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AN APPROACH FOR INVESTIGATING **SALT-IMPACTED SITES**



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OUTLINE

SALT IMPACTED SITES:

- Why Are We Concerned?
 - Approach to Investigation
 - Remedial Options
 - Salt Impacts Remedial Program Case Study
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WHY ARE WE CONCERNED?

- Environment Canada Assessment Report estimated that approximately **4.9 million tonnes** of road salt are released to the environment in Canada every year
- In August 2000, Environment Canada provisionally declared road salt as a Canadian Environmental Protection Act (CEPA) toxic substance

WHY ARE WE CONCERNED?

In February 2002, draft remedial standards involving sodium and chloride impacts in soils and groundwater were proposed under the *BC Contaminated Sites Regulation*

- Remedial programs at highways maintenance yards (road salt storage)
- Oil and gas exploration in Northern BC

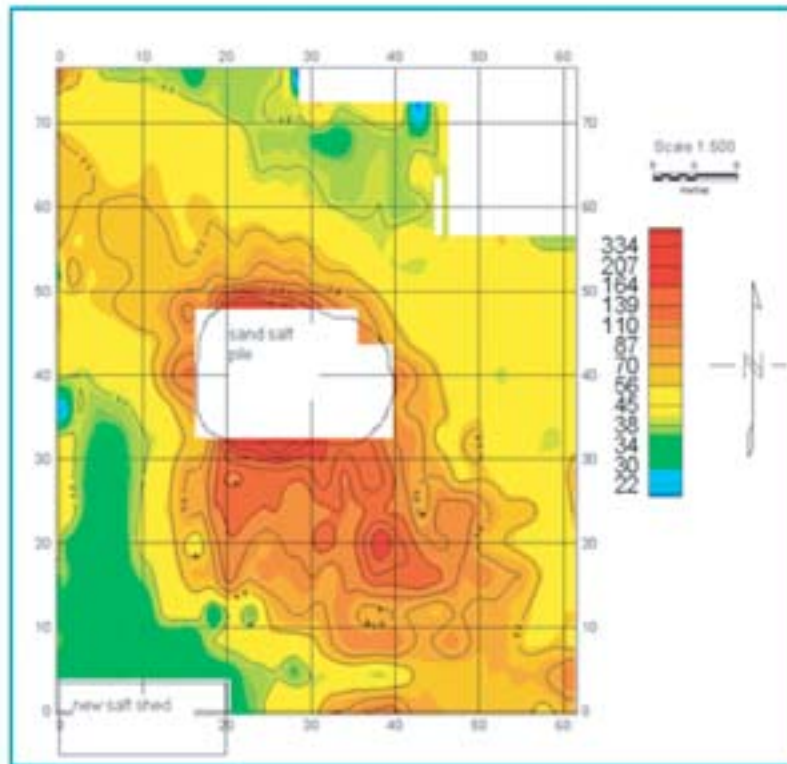
APPROACH TO INVESTIGATION

GEOPHYSICS

EM-31

- Conductivity survey
- Contours horizontal extents of salt impacts
- Identification of “hot spots”
- Aids in boreholes/CPT placement

APPROACH TO INVESTIGATION



APPROACH TO INVESTIGATION

GEOPHYSICS

EM-39

- Down hole conductivity survey
- Vertical delineation of salt impacts
- Identification of gravity driven salt plumes
- Aids in well screen placement

APPROACH TO INVESTIGATION

Conventional Drilling

(Boreholes coupled with down hole EM-39)

VS

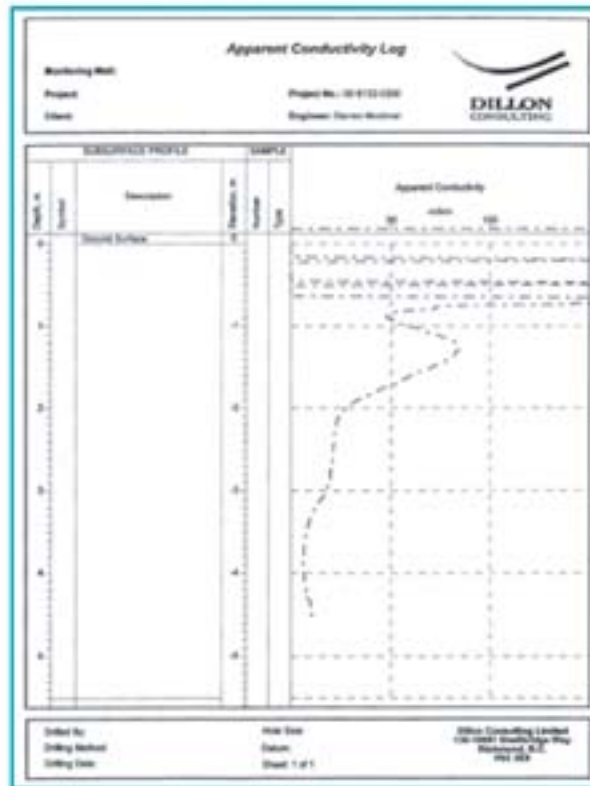
Direct Push Technology

(Cone Penetration Testing)



APPROACH TO INVESTIGATION

Conventional Drilling



CONVENTIONAL DRILLING

ADVANTAGES

Can be installed in any soil conditions

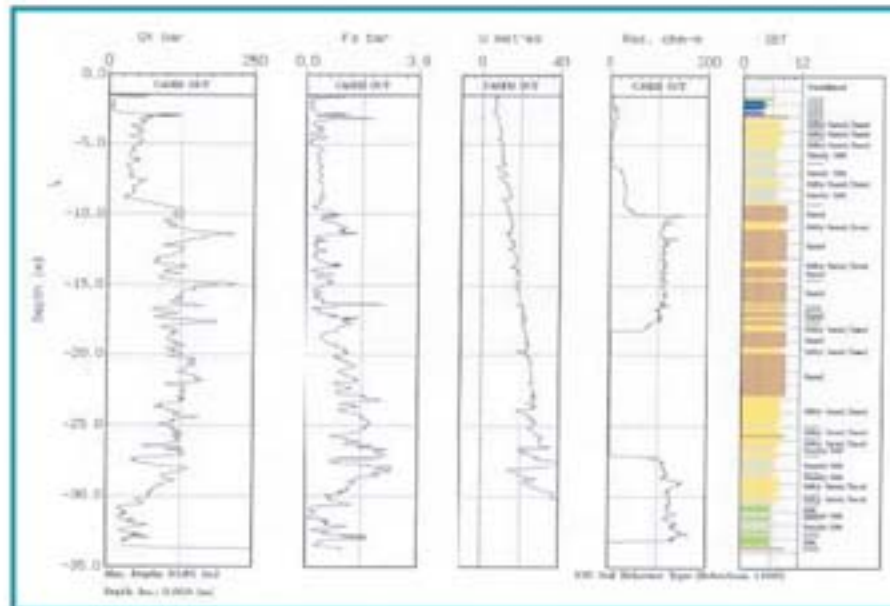
DISADVANTAGES

Time efficiency

- two step process
- No in situ groundwater or soil samples

APPROACH TO INVESTIGATION

Direct Push Technology



The freshwater/saltwater wedge is easily determined from soil resistivity

DIRECT PUSH TECHNOLOGY

ADVANTAGES

- Time efficient (vertical delineation completed as hole is advanced)
- In situ groundwater sampling
- Detailed stratigraphic logs produced including resistivity data

DISADVANTAGES

- Refusal in soils with gravel and cobbles
 - Two step process
 - No in situ groundwater or soil samples

SALT IMPACTED SOILS: REMEDIAL OPTION 1

REMEDIAL SOIL EXCAVATION AND OFF-SITE DISPOSAL

- Excavated material can be screened and reserved for future winter road application



SALT IMPACTED SOILS: REMEDIAL OPTION 2

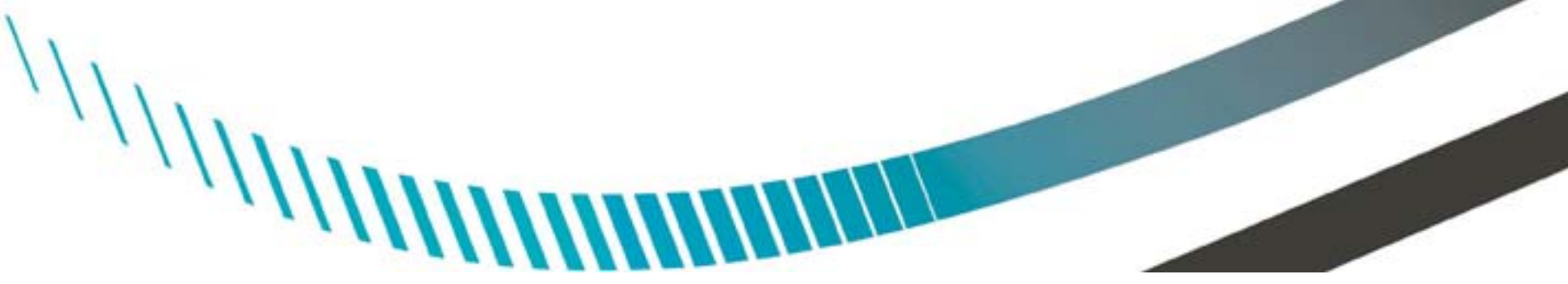
CALCIUM AMENDMENT ADDITION AND SOIL FLUSHING (IN SITU)

- Calcium amendments added to surface
- Irrigation of impacted area
- Collection of leachate in sub-horizontal catchment drains for disposal or treatment



SALT IMPACTED SOILS: REMEDIAL OPTION 3

REMEDIAL SOIL EXCAVATION AND SOIL FLUSHING (EX-SITU)

- Excavation of impacted soils
 - Placement of excavated soils in a partially sub-grade, PVC lined cell
 - Collection of salt-impacted water flushed through the cell in a perforated piping network installed beneath the cell
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SALT IMPACTED GROUNDWATER: REMEDIAL OPTION 1

MONITORED NATURAL ATTENUATION FOLLOWING SOIL REMEDIAL EXCAVATION

- Preliminary risk assessment required
- Source removal through excavation of soil hot spots
- Natural precipitation/flushing events remediate remaining soil and groundwater impacts
- Quarterly monitoring of groundwater perimeter wells

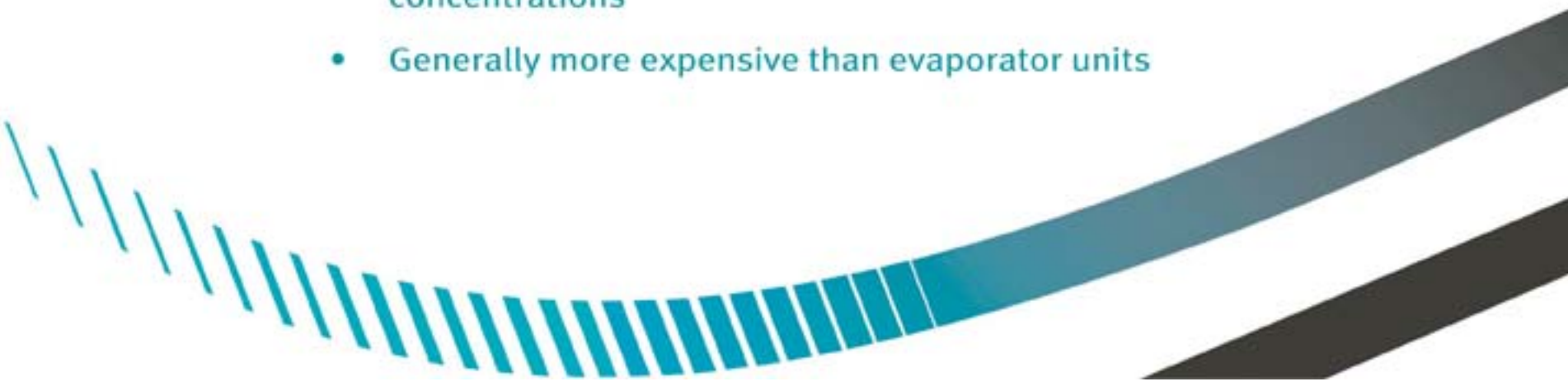
SALT IMPACTED GROUNDWATER: REMEDIAL OPTION 2

EVAPORATION

- Heating and evaporation of extracted groundwater and/or leachate collected from soil flushing activities
- Collection of salt in trap beneath evaporation unit
- Potential re-use of salt in winter road application

SALT IMPACTED GROUNDWATER: REMEDIAL OPTION 3

REVERSE OSMOSIS (RO)

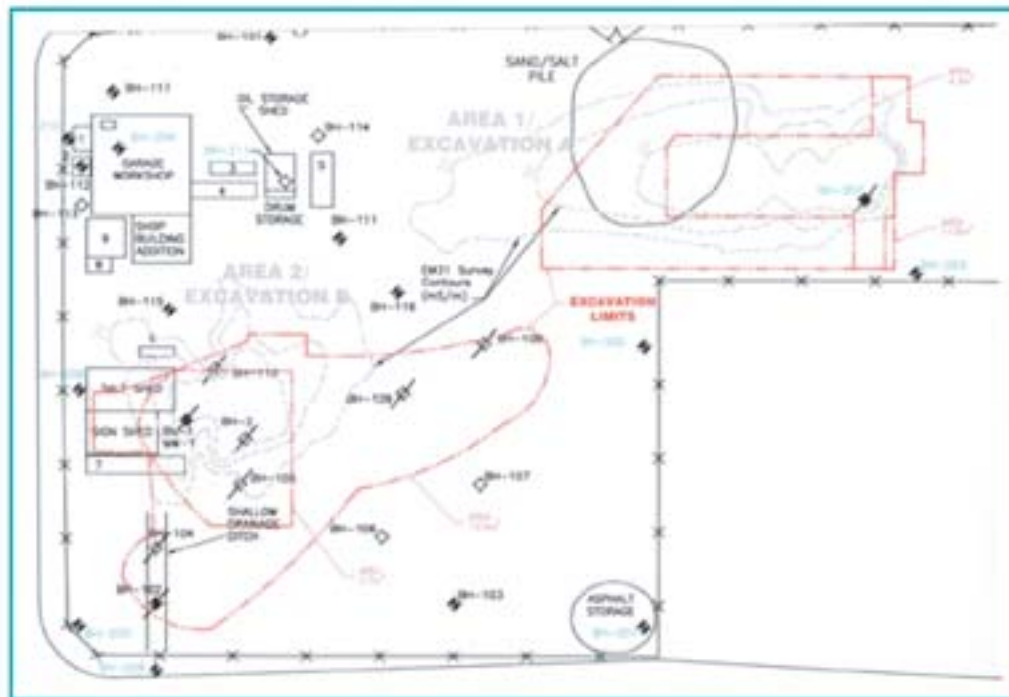
- Extracted groundwater and/or soil treatment leachate passed through a small RO unit
 - Separation of salt from water at ambient temperatures
 - RO system pressure requirements increase with dissolved salt concentrations
 - Generally more expensive than evaporator units
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REMEDIAL PROGRAM CASE STUDY

BACKGROUND

- Subject site has been a highways yard since the late 1960's
- Sodium chloride used in winter road de-icing was historically stored in two locations: ① inside a salt shed; and ② in an uncovered sand/salt pile
- Extensive soil and groundwater impacts were documented in the vicinity of both storage locations (PSI and DSI)

REMEDIAL PROGRAM CASE STUDY



REMEDIAL PROGRAM CASE STUDY

REMEDIAL APPROACH

- 1 EM-31 and EM-39 Surveys
- 2 Installation of Perimeter Monitoring Wells
- 3 Remedial Excavation and Off-Site Disposal



REMEDIAL PROGRAM CASE STUDY


REMEDIAL APPROACH

- 4 Construction of New Salt Shed with Leachate Collection System



REMEDIAL PROGRAM CASE STUDY

REMEDIAL APPROACH

- 5 Monitored natural attenuation of groundwater
(pre and post excavation groundwater monitoring)
 - 6 Development of a conceptual groundwater model
 - 7 Overview Ecological Risk Assessment
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REMEDIAL PROGRAM CASE STUDY

REMEDIAL RESULTS

- Decreasing trends in sodium and chloride concentrations were observed in site perimeter wells.
- The observed trends demonstrated that soils were being flushed by natural infiltration events and/or seasonal fluctuations in the water table.

REMEDIAL PROGRAM CASE STUDY

REMEDIAL RESULTS

- The Overview Ecological Risk Assessment concluded that the site posed little to no risk to down gradient receptors based on sodium and chloride concentrations in perimeter wells.
- The environmental liability of the site was demonstrated to be low and the site was subsequently sold.