Risk-Based Solutions for Salinity and Nitrate Impact at a Remote Drilling Waste Sump Site in Southern Alberta

Generic, stringent environmental guidelines can lead to overestimation of risk, potentially driving unnecessary and damaging remediation efforts. This case study demonstrates how integrating multiple site-specific guideline calculation methods provides a balanced, defensible contamination assessment approach to addressing environmental risk.

Trace Associates Inc. conducted a comprehensive assessment of a remote sump site historically used for drilling waste disposal via mix-bury-cover. Contaminants of potential concern included salinity, sodicity, and associated parameters (chloride, sodium, nitrate). Soil analytical results indicated exceedances of electrical conductivity (EC), sodium adsorption ratio (SAR), and pH in both surface and subsoil, primarily associated with buried cement and drilling waste.

To support a reclamation certificate application under Alberta's regulatory framework, a Tier 2 risk-based evaluation was performed with development of site-specific guidelines for chloride, sodium, SAR, and nitrate. The assessment incorporated the use of the Alberta Subsoil Salinity Tool (SST), a root zone pathway assessment aligned with the Native Prairie Protocol (NPP), and Tier 2 dilution factor calculations.

Soil and groundwater data collected from 2015 to 2023 through multiple environmental site assessments and monitoring events informed the evaluation. While shallow soils (0-1.5 mbgs) were assessed against the Alberta Tier 1 soil and groundwater remediation guidelines, SST modeling yielded subsoil (>1.5 mbgs) chloride and sodium guidelines significantly higher than Tier 1 values. The SST yielded subsoil chloride guidelines of 1,700 mg/kg for the root zone pathway and management limit guidelines of 7,000 mg/kg (34,000 mg/kg calculated) for groundwater pathways. For sodium guidelines, the SST provided guidelines of 4,500 mg/kg (management limit) (22,000 mg/kg calculated) for groundwater pathways. Measured chloride and sodium concentrations higher than calculated root zone SST guidelines in soil were deemed low risk due to their depth, limited extent, and alignment with NPP criteria.

Groundwater parameters, including EC, SAR, nitrate as nitrogen, nitrite as nitrogen, sodium, sulphate, and total dissolved solids (TDS), exceeded Tier 1 guidelines in select monitoring wells. Two Tier 2 approaches, dilution factor calculations, and SST-proxy modeling were applied in parallel to assess risks to groundwater-related receptors. The results of these two approaches yielded similar guidelines, and demonstrated that salinity, nitrate, and nitrite posed low risk to freshwater aquatic life, livestock and irrigation watering, and domestic use aquifers.

The integration of dilution factor calculations, SST modeling, site-specific hydrogeological characterization, minor exceedance justifications, and regulatory tools such as the NPP enabled the development of defensible, risk-based remediation endpoints. All soil and groundwater concentrations met applied Site-specific guidelines, and no further remediation was recommended beyond vegetation assessment for NPP compliance. This study highlights how combining regulatory tools and risk-based approaches can achieve cost-effective, scientifically robust, and environmentally sound outcomes.

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Sylvain's core competencies include contaminated site management, environmental site assessments (ESAs), soil vapour assessments, and human health and ecological risk assessments (HHERAs). Sylvain's experience has included projects for a variety of contaminated sites within Western Canada, including urban development sites, commercial/industrial sites, and upstream oil and gas facilities.