Overcoming barriers to intrusive investigations created by existing infrastructure

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ABSTRACT
Geo-environmental intrusive investigations are often challenged by limited or restricted access to some portions of the study area. Existing infrastructure must be identified and protected and isolated before work can proceed. Depending on the scope of the study and the complexity of the existing infrastructure, it may be necessary to seek permits, access agreements or negotiate licenses of occupation to gain access; these activities can add significant time and costs to an investigation. Additional safety measures needed to protect the infrastructure, the workers and the public. It may not be possible to obtain access from the property owner. This paper will discuss the value of completing an historical review that includes the existing infrastructure design and construction details, in advance of undertaking an intrusive investigation. Two case studies are discussed, both demonstrating the value added by the historical review, and challenges encountered searching for and interpreting historical records.

RÉSUMÉ
Les études géo-environnementales sur le terrain se compliquent souvent par un accès limité ou restreint à certaines parties de la zone d'étude. L'infrastructure existante doit être identifiée et protégée ou isolée avant que le travail puisse commencer. Selon la portée de l'étude et la complexité de l'infrastructure existante, il peut être nécessaire d'obtenir des permis, des accords d'accès ou de négocier des autorisations d'occupation afin d'obtenir l'accès; ces activités peuvent ajouter beaucoup de temps et de coûts à une étude. Des mesures de sécurité supplémentaires sont nécessaires pour protéger l'infrastructure, les travailleurs et le public. Il peut ne pas être possible d'obtenir l'accès au site de la part du propriétaire.

Ce document discutera l'importance de compléter une revue historique qui inclut les détails de conception et construction de l'infrastructure existante, avant d'entreprendre les travaux de terrain. Deux études de cas sont discutées en détail, démontrant à la fois la valeur ajoutée de l'analyse historique et les défis rencontrés lors de la recherche et de l'interprétation de documents historiques.

1 INTRODUCTION

Infrastructure development across Canada has transformed parts of our natural environment into urban and industrial areas serviced by a network of buried and above ground utilities and transportation corridors.

Intrusive investigations are generally focused on collecting information pertinent to the specific project within the scope of work. Geo-environmental investigations involve determining not only the geotechnical and hydrogeologic conditions of the site, but also the presence of potential contaminants of concern that may be present due to current and past site development.

The existing infrastructure forms a barrier to investigation, but design and construction details predating the infrastructure can serve as a benchmark to current conditions.

Two geo-environmental studies completed within Calgary, Alberta are discussed. In both cases, the original landscape has undergone significant transformation over time, restricting areas readily accessible by a drilling rig or back hoe. Historic investigations completed in support of that transformation provided valuable information to support the current studies.

The recent increased functionality of the City of Calgary's record management system provides desktop search functionality of historical records across department holdings and also corporate archives.

2 NEW LANDFILL CELL CONSTRUCTION

The Shepard Landfill in SE Calgary has evolved over the past 50 years with an ongoing progression of waste disposal cells and related supporting infrastructure. The site occupies an area of approximately 239 hectares.

Under the current operating approval, renewed in 2016, detailed construction plans and specifications for new landfill cells must be submitted to the Province at least 60 days prior to construction, for review by the Province.

A new landfill cell was planned for the Shepard Landfill in 2017, triggering a geotechnical investigation of the proposed area to confirm the suitability of native soil and the approximate available volume of clay liner material. The cell replaces a former settlement pond that received carwash sump wastes.

A geotechnical investigation was undertaken to support the landfill cell design. Consistent with past cell construction projects, the scope of work included confirmation of the suitability of the native soil within the proposed construction area, and an estimation of the approximate available volume of clay liner quality material (EBA, 2017).

The construction plans and specifications were submitted to the Province. Under review, the Province identified that the submission also needed to document the

depth to bedrock underlying the area to confirm the adequacy of the liner design.

As illustrated in Figure 1, the proposed landfill cell location is surrounded by landfill infrastructure. A search for historic geotechnical and hydrogeological reports was undertaken to determine if sufficient information existed in the landfill operating record confirming the depth to bedrock.

Figure 1. Area of Landfill Cell Construction.

Three reports were identified documenting the geotechnical and hydrogeological site conditions including depth to bedrock.

The oldest report found was completed by Underwood McLellan & Associates Ltd. (1968) as part of the construction of the Shepard sewage lagoons, located just north of the Shepard Landfill within the same section of land. The study area of the 1968 study included the entirety of 11-23-29-W4M. The investigation was completed in a grid pattern with a borehole spacing of between 195 m and 305 m. The land was still under rural land use, as shown in Figure 2.

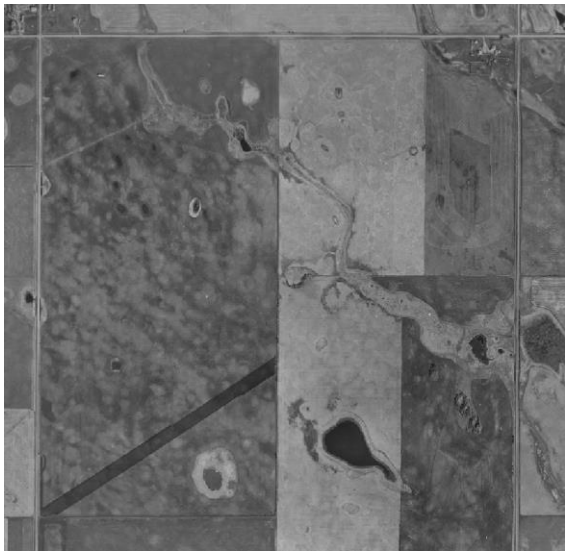

Figure 2. Land use prior to development (1959 air photo).

The purpose of the 1968 study was to determine the subsurface soil conditions and their suitability for the construction of the sewage lagoons (Underwood McLellan, 1968). Although not the original intent of the report, the report also documented the predevelopment condition of the future Shepard Landfill, which opened in 1972: topography, depth of topsoil, and underlying soil stratigraphy including depth to bedrock. The elevations of the boreholes were surveyed relative to established city datum points, so that the elevations and stratigraphy can be compared to current elevations.

Table 1 presents the soil properties as measured in 1968, compared to those measured in 2017. The best available copy of the 1968 report was found to be incomplete, lacking referenced attachments of soil analysis. Only a summary of the soil properties was available. The 2017 report included the full report from the geotechnical testing laboratory.

Table 1. Characteristics of tested soils

Characteristics (%)	1968[1]	2017[2]
Water content	Missing from report	22.1 to 24.1
Liquid Limit	34.1	25 to 36
Plastic limit	20.1	15 to 18
Gravel	Missing from report	1 to 2
Sand	Missing from report	43 to 29
Silt	Missing from report	35 to 38
Clay	Missing from report	21 to 31

[1] Underwood, McLellan & Associates Ltd.

[2] Tetra Tech Canada Inc.

The second report, by Stanley Associates Engineering Ltd. (1989) was commissioned by the City of Calgary to evaluate hydrogeologic conditions in support of an industrial landfill cell construction southwest of the 2017 new cell construction. The scope of work included determining the soil and geology within SW11-23-29-W4M.

The third report, by Golder Associates Ltd. (1997), incorporated data from both the Underwood McLellan and Stanley reports, to develop a more comprehensive map of the depth to bedrock, as shown in Figure 3.

The Golder report had been previously submitted to the Province in 1997 in support of a previous approval review process. The report was submitted as additional information in specific support the new cell construction, demonstrating sufficient data was available confirming the depth to bedrock below the proposed cell location.

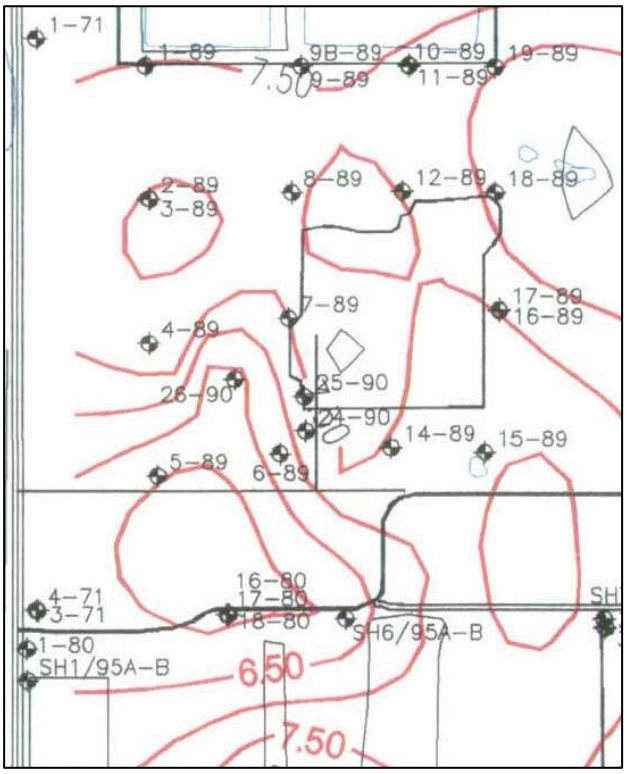

Figure 3. Depth to Bedrock (from Golder, 1997)

3 CLOSED LANDFILL FOOTPRINT

The City of Calgary is implementing an Environmental Management Plan for the closed Nose Creek Landfill. Municipal waste disposal occurred in three separate areas within the south portion of the Nose Creek valley during different time periods prior to 1970.

The focus in this case study is specifically with regards to historic waste disposal that occurred between the 1920s and 1959 at this landfill, as shown in Figure 4.

The landfill appears as the boot-shaped lightly coloured area in the upper right hand portion of the photo. The east-west road immediately south of the landfill was named Blackfoot Trail.

Figure 4. Nose Creek Landfill footprint, 1959 air photo.

Following landfill closure, significant redevelopment occurred, including development of an industrial business park and the construction of a major transportation interchange replacing Blackfoot Trail. The closed landfill site is unrecognizable under the current land use, as shown in a more recent air photo, presented in Figure 5. The only fixed features between those years are the rail line and bridge, and the weir across the Bow River.

Figure 5. Deerfoot Trail and Memorial Drive Interchange located within 13-24-1-W5M.

This extensive redevelopment occurred after the Nose Creek Landfill was closed, but prior to provincial requirements concerning the ongoing management of closed landfills, as identified under the Code of Practice for Landfills (Province of Alberta, 1996).

The old Blackfoot Trail was decommissioned and replaced with the new multi-lane Memorial Drive slightly north of the original trail in 1970, and the road alignment was improved through extensive cut and fill. A north-south freeway was constructed along the Nose Creek valley, Deerfoot Trail. The final traffic interchange shown in Figure 5 was completed in stages during the 1970s and 1980s.

Almost a decade after the new interchange was completed, The City of Calgary produced a reference map indicating that part of the Nose Creek Landfill was removed in 1969 and another part of the waste footprint was removed in 1974. An excerpt from the map is shown in Figure 6.

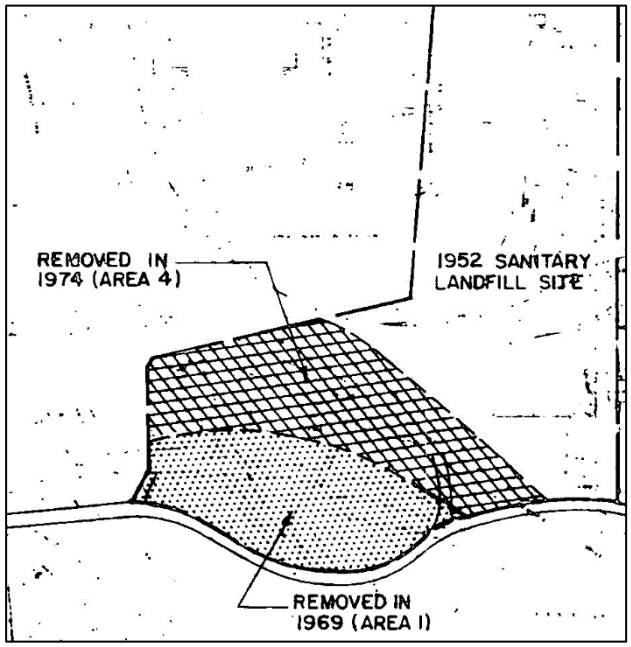

Figure 6. Nose Creek Landfill areas of waste removal.

In recent years, several intrusive investigations have been completed to develop a groundwater monitoring well network, as shown in Figure 7. Wells have been drilled along the southern boundary that confirm the absence of waste, and is in general agreement with the reference map shown in Figure 6, Drilling into the Memorial Drive road right of way has been very limited, with a few boreholes drilled in the middle of the clover leaf.

Reports done by others, however, had identified waste within the park space along the south boundary, raising concerns regarding the south extent of waste.

Figure 7. Groundwater monitoring network (from The City of Calgary, 2016)

A more detailed search for historical geotechnical and hydrogeological studies found a 1982 geotechnical investigation completed in advance of construction within the Deerfoot / Memorial interchange (Hardy, 1982), That investigation found buried municipal waste within the area that had previously been reported as removed in 1974. The 1982 investigation was completed in support of constructing a light rail transit line within the Memorial Drive road right of way in the 1980s.

The Hardy (1982) report identified waste within the proposed construction area of the proposed Deerfoot northbound ramp to connect to westbound Memorial Drives, as shown in Figure 8. The profile along the ramp, as shown in Figure 9, indicates a high volume of waste / refuse above the proposed grade, and a relatively small volume of waste below grade. It was recommended (Hardy, 1982) that waste be removed from below grade and backfilled with good quality imported glacial till. The overall volume to be removed was calculated to be 9600 m3 of material.

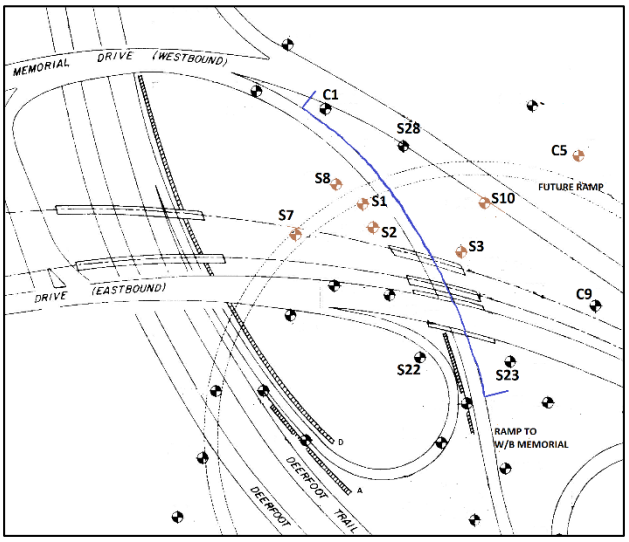

Figure 8. Drilling Program in advance of 1984 construction (from Hardy, 1982). Refuse was logged at borehole locations with brown markers.

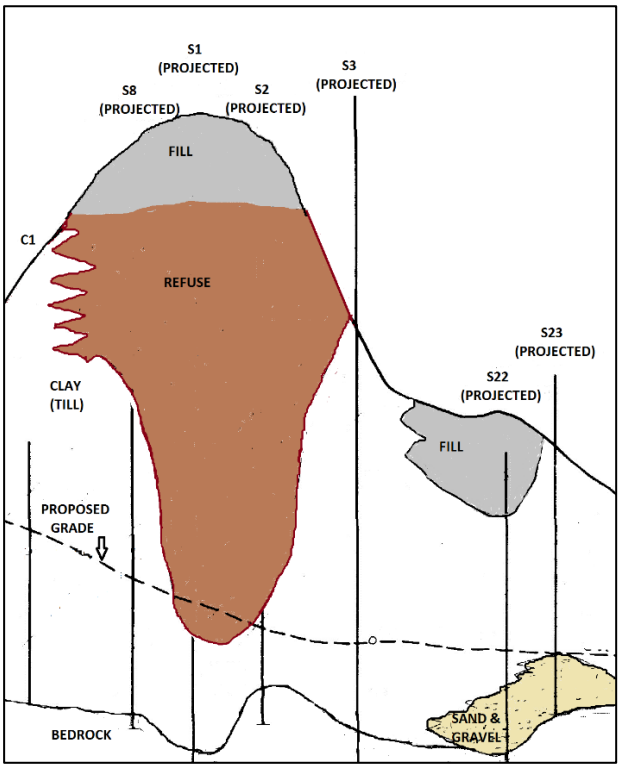

Figure 9. Cross-section along proposed ramp to westbound Memorial Drive (from Hardy, 1982).

Fortunately, record drawings were also filed for this project. From the available records, it seems the waste was removed through the construction area. Waste was not removed at the time of construction north of the Memorial Drive, and may be in place beneath the Memorial Drive westbound lane, given the presence of waste at both S10 and C5 locations. It is also possible that some waste remains below proposed grade, despite the recommendations found in the available report.

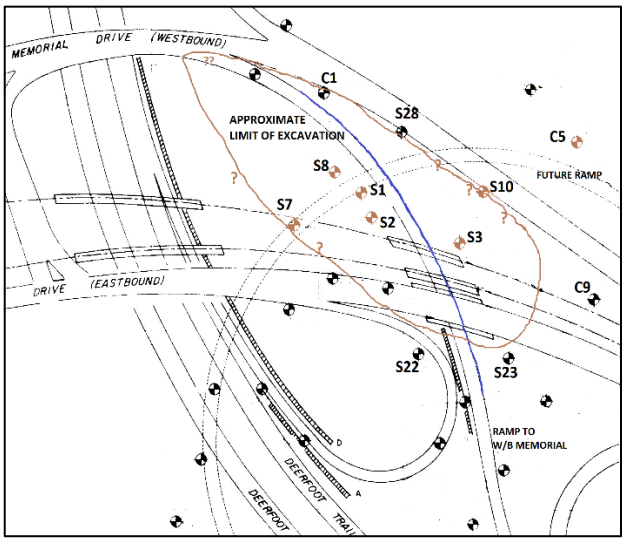

Figure 10. Record drawing indicating approximate limit of excavation (from City of Calgary, 1984)

The review of historical records identified a gap in the understood southern extend of waste for the Nose Creek Landfill, but any intrusive investigation to close this gap can be very targeted along a short distance. The historical records provide further documentation of the nature of the waste and post-closure activities including waste removal.

4 CONCLUSIONS

The case studies illustrate that relevant geo-environmental data presented within historical reports can both help inform new investigations, and provide valuable information of site conditions and ground disturbance that would otherwise would be prohibitively challenging to obtain under current site conditions.

Locating the records themselves can be a challenge. Efforts made by record holders to catalogue records in a searchable format support finding documents with an ease not possible a few years earlier. Tracing development history can hit roadblocks through changes in street names, land subdivisions and consolidations. Finding a point of reference that remains fixed over the years can serve as a useful benchmark.

The search of historical records did not locate a comprehensive construction completion reports for either the Shepard Industrial Facility construction project or the Deerfoot – Memorial Drive interchange project. A detailed description of the conditions encountered during construction would have been of great value in understanding the subsurface conditions encountered and that may be encountered in the future.

5 ACKNOWLEDGEMENTS

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6 REFERENCES

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