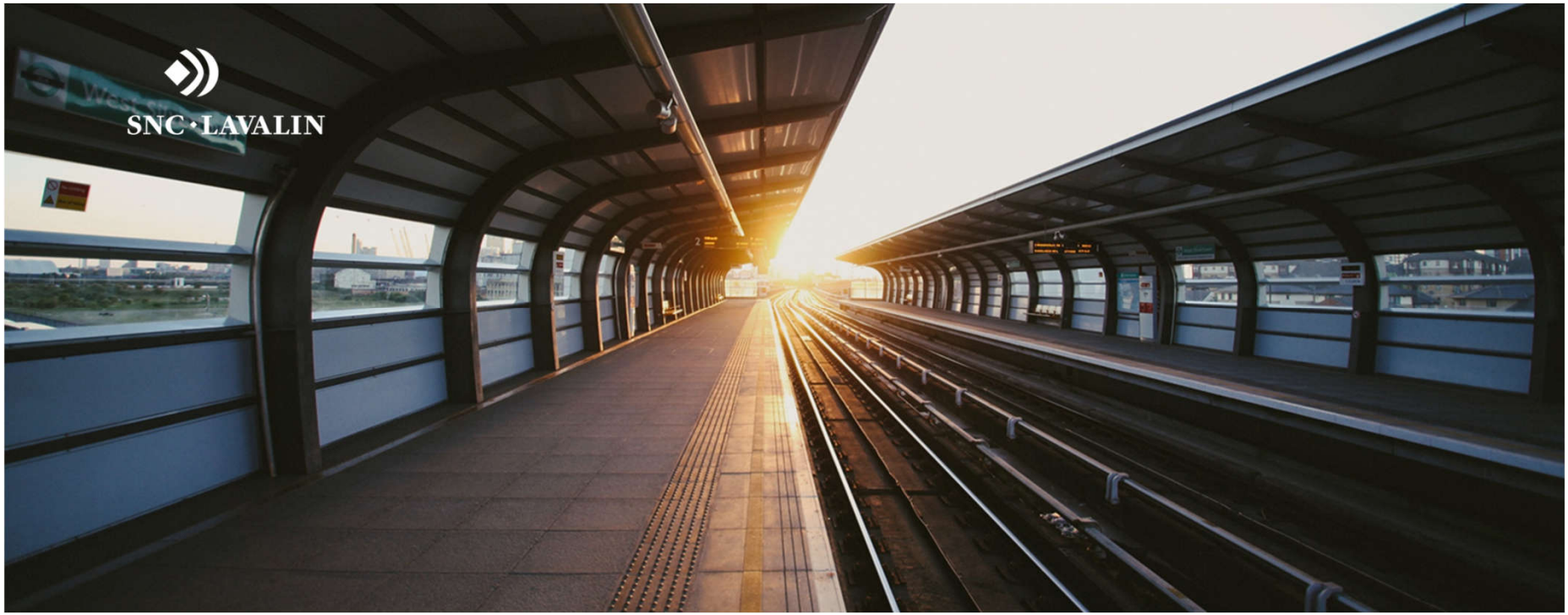


Conceptual Site Models – Built for Purpose

Ms. Sheila Duchek, M.Sc., P.Geol.

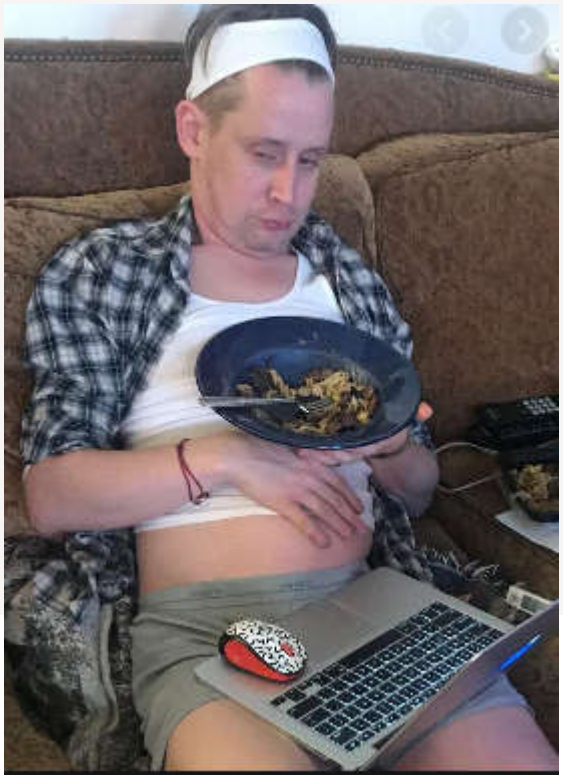
April 15, 2020

ESAA Webinar Series

ENVIRONMENTAL SERVICES ASSOCIATION OF ALBERTA

ESAA

This is How I am picturing YOU!



Or maybe that's just how I am dealing with WFH during COVID-19!

SNC·LAVALIN

Our vision

We strive to be the premier engineering solutions partner, committed to delivering complex projects from vision to reality for a sustainable lifespan.

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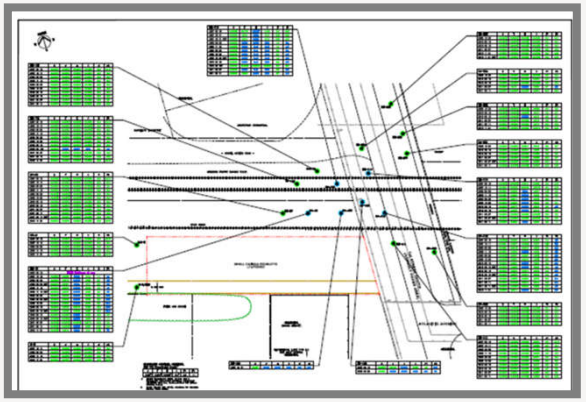
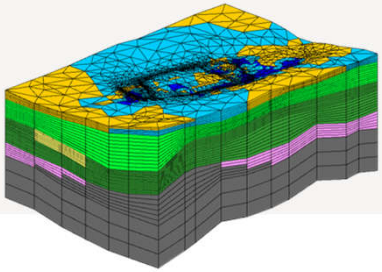
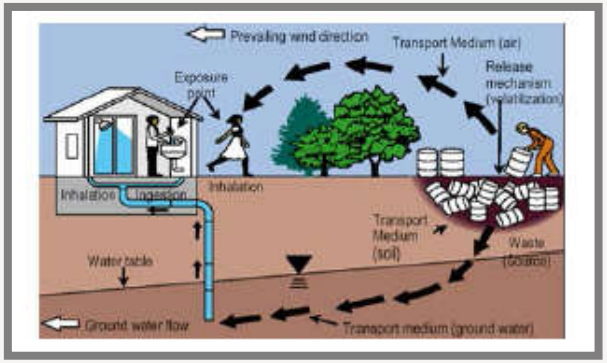
Presentation Outline

- Definition of a CSM
- Published Examples
- Developing a CSM
- CSM Evolution
- Key Components of Effective CSMs
- Examples from Actual Project Work

Today's Theme:
Complex ≠ Complicated.







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Definition of a Conceptual Site Model

Canadian Council of Ministers of the Environment (CCME):

a visual representation and written description of the relationships between the physical, chemical, and biological processes of the site and the human and environmental receptors.

US Environmental Protection Agency (USEPA):

a summary of how the site became contaminated, how the contamination was and is transported, where the contamination will ultimately end up, and whom it may affect.

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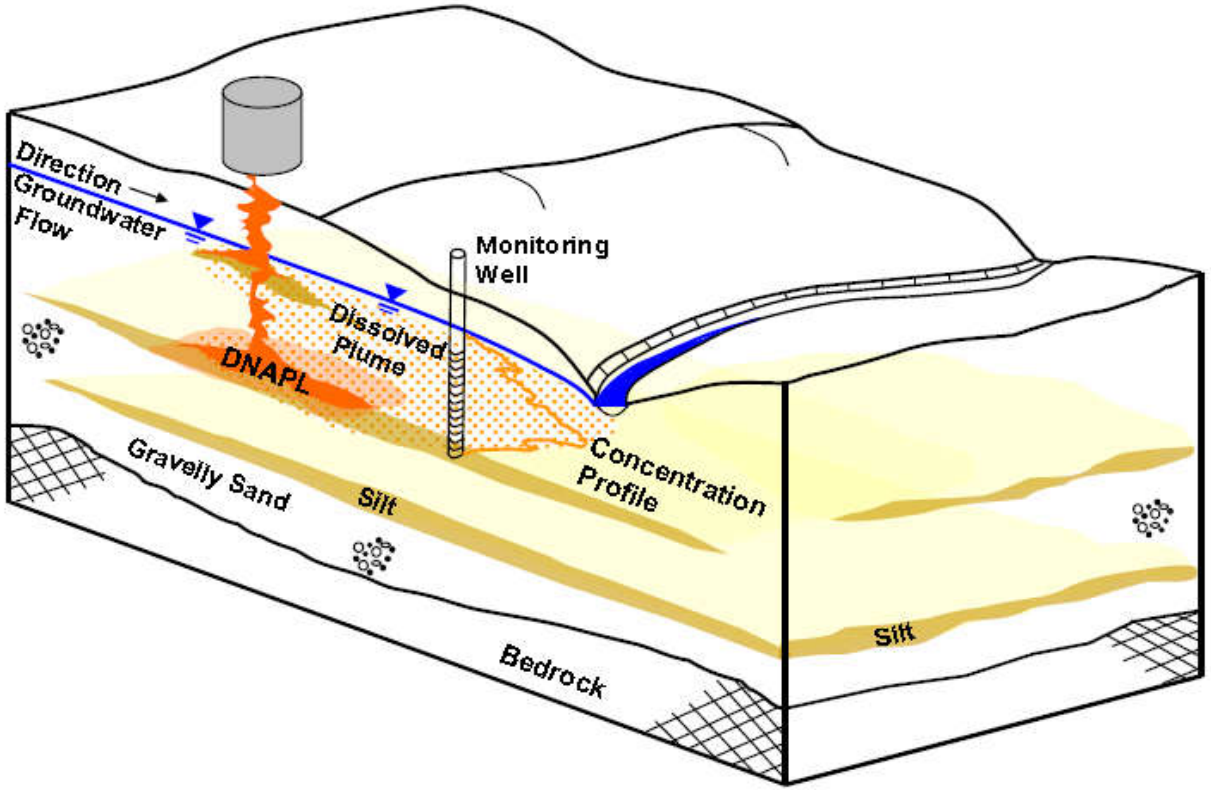
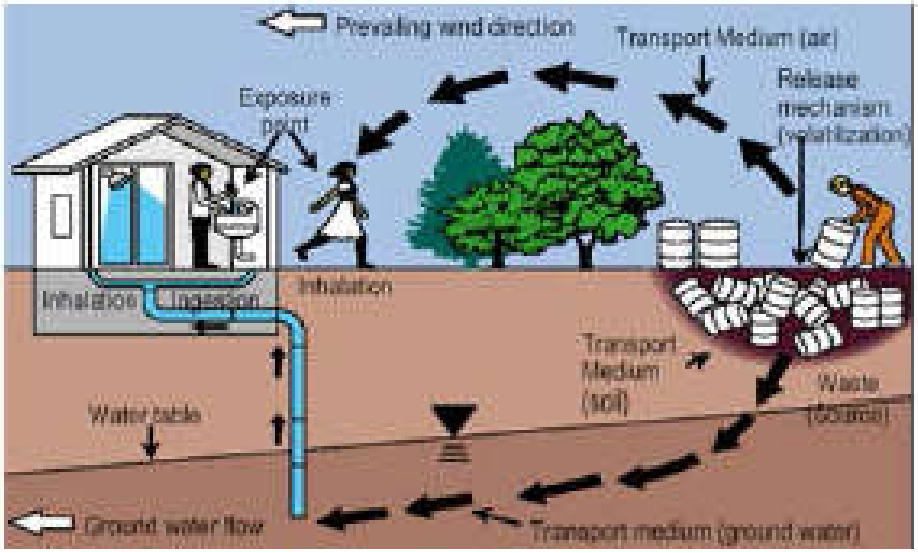
Published Examples: Hydrogeology Focus



Taken from the CCME: Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment

Published Examples: Risk Focus



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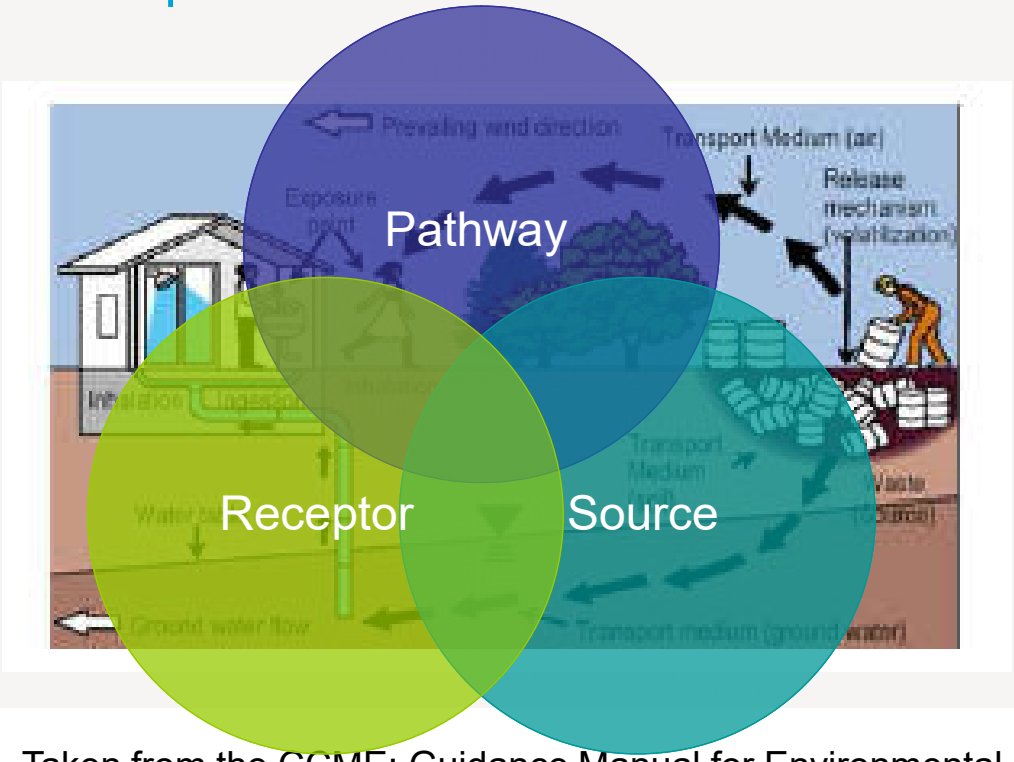
Published Examples: Risk Focus



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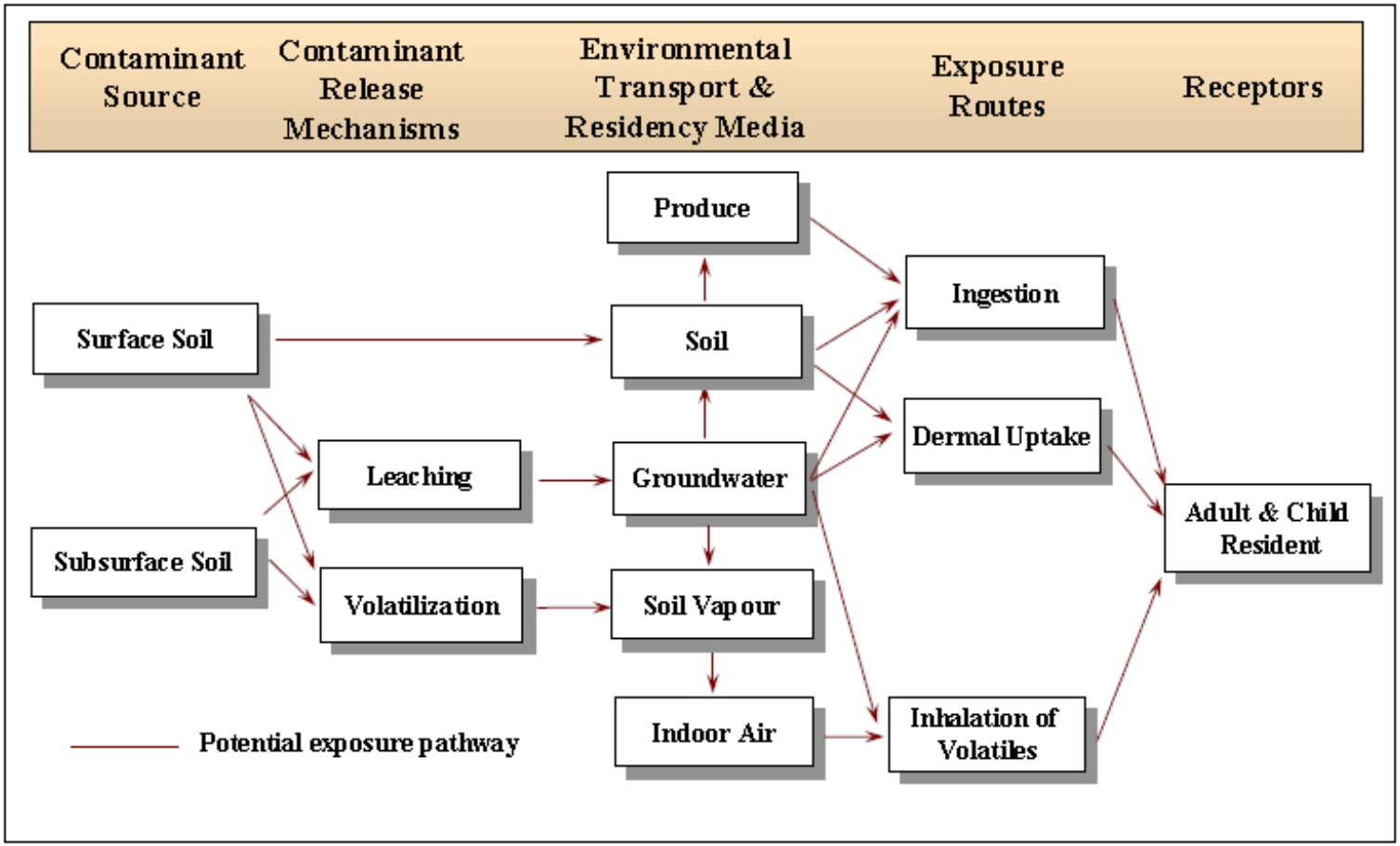
Published Examples: Risk Focus

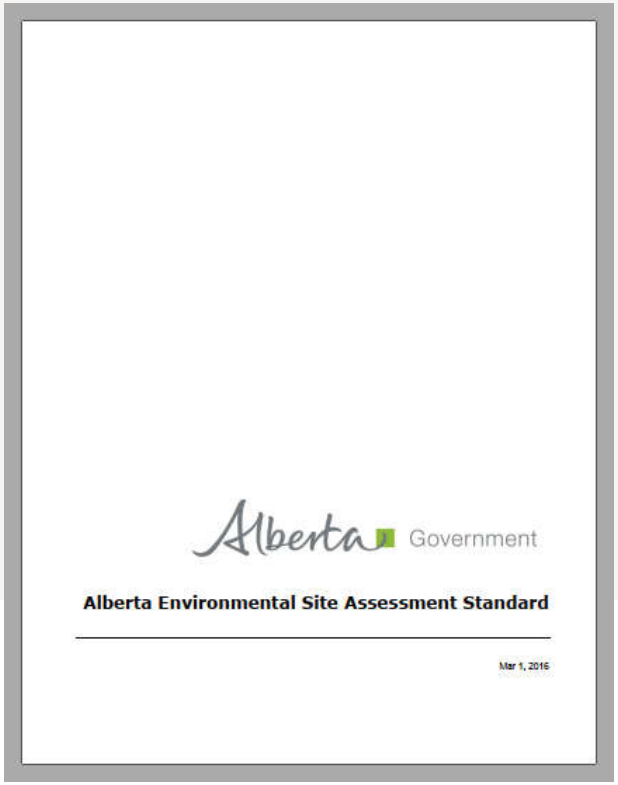


Taken from the CCME: Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment

AEP's Alberta Environmental Site Assessment Standard

https://open.alberta.ca/dataset/3acc7cff-8c50-44e8-8a33-f4b710d9859a/resource/579321b7-5b66-4022-9796-31b1ad094635/download/environmentsiteassessstandard-mar01-2016.pdf

Issued March 1 2016



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AEP's Alberta ESA Standard

CSM tells the story of contamination: how contamination was / is transported, where it will end up and whom or what it may affect.

Well developed CSM is an effective tool that:

- organizes, communicates, and interprets existing data
- while also identifying areas where additional data is required.

Less detailed CSM have conservative assumptions so ruling out pathways or receptors can be difficult.

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AEP's Alberta ESA Standard

As site information becomes more detailed, the CSM is progressively refined to provide information on the sources, types, and total extent of the contamination (vertically and horizontally), release and transport mechanisms, possible subsurface migration pathways and potential receptors and the routes of exposure.

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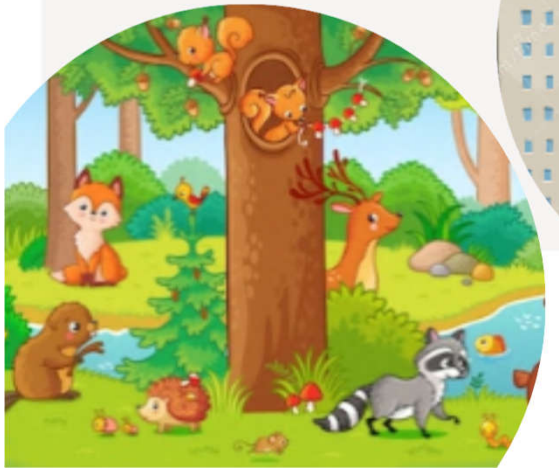
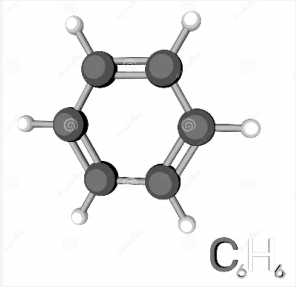


Specific Elements of the CSM include:

- An overview of the historical, current and planned future land uses (land use types, zoning)
- A detailed description of the site and its physical setting that is used to form hypothesis about the release and ultimate fate of contamination at the site

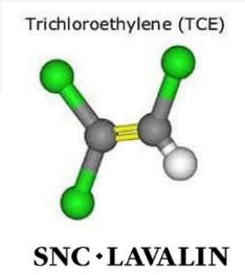
Benzene



PFAS, PFOS

Trichloroethylene

Salts



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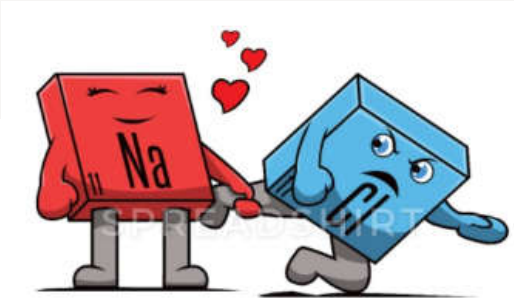
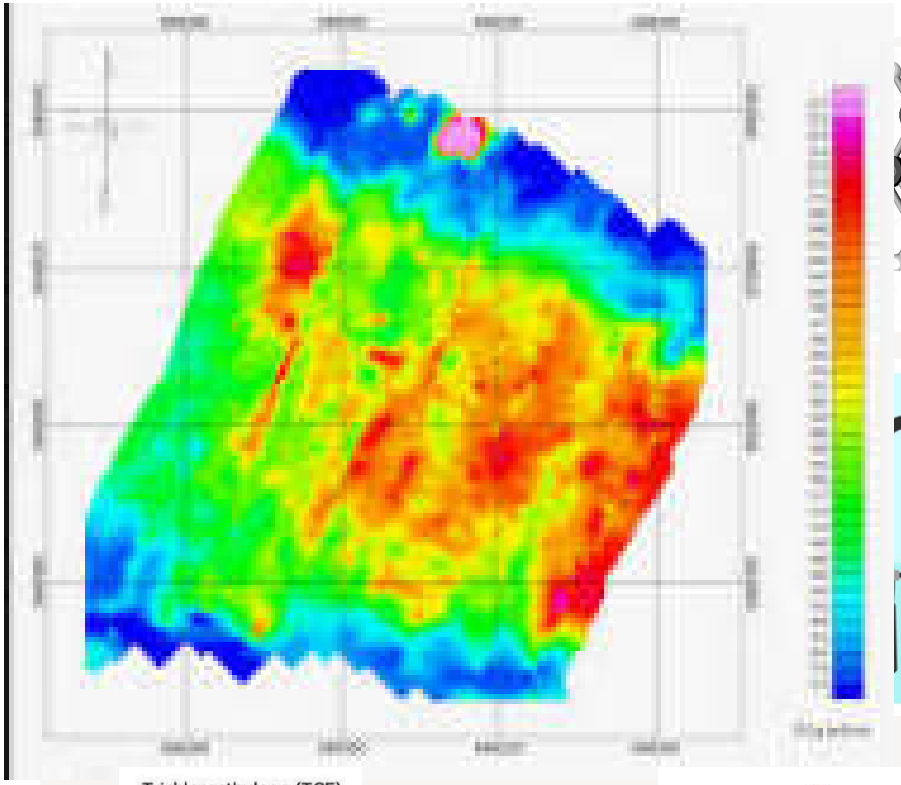
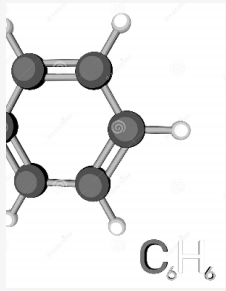


Specific Elements of the CSM include:

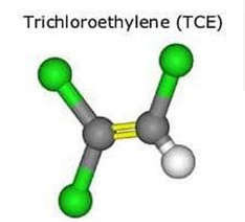
- Sources of contamination at the site, CoPCs and the media (soil groundwater, surface water, soil vapour, indoor air) that may be affected





Specific Elements of the CSM include:

- Sources of contamination at the site, CoPCs and affected media
- The distribution of chemicals within each medium, including information on the concentration, mass or flux



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Specific Elements of the CSM include:

- How CoPCs may be migrating from the sources, the media and pathways through which migration and exposure of potential human or environmental receptors could occur and information needed to interpret CoPC migration, such as soil properties, geology, hydrogeology, hydrology, and possible preferential pathways
- Information on climate and meteorological conditions that may influence contamination distribution and migration

Specific Elements of the CSM shall include:

- Where relevant, information pertinent to soil vapour intrusion into buildings, including construction features of buildings, (size, foundation depth and type, presence of foundation cracks, entry points for utilities) building heating, ventilation, and air conditioning (HVAC) design and operation, and subsurface utilities

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Definition of a Conceptual Site Model

SNC-Lavalin's Definition (in our Preferred Operating Practices):

- an analytical tool for defining the site, comprehending physical properties and addressing site issues. It's a framework of the site and a description of source, receptors and pathways.
- CSMs are scalable.
- Depending on final closure plans, some CSMs will rely on risk assessment applied in conjunction with remediation.
- Expressed as a figure or series of presentation slides or tables or text to facilitate communication.

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Question: Is this a CSM?

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Benefits of Using a CSM

› The earlier the better! A CSM provides definition and logic to evaluation.

› Early use of CSM can identify data issues before you get too far along…

› Provides a format to focus data requirements.

› Lays out problem: what is known and unknown?

› Identifies sources, pathways and receptors.

› Clarifies project goals.

WARNING: Don’t get caught in details when starting out with your CSM! The details will work themselves out as work progresses.

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Developing a CSM

Developing a CSM is a step-wise approach where data (available and needed) is reviewed, organized and presented in an accessible format:

› Establish your framework

› Know your impact

› Understand your receptors

› Assess data gaps to feed your CSM

Data is to a CSM as Cookies are to the Cookie-Monster; you have to keep feeding them both!

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What makes a good CSM?

- How complex do we need to be?
- When is a CSM too complex?
- What makes a CSM effective?
  - *Organized*
  - *Audience-focused*
  - *Summary of interpretation for existing data*
  - *Identifies areas where additional data needed*
- An effective CSM should be dynamic and scalable, which means updating and adjusting and then, sharing as new information becomes available.

Complex does not mean complicated.

Effective CSMs are clear and focused on message delivery.

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Feeding the CSM: Decoding Site Information into a CSM

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Feeding the CSM: Decoding Site Information into a CSM

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Feeding the CSM: Decoding Site Information into a CSM

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Feeding the CSM: Decoding Site Information into a CSM

Learning Has No End

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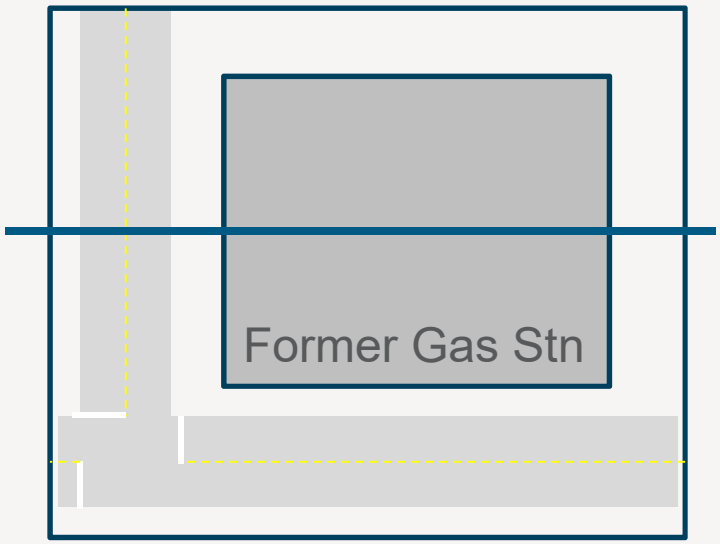
Feeding the CSM: Decoding Site Information into a CSM

Cross-Section View

Plan View



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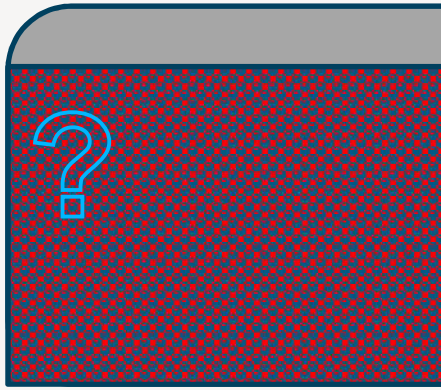
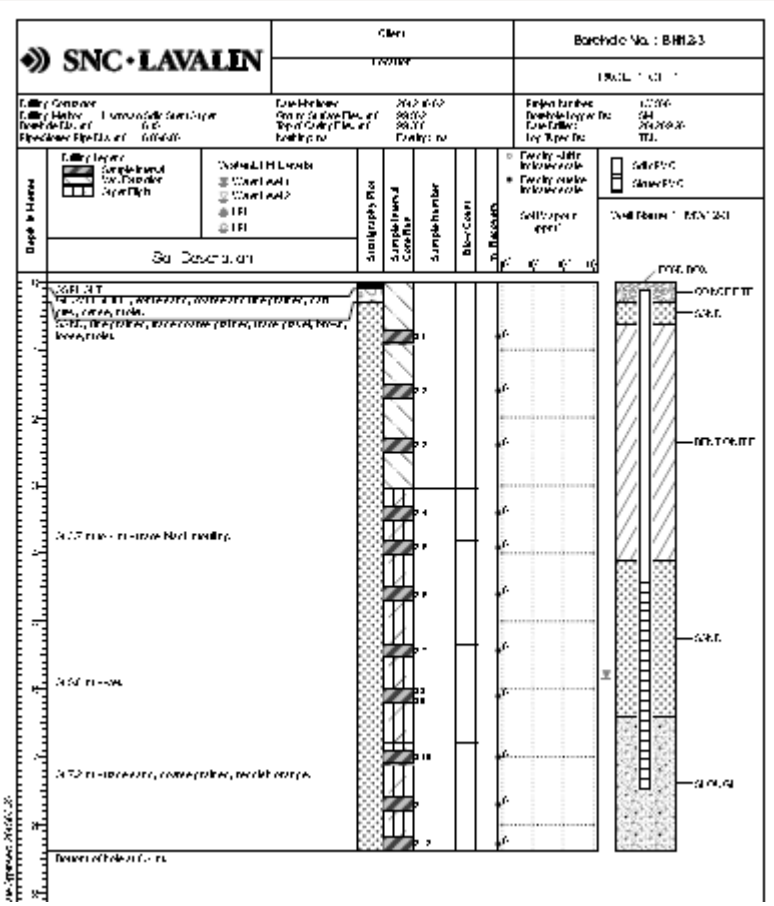
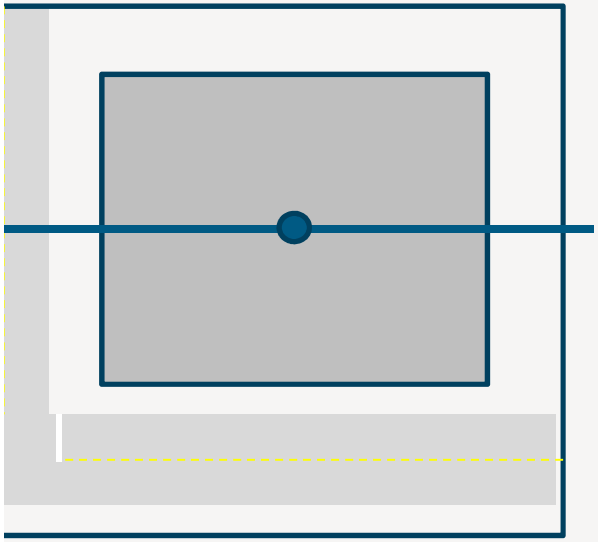
Feeding the CS o a CSM







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Feeding the CSM: Decoding Site Information into a CSM

TABLE 1: Groundwater Analytical Results - Petroleum Hydrocarbons

Sample Location	Sample ID	Sample Date (yyyy mm dd)	Monocyclic Aromatic Hydrocarbons				Petroleum Hydrocarbon Fractions	
			Benzene mg/L	Toluene mg/L	Ethyl-benzene mg/L	Xylenes mg/L	F1-BTEX (C6-C10) mg/L	F2 (>C10-C16) mg/L
Reported Detection Limit			0.00040	0.00040	0.00040	0.00080	0.10	0.10
BH25[b]	BH25	2016 05 25	6.7	0.015	1.0	1.3	4.2	1.7
	MW16-00A	Duplicate of BH25	6.5	0.014	0.90	1.2	4.8	1.8
	QA/QC RPD%		3	7	11	8	13	6
BH26[c]	BH26	2016 05 26	0.0034	< 0.00040	< 0.00040	0.0016	< 0.10	< 0.10
BH51[b]	BH51	2016 05 25	0.66	0.27	0.19	6.6	0.94	1.8
BH53[b]	BH53	2016 05 25	4.9	1.7	1.3	9.7	2.2	2.2
BH54[c]	BH54	2016 05 25	< 0.00040	< 0.00040	< 0.00040	< 0.00080	0.16	0.13
BH71[b]	BH71	2016 05 25	2.0	0.18	0.74	2.7	3.2	3.5
BH77[b]	BH77	2016 05 25	1.6	0.038	0.076	0.78	2.6	3.7
BH84[b]	BH84	2016 05 25	0.0015	0.00069	< 0.00040	0.014	0.12	0.13
BH87[b]	BH87	2016 05 25	0.0030	< 0.00040	< 0.00040	< 0.00080	< 0.10	< 0.10

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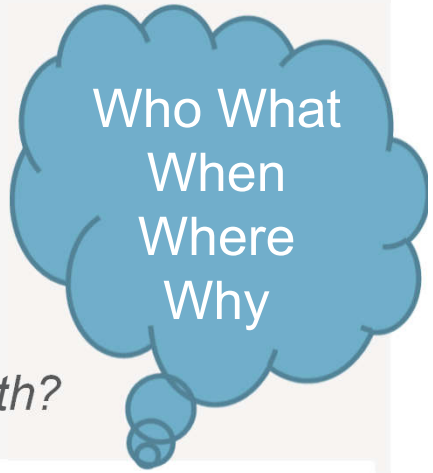
CSM Fundamentals: Communicating the 5 W's

- Who?
  - *Who are we preparing the CSM for?*
- What?
  - *What are the Site conditions? What are the CoCs?*
- When?
  - *When was the release? What time frame are we working with?*
- Where?
  - *Where are the problems? Where is the problem going?*
- Why?
  - *Why are we doing what we propose?*
  - *Is more data needed?*



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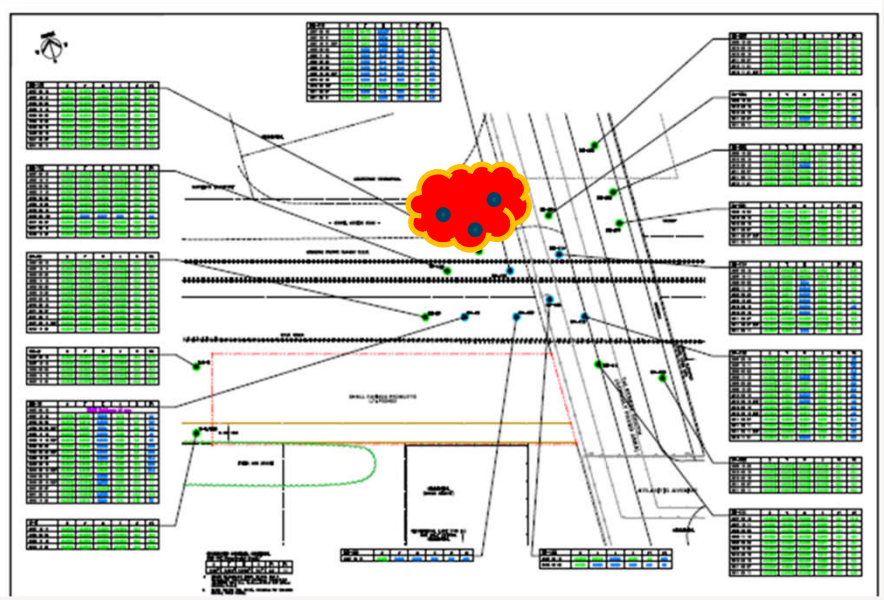
Same Site with Different Audiences: Project Team



- Who?
  - *Project team needs data shown spatially*
- What?
  - *Team confirms lateral delineation*
- When?
  - *Results shown with dates*
- Where?
  - *Red shows impact; green is 'clean'*
- Why?
  - *To show our SVE plan is sound*

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Series of Tabulated Data - CSM

- Version Control
- Project Information
- Site Information
- Lease Access Agreements
- Onsite & Offsite Receptors
- Infrastructure
- APEC PCOC
- Regulatory Contact & Involvement

- Pathway Exclusion
- Aerial Photographs
- Geology
- Hydrogeology
- Well logs
- Contaminant Status
- Risk
- Reports

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Same Site with Different Audiences: Public

- Who?
  - *Public and neighbours review RAP*
- What?
  - *SVE system placement with MWs*
- When?
  - *Predicted results shown with dates*
- Where?
  - *See SVE system in relation to neighbourhood*
- Why?
  - *Need buy-in from public and neighbours*

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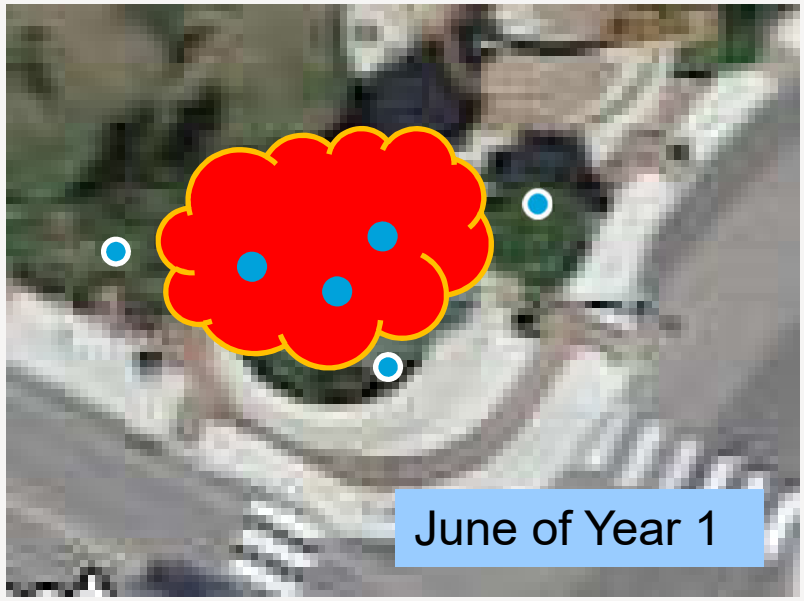
Same Site with Different Audiences: Public



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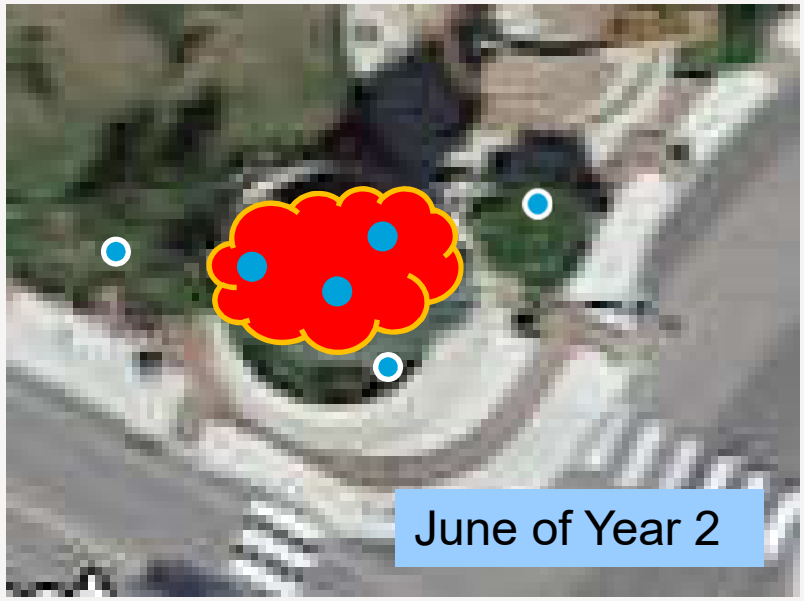

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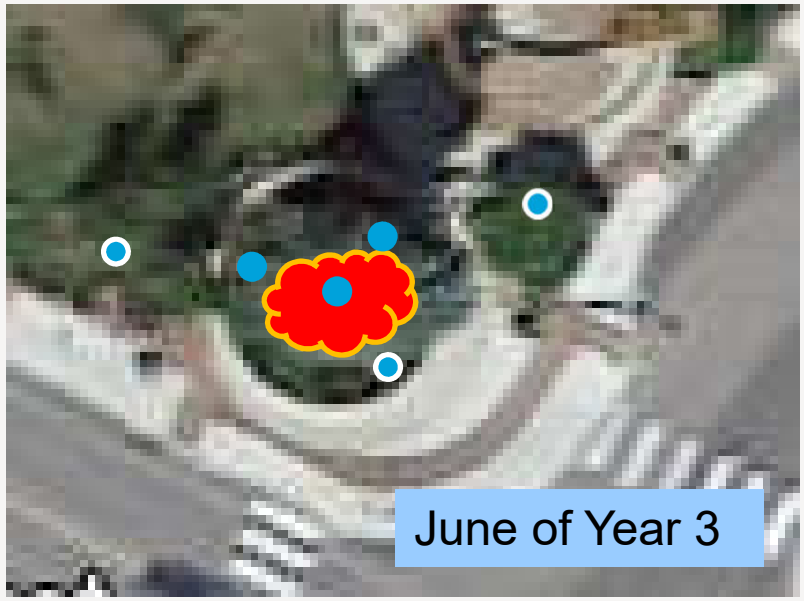

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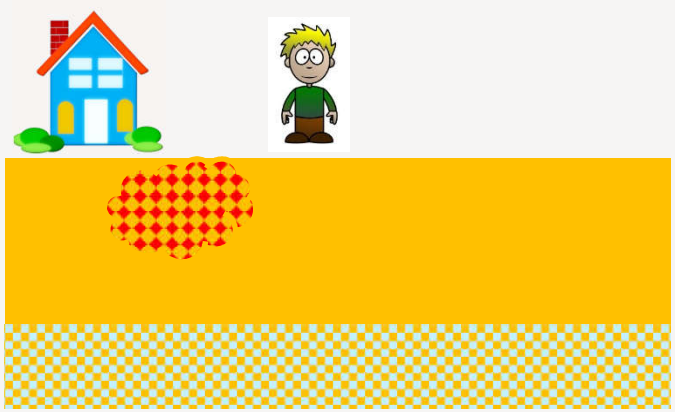
Same Site with Different Audiences: Risk Assessor



- Who?
  - *Who is at risk?*
- What?
  - *Are the sources, receptors, pathways?*
- When?
  - *How will impacts move through media?*
- Where?
  - *Are sources, receptors, pathways?*
- Why?
  - *Protection of human health and environment*

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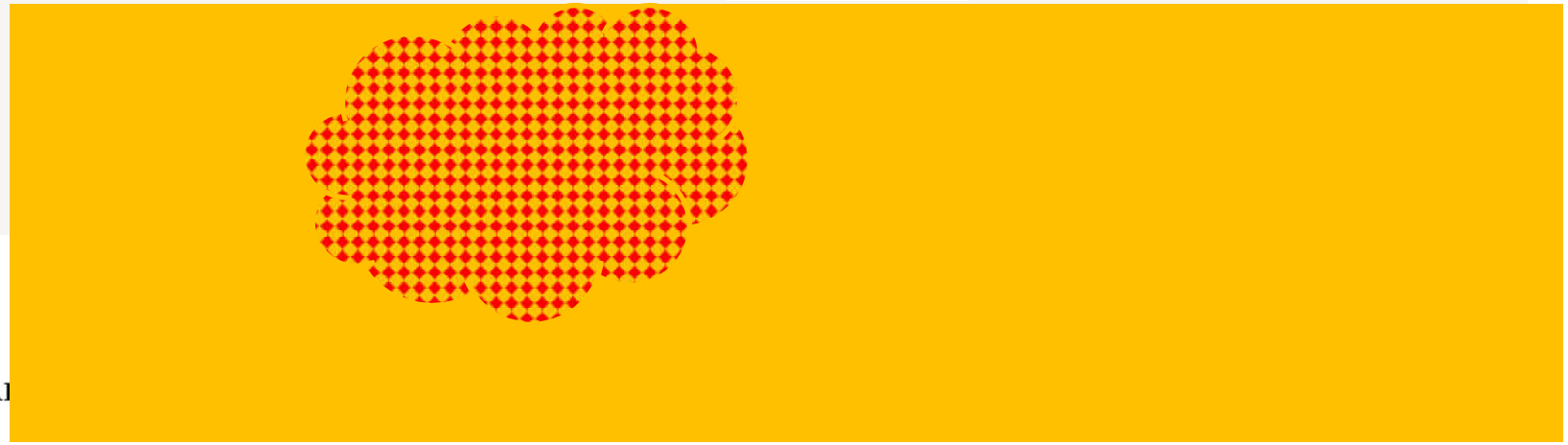
Same Site with Different Audiences: Risk Assessor

Direct Soil Contact



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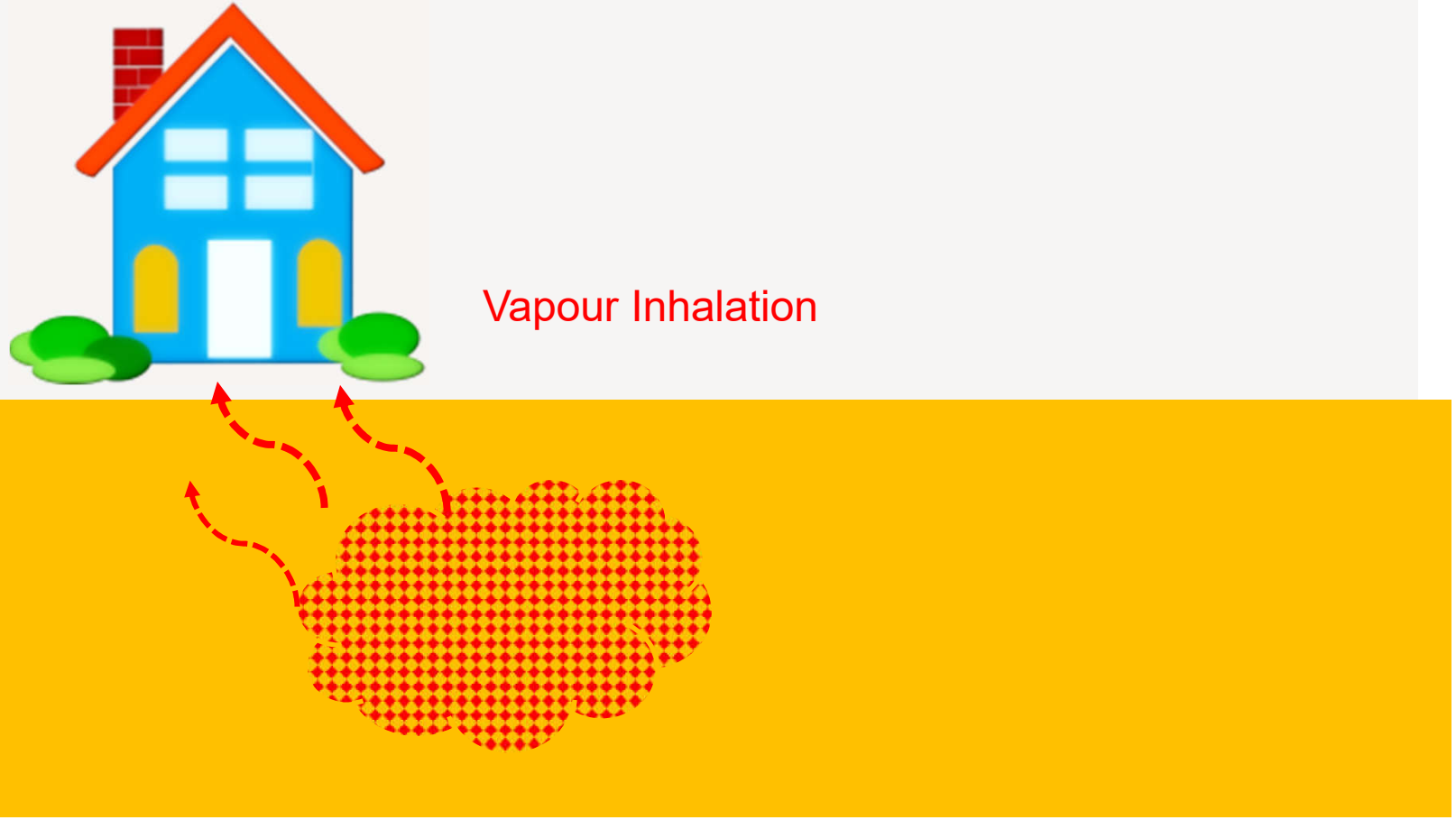
Same Site with Different Audiences: Risk Assessor



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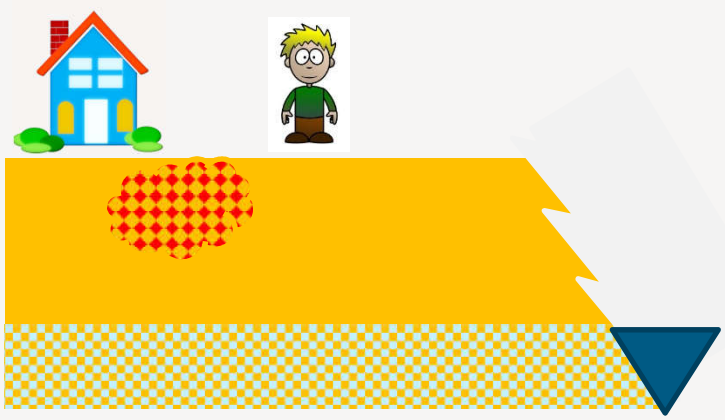
Same Site with Different Audiences: Risk Assessor



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  - *Protection of human health and environment*

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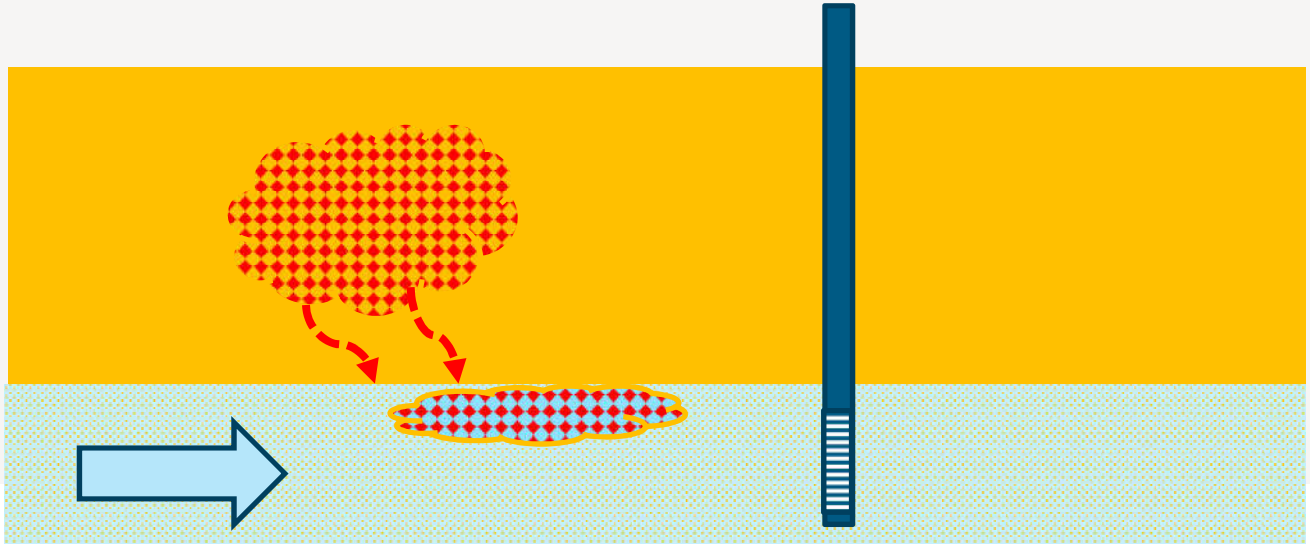
Same Site with Different Audiences: Risk Assessor

Domestic Use Aquifer



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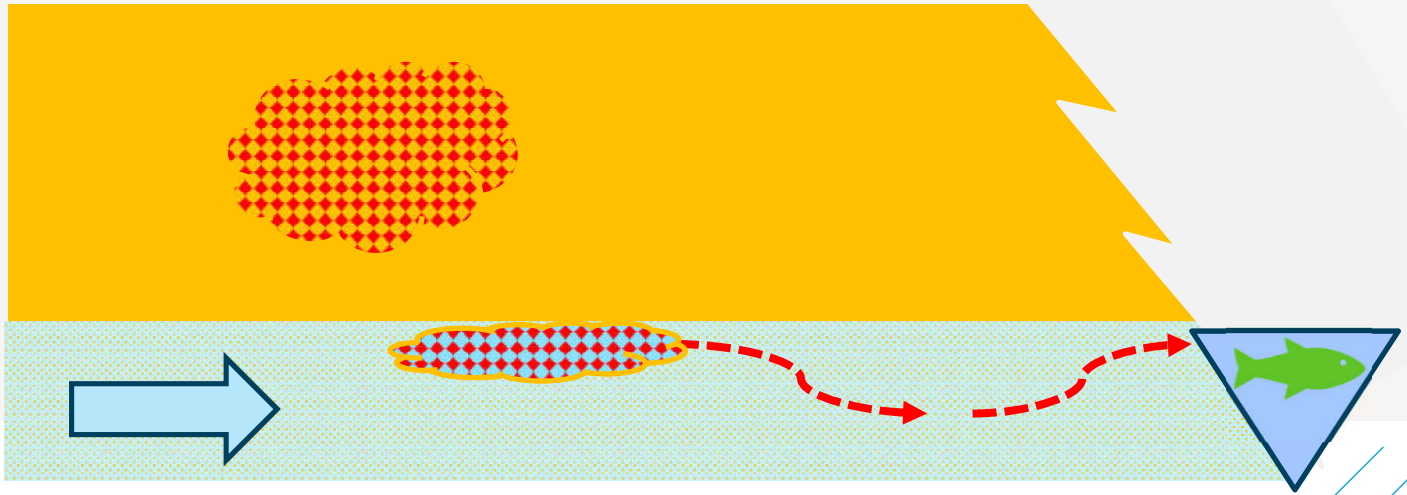
Same Site with Different Audiences: Risk Assessor

Freshwater Aquatic Life



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Actual Project Examples

CSMs can be developed for a variety of environmental assessment and remediation work:

- Estimating contaminant flux to receptors
- Predicting maximum plume length, particularly in areas where monitoring well installation is difficult or impossible
- Optimizing monitoring well locations
- Investigating landfill stormwater runoff disposal options
- Developing remedial system designs
- Supporting risk assessment

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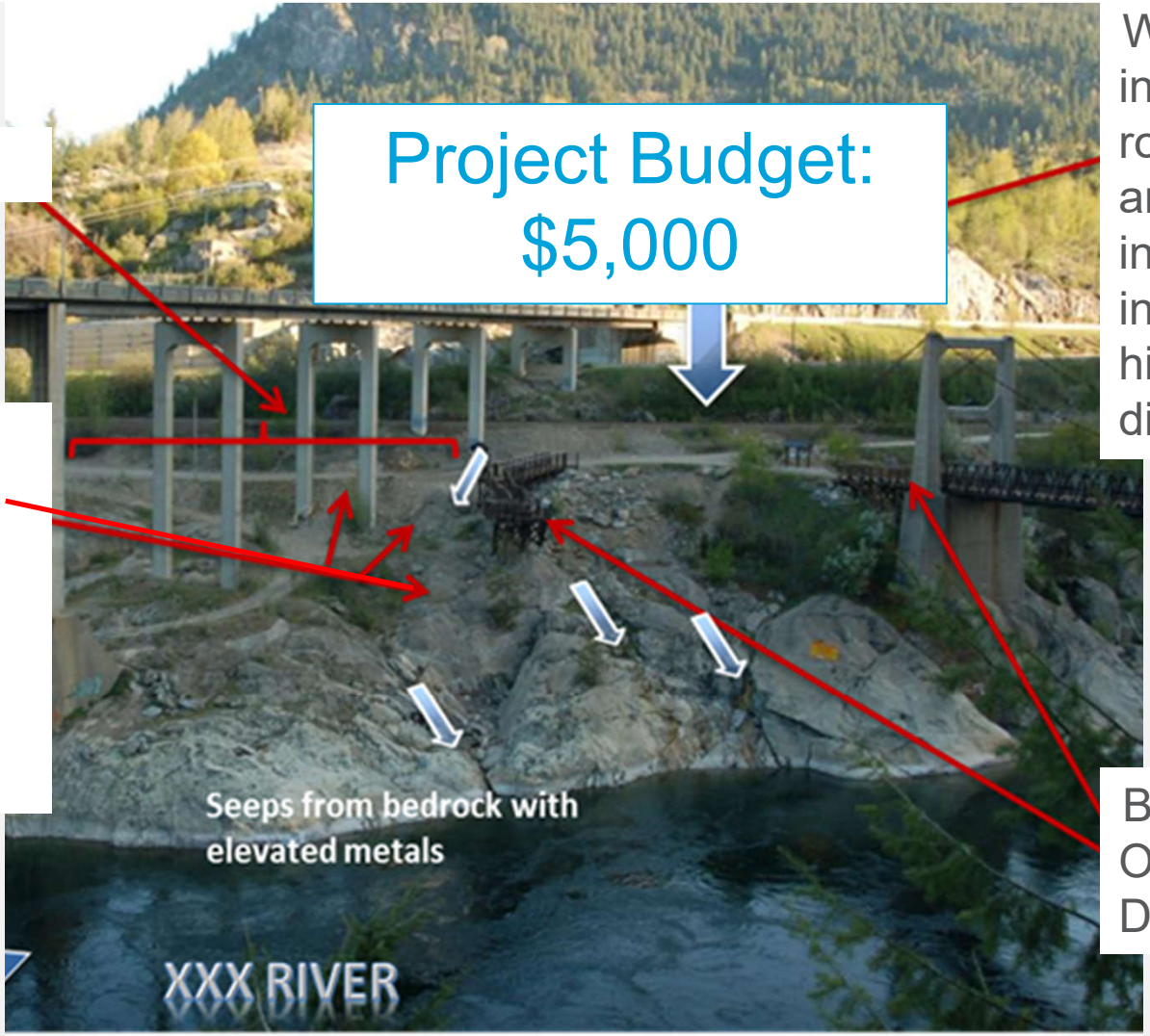
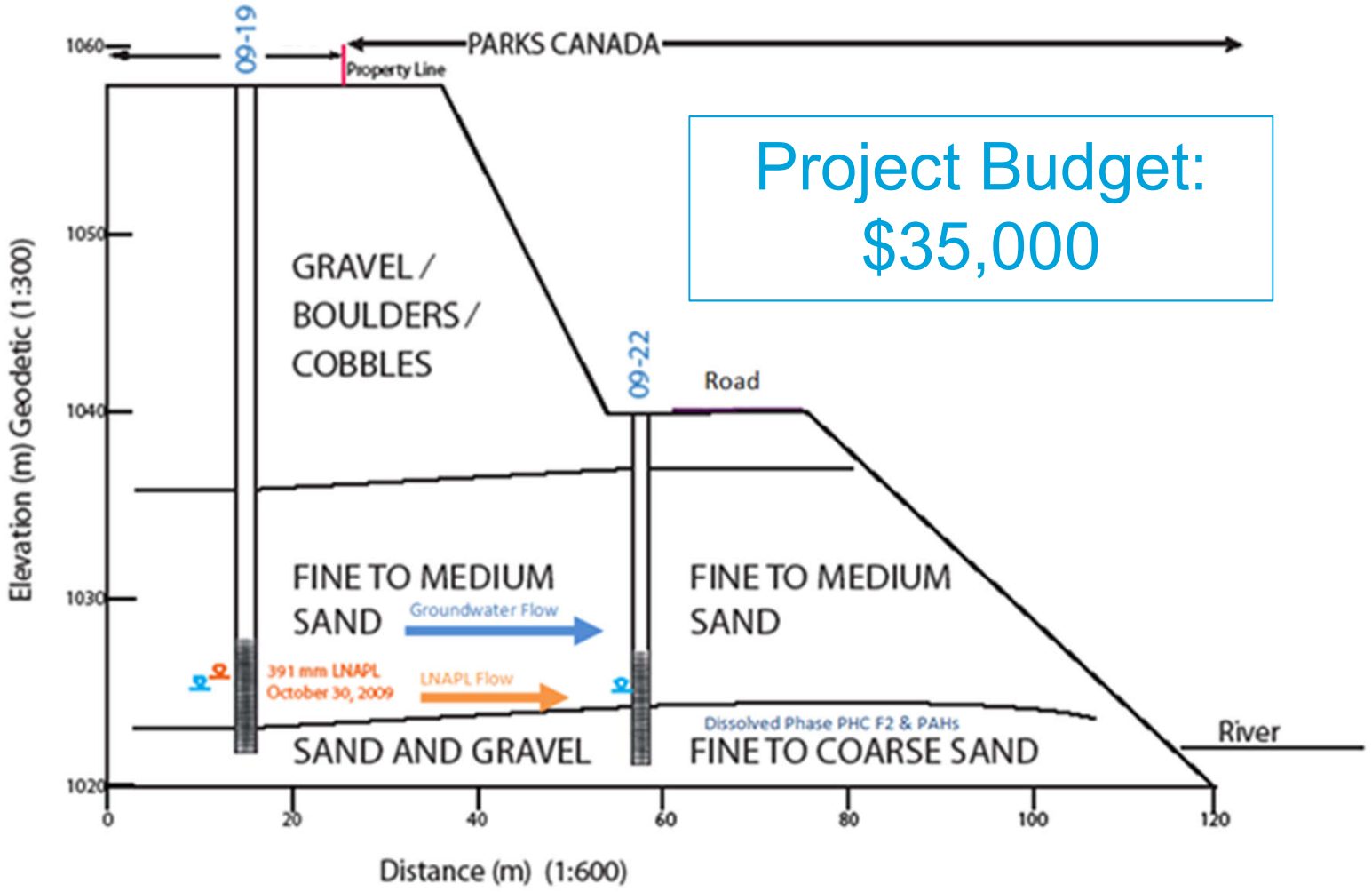
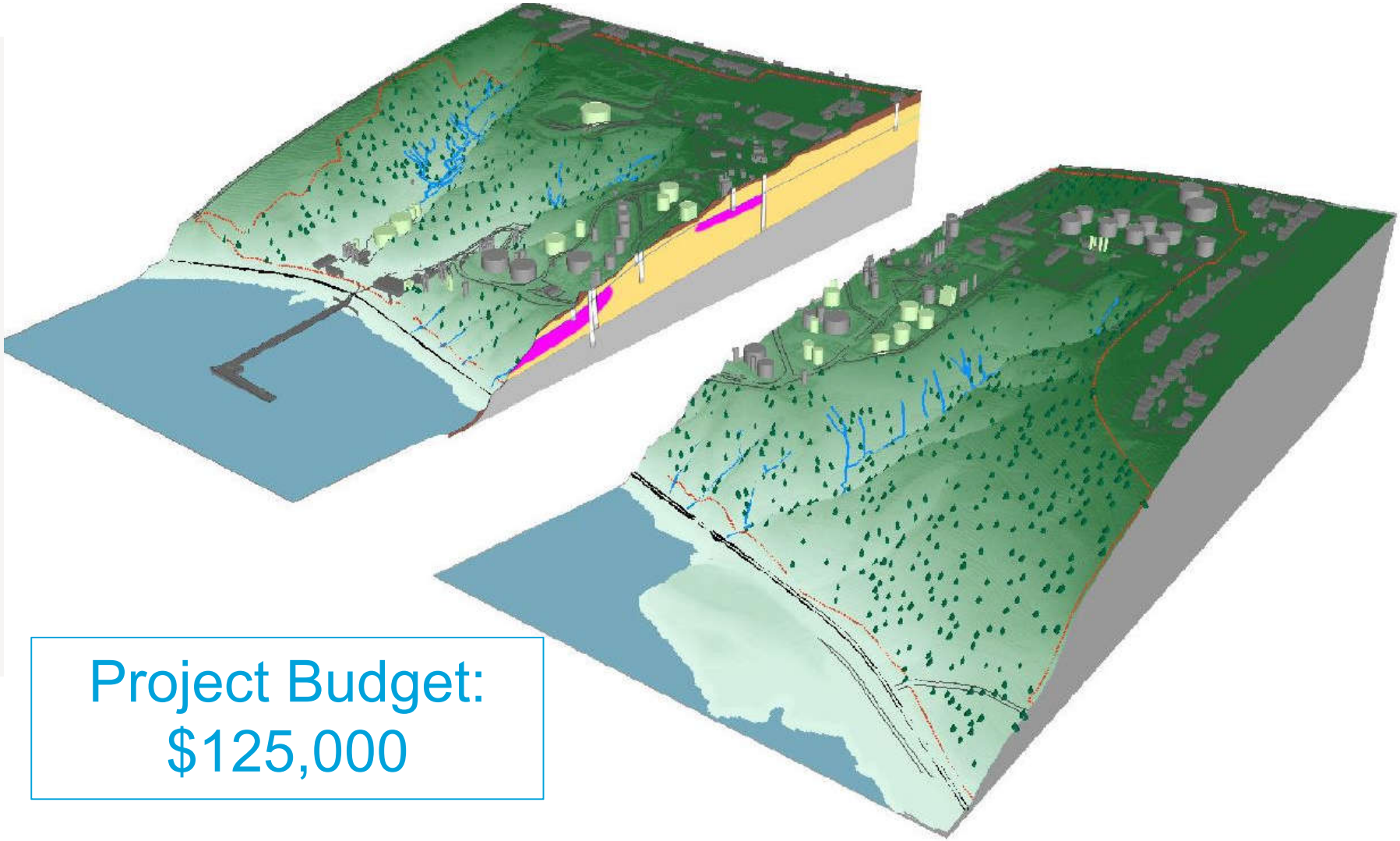

Project Budget:
$5,000
Derailment
Soils containing metals present in undulating bedrock topography
Water input from rock cut and infiltration into highway ditch
Bridge and Observation Deck
Seeps from bedrock with elevated metals
XXX RIVER

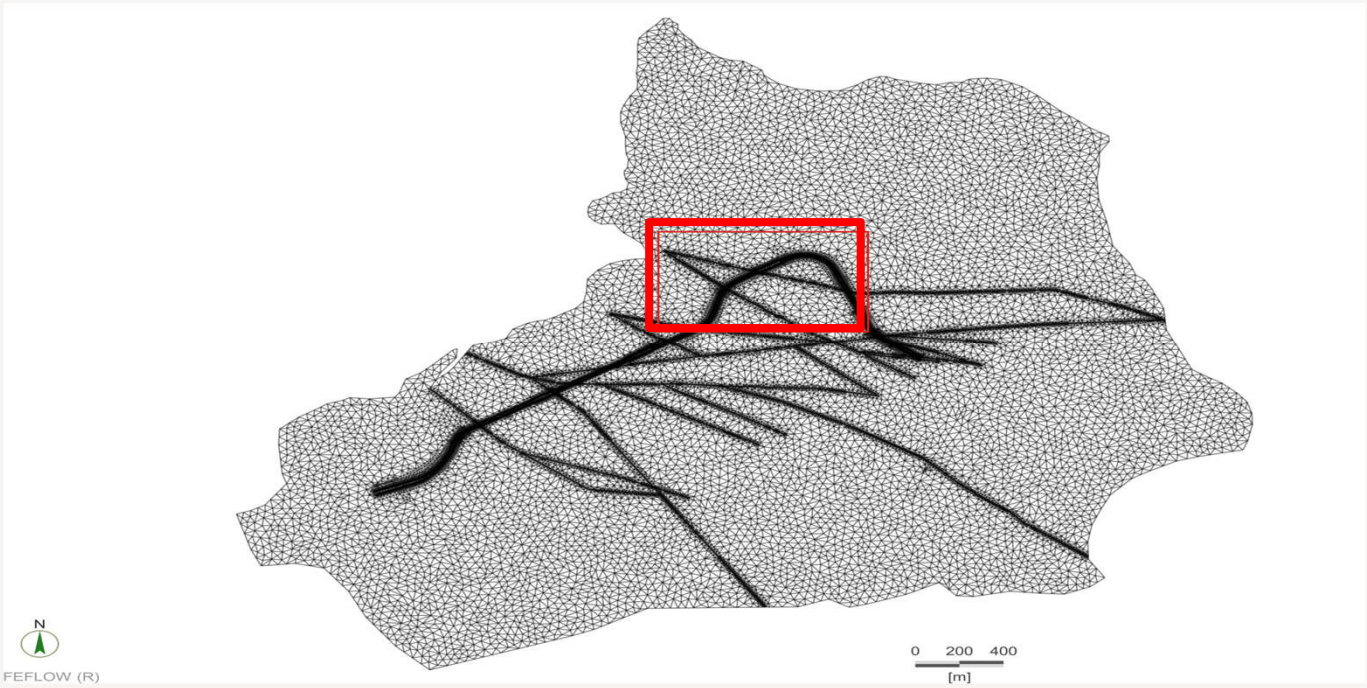


Project Budget:
$35,000



Project Budget:
$125,000

Model Mesh Design with Tunnel Alignment and Bedrock Fractures



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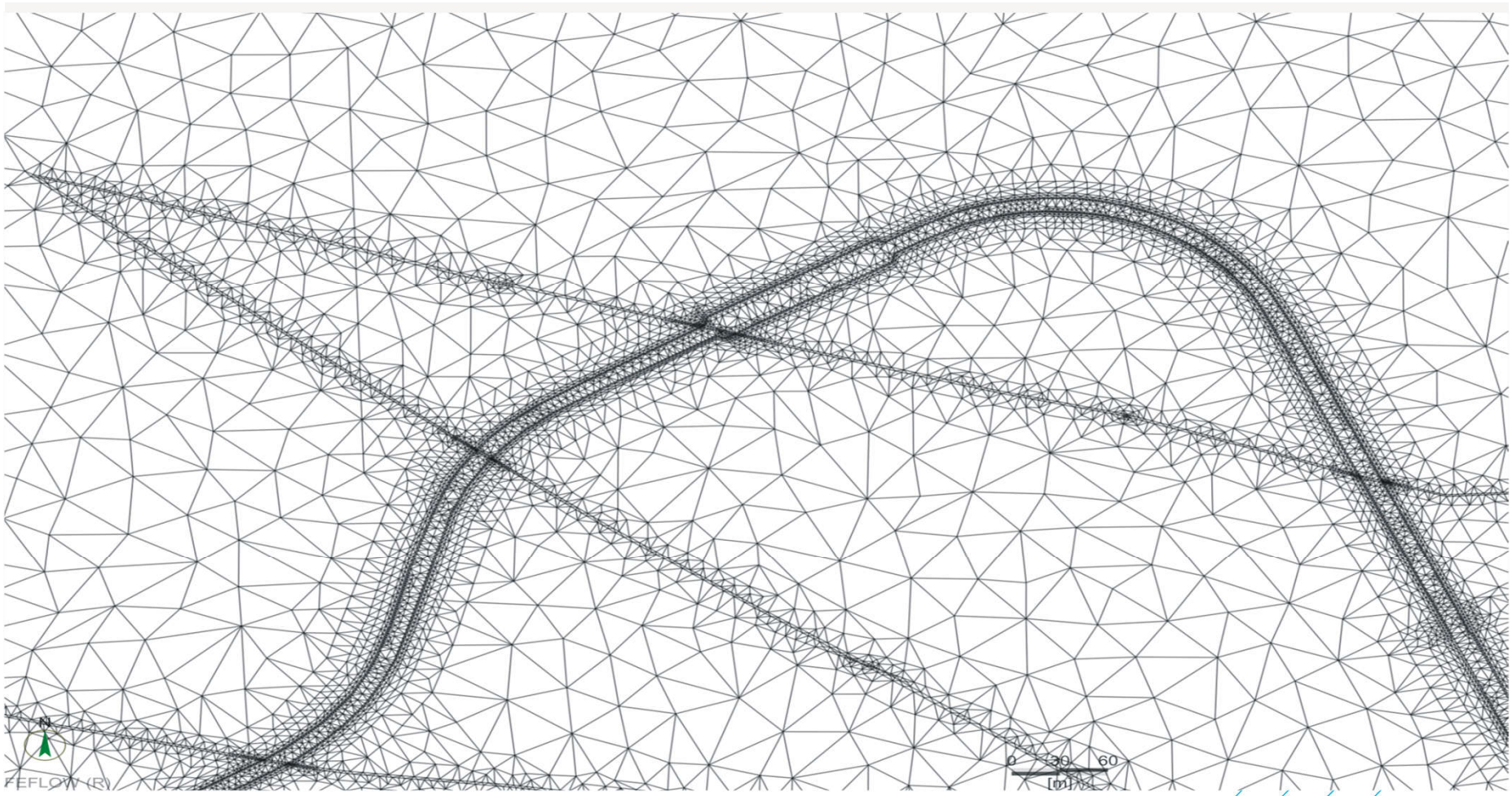
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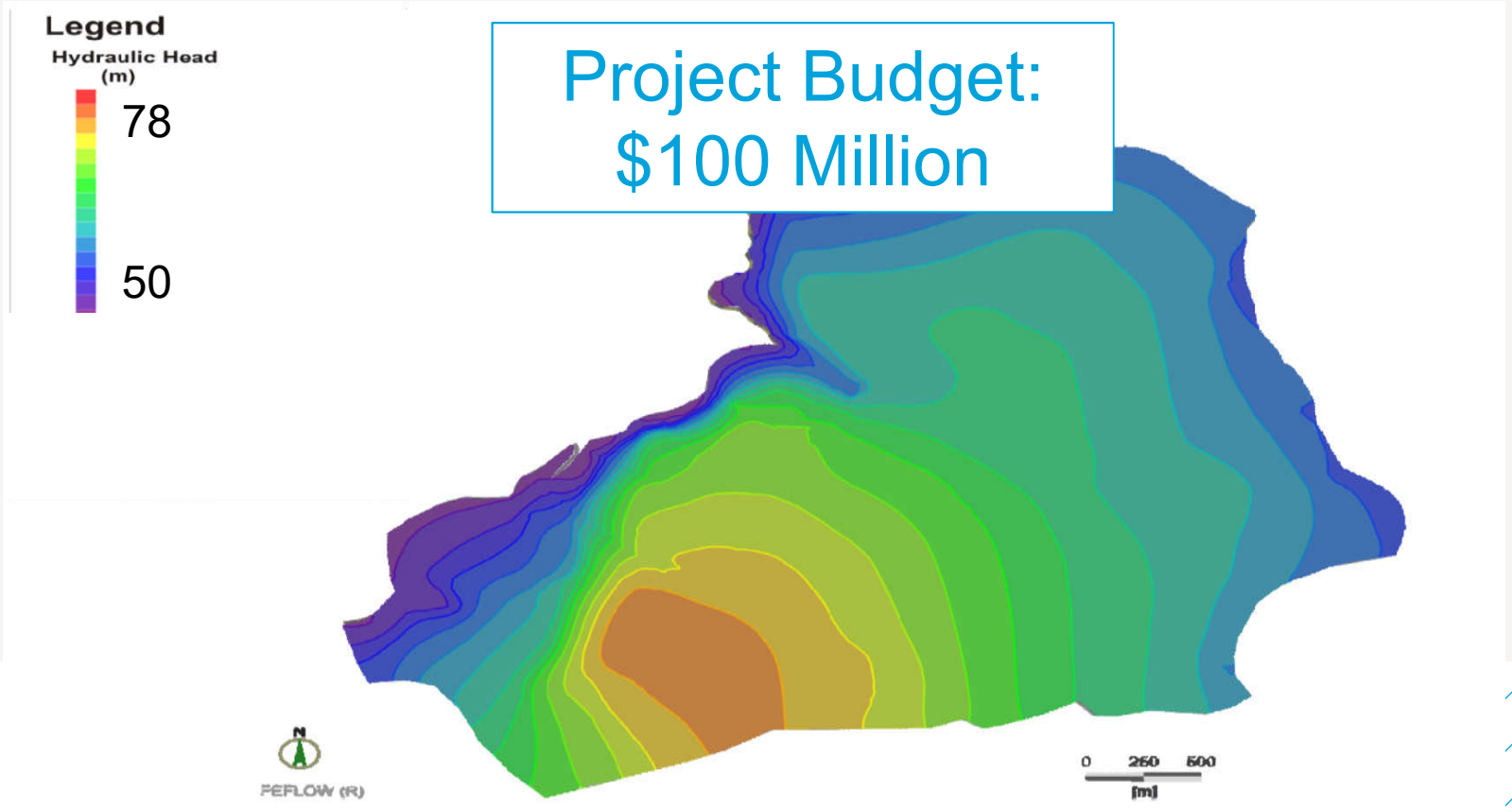
Sample Simulated Initial Hydraulic Heads in Model Domain



Feed your CSM!

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Good CSM's are Effective Communication Tools

CSMs are analytical tools for defining sites, comprehending physical properties and addressing site issues.

- CSMs are as complex or as simple as needed. Effective CSMs are clear and focused on message delivery.
- Effective communication can improve quality, resulting in better productivity.
- Complex does not mean complicated.
- CSM's should be dynamic and evolve as information is compiled.
- CSM's can be used to guide site assessment, remediation and risk management.

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Our values are the essence of our company's identity. They represent how we act, speak and behave together, and how we engage with our clients and stakeholders.

SAFETY

We put safety at the heart of everything we do, to safeguard people, assets and the environment.

INTEGRITY

We do the right thing, no matter what, and are accountable for our actions.

COLLABORATION

We work together and embrace each other's unique contribution to deliver amazing results for all.

INNOVATION

We redefine engineering by thinking boldly, proudly and differently.

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