CSAP

SOCIETY OF CONTAMINATED SITES
APPROVED PROFESSIONALS
OF BRITISH COLUMBIA

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17th Annual General Meeting

June 4, 2024

This meeting is being conducted from the traditional, ancestral, and unceded territory of the Coast Salish peoples, including Squamish, Tsleil-Waututh, Musqueam

Scholarships

- Each year, up to three scholarships are awarded to applied science and engineering graduate students whose studies are relevant to the assessment and remediation of contaminated sites.

- Applications are reviewed and successful applicants chosen by an independent selection panel comprised of Technical Review Committee members

Scholarship Recipients

Beatrice Chee (Mike Macfarlane Award) – MRM program, REM, SFU

- Research Topic: chemical activity-based risk assessment of perfluorohexanesulphonic acid (PFHxS).

Joey Egeland – MSc program, Environmental Science, TRU

- Research Topic: Improved bioremediation techniques and equipment.

Claire Kilgour – MSc program, Zoology, UBC

- Research Topic: Impacts of road salt exposure on Pacific salmon success.

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Performance Assessment Committee Lessons Learned

Chair: Chuck Jochems, P.Eng.

Agenda

- Overview of PAs and Submissions
- PA Lessons Learned
- Metes and Bounds on Schedule A figures

PAC Fiscal Summary

2023-2024 Summary (as of March 31, 2024)

Item	Number	Notes
Active PAs	5	
Sufficient	17	5 at Stage 1 Findings
Deficient	1	
Total PAs	23	Including 5 NRPAs

- Total of 150 Submissions received by CSAP Society

2023-2024 NRPA Summary

- Total of 5 NRPAs conducted:
  - 1 from Focused Review
  - 2 from Measures (i.e. Deficient Submission)
  - 1 was Site-Specific
  - 1 at request of ENV

PA LESSONS LEARNED

PAC Tracking of Lessons Learned

- Spreadsheet of potential issues provided to DM
- Categories follow the Stage 1 Findings letter template
- Feedback from PA panel members possible during PA
- DM(s) provide Lessons Learned feedback to CSAP when finalizing DS of the Submission
- Provide feedback in Member Updates

PA Lessons Learned - Categories

Standards Portion

- Stage 1 PSI
- Stage 2 PSI
- Standards (Applicability)
- DSI
- Remediation
- ENV Policy

Risk Portion

- Problem Formulation
- Exposure Assessment
- Toxicity/Effects Assessment
- Risk Characterization
- Uncertainty Analysis
- General and Regulatory
- Risk Management

PA Lessons Learned

- Examples provided in the following slides are from a cross-section of PAs
- Examples presented may not have resulted in a ‘Deficient’ Finding
- Additional context will be provided as needed to assist the Membership in understanding the issues raised during PAs

PA Lessons Learned

Category	Item	Details
Stage 1 PSI	Other	Various operations occurred at the site over differing periods and durations. Better clarity on these factors defining APECs would have been helpful.
Stage 1 PSI	Other	Former facilities not shown on figures along with dates of APEC activities in relation to historical aerial photographs, which required clarification.
Stage 1 PSI	Other	Stage 1 PSI was 3 years old at time of submission, but primary APEC was a former service station decommissioned 25 years ago. Update was provided in the Addendum.
Stage 1 PSI	Other	Current and old report did not match on location / extent of APECs and investigation locations.

PA Lessons Learned

Category	Item	Details
Stage 2 PSI	Other	Did not analyze samples for all PCOCs identified in Stage 1 PSI, with no rationale provided.
Stage 2 PSI	Other	Assessment of APECs considered inadequate due to investigation locations and density.
Stage 2 PSI	Other	Clarification required on location of prior work phases. Location of former AST and fuel supply lines later indicated an offsite APEC, inadequately investigated and unresolved.
Stage 2 PSI	Missed APECs	Clarification required around potential presence and characterization of fill material at the Site.

PA Lessons Learned

Category	Item	Details
DSI	Inadequate Characterization	Did not show vertical delineation of groundwater contamination on cross-sections or describe it within the report.
DSI	Insufficient trend analysis	Consider using Mann-Kendall trend analysis of the groundwater concentrations to further demonstrate plume stability in support of risk assessment.
DSI	Inadequate Characterization	Limited extent of low-level PHC groundwater contamination was not vertically delineated. It was addressed in Addendum and original work was based on a network of 30 monitoring wells.
DSI	Missing CSM	Soil vapour data evaluation was lacking and hard to follow. Unsure which VAFs were applied for future use.

PA Lessons Learned

Category	Item	Details
DSI	Insufficient trend analysis	Trend analysis on plume stability not completed. Additional testing identified higher concentration at leading edge of the plume.
Standards	Vapour evaluation	Vapour assessment for naphthalene was based on non-detect concentrations, which was not the case. Vapour modelling failed to meet CSR standard.
Remediation	Inadequate remediation	Show investigation sample exceedance locations on CoR figures and cross-sections to confirm removal of contamination.
Remediation	Other	Remediation Plan was lacking adequate detail as defined in Section 1 of the CSR in support of a numerical AIP.

PA Lessons Learned

Category	Item	Details
Remediation	Other	Details relating to the location and decommissioning of a former biocell by others was not provided in the CoR report.
ENV Policy	Technical guidance	Full details on the use of TG2 statistical evaluation not included with original report.
ENV Policy	Did not qualify under P6	Contaminated fill extended off property and a P6 Preapproval was not obtained (i.e. submission made between February 2021 and April 2024).
ENV Policy	Did not qualify under P6	Site was a lease area within a larger parcel owned by a municipality. Lease area was subject to an ENV Release, but clarification was required for eligibility under Protocol 6 for the submission.

METES & BOUNDS REMINDER

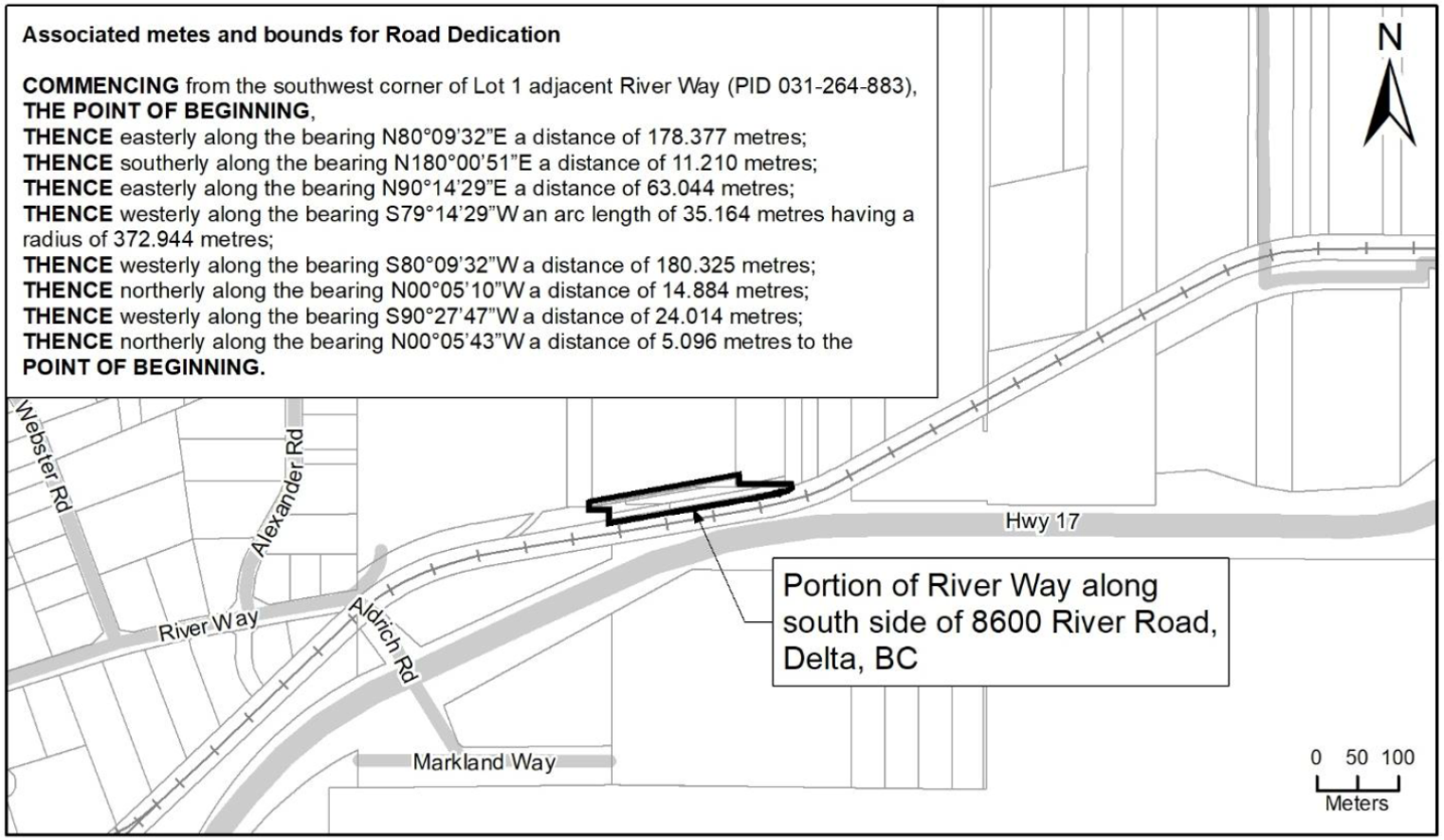
Schedule A Figures

M & B - Road Dedication example (CoC)

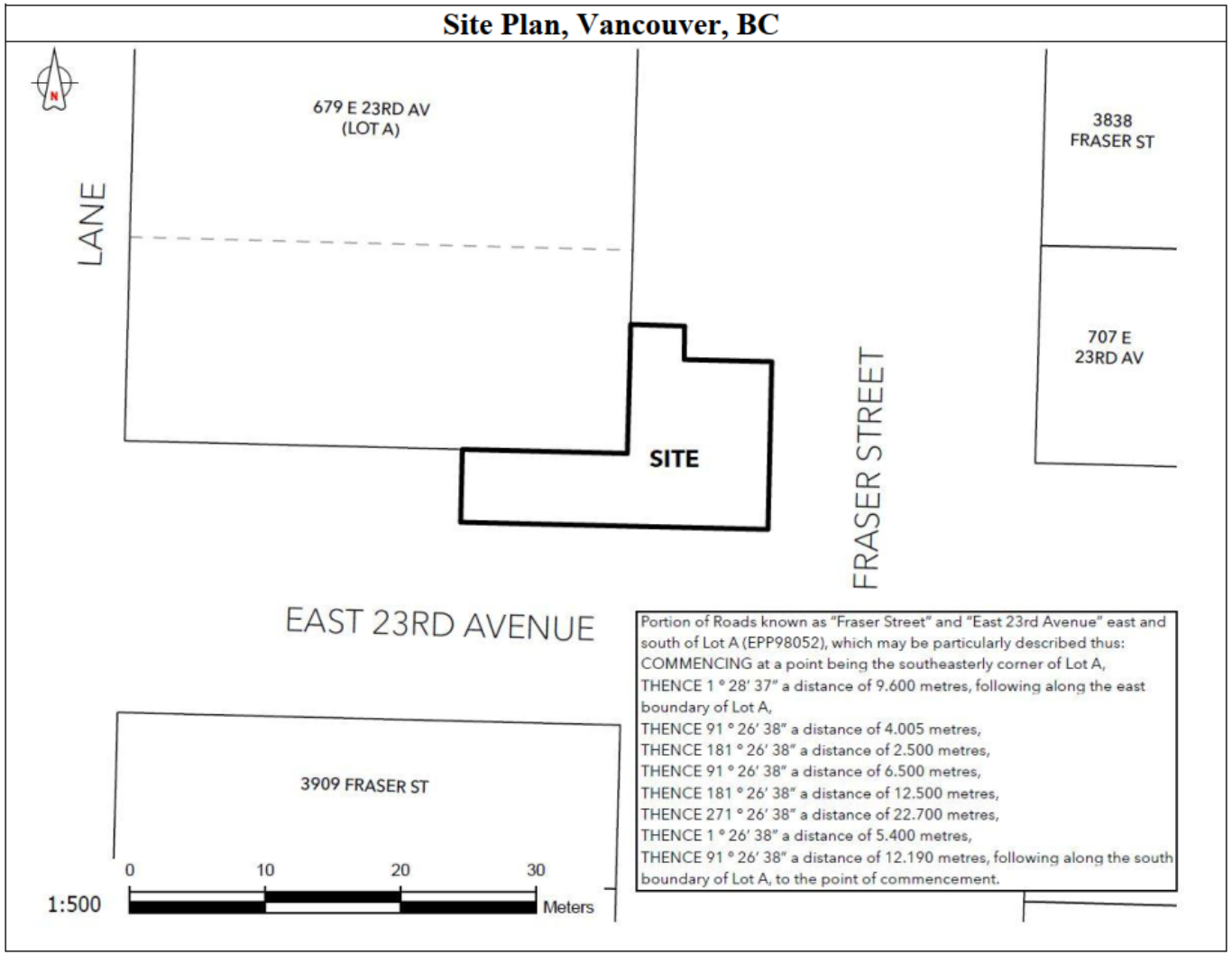
Site Plan, Delta, BC

Associated metes and bounds for Road Dedication

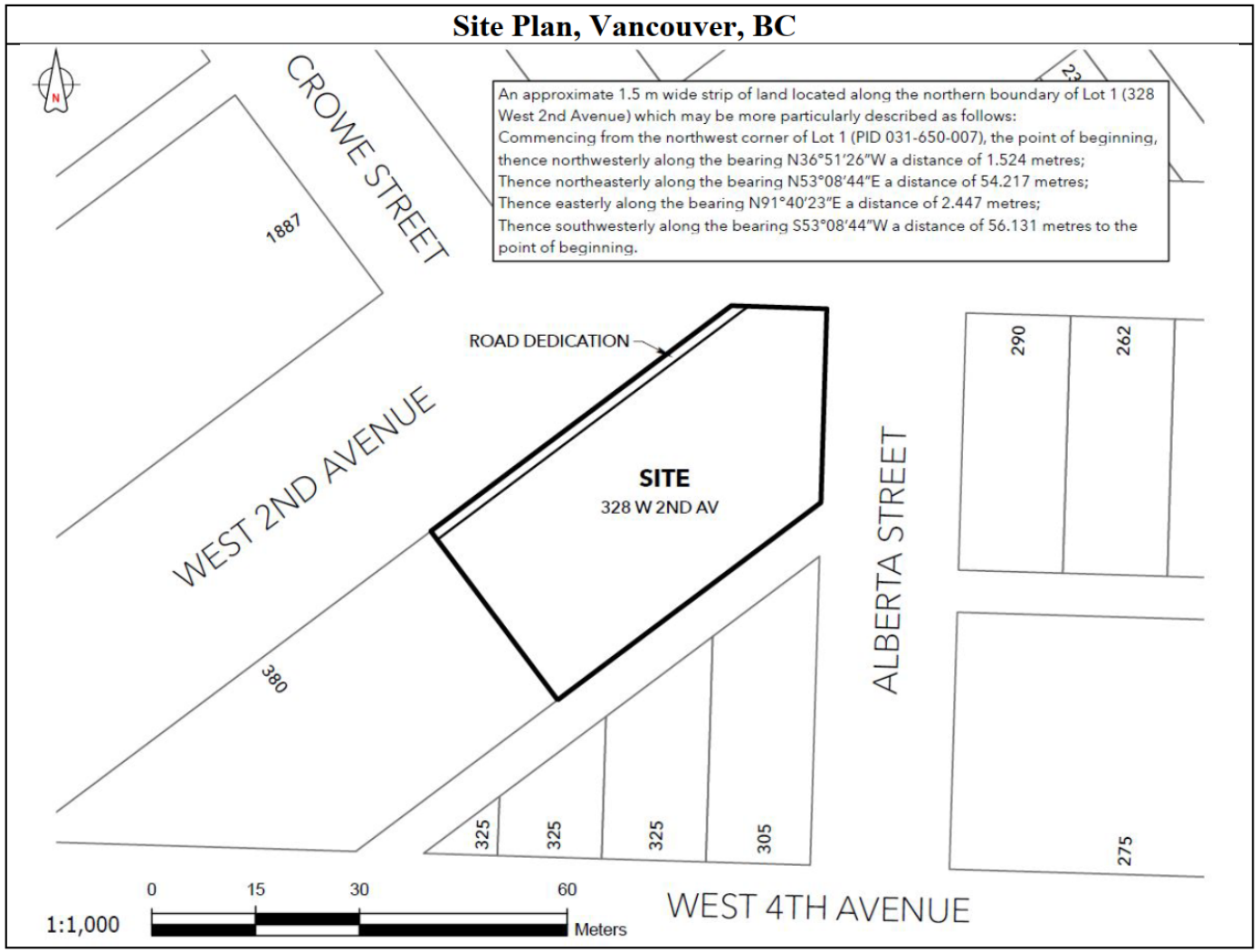
COMMENCING from the southwest corner of Lot 1 adjacent River Way (PID 031-264-883),
THE POINT OF BEGINNING,
THENCE easterly along the bearing N80°09'32"E a distance of 178.377 metres;
THENCE southerly along the bearing N180°00'51"E a distance of 11.210 metres;
THENCE easterly along the bearing N90°14'29"E a distance of 63.044 metres;
THENCE westerly along the bearing S79°14'29"W an arc length of 35.164 metres having a radius of 372.944 metres;
THENCE westerly along the bearing S80°09'32"W a distance of 180.325 metres;
THENCE northerly along the bearing N00°05'10"W a distance of 14.884 metres;
THENCE westerly along the bearing S90°27'47"W a distance of 24.014 metres;
THENCE northerly along the bearing N00°05'43"W a distance of 5.096 metres to the **POINT OF BEGINNING.**



M & B - OMA example (CoC)



M & B - Previous Road Dedication (AiP)

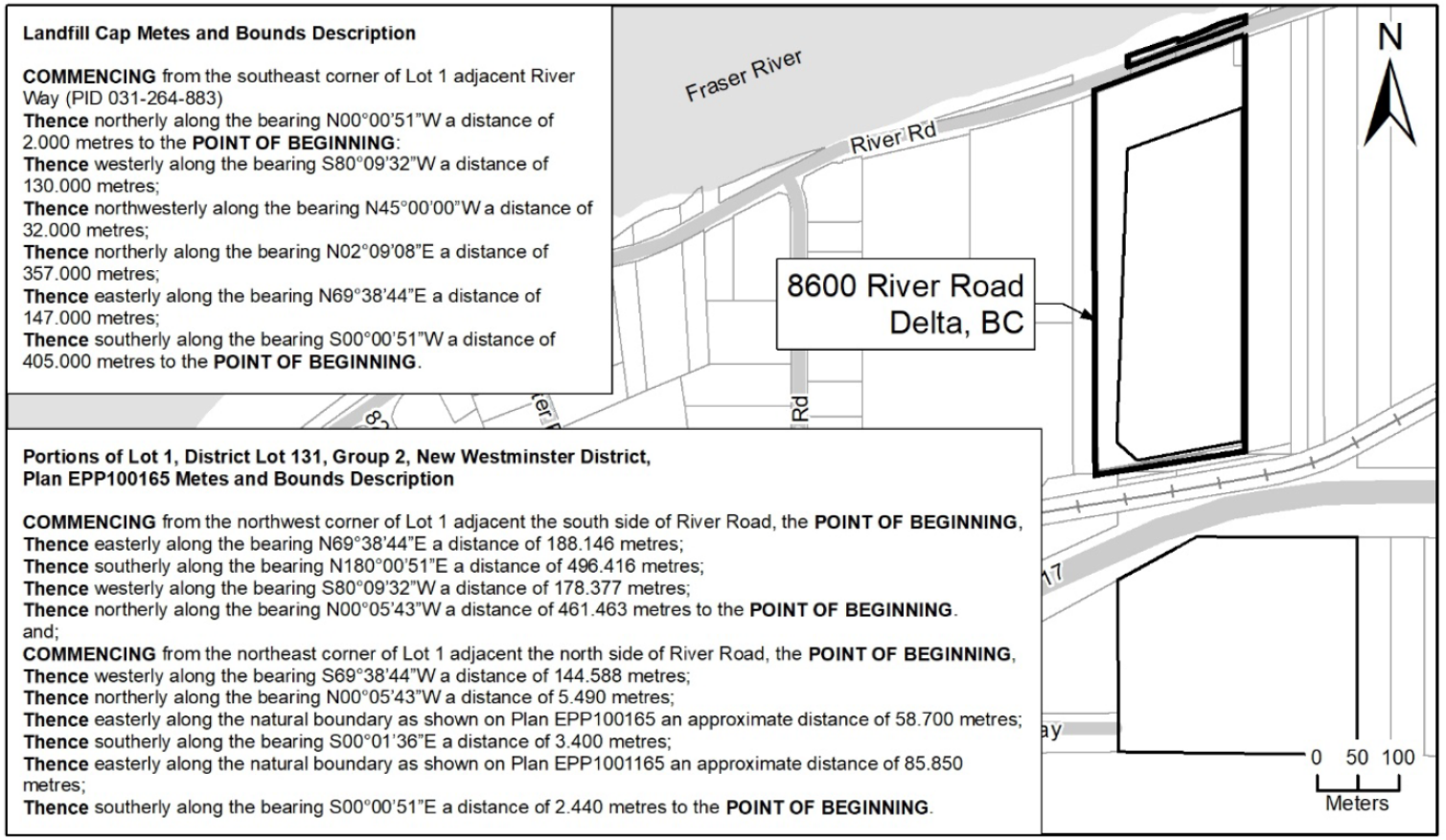


M & B - Risk Condition example

Site Plan, Delta, BC

Landfill Cap Metes and Bounds Description

COMMENCING from the southeast corner of Lot 1 adjacent River Way (PID 031-264-883)
Thence northerly along the bearing N00°00'51"W a distance of 2.000 metres to the **POINT OF BEGINNING**:
Thence westerly along the bearing S80°09'32"W a distance of 130.000 metres;
Thence northwesterly along the bearing N45°00'00"W a distance of 32.000 metres;
Thence northerly along the bearing N02°09'08"E a distance of 357.000 metres;
Thence easterly along the bearing N69°38'44"E a distance of 147.000 metres;
Thence southerly along the bearing S00°00'51"W a distance of 405.000 metres to the **POINT OF BEGINNING**.



Portions of Lot 1, District Lot 131, Group 2, New Westminster District, Plan EPP100165 Metes and Bounds Description

COMMENCING from the northwest corner of Lot 1 adjacent the south side of River Road, the **POINT OF BEGINNING**,
Thence easterly along the bearing N69°38'44"E a distance of 188.146 metres;
Thence southerly along the bearing N180°00'51"E a distance of 496.416 metres;
Thence westerly along the bearing S80°09'32"W a distance of 178.377 metres;
Thence northerly along the bearing N00°05'43"W a distance of 461.463 metres to the **POINT OF BEGINNING**.
and;
COMMENCING from the northeast corner of Lot 1 adjacent the north side of River Road, the **POINT OF BEGINNING**,
Thence westerly along the bearing S69°38'44"W a distance of 144.588 metres;
Thence northerly along the bearing N00°05'43"W a distance of 5.490 metres;
Thence easterly along the natural boundary as shown on Plan EPP100165 an approximate distance of 58.700 metres;
Thence southerly along the bearing S00°01'36"E a distance of 3.400 metres;
Thence easterly along the natural boundary as shown on Plan EPP1001165 an approximate distance of 85.850 metres;
Thence southerly along the bearing S00°00'51"E a distance of 2.440 metres to the **POINT OF BEGINNING**.

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Fee Guideline

Valuing risk and professionalism

CSAP AGM – June 4, 2024

Learn more about **Indigenous Peoples in the region** where you live by visiting **native-land.ca** and **whose.land.**

Check out ACEC-BC's Land Acknowledgement Get Started Guide.

Session overview

1. About ACEC-BC and our members
2. What is the ACEC-BC Fee Guideline
3. How we put the guideline together
4. Why is it important
5. Q&A

ACEC
BRITISH COLUMBIA

We achieve more together.

Advocacy

Opportunity

Profile

Community

90+
MEMBER FIRMS ACROSS BC

40+
MUNICIPALITIES REPRESENTED

12k+
EMPLOYED BRITISH COLUMBIANS

$5b
CONTRIBUTED TO BC ECONOMY

ACEC
BRITISH COLUMBIA

BC Consulting engineering companies directly employ more than

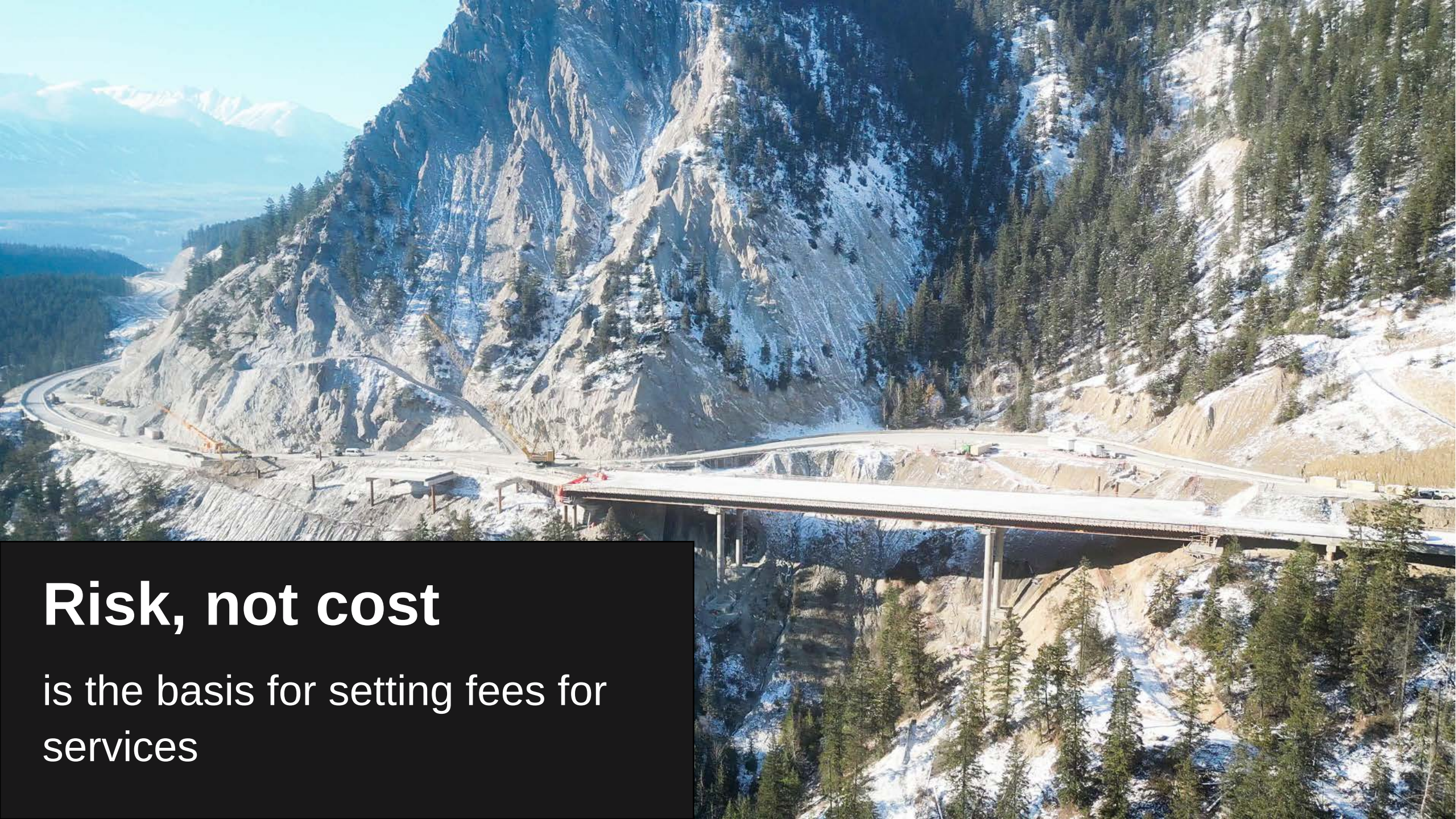
26,000 people

across BC.

ACEC
BRITISH COLUMBIA

Consulting Engineers Fee Guideline

Scan the QR code to access the 2024 guide!



Risk, not cost

is the basis for setting fees for services

How we put the guide together

Consultation

Business Practices Committee

Data review

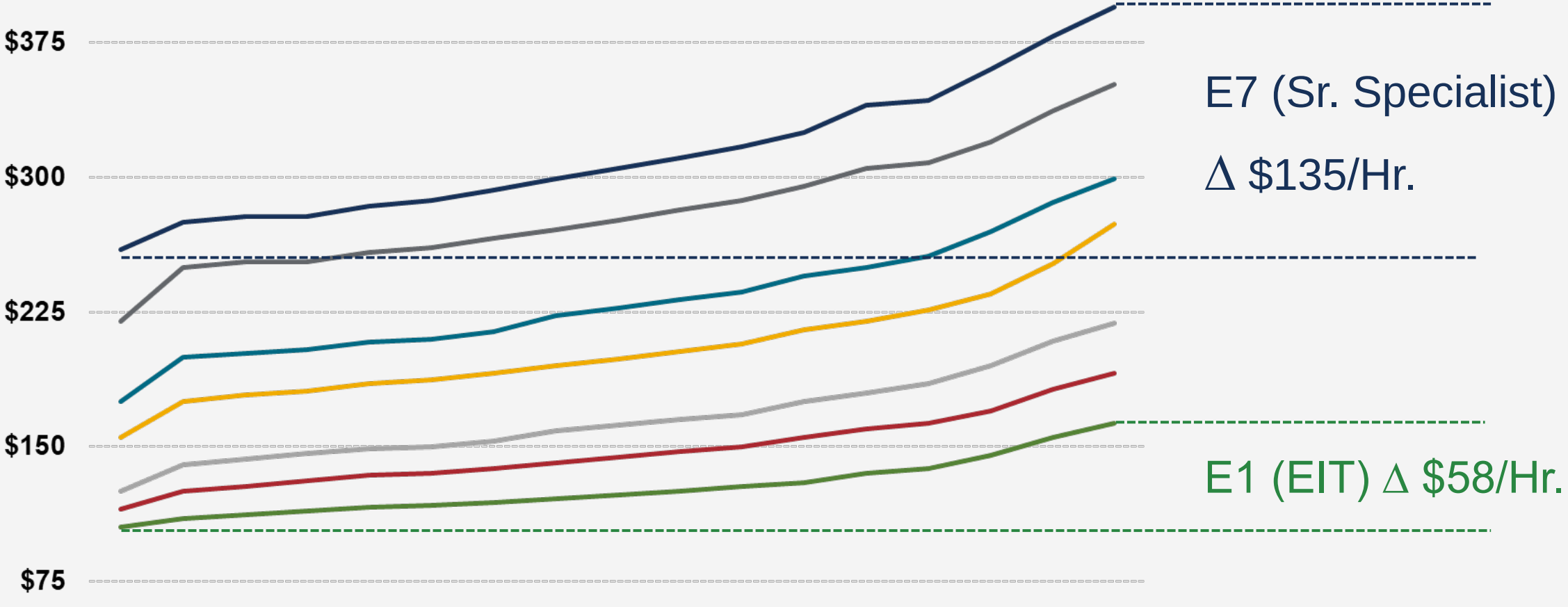
WCBC Salary Survey, CPI, Employment rates

Discussion, revision

Board review, iteration by committee, publication

How we put the guide together

Engineering hourly rates 2008 – 2024:



Why is it important

Informing clients

Sets the expectation that fees will increase over time

Point of reference representing the industry, not the individual

Market conditions

Builds awareness of market conditions across the industry

Influencing peers

Influences peers to appropriately value their services

Value the impact of your services.

Price your risk.

Recruit and retain qualified practitioners.

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Thank you

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Performance Assessment Case Study

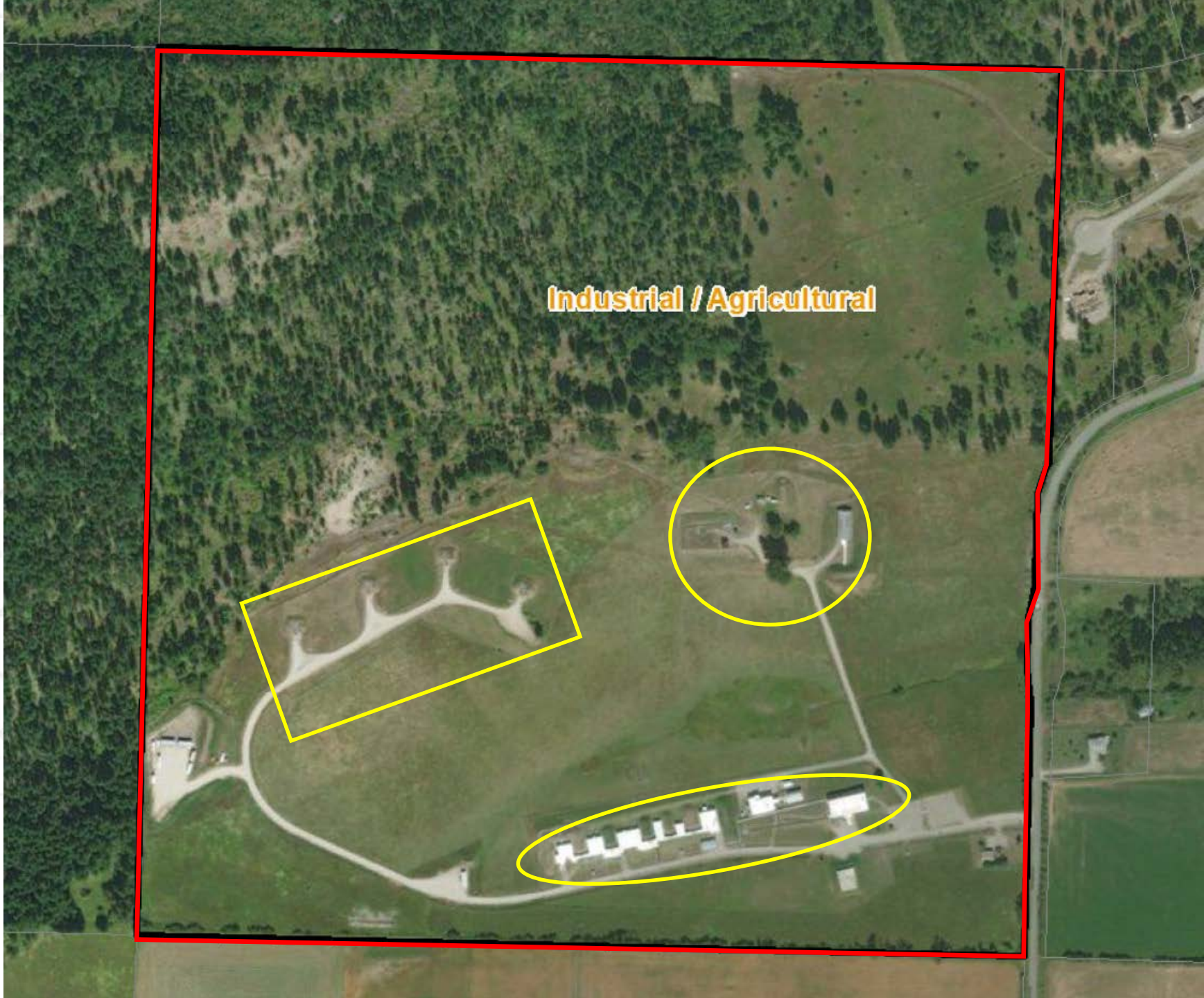
Chair: Chuck Jochems, P.Eng.

Submission Highlights

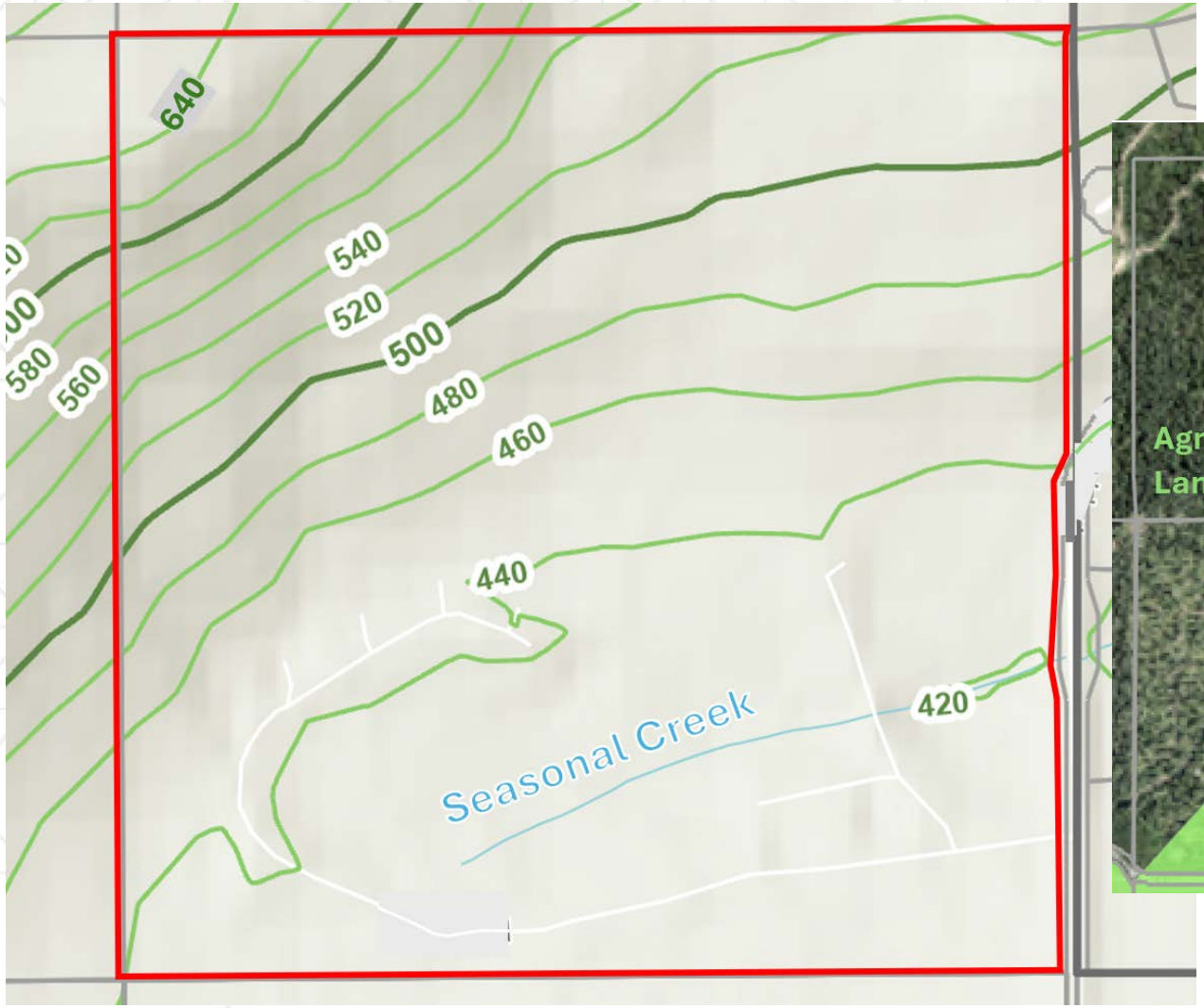
- Random PA
- Numerical COC Submission
- Former Industrial Facility associated with explosive devices
- Soil remediation completed
- No groundwater or soil vapour contamination identified

Site Plan

- Several buildings with various access roads
- Regulated substances used in three separate areas
- Agricultural land use (AL) applies



Site Features - Topography / ALR extent



Site Features / History

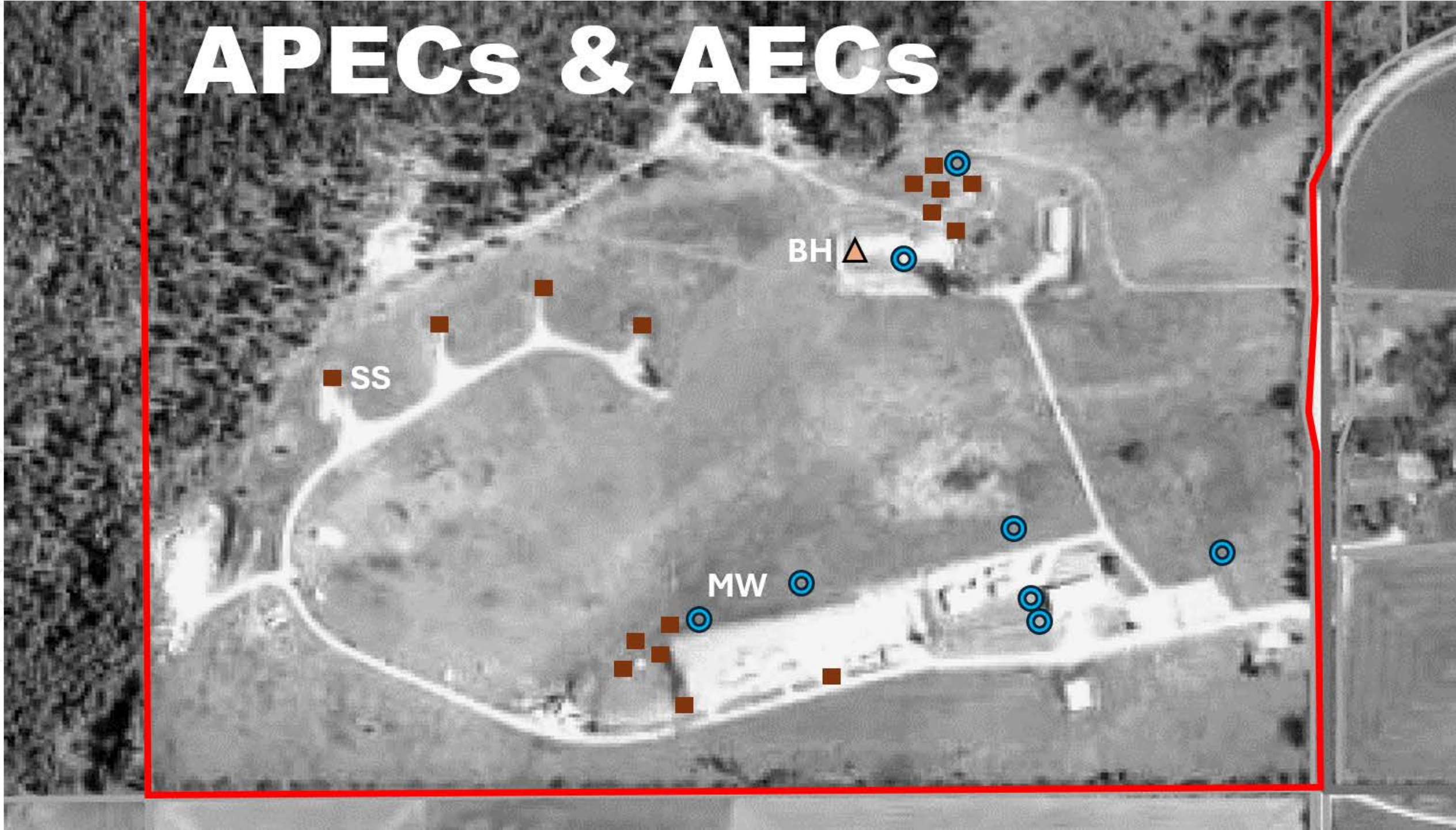
- Northern portion is a forested, steep slope
- Ephemeral stream in southern area
- Silty soils with minor clay and sand
- Depth to groundwater ranges from near surface to 3 m
- Agricultural Land Use (AL) standards applied based on future use
- Drinking water (DW), protection of freshwater aquatic life (AWf), Irrigation water (IW) and Livestock Watering (LW) standards apply to groundwater
- Soil vapour standards: AL

Site History

- Operated from late 1960s to late 2021 (50-year period)
- Manufactured detonation cords
- Used pentaerythritol tetranitrate (PETN), metals, VOCs, nitrogen compounds and PHCs in ASTs/USTs
- Identified APECs associated with onsite burning of waste, firing chambers, fuel ASTs, building vent areas, drainage ditch, septic field and dry well (discharge of cooling water and boiler blowdown)

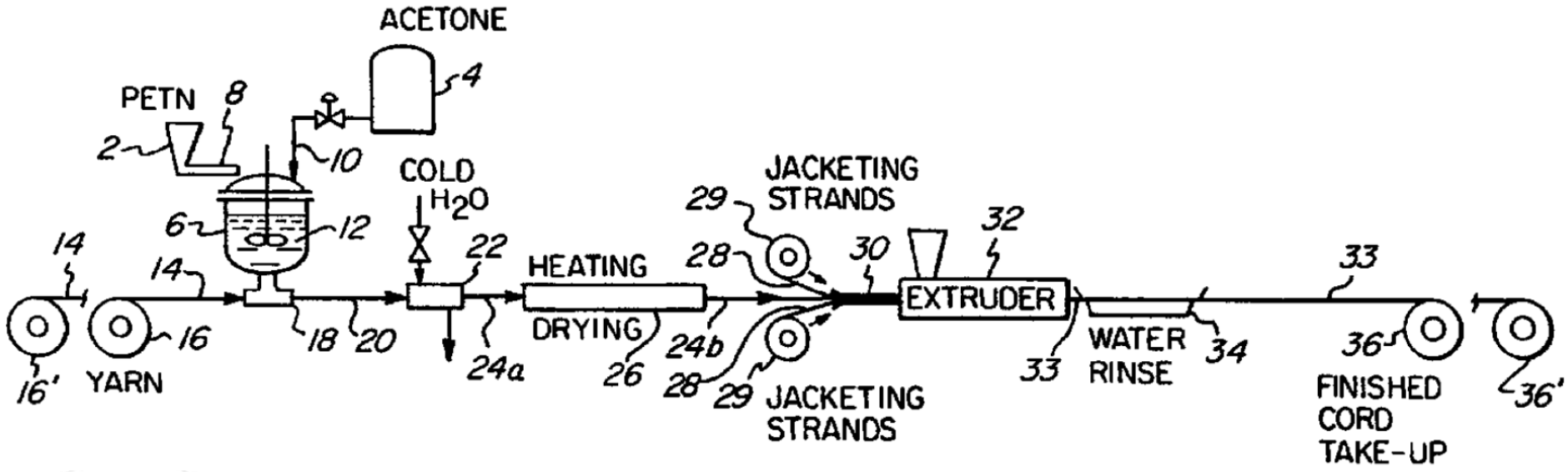
APECs & AECs

APECs & AECs



PA Stage 1 Findings

1) Previous investigation in 1997 identified burning of used solvents and oils. Could acetone and VOCs have been used in the manufacturing process associated with 3 APECs?



Addendum Response (AR)

- The facility operator confirmed they did not use acetone in the manufacturing process.
- The diagram sourced from the internet was for dry spun manufacturing of detonation cords, which was patented by another manufacturer and not used at this facility.
- Only minor amounts of acetone were purchased in 3.78 L containers from an automotive supply store and used to dissolve small amounts of PETN.
- Minimal product was treated, and no discharges were made to a dry well or septic field.

PA Stage 1 Findings / AR

2) Tributyl phosphate (TBP) was indirectly analyzed with the anion analysis, with no correlation to the CSR standards and whether further investigation was required? Can anion analyses be used as a surrogate for TBP given it is regulated in soil and groundwater?

TBP was considered a secondary contaminant to the primary PETN given it was used in small quantities (35 mL per batch). If PETN was not identified as a contaminant, then TBP was not suspected to be present.

Phosphates are not regulated in soil and no elevated concentrations were found.

PA Stage 1 Findings / AR

3) Fuel VOCs were not PCOCs for 2 APECs. Why not?

Fuel VOCs were assessed in soil and groundwater at the two APECS where needed to refine soil vapour but were inadvertently omitted from the APEC table and has been revised.

4) Boiler water was treated with 4 different chemicals prior to discharge to the ground or dry well, but MSDSs were not provided? Additional PCOCs for APEC 8?

The 4 chemicals were amines, which are inorganic derivatives of ammonia.

PA Stage 1 Findings / AR

The 4 chemicals were assessed by way of nitrogen compounds, with no exceedances identified.

5) Why was groundwater investigation excluded for identified PETN soil contamination at one AEC?

PETN was analyzed in groundwater at the well for this AEC, but it was not included in the data table. The PETN result was <0.50 µg/L.

PA Stage 1 Findings / AR

6) Because of access issues (i.e. steep containment berms), groundwater at some APECs was assessed 7 to 10 m down-gradient from the APEC. Provide rationale on proximity to potential source of contamination.

Groundwater at APEC 1 was assessed 7 m down gradient of the burning ground. The well was placed due to steep slopes and where overland flow from the burn cage would have directed.

Groundwater for two other APECs (building vents) had earthen berms surrounding them for explosion protection.

PA Stage 1 Findings / AR

Given the access limitations, fine-grained sandy soils and shallow water table, the well positions were considered reasonable to assess groundwater quality down-gradient of the APECs.

7) Amines were PCOC for one APEC, which are derivatives of ammonia. Why wasn't soil vapour assessment for ammonia completed?

The reported concentration for ammonia in groundwater was 56 µg/L vs an MDL of 50 µg/L, well below the AWf standard.

PA Stage 1 Findings / AR

The ammonia vapour standard is 100 µg/m^3. Ammonia volatilization occurs within days of contact as ammonium is converted to ammonia gas at/or near the soil surface.

It is unlikely a gw result of 56 µg/L would produce a vapour result above the 100 µg/m^3 vapour standard.

8) Delineation of PETN soil contamination to the south at one AEC based on confirmatory sampling?

The southern extent of the remedial excavation extended to the building foundation which was greater than 1 m in depth (i.e. depth of excavation). No sample was collected.

PA Stage 1 Findings / AR

9) TG2 calculations supporting remediation of copper appear incorrect and there is uncertainty on a single dataset population (i.e. mix of clay and sand)?

The statistics were recalculated using only clay samples. The revised upper 95th confidence limit (UCLM) was less than the applicable copper standard. The 90th percentile remained unchanged and below standard.

The clay sample set was considered one population.

The revised statistical evaluation met TG2 requirements.

PA Stage 1 Findings / AR

10) The 95th percentile for soil pH was used to determine that beryllium met the CSR standard in soil. BC ENV guidance (TG5) on calculating soil pH for soil relocation indicates the medium soil pH should be used?

CSR Schedule 3.1 Footnote 4 indicates that the pH is that of the soil at the Site.

The 95th percentile was used in error, instead of the median. With the median pH, Be did not exceed the P4 background.

Email correspondence with ENV for the P4 background indicated a stats-based pH could be used for one Be exceedance.

PA Summary

- Stage 1 Findings within 3 weeks of Submission date
- Draft Addendum provided within 6 weeks of S1 Findings
- Call with Submitting AP prior to finalizing Addendum
- Final Findings within 6 weeks of Draft Addendum, including a Holiday break
- Final Addendum accepted, **Sufficient** Submission
- Forwarded to ENV within 1 week of issuing FF with minimal Detailed Screening comments
- ENV issued Numerical COC within 5 weeks of transfer to ENV and less than 5 months from CSAP submission date

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Review of Attenuation Factors and Partitioning with a Focus on Shallow Contamination Scenario

Ian Mitchell, Millennium EMS Solutions

Agenda

- Background
- Review of Canadian/US Jurisdictions
- Review of Research on Attenuation Factors
- Review of Partitioning Models
- Empirical Data Analysis

Approach

- Review of Existing Approaches
  - Jurisdictional Review
  - Research on Vapour Attenuation Factors
  - Partitioning Models and Data
- Analysis of Data from BC Sites
  - 28 sites reviewed; 21 retained for detailed evaluation
  - First phase: 7 sites
  - Second phase: 14 sites
- Previous report: Review of Vapour Issues for Soil Relocation in British Columbia

Background

- Current Approach
- Protocol 22 attenuation factors used to estimate concentrations in indoor air
  - Shallow depths: empirical factors
  - Deeper: model-derived (Johnson & Ettinger)
- Are these applicable/realistic for shallow contamination near building?
- Is the factor for commercial/industrial buildings (0.02) overly conservative?
- How applicable are partitioning models if soil vapour data isn't available?

Approach

- Review of Existing Approaches
  - Jurisdictional Review
  - Research on Vapour Attenuation Factors
  - Partitioning Models and Data
- Analysis of Data from BC Sites
  - First phase: 7 sites
  - Second phase: 14 sites

Canadian Jurisdictions

Jurisdiction	Policy
CCME	2014 Soil Vapour Protocol: Soil vapour AF <1 m depth: 0.03 for residential, 0.01 for commercial - based on analysis of US EPA (2012) database 2008 PHC CWS: 10x reduction to equilibrium partitioning based on soil vs soil vapour data
Health Canada	2023 guidance: Soil AF<1 m depth: 0.03 for residential, 0.01 for commercial Indoor air sampling recommended if groundwater in contact with building
British Columbia	Protocol 22: soil vapour AF 0.02 for subslab (all building types) <1 m from building foundation NAPL in contact with foundation or utilities is precluding condition
Alberta	2023 Tier 1/Tier 2: soil vapour AF factor 0.01 for distance <0.3 m
Ontario	Soil vapour AF 0.02 for residential, 0.004 for commercial/industrial

Select US Guidance

Jurisdiction	Policy
US EPA (2015a) (focused on halogenated compounds)	Recommend indoor air investigation for groundwater <1.5 m below foundation Sub-slab or “near source” soil gas or AF 0.03
US EPA (2015b) (petroleum hydrocarbons)	Vertical screening distances (6’ for dissolved PHC, 15’ for LNAPL at UST sites, 30’ for LNAPL at industrial sites)
US States	Most at least partially adopt US EPA guidance, various state-specific modifications Georgia: commercial subslab AF 0.01 Wisconsin industrial/large commercial shallow & subslab AF 0.01 Wisconsin industrial/large commercial >5’ AF 0.001 Michigan has groundwater building contact model (regulator use only)

Research on Vapour Attenuation Factors

Study	Scenario	Findings
US EPA 2012	Paired subsurface and indoor air (primarily chlorinated, residential)	95th percentile Afs basis of US EPA 2015 guidance
Folkes et al 2010	Residential homes, DCE	AF 10^{-4} to 10^{-6}
Pennell et al 2016	Chlorinated solvents, residential + commercial	GW AFs 10^{-4} to 10^{-6} ~1000x attenuation observed vs theoretical partitioning
Derycke et al 2018	Chlorinated solvents, schools	90th percentile AF: 0.0075 (<50 yrs old), 0.037 (>50 yrs old)
Lahvis & Ettinger 2021	Chlorinated solvents, residential, commercial, industrial	AF 0.0008

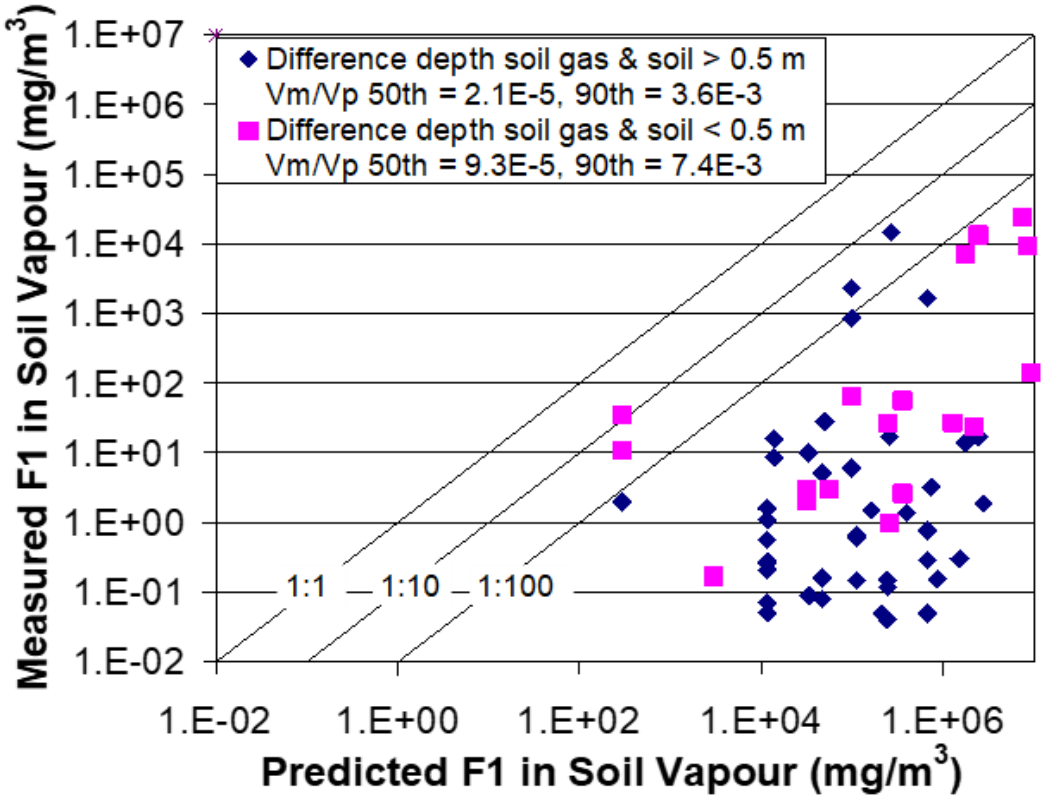
Research on Vapour Attenuation Factors

Study	Scenario	Findings
Halberg et al 2021 + Levy et al 2023	Industrial buildings at DOD sites	Upper range AF 0.001 for subslab and 0.0001 for groundwater
Eklund et al 2022	77 industrial buildings	95th percentile AF 0.0009
Abassi 2023	California residential and commercial/industrial sites, chlorinated solvents	95th percentile AF 0.005 subslab, 0.0009 vapour

- Conclusion: Recent studies show AFs mostly lower than US EPA 2012; commercial/industrial 0.001 or lower

Review of Partitioning Models

Field studies typically show measured vapour concentrations 1 to 3 orders of magnitude lower than predicted by conventional partitioning models



CPPI Database

F1 (TPH_g) vapor concentrations predicted using 3-phase model, f_{oc} = 0.005

Empirical Data Analysis – First Phase

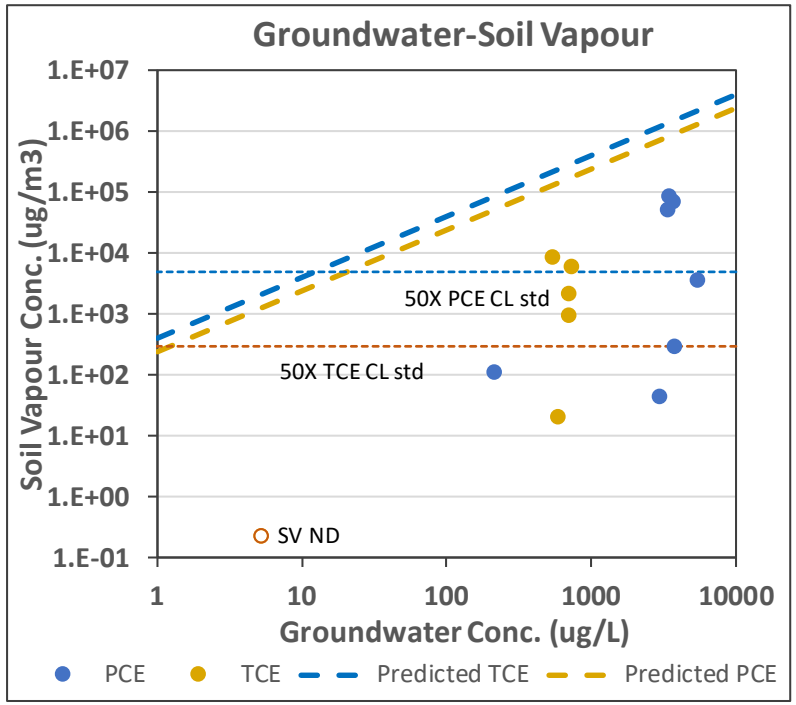
Soil – groundwater – soil vapour concentrations for 7 BC sites with publicly available data (3 PHC, 2 chlorinated, 2 both)

Site #1 **a**

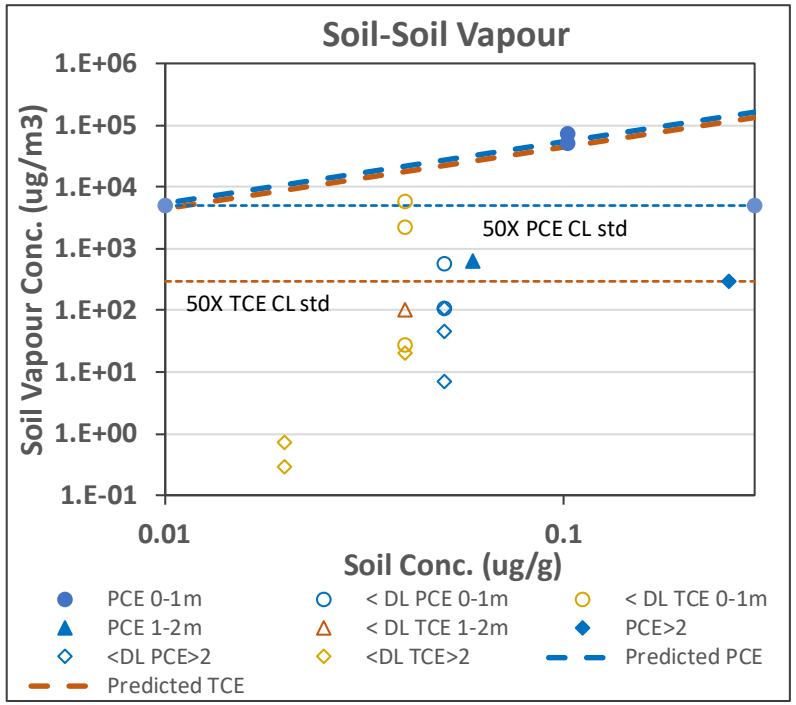
[redacted]

Soil type: granular fill up to 0.5 m thick underlain by till consisting of silty sand and some gravel
Depth to Groundwater: Approx 1-1.5 m prior to construction, < 0.5 m after construction
Source of contamination: Offsite dry cleaner
Comments: water table near top of well screen
Interpretation: Groundwater fair predictor of vapour, elevated soil vapour associated with detectable ground water concentrations. Soil poor predictor of vapour, many instances of elevated soil vapour associatd with non-detect concentrations in soil, but only 2 samples with attenuated soil vapour concentrations (AF=0.02) above CSR standard with non-detect soil concentrations

when conc. < DL, DL is plotted
1 to 2 rounds of soil vapour data were available
Data pairs were concurrent within 0.5 month



Soil vapour samples obtained from 0.2 to 1.2 m depth
Depth to top of well screen 1.1 to 1.5 m depth
Separation distance ranged from 0 to 1.3 m

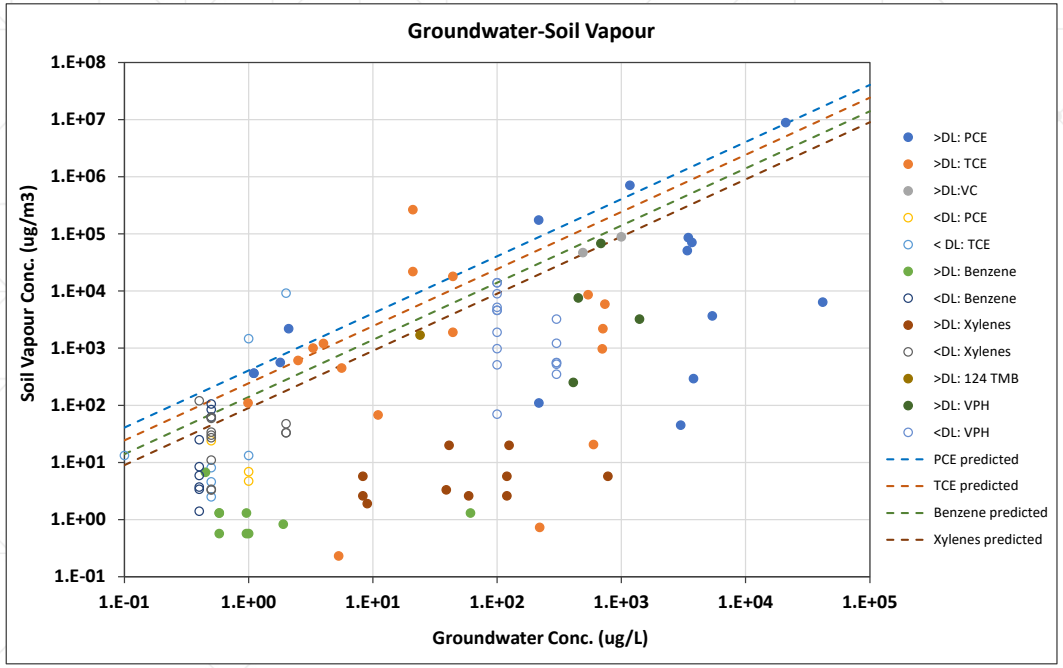


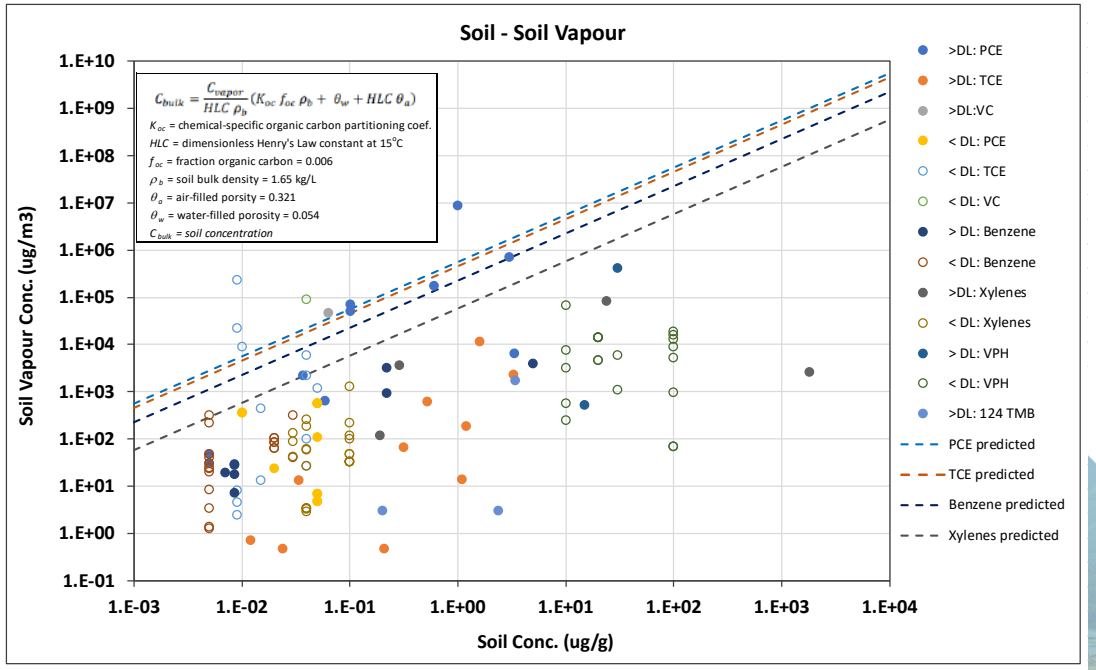
Soil vapour samples obtained from 0.2 to 1.2 m depth
Soil samples obtained from 0.38 to 5.2 m depth
Separation distance ranged from -0.75 to 4 m

Empirical Data Analysis – Second Phase

Data obtained from 21 sites; 14 retained

Goals: better understand partitioning relationships and vapour attenuation factors; evaluate attenuation through vadose zone





Conclusions

- Site-specific modelling not generally recommended for low density residential but may be appropriate for high density residential (underground parking), commercial, industrial
- Minimum distance of 0.3 m (soil contamination source & seasonal high water table) recommended for site-specific modelling
- Modelling should be constrained: no more than ½ order of magnitude reduction in Protocol 22 attenuation factor unless calibrated to site-specific data

Conclusions

- Residential subslab attenuation factor of 0.02 recommended (i.e. no change)
- Commercial/industrial attenuation factor of 0.01 would be conservative
- 10X adjustment for predicting soil vapour from soil is appropriate for PHC compounds (no NAPL)
- Methods can be adjusted for vapour contamination laterally adjacent to one side of a building or only below a portion of the building; more complex models also available