Soil Remediation in Coarse Gravelly Soils

Challenges and Lessons Learned

Michael L. Brewster, Jennifer Durden,
Kelly Jones and Michael Morden

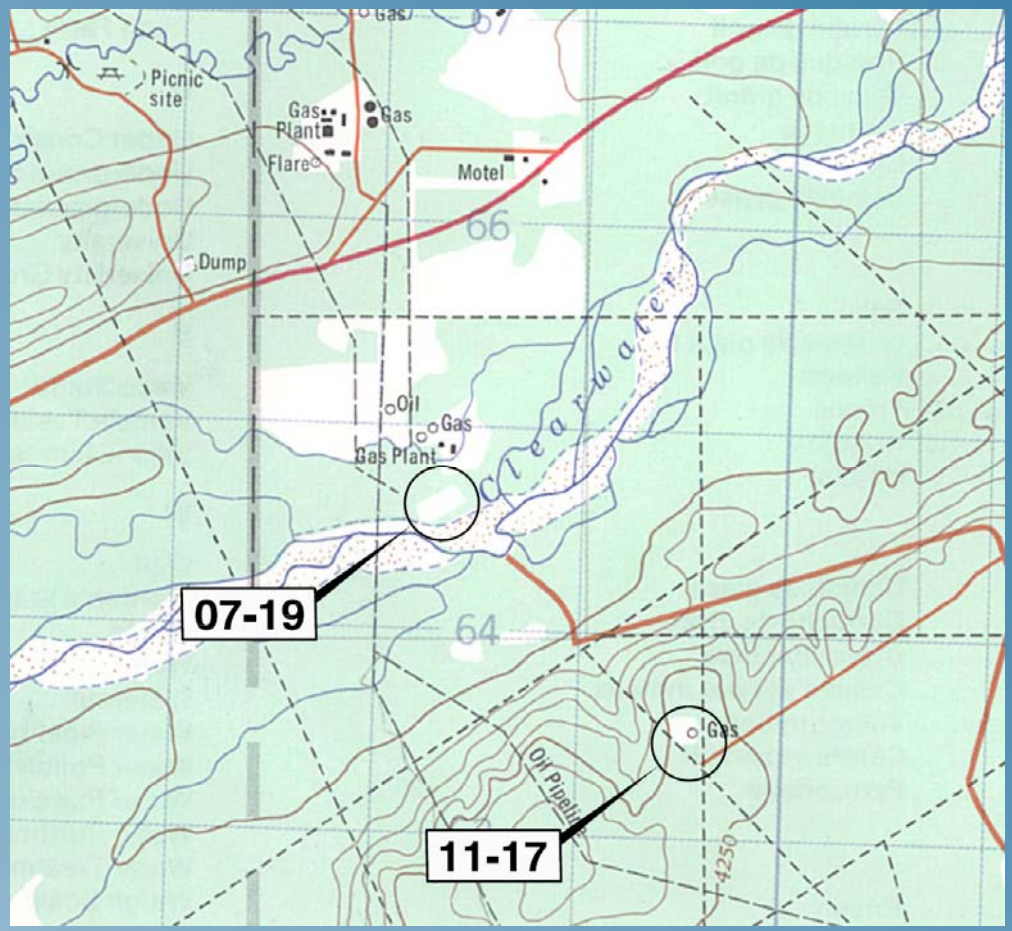
KOMEX

ETL EnviroTest LABORATORIES

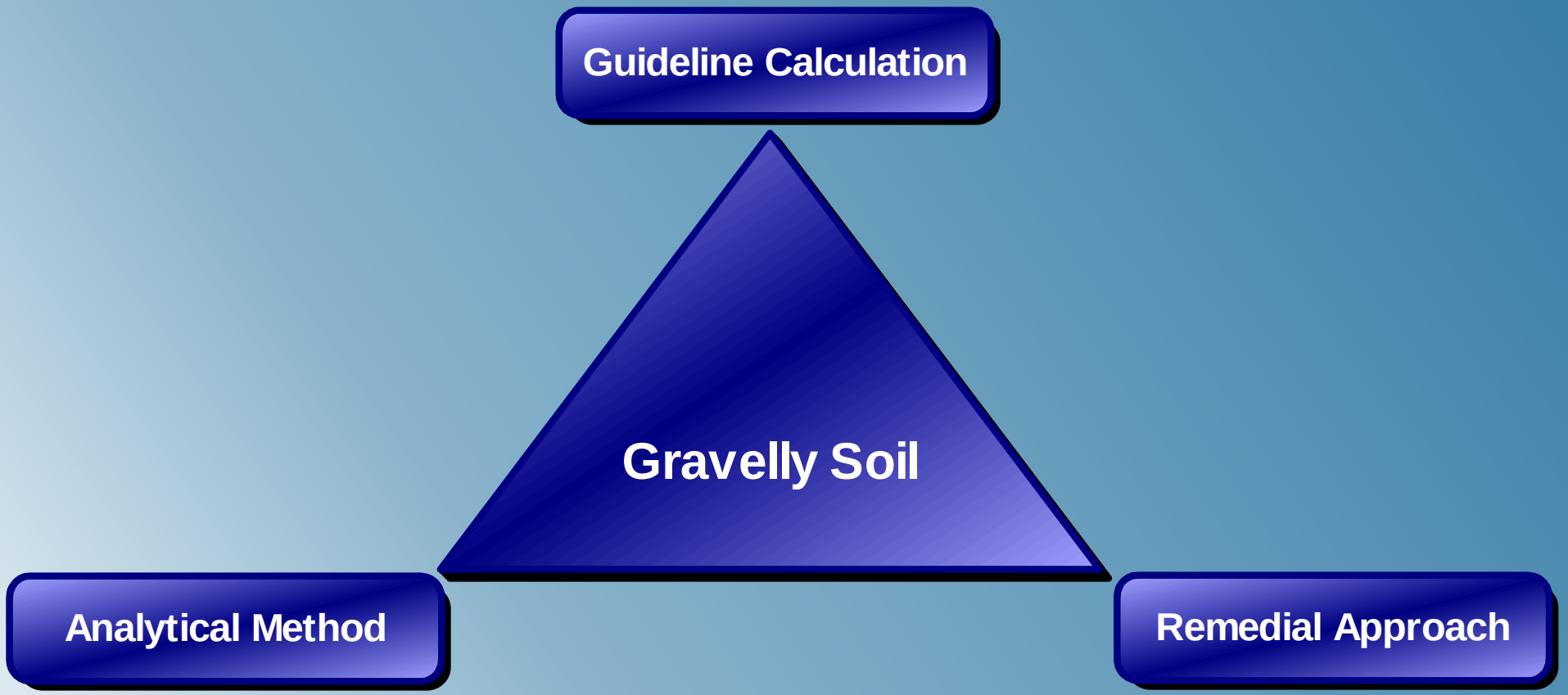
PETRO-CANADA

Introduction

- Two former PC gas well sites in Ricinus
- On the bank of Clearwater River and on former glacial river terraces

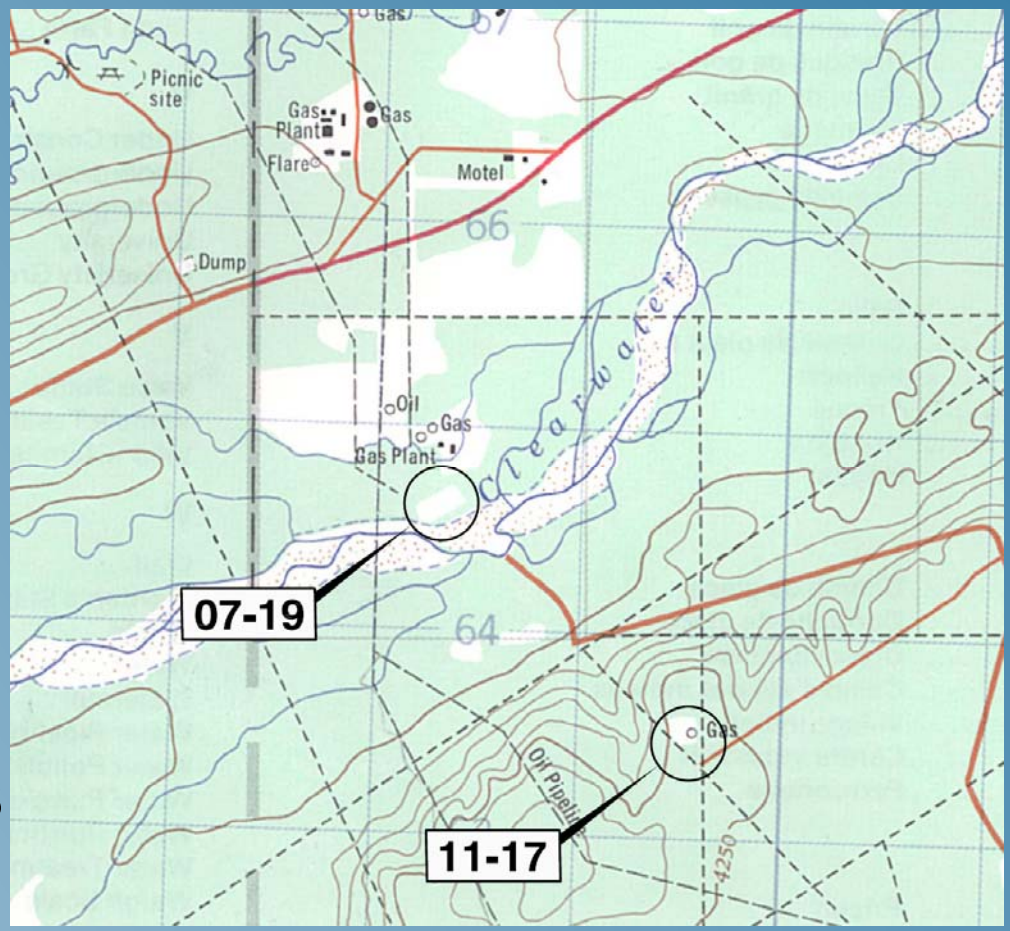


Challenges

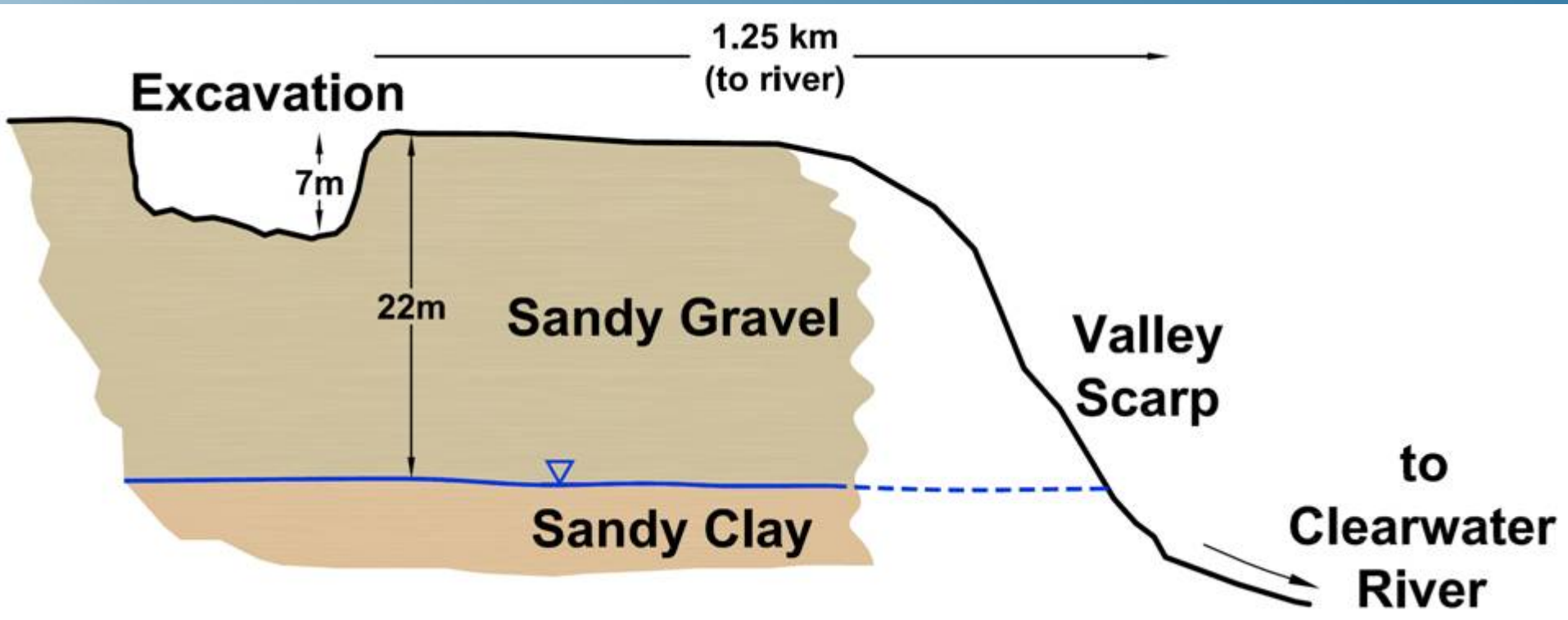

Guideline Calculation
Gravelly Soil
Analytical Method
Remedial Approach

11-17 Site Characteristics

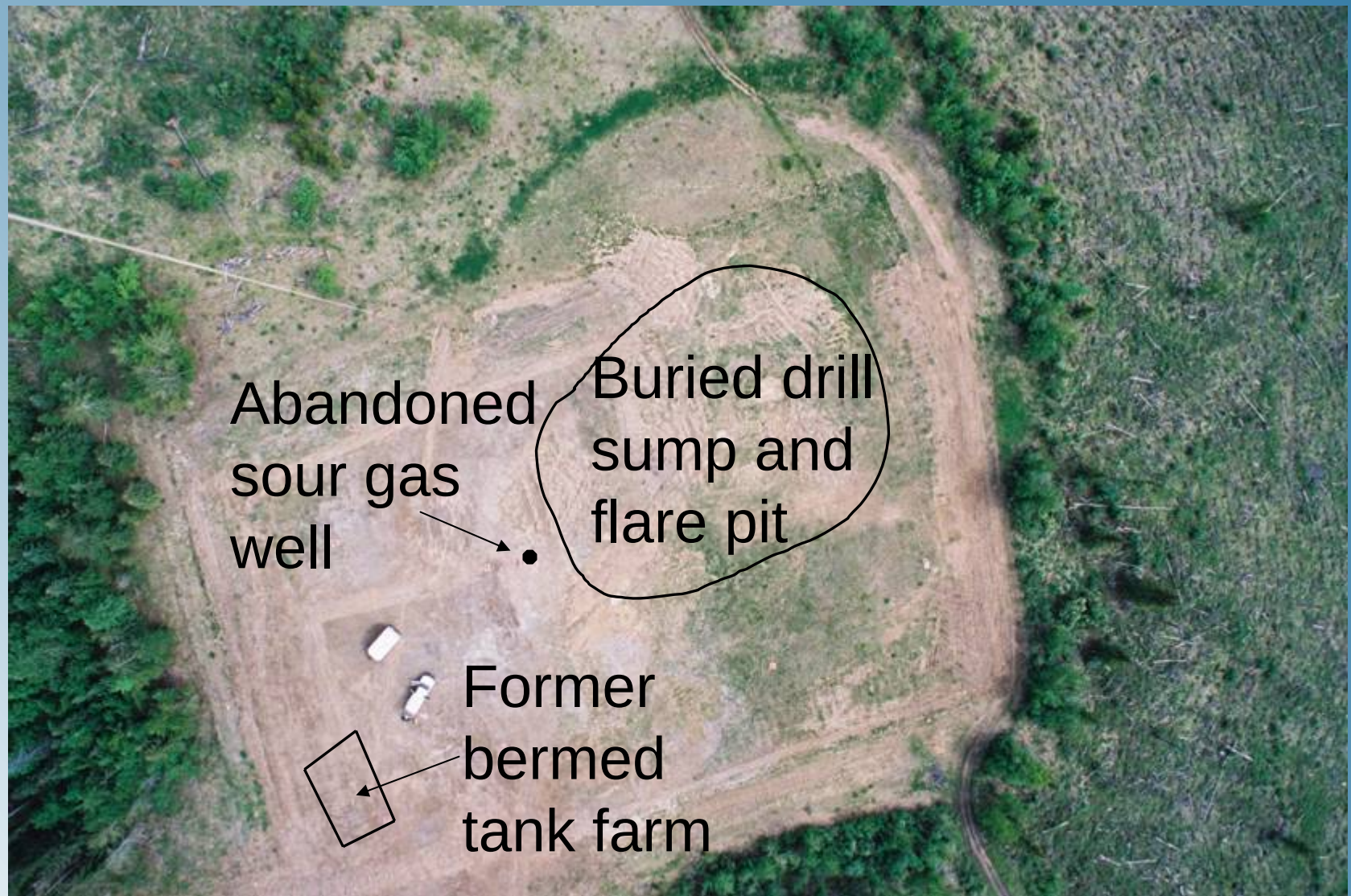
- Approx. 1.25 km southeast of the Clearwater River
- Surficial geology: glacio-fluvial valley train deposits of gravel
- Surface drainage to the west and north
- Groundwater approx. 22-24 mbgs



11-17 Site Characteristics

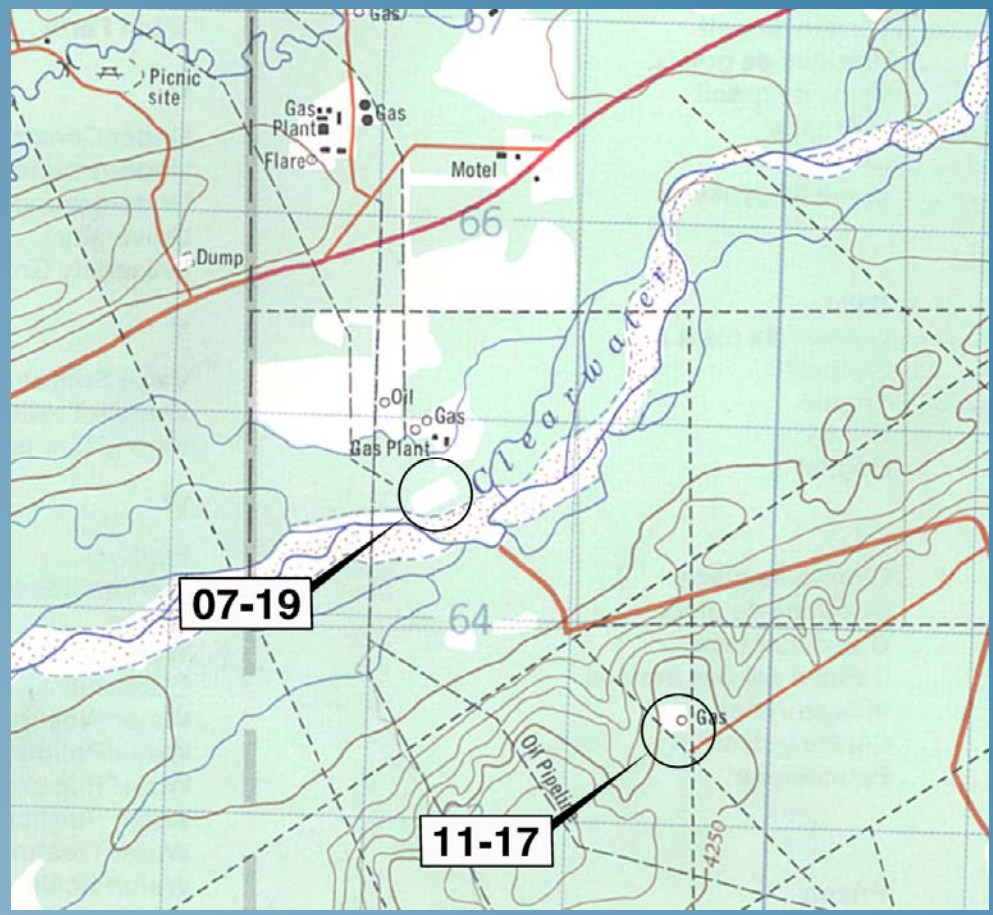


11-17 Contaminant Sources

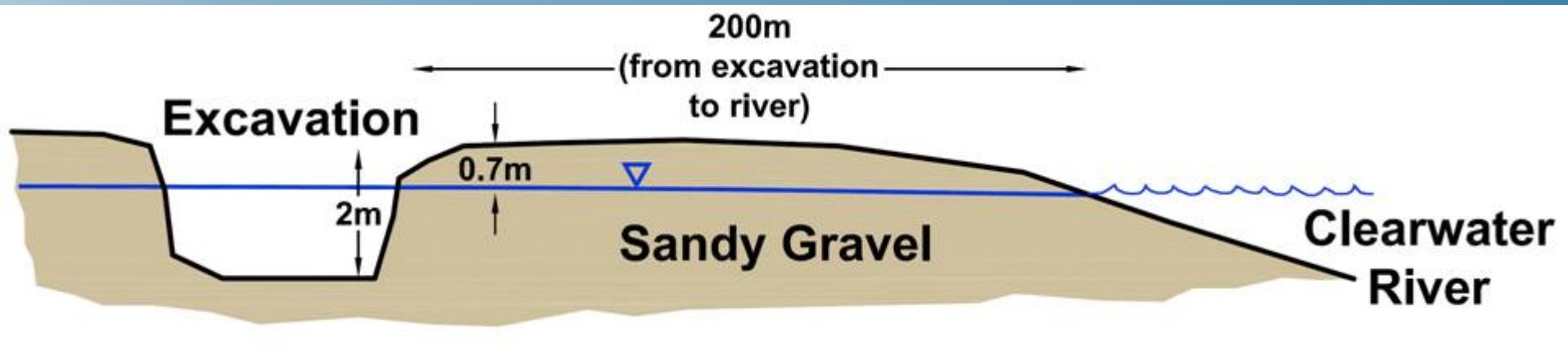


07-19 Site Characteristics

- On the north bank of the Clearwater River
- Elevation is 1.5 to 2 m above the non-flood river level
- On recent alluvial gravel deposits
- Groundwater is approx. 0.7 mbgs

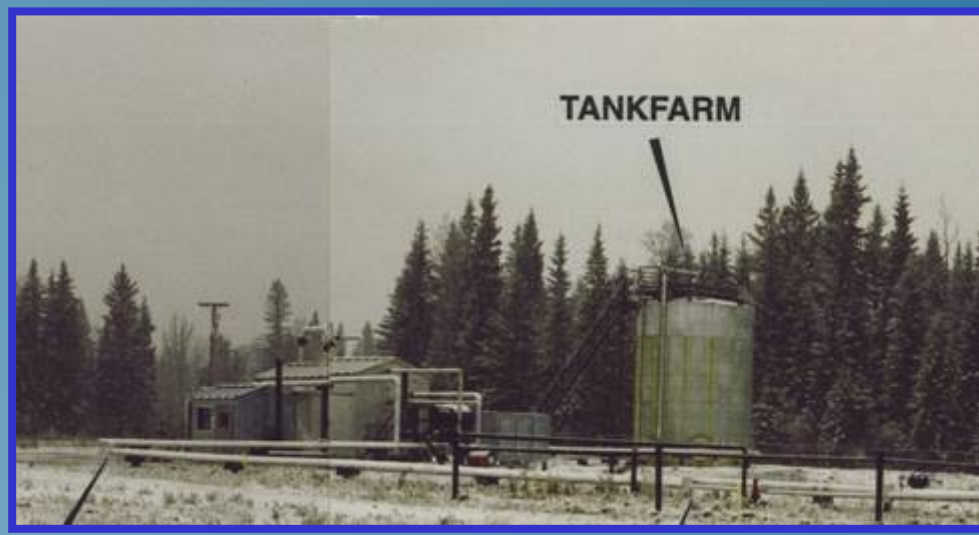


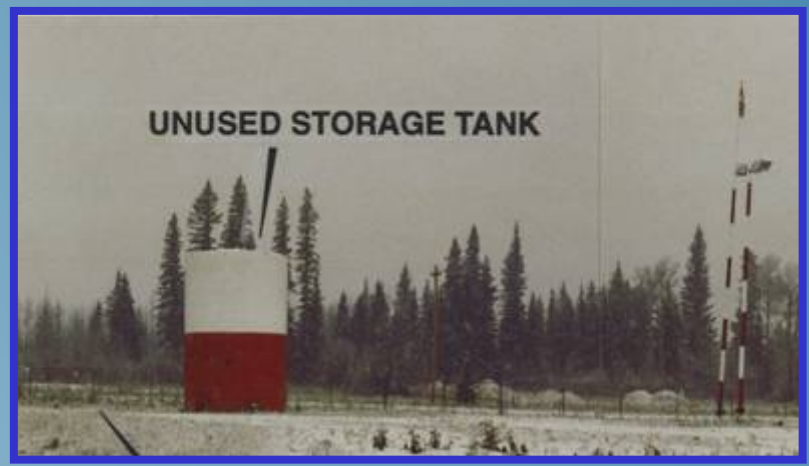
07-19 Site Characteristics



07-19 Contaminant Sources

- Sour water facility

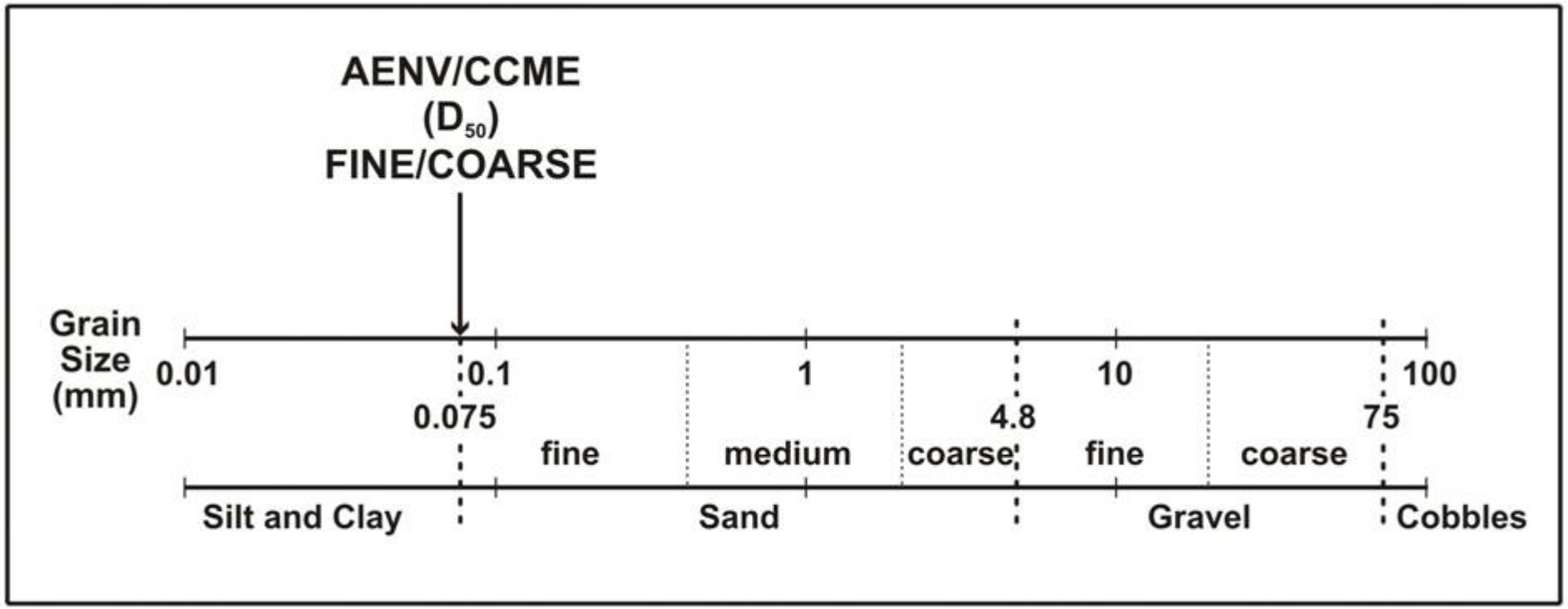




Regulatory Guidelines

- **AENV Soil and Water Quality Guidelines for Upstream Facilities**
- **Natural Area Land Use**
- **Tier 1 guidelines apply to silty sand and finer soil types ($K < 1 \times 10^{-5}$ m/s)**

Soil Particle Size Divisions



Tier 2 Site-Specific Guidelines

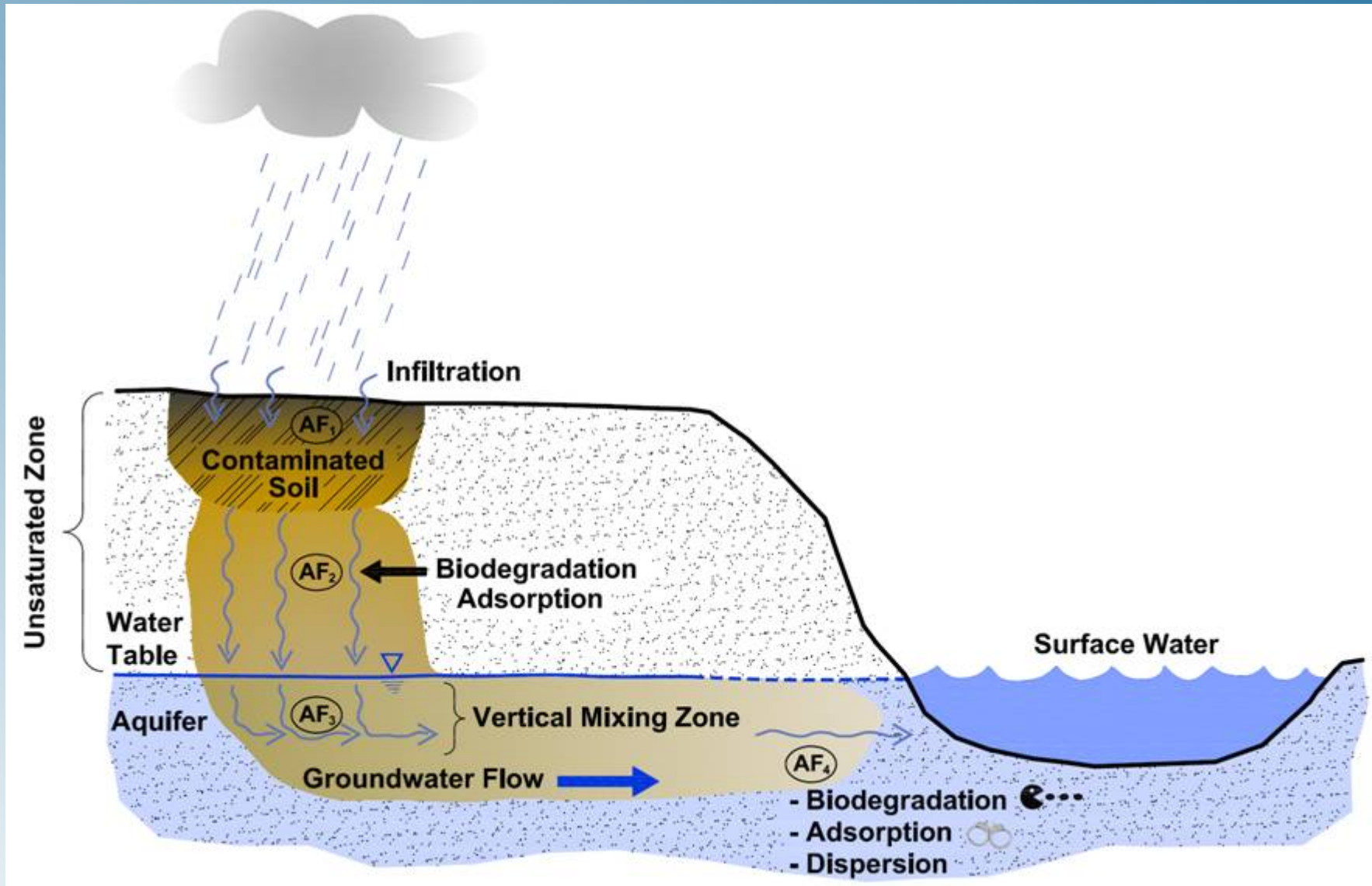
- **Tier 2 hydrocarbon guidelines for soil needed for these pathways:**

1. **soil contact (plants and invertebrates)**
2. **soil ingestion (wildlife)**
3. **protection of potable groundwater**
4. **protection of groundwater for aquatic life**
5. **protection of groundwater for wildlife**

Tier 2 Guideline Calculations

- **Soil contact guidelines only by conducting toxicity tests**
- **Tier 1 soil ingestion by wildlife guidelines are independent of soil texture**
- **Tier 2 guidelines for three groundwater pathways using site-specific properties**

Tier 2 Soil Guidelines – Protection of Aquatic Life



Tier 2 Soil Guidelines

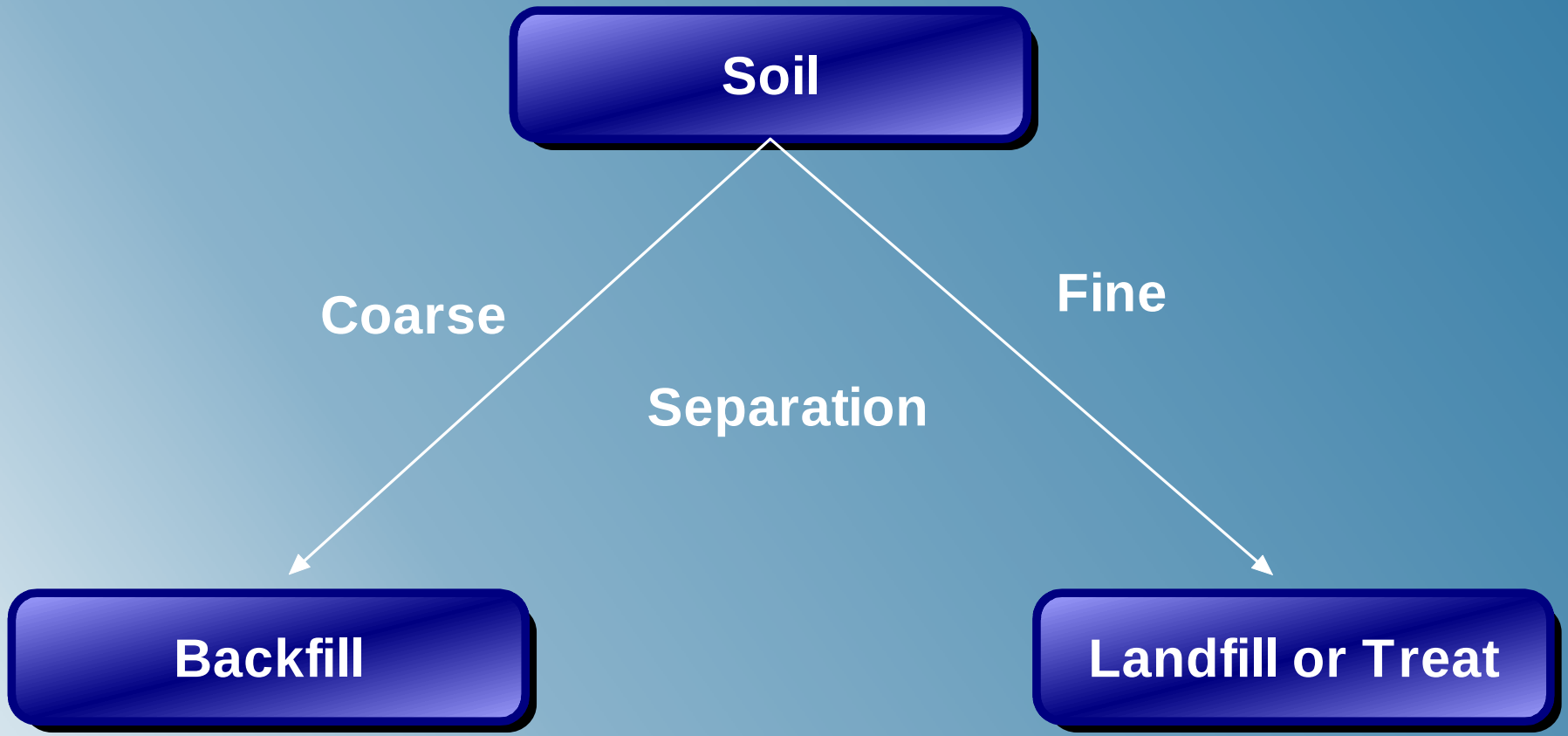
Protection of Groundwater for Aquatic Life

Site	B (mg/kg)	T (mg/kg)	E (mg/kg)	X (mg/kg)	F1 (mg/kg)	F2 (mg/kg)
Tier 1 Coarse	1.6	0.16	79	59	360	230
11-17	17	43	RES	RES	19,000	8,300
7-19	4.2	***0.14***	***30***	***27***	410	293

Distribution of Contaminants

- **Biomodal distribution of hydrocarbon:**
  - **Cobbles and gravel: surface coatings**
  - **Finer particles: adsorbed, diffused into soil matrix or surface coating**

Remedial Approach

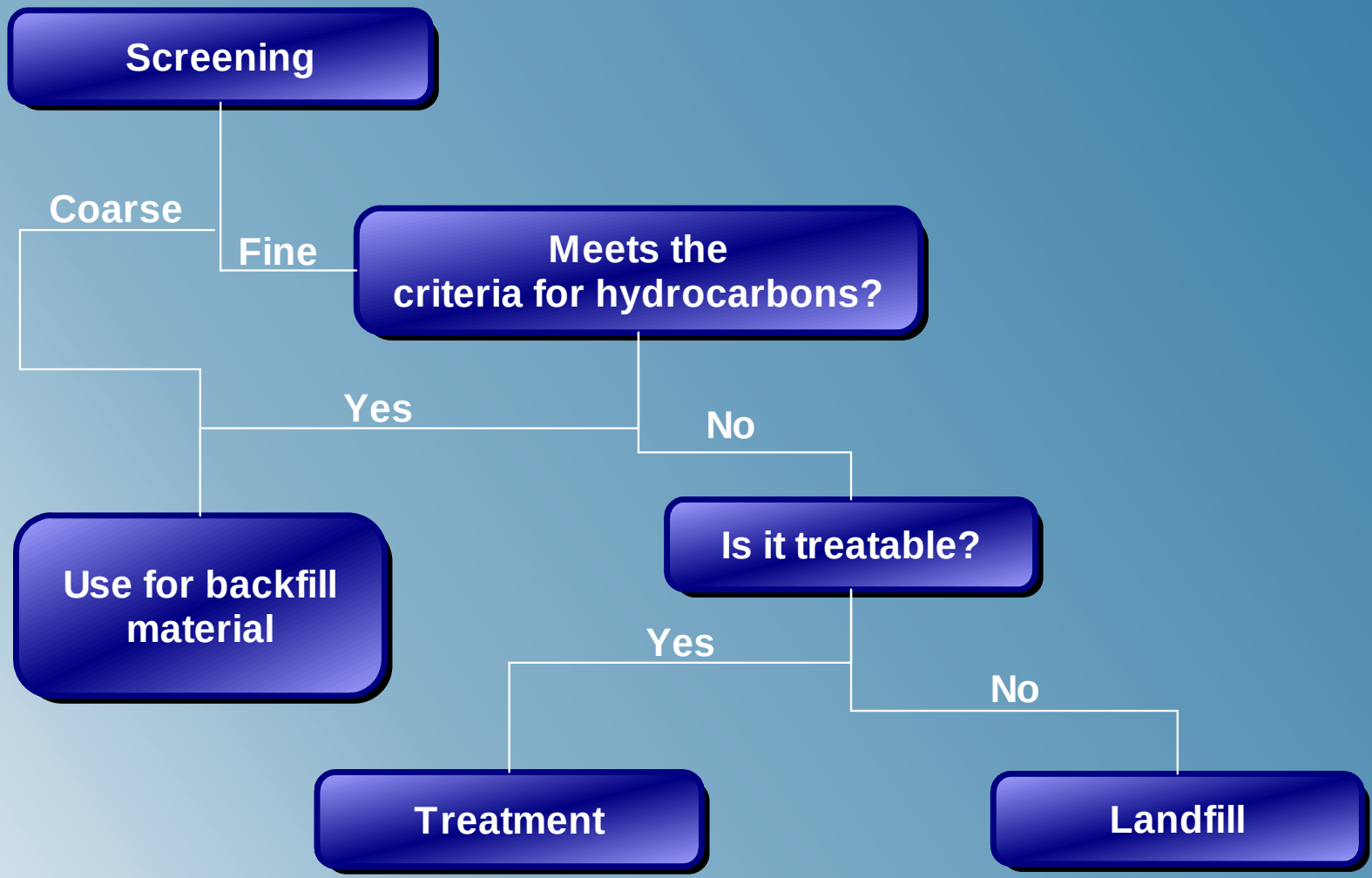


Pilot Scale Program

- biomodal distribution confirmed
- 11-17: 22% sand minus, 78% gravel plus

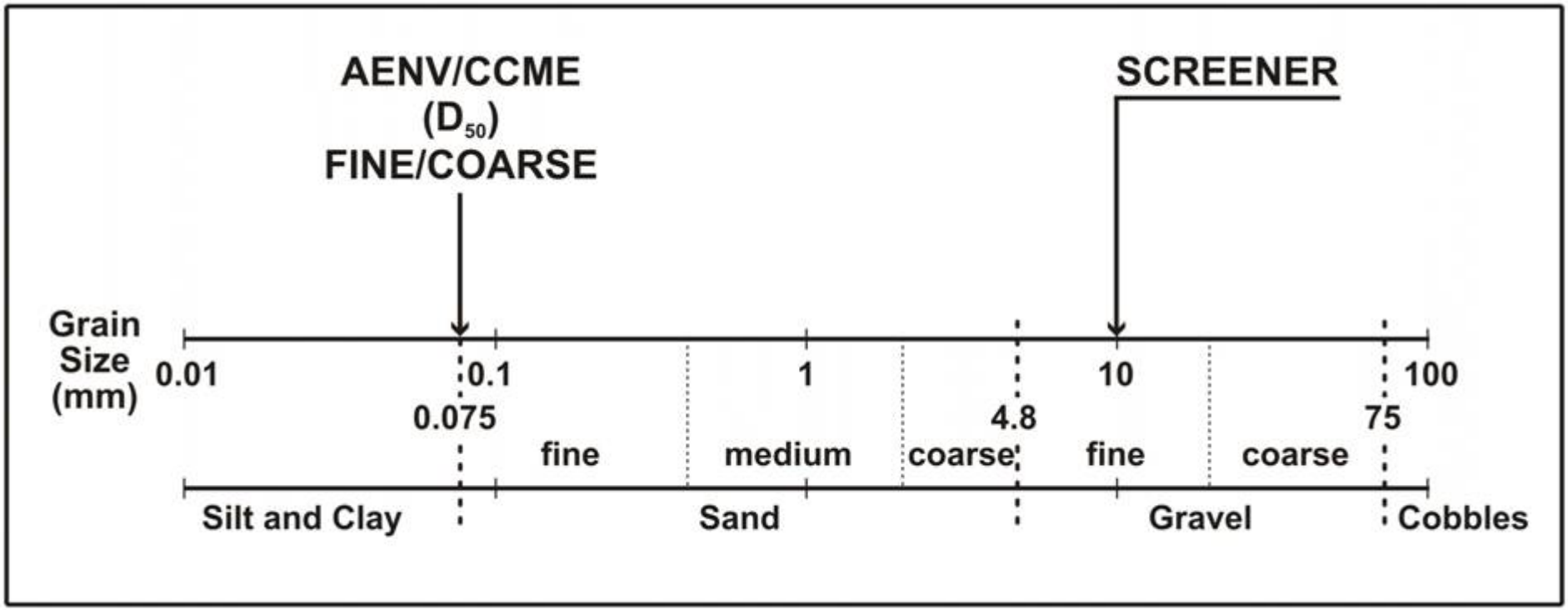
Hydrocarbon fraction (mg/kg)	Sand minus (<10mm)	Gravel Plus (>10mm)
F2	3,300	220
F3	4,500	190
F4	990	41

Full Scale Program



Screening Soil at 07-19

Soil Particle Size Divisions



11-17 Remedial Progress

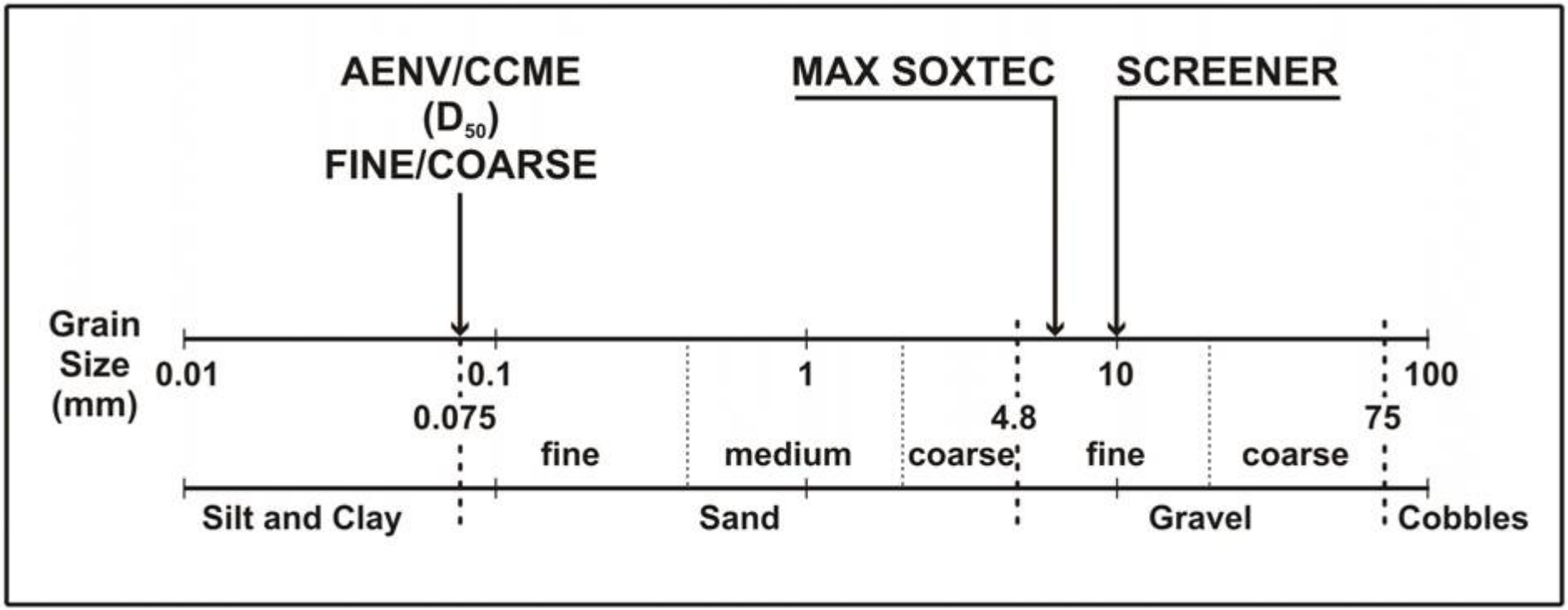
07-19 Remedial Progress

Analytical Procedure

- **arbitrarily biases results towards finer fraction of soil**

Analytical Procedure

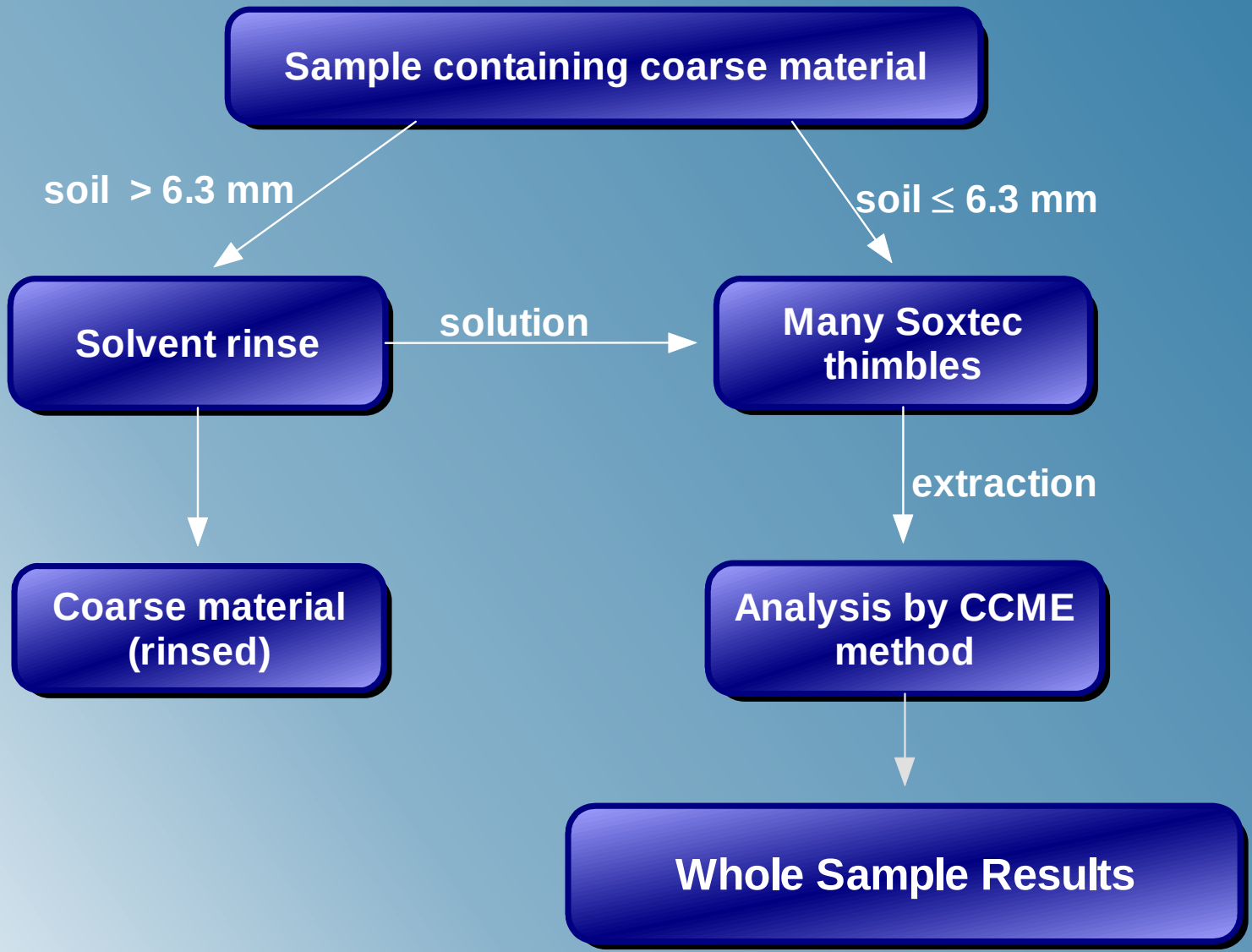
Soil Particle Size Divisions



Analytical Method Options

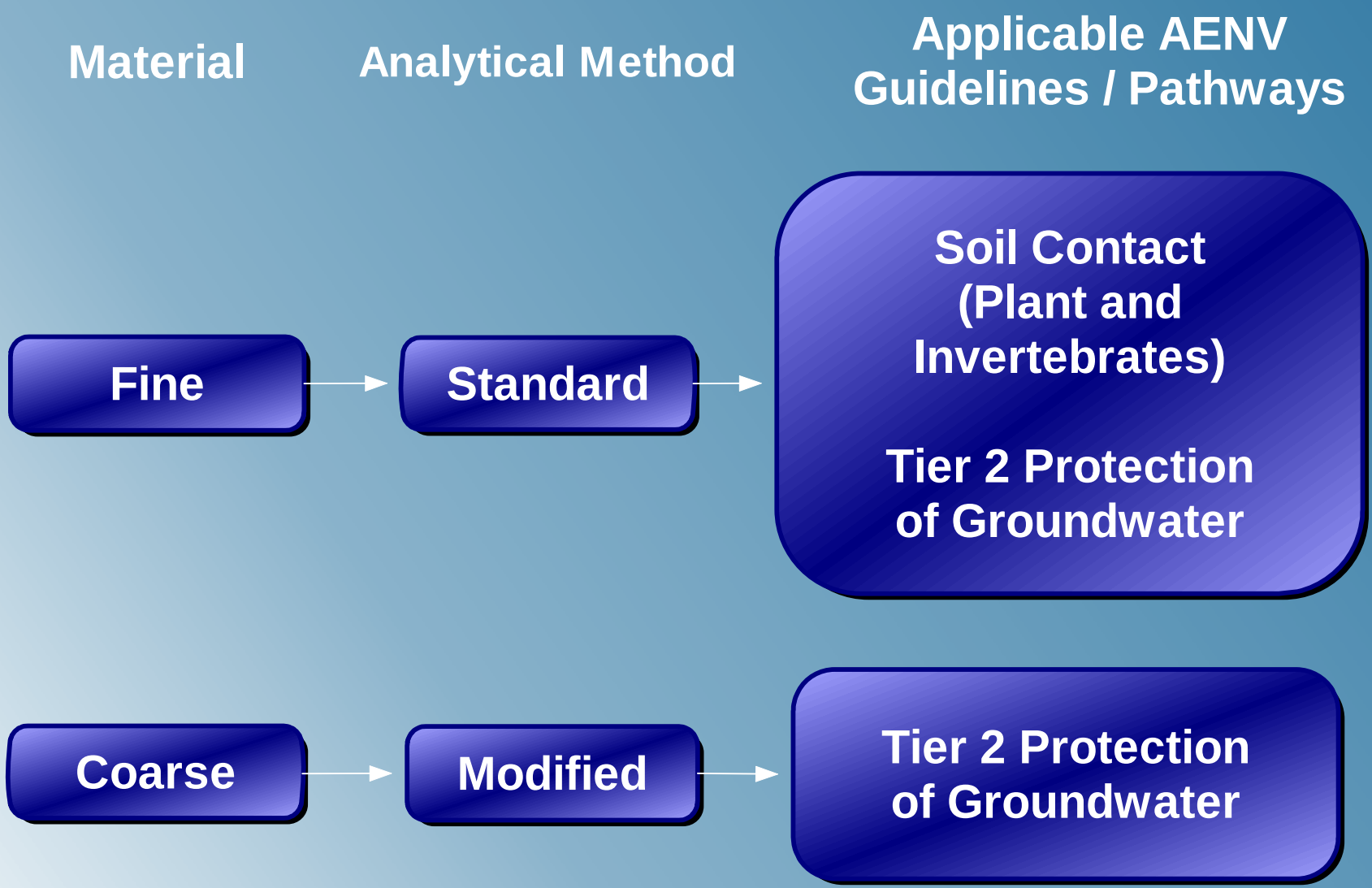
1. Gravel crushing
2. Constructing a large Soxtec/Soxhlet
3. Two-stage extraction

Two-Stage Analytical Procedure



Other Arbitrary Size Limitations

Discussion


Material
Analytical Method
Applicable AENV Guidelines / Pathways
Fine
Standard
Soil Contact (Plant and Invertebrates)
Tier 2 Protection of Groundwater
Coarse
Modified
Tier 2 Protection of Groundwater

Conclusions

- **We provided solutions to three challenges:**
  - **Tier 2 site-specific guidelines**
  - **Modified remedial approach**
  - **Modifications to analytical methods**

Conclusions

- **A gap exists in current regulations for gravelly soils**
- **Currently working to address these challenges with AENV on a site-specific basis**
- **Referred our methods and approaches to the CCME CWS 2005 review committee**

Acknowledgements

- **Special thanks to Lloyd Hodgins, Enviro-Test Laboratories**