

MEMORANDUM

To: Tim Aucott, P.Eng.
City of Port Moody

Date: May 22, 2020

From: Christopher Clarke, P.Eng.
(Reviewed by David Tara, P.Eng.)

File: 28256

**SLOPE STABILITY ASSESSMENT NEAR WASHINGTON DRIVE
AND PRINCETON AVENUE
PORT MOODY, BC
DRAFT**

Further to your request, Thurber completed a review of the known slope instability located about 120 m northwest of the intersection of Washington Drive and Princeton Avenue. This memorandum presents our geotechnical observations of the slope conditions, provides our recommendations for slope repair and provides a high level Type D cost estimate.

It is a condition of this memo that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

1. INTRODUCTION AND SITE DESCRIPTION

The Site of the soil erosion is situated northwest of the intersection of Washington Drive and Princeton Avenue. We understand that the City of Port Moody has observed slope erosion at the Site for at least two years. The City provided photographs from April 2018, January 7, 2020 and February 3, 2020. The photographs show some erosion has occurred between April 2018 and January 7, 2020. Significant erosion occurred between January 7, 2020 and February 3, 2020, likely the result of heavy rainfall. In response to the City's request, a site reconnaissance was conducted on April 28, 2020 by Christopher Clarke, P.Eng. and Amy Russell, P.Eng. of Thurber.

A gravel path bounds the Site to the east (above) and west (below) as shown on Sketch 1. The Site is sparsely vegetated. The Site comprises beds of dense to very dense gray sand with a trace to some gravel and cobbles that are typically between 100 mm and 400 mm thick (Photos 1 to 3). The Site's predominate feature is a section of the slope that has eroded, resulting in an exposed, near vertical soil face that is between 4 m and 5 m high and about 4 m wide (Photo 2). The slopes to the north and south of this eroded section are sloped at 30° to 35° and show only minor signs of erosion and undercutting of the topsoil. Groundwater seepage was not observed.

The primary erosion is occurring directly beneath a local low point in the path above the Site. There is evidence that water has flowed from the path, which is consistent with observations made from the City. The eroded sand has outwashed to the west of the erosion above the lower path (Photo 4).



2. SURFICIAL GEOLOGY

Published surficial geology maps produced by the Geological Survey of Canada (New Westminster, Surficial Geology, Map 1484A) show the Site is located near the mapped boundary of Vashon Drift and Capilano Sediments and Pre-Vashion Deposits. The Vashon Drift and Capilano Sediments are mapped as glacial drift including; lodgement and minor flow till, lenses and interbeds of substratified glaciofluvial sand to gravel, and lenses and interbeds of glacio-lacustrine laminated stony silt. The Pre-Vashion Deposits are mapped as Quadra fluvial channel fill and floodplain deposits, crossbedded sand containing minor silt and gravel lenses and interbeds.

3. GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS

The dense to very dense sands on Site are strong but easily eroded by flowing water. The existing path configuration above the Site has a low point directly above the primary area of erosion (Photo 5). The surface water from the path accumulates at this low point and runs off the path towards the slope erosion. This surface water runoff would have originally caused erosion of the sloped ground. The erosion would eventually form a small over-steepened, near vertical slope. This near-vertical slope would cause the surface runoff to waterfall, resulting in further erosion and causing the near-vertical slope to become larger and to retrogress over time.

Groundwater seepage was not observed during our site reconnaissance. However, seepage may occur during the winter months or after heavy rainfalls. Quadra sands are susceptible to internal erosion from groundwater seepage.

The path above the Site generally slopes downhill from north to south (Photos 5 and 6), with the exception of the local low point that accumulates water. Redirecting surface runoff from the erosion site will greatly reduce the amount of erosion. We believe that this is feasible by re-grading the section of pathway that is east (above) and south of the erosion Site. The re-grading would require lowering the elevation of the path. Further, as shown on Sketch 2, reinstating the ditch on the east (uphill) side of the pathway would help collect runoff and direct it downhill alongside the path. The path should have a slight crossfall to promote water to run off into the ditch on the east rather than down the hillside to the west as the lower exposed soil slopes would be subject to similar erosion if water was directed over down the slope (Photo 7).

There is a poorly developed ditch on the east side of the path, approximately 15 m to 20 m south of the Site. This ditch parallels the path until it crosses beneath a second path in a PVC culvert, south of the Site (Photo 8). After crossing beneath the second path, the water would travel in another broad ditch towards the west. The ditch ends above a steep slope. There is a PVC pipe that appears to collect water from this ditch and transport it somewhere down the slope. The PVC pipe was infilled with material and it was not obvious where it discharged.

We recommend that the reinstated ditch above the Site be connected to the existing ditch described above. Further, we recommend that the existing, poorly developed ditch be deepened and cleared of some of the vegetation. We recommend that the City maintain the ditch regularly



so that it stays operational and does not fill with debris. Although we believe re-grading the path to be a geotechnical feasible solution to divert surface water away from the Site, we recommend that the City consult with a hydrologist to determine if the increase runoff in the ditch may cause instability of the steep slopes to the west of the Site.

Given the size of the over-steepened slope, erosion will likely continue during heavy rainfall even if surface water from the pathway is directed elsewhere. We recommend that the eroded portions of the slope be backfilled with a well graded, 150 mm minus granular product that will be more resistant to erosion. Prior to backfilling, we recommend that a non-woven geotextile be placed on the existing slope to reduce the likelihood of internal erosion of the native sands on Site (Sketch 3).

Portions of the hillside adjacent to the eroded sections will be susceptible to surface erosion if water is directed over the slope, particularly where vegetation is thin. It will be critical for re-grading of the path to not cause water to flow down slope of the path where it could erode new sections. Re-vegetating the slopes would also help reduce the erosion risk, although the sandy soil may make re-vegetating the slope challenging.

4. COST ESTIMATE

We have prepared a high level cost estimate to complete the re-grading of the path and backfilling the erosion Site. The cost estimate does not include any hydraulic consultation or survey which we expect will be required. We have included a nominal allowance for revegetation. This will need to be confirmed.

Table 1: High Level Type D Cost Estimate for Path Re-Grading

Task	Quantity	Estimated Unit Cost	Cost
Mob/Demob	LS	\$12,000	\$12,000
Type D Excavation	150 cubic metres	\$35	\$5,250
Surfacing Gravel	50 cubic metres	\$70	\$3,500
Ditching	LS	\$2,500	\$2,500
Contingency (20%)			\$4,650
Estimated Total			\$27,900



Table 2: High Level Type D Cost Estimate Backfilling the Site

Task	Quantity	Estimated Unit Cost	Cost
Mob/Demob	LS	\$12,000	\$12,000
150 mm minus Well-Graded Granular Fill	200 cubic metres	\$70	\$14,000
Non-woven Geotextile	50 square metres	\$20	\$1,000
Revegetation of Slope	LS	\$2,500	\$2,500
Contingency (20%)			\$5,900
Estimated Total			\$35,400

5. CLOSURE

We trust that this information is sufficient for your needs. Should you require clarification of any item or additional information, please contact us at your convenience.

Attachments: Statement of Limitations and Conditions
 Site Photos (Photos 1 to 8)
 Sketches 1-3

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will 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 the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those 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. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.



Photo 1: Looking east from the base of the eroded slope.



Photo 2: Looking at eroded slope with person for scale.



Photo 3: Bedding and crossbeds of sand.



Photo 4: Looking down from the top of the eroded slope.



Photo 5: Looking south along pathway at top of eroded slope.



Photo 6: Looking north along pathway at top of eroded slope.



Photo 7: Exposed soil slopes adjacent to primary erosion area. These would be susceptible to similar erosion if surface water is directed over the slopes.



Photo 8: Ditch on the uphill side of the pathway that is above the erosion site. Note the PVC culvert crossing the other trail in an east-west direction.



Sketch 1

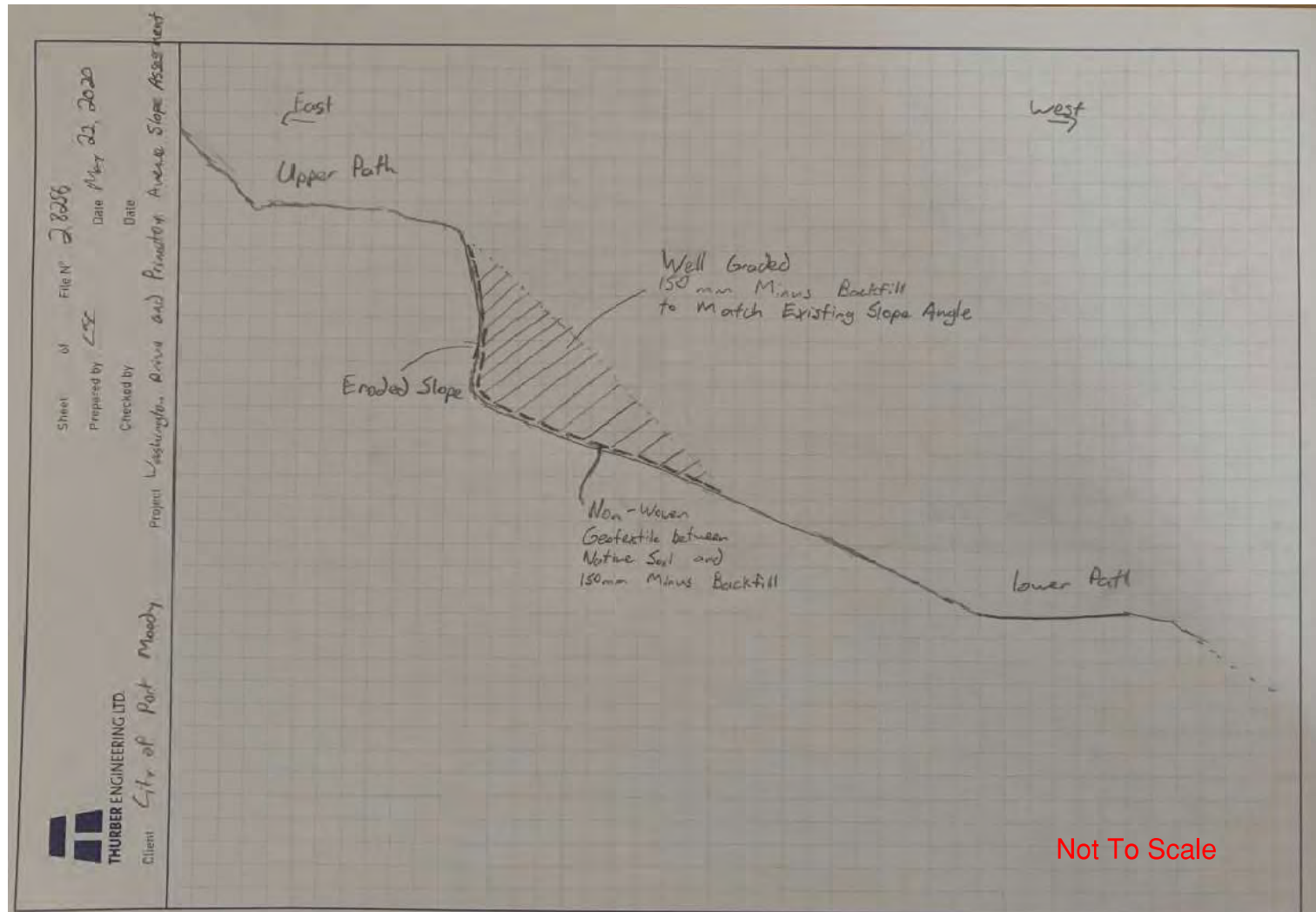
Reinstate ditch which is overgrown or filled in.

Current local low point along pathway which collects water that flows across the path causing further erosion



Re-grade pathway so the pathway slopes to the south. Currently a portion of the pathway slopes gently north, south of the erosion site,

Sketch 2



Sketch 3