:	1.91 Acres
Zoning:	Forest Valley (FV-3) Zone
Existing Land Use:	Residential
Proposed Land Use:	Residential
Parcel ID:	20-102-0002

Adjacent Land Use

North:	Residential	**South:**	Residential
East:	Residential	**West:**	Residential

Staff Information

Report Presenter: Steve Burton
sburton@webercountyutah.gov
801-399-8766

Report Reviewer: RG

Applicable Ordinances

- Title 101 (General Provisions) Section 7 (Definitions)
- Title 108 (Standards) Chapter 14 (Hillside Development)
- Title 108 (Standards) Chapter 22 (Natural Hazard Areas)

Background and Summary

The applicant is requesting approval of a Hillside Review for lot 2R of the Legends at Hawkins Creek Cluster Subdivision. Several lots within the Legends subdivision were platted with buildable areas. Lot 2R was designated as a restricted lot because a buildable area could not be established given the slope of the lot and potential geologic hazards.

The applicant has submitted a geologic hazards evaluation prepared by Western Geologic & Environmental LLC. The hazards evaluation cites earthquake ground shaking, landslides and slope failures as moderate to high risk for this property. Regarding the moderate risk for landslides, the hazards report explains the following:

> *We recommend the Project geotechnical engineer evaluate stability of slopes at the site based on site-specific soil conditions and the data provided in this report. Recommendations should be provided to reduce the landslide hazard risk if factors of safety are determined to be unsuitable. Water, steep man-made cuts, and non-engineered fill materials are often major contributors to slope instability. Care should therefore also be taken to maintain proper site drainage, that site grading does not destabilize slopes at the site without prior geotechnical analysis and grading plans, and that water from man-made sources is minimized in potentially unstable slope areas.*

The applicant has also submitted a geotechnical investigation prepared by Christensen Geotechnical. The geotechnical report provides recommendations regarding site preparation and the construction of the home. All recommendations within the geologic hazards report and the geotechnical investigation must be followed as this site is developed. Prior to receiving a certificate of occupancy, the applicant will need to provide a letter from the geologist and geotechnical engineer, stating that all recommendations were followed as the house was constructed.

The following section is staff's review of the hillside review requirements of Weber County Land Use Code 108-14 Hillside Development Review Procedure and Standards.

Planning Division Review

The Planning Division Staff has determined that, in compliance with review agency conditions, the requirements and standards provided by the Hillside Review Chapter have been met for the excavation and construction of the dwelling. The following submittals were required:

1. Engineered Plans
2. Geologic Hazards Evaluation and Geotechnical Study (see Exhibit B).
3. Landscaping Plan
4. Topographical site Plan

Weber County Hillside Review Board comments

The Weber County Hillside Review Board, on this particular application, made the following comments and conditions:

Weber County Engineering Division:

> *Follow the recommendations of the Geological and Geotechnical Reports provided for this project.*
>
> *I have tried to address all items of concern from the Engineering Department. However, this review does not forego other items of concern that may come to this department's attention during additional reviews or during construction of improvements. It is the responsibility of property owners to ensure that they are not building over an easement. If you have any comments or questions concerning this review, feel free to contact me.*

Weber Fire District:

> *The hydrant needs to at least flow with 1000 GPM. The builder will need to verify with the water company on fire flow and call or email me. If the hydrant can't produce the required fire flow than an alternate means of fire protection will be required. 8017823580 ext. 205 dreed@weberfd.com*
>
> *Impact fee $315.00*

Weber County Building Inspection Department: All questions and comments from the Weber County Building Inspection Department must be addressed as stated as a condition of approval.

Weber-Morgan Health Department: The applicant is connecting to the community septic system known as the Hawkins Creek system. The owner will need to obtain Health Department approval of the septic connection as part of building permit approval.

Weber County Planning Division: The Planning Division has granted approval subject to the applicant complying with all Board requirements and conditions. This approval is also subject to the applicant following through with the recommendations of the geologic and geotechnical studies. As part of the review of the Planning Division, staff reviewed the landscaping plan. The proposed landscaping plan consists of evergreen trees and native grass seed mix. No type of irrigation system is shown. Due to potential slope failure and landslide risks, any type of irrigation will need to comply with the recommendations of the geologic hazards report and geotechnical report.

Planning Division Findings

Staff recommends approval of HSR 2021-01 subject to all review agency requirements and the following conditions:

1. Development of the lot must follow all recommendations outlined in the geologic hazards evaluation prepared by Western Geologic & Environmental as well as the recommendations outlined in the geotechnical investigation prepared by Christensen Geotechnical.
2. A notice of natural hazards must be recorded against the property before a certificate of occupancy once a building permit is obtained.
3. Once the dwelling is complete, the applicant must provide a letter from the geologist and geotechnical engineer, that states the home was built in accordance with the geologic hazards study and the geotechnical report recommendations.

The recommendation for approval is based on the following findings:

1. The application was submitted and has been deemed complete.
2. The requirements and standards found in the Hillside Development Review Procedures and Standards Chapter have been met or will be met during the excavation and construction phase of the dwelling.
3. The Hillside Review Board members reviewed the application individually and have provided their comments.
4. The applicant has met or will meet, as part of the building permit process and/or during the excavation and construction phase of the dwelling, the requirements, and conditions set forth by the Hillside Review Board.

Administrative Approval

Administrative approval of HSR 2021-01 is hereby granted based upon its compliance with the Weber County Land Use Code. This approval is subject to the requirements of applicable review agencies and is based on the findings listed in this staff report.

Date of Administrative Approval: 3/16/21

____

Rick Grover

Weber County Planning Director

Exhibits

A. Geologic Reconnaissance
B. Geotechnical Study
C. Site plan and landscaping plan

Area Map

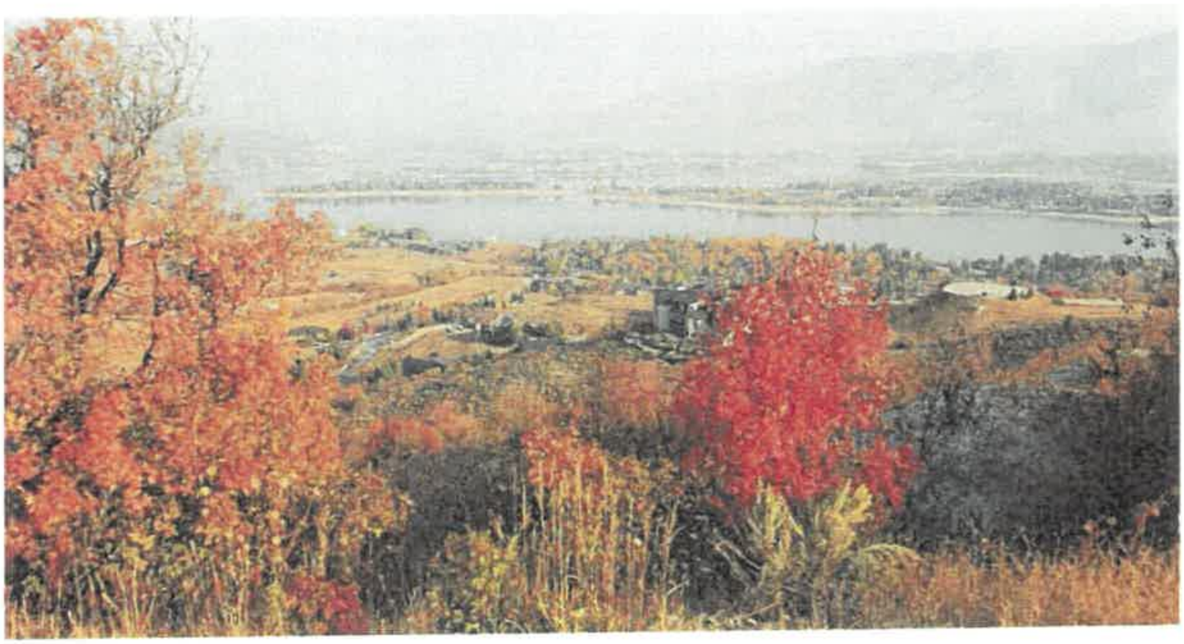
1383
6682
6694
6688
6654
6659
6671
6689
6645
6651
6634
6639
6612

Exhibit A
Geologic hazards
evaluation

REPORT

GEOLOGIC HAZARDS EVALUATION

LEGENDS AT HAWKINS CREEK LOT 2
6682 EAST CHAPARRAL ROAD
HUNTSVILLE, WEBER COUNTY, UTAH



Prepared for

Habitations Residential Design Group
1523 East Skyline Drive, Suite B
Ogden, Utah 84405

October 23, 2020

Prepared by

Western Geologic & Environmental LLC
2150 South 1300 East, Suite 500
Salt Lake City, UT 84106 USA

Voice: 801.359.7222
Fax: 801.990.4601
Web: www.westerngeologic.com

Exhibit A
Geologic hazards
evaluation

WESTERN GEOLOGIC & ENVIRONMENTAL LLC
2150 SOUTH 1300 EAST, SUITE 500
SALT LAKE CITY, UTAH 84106 USA

Phone: 801.359.7222 Fax: 801.990.4601 Email: kthomas@westerngeologic.com

October 23, 2020

Joe Sadler
Habitations Residential Design Group
1523 East Skyline Drive, Suite B
Ogden, Utah 84405

Letter of Transmittal: REPORT
Geologic Hazards Evaluation
Legends at Hawkins Creek Lot 2
6682 East Chaparral Road
Huntsville, Weber County, Utah

Dear Mr. Sadler:

Western Geologic & Environmental has completed a Geologic Hazards Evaluation for Legends at Hawkins Creek Lot 2 at 6682 East Chaparral Road in Huntsville, Utah and submits the attached report for your review.

If you have any questions regarding this report, please contact us at (801) 359-7222.

Sincerely,
Western Geologic & Environmental LLC

LICENSED PROFESSIONAL GEOLOGIST
10/23/2020
BILL DUANE BLACK
NO. 5224898-2250
STATE OF UTAH

Bill. D. Black, P.G.
Subcontract Geologist

Reviewed By:

LICENSED PROFESSIONAL GEOLOGIST
10/23/2020
KEVIN J THOMAS
11297638-2250
STATE OF UTAH

Kevin J. Thomas, P.G.
Principal Geologist

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WG&E Project No. 5522

Exhibit A
Geologic hazards
evaluation

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FIGURES

Exhibit A
Geologic hazards evaluation

1.0 INTRODUCTION

This report presents the results of a geology and geologic hazards review and evaluation conducted by Western Geologic & Environmental LLC (Western Geologic) for Legends at Hawkins Creek Lot 2 at 6682 East Chaparral Road in Huntsville, Utah (Figure 1 – Project Location). The Project consists of a 1.91-acre parcel identified as Weber County Assessor parcel number 20-102-0002. The property is currently undeveloped. The site is located in southern Ogden Valley on slopes overlooking Pineview Reservoir, and is in the SW 1/4 of Section 24, Township 6 North, Range 1 East (Salt Lake Base Line and Meridian; Figure 1). Elevation of the site is 5,368 to 5,478 feet above sea level. No formalized development plans were provided, but it is our understanding that the intended development is for a single-family residential home.

2.0 PURPOSE AND SCOPE

The purpose and scope of this investigation is to identify and interpret surficial geologic conditions at the site to identify potential risk from geologic hazards to the Project. This investigation is intended to: (1) provide preliminary geologic information and assessment of geologic conditions at the site; (2) identify potential geologic hazards that may be present and qualitatively assess their risk to the intended site use; and (3) provide recommendations for additional site- and hazard-specific studies or mitigation measures, as may be needed based on our findings. Such recommendations could require further multi-disciplinary evaluations, and/or may need design criteria that are beyond our professional scope. Our investigation was conducted concurrently with a geotechnical engineering study performed at the Project by Christensen Geotechnical.

2.1 Methodology

The following services were performed in accordance with the above-stated purpose and scope:

- A site reconnaissance conducted by an experienced certified engineering geologist to assess the site setting and look for adverse geologic conditions;
- Review of readily-available geologic maps, reports, and air photos;
- Logging of two walk-in test pits to assess subsurface conditions;
- Preparation of one geologic cross section based on geoprocessed LIDAR data, site-specific subsurface data, and inferred conditions; and
- Evaluation of available data and preparation of this report, which presents the results of our study.

The engineering geology section of this report has been prepared in accordance with Bowman and Lund (2016) and current generally accepted professional engineering geologic principles and practice in Utah, and meets specifications provided in Chapter 27 of the Weber County Land Use Code within the above stated scope. We do not include discussion of radon hazard potential, as recommended in Bowman and Lund (2016), because radon gas poses an environmental health hazard and indoor levels are heavily influenced by several post-construction, non-geologic factors. The hazard from radon should be evaluated by long-term testing following construction.

2.2 Limitations and Exceptions

This investigation was performed at the request of Habitations Residential Design Group (the Client) using the methods and procedures consistent with good commercial and customary practice designed to conform to acceptable industry standards. The analysis and recommendations submitted in this report are based upon the data obtained from site-specific observations and compilation of known geologic information. This information and the conclusions of this report should not be interpolated to adjacent properties without additional site-specific information. In the event that any changes are later made in the location of the proposed site, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or approved in writing by the engineering geologist.

This report has been prepared by the staff of Western Geologic for the Client under the professional supervision of the principal and/or senior staff whose seal(s) and signatures appear hereon. Neither Western Geologic, nor any staff member assigned to this investigation has any interest or contemplated interest, financial or otherwise, in the subject or surrounding properties, or in any entity which owns, leases, or occupies the subject or surrounding properties or which may be responsible for environmental issues identified during the course of this investigation, and has no personal bias with respect to the parties involved.

The information contained in this report has received appropriate technical review and approval. The conclusions represent professional judgment and are founded upon the findings of the investigations identified in the report and the interpretation of such data based on our experience and expertise according to the existing standard of care. No other warranty or limitation exists, either expressed or implied.

The investigation was prepared in accordance with the approved scope of work outlined in our proposal for the use and benefit of the Client; its successors, and assignees. It is based, in part, upon documents, writings, and information owned, possessed, or secured by the Client. Neither this report, nor any information contained herein shall be used or relied upon for any purpose by any other person or entity without the express written permission of the Client. This report is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose without the advance written consent of Western Geologic.

In expressing the opinions stated in this report, Western Geologic has exercised the degree of skill and care ordinarily exercised by a reasonable prudent environmental professional in the same community and in the same time frame given the same or similar facts and circumstances. Documentation and data provided by the Client, designated representatives of the Client or other interested third parties, or from the public domain, and referred to in the preparation of this assessment, have been used and referenced with the understanding that Western Geologic assumes no responsibility or liability for their accuracy. The independent conclusions represent our professional judgment based on information and data available to us during the course of this assignment. Factual information regarding operations, conditions, and test data provided by the Client or their representative has been assumed to be correct and complete. The conclusions presented are based on the data provided, observations, and conditions that existed at the time of the field exploration.

3.0 HYDROLOGY

The U.S. Geological Survey (USGS) topographic map of the Huntsville Quadrangle shows the site is in southern Ogden Valley between Smith Creek and Hawkins Creek, which are several hundred feet to the west and east respectively (Figure 1). The Huntsville South Bench Canal and Pineview Reservoir are north of the Project. No perennial, intermittent or ephemeral drainages are mapped crossing the Project or were observed during our site reconnaissance.

The site is at the southern margin of Ogden Valley, which is dominated in the valley bottom by unconsolidated lacustrine and alluvial basin-fill deposits. Slopes in the area are in weathered tuffaceous bedrock overlain by alluvium and colluvium from mixed sources, including landslides. The Utah Division of Water Rights Well Driller Database shows five water wells in the Project vicinity that report static groundwater depths of 128 to 220 feet below the ground surface (Figure 1). Given the reported groundwater depths in the nearest water well, which is at a lower elevation about 1,350 feet southwest of the site, we anticipate groundwater at the Project is more than 50 feet deep. However, groundwater depth at the site may vary seasonally from snowmelt runoff and annually from climatic fluctuations. Such variations would be typical for an alpine environment. Groundwater may also be seasonally shallow in the bottom of the erosional swale or locally perched above less-permeable, clay-rich layers in the subsurface.

Avery (1994) indicates groundwater in Ogden Valley occurs under perched, confined, and unconfined conditions in the valley fill to depths of 750 feet or more. A well-stratified lacustrine silt layer forms a leaky confining bed in the upper part of the valley-fill aquifer. The aquifer below the confining beds is the principal aquifer, which is in primarily fluvial and alluvial-fan deposits. The principal aquifer is recharged from precipitation, seepage from surface water, and subsurface inflow from bedrock into valley fill along the valley margins (Avery, 1994). The confined aquifer is typically overlain by a shallow, unconfined aquifer recharged from surface flow and upward leakage. Groundwater flow is generally from the valley margins into the valley fill, and then toward the head of Ogden Canyon (Avery, 1994). Based on topography, we expect groundwater flow at the site to be to the north.

4.0 GEOLOGY

4.1 Surficial Geology

The site is located on the southern margin of Ogden Valley, a sediment-filled intermontane valley within the Wasatch Range, a major north-south trending mountain range marking the eastern boundary of the Basin and Range physiographic province (Stokes; 1977, 1986).

Surficial geology of the site is mapped by Coogan and King (2016) as Tertiary-age Norwood Formation bedrock (unit Tn; Figure 2). The bedrock is shown dipping to the northeast in the area at between 18 to 24 degrees on Figure 2. The underlined units described below are those mapped at the site.

Coogan and King (2016) describe surficial geologic units in the site area on Figure 2 as follows:

Qlamh *– Lacustrine, marsh, and alluvial deposits, undivided (Historical).* Sand, silt, and clay mapped where streams enter Pineview Reservoir, and reservoir levels fluctuate such that lacustrine, marsh, and alluvial deposits are intermixed; thickness uncertain.

Qa2, Qa2?, Qay *– Younger alluvium (mostly Holocene).* Like undivided alluvium, with Qay at to slightly above present drainages, unconsolidated, and not incised by active drainages; likely mostly Holocene in age and postdates late Pleistocene Provo shoreline of Lake Bonneville; height above present drainages is low and is within certain limits, with suffix 1 (not present on this map) being the youngest and being at to slightly (<10 feet [3 m]) above drainages and suffix 2 being slightly higher and older, with y suffix where ages 1 and 2 cannot be separated; Qa2 is up to about 20 feet (6 m) above drainage on south side of Round Valley indicating unit includes slightly older post Provo-shoreline alluvium; generally 6 to 20 feet (2-6 m) thick. Mapped as Qa2 (queried) where about 20 feet (6 m) above incised stream in Stephens Canyon (Devils Slide quadrangle).

Qal, Qal1, Qal2, Qal2? *– Stream alluvium and flood-plain deposits (Holocene and uppermost Pleistocene).* Sand, silt, clay, and gravel in channels, flood plains, and terraces typically less than 16 feet (5 m) above river and stream level; moderately sorted; unconsolidated; along the same drainage Qal2 is lower than Qat2 and has likely been subject to flooding, at least prior to dam building; present in broad plains along the Bear, Ogden, and Weber Rivers and larger tributaries like Deep, Cottonwood, East Canyon, Lost, and Saleratus Creeks, along Box Elder, Heiners, and Yellow Creeks, and in narrower plains of larger tributary streams; locally includes muddy, organic overbank and oxbow lake deposits; composition depends on source area, so in back valleys typically contains many quartzite cobbles recycled from the Wasatch Formation; mostly Holocene, but deposited after regression of Lake Bonneville from the late Pleistocene Provo shoreline; width in Morgan Valley is combined flood plain of Weber River and East Canyon and Deep Creeks; 6 to 20 feet (2-6 m) thick and possibly as much as 50 feet (15 m) along Weber River and thinner in the Kaysville quadrangle; greater thicknesses (>50 feet [15 m]) are reported in Morgan Valley (Utah Division of Water Rights, well drilling database), but likely include Lake Bonneville and older Pleistocene deposits.

Suffixes 1 and 2 indicate ages where they can be separated, with 1 including active channels and 2 including low terraces 10 to 20 feet (3-6 m) above the Weber and Ogden Rivers, and the South Fork Ogden River that may have been in the flood plain prior to damming of these waterways. Qal2 queried in low terraces above Bear River, Saleratus Creek, and Dry Creek where deposits may not be in the flood plain.

Qac *– Alluvium and colluvium (Holocene and Pleistocene).* Unsorted to variably sorted gravel, sand, silt, and clay in variable proportions; includes stream and fan alluvium, colluvium, and, locally, mass-movement deposits too small to show at map scale; typically mapped along smaller drainages that lack flat bottoms; more extensive east of Henefer where Wasatch Formation (Tw) strata easily weather to debris that "chokes" drainages; 6 to 20 feet (2-6 m) thick. Some deposits are "perched" on benches 80 feet (25 m) and more above present-day drainages like Left Fork Heiners Creek (Heiners Creek quadrangle) and Harris Canyon (Henefer quadrangle). In the Devils Slide quadrangle, some deposits are "perched" on benches about 60 to 130 feet (18-40 m) above Quarry Cottonwood Canyon indicating the alluvium is at least partly Lake Bonneville age and older (see Qab and Qao in tables 1 and 2).

Qat, Qat2, Qaty, Qatp, Qatp?, Qatpb, Qato *– Stream-terrace alluvium (Holocene and Pleistocene).* Sand, silt, clay, and gravel in terraces above floodplains near late Pleistocene Lake Bonneville and are geographically in the Ogden and Weber River, and lower Bear River drainages; moderately sorted; variably consolidated; upper surfaces slope gently downstream; locally includes thin and small mass-movement and alluvial-fan deposits; where possible, subdivided into relative ages, indicated by number and letter suffixes, with 2 being the lowest/youngest terraces, typically about 10 to 20 feet (3-6 m) above adjacent flood plains; Qat with no suffix used where age unknown or age subdivisions of terraces cannot be shown separately at map scale; 6 to at least 20 feet (2-6+ m) thick, with Qatp 50 to 80 feet (15-24 m) thick in Mantua Valley.

Relative ages are largely from heights above adjacent drainages in Morgan and Round Valleys. This subdivision apparently works in and is applied in Ogden, Henefer, and Lost Creek Valleys and above the North, Middle, and South Forks of Ogden River (see tables 1 and 2). Despite the proximity to Lake Bonneville, terraces along and near Box Elder Creek in the northwest corner of the Ogden map area (Mantua quadrangle) seem to be slightly higher than comparable terraces in Morgan Valley. Terraces labeled Qat2 are post-Lake Bonneville and are likely mostly Holocene in age. A terrace labeled Qaty is up to 20 feet (6 m) above the South Fork Ogden River, but may be related to the Provo or regressional shorelines. Terraces labeled Qatp are likely related to the Provo and slightly lower shorelines of Lake Bonneville (at and less than ~4820 feet [1470 m] in area), and with Qap form "benches" at about 4900 feet (1494 m) along the Weber River and South Fork Ogden River. Qato terraces pre-date Lake Bonneville. Relative age queried (Qatp?) where age is uncertain, generally due to height not fitting into ranges in table 1 and/or typical order of surfaces contradicts height-derived age.

Qms, Qms?, Qmsy, Qmsy?, Qmso, Qmso? *– Landslide deposits (Holocene and upper and middle? Pleistocene).* Poorly sorted clay- to boulder sized material; includes slides, slumps, and locally flows and floods; generally characterized by hummocky topography, main and internal scarps, and chaotic bedding in displaced blocks; composition depends on local sources; morphology becomes more subdued with time and amount of water in material during emplacement; Qms may be in contact with Qms when landslides are different/ distinct; thickness highly variable, up to about 20 to 30 feet (6-9 m) for small slides, and 80 to 100 feet (25-30 m) thick for larger landslides. Qmsy and Qmso queried where relative age uncertain; Qms queried where classification uncertain. Numerous landslides are too small to show at map scale and more detailed maps shown in the index to geologic mapping should be examined.

Qms without a suffix is mapped where the age is uncertain (though likely Holocene and/or late Pleistocene), where portions of slide complexes have different ages but cannot be shown separately at map scale, or where boundaries between slides of different ages are not distinct. Estimated time of emplacement is indicated by relative-age letter suffixes with: Qmsy mapped where landslides deflect streams or failures are in Lake Bonneville deposits, and scarps are variably vegetated; Qmso typically mapped where deposits are "perched" above present drainages, rumpled morphology typical of mass movements has been diminished, and/or younger surficial deposits cover or cut Qmso. Lower perched Qmso deposits are at Qao heights above drainages (95 ka and older) and the higher perched deposits may correlate with high level alluvium (QTa_) (likely older than 780 ka) (see table 1). Suffixes y and o indicate probable Holocene and Pleistocene ages, respectively, with all Qmso likely emplaced before Lake Bonneville transgression. These older deposits are as unstable as other slides, and are easily reactivated with the addition of water, be it irrigation or septic tank drain fields.

***Qmc** – Landslide and colluvial deposits, undivided (Holocene and Pleistocene).* Poorly sorted to unsorted clay- to boulder-sized material; mapped where landslide deposits are difficult to distinguish from colluvium (slope wash and soil creep) and where mapping separate, small, intermingled areas of landslide and colluvial deposits is not possible at map scale; locally includes talus and debris flow and flood deposits; typically mapped where landslides are thin ("shallow"); also mapped where the blocky or rumpled morphology that is characteristic of landslides has been diminished ("smoothed") by slope wash and soil creep; composition depends on local sources; 6 to 40 feet (2-12 m) thick. These deposits are as unstable as other landslide units (Qms, Qmsy, Qmso).

***Qap, Qap?, Qab, Qab?, Qapb** – Lake Bonneville-age alluvium (upper Pleistocene).* Like undivided alluvium but height above present drainages appears to be related to shorelines of Lake Bonneville and is within certain limits, and unconsolidated to weakly consolidated; alluvium labeled Qap and Qab is related to Provo (and slightly lower) and Bonneville shorelines of Lake Bonneville (at ~4800 to 4840 feet [1463-1475 m] and 5180 feet [1580 m] in Morgan Valley), respectively; suffixes partly based on heights above adjacent drainages near Morgan Valley (see tables 1 and 2); Qap is typically about 15 to 40 feet (5-12 m) above present adjacent drainages, but is locally 45 feet (12 m) above; Qapb is used where more exact age cannot be determined, typically away from Lake Bonneville, or where alluvium of different ages cannot be shown separately at map scale; Qap is up to about 50 feet (15 m) thick, with Qapb and Qab, at least locally up to 40 and 90 feet (12 and 27 m) thick, respectively. Queried where classification or relative age uncertain (see Qa).

A prominent surface ("bench") is present on Qap and Qatp at about 4900 feet (1494 m) elevation and about 25 to 40 feet (8-12 m) above the Weber River in Morgan Valley and along the South Fork Ogden River.

In the Devils Slide quadrangle, the Qab that is mapped about 80 to 95 feet (24-29 m) above Round Valley and 40 to 50 feet (12-15 m) above adjacent drainages at the mouth of Geary Hollow appears unique. Based on heights above adjacent drainages, these deposits would be Qao (see table 1), but similar alluvial deposits to the east near Phil Shop Hollow have a Bonneville shoreline cut in them and are much thinner than 40 feet (12 m). The lack of a Bonneville shoreline, and small thickness and heights above drainages indicate the deposits could be a Bonneville shoreline fan-delta.

***Ql, Ql?** – Lake Bonneville deposits, undivided (upper Pleistocene).* Silt, clay, sand, and cobbly gravel in variable proportions; mapped where grain size is mixed, deposits of different materials cannot be shown separately at map scale, or surface weathering obscures grain size and deposits are not exposed in scarps or construction cuts; thickness uncertain.

***Qlf, Qlf?, Qlfb, Qlfb?** – Fine-grained lacustrine deposits (Holocene and upper Pleistocene).* Mostly silt, clay, and fine-grained sand deposited near- and off-shore in Lake Bonneville; typically mapped as Qlf below the Provo shoreline (P) because older transgressive (Qlfb) deposits are indistinguishable from younger regressive deposits; mapped as Qlfb above the Provo shoreline because these deposits can only be related to the Bonneville shoreline (B) and transgression; grades upslope with more sand into Qls or Qlsp; typically eroded from shallow Norwood Formation in Ogden and Morgan Valleys and at least 12 feet (4 m) thick near Mountain Green. Qlf and Qlfb queried where grain size is uncertain.

In the Kaysville quadrangle, Qlf deposits that are below the Gilbert (G) shoreline are at least partly the same age as this shoreline (Holocene-latest Pleistocene) and post-date late Pleistocene Lake Bonneville. Qlf deposits below the Holocene (H) highstand shoreline are Holocene. Both ages of deposits are generally less than 15 feet (5 m) thick.

Deeper water fine-grained deposits overlie older shoreline and delta gravels (Qlf/Qdlb) at the mouths of several drainages along the Weber River. These gravels were deposited above the Provo shoreline during transgression of Lake Bonneville to the Bonneville shoreline (see unit Qdlb).

***Qls, Qls?, Qlsp, Qlsb, Qlsb?** – Lake Bonneville sand (upper Pleistocene).* Mostly sand with some silt and gravel deposited nearshore below and near the Provo shoreline (Qlsp) and between the Provo and Bonneville shorelines (Qlsb); Qls mapped downslope from slope break below Provo shoreline beach deposits where thin Lake Bonneville regressional sand may overlie transgressional sand; grades downslope into unit Qlf with decreasing sand content and laterally with more gravel into units Qdlp, Qdlb, and upslope with more gravel into unit Qlgb; Qls and Qlsb queried where grain size or unit identification uncertain; may be as much as 75 feet (25 m) thick, and thickest near Ogden; typically less than 20 feet (6 m) thick in Morgan Valley; may include small deltas and deltas that lack typical delta shape.

***Qao, Qao?** – Older alluvium (mostly upper Pleistocene).* Sand, silt, clay, and gravel above and likely older than the Bonneville shoreline; mapped on surfaces above Lake Bonneville-age alluvium (Qap, Qab, Qapb); deposits lack fan shape (Qaf) and are distinguished from terraces (Qat) based on upper surface sloping toward adjacent streams from sides of drainage; also shown where areas of fans and terraces are too small to show separately at map scale; composition depends on source area; at least locally up to 110 feet (34 m) thick. Queried where classification or relative age is uncertain (see Qa for details); for example near head of Saleratus Creek.

Older alluvium is likely older than Lake Bonneville and the same age as Qafo, so likely Bull Lake age, 95,000 to 130,000 years old (see Chadwick and others, 1997, and Phillips and others, 1997); see table 1 and note revision from Coogan and King (2006) and King and others (2008). From our work in the Henefer (Coogan, 2010b) and Devils Slide quadrangles and ages in Sullivan and Nelson (1992) and Sullivan and others (1988), older alluvium (Qao, Qafo, Qato) may encompass an upper (pre-Bull Lake) and lower (Bull Lake) alluvial surface that is not easily recognized in Morgan Valley (see tables 1 and 2).

Tcg, Tcg? *– Unnamed Tertiary conglomeratic rocks (Oligocene?).* Characterized by rounded, cobble- to boulder-sized, quartzite-clast conglomerate with pebbles and less than 10 percent to more than 50 percent gray, tan, or reddish-gray to reddish-tan matrix; conglomerate clasts locally angular to subangular Tintic Quartzite and angular to rounded lower Paleozoic carbonate rocks; interbedded with tan, gray, and reddish-brown, pebble-bearing mudstone to sandstone and some claystone (altered tuff); most beds poorly indurated and poorly exposed; mudstone likely constitutes matrix of conglomeratic beds; in Morgan and Durst Mountain quadrangles, about 500 to 700 feet (150-210 m) thick and thickening northward to possibly 3000 feet (900 m), though faulting may make this estimate too large.

Reddish-hued Tcg strata mostly contain recycled Wasatch Formation clasts (quartzite and carbonate) with a distinct reddish patina in a reddish matrix. Some non-conglomeratic beds in Tcg look like gray upper Norwood Formation (Tn) and are locally tuffaceous, indicating the units are interbedded. Further, some Tcg pebble beds have carbonate and chert clasts (like the Norwood) and lesser quartzite clasts, and Tcg conglomerate includes rare altered tuff clasts from the Norwood Formation. Despite tuffaceous matrix, unit Tcg seems to be less prone to mass movements than Norwood strata.

Tn, Tn? *– Norwood Formation (lower Oligocene and upper Eocene).* Typically light-gray to light-brown altered tuff (claystone), altered tuffaceous siltstone and sandstone, and conglomerate; unaltered tuff, present in type section south of Morgan, is rare; locally colored light shades of red and green; variable calcareous cement and zeolitization; involved in numerous landslides of various sizes; estimate 2000-foot *(600 m) thick in exposures on west side of Ogden Valley (based on bedding dip,* outcrop width, and topography). Norwood Formation queried where poor exposures may actually be surficial deposits. For detailed Norwood Formation information see description under heading "Sub-Willard Thrust - Ogden Canyon Area" since most of this unit is in and near Morgan Valley and covers the Willard thrust, Ogden Canyon, and Durst Mountain areas.

ZYp, ZYp? *– Formation of Perry Canyon (Neoproterozoic and possibly Mesoproterozoic).* Argillite to metagraywacke upper unit, middle meta-diamictite, and basal slate, argillite, and meta-sandstone; phyllitic at least south of Pineview Reservoir; due to overturned folding, only one diamictite unit (Adolph Yonkee, Weber State University, February 2, 2011, email communication) rather than two (see Crittenden and others, 1983); total thickness likely less than 2000 feet (600 m) (this report). Queried in knob west of North Fork Ogden River in North Ogden quadrangle because rock is quartzite that may be in this unit or the Papoose Creek Formation. The formation of Perry Canyon is prone to slope failures.

Balgord's (2011; Balgord and others, 2013) detrital zircon uranium-lead and lead-lead maximum depositional ages (~950-1030 Ma) on the basal mudstone unit straddle the Upper and Middle Proterozoic boundary, but other maximum ages (925 Ma) on this mudstone unit are Upper Proterozoic; her maximum ages on the upper unit are about 640, 660, and 690 Ma.

Lower part of formation not measured where thick in the Wasatch Range and stratigraphy not worked out, because upper and lower parts incompletely measured and at least locally the upper and lower parts in the Wasatch Range are lithologically indistinguishable. Unit ("member") thicknesses vary due to syndepositional faulting (see Balgord and others, 2013). The best stratigraphic section of the lower unit (ZYpm), volcanic unit (Zpb), and diamictite (Zpd) is 30 miles (50 km) to the southwest on Fremont Island in Great Salt Lake, but the base of ZYpm is not exposed (see Balgord, 2011, figure 14, p. 51; Balgord and others, 2013, figure 5). The Fremont Island section is likely in a different Proterozoic faulted basin; compare thicknesses and lithologies between Fremont Island and Willard Peak shown by Balgord (2011, Balgord and others (2013). Also, although both localities are shown on the Willard thrust sheet by Yonkee and Weil (2011), they may be on different thrust sheets. Therefore, the formal term Perry Canyon Formation is not used. Where possible divided into several lithosomes which have been called members.

Citations, tables, and/or figures referenced above are not provided herein but are in Coogan and King (2016).

4.2 Seismotectonic Setting

The property is located at the northeastern margin of Ogden Valley, a roughly 40-square mile back valley described by Gilbert (1928) as a structural trough similar to Cache and Morgan Valleys to the north and south, respectively. The back valleys of the northern Wasatch Range are in a transition zone between the Basin and Range and Middle Rocky Mountains physiographic provinces (Stokes, 1977, 1986). The Basin and Range is characterized by a series of generally north-trending elongate mountain ranges, separated by predominately alluvial and lacustrine sediment-filled valleys and typically bounded on one or both sides by major normal faults (Stewart, 1978). The boundary between the Basin and Range and Middle Rocky Mountains provinces is marked by the Wasatch fault zone at the base of the Wasatch Range. Late Cenozoic normal faulting, a characteristic of the Basin and Range, began between about 17 and 10 million years ago in the Nevada (Stewart, 1980) and Utah (Anderson, 1989) portions of the province. The faulting is a result of a roughly east-west directed, regional extensional stress regime that has continued to the present (Zoback and Zoback, 1989; Zoback, 1989). The back valleys are morphologically similar to valleys in the Basin and Range, but exhibit less structural relief (Sullivan and others 1988).

Ogden Valley occupies a structural trough created by up to 2,000 feet of vertical displacement on normal faults bounding the northeastern and southwestern margins of the valley. Coogan and King (2016) and the Utah Geological Survey Quaternary Fault Database (Black and others, 2003; January 2017 update) map these faults several miles to the northeast and west, respectively. Both faults were most-recently active more than 10,000 years ago (Sullivan and others, 1986). The nearest active (Holocene-age) fault to the site is the Weber segment of the Wasatch fault zone about 7.2 miles to the west.

The site is also in the central portion of the Intermountain Seismic Belt (ISB), a generally north-south trending zone of historical seismicity along the eastern margin of the Basin and Range province extending from northern Arizona to northwestern Montana (Sbar and others, 1972; Smith and Sbar, 1974). At least 16 earthquakes of magnitude 6.0 or greater have occurred within the ISB since 1850; the largest of these earthquakes was a M 7.5 event in 1959 near Hebgen Lake, Montana. None of these earthquakes occurred along the Wasatch fault or other known late Quaternary faults (Arabasz and others, 1992; Smith and Arabasz, 1991). The closest event was the 1934 Hansel Valley (M 6.6) event north of the Great Salt Lake. The March 18, 2020 M 5.7 earthquake north of Magna, Utah reportedly showed a style, location, and slip depth consistent with an earthquake on the Wasatch fault system (https://earthquake.usgs.gov/earthquakes/eventpage/uu60363602/executive). Despite being less than magnitude 6.0, this earthquake was felt from southern Idaho to south-central Utah and damaged multiple building (https://www.ksl.com/article/46731630/). The University of Utah Seismograph Stations (https://earthquakes.utah.gov/magna-quake/#) indicates the Magna earthquake was weakly felt in Ogden Valley, with a peak acceleration of about 0.005 g and an instrument intensity of II-III (on a Roman numeral scale of I-X).

4.3 Lake Bonneville History

Lakes occupied nearly 100 basins in the western United States during late-Quaternary time, the largest of which was Lake Bonneville in northwestern Utah. The Bonneville basin consists of several topographically closed basins created by regional extension in the Basin and Range (Gwynn, 1980; Miller, 1990), and has been an area of internal drainage for much of the past 15 million years. Lake Bonneville consisted of numerous topographically closed basins, including the Salt Lake and Cache Valleys (Oviatt and others, 1992). Portions of Ogden Valley were inundated by Lake Bonneville at its highstand. However, the Project is situated above the highest (Bonneville) shoreline, which is north and east of the Project at an elevation of roughly 5,160 feet (blue line and B, Figure 2).

Timing of events related to the transgression and regression of Lake Bonneville is indicated by calendar age estimates of significant radiocarbon dates in the Bonneville Basin (Oviatt, 2015). Approximately 30,000 years ago, Lake Bonneville began a slow transgression (rise) to its highest level of 5,160 to 5,200 feet above mean sea level. The lake rise eventually slowed as water levels approached an external basin threshold in northern Cache Valley at Red Rock Pass near Zenda, Idaho. Lake Bonneville reached the Red Rock Pass threshold and occupied its highest shoreline, termed the Bonneville beach, around 18,000 years ago. During the transgression and highstand, major drainages that emanate from within the Wasatch Range (such as the Weber River) formed large deltaic complexes in the lake at their canyon mouths. Headward erosion of the Snake River-Bonneville basin drainage divide then caused a catastrophic incision of the threshold and the lake level lowered by roughly 360 feet in fewer than two months (Jarrett and Malde, 1987; O'Conner, 1993). Following the Bonneville flood, the lake stabilized and formed a lower shoreline referred to as the Provo shoreline between about 16,500 and 15,000 years ago. Climatic factors then caused the lake to regress rapidly from the Provo shoreline, and by about 13,000 years ago the lake had eventually dropped below historic levels of Great Salt Lake. Drainages that fed Lake Bonneville began downcutting through stranded deltaic complexes and near-shore deposits as the lake receded from the Provo shoreline. Oviatt and others (1992) deem this low stage the end of the Bonneville lake cycle. Great Salt Lake then experienced a brief transgression around 11,600 years ago to the Gilbert level at about 4,250 feet before receding to and remaining within about 20 feet of its historic average level (Lund, 1990).

5.0 SITE CHARACTERIZATION

5.1 Empirical Observations

On October 7, 2020 Bill D. Black, P.G. of Western Geologic conducted a brief reconnaissance of the property and nearby area. Weather at the time of the site visit was clear and sunny with a temperature of about 50 °F. The Project is located in southern Ogden Valley on slopes overlooking Pineview Reservoir. Native vegetation appeared to consist of grasses, sage brush, oak brush and scattered pine trees. Surficial soils appeared dry and firm. No active drainages, springs or seeps were evident at the Project, and no evidence for characteristic debris-flow features, landslides, recent or ongoing slope instability, or other geologic hazards was observed during the reconnaissance.

5.2 Air Photo Observations

Black and white orthophotography from 1997, color orthophotography from 2012, and bare earth DEM LIDAR imagery from 2016 (Figures 3A-3C) were reviewed to obtain information about the geomorphology of the Project area. Site-specific surficial geologic mapping for the area is shown on Figures 3A-C based on our air photo review and Coogan and King (2016; Figure 2). The site is on steep slopes underlain by Tertiary Norwood Formation bedrock. Geoprocessed LIDAR data indicate native slopes dip to the northwest at about an overall 32.9% gradient (or about 3:1 horizontal:vertical) across the property. No evidence for other geologic hazards was observed on the air photos at the site.

5.3 Subsurface Investigation

Two test pits were excavated at the Project on October 7, 2020 to assess subsurface conditions. The test pits were logged by Bill D. Black, P.G. of Western Geologic concurrently with the Project geotechnical investigation conducted by Christensen Geotechnical. Locations of the test pits are shown on Figures 3A-C. The test pit locations were measured using a hand-held GPS unit and by trend and distance methods. The test pits were logged at a scale of 1-inch equals five feet (1:60) following methodology in McCalpin (1996), and digitally photographed at 5-foot intervals to document the exposures. The photos are not provided herein, but are available on request. Logs of the test pits are provided on Figure 4. Stratigraphic interpretations and descriptions are provided on the logs. Bedrock strike and dips were measured in both test pits. Bedrock in TP-1 showed a strike and dip of 312° N 19° NE, whereas bedrock in TP-2 showed a strike and dip of 310° N 15° NE. The measured strike and dips appear similar to those reported nearby on Figure 2. Mean strike and dip of the test pit measurements is 311° N 17° NE.

5.4 Cross Section

Figure 5 shows one cross section (A-A') across the site at a scale of 1 inch equals 30 feet with no vertical exaggeration. Location of the cross section is shown on Figure 3C. Units and contacts are based on subsurface data from the test pits (Figure 4) and/or inferred from the geologic mapping on Figures 3A-C. The topographic profile is based on geoprocessed 2016 LIDAR data. The LIDAR data provides a snapshot of topographic conditions at the time it was acquired; past, present and future surficial topography may vary. Units and contacts should be considered approximate and inferred, and variations should be expected at depth and laterally. We caution that some portions of the cross section have limited or no subsurface data, particularly at depth. Schematic bedding dip was calculated using http://app.visiblegeology.com/apparentDip.html based on the profile trend (325° N) and the mean strike and dip (311° N 17° NE) from our measurements.

6.0 GEOLOGIC HAZARDS

Assessment of potential geologic hazards and the resulting risks imposed is critical in determining the suitability of the site for development. Table 1 below shows a summary of the geologic hazards reviewed at the site, as well as a relative (qualitative) assessment of risk to the Project for each hazard. A "high" hazard rating (H) indicates a hazard is present at the site (whether currently or in the geologic past) that is likely to pose significant risk and/or may require further study or mitigation techniques. A "moderate" hazard rating (M) indicates a hazard that poses an equivocal risk. Moderate-risk hazards may also require further studies or mitigation. A "low" hazard rating (L) indicates the hazard is not present, poses little or no risk, and/or is not likely to significantly impact the Project. Low-risk hazards typically require no additional studies or mitigation. We note that these hazard ratings represent a conservative assessment for the entire site and risk may vary in some areas. Careful selection of development areas can minimize risk by avoiding known hazard areas.

Table 1. *Geologic hazards summary.*

Hazard	H	M	L
Earthquake Ground Shaking	X		
Surface Fault Rupture			X
Liquefaction and Lateral-spread Ground Failure			X
Tectonic Deformation			X
Seismic Seiche and Storm Surge			X
Stream Flooding			X
Shallow Groundwater			X
Landslides and Slope Failures		X	
Debris Flows and Floods			X
Rock Fall			X
Problem Soil and Rock			X

6.1 Earthquake Ground Shaking

Ground shaking refers to the ground surface acceleration caused by seismic waves generated during an earthquake. Strong ground motion is likely to present a significant risk during moderate to large earthquakes located within a 60 mile radius of the Project area (Boore and others, 1993). Seismic sources include mapped active faults, as well as a random or "floating" earthquake source on faults not evident at the surface. The Utah Geological Survey Quaternary Fault Database (Black and others, 2003; January 2017 update) shows numerous class A faults within 60 miles of the Project that may pose potential seismic sources.

The extent of property damage and loss of life due to ground shaking depends on factors such as: (1) proximity of the earthquake and strength of seismic waves at the surface (horizontal motions are the most damaging); (2) amplitude, duration, and frequency of ground motions; (3) nature of foundation materials; and (4) building design. Based on 2018 IBC (ASCE 7-16) provisions, a site class of B (stiff soil), and a risk category of II, calculated seismic values for the site (centered on 41.240797 ° N, - 111.788767 ° W) are summarized below:

Table 2. *Seismic hazards summary.*

Type	Value
S_S	*0.835 g*
S_1	*0.293 g*
S_{MS} (F_a x S_S)	*0.751 g*
S_{M1} (F_v x S_1)	*0.234 g*
S_{DS} (2/3 x S_{MS})	*0.501 g*
S_{D1} (2/3 x S_{M1})	*0.156 g*
Site Coefficient, F_a	*= 0.9*
Site Coefficient, F_v	*= 0.8*
Peak Ground Acceleration, PGA	*= 0.368 g*

The site class should be confirmed by the Project geotechnical engineer based on site-specific data. Given the above information, we rate the hazard from earthquake ground shaking as high. Earthquake ground shaking is a regional hazard common to all Wasatch Front areas. The hazard is mitigated by design and construction of homes in accordance with the current adopted building code.

6.2 Surface Fault Rupture

Movement along faults at depth generates earthquakes. During earthquakes larger than Richter magnitude 6.5, ruptures along normal faults in the intermountain region generally propagate to the surface (Smith and Arabasz, 1991) as one side of the fault is uplifted and the other side down dropped. The resulting fault scarp has a near-vertical slope. The surface rupture may be expressed as a large singular rupture or several smaller ruptures in a broad zone. Ground displacement from surface fault rupture can cause significant damage or even collapse to structures located on an active fault.

No active faults are mapped or were observed at the site or nearby. The nearest active (Holocene-age) fault to the site is the Weber segment of the WFZ about 7.2 miles to the west. Given the above, the risk from surface faulting is low. No additional investigation regarding surface faulting appears needed given the proposed development plan and current paleoseismic information.

6.3 Liquefaction and Lateral-Spread Ground Failure

Liquefaction occurs when saturated, loose, cohesionless, soils lose their support capabilities during a seismic event because of the development of excessive pore pressure. Earthquake-induced liquefaction can present a significant risk to structures from bearing-capacity failures to structural footings and foundations, and can damage structures and roadway embankments by triggering lateral spread landslides. Earthquakes of Richter magnitude 5 are generally regarded as the lower threshold for liquefaction. Liquefaction potential at the site is a combination of expected seismic (earthquake ground shaking) accelerations, groundwater conditions, and presence of susceptible soils.

Weathered sandstone bedrock was observed in both test pits at the site. Given this, we rate the risk from liquefaction as low. Weber County GIS mapping also shows the site is in an area of very low liquefaction potential (code 1).

6.4 Tectonic Deformation

Tectonic deformation refers to subsidence from warping, lowering, and tilting of a valley floor that accompanies surface-faulting earthquakes on normal faults. Large-scale tectonic subsidence may accompany earthquakes along large normal faults (Lund, 1990). Tectonic subsidence is believed to mainly impact those areas immediately adjacent to the downthrown side of active normal faults.

The Project is not in close proximity to and on the downthrown side of any mapped active (Holocene) faults. Based on this, we rate the risk from tectonic subsidence as low.

6.5 Seismic Seiche and Storm Surge

Earthquake-induced seiche presents a risk to structures within the wave-oscillation zone along the edges of large bodies of water, such as the Great Salt Lake. Given the elevation of the subject property and distance from large bodies of water, we rate the risk from seismic seiches as low.

6.6 Stream Flooding

Stream flooding may be caused by direct precipitation, melting snow, or a combination of both. In much of Utah, floods are most common in April through June during spring snowmelt. High flows may be sustained from a few days to several weeks, and the potential for flooding depends on a variety of factors such as surface hydrology, site grading and drainage, and runoff. No active drainages were observed or are mapped crossing the Project and Federal Emergency Management Agency flood insurance rate mapping (Map Number 49057C0475F, unprinted, effective 06/02/2015) classifies the Project in "Zone X - Area of Minimal Flood Hazard". Given the above, we rate the risk from stream flooding as low.

6.7 Shallow Groundwater

As discussed in the Hydrology Section above, groundwater at the site is significantly more than 50 feet deep based on the nearby water well to the west (Figure 1). No groundwater was encountered in either of the test pits conducted for our investigation. Although shallower levels may occur seasonally, as would be expected for an alpine environment, we do not anticipate that groundwater will pose a significant development constraint. We therefore rate the risk from shallow groundwater as low. However, groundwater is a significant trigger for slope instability. Care should therefore be taken that proper surface and subsurface drainage is maintained.

6.8 Landslides and Slope Failures

Slope stability hazards such as landslides, slumps, and other mass movements can develop along moderate to steep slopes where a slope has been disturbed, the head of a slope loaded, or where increased groundwater pore pressures result in driving forces within the slope exceeding restraining forces. Slopes exhibiting prior failures, and also deposits from large landslides, are particularly vulnerable to instability and reactivation.

No landslides are mapped at the site and no evidence for recent or ongoing slope instability was observed at the Project during our reconnaissance. However, slopes at the site are steep and formed in bedrock that has been involved in numerous late Pleistocene to historical landslides in Ogden Valley and nearby Morgan Valley to the south. Given this, we rate the existing risk from landslides as moderate. We recommend the Project geotechnical engineer evaluate stability of slopes at the site based on site-specific soil conditions and the data provided in this report. Recommendations should be provided to reduce the landslide hazard risk if factors of safety are determined to be unsuitable. Water, steep man-made cuts, and non-engineered fill materials are often major contributors to slope instability. Care should therefore also be taken to maintain proper site drainage, that site grading does not destabilize slopes at the site without prior geotechnical analysis and grading plans, and that water from man-made sources is minimized in potentially unstable slope areas.

6.9 Debris Flows

Debris flow hazards are typically associated with unconsolidated alluvial fan deposits at the mouths of large range-front drainages, such as those along the Wasatch Front. Debris flows have historically caused significant damage in the Wasatch Front area. The Project is not in an area currently subject to alluvial-fan flooding and no debris-flow channels, levees, or other debris-flow features were observed during our reconnaissance. We therefore rate the risk from debris flows to the Project as low.

6.10 Rock Fall

No bedrock outcrops were observed at the site or in higher slopes that could present a source area for rock fall clasts. We therefore rate the hazard from rock falls to the Project as low.

6.11 Problem Soil and Rock

Surficial soils that contain certain clays can swell or collapse when wet. Based on subsurface conditions observed in the test pits at the Project, we rate the risk from problem soil as low. However, soil conditions and specific recommendations for site grading, subgrade preparation, and footing and foundation design should be provided in the Project geotechnical engineering evaluation.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Earthquake ground shaking is the only hazard identified as posing a high relative risk to the Project. Landslides are identified as posing a moderate risk. The following recommendations are provided with regard to the geologic characterizations in this report:

- ***Seismic Design*** – All habitable structures developed at the property should be constructed to current adopted seismic building codes to reduce the risk of damage, injury, or loss of life from earthquake ground shaking. The Project geotechnical engineer should confirm the ground-shaking hazard and provide appropriate seismic design parameters as needed. We note that earthquake ground shaking is a common hazard for all Wasatch Front areas.

- ***Geotechnical Considerations*** – The Project geotechnical engineer should assess soil foundation conditions and evaluate slope stability at the site. The stability evaluation should be based on geologic characterizations in this report and site-specific geotechnical data, and provide recommendations for reducing the risk of landsliding if the factors of safety are deemed unsuitable.

- ***Site Modifications and Drainage*** – No unplanned cuts should be made in the slopes at the site without prior geotechnical analyses, and proper surface and subsurface drainage should be maintained.

- ***Excavation Backfill Considerations*** – The test pits may be in areas where a structure could subsequently be placed. However, backfill may not have been replaced in the excavations in compacted layers. The fill could settle with time and upon saturation. Should structures be located in an excavated area, no footings or structure should be founded over the excavation unless the backfill has been removed and replaced with structural fill.

- ***Hazard Disclosures and Report Availability*** – All hazards identified as posing a high risk at the site should be disclosed to future buyers so that they may understand and be willing to accept any potential developmental challenges and/or risks posed by these hazards. This report should be made available to architects, building contractors, and in the event of a future property sale, real estate agents and potential buyers. The report should be referenced for information on technical data only as interpreted from observations and not as a warranty of conditions throughout the site. The report should be submitted in its entirety, or referenced appropriately, as part of any document submittal to a government agency responsible for planning decisions or geologic review. Incomplete submittals void the professional seals and signatures we provide herein. Although this report and the data herein are the property of the client, the report format is the intellectual property of Western Geologic and should not be copied, used, or modified without express permission of the authors.

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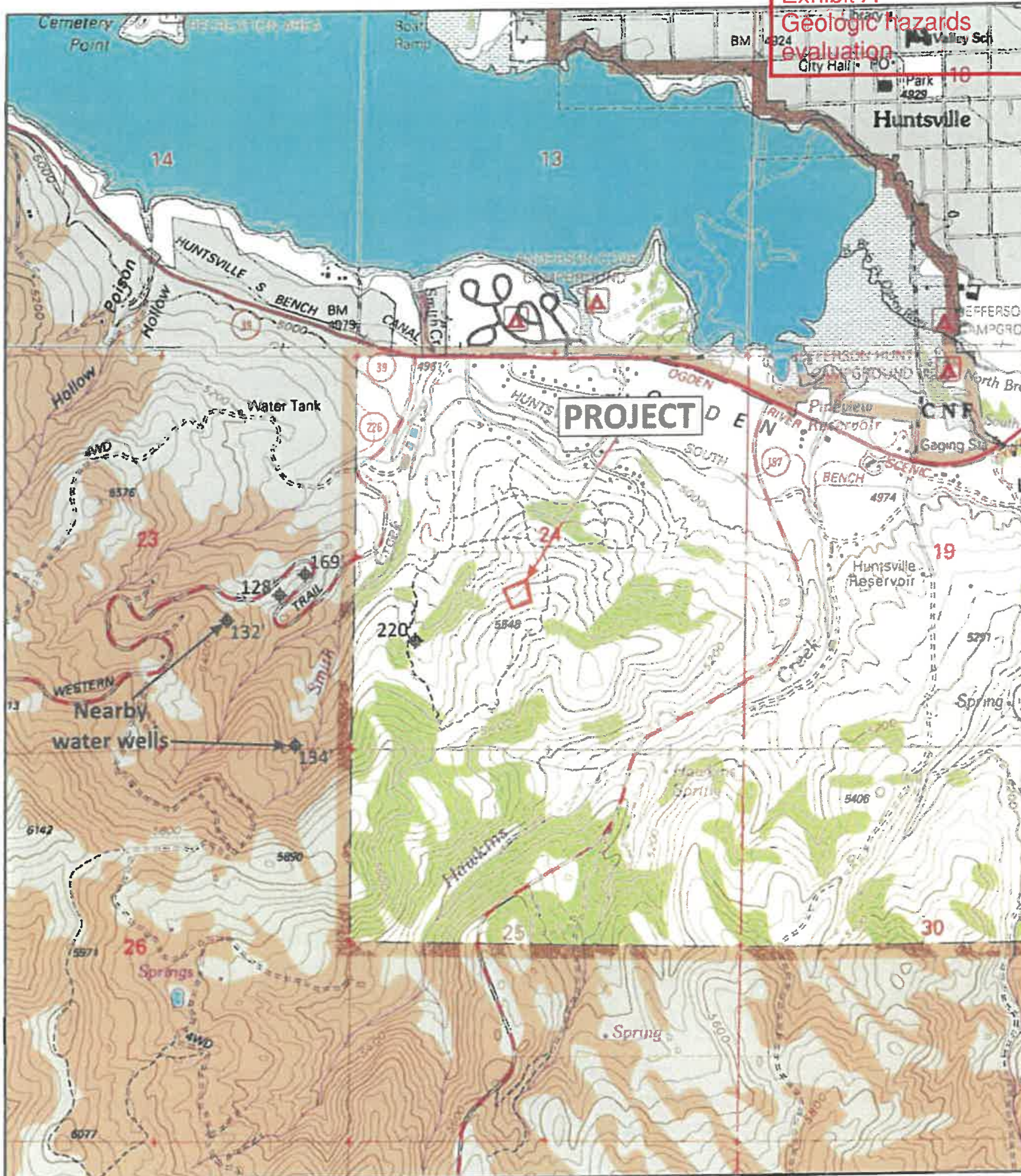
Zoback, M.L. and Zoback, M.D., 1989. Tectonic stress field of the conterminous United States: Boulder, Colorado, Geological Society of America Memoir, v. 172, p. 523-539.

Exhibit A
Geologic hazards
evaluation

FIGURES

Exhibit A
Geologic hazards evaluation



Source: U.S. Geological Survey 7.5 Minute Series Topographic Maps, Utah - Huntsville and Snow Basin, 1998;
Project location SW1/4, Section 24, T6N, R1E (SLBM).

LOCATION MAP

GEOLOGIC HAZARDS EVALUATION
Legends at Hawkins Creek Lot 2
6682 East Chaparral Road
Huntsville, Weber County, Utah

FIGURE 1

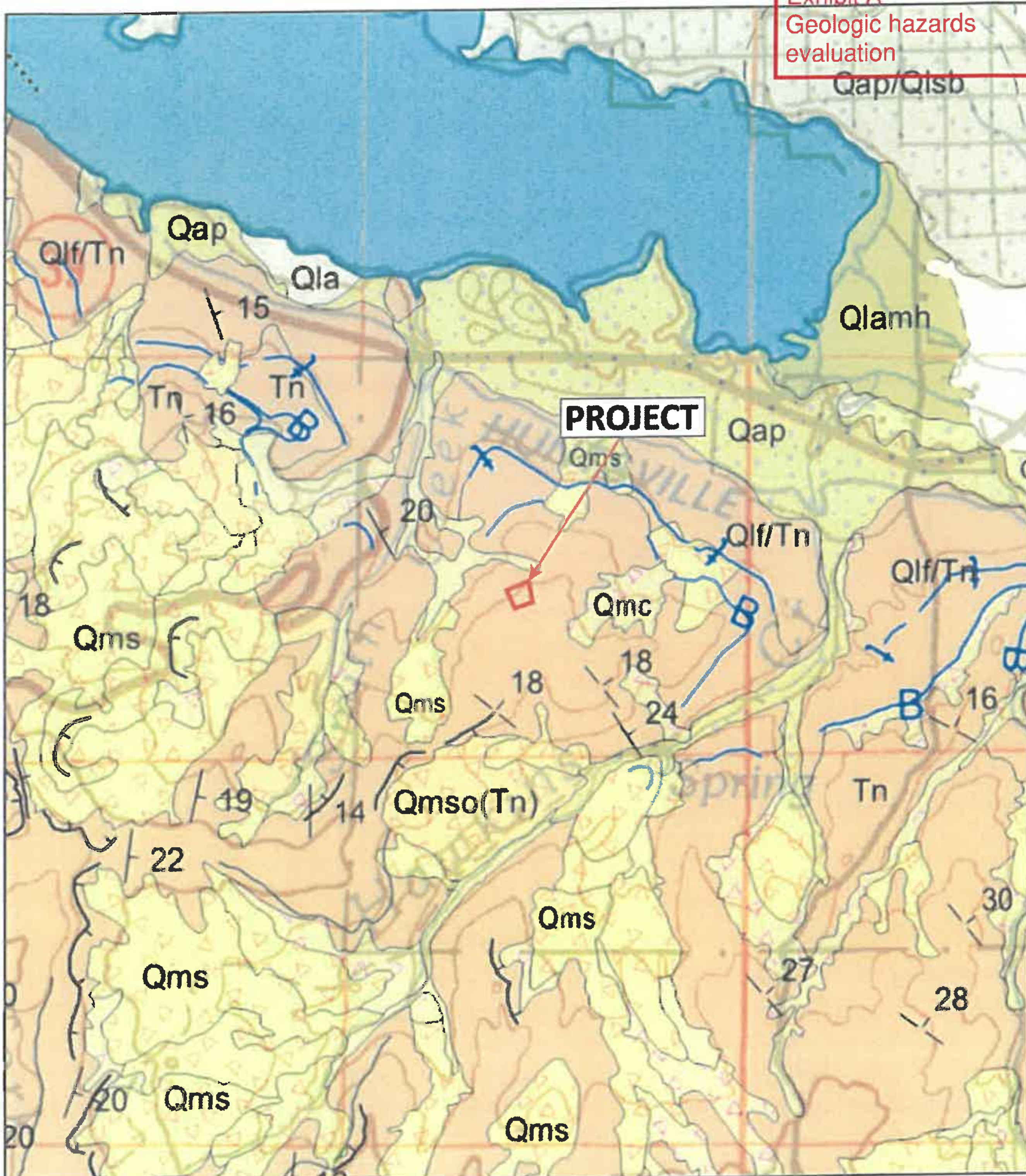
WESTERN GEOLOGIC

N
W E
S

0 1000 2000 feet

Scale 1:24,000
(1 inch = 2000 feet)

Exhibit A
Geologic hazards evaluation



Source: Coogan and King (2016), original map scale 1:100,000. See text for explanation of nearby surficial geologic units.

WESTERN GEOLOGIC

0 1000 2000 feet

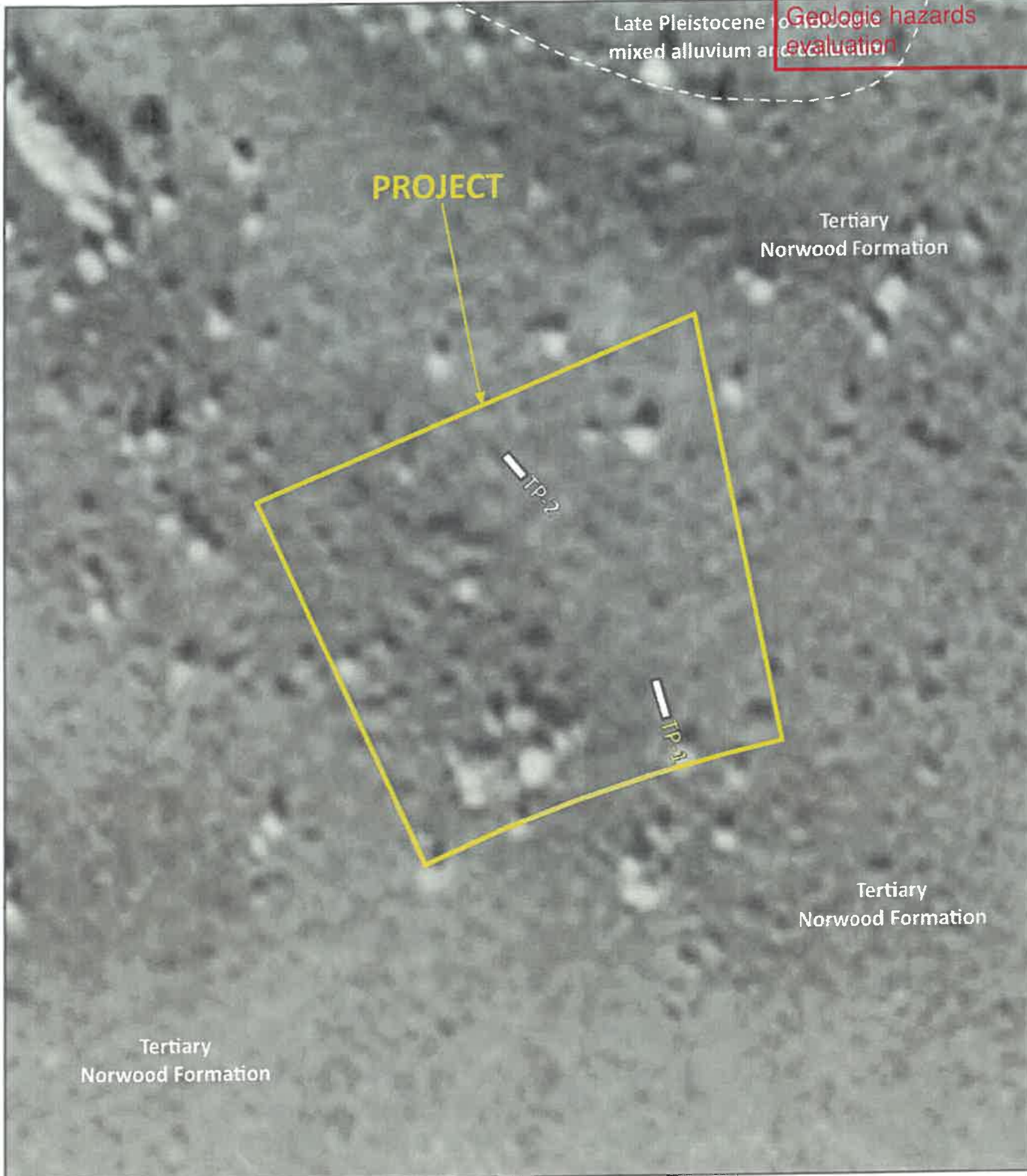
Scale 1:24,000
(1 inch = 2000 feet)

GEOLOGIC MAP

GEOLOGIC HAZARDS EVALUATION
Legends at Hawkins Creek Lot 2
6682 East Chaparral Road
Huntsville, Weber County, Utah

FIGURE 2

Exhibit A
Geologic hazards
evaluation



Source: Utah AGRC 1997 Digital Orthophoto, 1 m resolution.

N W E S

0 50 100 feet

Scale 1:1,200
(1 inch = 100 feet)

1997 AERIAL PHOTO

GEOLOGIC HAZARDS EVALUATION
Legends at Hawkins Creek Lot 2
6682 East Chaparral Road
Huntsville, Weber County, Utah

FIGURE 3A

WESTERN GEOLOGIC

Exhibit A
Geologic hazards evaluation

Source: Utah AGRC, 2012 High Resolution Orthophoto, 12.5 cm resolution.

WESTERN GEOLOGIC

N W E S

0 50 100 feet

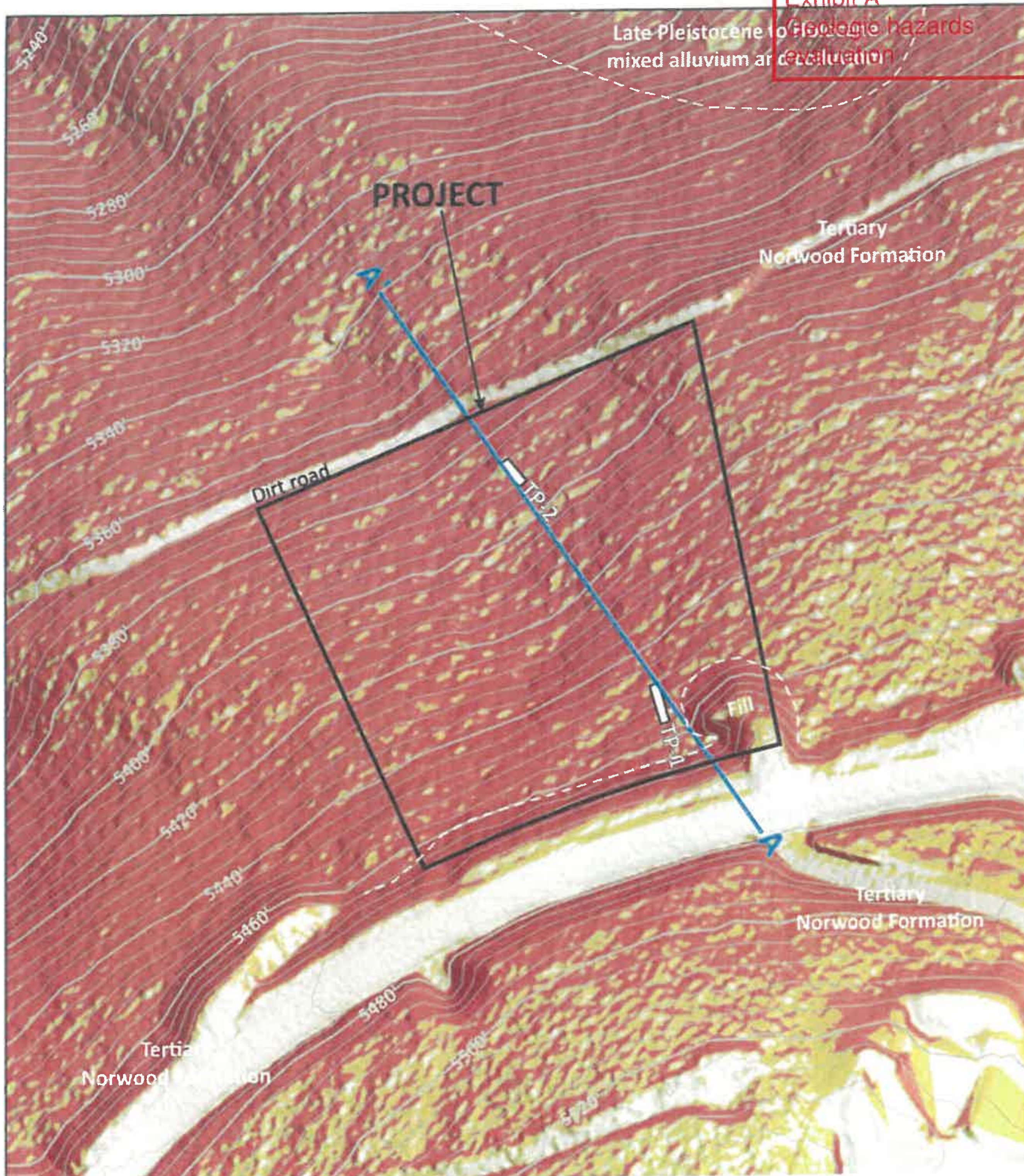
Scale 1:1,200
(1 inch = 100 feet)

2012 AIR PHOTO

GEOLOGIC HAZARDS EVALUATION
Legends at Hawkins Creek Lot 2
6682 East Chaparral Road
Huntsville, Weber County, Utah

FIGURE 3B

Exhibit A
Geologic hazards evaluation



Source: Utah AGRC, 2016 LIDAR Bare Earth DEM, 50 cm resolution; 4-foot contour interval; slope gradients <15% unshaded, 15-25% in yellow, and >25% in red.

WESTERN GEOLOGIC

N W E S

0 50 100 feet

Scale 1:1,200
(1 inch = 100 feet)

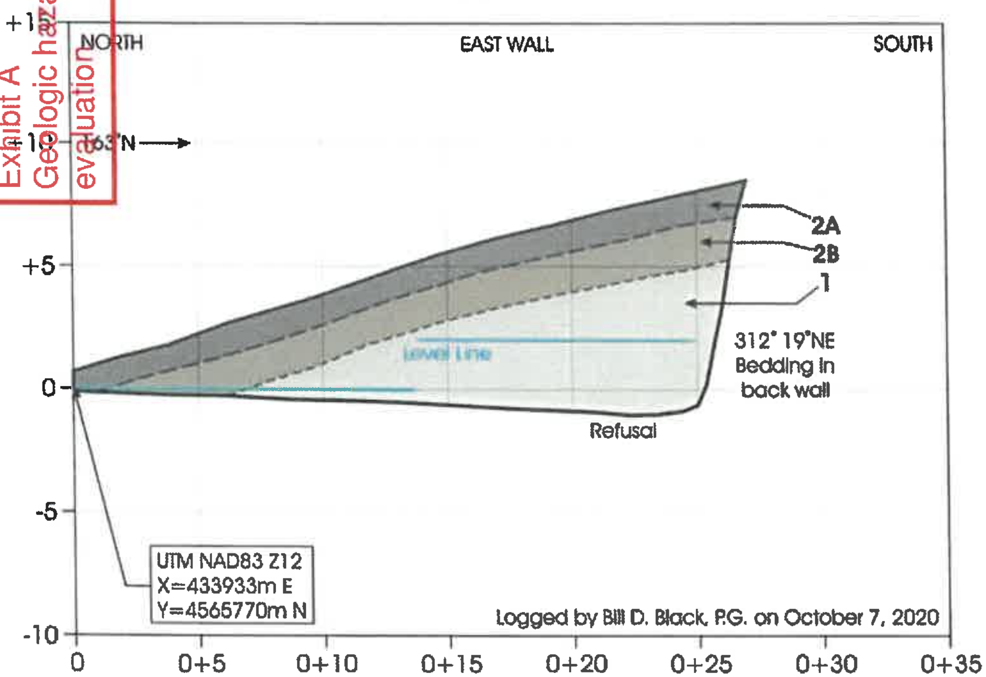
LIDAR ANALYSIS

GEOLOGIC HAZARDS EVALUATION
Legends at Hawkins Creek Lot 2
6682 East Chaparral Road
Huntsville, Weber County, Utah

FIGURE 3C

Exhibit A
Geologic hazards evaluation

TEST PIT 1

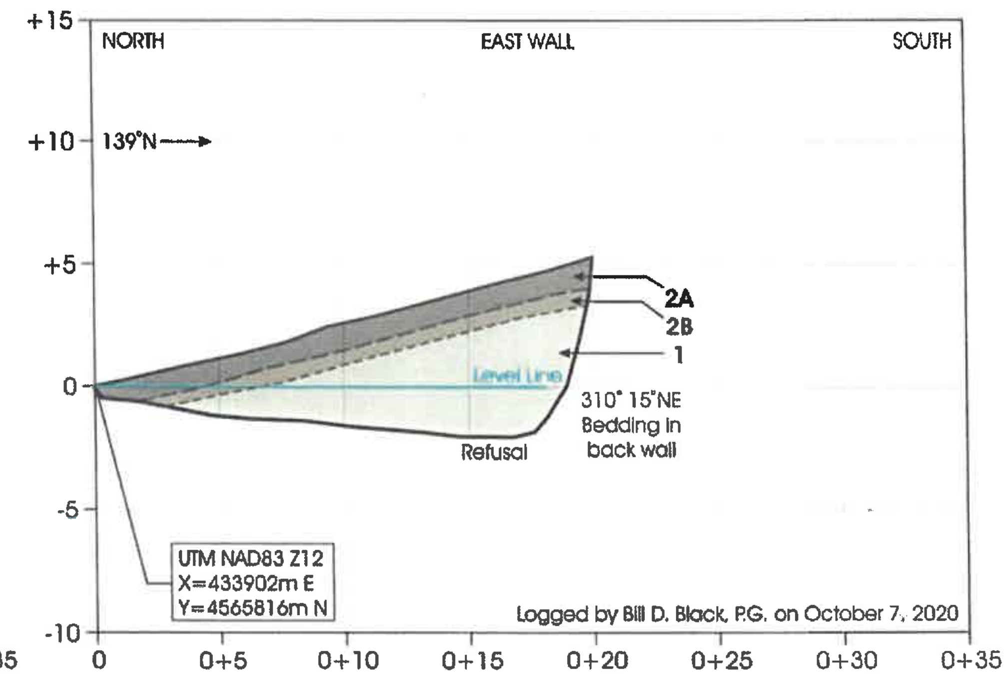


UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - well-bedded, dense, pale-olive-brown, tuffaceous sandstone bedrock; refusal at floor in south test pit end.

Unit 2. *Late Pleistocene to Holocene slope colluvium* - massive, moderate-high density, brown to dark brown, sandy clay (CL); modern A horizon (2A) and Bt vertisol (2B) formed in unit at surface.

TEST PIT 2



UNIT DESCRIPTIONS

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Unit 2. *Late Pleistocene to Holocene slope colluvium* - massive, moderate-high density, brown to dark brown, sandy clay (CL); modern A horizon (2A) and Bt vertisol (2B) formed in unit at surface.

WESTERN GEOLOGIC

Scale 1 inch equals 5 feet with no vertical exaggeration

TEST PIT LOGS

GEOLOGIC HAZARDS EVALUATION
Legends at Hawkins Creek Lot 2
6682 East Chaparral Road
Huntsville, Weber County, Utah

FIGURE 4

Christensen Geotechnical
8143 South 2475 East South Weber, Utah 84405
Phone: 801 814-1714

Exhibit B
Geotechnical
report

March 11, 2021

George Haley
george@haleyfamily.org

Subject: Rockery Retaining Wall Recommendations
Legends at Hawkins Creek Lot 2
6682 East Chaparral Road
Weber County, Utah
CG Project No.: 259-001

Mr. Haley,

At your request, Christensen Geotechnical has prepared this letter to present recommendations for construction of rockery retaining walls at Legends at Hawkins Creek Lot 2 located at 6682 East Chaparral Road in Weber County, Utah. Based on a site plan by Habitations Residential Design Group (Habitations), we understand that four rockery retaining walls are planned to be constructed north and west of the proposed house at the site. The location of the rockeries is shown on the attached site plan, Plate 1. Rockery 1 is to be up to 11 feet in height (10 feet exposed). Where the rockery height exceeds 6 feet, the rockery will be broken into two tiers. The lower tier will be up to 5 feet in height (4 feet exposed) and the upper tier will be up to 7 feet in height (6 feet exposed). The grade above this rockery will be nearly level. The grade below will slope down at a grade of about 35 percent. Rockery 2 is to be up to 13 feet in height (12 feet exposed) and is to be broken into three tiers with each tier 5 feet in height (4 feet exposed). The grade above this rockery will be nearly level. The grade below will slope down at a grade of about 35 percent. Rockery 3 is to be located west of the proposed house on the lot, below the driveway. This rockery is to be up to 12 feet in height (11 feet exposed). Where the rockery height exceeds 6 feet the rockery will be broken into two tiers. The lower tier will be up to 7 feet in height (6 feet exposed) and the upper tier will be up to 6 feet in height (5 feet exposed). The grade above this rockery will be nearly level. The grade below will slope down at a grade of about 35 percent. Rockery 4 will be located west of the proposed house above the driveway. This rockery is to be up to 11 feet in height (10 feet exposed). Where the rockery height exceeds 6 feet the rockery will be broken into two tiers. The lower tier will be up to 7 feet in height (6 feet exposed) and the upper tier will be up to 5 feet in height (4 feet exposed). The grade below the bottom tier will be nearly level. The grade above this rockery will slope up at a grade of 35 percent.

Stability of the proposed rockery was assessed as generally outlined in the FHWA "Rockery Design and Construction Guidelines" published November of 2006. Our analysis included rockery overturning, sliding, bearing capacity, and global stability.

Exhibit B
Geotechnical
report

Soil Conditions
Based on the geotechnical report for the lot by Christensen Geotechnical dated November 20, 2020, subsurface conditions at the site consist of 1½ to 3 feet of topsoil overlying sandstone bedrock. We have assumed that excavated sandstone will be placed behind the rockeries and that this material will consist of Sandy Lean CLAY (CL). We have assumed a soil strength for the retained soils to consist of an angle of internal friction of 28 degrees with a cohesion of 100 psf. The bedrock was assumed to have a strength consisting of a cohesion of 13,000 psf. The rockeries were assumed to have an anisotropic strength with a 2000 psf for the internal rock strength and an angle of internal friction of 45 between the rocks.

Horizontal Ground Acceleration
Seismic stability analysis of the rockeries was completed using the peak ground acceleration (PGA) resulting from an earthquake with a 2 percent probability of exceedance within a 50-year period. Based on the latitude and longitude of the site and the Applied Technology Council (ATC) web-based application used to develop spectral response values, the PGA was estimated to be 0.331g which was utilized in our seismic global and internal stability modeling.

Overturning, Sliding and Bearing Capacity
Engineering analysis of the proposed rockeries included analyzing overturning, sliding, and bearing capacity. Lateral earth pressures were calculated using the Coulomb method and the rockeries were assessed under static and seismic conditions. Typical minimum factor of safety requirements for the static condition are 2.0 for overturning, 1.5 for sliding, and 2.5 for bearing capacity. For the seismic condition, minimum factor of safety requirements are typically 1.5 for overturning, 1.1 for sliding, and 2.0 for bearing capacity. Results of our analyses indicate that these safety factors were met for the proposed rockeries with the recommendations presented in this letter.

Global Stability
The global stability of the proposed rockery retaining walls was analyzed using the Slide computer program and the modified Bishop's method of slices as well as the geometric conditions, soil strengths and rockery construction described in this letter. The rockeries were assessed under static and pseudo static conditions. The pseudo static condition is used to evaluate stability during a seismic event. As stated above, the peak ground acceleration at this site with a 2 percent probability of exceedance in 50 years is expected to be 0.331g. As is common practice, half of this value was used in our analysis.

Minimum factors of safety of 1.5 and 1.0 for static and seismic conditions, respectively, were considered acceptable. Our analyses indicate that these safety factors are achieved for the rockeries when constructed as recommended in this letter. The results of the global stability analyses are presented on Plates 2 through 9.

Recommendations
Based on our analyses, it is our opinion that the planned rockery retaining walls can perform adequately if constructed properly. In order for the rockeries at this site to perform properly, the recommendations presented below should be followed:

1. The rock face should slope no steeper than 1/4 to 1 (horizontal to vertical).

2. Minimum rock sizes, maximum tier height, and bench width should follow those outlined on the attached "Rockery Detail" sheets, Plates 10 through 14.

3. The rocks should be placed with the largest diameter set horizontally into the slope. No rock should be placed with the largest dimension parallel to the slope.

4. Rocks should have good three point rock to rock contact and no rocks should bear on a downward sloping face of the supporting rock. Larger gaps should be "chinked" with smaller rock or sealed with a cement grout.

5. All rocks should consist of durable rock. Limestone should not be used.

6. Grading to avoid concentrated runoff or ponding of water at the top of the slope and base of the rock face should be performed.

7. Final landscaping should be such that vegetation with large root systems are not planted above the rock facing and watering set such that only the top 6 inches of the soil remains moist in the irrigation season.

8. A drain should be constructed at the base of each tier as shown on Plates 10 through 14.

A detail of the rockeries is shown on Plates 10 through 14.

If inspection of the construction of the rockery is required, we recommend that inspection occur following placement of the first course of rock, during placement of the middle rows of rock and a final inspection after completion of the construction.

It should be understood that our analyses assumed that soils behind the rockeries will remain unsaturated and that grading above and below the rockeries will not allow ponding of water or concentrated surface flows in the vicinity of the rockery. Saturation of the soil behind the rockeries can cause rockery failure and concentrated surface water flows can erode soils behind the rocks. Irrigation behind the rockeries should be kept to a minimum, broken irrigation systems should be repaired immediately, roof drains should be directed away from the rockeries, and proper grading should be maintained to direct surface water away from the rockeries. This letter was prepared in accordance with the generally accepted standard of practice at the time this letter was written. No other warranty, expressed or implied, is made.

Exhibit B
Geotechnical
report

We appreciate the opportunity of providing our services on this project. If we can answer questions or be of further service, please call.

Sincerely,
Christensen Geotechnical

Mark I. Christensen, P.E.
Principal

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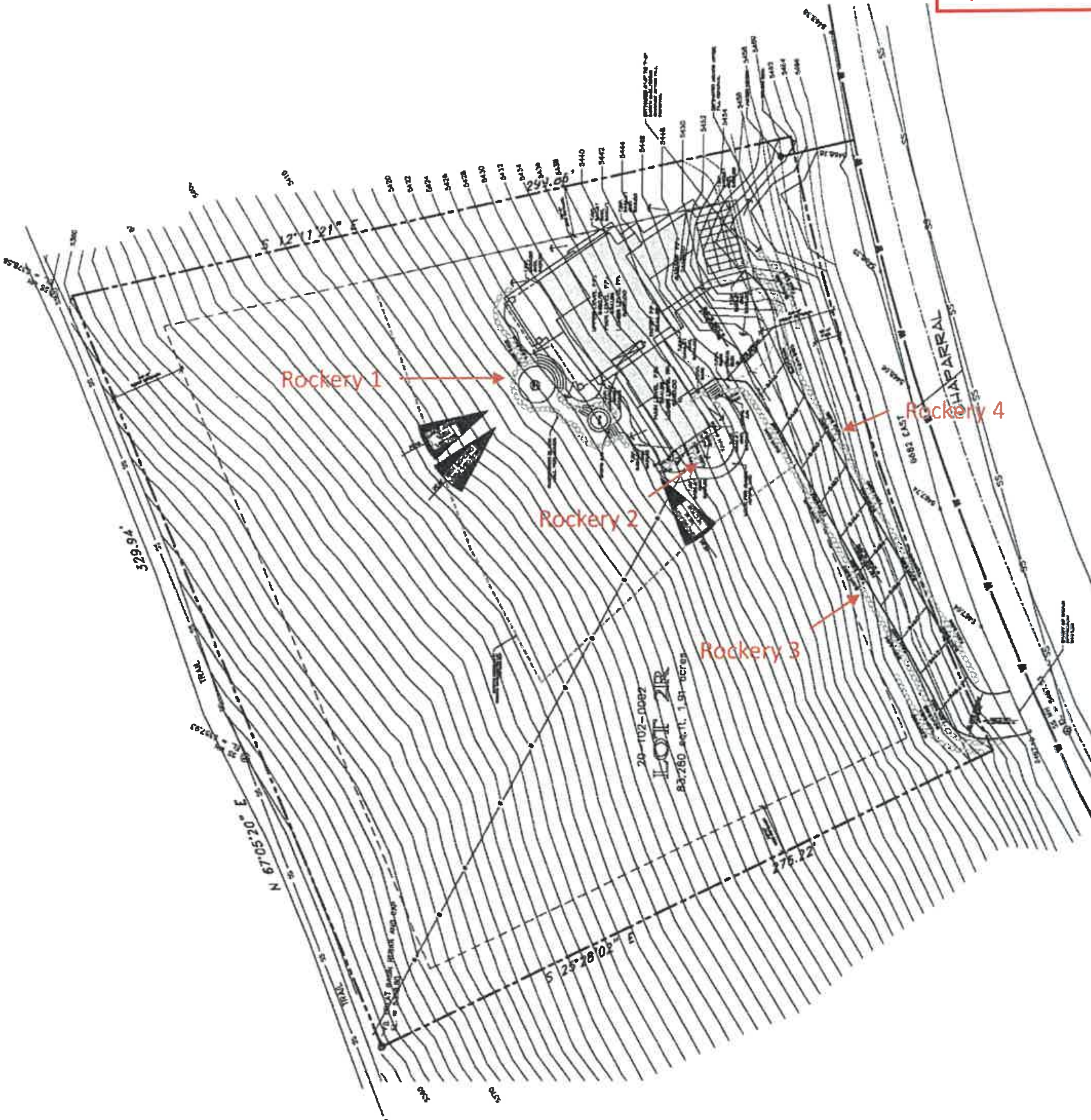
Geotechnical
report

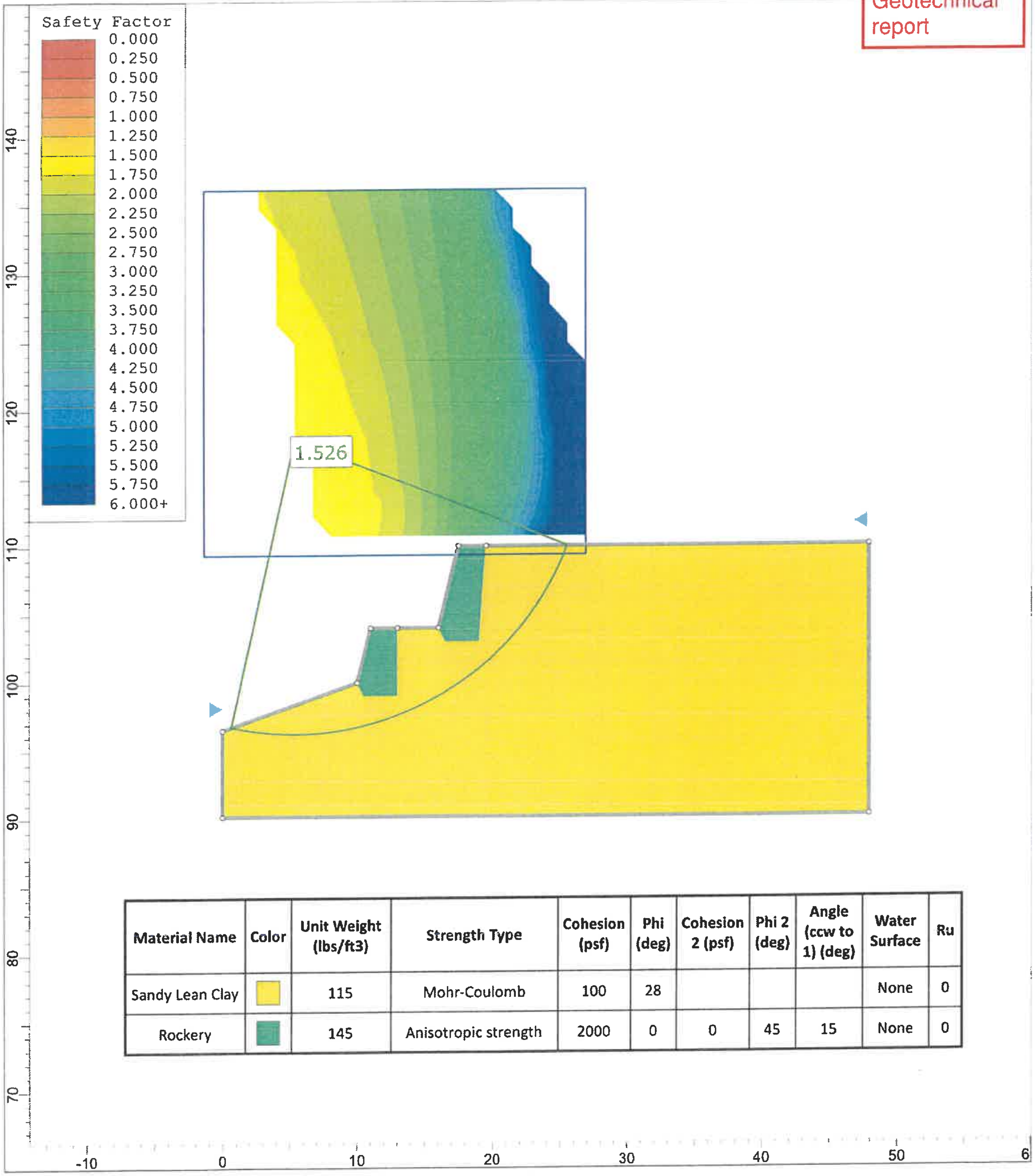


Base Map: Habitations Residential Design Group

Drawing Not to Scale

Christensen Geotechnical	George Haley Legends at Hawkins Creek Lot 2 Weber County, Utah Project No. 259-001 **Site Plan**	Plate 1

Exhibit B
Geotechnical
report



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion 2 (psf)	Phi 2 (deg)	Angle (ccw to 1) (deg)	Water Surface	Ru
Sandy Lean Clay		115	Mohr-Coulomb	100	28				None	0
Rockery		145	Anisotropic strength	2000	0	0	45	15	None	0

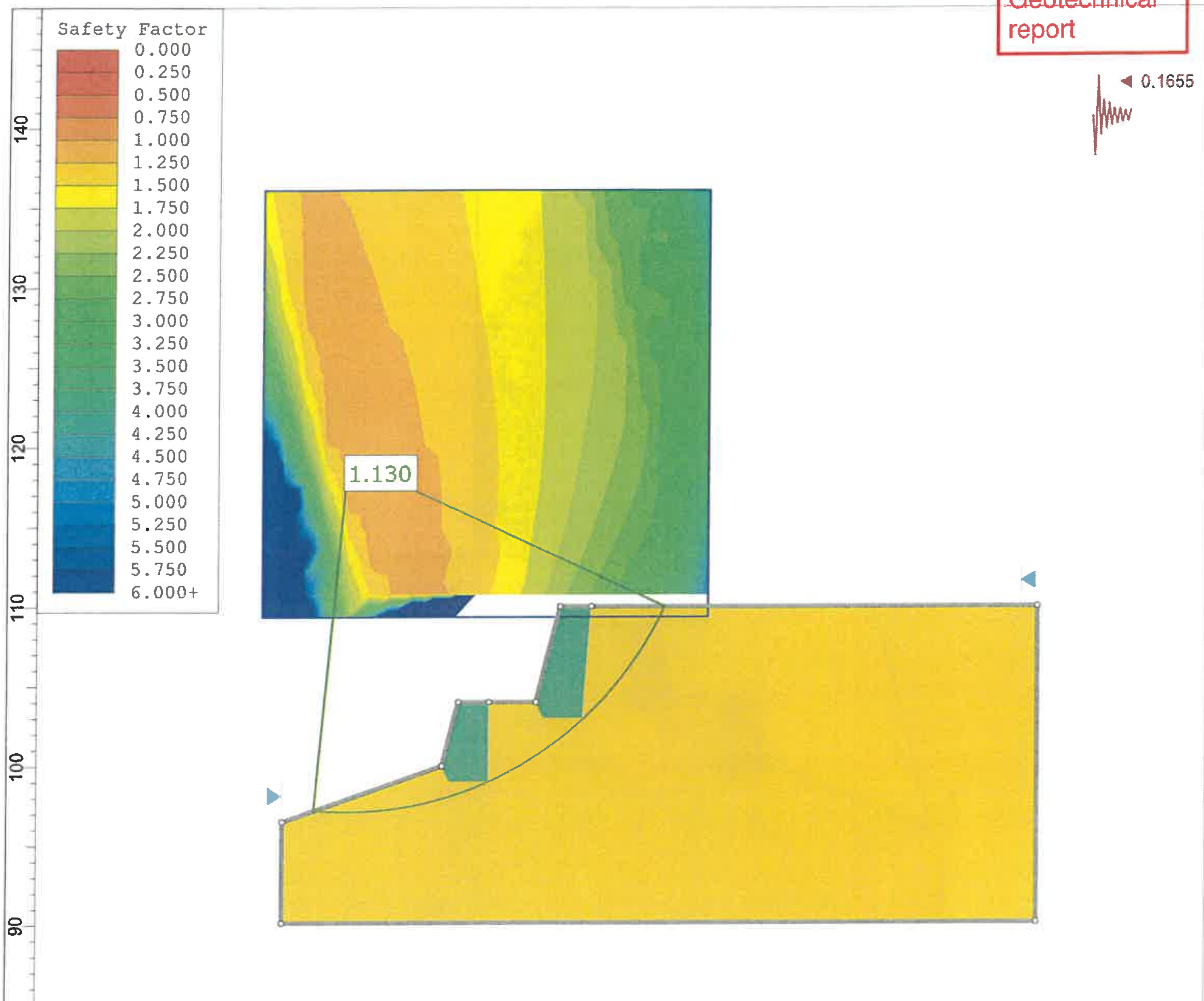
Rockery 1 - Static

Christensen Geotechnical

George Haley
Legends at Hawkins Creek Lot 2
Weber County, Utah
259-001

Plate
2

Exhibit B Geotechnical report



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion 2 (psf)	Phi 2 (deg)	Angle (ccw to 1) (deg)	Water Surface	Ru
Sandy Lean Clay		115	Mohr-Coulomb	100	28				None	0
Rockery		145	Anisotropic strength	2000	0	0	45	15	None	0

80 70

-10 0 10 20 30 40 50

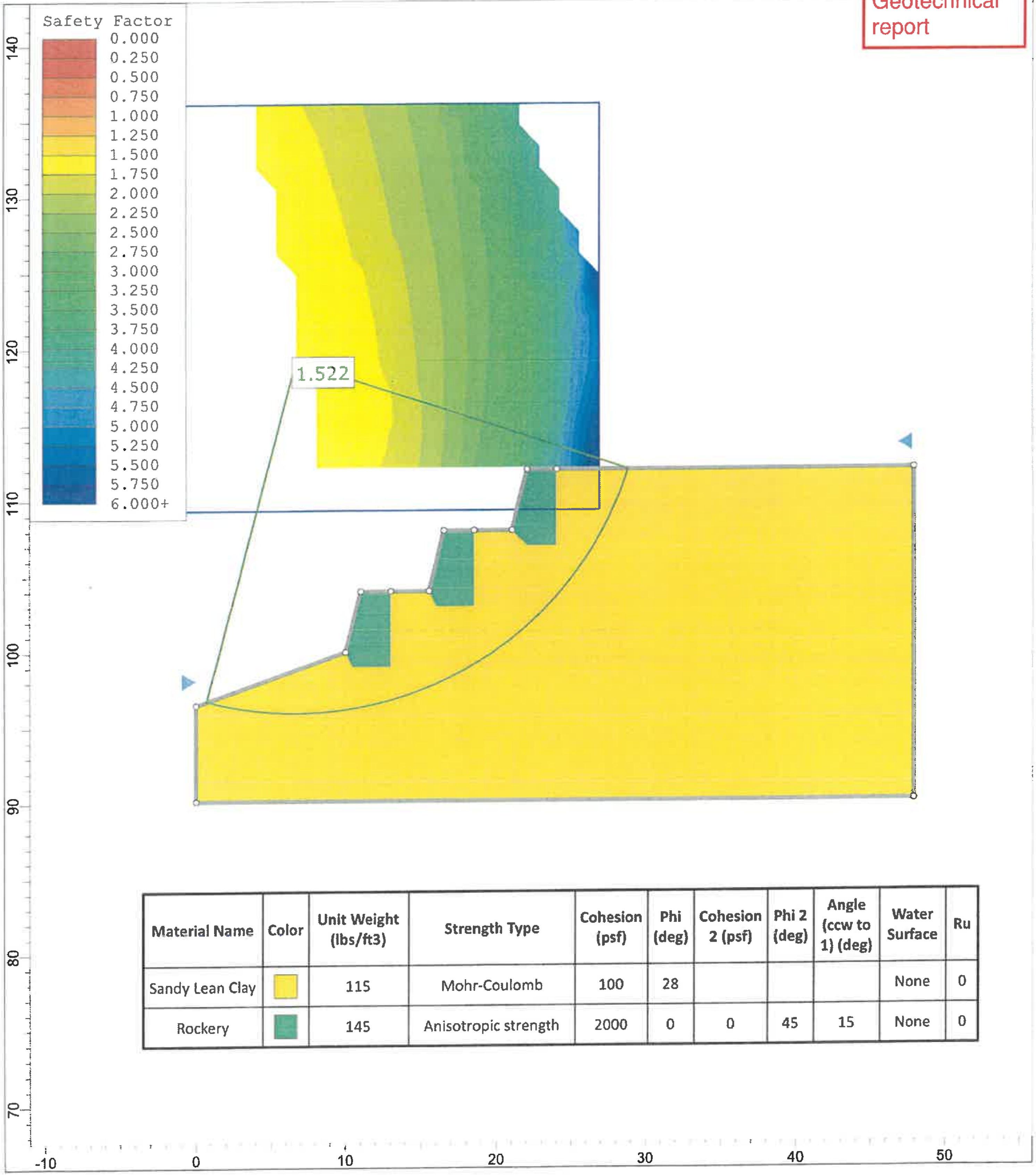
Rockery 1 - Pseudo Static

Christensen Geotechnical

George Haley
Legends at Hawkins Creek Lot 2
Weber County, Utah
259-001

Plate
3

Exhibit B Geotechnical report



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion 2 (psf)	Phi 2 (deg)	Angle (ccw to 1) (deg)	Water Surface	Ru
Sandy Lean Clay		115	Mohr-Coulomb	100	28				None	0
Rockery		145	Anisotropic strength	2000	0	0	45	15	None	0

Rockery 2 - Static

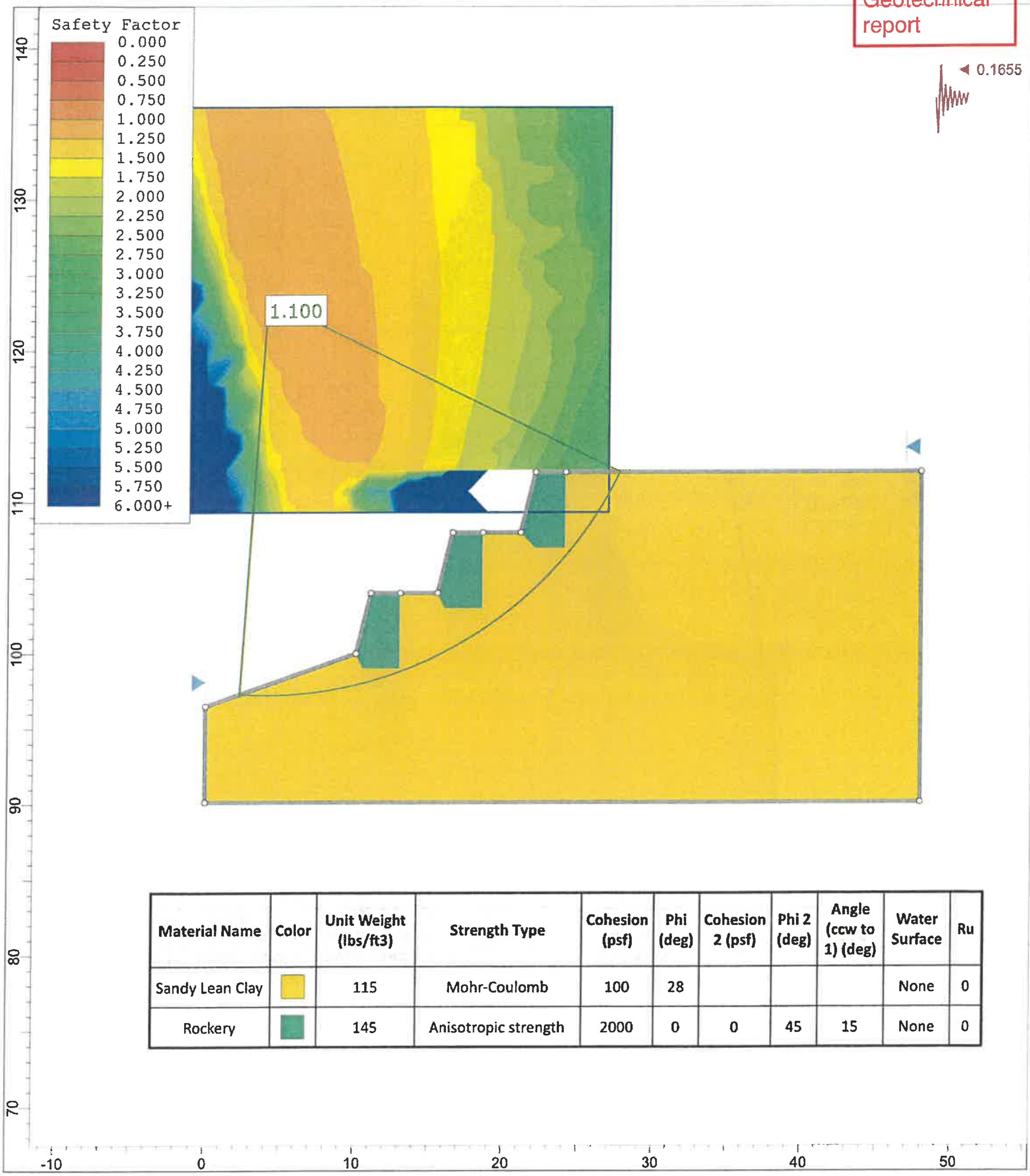
Christensen Geotechnical

George Haley
Legends at Hawkins Creek Lot 2
Weber County, Utah
259-001

Plate

4

Exhibit B Geotechnical report



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion 2 (psf)	Phi 2 (deg)	Angle (ccw to 1) (deg)	Water Surface	Ru
Sandy Lean Clay		115	Mohr-Coulomb	100	28				None	0
Rockery		145	Anisotropic strength	2000	0	0	45	15	None	0

Rockery 2 - Pseudo Static

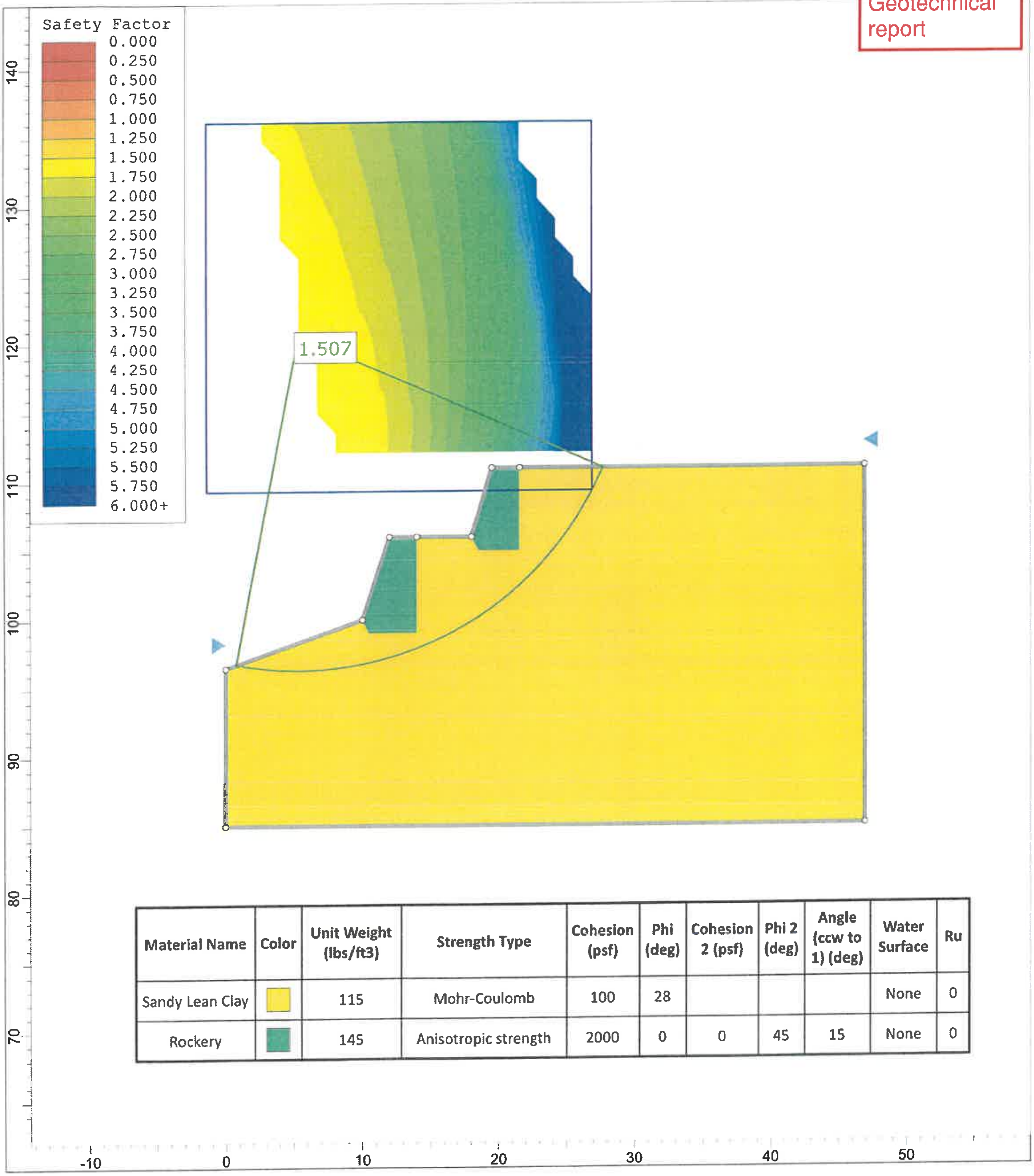
Christensen Geotechnical

George Haley
Legends at Hawkins Creek Lot 2
Weber County, Utah
259-001

Plate

5

Exhibit B Geotechnical report



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion 2 (psf)	Phi 2 (deg)	Angle (ccw to 1) (deg)	Water Surface	Ru
Sandy Lean Clay		115	Mohr-Coulomb	100	28				None	0
Rockery		145	Anisotropic strength	2000	0	0	45	15	None	0

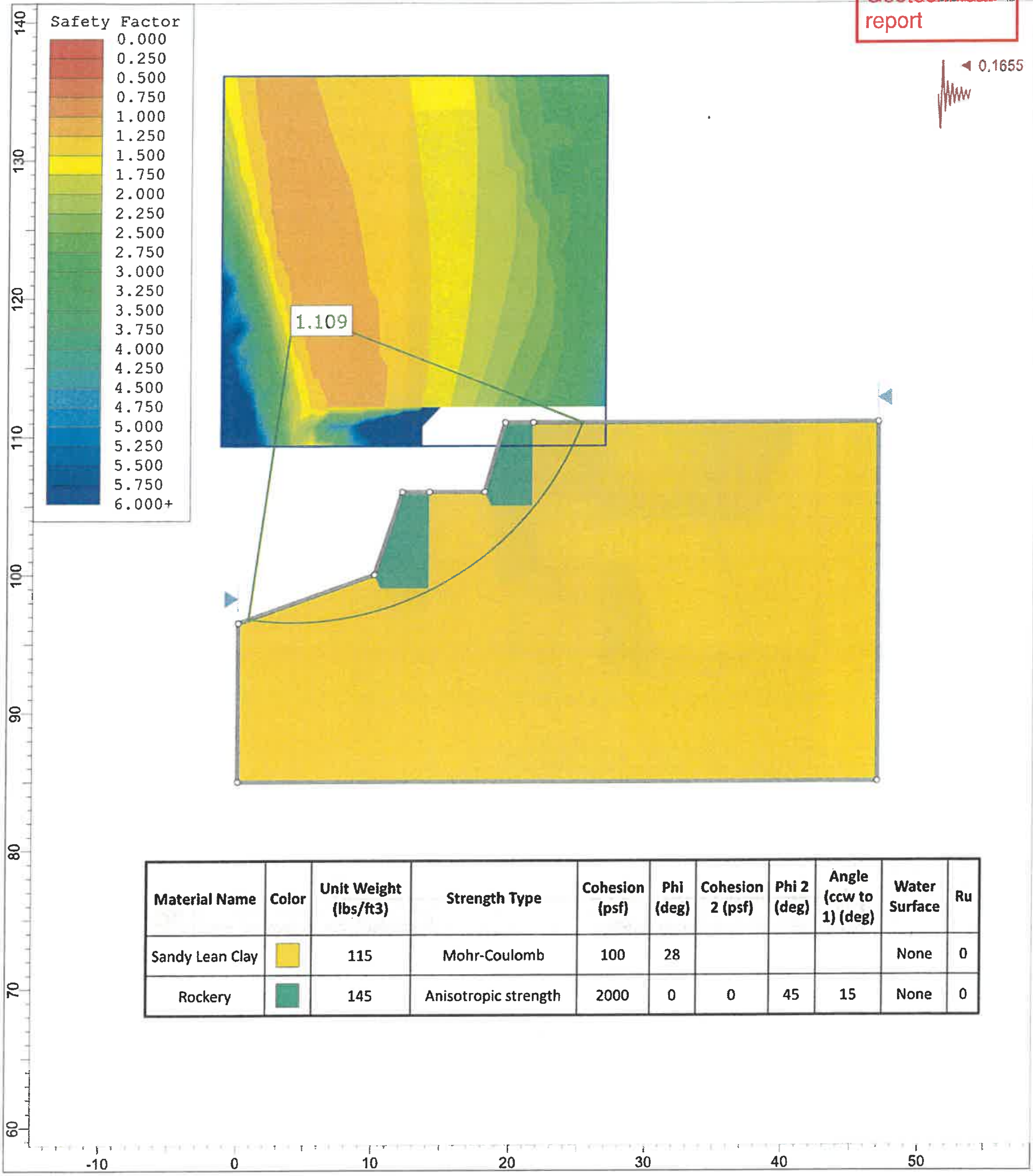
Rockery 3 - Static

Christensen Geotechnical

George Haley
Legends at Hawkins Creek Lot 2
Weber Coutnty, Utah
259-001

Plate
6

Exhibit B Geotechnical report



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion 2 (psf)	Phi 2 (deg)	Angle (ccw to 1) (deg)	Water Surface	Ru
Sandy Lean Clay		115	Mohr-Coulomb	100	28				None	0
Rockery		145	Anisotropic strength	2000	0	0	45	15	None	0

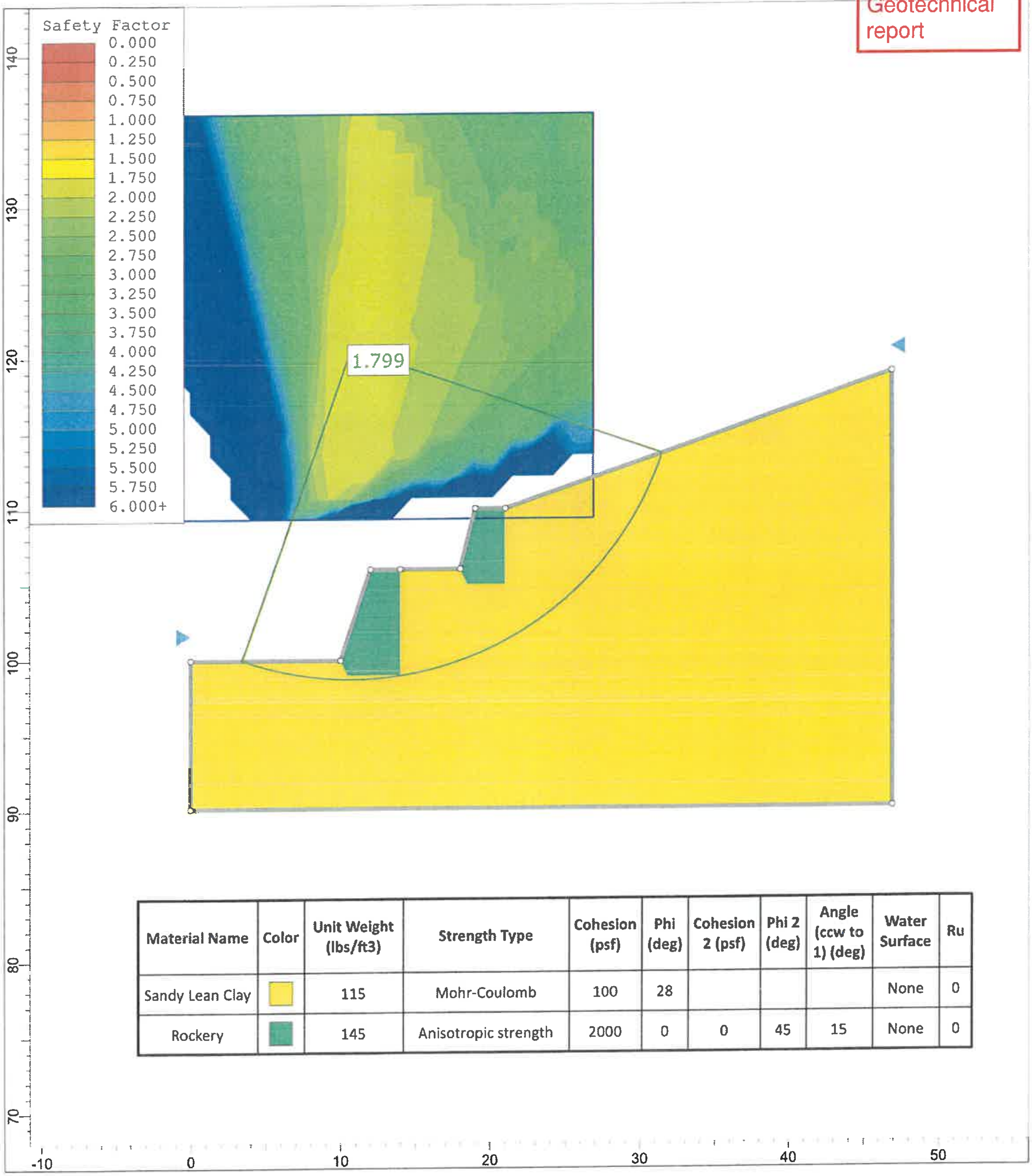
Rockery 3 - Pseudo Static

Christensen Geotechnical

George Haley
Legends at Hawkins Creek Lot 2
Weber Coutnty, Utah
259-001

Plate 7

Exhibit B
Geotechnical report



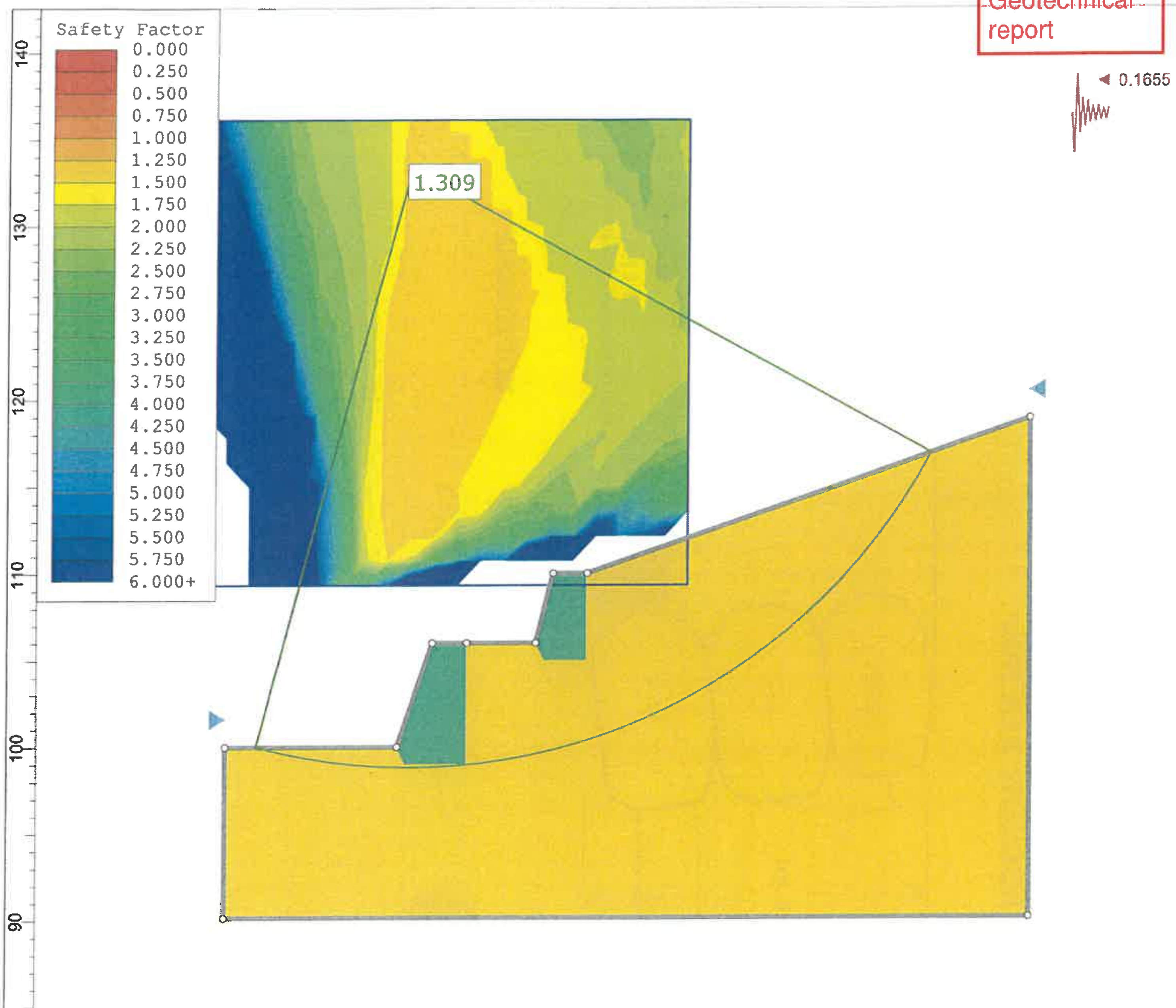
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion 2 (psf)	Phi 2 (deg)	Angle (ccw to 1) (deg)	Water Surface	Ru
Sandy Lean Clay		115	Mohr-Coulomb	100	28				None	0
Rockery		145	Anisotropic strength	2000	0	0	45	15	None	0

Rockery 4 - Static

Christensen Geotechnical

George Haley
Legends at Hawkins Creek Lot 2
Weber County, Utah
259-001

Plate
8



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion 2 (psf)	Phi 2 (deg)	Angle (ccw to 1) (deg)	Water Surface	Ru
Sandy Lean Clay		115	Mohr-Coulomb	100	28				None	0
Rockery		145	Anisotropic strength	2000	0	0	45	15	None	0

Rockery 4 - Pseudo Static

Christensen Geotechnical

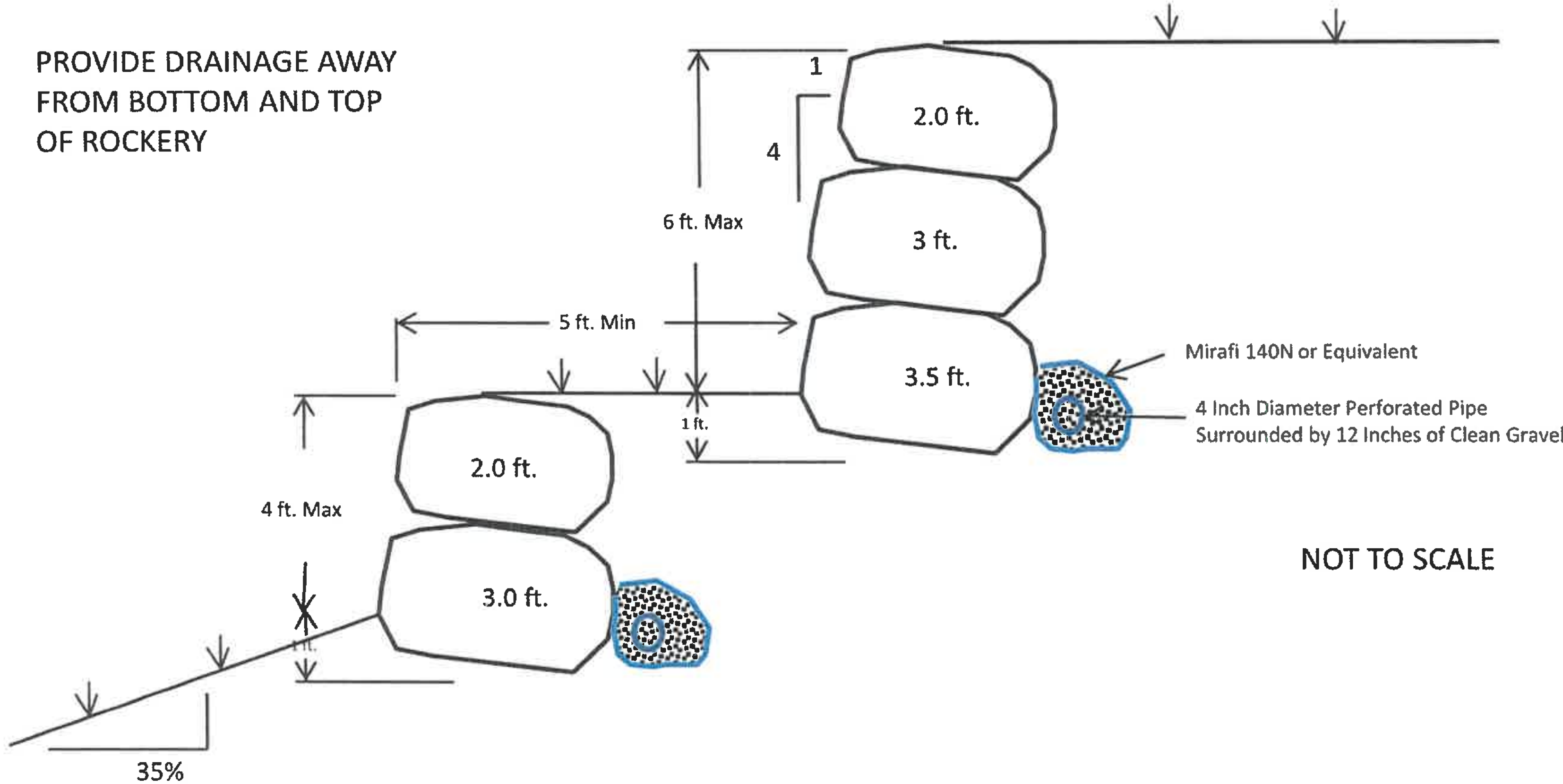
George Haley
Legends at Hawkins Creek Lot 2
Weber County, Utah
259-001

Plate
9

Exhibit B
Geotechnical
report

ROCKERY 1 DETAIL

PROVIDE DRAINAGE AWAY FROM BOTTOM AND TOP OF ROCKERY



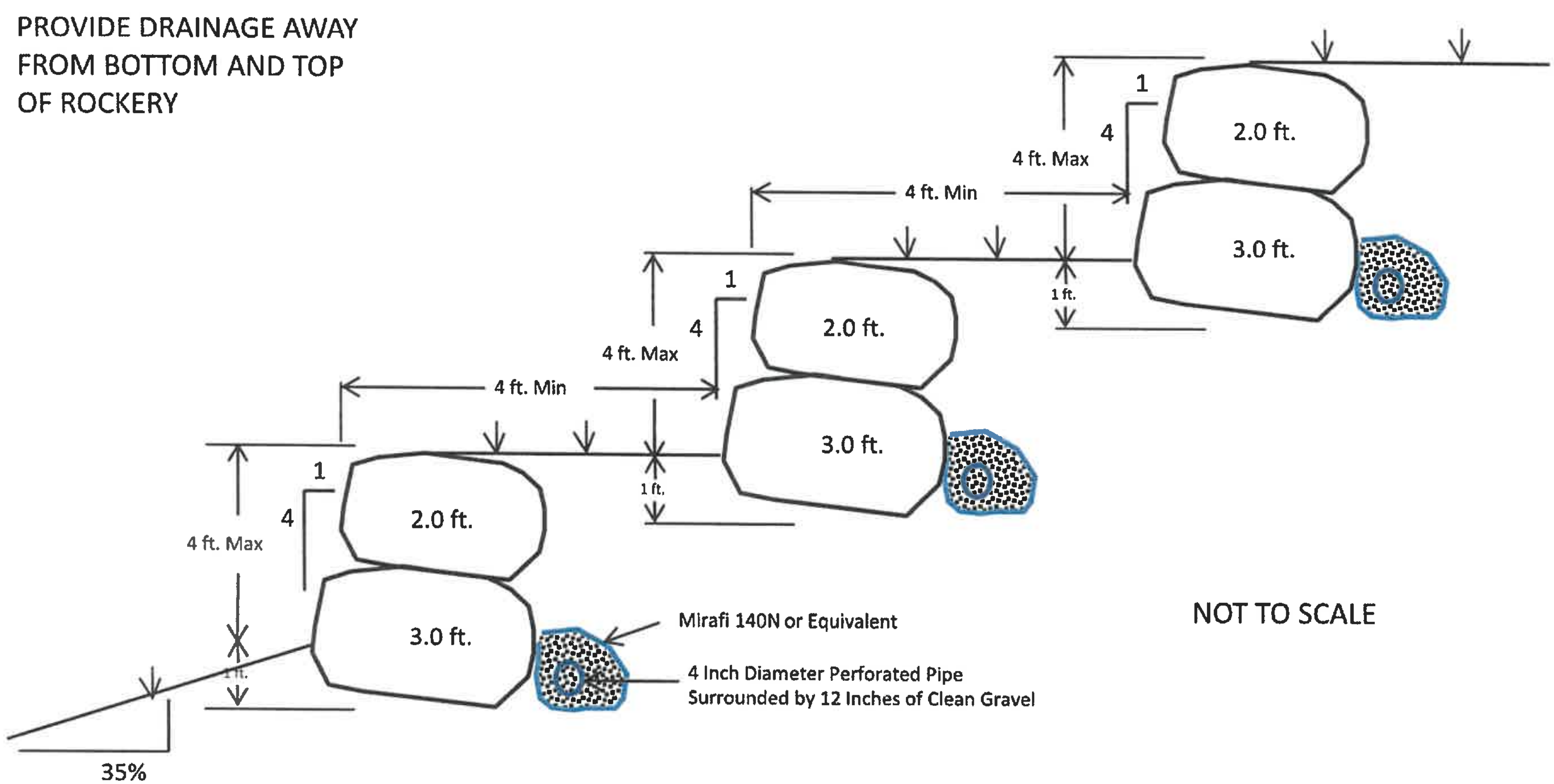
NOT TO SCALE

Christensen Geotechnical

George Haley
Legends at Hawkins Creek Lot 2
Weber County, Utah
Project No. 259-001

Plate 10

ROCKERY 2 DETAIL



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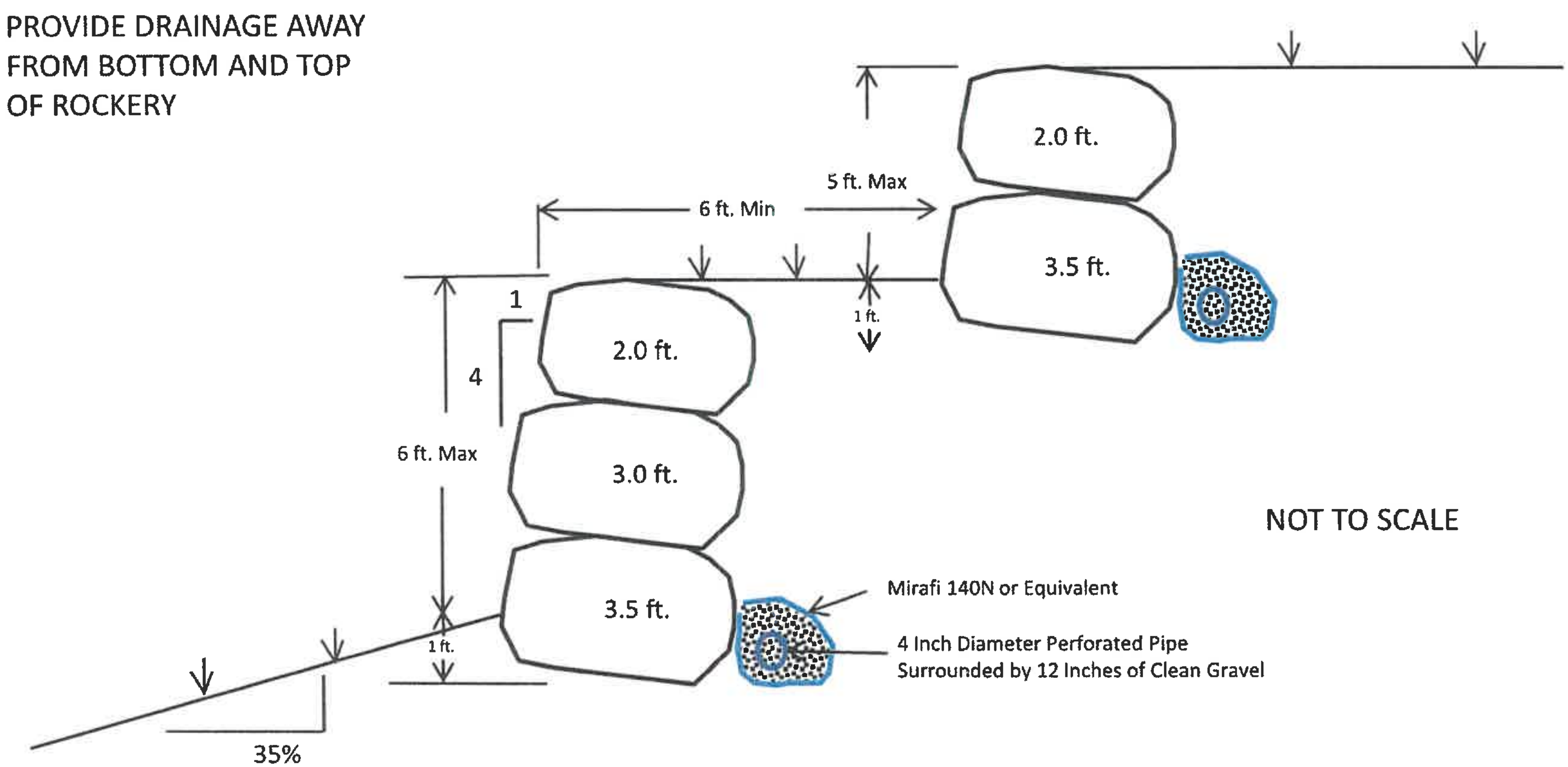
George Haley
Legends at Hawkins Creek Lot 2
Weber County, Utah
Project No. 259-001

Plate
11

Exhibit B Geotechnical report

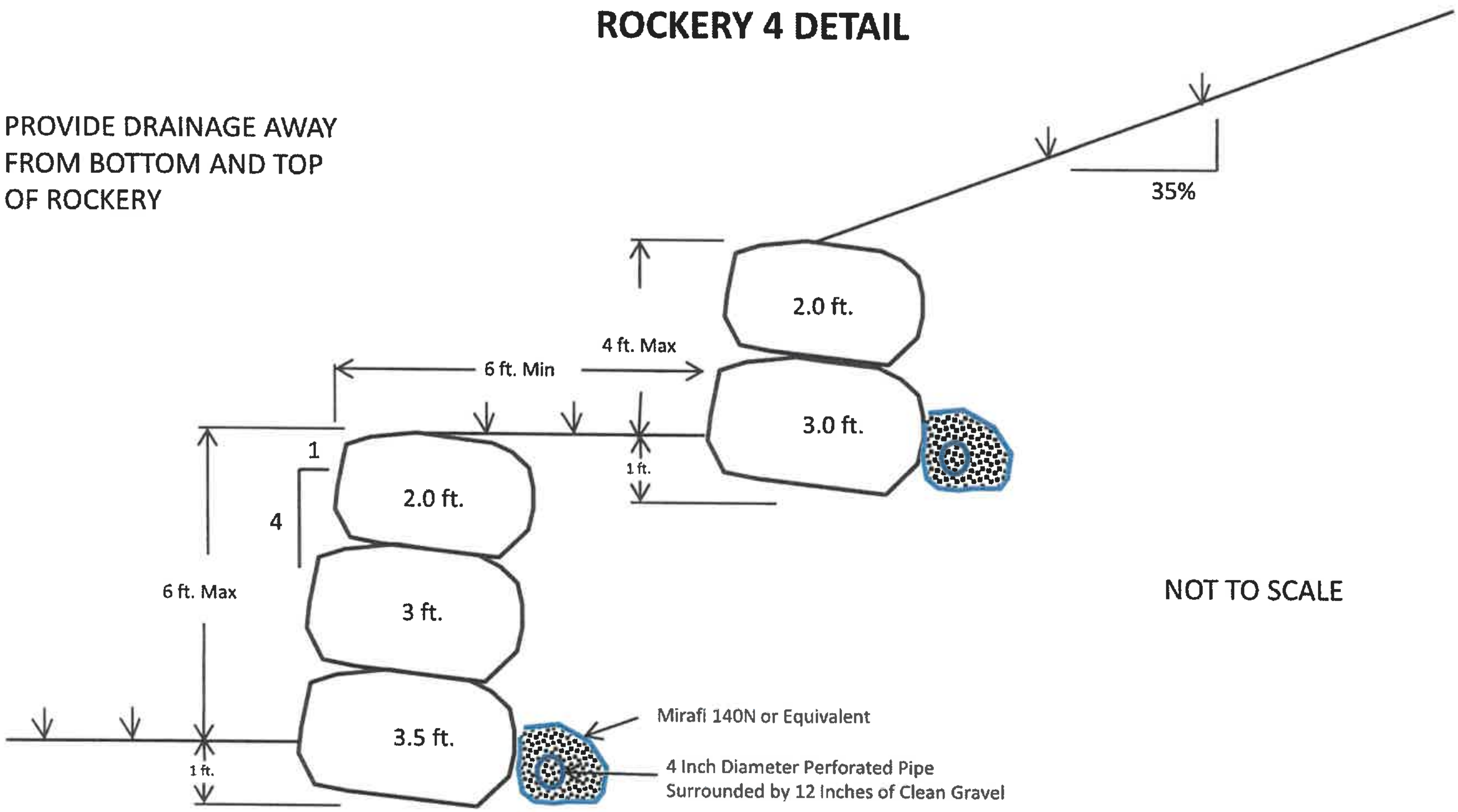
ROCKERY 3 DETAIL



Christensen Geotechnical	George Haley Legends at Hawkins Creek Lot 2 Weber County, Utah Project No. 259-001	Plate 12

Exhibit B Geotechnical report

ROCKERY 4 DETAIL



Christensen Geotechnical

George Haley
Legends at Hawkins Creek Lot 2
Weber County, Utah
Project No. 259-001

Plate 13

Exhibit B Geotechnical report

Exhibit B
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report

Exhibit B
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report

Geotechnical Investigation
Legends at Hawkins Creek Lot 2
Weber County, Utah

November 10, 2020

Prepared by:

Christensen Geotechnical
8143 South 2475 East, South Weber, Utah

Christensen
Geotechnical
8143 South 2475 East South Weber, Utah 84405
Phone: 801 814-1714

Exhibit B
Geotechnical
report

Prepared for:

Habitations Residential Design Group
1523 East Skyline Drive, Suite B
South Ogden, Utah 84405

Geotechnical Investigation
Legends at Hawkins Creek Lot 2
6682 East Chaparral Road
Weber County, Utah
CG Project No.: 259-001

Prepared by:

11/10/20
LICENSED PROFESSIONAL ENGINEER
MARK I CHRISTENSEN
No. 188039
LICENSED
STATE OF UTAH

Mark I. Christensen, P.E.
Principal

Christensen Geotechnical
8143 South 2475 East
South Weber, Utah 84405

November 10, 2020

Exhibit B
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ATTACHED PLATES

Exhibit B
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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical investigation that was performed for Legends at Hawkins Creek Lot 2 which is located at 6682 East Chaparral Road in Weber County, Utah. The general location of the project is indicated on the Project Vicinity Map, Plate 1. In general, the purposes of this investigation were to evaluate the subsurface conditions and the nature and engineering properties of the subsurface soils, and to provide recommendations for general site grading and for the design and construction of floor slabs and foundations. This investigation included subsurface exploration, representative soil sampling, field and laboratory testing, engineering analysis, and preparation of this report. Prior to the completion of our report, we reviewed the October 23, 2020 Geologic Hazards Evaluation by Western Geologic to assist in our assessments.

The work performed for this report was authorized by Mr. Joe Sadler and was conducted in accordance with the Christensen Geotechnical proposal dated August 19, 2020.

1.2 PROJECT DESCRIPTION

Based on conversations with our client, we understand that the proposed construction at the site is to consist of a single-family residence. The proposed structure is to have a footprint on the order of 3,000 square feet and is to be one to two stories in height with a basement. Up to 15 feet of structural fill is to be placed on the lot to facilitate the construction of the residence. The footing loads for the proposed structure are anticipated to be on the order of 3 to 4 klf for walls and 150 psf for floors. If the structural loads are different from those anticipated, Christensen Geotechnical should be notified in order to reevaluate our recommendations.

Exhibit B
Geotechnical
report

2.0 METHODS OF STUDY

2.1 FIELD INVESTIGATION

The subsurface conditions at the site were explored by excavating two test pits, one to 7½ feet and one to 9 feet, below the existing site grade. Each test pit was terminated due to trackhoe refusal on bedrock. The approximate test pit locations are shown on the Exploration Location Map, Plate 2. The subsurface conditions as encountered in the test pits were recorded at the time of excavation and are presented on the attached Test Pit Logs, Plates 3 and 4. A key to the symbols and terms used on the test pit logs may be found on Plate 5.

The test pit excavation was accomplished with a tracked excavator. Undisturbed soil samples were collected from the test pit sidewalls at the time of excavation. These undisturbed samples consisted of block samples, which were placed in bags. The samples were visually classified in the field and portions of each sample were packaged and transported to our laboratory for testing. The classifications for the individual soil units are shown on the attached Test Pit Logs.

2.2 LABORATORY TESTING

Of the soils collected during the field investigation, representative samples were selected for testing in the laboratory in order to evaluate the pertinent engineering properties. The laboratory testing included a Schmitt Hammer test that was performed on a block of the bedrock which had been collected from the test pits. The results of this test indicated a compressive strength of 260,000 psf.

The samples will be retained in our laboratory for 30 days following the date of this report, at which time they will be disposed of unless a written request for additional holding time is received prior to the disposal date.

Exhibit B
Geotechnical
report

3.0 GENERAL SITE CONDITIONS

3.1 SURFACE CONDITIONS

At the time of our investigation, the subject site was an undeveloped lot in an existing subdivision. The lot generally sloped down to the north with a grade of approximately 35 percent. The vegetation at the site generally consisted of common grasses and weeds with a few bushes and brush. The site was bordered by Chaparral Road to the south and undeveloped land on all other sides.

3.2 SUBSURFACE CONDITIONS

3.2.1 Soils

Based on the two test pits that were completed for this investigation, the site is covered with 1½ to 3 feet of topsoil. The subsurface materials below the topsoil consisted of sandstone bedrock which extended through the maximum depth explored. Each of our test pits was terminated due to trackhoe refusal on the bedrock.

3.2.2 Groundwater

Groundwater was not encountered within our test pits at the time of excavation. It should be understood that groundwater is likely below its seasonal high and may fluctuate in response to seasonal changes, precipitation, and irrigation.

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report

4.0 SEISMIC CONSIDERATIONS

4.1 SEISMIC DESIGN CRITERIA

The State of Utah and Utah municipalities have adopted the 2018 International Building Code (IBC) for seismic design. The IBC seismic design is based on seismic hazard maps which depict probabilistic ground motions and spectral response; the maps, ground motions, and spectral response having been developed by the United States Geological Survey (USGS). Seismic design values, including the design spectral response, may be calculated for a specific site using the web-based application by the Applied Technology Council (ATC), the project site's approximate latitude and longitude, and its Site Class. Based on our field exploration, it is our opinion that this location is best described as a Site Class B, which represents a "rock" profile. The spectral acceleration values obtained from the ATC's web-based application are shown below.

Table 2: IBC Seismic Response Spectrum Values

Site Location: 41.240797° N -111.788767° W	
Name	**Response Spectral Value**
S_S	0.835
S_1	0.293
S_{MS}	0.751
S_{M1}	0.234
S_{DS}	0.501
S_{D1}	0.156
PGA	0.368
PGA_M	0.331

4.2 LIQUEFACTION

Certain areas in the intermountain west possess a potential for liquefaction. Liquefaction is a phenomenon in which soils lose their intergranular strength due to an increase of pore pressures during a dynamic event such as an earthquake. The potential for liquefaction is based on several factors, including 1) the grain-size distribution of the soil, 2) the plasticity of the fine fraction of the soil (material passing the No. 200 sieve), 3) the relative density of the soils, 4) earthquake strength (magnitude) and duration, 5) overburden pressures, and 6) the depth to groundwater.

Exhibit B
Geotechnical
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Due to the shallow bedrock encountered within our test pits, we assess the liquefaction potential at this site to be very low.

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5.0 ENGINEERING ANALYSIS AND RECOMMENDATIONS

5.1 GENERAL CONLUSIONS

Based on the results of our field and laboratory investigations, it is our opinion that the subject site is suitable for the proposed construction provided that the recommendations contained in this report are incorporated into the design and construction of the project.

5.2 EARTHWORK

5.2.1 General Site Preparation and Grading

Prior to site grading operations, all vegetation, topsoil, and all other soils should be stripped (removed) from the building pad, flatwork concrete areas, and any other areas where structural fill will be placed in order to exposed the underlying bedrock. Following the stripping operations, the exposed bedrock should be excavated into horizontal terraces. The excavation of terraces provides a non-uniform plain below the proposed construction which will key the overlying fill and structure into the bedrock, providing greatly increased resistance to slope failures. The vertical distance in between the terraces should be 3 to 5 feet in height. Once the bedrock has been terraced, structural fill may be placed to bring the site to design grade. A Christensen Geotechnical representative should observe the site grading operations.

5.2.2 Temporary Construction Excavations

Based on OSHA requirements and the soil conditions encountered during our field investigation, we anticipate that temporary construction excavations at the site that have vertical walls that extend to depths of up to 5 feet may be occupied without shoring; however, where groundwater or fill soils are encountered, flatter slopes may be required. Excavations that extend to more than 5 feet in depth into structural fill of native soils should be sloped or shored in accordance with OSHA regulations for a type C soil. The stability of construction excavations is the contractor's responsibility. If the stability of an excavation becomes questionable, the excavation should be evaluated immediately by qualified personnel.

5.2.3 Structural Fill and Compaction

All fill that is placed for the support of structures and concrete flatwork should consist of structural fill. The sandstone bedrock may be used as structural fill below any exterior flatwork concrete and pavements if it is crushed to a maximum particle size of 4 inches. All structural fill placed below the proposed residence should consist of an imported material. The imported structural fill should consist of a relatively well-graded granular soil with a maximum particle size of 4 inches, with a maximum of 50 percent passing the No. 4 sieve, and with a maximum of 30 percent passing the No. 200 sieve. The liquid limit of the fines (material passing the No. 200 sieve) should not exceed 35 and the plasticity index should be less than 15. Additionally, all structural fill should be free of topsoil, vegetation, frozen material, particles larger than 4 inches in diameter, and any other deleterious materials. All imported materials should be approved by the geotechnical engineer prior to importing.

The structural fill should be placed in maximum 8-inch-thick loose lifts at a moisture content within 3 percent of optimum and compacted to at least 95 percent of the maximum density as determined by ASTM D 1557. Where the fill heights exceed 5 feet, the level of compaction should be increased to 98 percent.

5.2.4 Excavatability

As indicated earlier, bedrock was encountered within each of our test pits. The trackhoe experienced practical equipment refusal at 7½ and 9 feet below grade. The bedrock was in a moderately strong condition. We anticipate that the minimum equipment required for excavations within the bedrock would be the use of a heavy excavator with a ripper tooth or the use of a hoe-ram. Of note, prior to bidding, this report should be provided to all contractors in order for them to be informed of the subsurface conditions and make their own assessment as to the type of equipment best suited for these conditions.

5.3 FOUNDATIONS

The foundations for the planned structure may consist of conventional continuous and/or spread footings established entirely on bedrock or entirely on at least 12 inches of properly placed and compacted structural fill. The footings for the proposed structure should be a minimum of 20 inches and 30 inches wide for continuous and spot footings, respectively. The exterior footings should be established at a minimum of 36 inches below the lowest adjacent grade to provide frost protection and confinement. Interior footings that are not subject to frost should be embedded a minimum of 18 inches for confinement.

Continuous and spread footings that are established on bedrock or structural fill may be proportioned for a maximum net allowable bearing capacity of 3,000 psf. A one-third increase may be used for transient wind or seismic loads. All footing excavations should be observed by the geotechnical engineer prior to the construction of footings.

5.4 ESTIMATED SETTLEMENT

If the foundations are designed and constructed in accordance with the recommendations presented in this report, there is a low risk that total settlement will exceed 1 inch and a low risk that differential settlement will exceed ½ inch for a 30-foot span.

5.5 LATERAL EARTH PRESSURES

Buried structures, such as basement walls, should be designed to resist the lateral loads imposed by the soils retained. The lateral earth pressures on the below-grade walls and the distribution of those pressures will depend upon the type of structure, hydrostatic pressures, in-situ soils, backfill, and tolerable movements. Basement and retaining walls are usually designed with triangular stress distributions, which are based on an equivalent fluid pressure and calculated from lateral earth pressure coefficients. If soils similar to the native soils are used to backfill the basement walls, then the walls may be designed using the following ultimate values:

Table No. 3: Lateral Earth Pressures

Condition	Lateral Pressure Coefficient	Equivalent Fluid Density (pcf)
Active Static	0.27	33
Active Seismic	0.11	14
At-Rest	0.43	51
Passive Static	3.69	443
Passive Seismic	-0.31	-38

We recommend that walls which are allowed little or no wall movement be designed using "at rest" conditions. Walls that are allowed to rotate at least 0.4 percent of the wall height may be designed with "active" pressures. The coefficients and densities that are presented above assume a level backfill with no buildup of hydrostatic pressures. If anticipated, hydrostatic pressures and any surcharge loads should be added to the presented values. If sloping backfill is present, we recommend that the geotechnical engineer be consulted to provide more appropriate lateral pressure parameters once the design geometry is established.

The seismic active and passive earth pressure coefficients provided in the table above are based on the Mononobe-Okabe method and only account for the dynamic horizontal force produced by a seismic event. The resulting dynamic pressure should therefore be added to the static pressure to determine the total pressure on the wall. The dynamic pressure distribution can be represented as an inverted triangle, with stress decreasing with depth, and the resultant force acting approximately 0.6 times the height of the retaining wall, measured upward from the bottom of the wall.

Lateral building loads will be resisted by frictional resistance between the footings and the foundation soils and by passive pressure developed by backfill against the wall. For footings on bedrock or structural fill, we recommend that an ultimate coefficient of friction of 0.45 be used. If passive resistance is used in conjunction with frictional resistance, the passive resistance should be reduced by ½. The passive earth pressure from soils subject to frost or heave should usually be neglected in design.

The coefficients and equivalent fluid densities presented above are ultimate values and should be used with an appropriate factor of safety against overturning and sliding. A value of 1.5 is typically used.

5.6 CONCRETE SLAB-ON-GRADE CONSTRUCTION

Concrete slabs-on-grade should be constructed over at least 4 inches of compacted gravel to help distribute floor loads, break the rise of capillary water, and to aid in the curing process. The gravel should consist of free-draining gravel compacted to a firm, unyielding condition. To help control normal shrinkage and stress cracking, the floor slab should have adequate reinforcement for the anticipated floor loads, with the reinforcement continuous through the interior joints. In addition, we recommend adequate crack control joints to control crack propagation.

5.7 MOISTURE PROTECTION AND SURFACE DRAINAGE

Any wetting of the foundation soils will likely cause some degree of volume change within the soil and should be prevented both during and after construction. We recommend that the following precautions be taken at this site:

1. The ground surface should be graded to drain away from the structures in all directions, with a minimum fall of 8 inches in the first 10 feet.
2. Roof runoff should be collected in rain gutters with downspouts that are designed to discharge well outside of the backfill limits.
3. Sprinkler heads should be aimed away from and placed at least 12 inches from foundation walls.
4. There should be adequate compaction of backfill around foundation walls, to a minimum of 90% density (ASTM D 1557). Water consolidation methods should not be used.

Exhibit B
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5.8 SUBSURFACE DRAINAGE

Due to the high alpine setting of the subject site, we recommend that all basement and retaining walls incorporate a foundation drain. The foundations drain should consist of a 4-inch-diameter slotted pipe placed at or below the bottom of footings and encased in at least 12 inches of free-draining gravel. The gravel should be extended up the foundation wall to within 2 feet of the final ground surface, and a filter fabric, such as Mirafi 140N, should separate the gravel from the native soils. The pipe should be graded to drain to the land drains, a storm drain or another free-gravity outfall unless provisions for pumped sumps are made. The gravel which is to extend up the foundation wall may be replaced by a fabricated drain panel such as Mirafi G200N or equivalent.

5.9 SLOPE STABILITY

As recommended in the Western Geologic hazards evaluation (Black, 2020), a slope stability assessment was performed using the Slide computer program and the modified Bishop's method of slices. The profile assessed was based on Figure 5 of the Western Geologic report, our understanding of the proposed development of the site, and on the subsurface conditions that were exposed in our test pits. The location of the profile is shown on Plate 2. A Schmitt hammer test was performed on a block sample of the sandstone bedrock that had been collected from the site; this test indicated a compressive strength of 260,000 psf. For our analyses, we reduced this value to 26,000 psf (cohesion value of 13,000 psf). The near-surface Sandy Lean CLAY (CL) was assumed to have a strength consisting of an angle of internal friction of 28 degrees and a cohesion of 100 psf. All structural fill that is to be placed below the house should consist of a Silty GRAVEL with sand (GM) which has a minimum strength consisting of an angle of internal friction of 35 degrees and a cohesion of 50 psf.

The profile was assessed under static and pseudo static conditions. The pseudo static condition is used to assess the slope during a seismic event. As indicated in Section 4.1, the peak ground acceleration at this site is estimated to be 0.331g. As is common practice, half of this value was used in our pseudo static assessments. Minimum factors of safety of 1.5 and 1.0 for static and seismic conditions, respectively, were considered acceptable. Our analyses indicate that the profile has safety factors greater than 1.5 and 1.0 for the static and pseudo static conditions and is therefore considered suitable for the planned construction.

As indicated in Section 5.2.1, following the stripping operations, it is important that the exposed bedrock be excavated into horizontal terraces with each terrace being 3 to 5 feet in height. This

Exhibit B
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report

will provide a non-uniform plain below the proposed construction which will key the overlying fill and structure into the bedrock, providing greatly increased resistance to slope failures.

The slope stability analysis presented above is based on our understanding of the proposed construction. Significant changes to the site grade, such as the steepening of slopes by way of cuts or fills, may adversely affect the stability of the slopes at the site and increase the risk of slope failures. If significant cuts of more than 15 feet of fill are planned to be placed on the lot, additional slope stability assessments may be necessary and Christensen Geotechnical should be contacted to provide the additional assessments.

Exhibit B
Geotechnical
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6.0 LIMITATIONS

The recommendations contained in this report are based on limited field exploration, laboratory testing, and our understanding of the proposed construction. The subsurface data used in this report was obtained from the explorations that were made specifically for this investigation. It is possible that variations in the soil and groundwater conditions could exist between and beyond the points explored. The nature and extent of variations may not be evident until construction occurs. If any conditions are encountered at this site that are different from those described in this report, Christensen Geotechnical should be immediately notified so that we may make any necessary revisions to the recommendations contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, Christensen Geotechnical should be notified.

This report was prepared in accordance with the generally accepted standard of practice at the time the report was written. No other warranty, expressed or implied, is made.

It is the client's responsibility to see that all parties to the project, including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

Exhibit B
Geotechnical
report

7.0 REFERENCES

Black, Bill, October 23, 2020, "Geologic Hazards Evaluation, Legends at Hawkins Creek Lot 2, 6682 East Chaparral Road, Huntsville, Weber County, Utah," Western Geologic, consultant's unpublished report.

Exhibit B
Geotechnical
report

Base Photo: Utah AGRC

Drawing Not to Scale

N

Approximate Project Boundary

Christensen Geotechnical	Habitations Residential Design Group Legends at Hawkins Creek Lot 2 Weber County, Utah Project No. 259-001 **Vicinity Map**	Plate 1

Exhibit B
Geotechnical
report

Approximate Test Pit Location

Slope Stability Profile

Approximate Project Boundary

Base Photo: Utah AGRC

Drawing Not to Scale

N

Christensen Geotechnical

Habitations Residential Design Group
Legends at Hawkins Creek Lot 2
Weber County, Utah
Project No. 259-001

Exploration Location Map

Plate
2

Exhibit B Geotechnical report

Date				
Started:	10/8/2020	# TEST PIT LOG	Logged By: M Christensen	Test Pit No.
Completed:	10/8/2020		Equipment: Trackhoe	TP-1
Backfilled:	10/8/2020		Location: See Plate 2	Sheet 1 of 1

Depth (feet)	Sample Type	Groundwater	Graphic Log	Group Symbol	Material Description	Dry Density (pcf)	Moisture Content (%)	Minus #200 (%)	Liquid Limit	Plasticity Index
0–3					Topsoil; Sandy Lean CLAY - slightly moist, dark brown					
3–9	⊠ (approx. 8–8.5)				Sandstone Bedrock - weak, weathered, light gray - moderately strong below 5 feet					
9					Refusal at 9 feet					

Depth scale: 5, 10, 15

⊠ Bulk/Bag Sample
▥ Undisturbed Sample
Stabilized Groundwater
Groundwater At Time of Excavation

Christensen Geotechnical

Habitations Residential Design Group
Legends at Hawkins Creek Lot 2
Weber County, Utah
Project No.: 259-001

Plate
3

Exhibit B Geotechnical report

Date		TEST PIT LOG		Test Pit No.
Started:	10/8/2020		Logged By: M Christensen	TP-2
Completed:	10/8/2020		Equipment: Trackhoe	
Backfilled:	10/8/2020		Location: See Plate 2	Sheet 1 of 1

Depth (feet)	Sample Type	Groundwater	Graphic Log	Group Symbol	Material Description	Dry Density (pcf)	Moisture Content (%)	Minus #200 (%)	Liquid Limit	Plasticity Index
0–1½					Topsoil; Sandy Lean CLAY - slightly moist, dark brown					
1½–7½	☒ (at about 6 feet)				Sandstone Bedrock - weak, weathered, light gray - moderately strong below 3 feet					
7½					Refusal at 7½ feet					

Depth scale: 5, 10, 15

☒ Bulk/Bag Sample
▥ Undisturbed Sample

Stabllized Groundwater
Groundwater At Time of Excavation

Christensen Geotechnical

Habitations Residential Design Group
Legends at Hawkins Creek Lot 2
Weber County, Utah
Project No.: 259-001

Plate
4

Exhibit B
Geotechnical
report

RELATIVE DENSITY – COURSE GRAINED SOILS

Relative Density	SPT (blows/ft.)	3 In OD California Sampler (blows/ft.)	Relative Density (%)	Field Test
Very Loose	<4	<5	0 – 15	Easily penetrated with a ½ inch steel rod pushed by hand
Loose	4 – 10	5 – 15	15 – 35	Difficult to penetrate with a ½ inch steel rod pushed by hand
Medium Dense	10 – 30	15 – 40	35 – 65	Easily penetrated 1-foot with a steel rod driven by a 5 pound hammer
Dense	30 – 50	40 – 70	65 – 85	Difficult to penetrate 1-foot with a steel rod driven by a 5 pound hammer
Very Dese	>50	>70	85 - 100	Penetrate only a few inches with a steel rod driven by a 5 pound hammer

CONSISTENCY – FINE GRAINED SOILS

Consistency	SPT (blows/ft)	Torvane Undrained Shear Strength (tsf)	Pocket Penetrometer Undrained Shear Strength (tsf)	Field Test
Very Soft	<2	<0.125	<0.25	Easily penetrated several inches with thumb
Soft	2 – 14	0.125 – 0.25	0.25 – 0.5	Easily penetrated one inch with thumb
Medium Stiff	4 – 8	0.25 – 0.5	0.5 – 1.0	Penetrated over ½ inch by thumb with moderate effort. Molded by strong finger pressure
Stiff	8 – 15	0.5 – 1.0	1.0 – 2.0	Indented ½ inch by thumb with great effort
Very Stiff	15 – 30	1.0 – 2.0	2.0 – 4.0	Readily indented with thumbnail
Hard	>30	>2.0	>4.0	Indented with difficulty with thumbnail

CEMENTATION

Weakly	Crumbles or breaks with handling or little finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumble or break with finger pressure

MOISTURE

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually below water table

GRAIN SIZE

Description		Sieve Size	Grain Size (in)	Approximate Size
Boulders		>12"	>12"	Larger than basketball
Cobbles		3" – 12"	3" – 12"	Fist to basketball
Gravel	Coarse	3/4" - 3"	3/4" - 3"	Thumb to fist
	Fine	#4 – 3"	0.19 – 0.75	Pea to thumb
Sand	Coarse	#10 - #4	0.079 – 0.19	Rock salt to pea
	Medium	#40 - #10	0.017 – 0.079	Sugar to rock salt
	Fine	#200 - #40	0.0029 – 0.017	Flour to sugar
Silt/Clay		<#200	<0.0029	Flour sized or smaller

STRATAFICATION

Occasional	One or less per foot of thickness
Frequent	More than one per foot of thickness

MODIFIERS

Trace	<5%
Some	5-12%
With	>12%

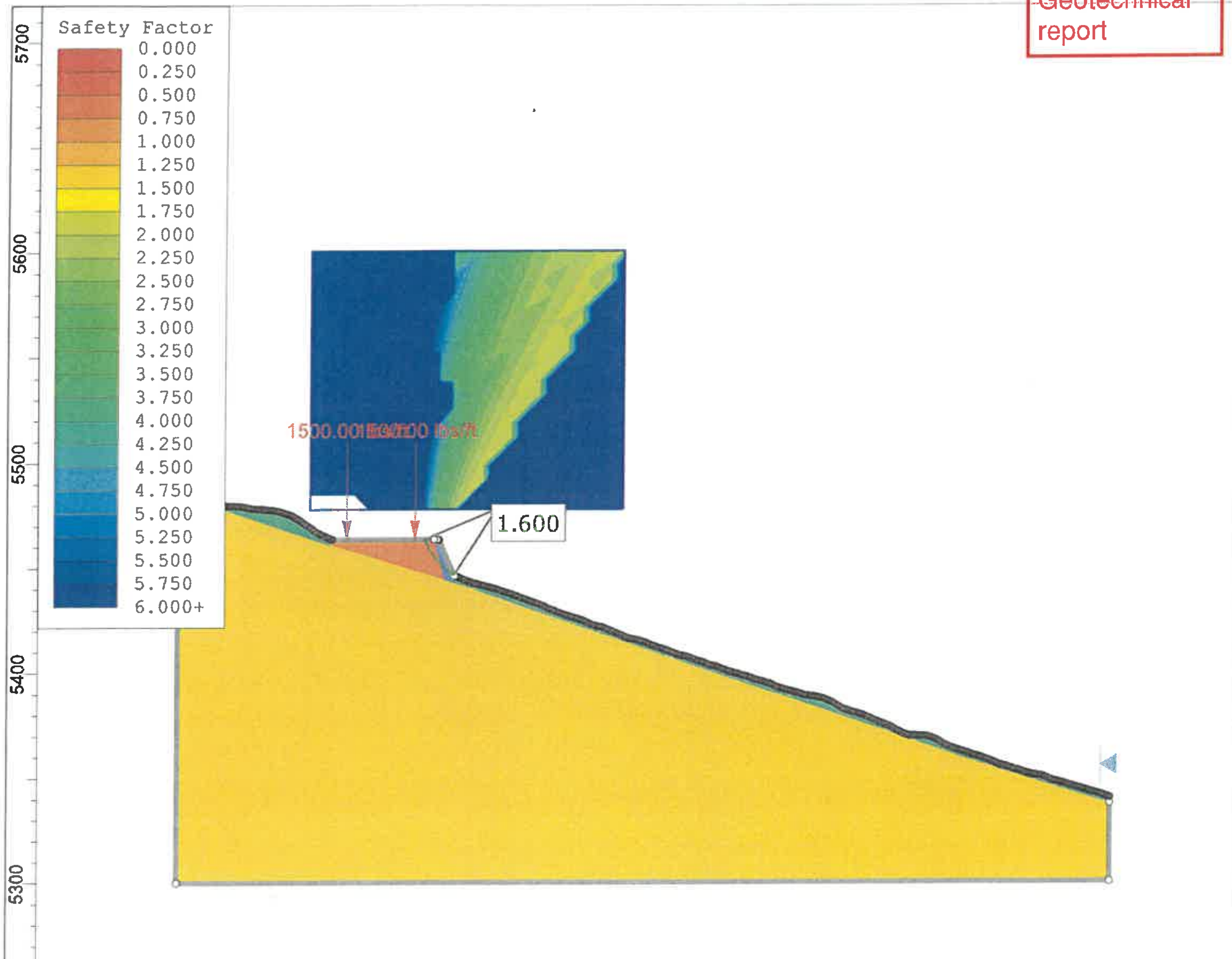
STRATIFICATION

Seam	1/16 to 1/2 inch
Layer	1/2 to 12 inch

NOTES

1. The logs are subject to the limitations and conclusions presented in the report.
2. Lines separating strata represent approximate boundaries only. Actual transitions may be gradual.
3. Logs represent the soil conditions at the points explored at the time of our investigation.
4. Soils classifications shown on logs are based on visual methods . Actual designations (based on laboratory testing)may vary.

Exhibit B
Geotechnical report



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion 2 (psf)	Phi 2 (deg)	Angle (ccw to 1) (deg)	Water Surface	Ru
Bedrock		140	Mohr-Coulomb	13000	0				None	0
Sandy Lean Clay		115	Mohr-Coulomb	100	28				None	0
Silty Gravel		120	Mohr-Coulomb	50	35				None	0
Rockery		120	Anisotropic strength	2000	0	0	45	15	None	0

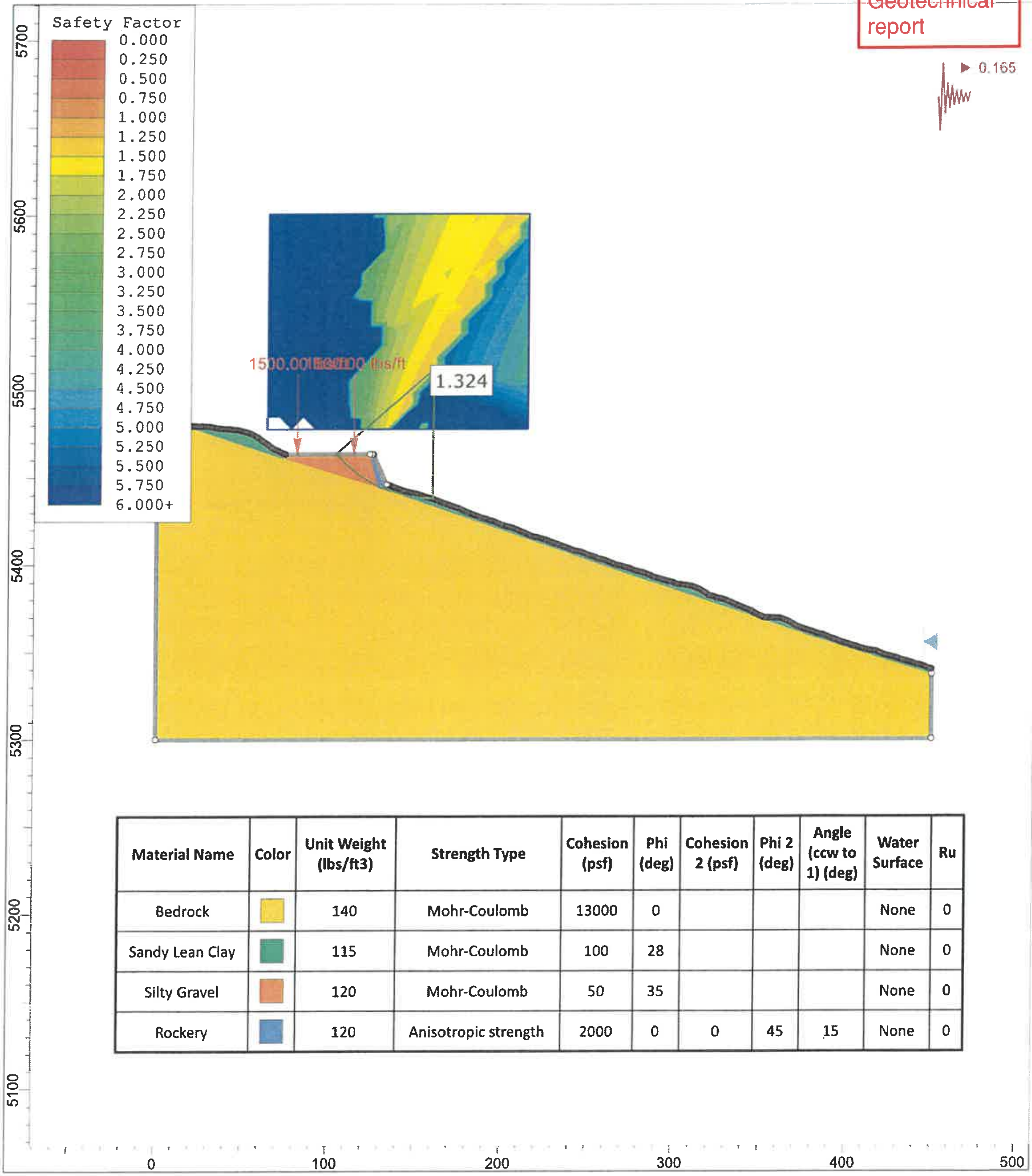
Global Stability - Static

Christensen Geotechnical

Habitations Residential Design Group
Legends at Hawkins Creek Lot 2
Weber County, Utah
259-001

Plate
6

Exhibit B Geotechnical report



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion 2 (psf)	Phi 2 (deg)	Angle (ccw to 1) (deg)	Water Surface	Ru
Bedrock		140	Mohr-Coulomb	13000	0				None	0
Sandy Lean Clay		115	Mohr-Coulomb	100	28				None	0
Silty Gravel		120	Mohr-Coulomb	50	35				None	0
Rockery		120	Anisotropic strength	2000	0	0	45	15	None	0

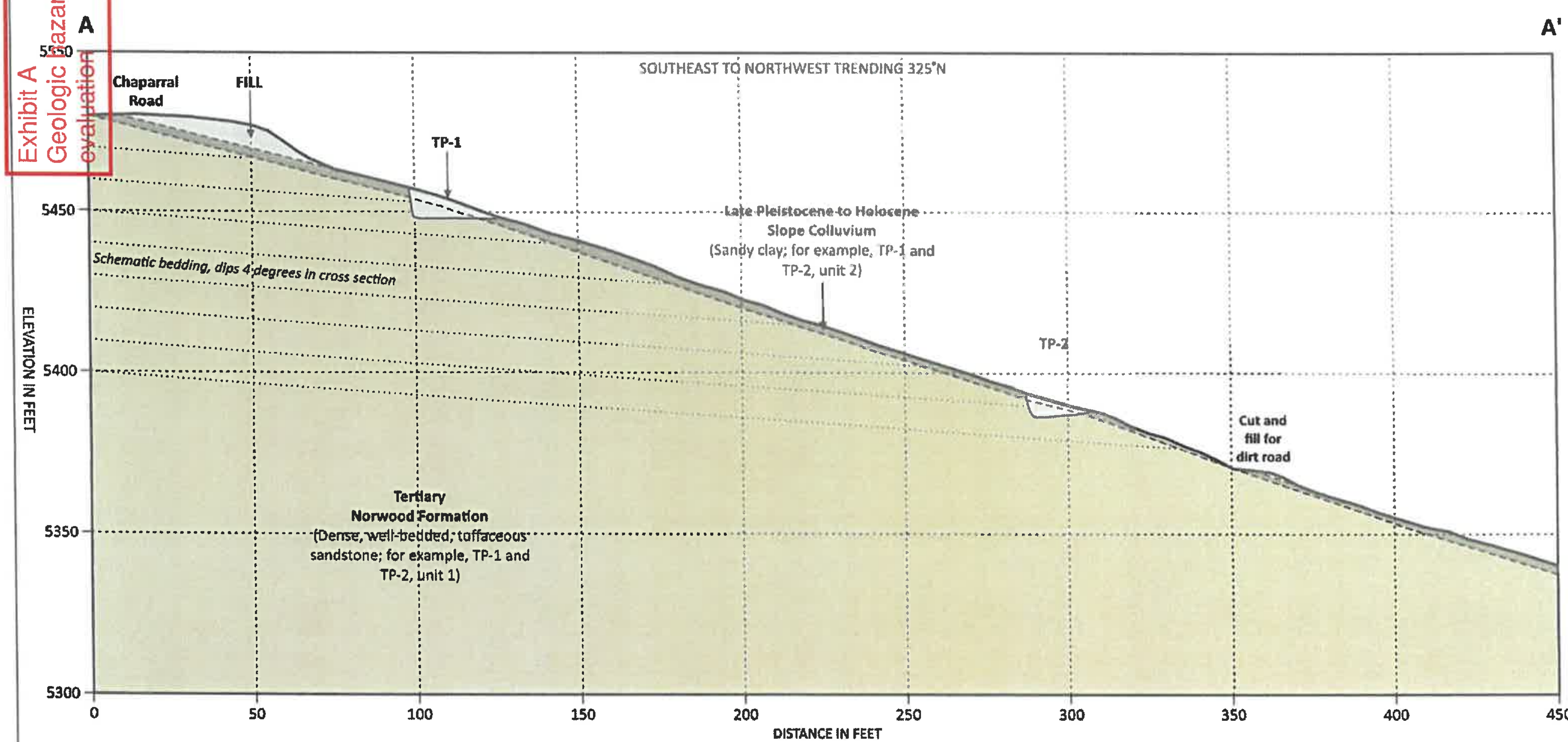
Global Stability - Pseudo Static

Christensen Geotechnical

Habitations Residential Design Group
Legends at Hawkins Creek Lot 2
Weber County, Utah
259-001

Plate 7

Exhibit A
Geologic hazards evaluation



Cross section south to north, view to west. Scale 1 inch equals 30 feet, no vertical exaggeration. Topographic profile from 2016 LIDAR data. Profile location on Figure 3C. Units and contacts inferred based on subsurface information.

WESTERN GEOLOGIC

CROSS SECTION A-A'

GEOLOGIC HAZARDS EVALUATION
Legends at Hawkins Creek Lot 2
6682 East Chaparral Road
Huntsville, Utah

FIGURE 5

Exhibit C
Site plan and landscaping plan

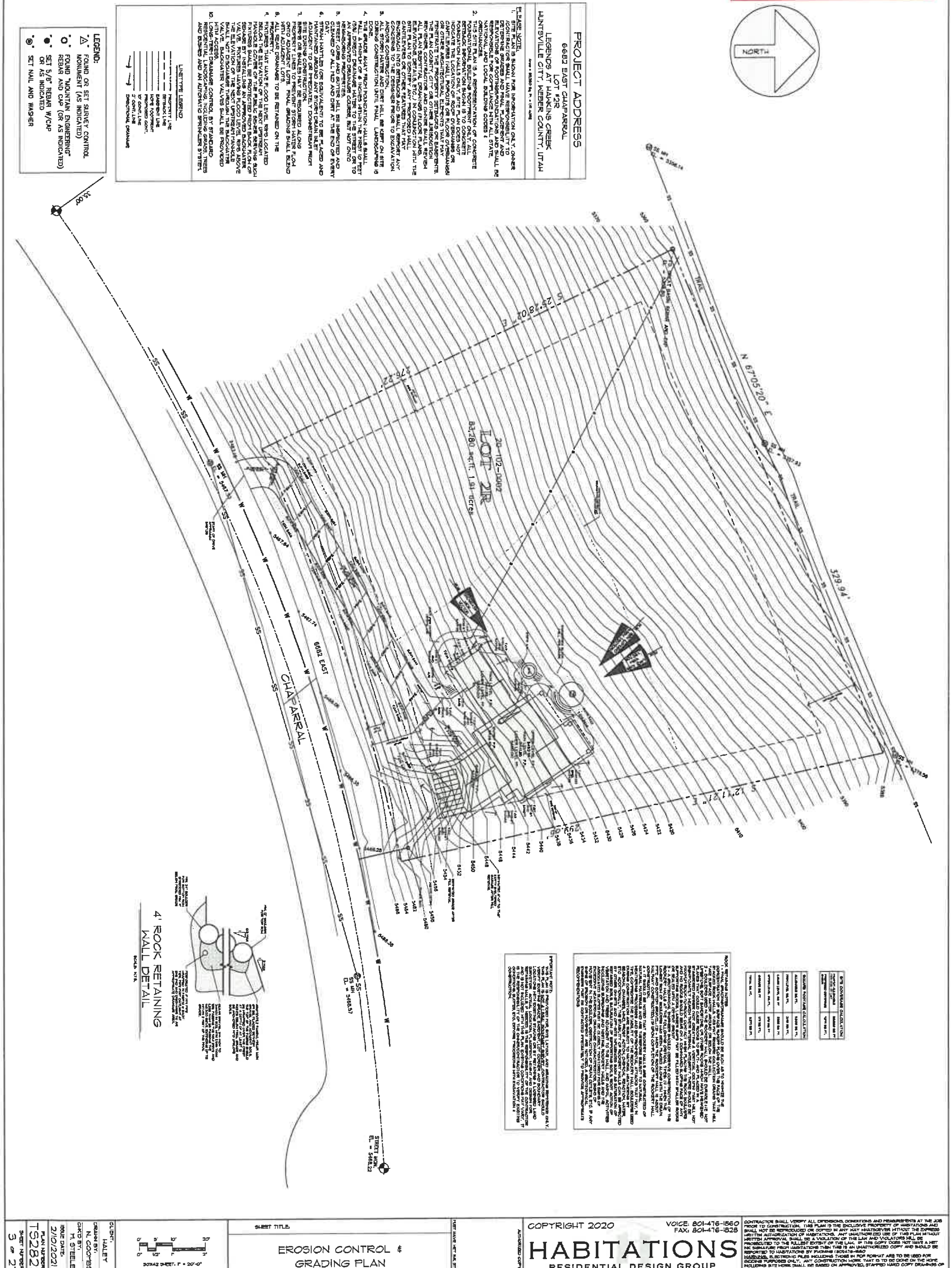
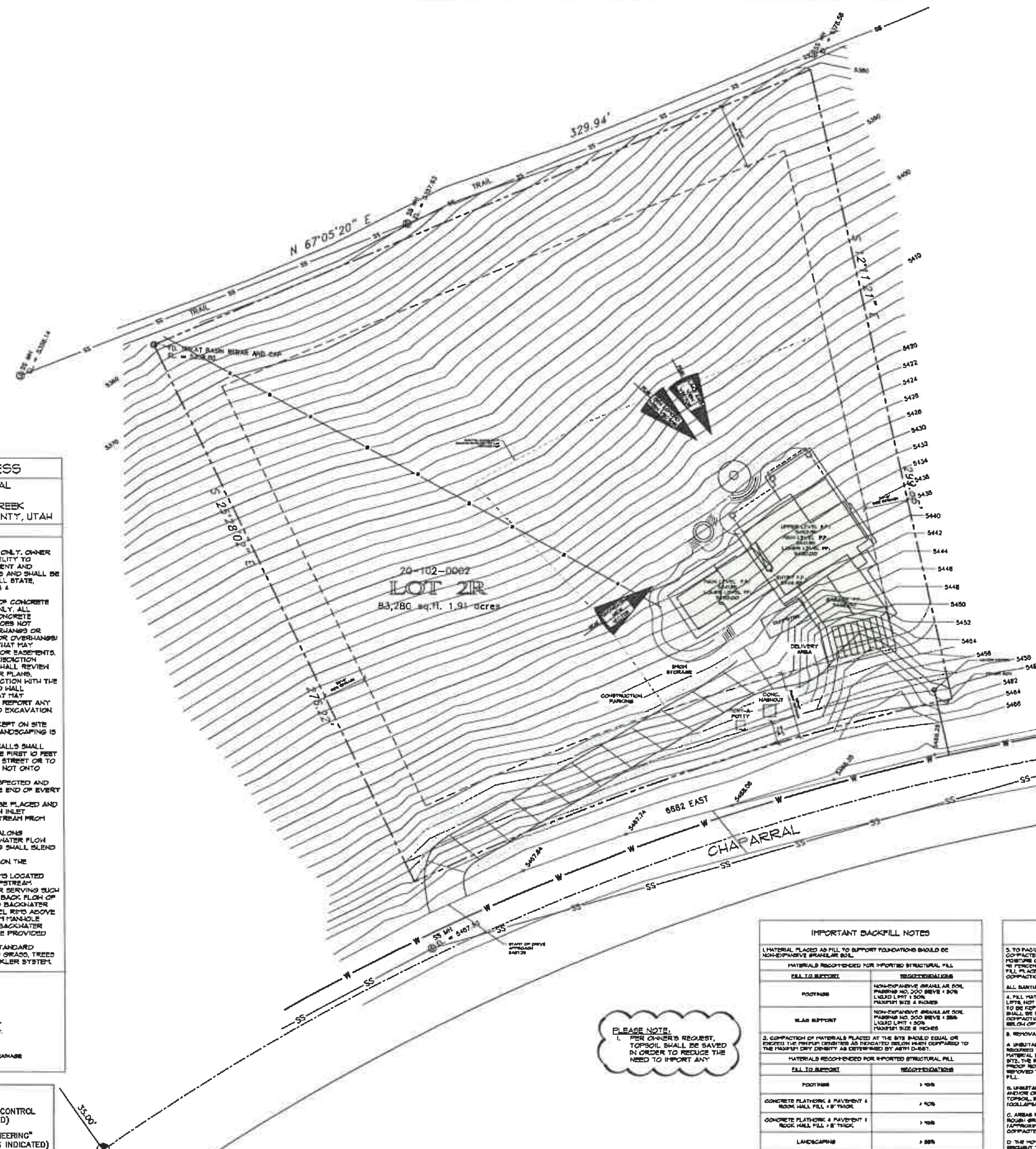


Exhibit C
Site plan and landscaping plan



PROJECT ADDRESS

6682 EAST CHAPARRAL
LOT #2R
LEGENDS AT HAWKINS CREEK
HUNTSVILLE CITY, WEBER COUNTY, UTAH

PLEASE NOTE:

1. SITE PLAN IS SHOWN FOR INFORMATION ONLY. OWNER /CONTRACTOR SHALL HAVE RESPONSIBILITY TO DETERMINE GRADES AND FINAL PLACEMENT AND ELEVATIONS OF FOOTINGS/FOUNDATIONS AND SHALL BE RESPONSIBLE FOR COMPLIANCE WITH ALL STATE, NATIONAL, AND LOCAL BUILDING CODES & ORDINANCES.
2. THIS SITE PLAN IS A REPRESENTATION OF CONCRETE FOUNDATIONAL BUILDING FOOTPRINT ONLY. ALL SETBACK INFORMATION SHOWN IS TO CONCRETE FOUNDATION WALLS ONLY. SITE PLAN DOES NOT INDICATE THE LOCATION OF ROOF OVERHANGS OR CANTILEVERS (WALL POPOUTS OR FLOOR OVERHANGS) OR OTHER ARCHITECTURAL ELEMENTS THAT MAY PENETRATE THE PROPERTY SETBACKS OR EASEMENTS. THE PLAN COUNTY, CITY OR OTHER JURISDICTION REVIEWER, CONTRACTOR AND OWNER SHALL REVIEW ALL PLAN SUBMITTAL DRAWINGS (FLOOR PLANS, ELEVATIONS, DETAILS, ETC.) IN CONJUNCTION WITH THE SITE PLAN TO IDENTIFY ANY PROPOSED WALL CANTILEVERS OR OTHER FEATURES THAT MAY ENCROACH INTO SETBACKS AND SHALL REPORT ANY CONCERNS TO THE DESIGNER PRIOR TO EXCAVATION AND/OR CONSTRUCTION.
3. ALL STORM WATER AND DIRT WILL BE KEPT ON SITE DURING CONSTRUCTION UNTIL FINAL LANDSCAPING IS DONE.
4. THE GRADE AWAY FROM FOUNDATION WALLS SHALL FALL A MINIMUM OF 6 INCHES WITHIN THE FIRST 10 FEET (5%). DIRECT DRAINAGE WATER TO THE STREET OR TO AN APPROVED DRAINAGE COURSE, BUT NOT ONTO NEIGHBORING PROPERTIES.
5. STREET, CURB AND GUTTER WILL BE INSPECTED AND CLEANED OF ALL MUD AND DIRT AT THE END OF EVERY DAY.
6. STRAW WATTLES (OR EQUIVALENT) TO BE PLACED AND MAINTAINED AROUND ANY STORM DRAIN INLET ADJACENT TO OR IMMEDIATELY DOWNSTREAM FROM SITE DURING CONSTRUCTION.
7. BERMS OR SWALES MAY BE REQUIRED ALONG PROPERTY LINES TO PREVENT STORM WATER FLOW ONTO ADJACENT LOTS. FINAL GRADING SHALL BLEND WITH ADJACENT LOTS.
8. ALL REAR DRAINAGE TO BE RETAINED ON THE PROPERTY.
9. FIXTURES THAT HAVE FLOOD LEVEL RIMS LOCATED BELOW THE ELEVATION OF THE NEXT UPSTREAM MANHOLE COVER OF THE PUBLIC SEWER SERVING SUCH FIXTURES SHALL BE PROTECTED FROM BACK FLOW OF SEWAGE BY INSTALLING AN APPROVED BACKWATER VALVE. FIXTURES HAVING FLOOD LEVEL RIMS ABOVE THE ELEVATION OF THE NEXT UPSTREAM MANHOLE SHALL NOT DISCHARGE THROUGH THE BACKWATER VALVE. BACKWATER VALVES SHALL BE PROVIDED WITH ACCESS.
10. LONG-TERM DRAINAGE CONTROL BY STANDARD RESIDENTIAL LANDSCAPING, INCLUDING GRASS, TREES AND BUSHES AND AN AUTOMATIC SPRINKLER SYSTEM.

LINETYPE LEGEND

- PROPERTY LINE
- SETBACK LINE
- EASEMENT LINE
- HOME FOOTPRINT
- PROPOSED CONT.
- 10' CONT. LINE
- 2' CONT. LINE
- DIRECTIONAL DRAINAGE

LEGEND:

- "△" FOUND OR SET SURVEY CONTROL MONUMENT (AS INDICATED)
- "○" FOUND "MOUNTAIN ENGINEERING" REBAR AND CAP (OR AS INDICATED)
- "●" SET 5/8" REBAR W/CAP OR AS INDICATED
- "◉" SET NAIL AND WASHER

PLEASE NOTE:
1. PER OWNER'S REQUEST, TOPSOIL SHALL BE SAVED IN ORDER TO REDUCE THE NEED TO IMPORT ANY

SWPPP INFORMATION

1. HOW MUCH AREA WILL BE DISTURBED? APPX. [illegible] SQ. FT. OF THE LOT, JUST OVER [illegible] OF THE ENTIRE LOT AREA.
2. WHO WILL BE RESPONSIBLE FOR THE CONDITIONS OF THE SITE DURING CONSTRUCTION? [illegible]
3. WHAT WILL BE DONE TO PREVENT THE NEIGHBORS FROM BEING AFFECTED BY THE PROPOSED CONSTRUCTION ACTIVITIES? THE SITE INCLUDING THE STREET, ETC. WILL BE CLEANED OF MUD AND DEBRIS DAILY.
4. WHAT WILL BE DONE WITH ALL EXCAVATED MATERIAL TEMPORARILY AND PERMANENTLY? ALL MATERIAL WILL BE USED ON SITE FOR LANDSCAPING AND SHAPING OF THE LAND AFFECTED.
5. WHERE IS THE CONCRETE WASHOUT AND HOW WILL IT BE MAINTAINED? CONCRETE WASHOUT AREA SHOWN ON SITE PLAN, SEE NOTES ABOVE.
6. WHERE ARE THE PORTA-JOHNS LOCATED AND HOW ARE THEY INSTALLED. SEE SITE PLAN FOR LOCATION AND THEY ARE STAND ALONE UNITS AND WILL BE DELIVERED AND PICKED UP FOR SERVICE AND INSTALLATION.
7. HOW WILL THE CONSTRUCTION ENTRANCE BE BUILT AND WHERE WILL IT BE LOCATED? THE ENTRANCE WILL BE BUILT WHERE THE PROPOSED DRIVEWAY LOCATION IS SHOWN. IT WILL CONSIST OF GRAVEL ROAD BASE FROM THE RIGHT OF WAY AND BE AT LEAST 40 FEET LONG TO REDUCE MUD AND DEBRIS FROM TRACKING OUT TO THE RIGHT OF WAY.
8. WHAT WILL YOU DO WHEN MUD AND/OR DIRT GETS TRACKED ON THE ASPHALT? IT WILL BE SCRAPED AND SWEPT DAILY.
9. IS THERE A DRAINAGE DITCH OR SWALE ON OR NEAR YOUR PROPERTY? IF SO HOW WILL IT BE PROTECTED? THERE IS A DRAINAGE EASEMENT ON THE PROPERTY. STAKED STRAW WATTLES AND A SILT FENCE WILL BE INSTALLED ON THE CONSTRUCTION SIDE OF THE EASEMENT TO ENSURE DEBRIS WILL NOT ENTER OR AFFECT THE EASEMENT.
10. WHAT CURRENTLY HAPPENS TO THE RAIN/STORM WATER WHEN IT REACHES THIS PROJECT SITE? STORMWATER REACHING THIS SITE IS ABSORBED INTO THE VEGETATION AND GROUND.
11. SHOW ALL EXISTING OCCUPATION ON THE PROPERTY. NO EXISTING OCCUPATION CURRENTLY EXISTS ON THE PROPERTY.

CONCRETE WASTE MANAGEMENT

NOTES:

1. EXCESS AND WASTE CONCRETE SHALL NOT BE WASHED INTO THE STREET OR INTO A DRAINAGE SYSTEM.
2. FOR WASHOUT OF CONCRETE AND MORTAR PRODUCTS, A DESIGNATED CONTAINMENT FACILITY OF SUFFICIENT CAPACITY TO RETAIN LIQUID AND SOLID WASTE SHALL BE PROVIDED ON SITE. THIS DISCHARGE AREA MUST BE LINED WITH AN IMPERMEABLE BARRIER.
3. SLURRY FROM CONCRETE AND ASPHALT SAW CUTTING SHALL BE VACUUMED OR CONTAINED, DRIED, PICKED UP, AND DISPOSED OF PROPERLY.

IMPORTANT BACKFILL NOTES

1. MATERIAL PLACED AS FILL TO SUPPORT FOUNDATIONS SHOULD BE NON-EXPANSIVE GRANULAR SOIL.

MATERIALS RECOMMENDED FOR IMPORTED STRUCTURAL FILL

FILL TO SUPPORT	RECOMMENDATIONS
FOOTINGS	NON-EXPANSIVE GRANULAR SOIL PASSING NO. 200 SIEVE < 30% LIQUID LIMIT < 30% MAXIMUM SIZE 4 INCHES
SLAB SUPPORT	NON-EXPANSIVE GRANULAR SOIL PASSING NO. 200 SIEVE < [illegible] LIQUID LIMIT < 30% MAXIMUM SIZE [illegible] INCHES

2. COMPACTION OF MATERIALS PLACED AT THE SITE SHOULD EQUAL OR EXCEED THE MINIMUM DENSITIES AS INDICATED BELOW WHEN COMPARED TO THE MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D-1557.

MATERIALS RECOMMENDED FOR IMPORTED STRUCTURAL FILL

FILL TO SUPPORT	RECOMMENDATIONS
FOOTINGS	> [illegible]
CONCRETE FLATWORK & PAVEMENT & ROCK WALL FILL < 5' THICK	> 90%
CONCRETE FLATWORK & PAVEMENT & ROCK WALL FILL > 5' THICK	> [illegible]
LANDSCAPING	> [illegible]
RETAINING WALL BACKFILL	[illegible] - 90%

IMPORTANT BACKFILL NOTES (CONT.)

3. TO FACILITATE THE COMPACTION PROCESS, THE FILL SHOULD BE COMPACTED AT A MOISTURE CONTENT WITHIN 2 PERCENT OF THE OPTIMUM MOISTURE CONTENT. THE BASE COURSE SHOULD BE COMPACTED TO AT LEAST [illegible] PERCENT OF THE MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D-1557. FILL PLACED FOR THE PROJECT SHOULD BE FREQUENTLY TESTED FOR COMPACTION.

ALL EARTH WORK SHALL CONFORM WITH THE SITE GEOTECHNICAL REPORT.

4. FILL MATERIAL MUST BE DEPOSITED AND SPREAD IN UNIFORM HORIZONTAL LIFTS, NOT MORE THAN 8" THICK, LOOSE MEASUREMENT, AND THESE LIFTS ARE TO BE KEPT APPROXIMATELY LEVEL. FIELD DENSITY TESTS (ASTM-D-1556) SHALL BE PERFORMED AT REGULAR INTERVALS TO CHECK ADEQUACY OF THE COMPACTION. MOISTURE CONTENT SHALL NOT VARY MORE THAN [illegible] ABOVE OR BELOW OPTIMUM.

5. REMOVAL OF UNSUITABLE MATERIAL

A. UNSUITABLE MATERIAL IN SOFT SPOTS SHALL BE REMOVED TO THE DEPTH REQUIRED TO PROVIDE A FIRM FOUNDATION AND SHALL BE REPLACED WITH A MATERIAL EQUAL TO OR BETTER THAN THE BEST SUBGRADE MATERIAL ON THE SITE. THE IN-PLACE MATERIALS, IE. NATURAL OR EXCAVATED AREAS, SHALL BE PROOF ROLLED. SOFT SOILS IDENTIFIED DURING PROOF ROLL SHALL BE REMOVED TO A MAXIMUM DEPTH OF 2' AND BACKFILLED WITH STRUCTURAL FILL.

B. UNSUITABLE MATERIAL SHALL BE DEFINED AS ANY SOIL CONTAINING DEBRIS AND/OR ORGANIC MATERIAL OR ANY KIND SUCH AS MUCK, PEAT, ORGANIC TOPSOIL, SOD, VEGETABLE MATTER, AND/OR MOISTURE SENSITIVE SOILS (COLLAPSIBLE/EXPANSIVE SOILS).

C. AREAS REQUIRING IMPORTATION OF FILL MATERIAL SHALL BE BROUGHT TO ROUGH GRADE ELEVATIONS IN LIFTS NOT TO EXCEED 8 INCHES LOOSE (APPROXIMATELY 6 INCHES COMPACTED), AND EACH LIFT SHALL BE COMPACTED TO REQUIRED DENSITY AND REQUIRED MOISTURE.

D. THE MOISTURE CONTENT FOR ALL MATERIALS TO BE COMPACTED SHALL BE BROUGHT TO APPROXIMATE OPTIMUM CONDITIONS BY THE ADDITION OF WATER, BY THE BLENDING OF DRY MATERIAL, OR BY AERATION OF THE EXISTING MATERIAL.

6. BACKFILL NOTES ON THIS PLAN REFERENCE GEOTECHNICAL ENGINEER'S DOCUMENTATION, AND ARE NOT THOSE OF THE ENGINEERING OF RECORD FOR THIS SITE PLAN.

VOICE: 801-416-1860
FAX: 801-416-1825
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MUST HAVE WET INK STAMP

SHEET TITLE:
CONSTRUCTION MITIGATION PLAN

30X42 SHEET: 1" = 20'-0"

CLIENT: HALEY
DRAWN BY: N. COOMBS
CHK'D BY: M. STEELE
ISSUE DATE: 2/10/2021
PLAN NUMBER: TS2823
SHEET NUMBER: 4 OF 27

Exhibit C
Site plan and landscaping plan