

MEMORANDUM

To: Serge Fjetland
District of Sechelt

Date: October 18, 2016

From: Caleb Scott, E.I.T.
(Reviewed by David Tara, P.Eng.)

File: 14-214-4

REVIEW OF AUGUST 22, 2016 PIPE INSPECTION REPORTS THE SHORES - PHASE 1 DEVELOPMENT, SECHULT, B.C.

This memorandum provides our review of the August 22, 2016 pipe camera inspection reports completed by ABC Pipe Cleaning Services Ltd. (ABC Pipe Cleaning) at The Shores – Phase 1 Development and our comments and recommendations regarding next steps.

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

1. BACKGROUND

As you know, Thurber Engineering Ltd. (Thurber) prepared a report titled "The Shores – Phase 1 Subdivision Sinkhole Investigation and Geotechnical Assessment" dated July 16, 2015 (2015 Report). Since that time, Thurber has completed a limited number of site reviews and has reviewed site inspection reports completed by District of Sechelt (District) personnel. Comments and recommendations were also provided in our memorandum dated July 12, 2016.

In our most recent site review report, dated August 8, 2016, Thurber recommended that the District consider completing camera inspections of the sanitary and storm sewer lines on Gale Avenue North to inspect for signs of deformation and damage in an area adjacent to Lot 9 which had recently experienced settlement and localized asphalt collapse.

On August 22, 2016, ABC Pipe Cleaning completed video camera inspections of portions of the network of storm sewer, sanitary sewer and drainage pipes along Gale Avenue North adjacent to Lot 2 through Lot 12, totalling 715 m in length. ABC Pipe Cleaning recorded its observations, including still images captured from the inspection videos, in 25 numbered inspection reports. These camera inspection reports were provided to Thurber on October 5, 2016 for our review. However, the video footage was not provided to Thurber.

2. REVIEW COMMENTS

Thurber reviewed the provided camera inspection reports to identify observations and photographs interpreted to have geotechnical significance. Our comments are provided below. The camera inspection reports describe the locations of the inspected pipes with reference to manhole (MH) numbers. Thurber referred to the as-built drawings of Web Engineering Ltd.



dated November 27, 2013 in interpreting the pipe inspection locations. Our comments have been organized to group reports regarding similar pipes.

Report No.1 – 250 mm PVC Storm Sewer from MH 16 to MH 15

No observations or photographs were provided of geotechnical significance.

Report No.2 – 250 mm PVC Storm Sewer from MH 15 to MH 14

No observations or photographs were provided of geotechnical significance.

Report No.3 – 250 mm PVC Storm Sewer from MH 14 to MH 13

No observations or photographs were provided of geotechnical significance.

Report No.4 – 250 mm PVC Storm Sewer from MH 13 to MH 11

ABC Pipe Cleaning observed that the pipe cross section was deformed 10% at a distance of 7.6 m downstream from MH 13 (adjacent to Lot 7). Deformed pipe sections may indicate areas where the soils surrounding the pipe have settled due to the erosion of subsurface soils.

Report No.9 – 250 mm PVC Storm Sewer from MH 11 to MH 9

No observations or photographs were provided of geotechnical significance.

Report No.12 – 375 mm PVC Storm Sewer from MH 10 to MH 11

ABC Pipe Cleaning observed that a pipe joint was moderately separated at a distance of 1.4 m downstream from MH 10 (adjacent to Lot 20). Separated pipe joints may indicate areas where the soils surrounding the pipe have settled by different amounts (differential settlement) due to the erosion of subsurface soils.

Report No.13 – 450 mm PVC Storm Sewer from MH 11 to MH 12

This pipe is located within the Right of Way between Lot 9 and Lot 10. ABC Pipe Cleaning observed that a pipe joint was largely angular at the pipe invert at a distance of 7.9 m downstream from MH 11. Angular pipe joints at the invert may indicate areas where the soils surrounding the pipe have settled due to the erosion of subsurface soils.

This camera survey was not completed during the first attempt. The survey was later completed as described in Report 24.



Report No.24 – 450 mm PVC Storm Sewer from MH 11 to MH 12

No observations or photographs were provided of geotechnical significance, other than those discussed in Report No. 13.

Report No. 25 – 450 mm Corrugated Metal Storm Sewer from MH 12 to MH 4A

ABC Pipe Cleaning observed that the pipe wall was buckling at a distance of 2.4 m downstream (North) from MH 12, within the Right of Way between Lot 9 and Lot 10. Damage to this general section of the storm sewer was reported by ABC Pipe Cleaning during a previous inspection on March 19, 2015 (described in our 2015 Report). Without video footage for comparison, it is unclear if the pipe condition has changed.

Report No.10 – 300 mm Perforated PVC Groundwater Drain entering Storm MH 10 from West

ABC Pipe Cleaning observed deposits of fine sediment and gravel within this perforated drain pipe adjacent to Lot 20, filling 5% to 20% of the pipe cross sectional area. The photographs provided show clumps of sediment clinging to the pipe wall above the current level of deposited sediment, suggesting that at times the pipe may contain more sediment than at present. A large clump of built up sediment obstructed the completion of the camera survey which was abandoned at a distance of 16 m west of MH 10 (near the west edge of Lot 20).

From utility drawings and construction records available to Thurber, we interpret this perforated drain pipe to be installed near the base of the road embankment for the purpose of intercepting groundwater, which was observed as significant seepage in excavations in this area during construction. The presence of significant quantities of fine sediment (interpreted as sand and silt sized) within the perforated pipe suggests that this pipe provides a pathway for the episodic erosion of subsurface soils, consistent with the findings of our 2015 Report. Gravel particles larger than the perforations may have entered during installation of the pipe or may indicate an unidentified break in the pipe beyond the sediment obstruction.

Report No.11 – 300 mm Perforated PVC Groundwater Drain entering Storm MH 10 from East

ABC Pipe Cleaning observed deposits of fine sediment within this perforated drain pipe adjacent to Lot 21, filling up to 5 % of the pipe cross sectional area. The photographs provided show clumps of sediment clinging to the pipe wall above the current level of deposited sediment, suggesting that at times the pipe may contain more sediment than at present. The photograph taken at a distance of 16.3 m upstream (East) from MH 10 clearly shows the process of sediment entering the pipe through the perforations.

Moderately separated joints were observed at distances of 19.6 and 23.6 m from MH 10. Separated pipe joints may indicate areas where the soils surrounding the pipe have settled by different amounts (differential settlement) due to the erosion of subsurface soils.



The inspection was terminated at a cap in the pipe at a distance of 27.9 m upstream (east) of MH 10, adjacent to the Lot 21/22 property line. However, the as-built drawings show this pipe continuing as far as Lot 24. Groundwater infiltration was observed by ABC Pipe Cleaning at the end cap.

From utility drawings and construction records available to Thurber, we interpret this perforated drain pipe to be installed near the base of the road embankment for the purpose of intercepting groundwater, which was observed as significant seepage in excavations in this area during construction. The presence of significant quantities of fine sediment (interpreted as sand and silt sized particles) within the perforated pipe suggests that this pipe provides a pathway for the episodic erosion of subsurface soils, consistent with the findings of our 2015 Report.

Report No.21 – 150 mm Perforated PVC Wall Toe Drain from Cleanout Adjacent to Lot 26

ABC Pipe Cleaning observed deposits of fine sediment within this perforated drain pipe at the toe of the rock stack retaining wall adjacent to Lot 25 and Lot 26, filling up to 5 % of the pipe cross sectional area. The photographs provided show clumps of sediment clinging to the pipe wall above the current level of deposited sediment, suggesting that at times the pipe may contain more sediment than at present.

Moderately and largely separated joints were observed at distances of 21.7 m, 25.1 m, 27.7 m and 30.7 m from the cleanout adjacent to Lot 26. Separated pipe joints may indicate areas where the soils surrounding the pipe have settled by different amounts (differential settlement) due to the erosion of subsurface soils.

In this area the constructed road embankment is not as thick as in other areas of the site. From utility drawings and construction records available to Thurber, we interpret this perforated drain pipe to be installed near the base of the wall and road excavation. The presence of significant quantities of fine sediment (interpreted as sand and silt sized particles) within the perforated pipe suggests that this pipe provides a pathway for the episodic erosion of subsurface soils, consistent with the findings of our 2015 Report.

Report No.22 – 150 mm Perforated PVC Wall Toe Drain from Cleanout Adjacent to Lot 24

ABC Pipe Cleaning observed deposits of fine sediment within this perforated drain pipe at the toe of the rock stack retaining wall adjacent to Lot 24, filling up to 15% of the pipe cross sectional area. The survey was abandoned prior to completion due to obstructing sediment in the pipe, at a distance of 19.4 m west from the cleanout adjacent to Lot 24.

In this area the constructed road embankment is not as thick as in other areas of the site. From utility drawings and construction records available to Thurber, we interpret this perforated drain pipe to be installed near the base of the wall and road excavation. The presence of significant quantities of fine sediment (interpreted as sand and silt sized particles) within the perforated



pipe suggests that this pipe provides a pathway for the episodic erosion of subsurface soils, consistent with the findings of our 2015 Report.

Report No.23 – 150 mm Perforated PVC Wall Toe Drain from Cleanout Adjacent to Lot 23

ABC Pipe Cleaning observed deposits of fine sediment within this perforated drain pipe at the toe of the rock stack retaining wall adjacent to Lot 23 and Lot 22, filling up to 15% of the pipe cross sectional area. The survey was abandoned prior to completion due to obstructing sediment in the pipe, at a distance of 27.2 m west from the cleanout adjacent Lot 23.

ABC Pipe Cleaning observed that the pipe cross section was deformed 12.7% at a distance of 21.5 m downstream (west) from the cleanout adjacent to Lot 23. Deformed pipe sections may indicate areas where the soils surrounding the pipe have settled due to the erosion of subsurface soils.

From utility drawings and construction records available to Thurber, we interpret this perforated drain pipe to be installed near the base of the wall and road excavation. The presence of significant quantities of fine sediment (interpreted as sand and silt sized particles) within the perforated pipe suggests that this pipe provides a pathway for the episodic erosion of subsurface soils, consistent with the findings of our 2015 Report.

Report No.5 – 200 mm PVC Sanitary Sewer from MH 12 to MH 11

No observations or photographs were provided of geotechnical significance.

Report No.6 – 200 mm PVC Sanitary Sewer from MH 11 to MH 10

No observations or photographs were provided of geotechnical significance.

Report No.7 – 200 mm PVC Sanitary Sewer from MH 10 to MH 9

No observations or photographs were provided of geotechnical significance.

Report No.8 – 200 mm PVC Sanitary Sewer from MH 9 to MH 8

ABC Pipe Cleaning observed that a pipe joint was moderately angular at the pipe invert at a distance of 18.1 m downstream from MH 9 (adjacent to Lot 7). Angular pipe joints at the invert may indicate areas where the soils surrounding the pipe have settled due to the erosion of subsurface soils.

ABC Pipe Cleaning observed that the pipe cross section was deformed 9.2% at a distance of 19.8 m downstream from MH 9 (adjacent to Lot 7). Deformed pipe sections may indicate areas where the soils surrounding the pipe have settled due to the erosion of subsurface soils.



Report No.14 – 200 mm PVC Storm Sewer from Catch Basin at Lot 20 to Mainline

No observations or photographs were provided of geotechnical significance.

Report No.15 – 200 mm PVC Storm Sewer from Second Catch Basin at Lot 20 to Mainline

No observations or photographs were provided of geotechnical significance.

Report No.16 – 200 mm PVC Storm Sewer from Catch Basin at Lot 11 to Mainline

No observations or photographs were provided of geotechnical significance.

Report No.17 – 200 mm PVC Storm Sewer from Catch Basin at Lot 3 to Mainline

No observations or photographs were provided of geotechnical significance.

Report No.18 – 200 mm PVC Storm Sewer from Catch Basin at Lot 7 to Mainline

No observations or photographs were provided of geotechnical significance.

Report No.19 – 200 mm PVC Storm Sewer from Catch Basin at Lot 23 to Mainline

No observations or photographs were provided of geotechnical significance.

Report No.20 – 200 mm PVC Storm Sewer from Catch Basin at Lot 25 to Mainline

No observations or photographs were provided of geotechnical significance.

Specific Area of Concern

On Gale Avenue North, in the vicinity of Lots 7, 8, 22, and 23, the pipe camera inspections identified a concentration of deformed pipe sections and joints as discussed above (Reports No. 4, 8 and 23). In this area, Thurber's 2015 Report also identified an interpreted loosened zone adjacent to Lot 8 (TH15-6) which appeared to be increasing in thickness and severity towards the east, beyond the limits of the 2015 investigation. Further, the 2015 geophysical survey results described in the 2015 Report identified a substantial anomaly in this area.

This area coincides with the approximate location of a large groundwater spring which was encountered in 2005 during excavation for Gale Avenue North and triggered a 20 m wide landslide, as described in construction period documents (2015 Report, Section 4.2). Surface settlement and sinkholes have not been observed in this area to our knowledge.



3. RECOMMENDATIONS

The observations contained in the pipe camera inspection reports, as well as during the site inspections conducted since issuing our 2015 Report, provide further evidence that erosion of subsurface soils continues to take place, even during periods of low or no precipitation and low groundwater levels. Based on this observation, there continues to be a significant potential for loss of ground that could result in the formation of additional sinkholes or damage to other infrastructure. Given that there continues to be loss of material and that there is often little or no warning of sinkhole formation, we strongly encourage the District to proceed with a comprehensive geotechnical investigation recommended in our 2015 Report.

In the interim, we recommend consideration be given to completing a targeted drilling investigation on Gale Avenue North adjacent to Lots 7, 8, 22 and 23 which we have identified as a specific area of concern. This portion of Gale Avenue North is important because it is the primary access to the occupied homes on Lots 7 and 8. The objective of this targeted investigation would be to provide data on the present integrity of the road embankment in this area to inform the District's ongoing risk management strategies for Gale Avenue North. The targeted investigation would be limited in scope and would not replace our recommendation for a comprehensive geotechnical investigation of the overall site as described in our 2015 Report.

In general, the pipe camera inspections were found to provide useful data on the current geotechnical conditions at the portions of the site inspected. We recommend consideration be given to completing camera inspections of all of the accessible utilities within the development on a regular basis (e.g. annually at a minimum) for review by District staff, Thurber, and the District's civil engineering consultant. Regular camera inspections should not be considered to replace regular surface inspections and the recommended comprehensive geotechnical investigation in our 2015 Report.

It is noted that the assessment of acceptable deformations, as it relates to the performance of utilities, is outside of Thurber's expertise. We recommend the District consider providing the reports to their civil engineering consultant for review.

We trust that this is sufficient for your present needs. Please contact us if you have any questions.

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.

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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.

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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.