THURBER ENGINEERING LTD.

Suite 900 – 1281 West Georgia Street
Vancouver, BC V6E 3J7
Phone: (604) 684-4384
Fax: (604) 684-5124

FIELD REVIEW REPORT NO.: 11680-017

THURBER FILE NO.: 11680

FIELD REVIEW REPORT	DATE: September 24, 2018
TO: District of Sechelt	ATTENTION: Sanath Bandara EMAIL: SBandara@sechelt.ca

PROJECT NAME: Sinkholes at The Shores Subdivision Sechelt, BC

CONTRACTOR(S): Concordia Homes Ltd.

PURPOSE OF SITE VISIT: Visually assess site status including development of a new sinkhole on Lot 6.

REFERENCE DRAWING / DOCUMENTS: See Thurber Engineering Ltd. reports dated April 5, 2013 and July 16, 2015

THURBER PERSONNEL ON SITE:	CLIENT/CONTRATOR PERSONNEL ON SITE:	TIME ON SITE:
David J. Tara (DJT)	Sanath Bandara (District of Sechelt) Adam Bullock (District of Sechelt)	From 12h10 to 13h45 WEATHER: Sunny.

BACKGROUND

1. In 2015, two sinkholes developed on Lots 9 and 21 and were first described in our report dated February 27, 2015. A limited scope drilling investigation was completed under Thurber's supervision in the areas surrounding those sinkholes as described in our July 2015 report.
2. In May of 2017, signs of potential sinkhole activity were reported on Gale Avenue North adjacent to Lots 7, 8, 22 and 23, and the District of Sechelt requested that Thurber conduct a limited scope investigation as described in our report dated June 30, 2017.
3. In a memorandum dated July 11, 2017, Thurber provided an assessment of current groundwater management issues and provided recommendations for proactive groundwater management measures to mitigate the ongoing formation of sinkholes at the site.
4. In May of 2018, renewed signs of potential sinkhole activity were reported on Gale Avenue North adjacent to Lots 7, 8, 22 and 23. In our memorandum dated June 15, 2018 Thurber recommended closure of this portion of Gale Avenue North pending groundwater control measures and sinkhole remediation.
5. The District is carrying out routine inspections and groundwater level monitoring at the site using a customized checklist developed by Thurber.
6. Unless specifically requested, Thurber does not conduct site visits or review the District's Site Monitoring Reports.
7. By way of email on September 19, 2018, the District advised Thurber that a new sinkhole had formed on private property on Lot 6. Photos included with the email show that the sinkhole is located close to the western property line near Lot 7, nominally upslope of the existing house. The District reported that the sinkhole opening was approximately 1.5 m in diameter. Photographs indicate the ground surface settled approximately 0.5 m. The District reported that loose ground conditions were encountered to approximately 3 m depth when the base of the sinkhole was probed with a metal rod.
8. The District installed yellow caution flagging along the edge of the Gale Avenue North right of way adjacent to Lot 6 and relocated the road closure traffic barriers approximately 20 m east (towards Crowston Road). Following a conference call with District personnel, it was agreed that Thurber would conduct a site visit.

ACTIVITIES/OBSERVATIONS:

9. Thurber's September 24 site visit was completed in conjunction with District personnel.
10. Gale Avenue North remains closed with concrete barriers in front of Lot 9 (6660 Gale Avenue North) and Lot 21 (6657 Gale Avenue North) and the plastic barriers had been moved 20 m further east adjacent to Lot 5.
11. Some additional cracking of Gale Avenue North was identified between Lots 9 and 21 and curb in front of the Lot 9 driveway appears to have sagged since our December 2017 visit. See Photos 1 and 2.
12. No significant changes in the asphalt patch adjacent to catch basin located near Sta. 2+60 between Lot 7 (6652 Gale Avenue North) and Lot 23 (6648 Gale Avenue North) were observed.
13. The sinkhole located in front of the residence on Lot 21 (6657 Gale Avenue North) was backfilled with granular

material and partially covered with polyethylene sheeting in 2015. The elevation of the top surface of the granular infill material appears to be slightly depressed relative to the surrounding ground surface. It is not obvious if the changes are due to surface erosion or loss of ground into the sinkhole. See Photo 3.

14. Concrete panels in the Lot 21 driveway appear to be deforming relative to one another and we understand that the District is monitoring this movement. See Photos 4 and 5.
15. Flow from the storm outfall below the lower statutory right of way (SRW) bench between Lots 9 and 10 (6664 Gale Avenue North) appeared relatively clear. The outlet is partly infilled by deposited fine sand and silt. See Photo 6.
16. No obvious changes in the depression in the asphalt at the location of the 2012 Seawatch Lane sinkhole adjacent to Lot 28 (6629 Gale Avenue North) since our last visit were observed.
17. Seepage continues from multiple springs on the slope on Lot 3 just below the dwelling bench and above the lower SRW bench. The springs coalesce on the lower SRW bench where they appear to be collected into a French drain which discharges below the bench.
18. Downslope of the SRW bench at Lot 4, 5 and 6, wet areas were noted along with hydrophilic vegetation such as horsetail. The subdrain pipe which collects groundwater from the drainage blanket was reviewed where it discharges below Lots 5/6 approximately. Water relatively clear. Steady flow.
19. The Lot 3 spring seepage mitigation works appear to be relatively wet with build-up of vegetation near the top of the PVC sumps inside the concrete collar. See Photo 7. No obvious signs that any maintenance of the spring remedial works has been conducted since December 2017 site visit.
20. As noted, a new sinkhole has formed on Lot 6. See Photo 8. Snow fencing has been installed around the perimeter of the sinkhole. No remedial work appears to have been completed. According to District personnel, the sinkhole has not changed significantly in size or shape since it was first observed.

PHOTOS



Photo 1. Sagging curb and deforming asphalt in front of Lot 9.

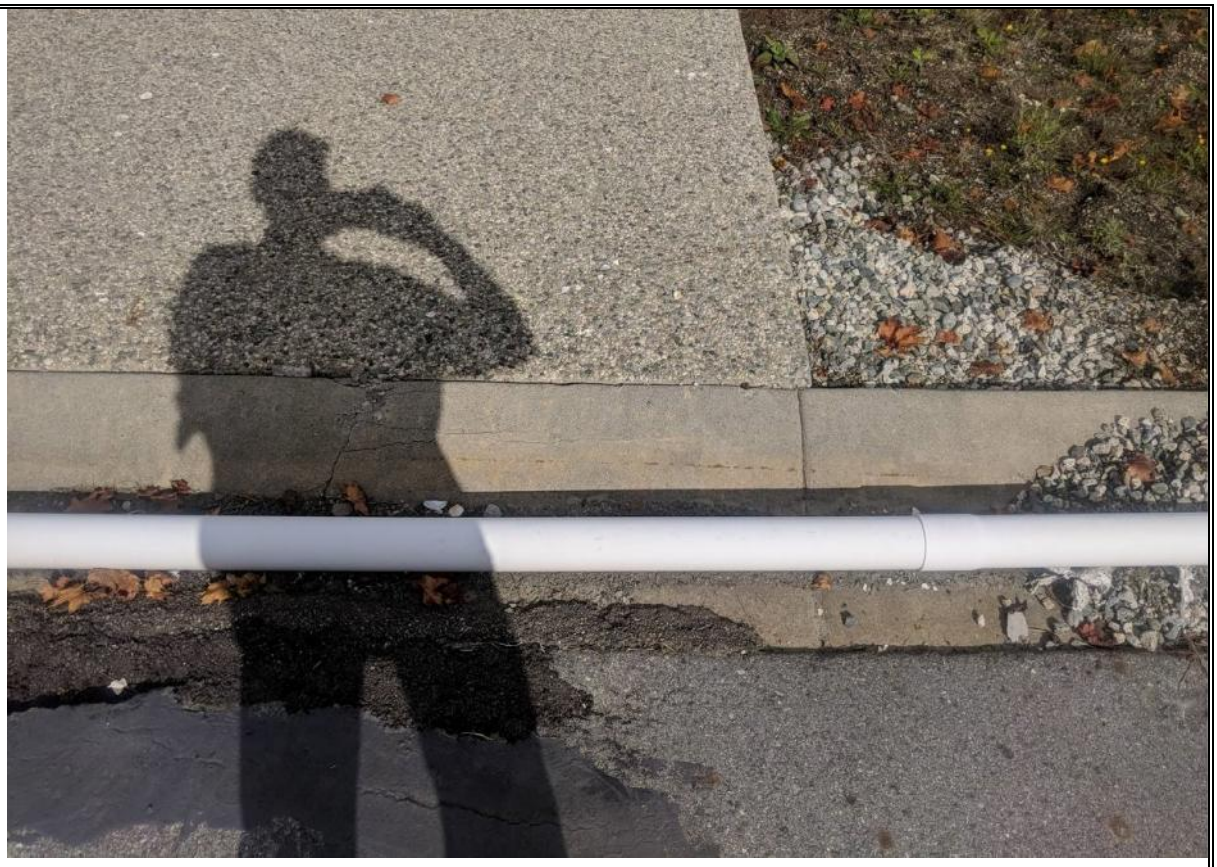


Photo 2. Sagging curb and deforming asphalt in front of Lot 9.



Photo 3. Backfilled sinkhole at Lot 21 and granular material deposited at base of driveway.



Photo 4. Deformed concrete panels in Lot 21 driveway.



Photo 5. Deformed concrete panels in Lot 21 driveway.



Photo 6. Deposition of fine sand and silt at storm outfall in SRW between Lots 9 and 10.



Photo 7. Build-up of vegetation around Lot 3 seepage mitigation works.



Photo 8. New sinkhole on Lot 6 viewed from Lot 7 driveway.

INSTRUCTIONS / RECOMMENDATIONS / REMARKS

21. As a short-term emergency repair, the District should advise the owner of Lot 21 that additional granular material and polyethylene sheeting should be placed to direct runoff away from the backfilled sinkhole.
22. Gale Avenue North traffic restrictions should remain in place until remedial works have been undertaken. The restrictions should extend from west side of Lot 5 to west side of Lot 9.
23. District personnel should continue to regularly inspect the site for signs of movement particularly between the two sinkholes on Lots 9 and 21 and in the vicinity of the new sinkhole Lot 6.
24. We recommend that the piezometers be monitored weekly. Further, we recommend that the site be visually inspected for changes or signs of distress at the same time. We understand District personnel now routinely monitor the piezometers and conduct weekly site inspections.
25. Based on our observations, the comments and recommendations in our July 11, 2017 memorandum continue to be relevant and we strongly recommend that the District review and implement them.
26. The Lot 3 seepage mitigation works described in Item 16 and shown in Photo 7 do not appear to be functioning as intended. Further, it appears that the recommendations in Golder Associate's report to the District titled "Geotechnical Inspection and Recommendations, Sinkhole Treatment and Seepage Control Measures, Seawatch Residential Subdivision, Sechelt, BC" dated June 23, 2015 have not yet been implemented by the owner(s) of Lot 3. We recommend that this be brought immediately to the attention of the Lot 3 owner(s) and their engineer, Golder, to be rectified.
27. The newest sinkhole is located on Lot 6 which is private property. Based on our observations, no remedial works have been undertaken. We caution that District personnel should not approach the sinkhole. We recommend maintaining a minimum 5.0 m distance from the edges of the sinkhole. We caution that left untreated, the sinkhole may become active and has the potential to damage the adjacent lots, District infrastructure as well as other buried infrastructure located within the Gale Avenue North right of way.
28. We recommend that the location of the sinkhole on Lot 6 be surveyed for future reference.
29. Visitors to the site including service providers and passers-by may not be aware of the sinkhole hazard which is not visible. We recommend that warning signs be installed on Crowston Road at both entrances to the site including Gale Avenue North and Seawatch Lane, and near the Lot 6 sinkhole to inform the general public of the sinkhole hazard (similar to landslide and rockfall hazard signs used on public highways).

FURTHER EXAMINATION REQUIRED: ☒ YES ☐ NO ☐ NOT APPLICABLE	REPORT BY: David Tara, P.Eng.	REVIEWED BY: David Regehr, P.Eng.