Computer Assisted Radiological Survey (CARS) Technology for the Identification and Delineation of NORMs

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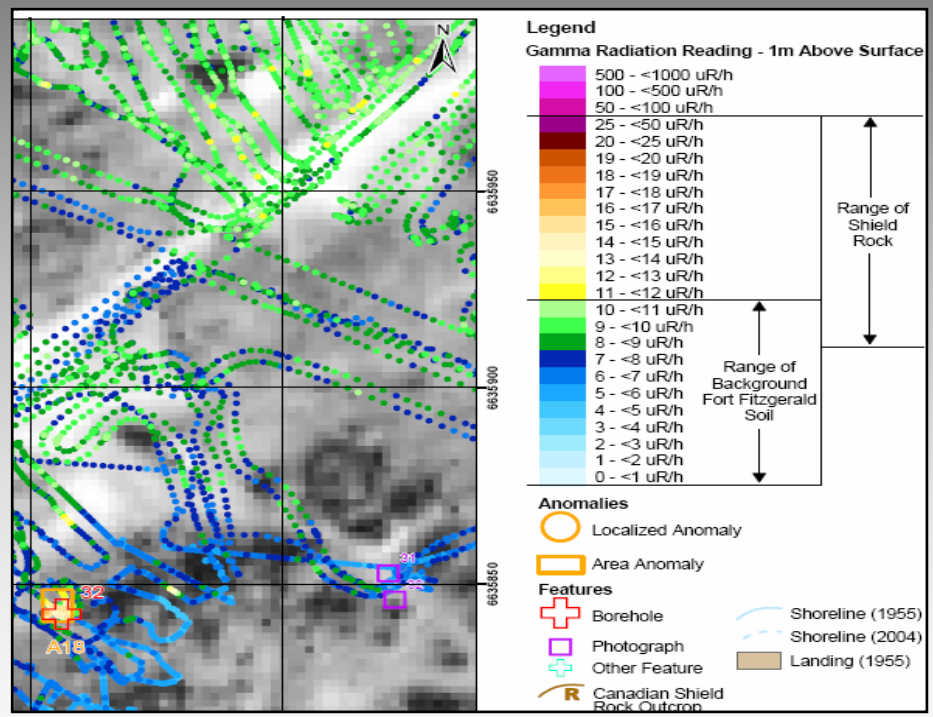
Computer Assisted Radiological Survey (CARS)

Identifies and Delineates Naturally Occurring Radioactive Materials (NORMs)

- real-time measurement technology
- compiles geo-referenced gamma radiation data over large surface areas
- displays data using computerized mapping systems
- used to support site management decisions



What is NORM?

An acronym for naturally occurring radioactive materials (including radioactive elements found in the environment)

- alpha (α) radiation: heavy, charged particles that do not easily penetrate solids (stopped by a piece of paper)
- beta (β) radiation: lighter charged particles that are more penetrating than alpha radiation (stopped by a few centimeters of plywood)
- gamma (γ) radiation: high-energy, penetrating particles (stopped by a metre of concrete or several metres of water)

Radiation Warning Symbol

Where can NORM be found?

Industries where NORM may be present:

- **Mineral Extraction and Processing**: NORM may be released or concentrated in a process stream during the processing of ore.
- **Oil and Gas Production**: NORM may be found in the liquids and gases from hydrocarbon-bearing geological formations.
- **Metal Recycling**: NORM-contaminated materials can be redistributed resulting in the formation of new NORM-contaminated products.

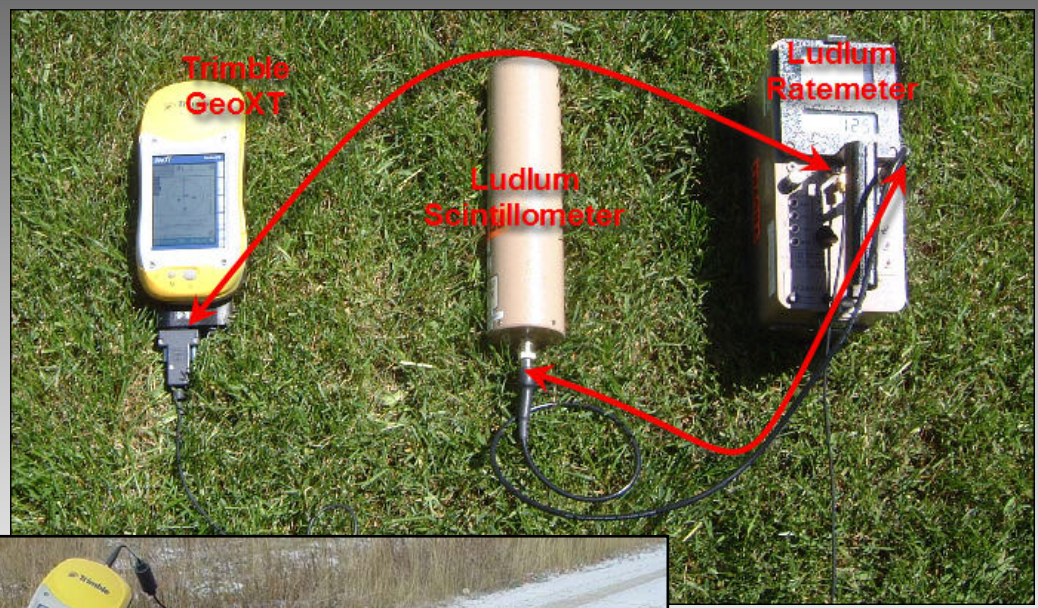
- **Forest Products and Thermal-Electric Production**: mineral ashes from combustion may concentrate the NORM present naturally in plant materials and in coal.
- **Water Treatment Facilities**: water treated through sorptive media or ion-exchange resins to remove minerals and other impurities may release radon.
- **Tunnelling and Underground Workings**: in areas where small amounts of indigenous radioactive minerals or gases may be present, such as in underground caverns, electrical vaults, tunnels, or sewer systems.

Our Experience

- **The Northern Transportation Route**
  - Delineation and/or remediation along Great Bear River and at Bell Rock, Fort Smith, Fort Fitzgerald and Fort McMurray
- **Light Industrial Property Re-Development, Ontario**
  - Delineation and remediation of brownfield site
- **First Nation Lands, Ontario**
  - Delineation studies
- **NE BC Oil & Gas Facilities**
  - Delineation studies

CARS - Hardware Configuration

- Trimble GeoXT Pocket PC
- Ludlum Model 2221 Portable Scaler Ratemeter
- Ludlum Model 44-10 Gamma Scintillometer
- Personal Computer

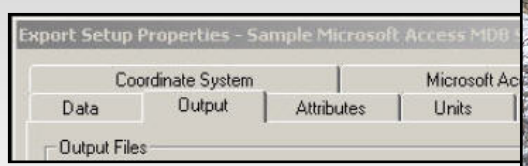


CARS - Software Configuration

Uses software to collect, analyze and display radiological data in the field:

- **TerraSync™**
  - collects and maintains data
- **Trimble® GPS Pathfinder®**
  - downloads data and differentially corrects
- **Microsoft Access**
  - stores data
- **Microsoft Excel**
  - sorts, categorizes, reviews and summarizes data
- **OziExplorer**
  - displays data on maps in the field
- **GIS**
  - final data display

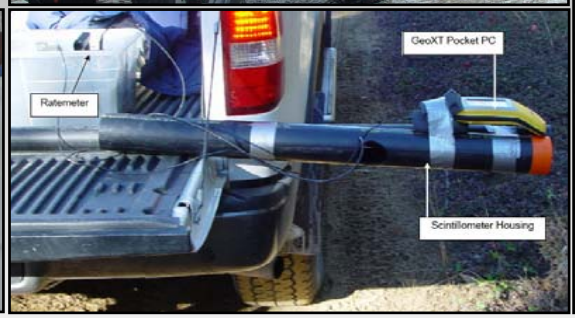
Longitude	Latitude	CPS	uR/hr
-79.8695572	46.3187963	1114	51.67
-79.8695498	46.3187917	1077	49.95
-79.8695515	46.3187948	1070	
-79.869555	46.3187947	1054	
-79.8695563	46.3187962	1047	
-79.8695556	46.318796	1048	
-79.8695502	46.3187941	1044	
-79.8695472	46.318793	1028	
-79.869555	46.3187952	1026	



Carry Mode

The CARS system can be transported via:

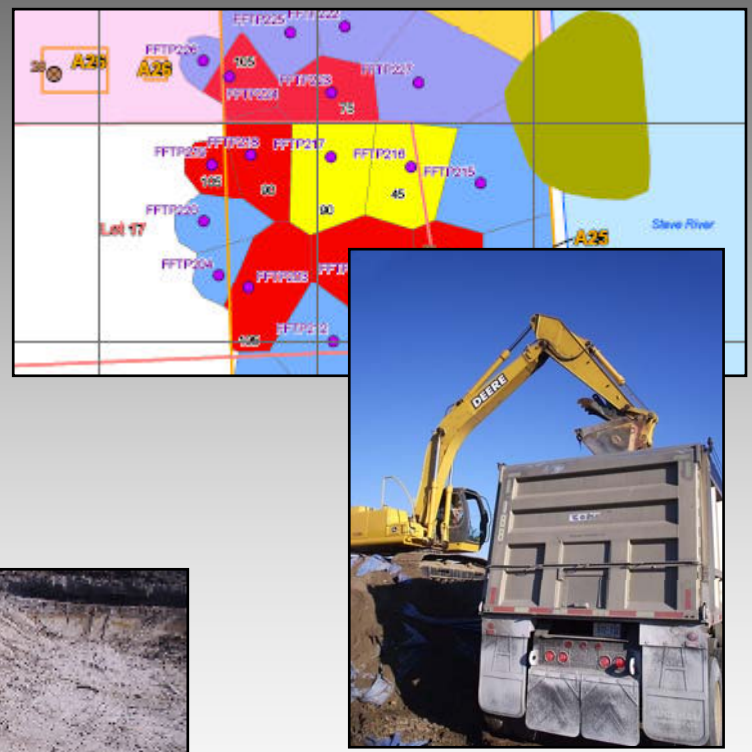
- Backpack
- Cart
- Quad
- Truck



Delineate / Remediate / Confirm

Surveys can be conducted to:

- Identify and delineate target areas
- Guide remedial excavation efforts
- Verify post remediation conditions



Survey Grid Density

Data is often collected relative to a grid system

- **1 m Dense Coverage**
  - 3 to 5 m grid pattern
  - rate of 1 m/s (a slow walk)
  - probe at 1 m above ground
  - delineates elevated areas to within 2 m of their true boundary
- **1 m Normal Level Coverage**
  - 3 to 5 m grid pattern
  - rate of 2 m/s (a brisk walk)
  - probe at 1 m above ground
  - small point source detection less likely
- **1 m Screening Level Coverage**
  - 5 to 10 m grid pattern
  - rate of 2 m/s (a brisk walk)
  - probe at 1 m above ground
  - small point source detection unlikely
- **Contaminant Delineation**
  - 1 to 3 m grid pattern
  - rate of 1 m/s (a slow walk)
  - probe at near contact (<15 cm) with the ground
  - provides an accurate picture of the anomaly

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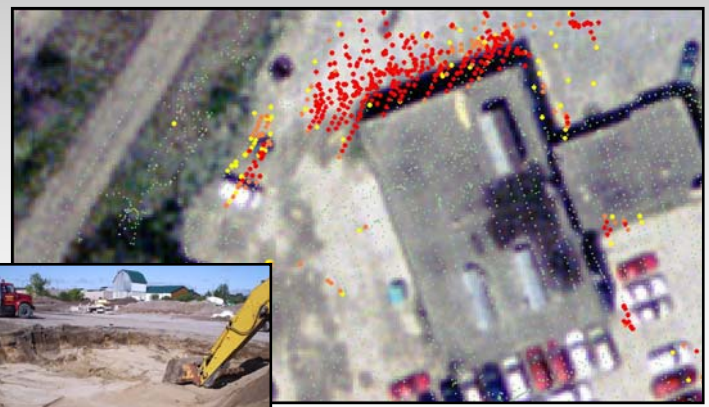
Case Study 1 – Light Industrial Property Re-Development

Real-time data managed and analyzed on-site using CARS

- Short fuse, turnkey remediation project in Peterborough, Ontario
- Owner expanding onto a site adjacent to existing operations
- Property had been used to process uranium ores
- Property exhibited elevated levels of radiation in addition to more conventional contaminants (hydrocarbons and metals)



Case Study 1 – Light Industrial Property Re-Development

Site investigation, remediation, and close-out activities rolled into one field deployment

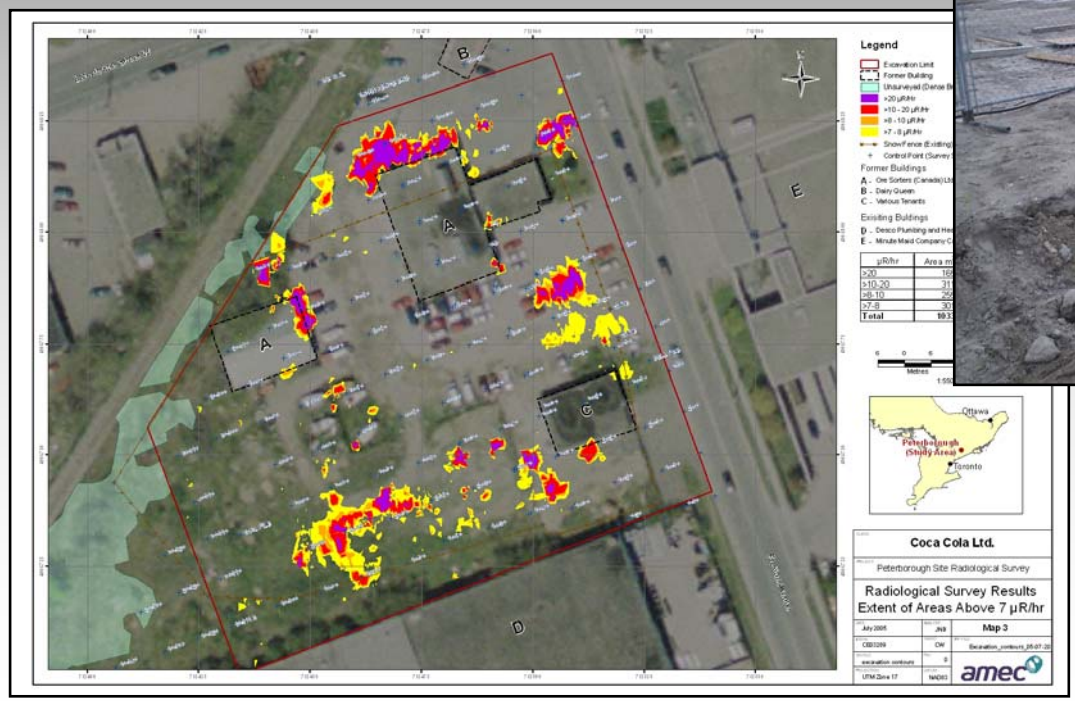
- **Owner retained AMEC in July 2005 at suggestion of Atomic Energy of Canada Limited (AECL)**
- **AMEC's scope was to:**
  - **Remove or contain radioactive ores**
  - **Prepare buildings for demolition by removing hazardous materials**
  - **Remediate hydrocarbon and metal contaminated soils**
- **Needed to minimize disruption to planned site development work**

Case Study 1 – Light Industrial Property Re-Development

- About 2.5 tonnes of concentrated ore separated from 4,000 m^3 of soil
- Ores transferred to a secure off-site storage facility maintained by AECL
- 300 m^3 of less concentrated material stored securely on-site per Canadian Nuclear Safety Commission (CNSC) directives
- Entire process completed in 3½ months with minimal impact on original site development schedule

Case Study 1 – Light Industrial Property Re-Development

- Surveys used to identify starting points for excavation
- Surveys repeated with each lift as excavation progressed vertically
- Detector at near contact (<15 cm) with the ground
- 1 meter survey grid
- Accurate picture of the anomaly



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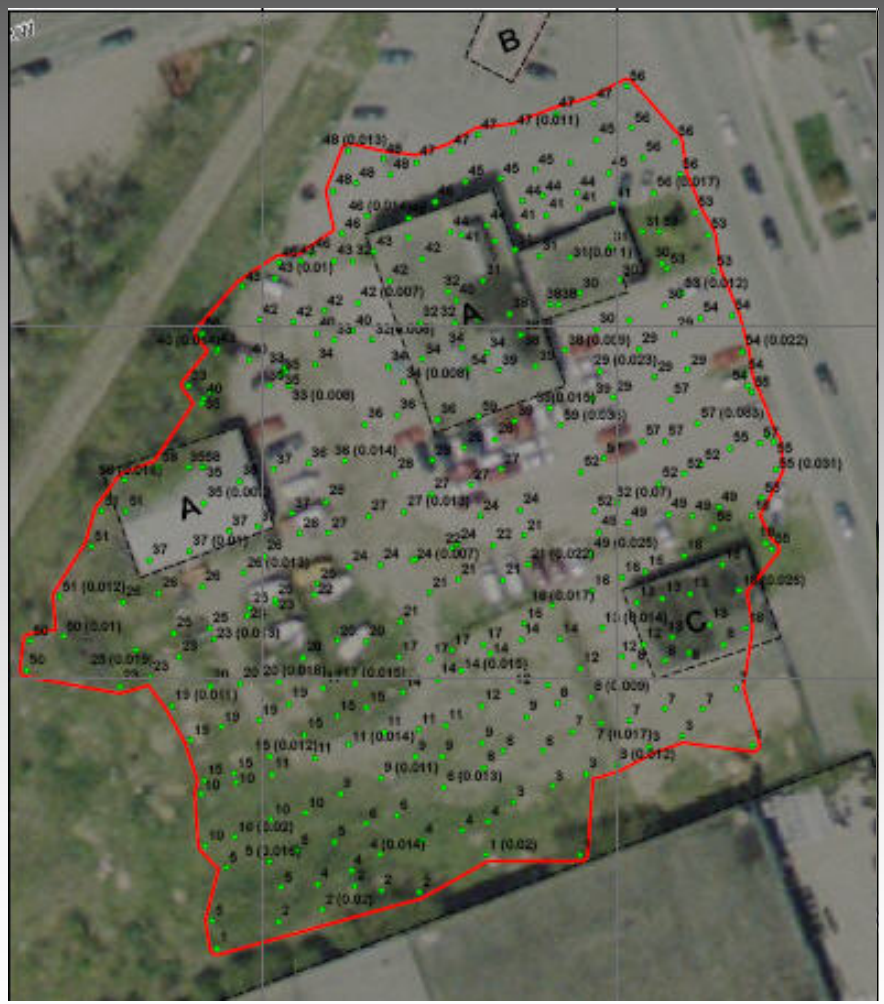
Case Study 1 – Light Industrial Property Re-Development

ARC GIS used to generate final report survey maps:

Case Study 1 – Light Industrial Property Re-Development



Delineation survey field results

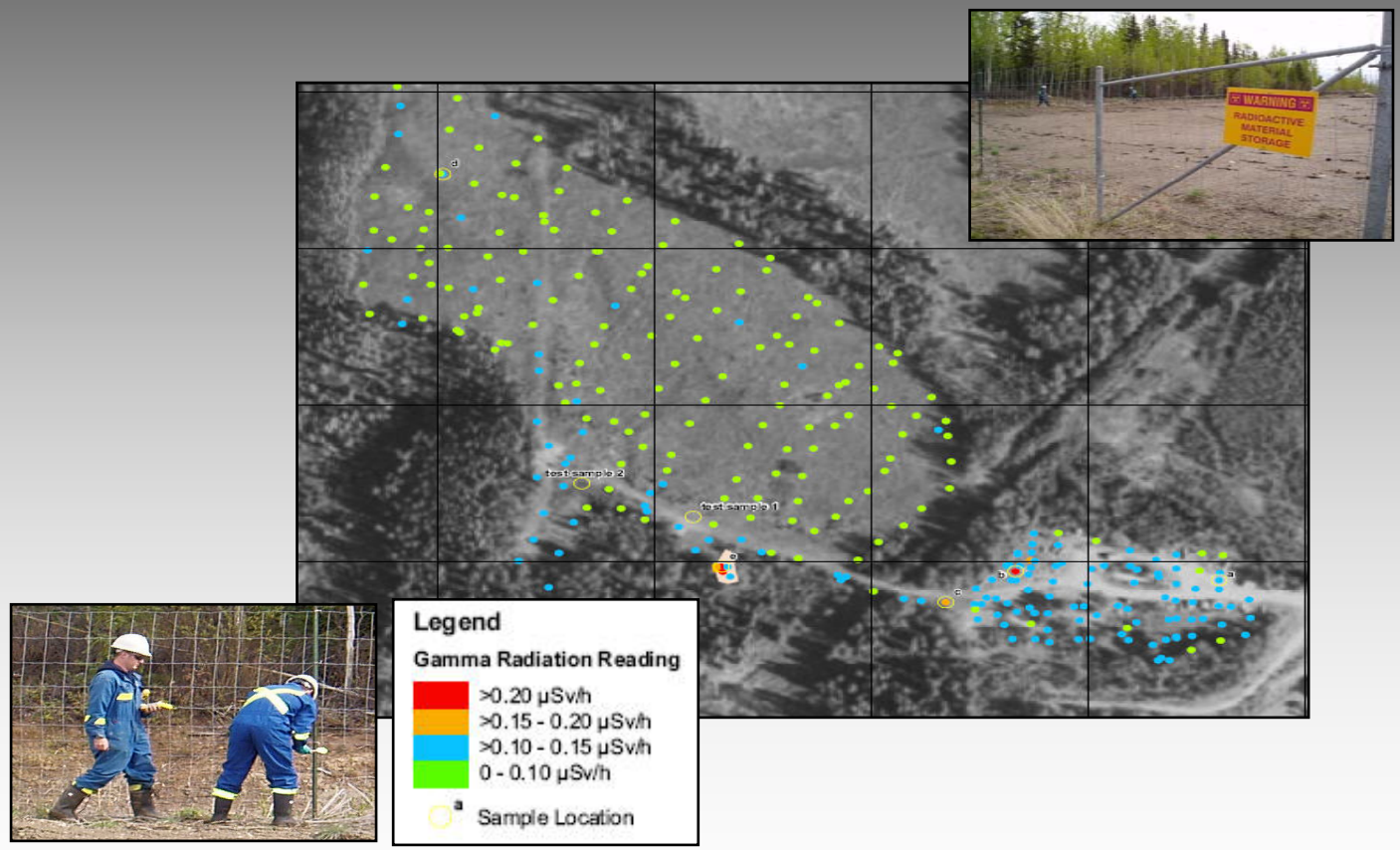
Delineation survey final results

Post remediation survey results

Post remediation sample locations

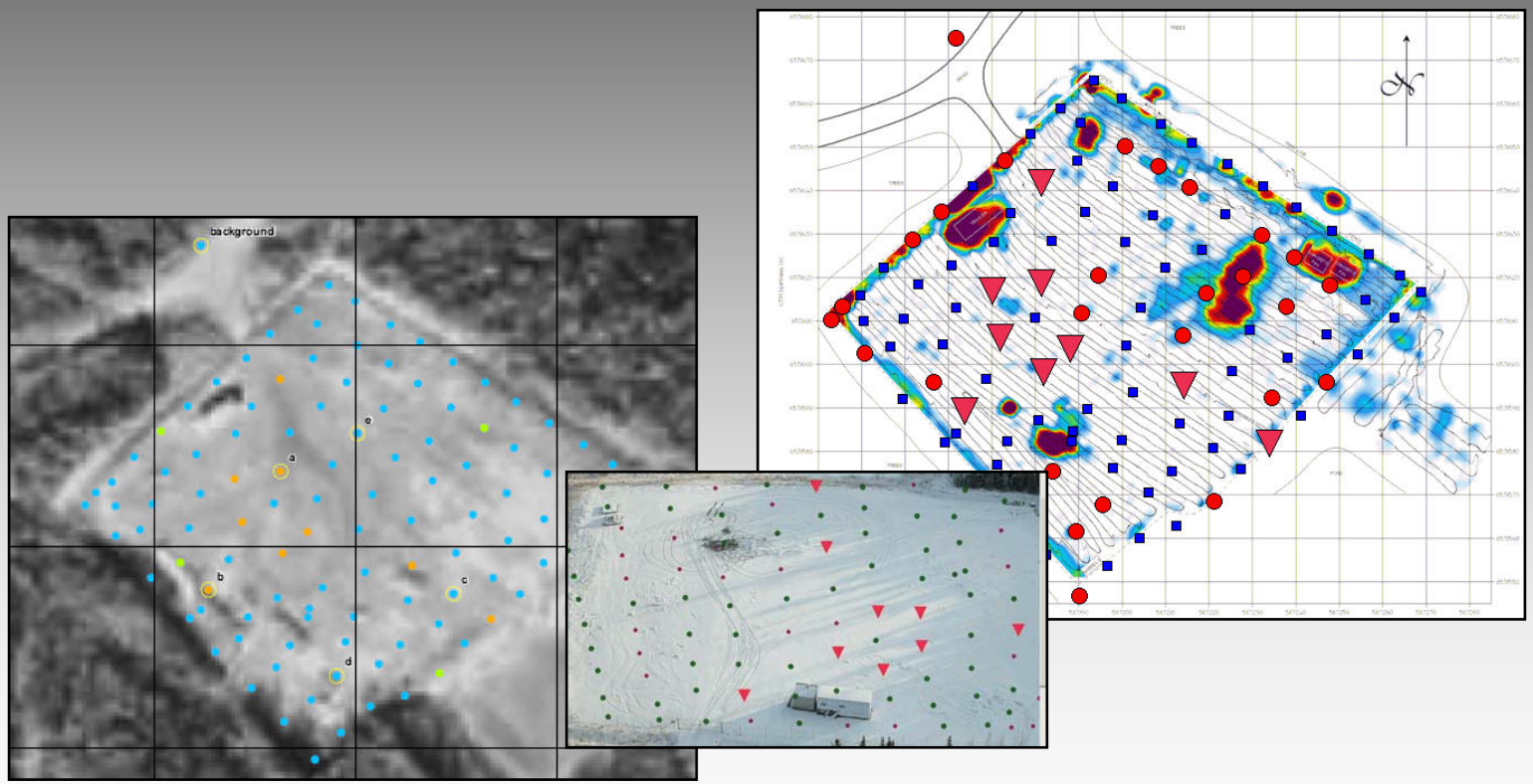
Case Study 2 – Northeastern BC Gas Wells

Utilization of CARS at oil and gas facilities and well sites



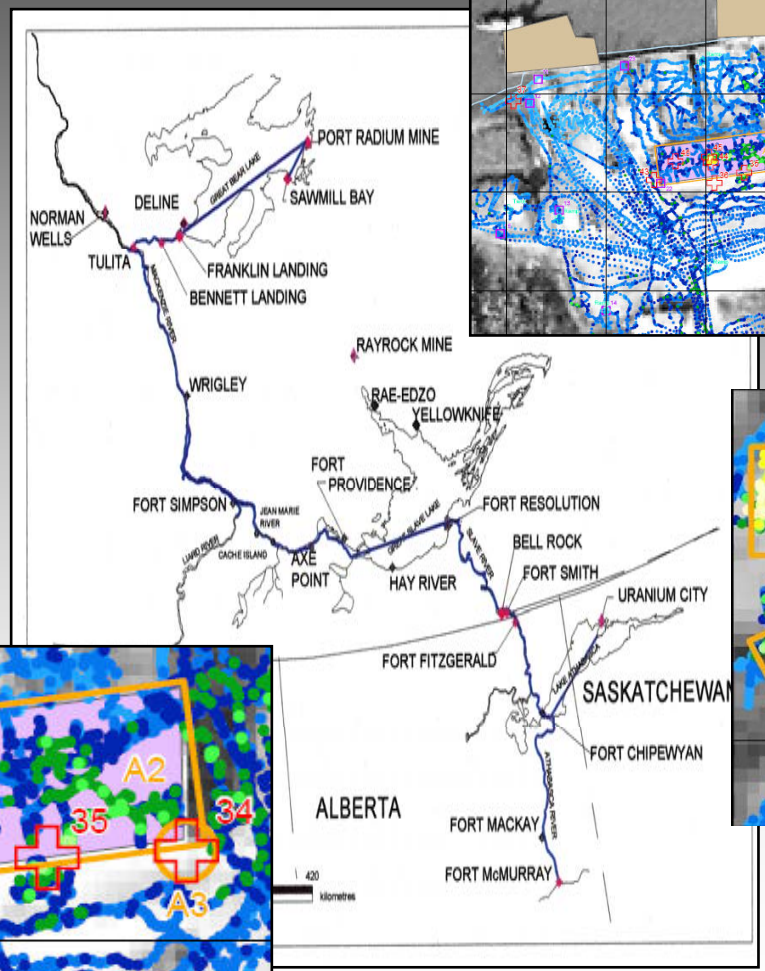
Case Study 2 – Northeastern BC Gas Wells

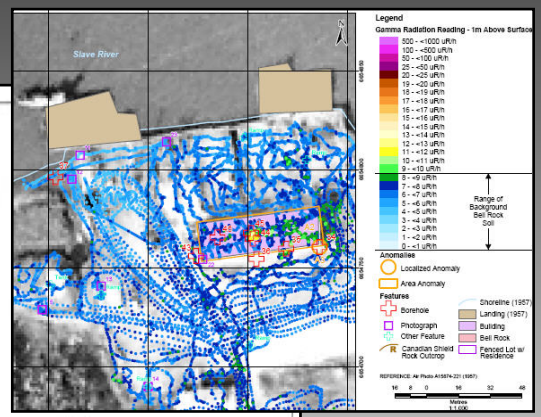
CARS data displayed over air photos, historic photographs and EM survey maps while in the field

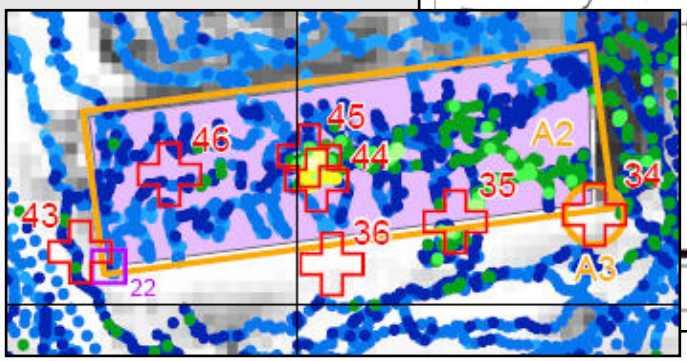


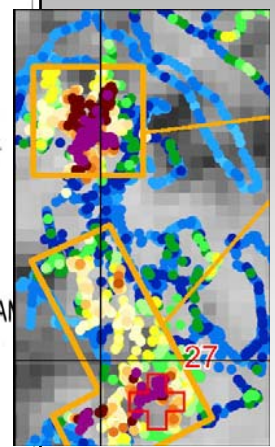
Case Study 3 – Uranium Transportation Route

- Recently applied CARS to refine volume estimates at various sites
- Information will be used by AECL, the CNSC and local communities to support site management plans









Case Study 3 – Uranium Transportation Route

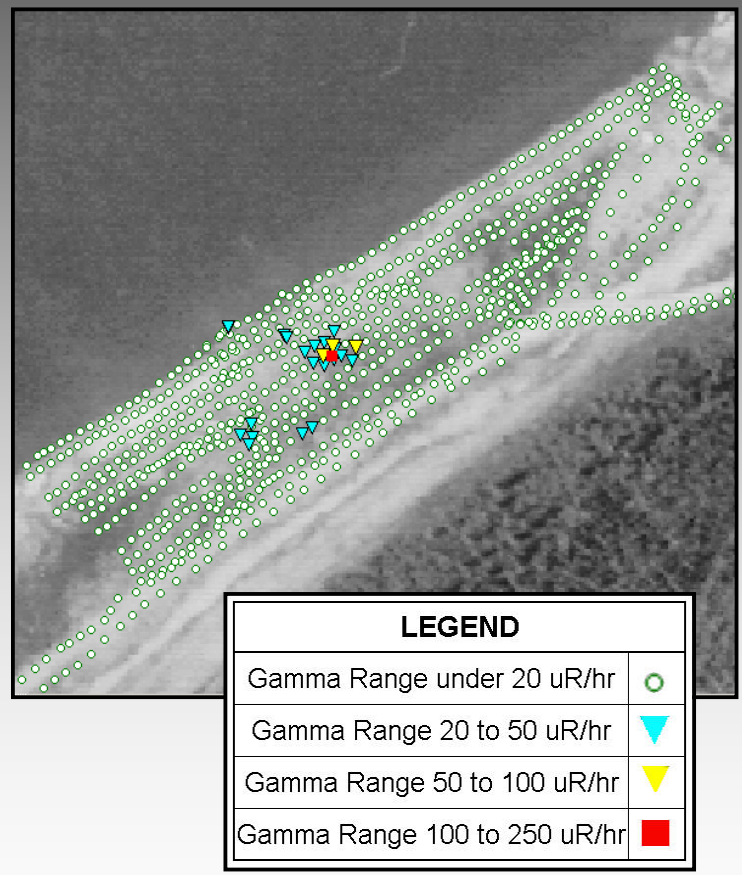
Scope included the design, data collection and data interpretation for radiological surveys at:

- **Great Bear River Portage**
- **Bell Rock**
- **Former haul roads (portage routes) between Bell Rock and Fort Smith**
- **Selected sites within Fort Smith**
- **Former haul roads (portage routes) between Fort Smith and Fort Fitzgerald**
- **Fort Fitzgerald (including the former NTCL Marine Terminal Lands)**

Case Study 3 – Uranium Transportation Route

Example results:

- **810 gamma radiation readings over 2.7 ha**
- **24 (3%) of readings above the typical upper range of exposures from terrestrial sources**
- **Maximum gamma radiation reading was 195 µR/h**
- **Elevated readings clustered near centre of site**



Case Study 4 – First Nation Lands, Ontario

Problem was the legacy of a pilot ore processing operation set up on lake front property. AMEC's work was designed to:

- **assess gamma radiation on 50 residential lots**
- **estimate the potential for contamination more generally throughout the local communities**
- **Evaluate remedial options and costs**

Case Study 4 – Nipissing First Nation

Methods Employed:

- **Surveys conducted on a 5 m grid pattern**
- **Grid pattern modified to 3 m in areas of higher radiation**
- **Backpack carry mode with the scintillometer positioned 1 m above surface.**
- **3 surveyors**

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