Memo

Project No. 10161797

Date:	Friday, May 10, 2019
Project:	CN MP 197.4, Rivers Subdivision Derailment
To:	Ira Boulet
From:	Loni Waldner
Subject:	Summary of Intrusive Investigation – May 2019

Dear Ms. Boulet,

This memo provides a summary of the intrusive investigation of the CN Right of Way (ROW) at Mile 197.4 on the Rivers Subdivision, Manitoba (the Site) between May 1 and May 7, 2019 (see Appendix 1 for the borehole/monitoring well summary). Analytical results from May 1 through May 7, 2019 are pending.

The purpose of this investigation was to characterize and delineate any remaining impacted soils and to identify potential effects on groundwater to assess the potential impacts within the CN ROW including the east culvert.

SCOPE OF WORK

The following scope of work was conducted to assess the CN Property:

- Directional boreholes were advanced, 9 locations on the south embankment and 2 locations on the north embankment, to investigation the track bed.
- Locations for initial directional boreholes were chosen based on hot spots identified through previous test pitting on the south embankment.
- Directional boreholes were advanced at least every 20 meters along the south side of the Site where the primary flow of Cold Lake Dilbit Blend (CLB) during the derailment was observed and the potentially for impacted soils remain within the CN track bed.
- The directional boreholes were completed at angles the ranging from 19 to 49 degrees from horizontal to investigate the soil quality beneath the track bed and to evaluate the underlining clay stratigraphy's potential to act as a confining layer.
- The directional boreholes were advanced to vertical depths between 1.5 to 8.8 m below the base of the rail line.
- Three vertical boreholes were completed from the top of the track bed to delineate observed impacts in directional borehole BH19-1. Vertical boreholes were completed from

the top of the track bed and were advanced to an estimated depth of 3 m below the base of the rail line.

- Directional boreholes were backfilled with a bentonite slurry from the bottom of the borehole using tremmie pipe with the exception of BH19-14 and BH19-15 that were backfilled through the auger casings with coated bentonite pellets and bentonite chips due to the close proximity to the rail line.
- Boreholes drilled from the top of the track bed were backfilled with bentonite chips.
- The east culvert was investigated with the advancement of 7 boreholes ranging in depth of approximately 5.7 to 8.8 m below the base of the rail line:
    - Four vertical boreholes and one directional borehole were advanced to assess the presence of product and/or soil impacts above and adjacent to the east culvert; and
    - Two of the 7 boreholes were completed as monitoring wells.
- Six monitoring wells were also installed at depths ranging from 6.6 to 8.8 m below the base of the rail line to assess groundwater quality.
- A Ground Penetrating Radar (GPR) survey was conducted to assist in determining the depth of the sub ballast material beneath the track bed within the derailment area.
- Soil samples were collected directly from the core barrel samplers and were submitted for laboratory analysis of benzene, toluene, ethylbenzene, xylenes (BTEX), and petroleum hydrocarbon (PHC) Fractions F1 to F4 along with representative samples for grain-size. Soil samples were also collected to correspond with samples taken by the landowner's consulting representative for analysis of BTEX, PHC Fractions F1 through F4, polycyclic aromatic hydrocarbons (PAHs) and alkylated PAHs. Laboratory results are pending.

The area of investigation showing the borehole/monitoring well locations along with a cross-section are present in the attached Cross-Section Figure.

OBSERVATIONS

The following observations were made during the completion of the intrusive investigation:

- Analytical results for soils sampled during the intrusive investigation are pending, so observations regarding potential soil impacts are based on visual assessment and soil headspace reading;
- The average depth of the investigation beneath the track bed was approximately 6 m vertically with the estimate depth of the sub ballast material ranging in depth from approximately 2.3 to 3 m below the base of rail from drilling and GPR observations;
- The trestle was contacted during drilling of 4 locations confirmed by timbers recovered within the core barrel samplers. Based on the observed timbers, it does not appear that the trestle is acting as a preferential pathway at this time as no CLB was observed;

- At depth, frozen soils and buried organic soils were noted within several borehole locations;
- Potential soil impacts associated with the derailment in February 2019 were only observed within the coarse-grained materials associated with the sub ballast materials beneath the track bed in 1 directional borehole BH19-1 and 2 vertical boreholes completed from the top of the track bed to delineate BH19-1;
- Rail traffic limited the number of vertical boreholes that could be completed from the top of the track bed, so while impacts were partially delineated in the vicinity of BH19-1, it is anticipated that some additional impacts to remain in sub ballast material within the track bed;
- Clay layers underlying the sub ballast material did not appear to be impacted based on visual assessment and soil headspace readings;
- The clay layer beneath sub ballast material containing CLB appeared to act as a very effective confining layer with no downward migration of CLB observed within the clay layer;
- Based on the drilling investigation and the GPR survey conducted during drilling, the buried trestle spans the length of the derailment Site;
- Boreholes were advanced adjacent to both the east and west sides of the east culvert and at both the south and north ends as well as on top of the culvert at the south end. No soil impacts were observed;
- A total of 6 monitoring wells were installed to assess groundwater quality at the Site in relation to the track bed and east culvert; however, in drilling the boreholes for the monitoring wells, it was observed that the majority of the natural soil stratigraphy on the south side of the Site was excavated to remove CLB impacts and backfilled to return to an equivalent grade. In doing so, the natural pathways for groundwater recharge have been removed; and
- The water level within the oxbow monitoring area versus the west end of the oxbow beyond the south berm, which is no longer connected to the Assiniboine River, was lower. With the primary pathways for groundwater recharge removed, the risk of contaminate migration to the oxbow is reduced and potentially eliminated.

CONCLUSIONS

An area of residual CLB was identified in the vicinity of BH19-1. The CLB appeared to be confined to the sub ballast material within the track bed with the clay layer below acting as a confining layer. It is anticipated that some additional CLB may remain in the sub ballast material within the track bed beyond this area; however, rail traffic limited the number of vertical boreholes that could be completed from the top of the track bed.

While laboratory analytical results are still pending, an excavation area has been identified for the track bed based on Site imagery collected of the derailment Site from the day after the derailment

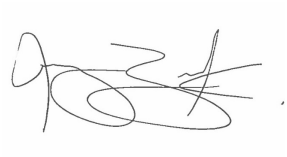
(February 17) to demobilization of the initial response, the GPR survey and the soil stratigraphy observed during the intrusive investigation. The volume of potentially impacted soils to excavate, based on the area identified is approximately 1,178 m^3.

No CLB or potential soil impacts were identified in the vicinity of the east culvert.

CLOSURE

We trust that the information presented in this document meets your needs. If you have any questions concerning the content of this memo, please do not hesitate to contact Loni Waldner at (403) 804-6775.

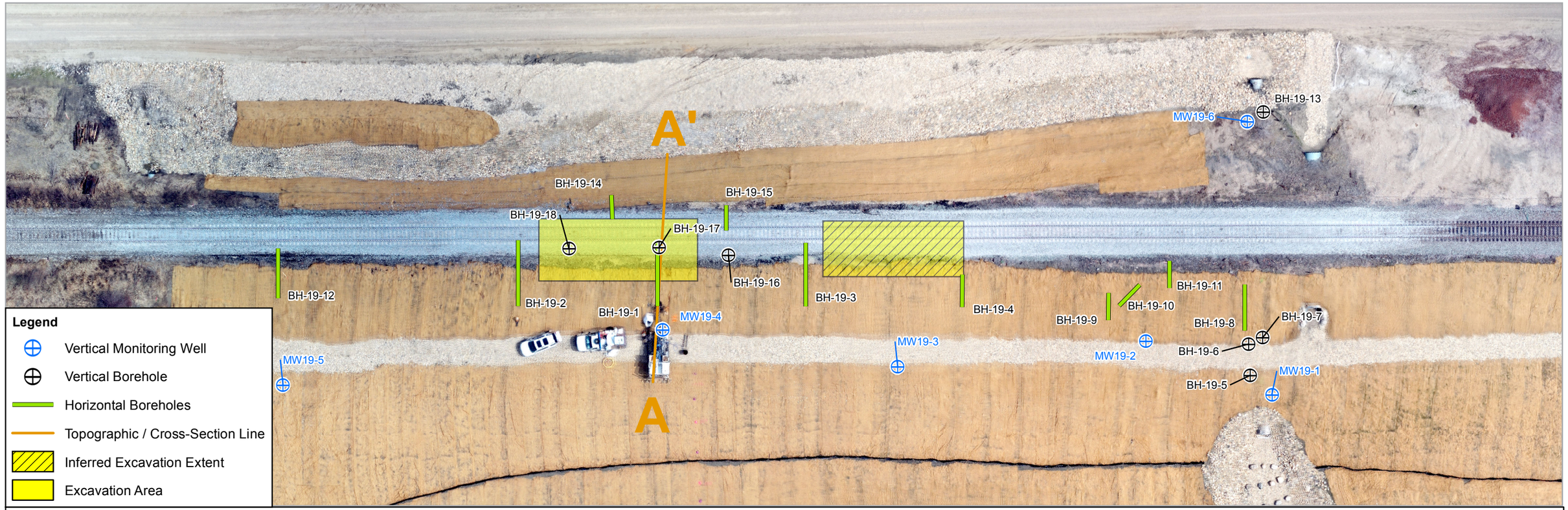
HDR Corporation

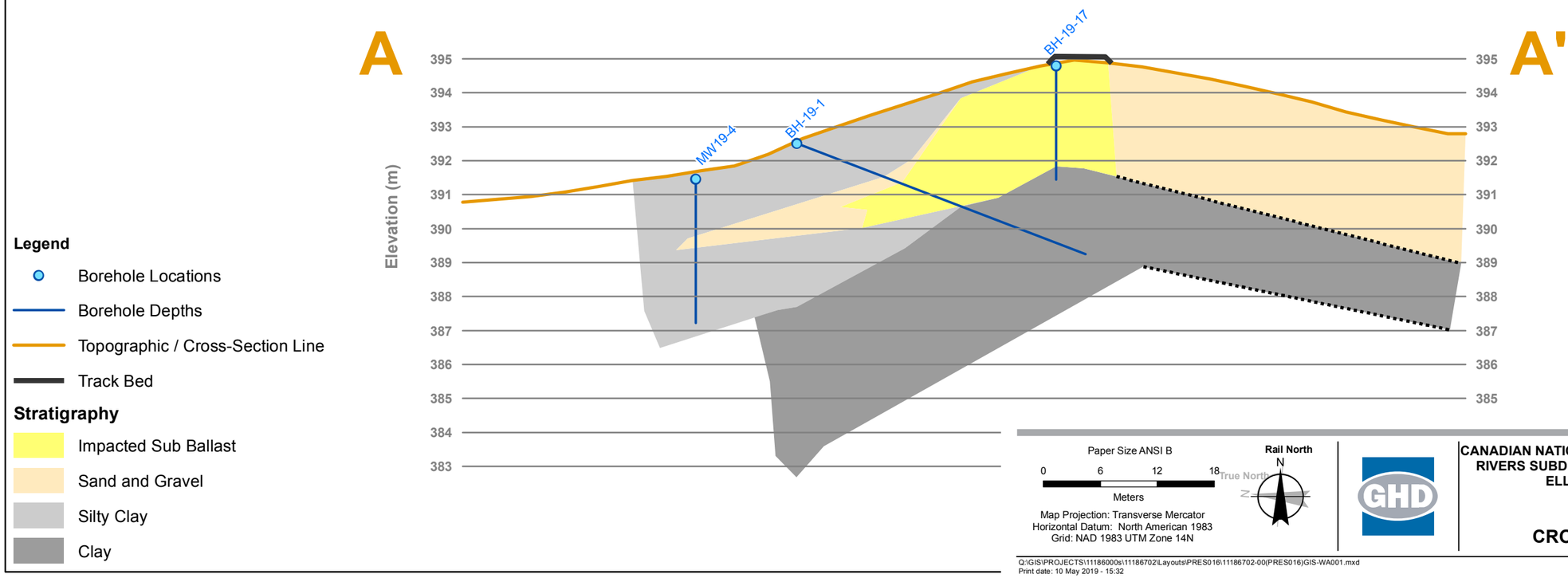


Jeremy Zemek, EP
Environmental Technician

Loni Waldner, P. Eng.
Senior Environmental Engineer

Attachments: Cross-Section Figure
Appendix 1





Paper Size ANSI B

0 6 12 18

Meters

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 14N

Rail North
N
True North

GHD

CANADIAN NATIONAL RAILWAY DERAILMENT
RIVERS SUBDIVISION - MILE POINT 197.4
ELLICE, MANITOBA

CROSS-SECTION

Project No. **11186702**
Revision No. **-**
Date **May 10, 2019**

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Print date: 10 May 2019 - 15:32

Data sources: 2019-02-17 Imagery provided by Matrix Solutions Inc.

Appendix 1: Summary of Monitoring Well/Borehole Locations

Computed by: Waldner, Loni Date:5/10/2019

Area Investigated	Borehole / Monitoring Well Number	Completion Date	Directional or Vertical Borehole	Drilling Depth (meters)	Vertical Distance[1] (meters)	Observations	Trestle encountered (Yes/No)	Soil Sampling
East culvert	MW19-1	3/5/2019	Vertical	4.6	8.8	No soil impacts observed. Borehole advanced vertically to 4.6 m. Wet sand encounter at 2.4 m. Monitoring well installed at a depth of 3.4 m with a 2.1 m screen interval.	No	No soil impacts observed; soil sample collected to verify soil quality at the soil water interface that coincided with the stratigraphic change from sand to clay within the borehole.
South Embankment	MW19-2	5/5/2019	Vertical	4	6.6	No soil impacts observed. Primarily clay soil stratigraphy with a sand and gravel layer between 3 and 4 m.	No	No soil impacts observed; soil sample collected at sand/clay interface at 4 m to verify soil quality at the bottom of the borehole.
South Embankment	MW19-3	6/5/2019	Vertical	4.6	8.8	No soil impacts observed. Borehole advanced vertically to 4.6 m. Monitoring well installed at a depth of 4.6 m with a 3 m screen interval.	No	No soil impacts observed; soil sample collected to verify soil quality.
South Embankment	MW19-4	6/5/2019	Vertical	4.6	8.8	No soil impacts observed. Borehole advanced vertically to 4.6 m. Monitoring well installed at a depth of 4.6 m with a 3 m screen interval.	No	No soil impacts observed; soil sample collected to verify soil quality.
South Embankment	MW19-5	6/5/2019	Vertical	6.1	8.8	No soil impacts observed. Borehole advanced vertically to 6.1 m. Monitoring well installed at a depth of 6.1 with a 3 m screen interval.	No	No soil impacts observed; soil sample collected to verify soil quality.
East culvert	MW19-6	6/5/2019	Vertical	4.6	8.8	No soil impacts observed. Borehole advanced vertically to 4.6 m adjacent to the west side of the east culvert, north of the rail line. Monitoring well installed at a depth of 4.6 with a 2.1 m screen interval.	No	No soil impacts observed; soil sample collected to verify soil quality.
South Embankment	BH19-1	1/5/2019	Directional at approx. 21 degree angle from horizontal	9.1	5.4	Soil impacts observed in sub-ballast material observed and contained hydrocarbon impacts. Sand and fine gravel inclusions within clay below also impacted by hydrocarbons to vertical depth of about 3.6 m.	Yes – some timbers noted.	Sample collected beneath impact sub ballast material and at the end of borehole to confirm soil quality with respect to hydrocarbons.
South Embankment	BH19-2	1/5/2019	Directional at approx. 21 degree angle from horizontal	9.1	5.4	No soil impacts observed.	No contact with buried trestle.	No soil impacts observed; soil sample collected at the end of borehole to confirm soil quality beneath the rail line.

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Area Investigated	Borehole / Monitoring Well Number	Completion Date	Directional or Vertical Borehole	Drilling Depth (meters)	Vertical Distance[1] (meters)	Observations	Trestle encountered (Yes/No)	Soil Sampling
South Embankment	BH19-3	2/5/2019	Directional at approx. 21 degree angle from horizontal	8.8	5.3	No soil impacts observed with the exception of soil that directly contacted a trestle timber that was drilled through. Coal noted during drilling. Third party consultant concurred that it was coal and not hydrocarbons and no samples were collected.	Yes - drilled through trestle at 2.4 m vertical from the tracks and 6.2 m horizontal to the south. Compression and drilling of the timber released oil consistent with creosote.	Samples collected from soils impacted during drilling as well as soils that would be present on either side of the timber.
South Embankment	BH19-4	2/5/2019	Directional at approx. 21 degree angle from	4.5	1.5	No soil impacts observed. Borehole advanced at approximately a 21 degree angle from horizontal. Refusal due sand and gravels encountered at 1.5 m.	No	No soil impacts observed; soil sample collected at the end of borehole to confirm soil quality beneath the rail line.
East culvert	BH19-5	3/5/2019	Vertical	2.4	6.6	No soil impacts observed. Refusal due boulders and cobbles encountered at 2.4 m below ground surface, which was the estimated midpoint of the east culvert at this location. Sand and fine gravel observed at 1.8 m to the total depth. Borehole backfilled with bentonite chips.	No	No soil impacts observed. Low soil headspace reading but insufficient soil volume for soil sampling.
East culvert	BH19-6	3/5/2019	Vertical	2.7	7.1	No soil impacts observed. Borehole advanced vertically with refusal due sand and gravels encountered at 2.7 m. Borehole backfilled with bentonite chips.	No	No soil impacts observed; soil sample collected at the end of borehole to confirm soil quality beneath the rail line.
East culvert	BH19-7	4/5/2019	Vertical	1.5	5.7	No soil impacts observed. Vertical borehole directly above the east culvert on the south side of the rail line. Completed to approximately 1.5 m below ground surface, touching the top of east culvert. Primarily clay with a 0.1 m sand seam. Borehole backfilled with bentonite chips.	No	No soil impacts observed; soil sample collected at the end of borehole to confirm soil quality beneath the rail line.
East culvert	BH19-8	4/5/2019	Directional at approx. 49 degree angle from horizontal	9.1	7.5	No soil impacts observed. Borehole completed directly beside the west side of the east culvert on the south side of the rail line. Advanced the borehole to approximately 7.5 m measured vertically, which corresponds to the estimated base of the east culvert at this location.	No	No soil impacts observed; soil sample collected at the end of borehole to confirm soil quality beneath the rail line.

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Area Investigated	Borehole / Monitoring Well Number	Completion Date	Directional or Vertical Borehole	Drilling Depth (meters)	Vertical Distance[1] (meters)	Observations	Trestle encountered (Yes/No)	Soil Sampling
South Embankment	BH19-9	4/5/2019	Directional at approx. 19 degree angle from horizontal	3.7	3.3	No soil impacts observed. Refusal at 3.7 m directionally or 3.3 m vertically and 4.9 m horizontally south of the rail line due to trestle timbers. Sands and gravel stratigraphy indicated sub ballast material.	Yes	No soil impacts observed; soil sample collected at the end of borehole to confirm soil quality beneath the rail line.
South Embankment	BH19-10	4/5/2019	Directional at approx. 19 degree angle from horizontal	4	3.4	No soil impacts observed. Position of borehole angled approximately 45 degrees from the rail line to avoid the trestle contacted in BH19-9. Refusal at 4 m directionally or 3.4 m vertically and 4.9 m horizontally south of the rail line due soil stratigraphy. Sands and gravel stratigraphy indicated sub ballast material.	No	No soil impacts observed; soil sample collected at the end of borehole to confirm soil quality beneath the rail line.
South Embankment	BH19-11	5/5/2019	Directional at approx. 45 degree angle from horizontal	5	6.1	No soil impacts observed. Limited recovery due to sub ballast material in the first 5 m directional. Contacted clay base at 5 m directional. Advanced to 6.1 m vertically measured from the base of the tracks and contacted the trestle.	Yes – verified by pieces trestle timbers in the end of the core barrel and creosote odours.	No soil impacts observed; soil sample collected at the end of borehole to confirm soil quality beneath the rail line.
South Embankment	BH19-12	5/5/2019	Directional at approx. 45 degree	9.1	8.3	No soil impacts observed. Borehole advanced through clay from surface to completion.	No	No soil impacts observed; soil sample collected at the end of borehole to confirm soil quality beneath the rail line.
East culvert	BH19-13	6/5/2019	Vertical	4.6	8.8	No soil impacts observed. Borehole advanced vertically to 4.6 m adjacent to the east side of the east culvert, north of the rail line.	No	No soil impacts observed; soil sample collected to verify soil quality.
North Embankment	BH19-14	7/5/2019	Directional at approx. 48 degree	4.6	3.4	No soil impacts observed. Borehole completed directly on the north side of the embankment, adjacent to the ballast.	No	No soil impacts observed; soil sample collected at the end of borehole to confirm soil quality beneath the rail line.
North Embankment	BH19-15	7/5/2019	Directional at approx. 45 degree angle from horizontal	4.6	3.2	No soil impacts observed associated with the derailment. However, there appeared to be an interval within the borehole at approximately 3.6 m what appeared to be ash was present with a headspace of 15 ppm. Borehole completed directly on the north side of the embankment, adjacent to the ballast.	No	No soil impacts observed associated with the derailment. However, there appeared to be an interval within the borehole at approximately 3.6 m what appeared to be ash was present with a headspace of 15 ppm; a soil sample was collected to verify soil quality.

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Area Investigated	Borehole / Monitoring Well Number	Completion Date	Directional or Vertical Borehole	Drilling Depth (meters)	Vertical Distance[1] (meters)	Observations	Trestle encountered (Yes/No)	Soil Sampling
Sub Ballast beneath Track Bed	BH19-16	7/5/2019	Vertical	3.4	3.5	No soil impacts observed but slight hydrocarbon odour in the initial surface interval. Borehole advanced vertically from the top of the rail bed, adjacent to the south rail line.	No	Soil sample collected to verify soil quality.
Sub Ballast beneath Track Bed	BH19-17	7/5/2019	Vertical	3.4	3.5	Crude was observed within the samples obtained from 0.3 m to approximately 3.2 m. From 3.2 to 3.4 m, clay was observed that did not appear to be impacted. Borehole advanced vertically from the top of the rail bed, adjacent to the south rail line.	No	Soil sample collected corresponding with RESPEC's sample of the crude as well as the clay base below to verify soil quality.
Sub Ballast beneath Track Bed	BH19-18	7/5/2019	Vertical	3.4	3.5	Crude observed within the samples obtained from 1.2 m to approximately 1.5 m followed by clay that did not appear to be impacted; Borehole advanced vertically from the top of the rail bed, adjacent to the south rail line to 3.4 m.	No	Soil sample collected corresponding with RESPEC's sample of the crude as well as the clay base below to verify soil quality.

[1] Estimated from the base of rail.