

Case Study: Sulphate-Impacted Soils Used for a Highway Construction Project

Margaret Allan, M.Eng., P.Eng.
Senior Engineer, Matrix Solutions Inc., Calgary

Abstract

Urban growth in the Town of Okotoks, Alberta led to two key needs that set the stage for a soil reuse project: the need for improved highway access and the need for additional commercial/industrial lands. Relocating 54,000 tonnes of sulphate-impacted soils from a local sour gas plant to the roadbed of a widened section of highway aided in bringing the new section of highway to the correct elevation and will provide the town with approximately 20 hectares of viable commercial/industrial development.

This presentation describes the nature of soils used in the road construction project, approvals and conditions that were required to move this project ahead, and factors that led to project acceptability and success. While this case study is not considered precedent setting, factors to consider for other applications are presented for discussion, along with recommendations to aid the approvals process.

Background

The Town of Okotoks is situated along the Sheep River approximately 30 km south of Calgary, Alberta. The Town's picturesque location and proximity to Calgary have been factors in its urban growth. The population of Okotoks is 10,000 and rising.

Urban growth has increased the volume of traffic on Highway 2A, one of the main access routes between Okotoks and Calgary. Twinning of the highway began in 2000. The burgeoning population has also led to the demand for more commercial and industrial lands to serve as places of employment, aid the Town's tax base, and to provide goods and services in the High River-Okotoks-Calgary area.

Between 1960 and 1990, Nexen Inc. and its predecessors operated a sour gas plant east of the Town of Okotoks. The Okotoks Gas Plant lands were annexed by the Town in 1999, while gas plant decommissioning was underway. The southern portion of the gas plant site (the Lower Terrace) is adjacent to an existing commercial/light industrial area and was used for sulphur storage. It was recognized from early on that the Lower Terrace would be well suited for commercial/industrial use once decommissioning activities were complete. The northern portion of the gas plant site (the Upper Terrace) is situated above an escarpment of the Sheep River and is destined for future parkland use.

For the thirty years that the gas plant was in operation, gas processing took place on the Upper Terrace and elemental sulphur removed from the sour gas was sent by pipeline to the Lower Terrace for storage and shipping. Two sulphur blocks were poured and mined over the years, a process that added sulphur dust to the ground surface. Two water wells

on the Lower Terrace provided the Upper Terrace with fresh water. Other than the water wells and the sulphur handling and storage activities, most of the Lower Terrace was unused by the plant.

Decommissioning of the Lower Terrace began with break-up and removal of the sulphur blocks in the late 1980s. Near-surface soils containing sulphur were excavated and disposed of at this time and the pH was adjusted through the addition of alkaline amendments. Topsoil and seed were applied and the land was left dormant. Environmental investigations in the mid-1990s indicated that soils in the vicinity of the former sulphur basepad required further remediation for residual sulphur and its oxidation products. Approximately 11,000 tonnes of the most affected soil was disposed of at an industrial landfill in 1999. This soil contained visible sulphur and exhibited acidic pH and elevated electrical conductivity (EC). A follow-up sampling program established the character of soils remaining onsite, and a further 5,000 tonnes were disposed of at the landfill at the beginning of the 2000 field season.

Soil Character

Soils remaining onsite following landfill disposal of the most highly affected soils can be characterized as silty sand and gravel with sulphur content up to 3%, pH in the 3 to 8 range and electrical conductivity (EC) typically in the 5 to 8 dS/m range. The acidic pH and elevated EC were attributable to sulphur oxidation; sulphate was the dominant ion in saturated paste extracts prepared from soil samples. The sodium adsorption ratio (SAR) and metals concentrations met Alberta Tier I criteria for unrestricted land use. Crushed limestone was added to buffer soils with pH less than 6 prior to stockpiling soils for use in the road construction project.

Project Rationale—Highway Construction Perspective

In June 2000 Nexen was approached by Top Notch Construction Ltd., the construction company responsible for sourcing suitable materials for construction of a twinned section of Highway 2A. Considerable material was required to raise the roadbed approximately 1.5 m above existing grade. The Lower Terrace soils were viewed as desirable because of their granular nature (which resists frost heave) and availability. The elevated EC was not viewed as a concern because the roadbed itself would not be required to support vegetation. In fact, it was noted that long-term reaction of sulphate with calcium ions in the soil could lead to the creation of gypsum-like crystals that would tend to strengthen the soil.¹

The Lower Terrace soils were reported to exhibit a lower EC than another borrow source under consideration, which contained elevated concentrations of salts of natural origin.

¹ Merl Korchinski, Principal of Pro-EnviroCore Consulting Inc., the environmental consultant retained by the highway construction company, Top Notch Construction Ltd. of Calgary, Alberta.

Finding, testing and obtaining approval to use a traditional borrow source may have compromised the schedule of the highway construction project, whereas the Lower Terrace soils were of suitable quality, were available and accessible, and were located within a few kilometres of the construction site.

Project Rationale—Site Remediation Perspective

Site-specific risk assessment indicated that the elevated EC of Lower Terrace soils did not represent a cause for concern under a commercial/industrial land use scenario dominated by warehouses and pavement. However, landscaped areas would require less saline soils in order to support ornamental vegetation. If risk management, rather than remediation, were implemented, procedures would have to be implemented to manage salinity left in place. Risk management plans would be required to address the possibility that future owners of commercial/industrial lots on the Lower Terrace could bring saline soils to surface during the course of normal excavation activities (such as installing utility lines) and that these soils might impact landscaped areas. Developing mechanisms to advise all future owners how to manage the saline soils at depth proved to be tricky, and remediation to a generic commercial/industrial standard that eliminated the need for such mechanisms appeared to offer procedural advantages.

Traditional forms of remediation, however, would bring about their own environmental consequences. It was not viewed as environmentally responsible to fill valued landfill space with such marginally contaminated soils. Soil washing would have removed over 100,000 m³ clean water from the Sheep River system.

Relocating the saline soils to the Highway 2A roadbed would allow the site to attain a higher remediation standard, while allowing the sulphate-impacted soils to go to a good use.

Approvals Process

Both the highway construction and site remediation viewpoints showed many apparent benefits with reusing Lower Terrace soils as roadbed material. To move this project ahead, approvals were sought from Alberta Infrastructure (now called Alberta Transportation), Alberta Environment and the Town of Okotoks.

Alberta Environment representatives reviewed project information and granted approval subject to the following conditions:

- That written permission be obtained from the party with long-term ownership/care/control responsibilities for the road (i.e., Alberta Infrastructure);
- After incorporation into the roadbed, soil EC must not exceed 4 dS/m and must meet Alberta Tier I criteria for all other parameters;
- The material must be covered on the top and sides with a minimum thickness of 0.5 m soil with EC not greater than 2 dS/m;
- The incorporated material must be at least 1 m above water table;

- Placement must be north of a specific turnoff (where the water table was in clay at depths of 1.7 to 4.4 m);
- Confirmatory sampling must be done according to a plan developed for the project by Alberta Environment; and
- A report must be submitted to Alberta Environment by March 30, showing that all these were met.

Alberta Infrastructure's representative, Stantec Consulting Ltd., verified that the Lower Terrace soils met project contractual criteria (geotechnical considerations). Alberta Infrastructure representatives then reviewed information and approved the project subject to the following:

- Alberta Infrastructure must be held harmless;
- Alberta Infrastructure's geotechnical requirements must be met;
- Placement and testing of the material must meet Alberta Environment requirements;
- Results of testing must be made available to Stantec on request;
- There must be no additional costs to Alberta Infrastructure for items such as use of a different seed mix or different concrete, if required, or for increased monitoring, testing or reporting costs.

The Town of Okotoks was approached and requested that, if this project were to go ahead, the following should happen:

- Surface water on the Lower Terrace should be properly managed to control runoff;
- The Lower Terrace working area should be brought back up to grade after soil removal;
- The working area should be stabilized to prevent wind erosion; and
- If development on the Lower Terrace is not imminent, topsoil and seeding may be required.

The work plans were modified to reflect the requirements of Alberta Environment, Alberta Infrastructure and the Town of Okotoks. Nexen agreed to assume liability for any adverse impacts that may occur along the stretch of road as a result of the sulphate-rich soils. However, since the soils were similar to naturally saline soils used with success in previous highway construction projects and there was good separation between the roadbed, the water table and local water wells, this risk was viewed as small and acceptable.

Public Concerns

Since the soil met project criteria and the necessary approvals were obtained, there was no specific requirement to inform area residents. In hindsight, however, advising those nearest the highway construction site before making application would have been prudent and helped to allay apprehension on the part of area residents. An information meeting was held ten days after project start-up, in response to residents' concerns, which can be summarized as follows:

- Why weren't residents advised? (Answer: because the soils to be used in the roadbed met acceptance criteria, because there is no requirement to advise residents when other borrow sources are imported, and because using this material is not a cause for concern);
- What will be the long-term effects on water wells? (Answer: None. There are no wells adjacent to the road, and the roadbed is founded on low permeability clay till soils, so wells are unlikely to exhibit measurable effects);
- Why couldn't different soils be used? (Answer: Availability and quality. From a road construction perspective, this soil was superior to other borrow sources being considered); and
- How bad is the soil? (Answer: results of laboratory analyses were posted and described).

Work Plan

The project proceeded as follows:

- Crushed limestone was incorporated into Lower Terrace soils with pH less than 6.
- Soils with EC greater than 4 dS/m, including the limestone-amended soil, were collected and stockpiled on the Lower Terrace.
- The soil stockpiles were tested for EC, then loaded into trucks and transported to the highway construction site.
- On the basis of measured EC, the soils were mixed with other, low EC soils and spread in place at the highway construction site.
- Placed soils were tested for EC. If the EC exceeded 4 dS/m, additional low EC soils were added and the soils were retested.
- Once EC criteria were met, the soils were capped on the top and sides with low EC clay and then road was and paved.

To improve accountability, independent consultants directed work at the gas plant site and the road construction site. Matrix Solutions Inc. directed the excavation and stockpiling of soils for use, and Pro-EnviroCore Consulting Inc. tested soils for EC before utilization in the roadbed and after the incorporation of lower EC material.

In total, 54,000 tonnes of Lower Terrace soils were used in the project. Work began in late August 2000 and was completed in mid-October 2000.

At the former gas plant site, confirmatory testing was conducted after soil removal, and grade was replenished with an equivalent volume of soil the following year.

Results and Conclusions

The former sulphur basepad soil was of good quality for use in highway roadbed construction. The highway was completed to specifications and on schedule. Using this material brought no increased costs.

The former basepad area of the gas plant was remediated to allow for subsequent sale and use by others. Re-using this land to meet the Town's need for commercial/industrial space is more environmentally sound than exploiting virgin lands for this purpose.

Using the sulphur basepad soils saved over 30,000 m³ of Alberta landfill space and no water contamination for soil washing was incurred.

Recommendations

Professionals in the environmental sector have unique opportunities to act as stewards of the Earth's finite resources. As such, they should pursue opportunities for environmentally responsible management of these resources.

Projects such as this one should be reviewed on a case-by-case basis, as there are many factors that could affect success. Factors to be evaluated include the geotechnical and environmental suitability of the source soil, the suitability of the receiving area, and other pertinent factors. The receiving area should be suitably isolated from the water table and should have a long expected life, since future excavation through the receiving area may require special soil handling protocols, depending on the nature of the source soils.

To facilitate communication of future project details and streamline approvals processes, it is recommended that proponents approach all stakeholders beforehand (including area residents), even if there is no real or perceived need to do so. Preparing a material safety data sheet (MSDS) for soils or other recyclable materials may help to communicate the nature of the material and any specialized handling requirements.

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