



March 1, 2017

WSP File No: 171-02203-00

City of Chilliwack
8550 Young Road
Chilliwack, BC V2P 8A4

Attention: Rod Sanderson, ASc.T.
Deputy Director of Engineering

Project: Vedder Mountain Landslide near 43980 Vedder Mountain Road, Chilliwack, BC

Subject: Geotechnical Assessment Report

Dear Sir,

1 INTRODUCTION

In general accordance with our email proposal dated February 20, 2017, WSP Canada Inc. (WSP) has prepared this geotechnical assessment report for a recent landslide that occurred upslope of a single-family residence at 43980 Vedder Mountain Road (VMR) in Chilliwack, BC. Authorization to proceed with the scope of work discussed in the email proposal was received from the City of Chilliwack (the City) on February 20, 2017.

The landslide initiated within the northwestern portion of the Western Explosives Ltd. rock quarry (at 4384 Parmenter Road) located about 500 m upslope of 43980 VMR. We understand that the landslide occurred at about 11:00 am on February 18, 2017. The landslide is about 470 m long (horizontal) and ranges between 4 and 40 m wide. The elevations of the initiation and termination zones of the landslide are approximately 50 and 320 m, respectively. The landslide impacted the following properties and infrastructure downslope of the initiation zone:

- 4384 Parmenter Road within the City;
- Crown owned land within the Fraser Valley Regional District (FVRD);
- Vedder Forest Service Road (FSR) also known as the Vedder Mountain Railway Grade Trail;
- 43920 VMR within the FVRD;
- 4454 Parmenter Road within the City; and
- An unnamed watercourse located within 43920 VMR.

The attached Figure 1 shows the approximate location of the landslide. The approximate margins and extent of the landslide are further illustrated with more accuracy on the Landslide Site Plan, Figure 2. Based on the BC Government online mapping, the unnamed watercourse is not fish bearing and no water intakes are shown in the vicinity.

WSP Canada Inc.
100 – 20339 – 96 Avenue
Langley, BC V1M 0E4

Phone: 604-533-2992
Fax: 604-533-0768
www.wspgroup.com



The purpose of the assessment was to review the area impacted by the landslide, determine if the residence at 43980 VMR can be safely occupied (i.e. safe from hazards from the current landslide and the gully south of the residence) and identify the potential cause(s) of the landslide. It should be understood that this is not a geotechnical hazard assessment for the residence at 43980 VMR. This report provides recommendations and commentary to minimize impacts from the recent landslide and any mitigative measures that should be taken to minimize the risk of future slope instability.

2 BACKGROUND

2.1 SURFICIAL AND BEDROCK GEOLOGY

The Geological Survey of Canada (GSC) bedrock geology map covering Chilliwack describes the bedrock underlying the landslide site as Vedder Mountain Complex comprised of amphibolite, gneiss and minor ultramafic rocks. The surficial geology mapping shows that the bedrock is overlain by 1 to 5 m of glacial, colluvial and Aeolian sediments.

2.2 CLIMATE AND PRECIPITATION

The Canadian Climate Normals 1981 to 2010 for Abbotsford International Airport (YXX), about 27 km west of the site, shows that the mean monthly precipitation for February is 123.4 mm of rain and 8.6 cm of snow.

The Environment Canada historic weather data from February 1 to 19, 2017 for YXX, recorded 103.7 mm of rain and 57.8 cm of snow. During the previous 7 days prior to the landslide occurring about 61 mm of rainfall was recorded at YXX with no snowfall. This shows that over the previous 19 days YXX in general has received approximately 20 mm and 52 cm greater rainfall and snowfall than the mean, respectively, for this area. It is well documented that many landslides are initiated in response rain and snow weather events.

2.3 PREVIOUS REPORTS AND OTHER INFORMATION

Field Reports prepared by Ecora Engineering and Resource Group Ltd. (Ecora) and dated February 18 and 20, 2017 provides recommendations to mitigate risks from the landslide.

The main findings of the February 18, 2017 Ecora field report were:

- Vedder Mountain Road can be re-opened since the probability of debris reaching the road is very low;
- Re-initiating of entrapped material within the debris flow channel above the residence cannot be ruled out during prolonged periods of rain;
- A protective berm should be constructed on a bench above the residence. The berm should be about 3 m high, constructed with a mix of large boulders and smaller size crushed rock;
- The single-family residence at 43980 VMR should not be occupied until the protective berm is completed. The two adjacent residences do not appear to be at risk from the landslide; and
- A qualified geotechnical engineer should conduct a geotechnical review in approximately two weeks to re-assess the site and provide additional recommendations, as required.



The main findings of the February 20, 2017 Ecora field report were:

- Ecora recommended that the protective berm be constructed atop the existing berm and should extend from the toe of slope at the west side of the creek to approximately 15 m to the east;
- Recommendations for the protective berm were provided in a cross section drawing as follows:
 - The berm should be constructed in maximum 300 mm thick lifts of 75 mm minus crushed rock and compacted to 98% Standard Proctor Density (SPD);
 - The downstream side of the berm should be sloped no greater than 1.5H:1V (Horizontal:Vertical);
 - The upstream side of the berm should be sloped no greater than 0.5H:1V and armoured with 0.9 m diameter strong angular durable boulders, embedded a minimum of 0.5 m and setback a minimum of 1 m from the creek channel; and
 - The crest of the berm should be a minimum of 1.5 m wide.

We understand from the City of Chilliwack that a previous landslide occurred in 1999 about 100 m east of the recent landslide and impacted a house located at 44100 VMR. The previous landslide runout path was observed on historic air photographs and the City webmap. The house was demolished and not replaced. It is unclear what initiated the landslide, however we understand from Western Explosives Ltd that it may have been caused by a drainage diversion along an old road/trail located on the slopes below the north side of the rock quarry. We also understand from the City that a landslide impacted a property located at 44470 VMR, 1 km northeast of 43980 VMR, about 10 years ago. This landslide was visible on the available online imagery, however no information was available regarding the cause.

Geomedia Engineering Ltd. (Geomedia) prepared a previous geotechnical hazard assessment report dated August 26, 2008 for the single-family residence located at 43980 VMR located downslope of the recent landslide. Geomedia conducted a site reconnaissance, however no observations were discussed in the report. Geomedia estimated that the landslide probability is low, the estimated landslide runout is less than 10 m, the probability of a downslope interaction is low to moderate and the partial risk is very low to low.

Geomedia prepared two additional supplemental geotechnical hazard reports dated April 27, 2009 and June 5, 2009 for the single-family residence located at 43980 VMR. The April 27, 2009 report provided site reconnaissance observations and no previous slope instabilities were observed. They estimated that a debris flow or debris flood would be poorly confined and limited to depths of less than 1 m. Based on the FVRD's Hazard Acceptability Thresholds for Development Approvals by Local Government (Cave, 1993), Geomedia estimated that the return period of a debris flow or debris flood is 100 to 500 years. Geomedia recommended that the house be placed on a reinforced concrete perimeter foundation wall or a structural fill pad so that the top of the foundation wall is a minimum of 1 m above the surrounding grade, scour protection be placed around the foundation wall, surface water should be drained away from the residence and the site should be surveyed to confirm the raised foundation grades are achieved.

The Chilliwack Forest District prepared a Road Deactivation Completion Report for the Vedder FSR (Road Number ID 5842.01) dated March 9, 2009. The report indicates that several landslides occurred from this road during the winter storm of December/January 2008/2009 impacting public road systems and private property at the toe of slope. However no map showing the locations of these landslides was provided. The Vedder FSR was permanently deactivated from Station (Sta.) 17.4 km to Sta. 20.14 km (the segment within the transport

zone of the current landslide). The pullback was completed so as to allow only walking and mountain bike access with a small 0.6 to 1 m wide trail. The District indicates that the likelihood of landslides and erosion has been substantially reduced by the road deactivation but residual hazards remain.

Imagery from the City online mapping shows that a turn-around area was constructed in the vicinity of the landslide initiation zone between 2012 and 2016. This imagery suggests that quarry material may have been pushed onto or over the top of slope to construct the turn-around area. The 2012 and 2016 imagery is shown on Figures 3 and 4, respectively.



Figure 3: The 2012 imagery with the red arrow showing the approximate location of the landslide headscarp.



Figure 4: The 2016 imagery showing approximate location of the initiation zone marked with a red arrow. The new turn around area extends to the north within the initiation zone.

3 SITE RECONNAISSANCE OBSERVATIONS

A site reconnaissance was conducted by Jim McDonald, M.Sc., P.Eng, P.Geo. of WSP and was accompanied by Kyle St. Amour and James MacDonald representing the City on February 20, 2017. Jim McDonald also conducted site visits on February 21 and 24, 2017 to review the construction of the protective berm. The site reconnaissance included the following:

- Mapping the extent of the recent landslide;
- Reviewing the surrounding slopes for any recent instability;
- Assess if there is significant risk of an impact to the residence located at 43980 VMR or to Vedder Mountain Road from debris remaining within the initiation, transport and runout zones of the landslide. Based on the assessment, determine whether the house can be occupied and if there is a risk to VMR;
- Provide recommendations to reduce the hazard of subsequent landslides initiating from within and/or on the steep slopes below the rock quarry;
- Provide commentary for reconstruction, if required, and safety along the Vedder FSR (Vedder Mountain Railway Grade Trail) and additional mitigative measures for the residence located at 43980 VMR, if required.



Western Explosives Ltd. Rock Quarry – Landslide Initiation Zone

The slopes within the initiation zone or headscarp at GPS Waypoint (WP) 16, ranged between about 30 and 45 degrees (Note: all slope gradients are measured from the horizontal). The approximate margins of the landslide and WP's are shown on the attached Figure 2. A typical landslide profile is shown on Figure 5. Loose angular cobbles and boulders between about 0.2 and 1 m in diameter were observed at the toe of the initiation zone (see Photograph 1). The slope immediately below the headscarp averages 45 degrees for 8 m. The headscarp measured up to about 6 m high, 30 m wide and 15 m long (see Photograph 2). A greenish to grey fine grained metamorphic rock, possibly a partially metamorphosed volcanic rock was observed within the scarp. A 4 to 5 m high near vertical bedrock face was observed within the eastern portion of the scarp. The bedrock was moderately fractured and jointing was oriented perpendicular to the slope (Photograph 3). The jointing orientation could not be measured due to the steep bedrock face within the eastern portion of the headscarp.

A narrow old road/trail, up to about 3 m wide, was observed at WP. 15 near the toe of the initiation zone (Photograph 4). No fill slope failures were observed along the old road/trail immediately west of the headscarp. The east portion of the old road could not be accessed.

Based on our discussion with Brian Kirkness of Western Explosives Ltd., up to about a 3 m high berm of blast rock was placed at the top of slope and extended into the quarry (south) about 10 m (Photograph 5). The landslide initiated immediately after blasting was conducted on the south side of the berm. We understand that the 3 m high berm was removed after the landslide occurred on February 18.

During our review of the northwestern portion of the quarry, WSP observed an approximate 100 m long segment of perched fill along the top of slope, shown on Figure 2. The perched fill is comprised of loose angular cobbles and boulders, trees, stumps and overburden material comprised of various amounts of sand and silt (see Photographs 6 and 7). The gradients of the fill slopes ranged between about 30 and 45 degrees for about 5 to 10 m. The native slope gradients below the perched fill slopes ranged between about 35 and 45 degrees for at least 30 m. Buried trees and stumps were observed supporting the fill slopes at several locations along this portion of the top of slope.

Landslide Transport Zone

Immediately below the initiation zone, the slope failure formed a debris avalanche that was up to about 40 m wide. The slopes range between about 35 and 60 degrees for about 80 m to the Vedder FSR. The Vedder FSR at WP. 8 was destroyed within the debris avalanche path (Photograph 8). The FSR was noted at the east and west ends of the debris avalanche path. The FSR was up to about 2 m wide and overgrown with alder that was less than 10 years old. No slope instability was observed along the FSR immediately east and west of the debris avalanche path.

The gradients below the FSR ranged between about 30 and 35 degrees for about 85 m to WP. 7 then flatten to about 20 degrees for approximately 50 m to WP. 6. Loose angular cobbles and boulders were observed on the slopes below the FSR for about 30 m (Photograph 9). Debris levees up to about 2 m high were observed within this portion of the transport zone. Scour between about 1 and 2 m deep was also observed.



A large debris lobe up to about 1.5 m high, 12 m wide and 8 m long was observed near WP. 7 (Photograph 10). A majority of the debris was deposited on the 20 degree slope.

From WP. 6 to WP. 12 the slopes steepen and average about 35 degrees for 200 m. Downslope of WP. 6, the landslide becomes channelized into a debris flow within a shallow swale up to 1 to 2 m deep (Photograph 11). Debris levees up to about 1 m high were observed within this section. The debris flow path ranged between 5 and 15 m wide and surface water flow was also observed within this portion of the path. The path was scoured down to bedrock in portions of the debris flow.

Landslide Termination Zone

Between WP. 12 and WP. 4 (termination zone) the debris flow enters a 6 to 10 m deep gully with sidewall gradients that average 45 degrees. The gradient of the gully averages 50 degrees for about 30 m. A log jam with cobbles and various amounts of sand and silt were observed adjacent to a mature cedar tree. The debris jam was approximately 3 m high, 4 m wide and 4 m long (Photograph 12). A shallow gully, about 2 to 3 m deep, containing an unnamed watercourse is located about 10 to 30 m east of the debris avalanche path between WP. 9 and WP. 4. The watercourse is up to about 0.6 m wide with minimal alluvial bed observed. This watercourse flows into the gully near WP. 4. An old debris lobe about 1 m high and 5 m wide from an old debris flows was observed near WP. 9.

The slopes below the termination zone ranged between about 15 and 20 degrees for about 35 m to WP. 13. An existing berm about 1 m high and 1.5 m wide was observed at WP. 13 and extended from the west gully sidewall to the east side (Photograph 13). A berm and ditch extend beyond the east side of the mouth of the gully and diverts stream flow further east into the property located at 44100 VMR and into the ditch along the south side of VMR.

Berm Construction and Site Conditions upslope of 43980 VMR

The new protective berm at the site was constructed over the existing berm to a height of about 3 m above the existing watercourse on the upstream side, about 1.5 m wide along the crest and approximately 15 m long (east of the west gully sidewall). The berm was constructed with 75 to 150 mm minus crushed rock and armoured with angular boulders up to about 1 m diameter on the upstream side (Photographs 14 and 15). The upstream side of the berm was sloped at approximately 1H:1V and the downstream side was sloped at about 1.2H:1V to 1.3H:1V. The berm is situated on a gently sloping bench with gradients ranging between 10 and 15 degrees for about 30 m downslope toward the residence. A ditch up to about 1 m deep and 1 m wide diverts flows from immediately upstream of the berm to the east and into 44100 VMR (Photograph 16). The ditch is not lined with rock and is comprised of native silty sand material.

WSP also reviewed the slopes immediately upslope of the residence at 43980 VMR to the west of the gully. Two old debris lobes/levees from previous debris flows were observed at WP. 2 and WP. 3 and measured between 0.7 and 1.2 m high (Photographs 17 and 18). The debris lobe at WP. 2 was situated on gradients ranging between 15 and 22 degrees for about 50 m that extended to within about 15 m upslope of the residence. The debris lobes/levees were comprised of boulders and cobbles and based on the ages of the adjacent trees they were estimated to be about 30 to 40 years old.



An old landslide, about 20 years old, was also observed about 100 m east of the residence. The initiation zone was about 15 m wide, 30 m long and 1 m high and initiated on a 40 degree slope. The runout extended about 130 m downslope to VMR. Debris levees and scarred trees were observed on the slopes below this landslide (Photograph 19).

The south side of the residence was setback about 3 m from the toe of the cut slope (Photograph 20). The cut slope gradients immediately south of the residence ranged between about 45 and 50 degrees for up to 4 m. The cut slope is between approximately 2.5 and 3 m high and comprised of sand and angular gravel and some silt (alluvial deposits). The slopes above this cut slope ranged between 5 and 15 degrees for about 10 m then the gradients steepen to about 30 degrees for up to 50 m. The concrete foundation wall is approximately 300 to 400 mm above surrounding grades.

4 CONCLUSIONS AND RECOMMENDATIONS

1. Potential Causes of the Landslide and Risk Mitigation

Based on observations made at the initiation zone within the rock quarry, the following factors likely contributed to the landslide on February 18, 2017:

- A material stock pile up to about 3 m high comprised of blast rock and boulders was placed along the top of slope within the northwest portion of the Western Explosives Ltd. rock quarry. Blast material was perched along the top of slope similar to that observed for about 100 m to the east of the headscarp. The City online historic imagery shows that a possible turn-around area was constructed in the vicinity of the initiation zone between 2012 and 2016;
- An old road/trail is located below the top of slope and may have failed due to perched fill on this trail;
- Based on our observations, a bedrock failure likely occurred within the initiation zone. The bedrock was moderately fractured and appears to have failed along some of these fractures and joints;
- Above average rainfall and snowfall preceded the landslide event within the previous three weeks; and
- Based on our discussion with the City and Western Explosives Ltd., blasting was conducted immediately prior to landslide initiation.

Overloading the top of slope with blast rock material while blasting was taking place about 10 m to the south were likely the main contributing factors.

To mitigate the risk of future landslides occurring and the re-initiation of material within the existing landslide initiation and transport zones, WSP recommends the following:



- Western Explosives Ltd. should safely pulled back any residual loose blast rock or fractured bedrock within and immediately below the landslide headscarp. Loose rock immediately below the scarp could be a rock fall hazard downslope;
- Perched fill located along the top of slope east of the landslide headscarp, area shown on Figure 2, should be pulled back to minimize the likelihood of a fill slope failure. Detailed recommendations for pull back of material should be provided by a qualified geotechnical engineer. Work should be conducted under the full time review of a geotechnical engineer;
- A geotechnical engineer should review the old road/trail, shown on Figure 2, that is located below the top of slope beyond the north side of the quarry and determine if any deactivation or drainage improvements are required; and
- Blasting should not be conducted adjacent to the top of slope until the perched fill slope and residual loose blast rock has been removed. The geotechnical engineer should also provide recommendations for stockpile setback from the top of slope. The actual blasting setback distance should be determined by a geotechnical engineer.

2. Vedder FSR

We understand that the Vedder FSR was permanently deactivated in 2009. However, if the City or Chilliwack Forest District proposes to reconstruct the road for a future trail or FSR, they should engage a geotechnical engineer to provide recommendations for reconstruction of the trail and conduct a hazard assessment to determine if there are any upslope hazards that could put road or trail users at risk.

3. Private Property at 43920, 43980 and 44100 Vedder Mountain Road

Based on our site reconnaissance and background information WSP recommends the following for the properties downslope of the landslide:

- The protective berm built upslope of the residence at 43980 VMR is considered suitable for use as a protective berm for mitigating future debris flows contained in the gully as well as residual material from the existing landslide. However debris may not be contained within the existing 1 m deep ditch east of the protection berm and could flow onto the access road and then onto VMR.
- We understand that Western Explosives Ltd. owns the property to the east at 44100 VMR and access to construct the new berm was made available via 44100 VMR. However based on the Chilliwack Webmap and discussions with the City, the berm appears to be located partially or entirely on 43920 VMR which we understand is not owned by Western Explosives Ltd. It should also be noted that 43920 is within the jurisdiction of the FVRD. WSP recommends that a legal survey be conducted by a BC Land Surveyor to determine the location of the protective berm. In addition, a covenant should be signed by the owner of 43920 VMR to allow access to the berm for periodic maintenance. The berm should remain in place during the life of the residence at 43980 VMR.



- It should also be noted that the berm will deflect debris flows and debris floods towards 44100 VMR. The new protective berm and the past debris flow event that occurred in 1999 adversely affect future development of this lot. The owner of 44100 VMR should understand that this property may not be developable and will require a detailed geotechnical hazard assessment to determine if it can be developed in the future.
- Several old debris flow levees and lobes were observed upslope of the residence at 43980 VMR on the west side of the gully and debris flows have occurred about 100 m to the east and west of the residence. In addition, the concrete foundation wall for the residence is only about 300 to 400 mm above surrounding grade and is setback about 3 m from a 2.5 to 3 m high 50 degree cut slope. It is unknown if a scour pad was constructed around the foundations of this residence as recommended by Geomedia. WSP recommends that a qualified geotechnical engineer with experience in terrain and slope assessment conduct a geotechnical hazard assessment to determine if any additional mitigative measures are required to reduce the risk of landslides impacting the house from potential landslides on the slopes west of the protective berm.

5 CLOSURE

This geotechnical assessment report has been prepared by WSP Canada Inc. exclusively for the City of Chilliwack and their appointed agents. The opinions and recommendations provided in this report reflect our judgement in light of the information provided to us at the time that it was prepared.

Any use of this report by third parties, or any reliance on or decisions made based on it, are the responsibility of such third parties. WSP does not accept responsibility for damages suffered, if any, by a third party as a result of their use of or reliance on this report.

The attached Terms of Reference are an integral part of this geotechnical assessment report.



We trust the information provided in this report meets with your immediate requirements. If you have any questions or require further information, please contact the undersigned.

WSP Canada Inc.



Per: Jim McDonald, M.Sc., P.Eng., P.Geo.
Geotechnical Engineer

Reviewed by:

Calum Buchan, P.Eng., P.E.
Senior Geotechnical Engineer

Attachments: Terms of Reference
Figure 1 – Site Location Plan
Figure 2 – Landslide Site Plan
Figure 5 – Landslide Profile
Photographs 1 to 20

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The terms of reference for geotechnical reports issued by WSP (the "Terms of Reference") contained in the present document provide additional information and caution related to standard of care and the use of the Report. The Client should read and familiarize itself with these Terms of Reference.

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All documents, records, drawings, correspondence, data, files and deliverables, whether hard copy, electronic or otherwise, generated as part of the services for the Client are inherent components of the Report and, collectively, form the instruments of professional services (the "Instruments of Professional Services"). The Report is of a summary nature and is not intended to stand alone without reference to the instructions given to WSP by the Client, the communications between WSP and the Client, and to any other reports, writings, proposals or documents prepared by WSP for the Client relative to the specific site described in the Report, all of which constitute the Report.

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3. BASIS OF THE REPORT

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TERMS OF REFERENCE FOR GEOTECHNICAL REPORTS ISSUED BY WSP CANADA INC. (continued)

5. INTERPRETATION OF THE REPORT

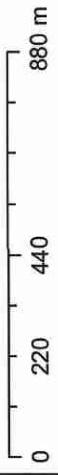
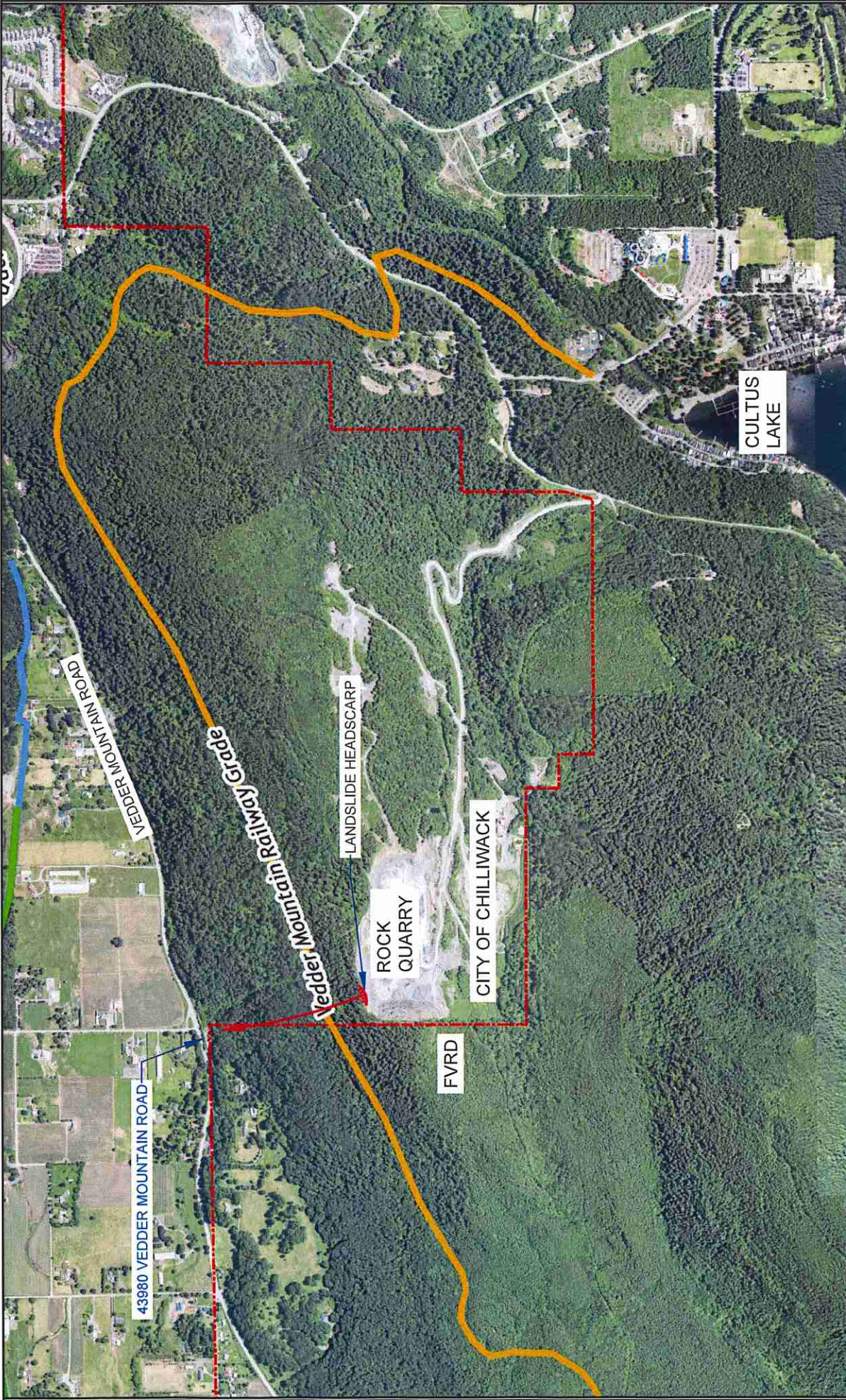
- a. **Nature and Exactness of Descriptions:** The classification and identification of soils, rocks and geological units, as well as engineering assessments and estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1 above. The classification and identification of these items are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations or assessments utilizing the standards of Paragraph 1 involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to changes over time and the parties making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or when the Client has special considerations or requirements, the Client must disclose them to WSP so that additional or special investigations may be undertaken, which would not otherwise be within the scope of investigations made by WSP or the purposes of the Report.
- b. **Reliance on information:** The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site investigation and field review and on the basis of information provided to WSP. WSP has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, WSP cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.
- c. **Additional Involvement by WSP:** To avoid misunderstandings, WSP should be retained to assist other professionals to explain relevant engineering findings and to review the geotechnical aspects of the plans, drawings and specifications of other professionals relative to the engineering issues pertaining to the geotechnical consulting services provided by WSP. To ensure compliance and consistency with the applicable building codes, legislation, regulations, guidelines and generally-accepted practices, WSP should also be retained to provide field review services during the performance of any related work. Where applicable, it is understood that such field review services must meet or exceed the minimum necessary requirements to ascertain that the work being carried out is in general conformity with the recommendations made by WSP. Any reduction from the level of services recommended by WSP will result in WSP providing qualified opinions regarding adequacy of the work.

6. ALTERNATE REPORT FORMAT

When WSP submits both electronic and hard copy versions of the Instruments of Professional Services, the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding upon WSP. The hard copy versions submitted by WSP shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancy, the hard copy versions shall govern over the electronic versions; furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed and sealed versions of the Instruments of Professional Services maintained or retained, or both, by WSP shall be deemed to be the overall originals for the Project.

The Client agrees that the electronic file and hard copy versions of Instruments of Professional Services shall not, under any circumstances, no matter who owns or uses them, be altered by any party except WSP. The Client warrants that the Instruments of Professional Services will be used only and exactly as submitted by WSP.

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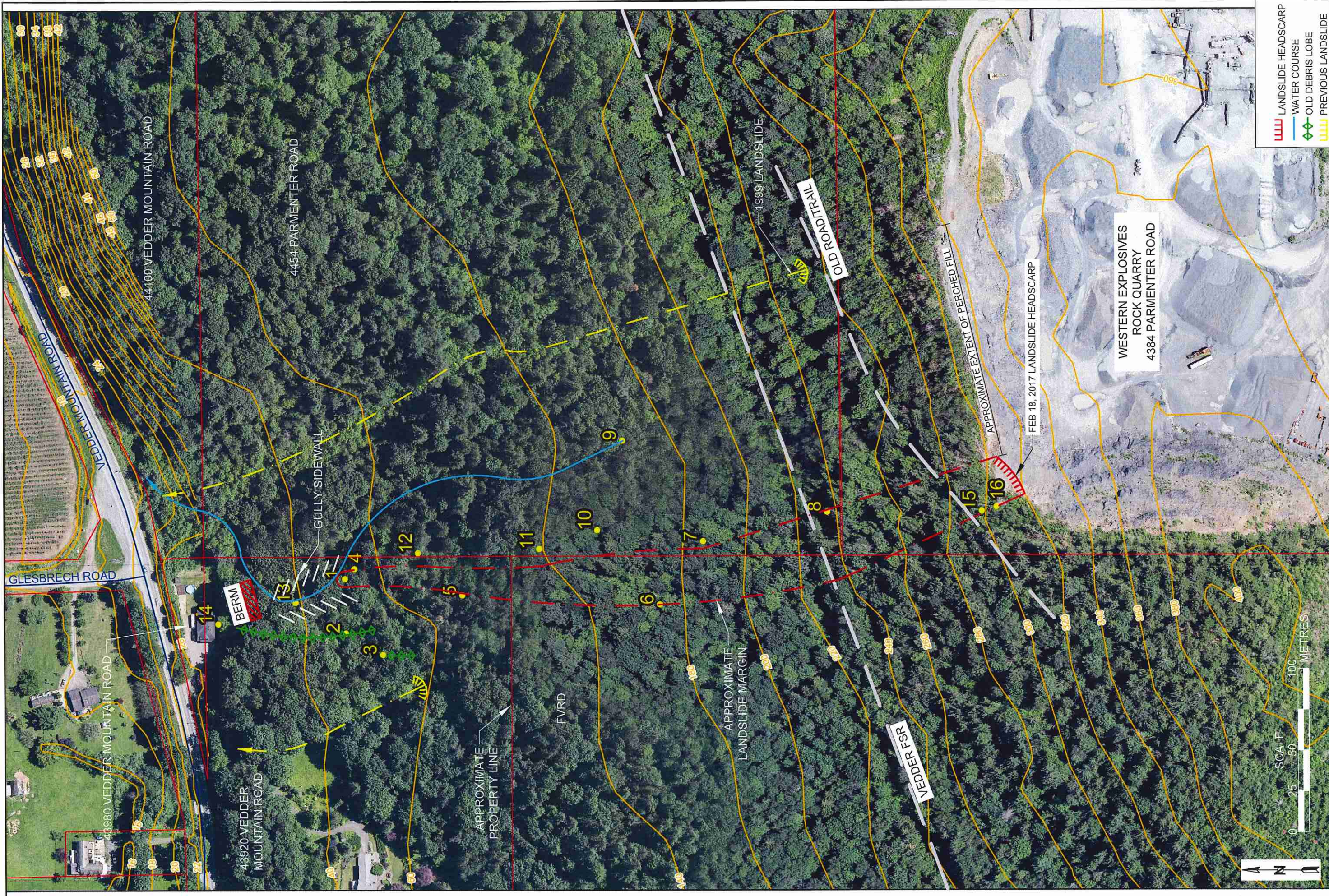


Data accuracy not guaranteed

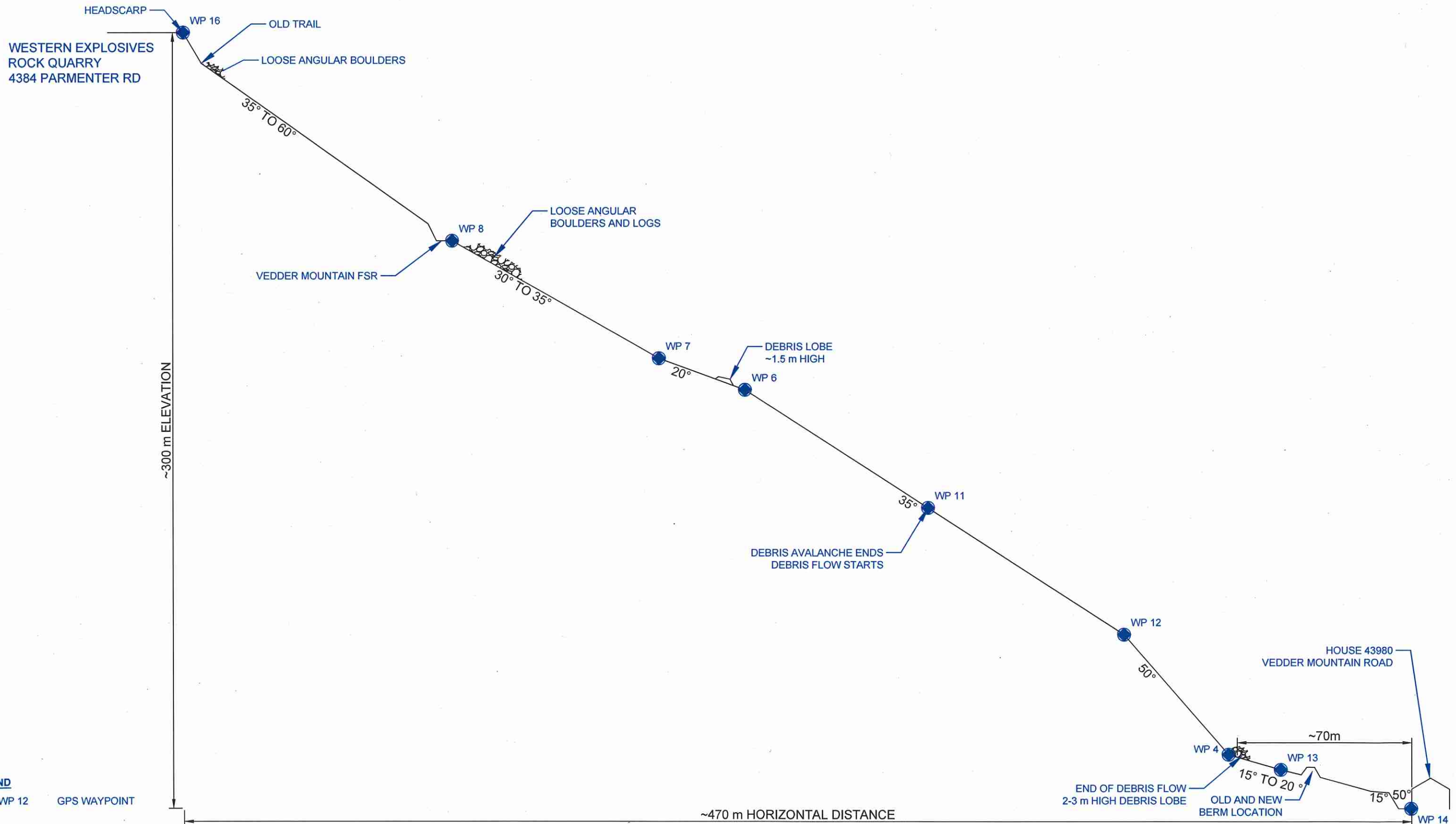
REV	Date	Issue/Revision Description	Drawn	Check

ADAPTED FROM: CHILLIWACK WEBMAP	TITLE: SITE LOCATION PLAN
PROJECTING NO: N/A	PROJECT: VEDDER MOUNTAIN LANDSLIDE
DATE: FEBRUARY 2017	ADDRESS: 43980 VEDDER MOUNTAIN ROAD, CHILLIWACK, BC
<small>This drawing is the sole property of WSP Canada and shall remain confidential. It is to be used only for the project and site for which it was prepared. It is not to be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or by any information storage and retrieval system, without the prior written permission of WSP Canada Inc.</small>	
DATE: FEBRUARY 2017	CLIENT: CITY OF CHILLIWACK
CHECK: JM	SCALE: NTS
DRAWN: TP	FILE NO: 171-02203-00
PERSON: N/A	

SEAL:	1



REV	Date	Description	Drawn	Checked
ADAPTED FROM: CHILLIWACK WEBMAP PROJECT/DRAWING NO: N/A DATE: FEBRUARY 2017 <small>This drawing is for informational purposes only. It is not a contract. It is subject to the terms and conditions of the contract. All dimensions and quantities are approximate. WSP is not responsible for any errors or omissions. All dimensions and quantities are approximate. WSP is not responsible for any errors or omissions.</small>				
TITLE: LANDSLIDE SITE PLAN PROJECT: VEDDER MOUNTAIN LANDSLIDE ADDRESS: 43980 VEDDER MOUNTAIN ROAD, CHILLIWACK, BC CLIENT: CITY OF CHILLIWACK				
DESIGN: N/A DATE: FEBRUARY 2017 CHECK: JM SCALE: NTS DRAWN: TP FILE NO: 171-02203-00 PLOT NO: 2				
				SEAL



LEGEND
 ● WP 12 GPS WAYPOINT

REV	Date	Issue/Revision Description	Drawn	Check

ADAPTED FROM: N/A
 PROJECT/DWG. NO: N/A
 DATE: N/A
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TITLE: **LANDSLIDE PROFILE**
 PROJECT: VEDDER MOUNTAIN LANDSLIDE
 ADDRESS: 43980 VEDDER MOUNTAIN ROAD, CHILLIWACK, BC
 CLIENT: CITY OF CHILLIWACK

SEAL:



DESIGN: N/A DATE: FEBRUARY 2017
 CHECK: JM SCALE: NTS
 DRAWN: TP FILE NO: 171-02203-00
 FIG. NO: **5**



Photograph 1. – Loose cobbles and boulders immediately below initiation zone.



Photograph 2. – Initiation Zone viewed toward the west.



Photograph 3. – Initiation zone viewed to the east. Note the fractured bedrock.



Photograph 4. – A 2 to 3 m wide old road/trail located immediately below the initiation zone. Viewed to the west of the landslide.



Photograph 5. – Approximate blasting area location shown with a green arrow and the landslide initiation zone shown with a red arrow.



Photograph 6. – Perched fill along top of north slope of quarry viewed to the west.



Photograph 7. – Perched fill along top of north slope of quarry viewed toward the east.



Photograph 8. – Location of Vedder FSR impacted by debris avalanche.



Photograph 9. – Loose cobbles and boulders downslope of Vedder FSR.



Photograph 10. – Debris lobe on 20 degree slope in partial deposition zone.



Photograph 11. – Debris flow confined in shallow swale near WP. 5.



Photograph 12. – Debris lobe at termination of debris flow in gully.



Photograph 13. – Existing berm built prior to debris flow with diversion ditch conveying flows towards 44100 VMR to east.



Photograph 14. – Protective berm viewed to the west.



Photograph 15. – Protective berm viewed to the east.



Photograph 16. – Ditch east of protective berm.



Photograph 17. – Debris levee (on right side of photograph) about 30 m upslope of residence between WP. 2 and WP. 14.



Photograph 18. – Debris lobe observed near WP. 3 with impacted tree on right side of photograph.



Photograph 19. – Debris levee along east side of debris flow observed at 43920 VMR about 100 west of residence.



Photograph 20. – Approximate 3 m high slope immediately upslope of residence. Approximate 400 mm high concrete foundation wall along south side of residence.