Conceptual Site Models

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Mā te mahi tahi
Driving impact through collaboration

wasteMINZ ALGA

Agenda

- Conceptual Site Models – what they are and why they matter for groundwater
- The Source – Pathway – Receptor framework
- Key components of a Groundwater CSM
- Breaking down the CSM: Physical and Chemical aspects
- Common Pitfalls and Things to Watch Out For
- Ways to present CSMs Effectively (using case studies)

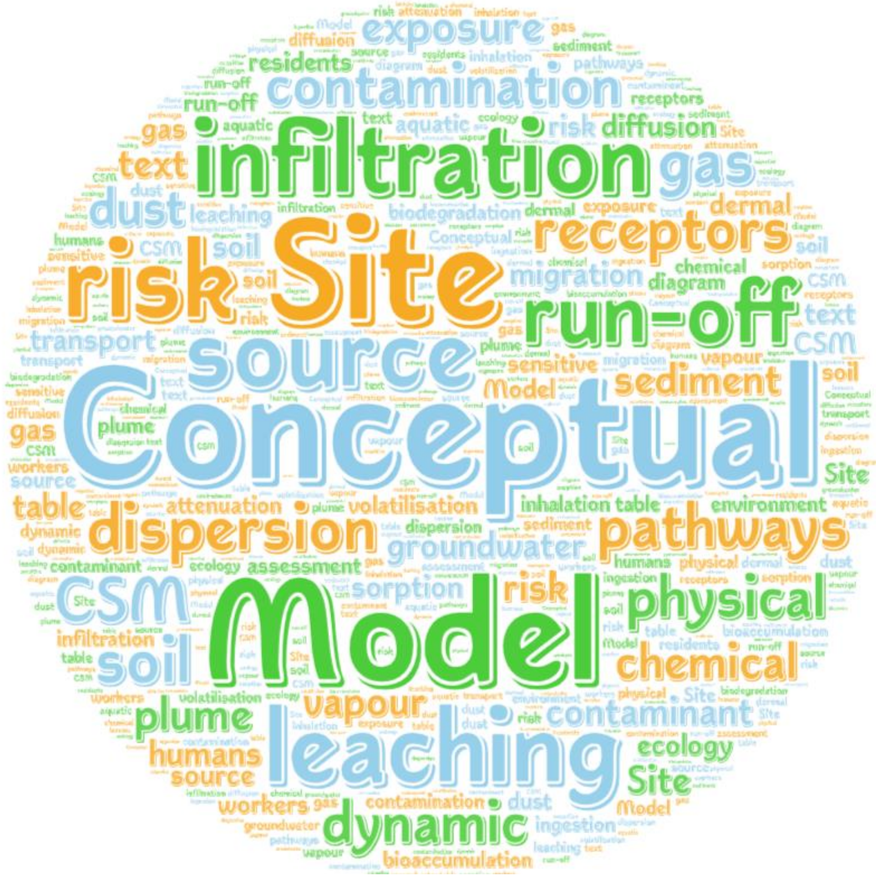
Conceptual Site Models – what they are and why they matter for groundwater

- **A structured diagram + narrative describing:**
  - Sources of contamination
  - Groundwater system & migration pathways
  - Receptors and exposure routes
  - Current best explanation of the site contamination

- **For groundwater, a simple source–pathway–receptor model isn't enough – we also need to consider:**
  - Changes in contamination over time
  - Three-dimensional flow and transport
  - Site heterogeneity

- **Key characteristics:**
  - Iterative - updated as new data and understanding emerge
  - Decision-focused - directly informs investigation and management
  - Testable - expresses hypotheses that can be checked with data

- **Useful communication tool**



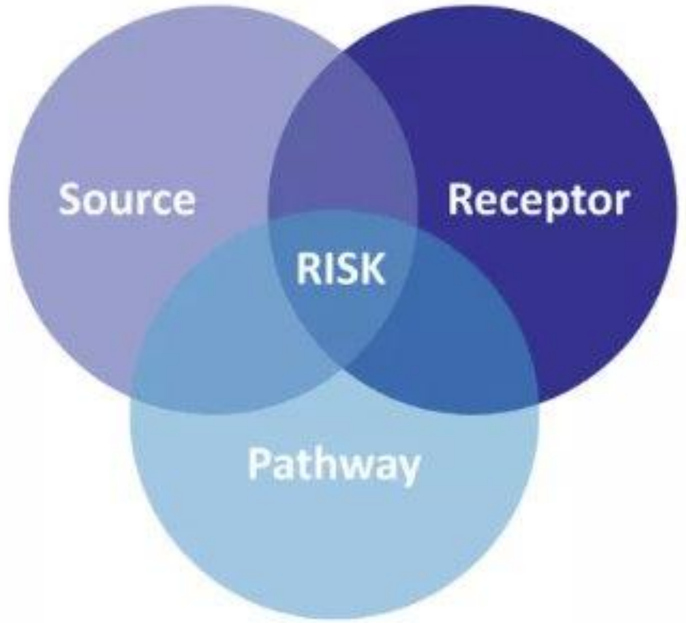
Include all important data in the CSM

The Source – Pathway – Receptor framework

- ***Source:*** Where contaminants originate *(e.g. tanks, tailings, landfills, legacy spills).*
- ***Pathway:*** How contaminants move and transform *(e.g. groundwater flow, fractures, drains, vapour).*
- ***Receptor:*** Who/what can be impacted *(e.g. drinking water bores, ecosystems, surface water, infrastructure).*

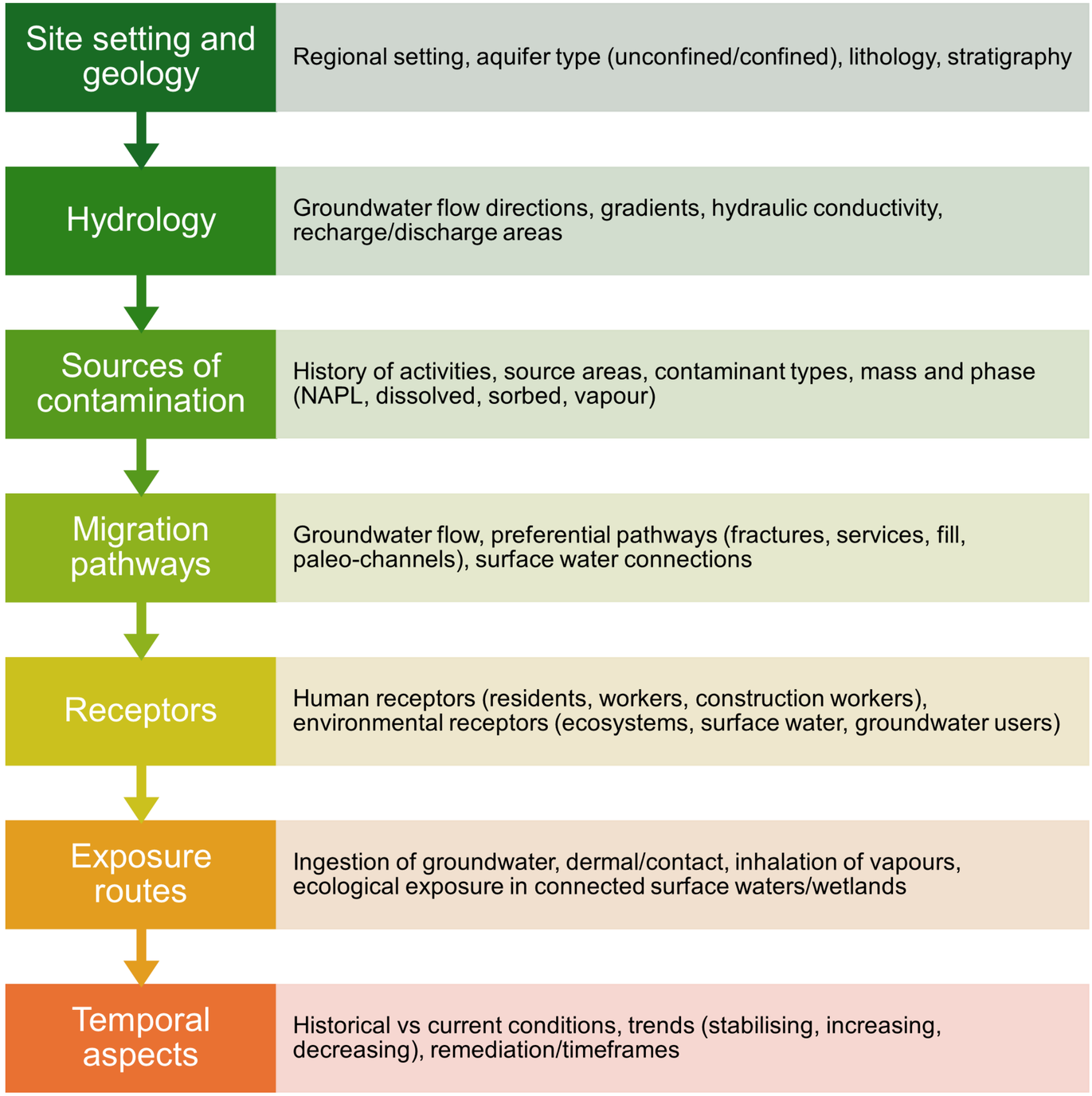
- ***Source + Pathway + Receptor = Potential Risk***
  - No source → No contaminant
  - No pathway → No exposure
  - No receptor (now or reasonably foreseeable) → Limited practical risk

- **Exposure Pathways:**
  - ***Complete pathway***
    - *Continuous linkage from source to receptor*
    - *Potentially complete future pathway*
  - ***Incomplete pathway***
    - *Breaks in the linkage (e.g. no hydraulic connection between aquifers)*

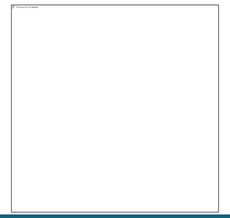


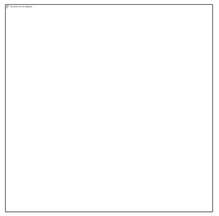
SPR provides the skeleton that physical and chemical CSMs are built around

Key components of a Groundwater CSM



Breaking down the CSM: Physical and Chemical aspects





Physical CSM – Hydrogeological framework – where does the water go?	Chemical CSM – Contaminant behaviour along the way
• Geology and stratigraphy • Permeability contrasts • Groundwater levels and gradients • Recharge and discharge • Surface water connections • Preferential pathways and barriers • Wells, drains, and utilities	• Partitioning between media *- Dissolved, sorbed, NAPL, vapour* • Mobility *- Solubility, volatility, sorption, organic carbon* • Transformations *- Biodegredation, oxidation/reduction, daughter products* • Persistence and plume stability • -Stable, shrinking, or expanding plumes

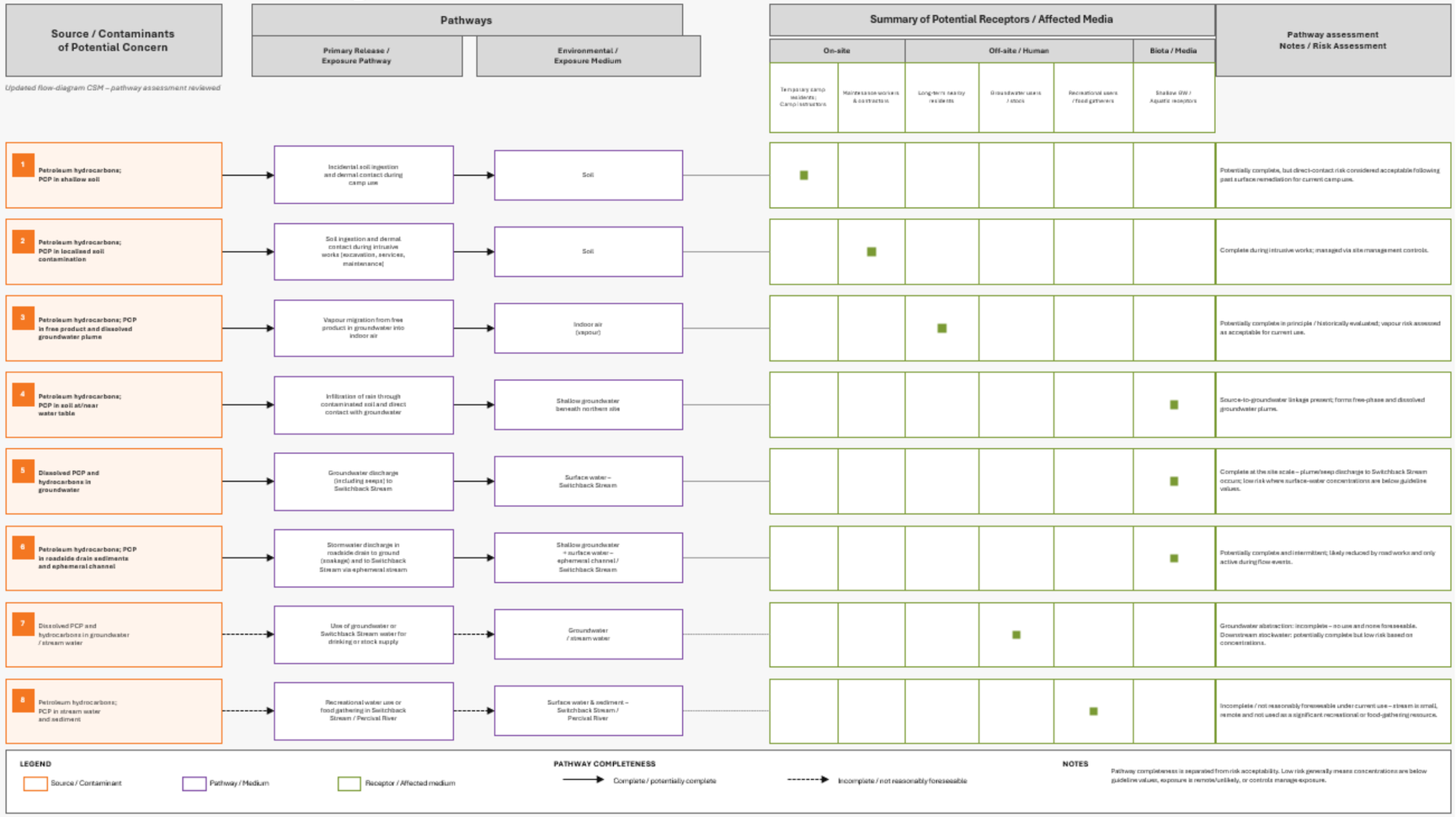
Common Pitfalls and Things to Watch out for

- Treating the CSM as a static figure
- Confusing the monitoring network with the plume
- Over-focusing on concentrations and under-focusing on flow system
- Assuming a complete pathway = high risk
- Ignoring vertical distribution
- Forgetting future receptors / land use
- Hiding uncertainty

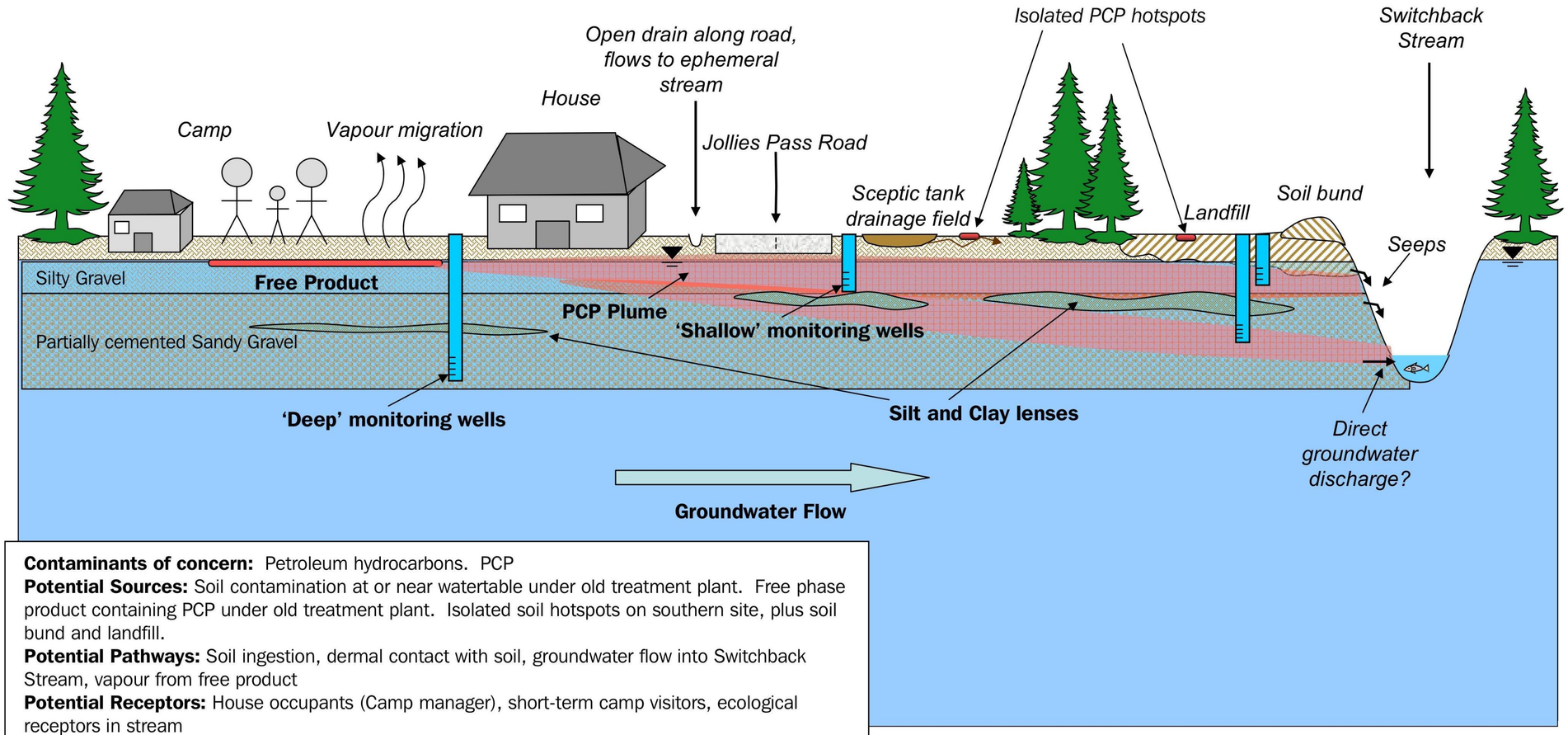
JPR – Tabular CSM

Contaminants of potential concern	Exposure pathway	Potential receptor	Pathway complete?
Petroleum hydrocarbons; PCP in shallow soil	Incidental soil ingestion and dermal contact during camp use	Temporary camp residents (school children and other campers); Camp instructors	No – assumed acceptable following past surface remediation for current camp use
Petroleum hydrocarbons; PCP in localised soil contamination	Soil ingestion and dermal contact during intrusive works (excavation, services, maintenance)	Maintenance workers and contractors	Yes – complete during intrusive works; managed via site management controls
Petroleum hydrocarbons; PCP in free product and dissolved groundwater plume	Vapour migration from free product in groundwater into indoor air	Long-term residents in nearby houses (including former DoC house/camp manager's house)	Historically complete, but vapor risk assessed as acceptable - treated as effectively incomplete for current use
Petroleum hydrocarbons; PCP in soil at/near water table	Infiltration of rain through contaminated soil and direct contact with groundwater	Shallow groundwater beneath northern site	Yes – source to groundwater pathway present; forms free-phase and dissolved plume
Dissolved PCP and hydrocarbons in groundwater	Groundwater discharge (including seeps) to Switchback Stream	Switchback Stream adjacent to camp; Aquatic ecological receptors	Yes – plume discharges to stream; dissolved PCP present but surface water below guideline values (low risk)
Petroleum hydrocarbons; PCP in roadside drain sediments and ephemeral channel	Stormwater discharge in roadside drain to ground (soakage) and to Switchback Stream via ephemeral stream	Groundwater; Aquatic receptors in ephemeral channel and Switchback Stream	Yes – but magnitude reduced by road works and intermittent flows
Dissolved PCP and hydrocarbons in groundwater / stream water	Use of groundwater or Switchback Stream water for drinking or stock supply	Human groundwater users; Stock	Groundwater: No - no abstraction and none foreseeable. Stream for stock: Yes – but concentrations well below guideline values (low risk)
Petroleum hydrocarbons; PCP in stream water and sediment	Recreational water use or food gathering in Switchback Stream / Percival River	Recreational users; Food gatherers	No – stream is small, remote and not used as a significant recreational or food-gathering resource

CSM – Flow Diagram



Schematic cross section



Contaminants of concern: Petroleum hydrocarbons. PCP
Potential Sources: Soil contamination at or near watertable under old treatment plant. Free phase product containing PCP under old treatment plant. Isolated soil hotspots on southern site, plus soil bund and landfill.
Potential Pathways: Soil ingestion, dermal contact with soil, groundwater flow into Switchback Stream, vapour from free product
Potential Receptors: House occupants (Camp manager), short-term camp visitors, ecological receptors in stream

JPR Site – 3D Conceptual Site Model

Hanmer Springs Forest Camp / Jollies Pass Road