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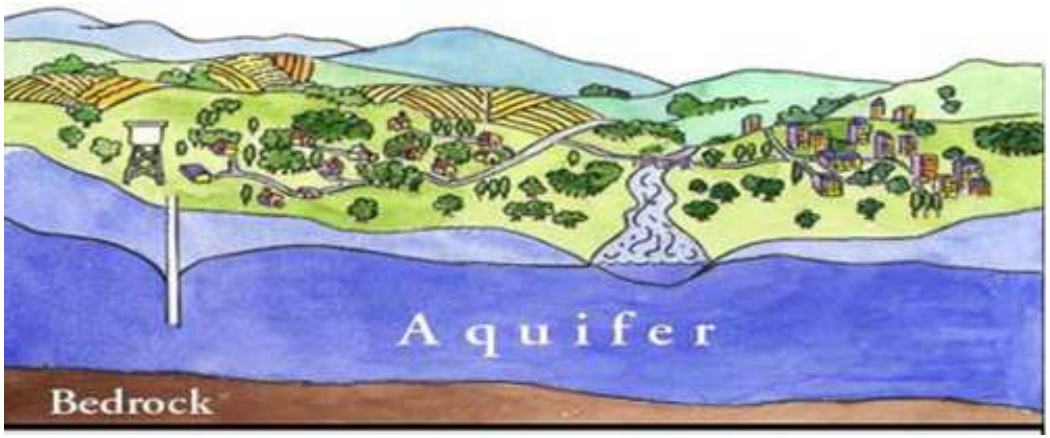


New Groundwater Guidance for Land Remediation

Northeast British Columbia Producers Society
Fort St. John

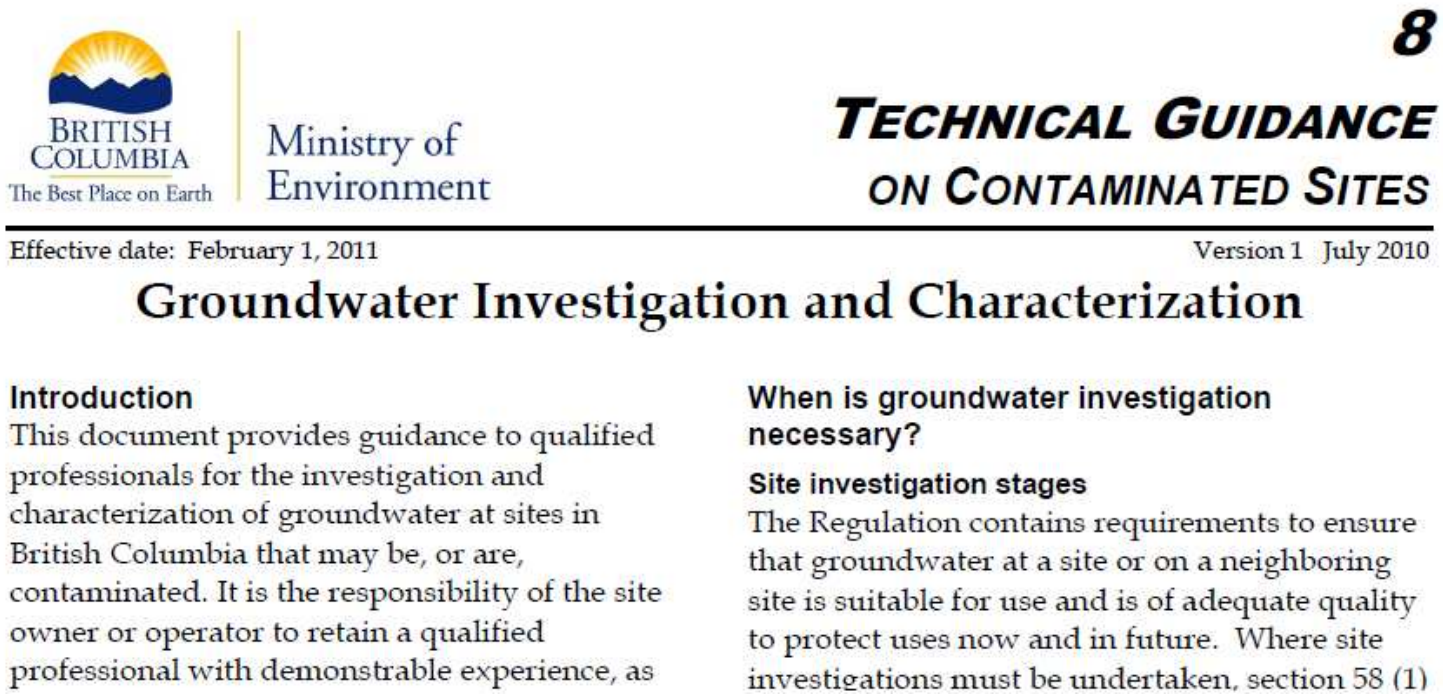
December 2, 2010

Steve Dankevy

Two New Technical Guidance Documents

- **Groundwater Investigation and Characterization**

  (Technical Guidance Document #8)



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8

TECHNICAL GUIDANCE ON CONTAMINATED SITES

Effective date: February 1, 2011 Version 1 July 2010

Groundwater Investigation and Characterization

Introduction

This document provides guidance to qualified professionals for the investigation and characterization of groundwater at sites in British Columbia that may be, or are, contaminated. It is the responsibility of the site owner or operator to retain a qualified professional with demonstrable experience, as

When is groundwater investigation necessary?

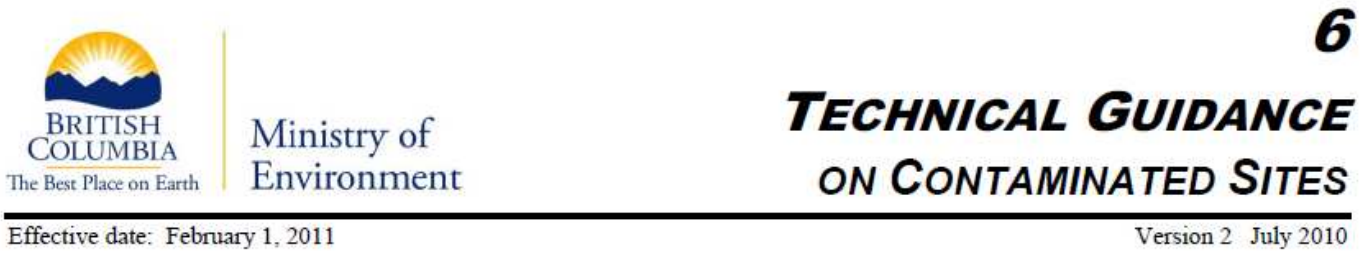
Site investigation stages

The Regulation contains requirements to ensure that groundwater at a site or on a neighboring site is suitable for use and is of adequate quality to protect uses now and in future. Where site investigations must be undertaken, section 58 (1)

Two New Technical Guidance Documents (continued)

- **Water Use Determination**

  (Technical Guidance Document #6)



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6

TECHNICAL GUIDANCE ON CONTAMINATED SITES

Effective date: February 1, 2011 Version 2 July 2010

Water Use Determination

Definitions

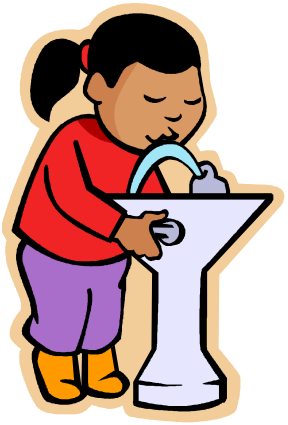
The following terms used in this guidance are defined in the procedure "Definitions and Acronyms for Contaminated Sites": agricultural land use, aquatic life water use, contamination source, drinking water use, ecologically active zone, groundwater contamination source, industrial land use, irrigation water use, livestock water use,

Standards to Groundwater and Surface Water" last revised in June 2005.

Groundwater may be used for all defined purposes specified in section 12 (4) of the Regulation (aquatic life, drinking, irrigation and livestock). Further details in this guidance are provided to aid responsible parties and qualified professionals in determining

Groundwater Policy Background

- BC MOE is placing an emphasis on planning and protecting our groundwater resource to ensure it is sustainable for future generations
- Groundwater resources are owned by the crown
- Contaminated Sites Approved Professionals requested BC MOE guidance to provide greater certainty when submitting applications
- Extensive consultation on both documents



Groundwater Investigation and Characterization Guidance

Purpose:

- To ensure that hydrogeological investigations are consistent, representative and scientifically defensible

- To provide clear guidance regarding expectations for groundwater investigations and assist CSAP society during performance reviews and audits

Groundwater Investigation and Characterization Guidance

Scope:

- Provide clear direction on the framework for groundwater investigation
- Present expectations for each stage of groundwater investigation
- Acceptable methods and approaches for use at contaminated sites in BC

Groundwater Investigation and Characterization Guidance

Specific Goals

- Obtain ***accurate*** and ***reliable*** groundwater quality data
- Acquire data in a manner that represents, as best as practical, the quality of groundwater in the aquifer
- Understand ***limitations*** of the approaches used, translate these into ***uncertainty*** with respect to the conclusions, and effectively ***communicate*** this uncertainty

Groundwater Investigation and Characterization Guidance

Outline:

- When groundwater investigation is necessary
- Designing the field program
- Developing a conceptual site model
- Acceptable methods and approaches for investigation
- What level of investigation is necessary for:
  - a Stage 1 Preliminary Site Investigation
  - a Stage 2 Preliminary Site Investigation
  - Detailed Site Investigation
  - Confirmation of Remediation

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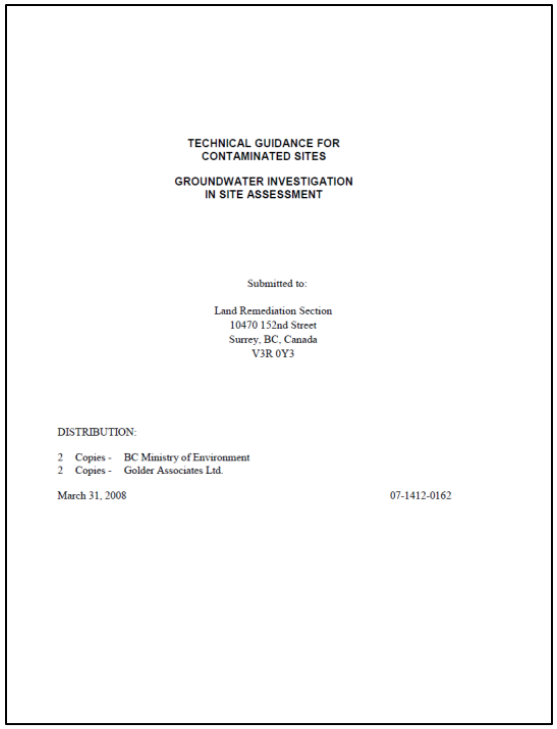
Groundwater Investigation and Characterization Guidance

Outline (continued):

- Investigating LNAPL and DNAPL
- Post remediation groundwater monitoring – when it is necessary and when it can stop
- De-activating or closing monitoring wells
- Grandfathering process

Groundwater Investigation Guidance

More detail is available in the parent document



TECHNICAL GUIDANCE FOR
CONTAMINATED SITES

GROUNDWATER INVESTIGATION
IN SITE ASSESSMENT

Submitted to:

Land Remediation Section
10470 152nd Street
Surrey, BC, Canada
V3R 0Y3

DISTRIBUTION:

2 Copies - BC Ministry of Environment
2 Copies - Golder Associates Ltd.

March 31, 2008 07-1412-0162

Available at:
http://www.env.gov.bc.ca/epd/remediation/reports/index.htm

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Groundwater Investigation and Characterization Guidance

When is Groundwater Investigation Necessary?

- Groundwater investigation begins during the Stage 1 PSI
- When APECs are found, ***relevant environmental media must include groundwater*** for each APEC.
- If groundwater is to be excluded, **"detailed supporting rationale must be provided"**

Groundwater Investigation and Characterization Guidance

Designing the Field Program

- Should yield a data set representative physical and chemical information on all relevant media.
- Data from a number of locations and depths at various times.
- Critical to obtain accurate and reliable data to be compared to applicable standards

Groundwater Investigation and Characterization Guidance

The Conceptual Site Model

- Key Elements
  - Geology and Stratigraphy
  - Aquifers and Aquitards
  - Groundwater Levels/Elevations and Hydraulic Gradients
  - Boundaries (physical and hydrogeologic)
  - All Potential Source Zones
  - All Plumes
  - All Pathways for Contaminant Transport

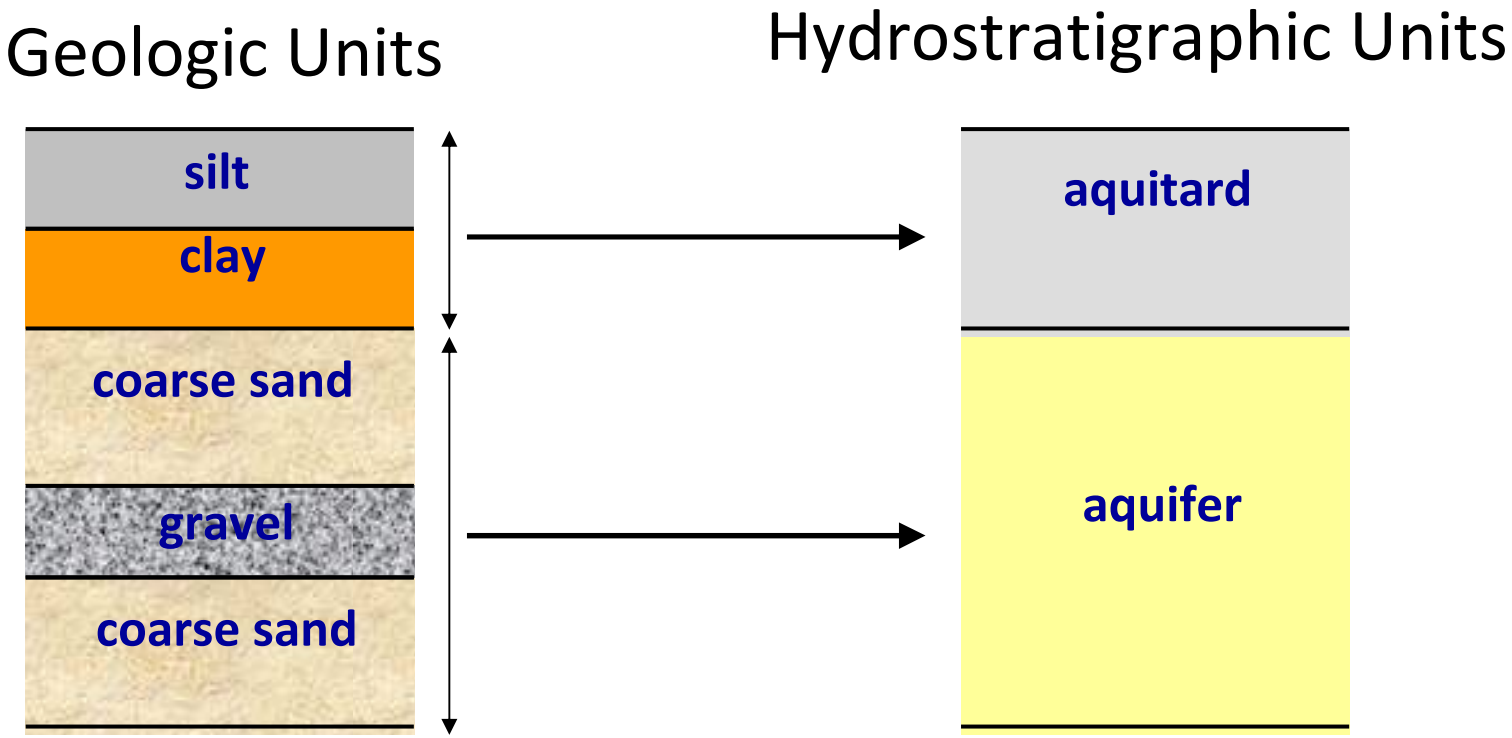
Groundwater Investigation and Characterization Guidance

The Conceptual Site Model

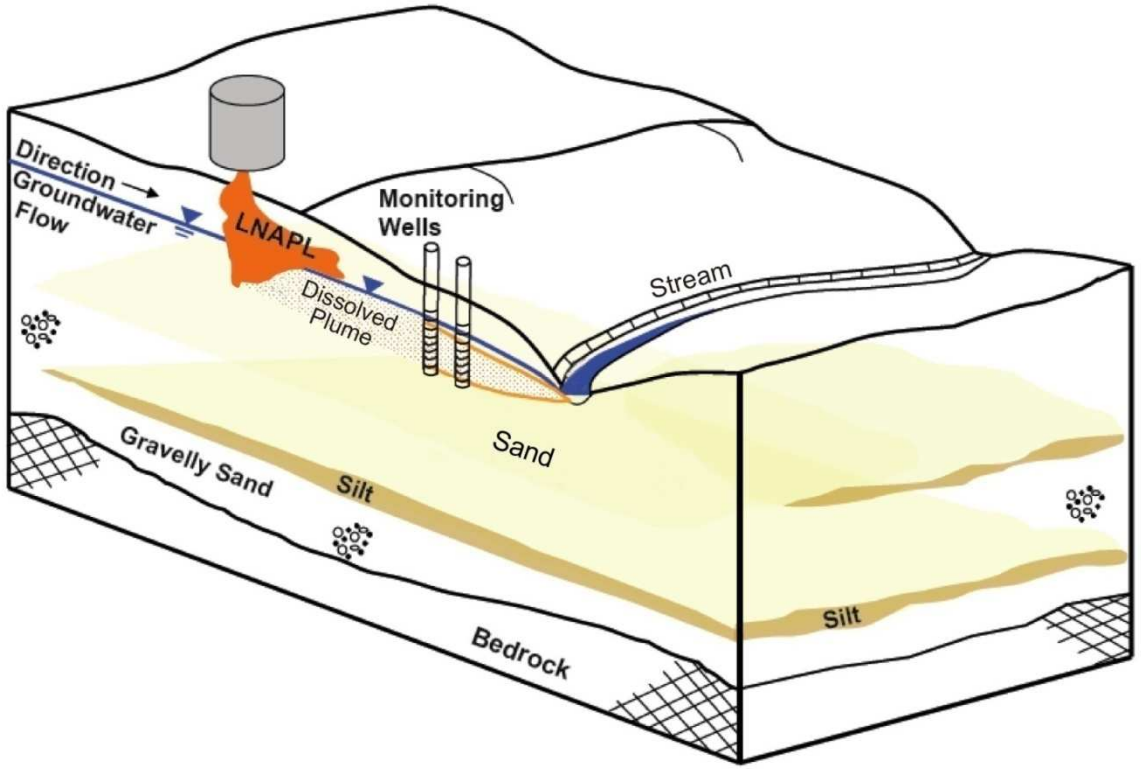
- A CSM should be developed for every site
- The CSM is a **"living"** concept and should be refined after each stage of investigation

Groundwater Investigation and Characterization Guidance

Conceptual Site Model
Aquifer versus Aquitard



Groundwater Investigation and Characterization Guidance



Groundwater Investigation and Characterization Guidance

Acceptable Field Methods

- Whatever works! **BUT**, your approach also "must include acquisition and analysis of representative samples."
- Wide range of direct and indirect approaches available. Apply the method most suitable to the site characteristics
  - See British Columbia Field Sampling Manual
  - Health Canada Guidance Manual
- Conventional monitoring wells are acceptable if properly installed and sampled correctly.

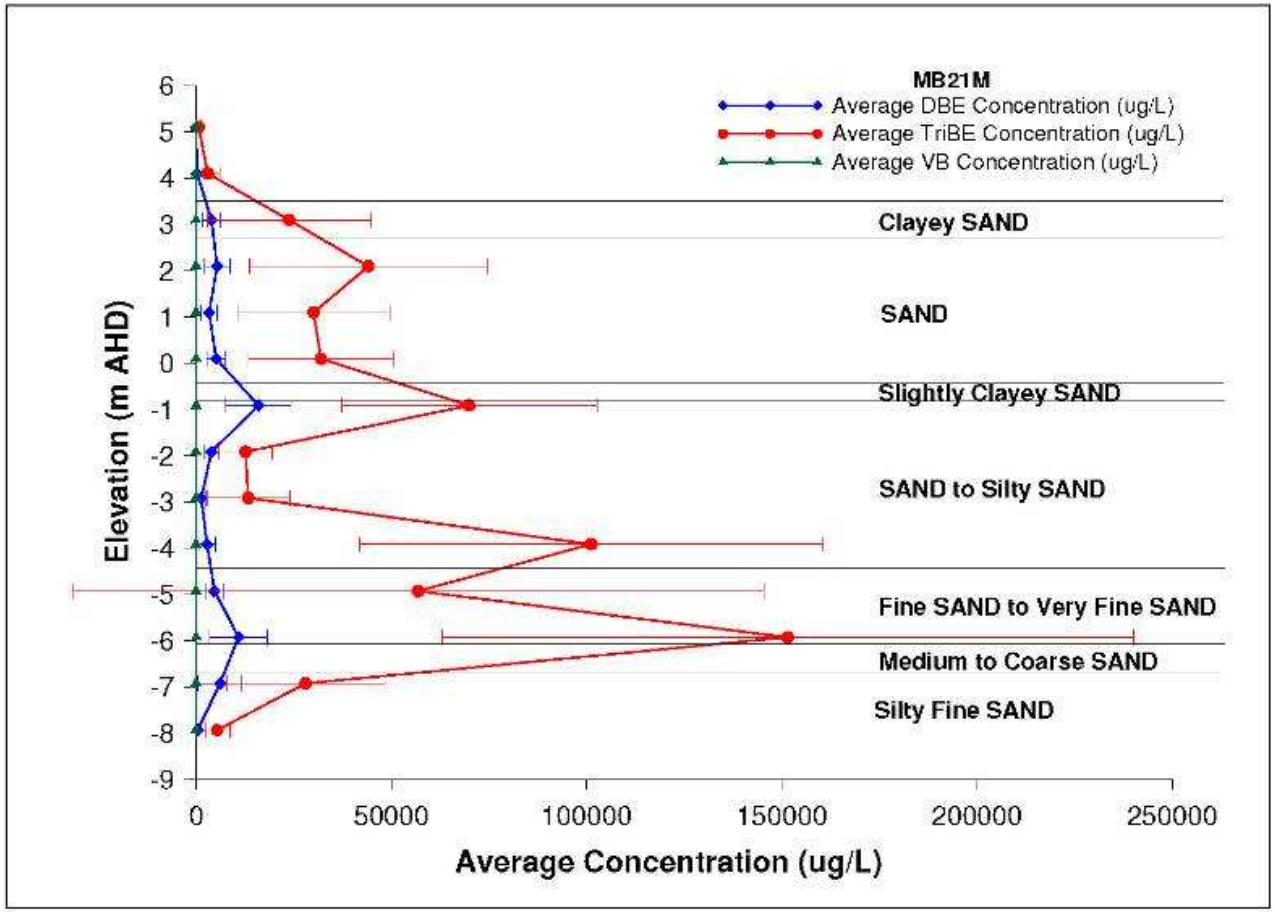
Acceptable Field Methods

Conventional Monitoring Wells

- Limits on acceptable well screen lengths
  - Saturated screen length limited to 1.8 m including sand pack
  - ***Rationale must be provided*** where longer well screen lengths are used
- Use of drill cuttings as backfill is to be avoided

Groundwater Investigation and Characterization Guidance

Groundwater Plumes are Variable



Acceptable Field Approaches/Methods

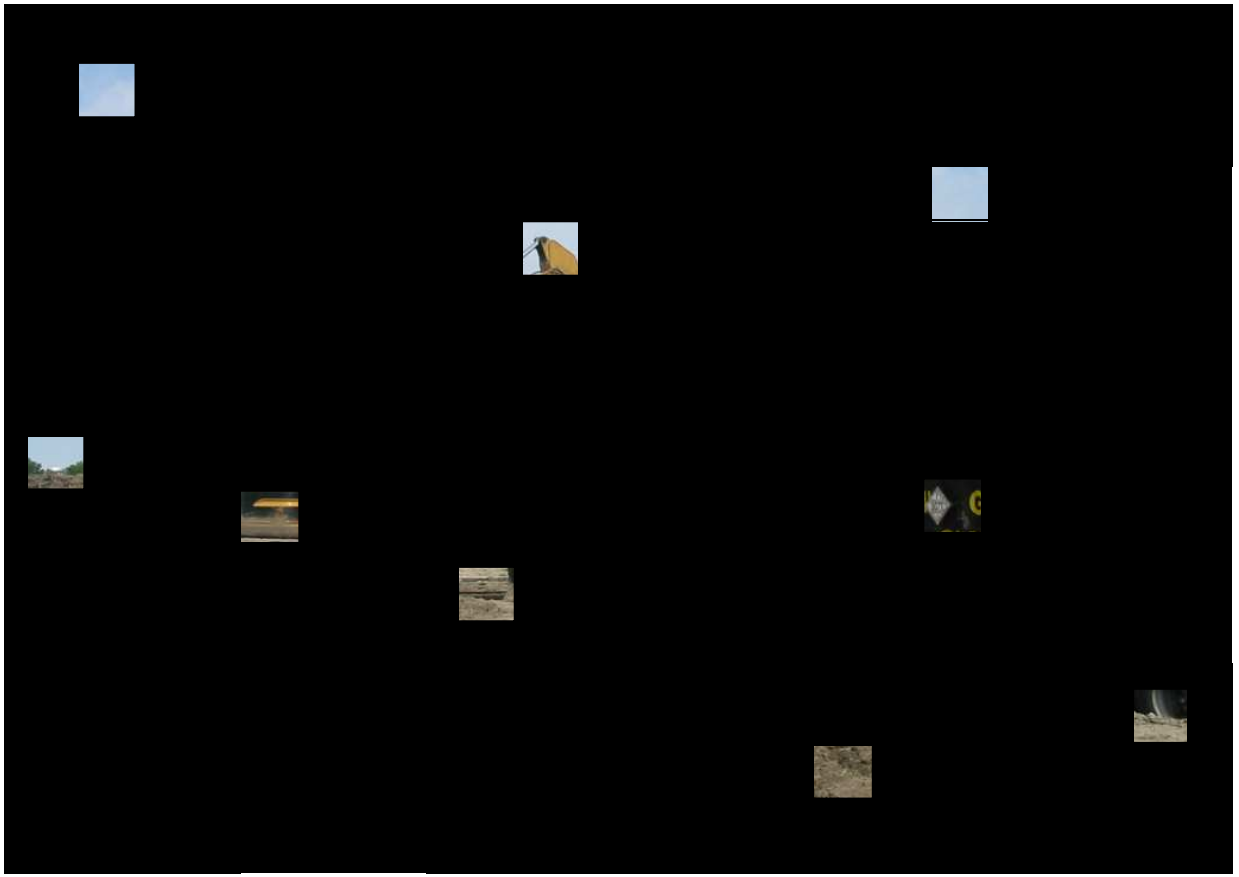
Innovative Approaches Acceptable

- Screening-level approaches
  - geophysics, soil chemistry, profiling

- Direct-Push Technologies
  - Waterloo Profiler™
  - Laser induced Fluorescence (LIF)
  - Membrane Interface Probe (MIP)

Groundwater Investigation and Characterization Guidance

Precise Data, Limited Extent



Groundwater Investigation and Characterization Guidance

Less Precise Data, Greater Extent

Site Investigation Levels

Preliminary Site Investigation

- PSI Stage 1:Desktop level study to establish a CSM of site and vicinity and potential areas and contaminants of concern
- PSI Stage 2: Limited field study to confirm APECs and PCOCs and determine maximum concentrations onsite for comparison to applicable standards. Update the CSM.

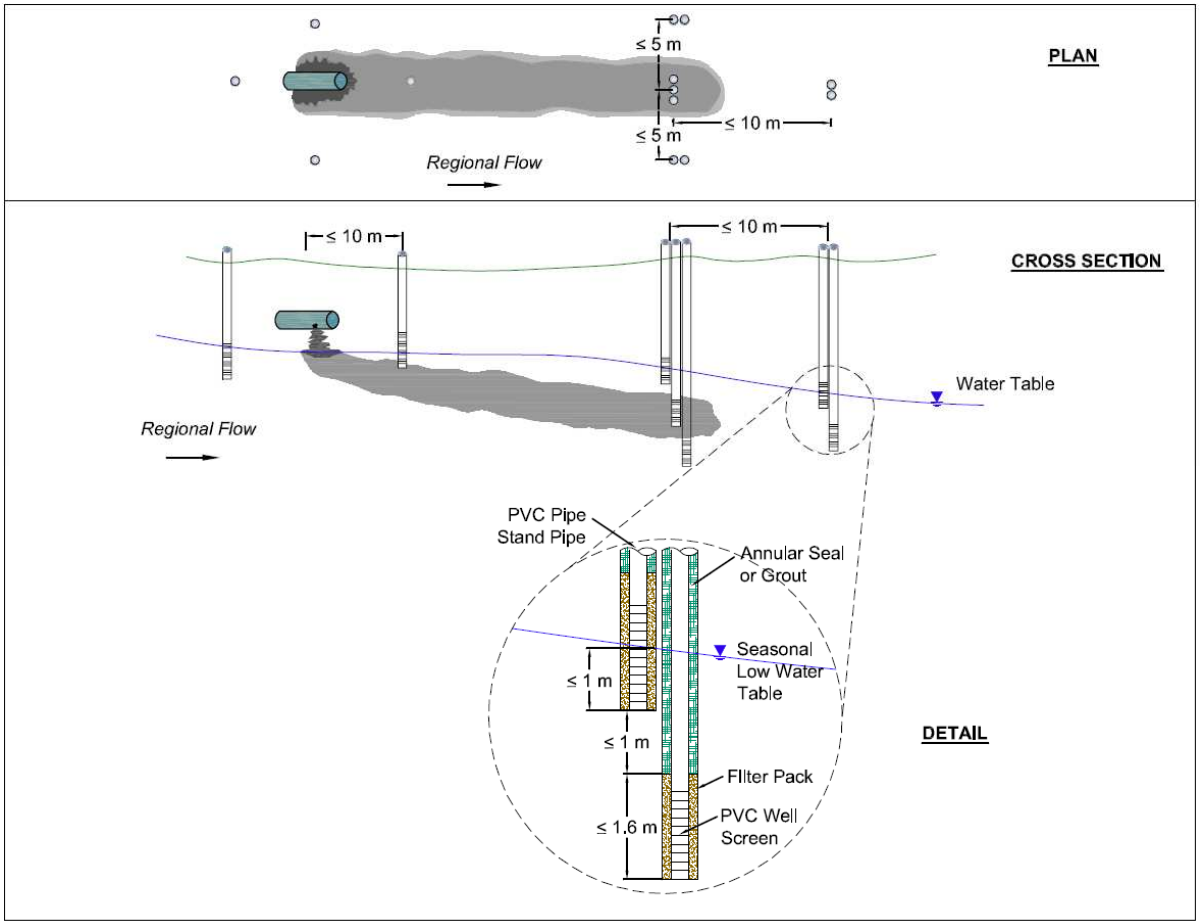
Groundwater Investigation and Characterization Guidance

Site Investigation Levels (con't)

Detailed Site Investigation

- Full scale site investigation to establish magnitude and extent of contamination
- Sufficient information collected to complete a risk assessment and remediation plan
- Example provided in Figure 1 of guidance

Site Investigation Levels (con't)



Groundwater Investigation and Characterization Guidance

LNAPL Monitoring

- Well screen should straddle the water table
- At least one well should be placed in expected thickest LNAPL zone
- Extent of the LNAPL zone should be resolved at a scale of 5 to 7 m or less
- Monitoring for LNAPL should take place at least 24 hours after installation, and preferably after at least one week

LNAPL Monitoring

- *Continue regular monitoring until:*
  - Have obtained 12 months of monitoring data
  - Remediation is complete, or
  - LNAPL is demonstrated to be immobile (as per Protocol 16 – Mobile NAPL)

- *Monitoring Frequency*
  - Minimum once every two months
  - Preferably, monthly
  - Can move to quarterly monitoring based on collected data

DNAPL Monitoring

- Risk of cross-contamination → Avoid drilling directly through DNAPL

- Use indirect data and inference to resolve the likely extent of a DNAPL source:
  - Horizontal - resolve to 5 m to 7 m
  - Vertical - resolve to 1 m to 2 m

- References are provided for further information on DNAPL assessment

Data Presentation

- a scaled regional location plan and site plan
- showing relevant hydrological, topographical and physiographic features
- a contour plan of piezometric heads in each aquifer of interest
- data points posted at measurement locations on each drawing
- longitudinal and transverse cross sections with respect to the known or estimated groundwater flow direction

Data Presentation

- contours, in plan and cross section, of chemical concentrations
- for each COC in on-site and off-site soil and groundwater
- sample locations with corresponding analytical results used to develop each figure
- shown on the figure and in tabular form with reference to applicable criteria

Groundwater Investigation and Characterization Guidance

Confirmation of Remediation

- **minimum of three** monitoring locations within each affected aquifer
- Locate wells strategically within remediated zone or along immediate perimeter of zone
- Ensure static conditions achieved before sampling
- Obtain **at least two sets** of groundwater samples at least 24 hours apart, and preferable two weeks apart

Groundwater Investigation and Characterization Guidance

Confirmation of Remediation (con't)

- Where seasonal effects may be significant, at least two sets of groundwater samples should be collected over **more than one season**
- Remediation complete when substances concentrations:
  - Are less than applicable standards
  - Stable or decreasing trend
  - No concentration rebound

Monitoring Well Deactivation and Closure

- When remediation is complete and the monitoring well network is no longer useful, they should be deactivated and ultimately closed.
- Section 75 of the Water Act stipulates requirements

Groundwater Investigation and Characterization Guidance

Grandfathering Provision

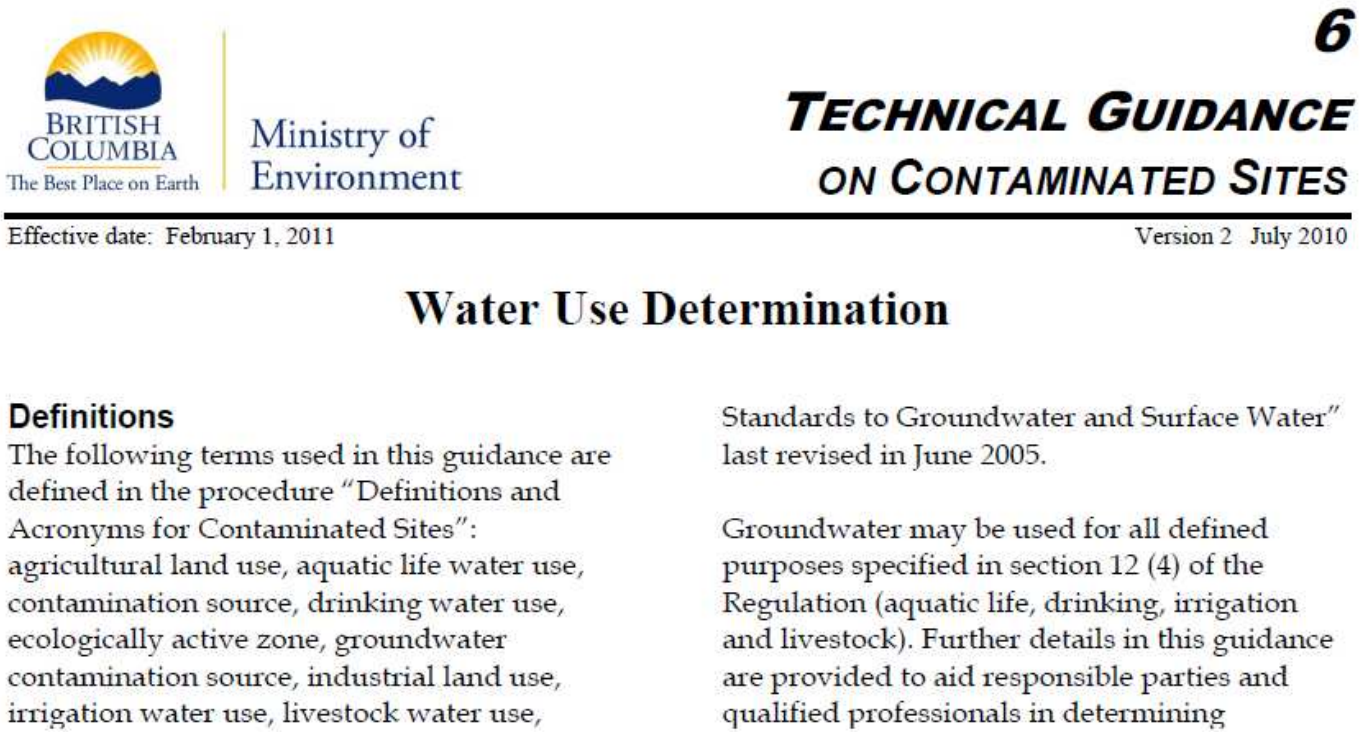
- Six months after the guidance was posted to ministry website as final version

- Posted in July, the groundwater investigation guidance comes into effect on **February 1, 2011**

Two New Technical Guidance Documents (continued)

- **Water Use Determination**

  (Technical Guidance Document #6)



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6

TECHNICAL GUIDANCE ON CONTAMINATED SITES

Effective date: February 1, 2011 Version 2 July 2010

Water Use Determination

Definitions

The following terms used in this guidance are defined in the procedure "Definitions and Acronyms for Contaminated Sites": agricultural land use, aquatic life water use, contamination source, drinking water use, ecologically active zone, groundwater contamination source, industrial land use, irrigation water use, livestock water use,

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Groundwater may be used for all defined purposes specified in section 12 (4) of the Regulation (aquatic life, drinking, irrigation and livestock). Further details in this guidance are provided to aid responsible parties and qualified professionals in determining

Technical Guidance 6 – Water Use Determination

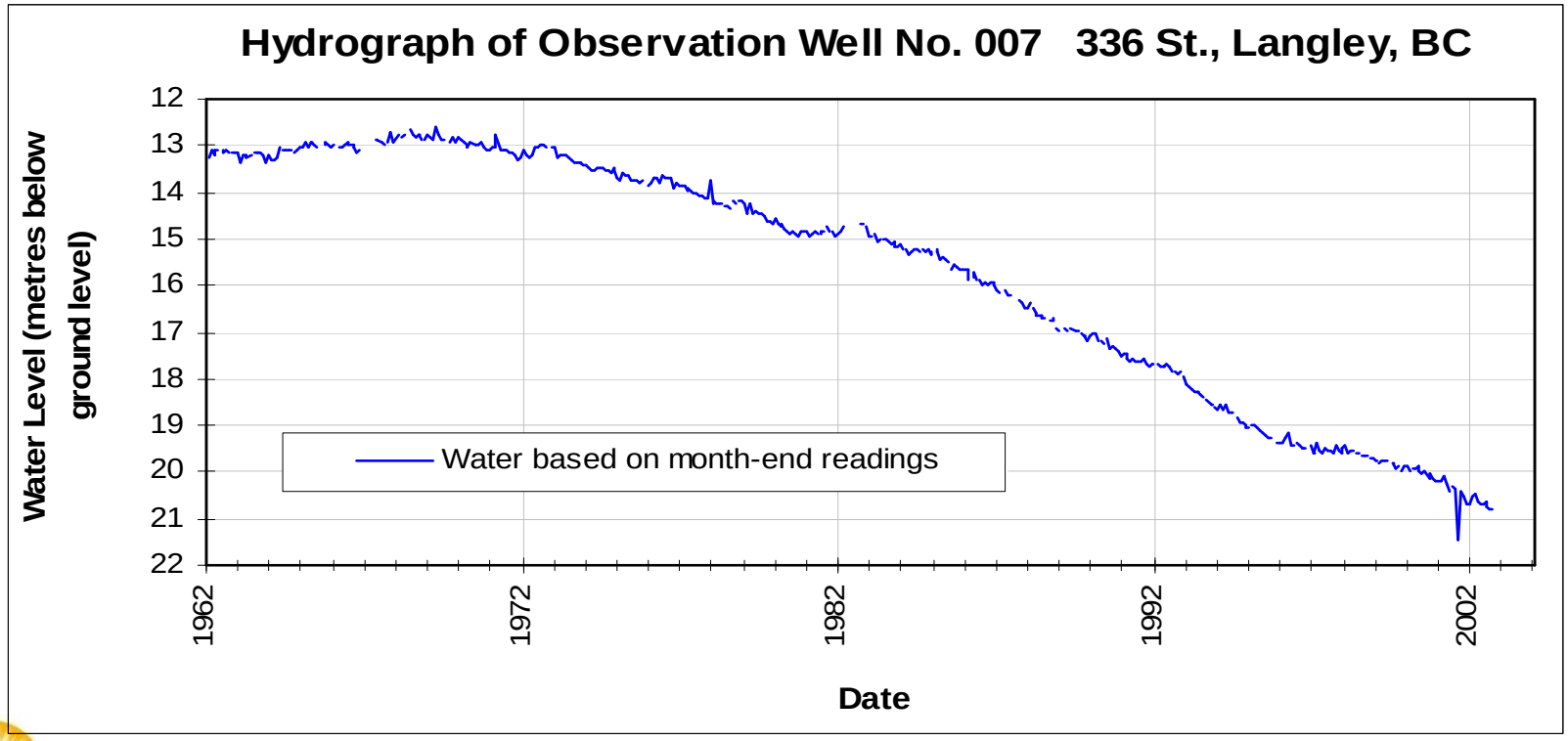
Purpose:

- To recognize that groundwater is a valuable resource that should be protected for future use.
- To have a policy that directs polluters to remediate the groundwater quality on-site, and adjacent to the site, to standards suitable for both current and future uses.
- Provide clear reasoning and direction with respect to the procedure for establishing groundwater use at a site.

Technical Guidance 6 – Water Use Determination

Addressing the Key Challenges to Groundwater Sustainability

Example of depletion



Water Use Determination: Overview

- There are four water uses defined in the Contaminated Sites Regulation for groundwater:
  - Drinking
  - Aquatic Life
  - Irrigation
  - Livestock
- TG6 helps the practitioner decide which water use will apply at a site, or even if "no water use" applies.
- Groundwater standards for remediation are based on water use at a site.

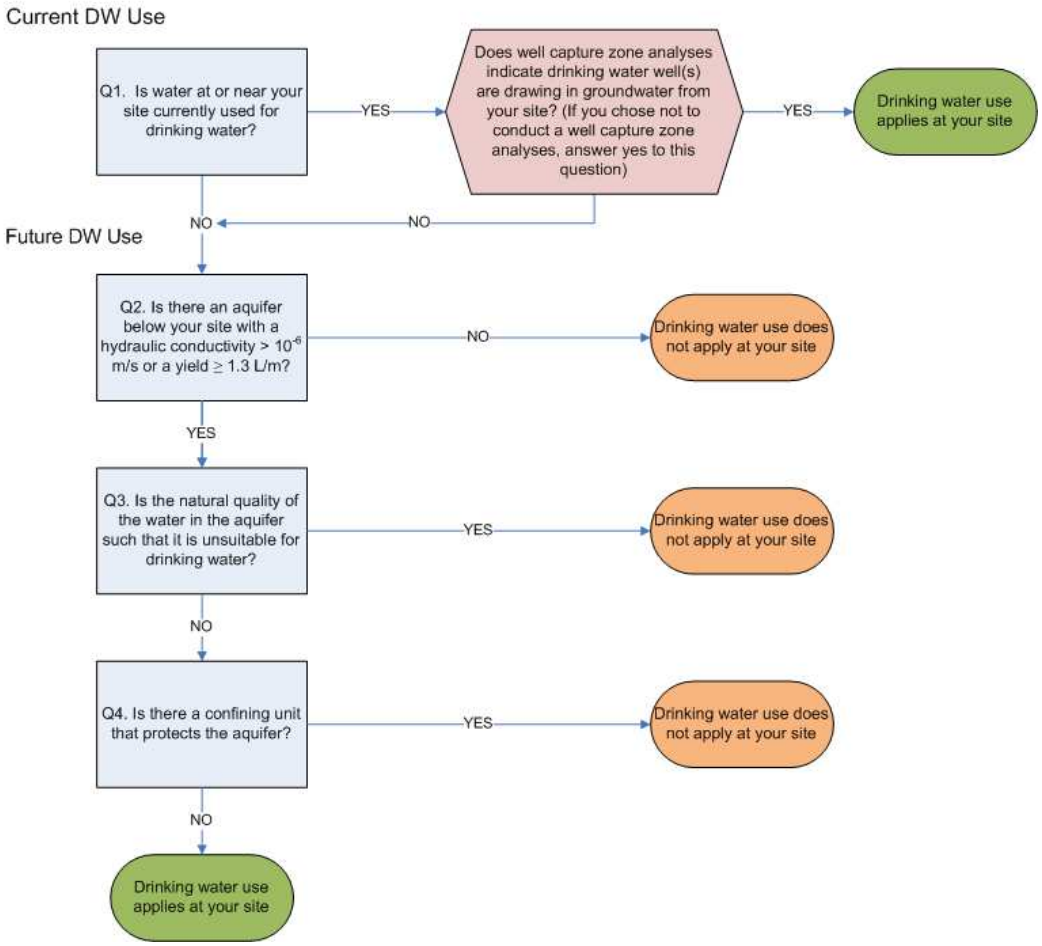
Water Use Determination: The "old" TG6

- Estimates distance and travel times of contaminant to current receptors which can be overly conservative at times, at other times not.
- Does not address potential future groundwater use.

Water Use Determination: The "new" TG6

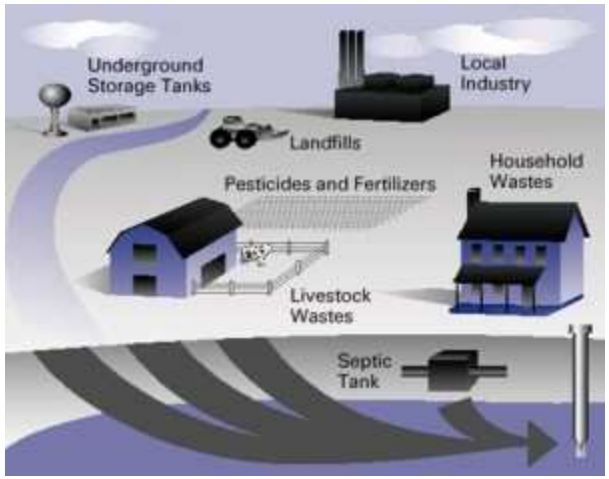
- Considers groundwater as a valuable future resource.
- Has more of a scientific basis, rather than arbitrary distance/time.
- Similar to many other jurisdictions.

TG6: Current and Future DW



Water Use Determination: Current DW

Q 1. Is the water currently used for drinking?



- Based on receptors in area of site.
- 500 m distance to receptor.
- Consideration up-gradient or downgradient of source.
- Guidance for types of searches.

Water Use Determination: Future DW

Q 2. Does the geological unit have a hydraulic conductivity less than or equal to 1 x 10^{-6} m/s or a yield less than 1.3 L/min?

- Can the geological unit yield enough water to supply a single family dwelling?
- Unconfined aquifers that are seasonal or <1 m saturated thickness exempt.
- Example yield calculation provided.

Water Use Determination: Future DW

Q 3. Is the natural quality of the water such that it is unsuitable for drinking water?

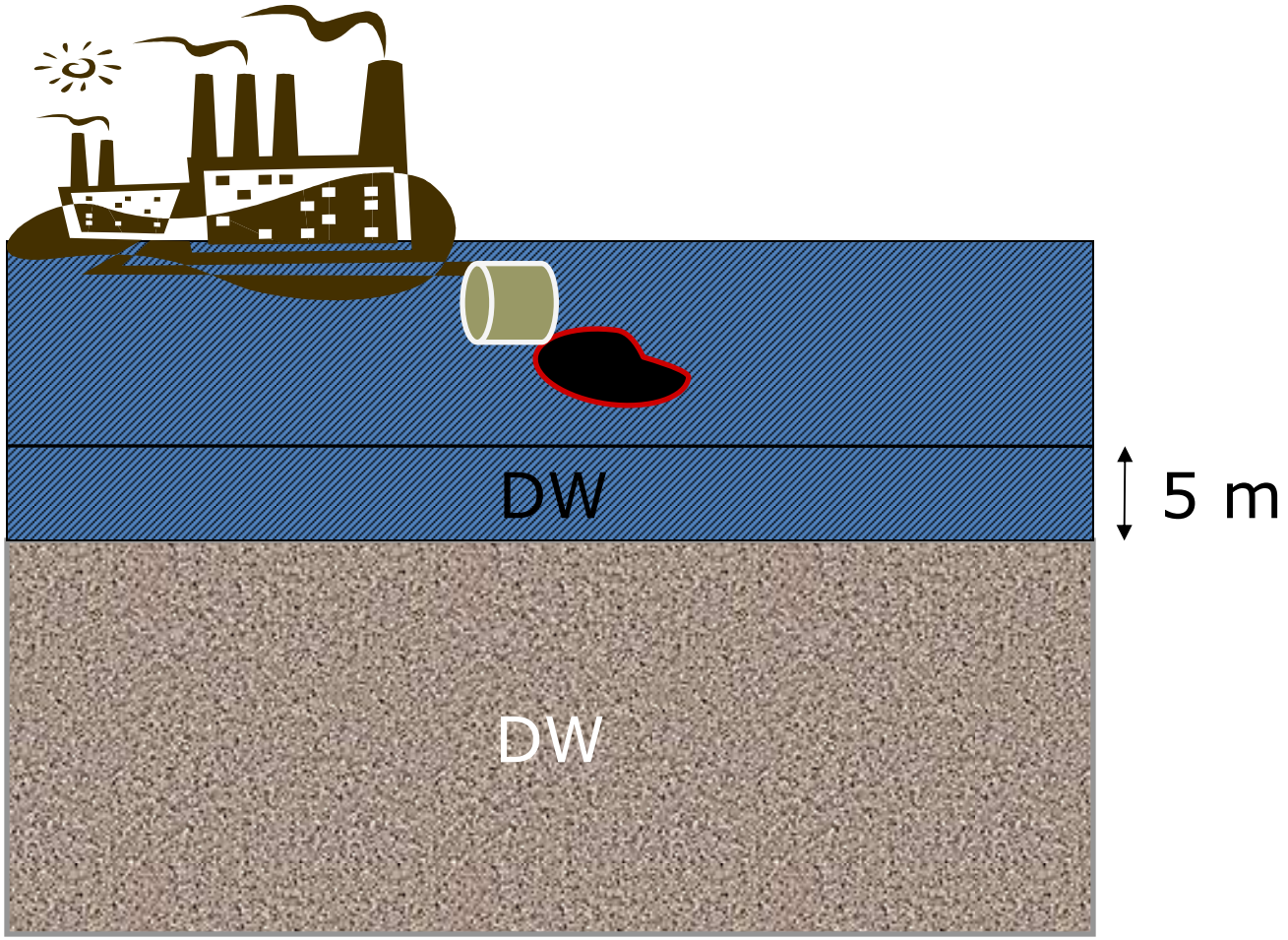
- Equal to or greater than 4,000 mg/L TDS is considered unsuitable for DW purposes.
- There may be other situations (e.g. water in organic soils like muskeg).

Water Use Determination: Future DW

Q 4. Is their a confining geological unit that protects the aquifer ?

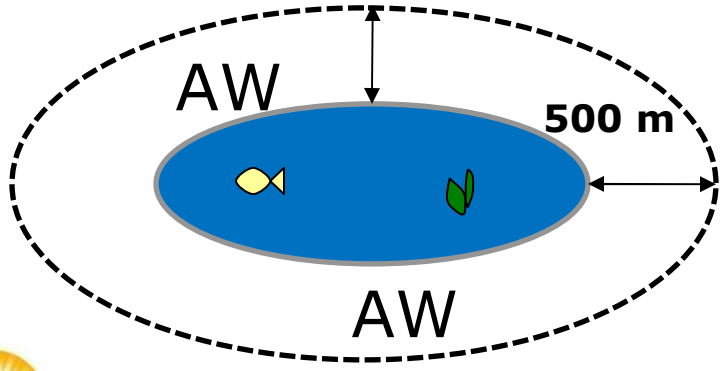
- Differing water uses may apply for units overlying a deeper drinking water aquifer if a natural confining geological unit exists to protect the deeper aquifer.
- the natural confining unit must:
  - be greater than or equal to 5 metres thick;
  - have a bulk hydraulic conductivity that is less than or equal to 1 x 10^{-6} m/s;
  - be relatively uniform and free of fractures; and
  - is continuous across the extent and predicted migration of the shallow subsurface contamination.

TG6: Multiple Aquifers



Water Use Determination: Aquatic Life (AW)

- Aquatic life groundwater use applies to all land located within 500 metres from a surface water body containing aquatic life.
- Aquatic life water use applies at sites where there is the potential for contaminated groundwater to flow through preferential corridors that discharge directly to a surface water body containing aquatic life.



Water Use Detemination: Irrigation (IW) and Livestock (LW) Watering

IW and LW uses apply when:

- A site is considered agricultural land use or is within a provincial Agricultural Land Reserve (ALR).
- Irrigation or livestock watering wells are within a distance of 500 metres down-gradient or 100 m up-gradient of a groundwater contamination source.

IW and LW do not apply when $K<10^{-6}$ m/s

New Groundwater Guidance

Questions?

website:

http://www.env.gov.bc.ca/epd/remediation/guidance/index.htm#tech

E-mail:

stephen.dankevy@gov.bc.ca – TG#8

Lavinia.zanini@gov.bc.ca - TG#6