Agenda

- Risk assessment (RA) and Remediation
  - What is an RA
  - Risk Based CSM
  - How RAs support development of remediation goals
- Differences in Regional RA Approaches
  - Regulations
  - Tiered system
- Challenges with remediation approaches and meeting guidelines
- Case studies

RISK ASSESSMENT
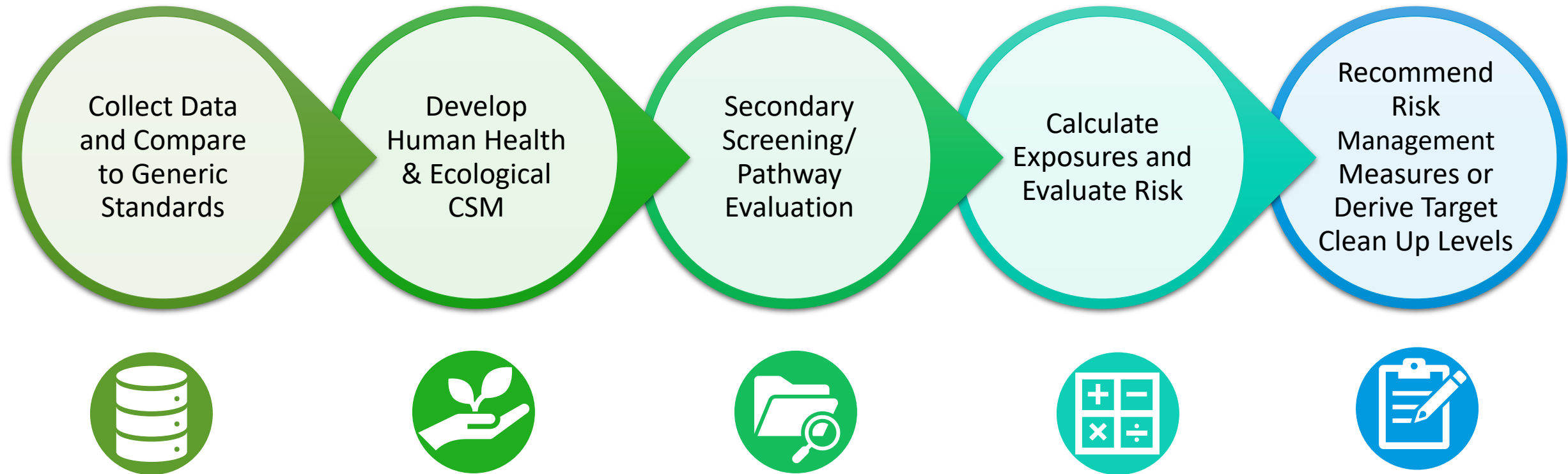AND REMEDIATION

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What is Risk Assessment?

"a systematic process of evaluating the potential risks that may be involved in a projected activity or undertaking."
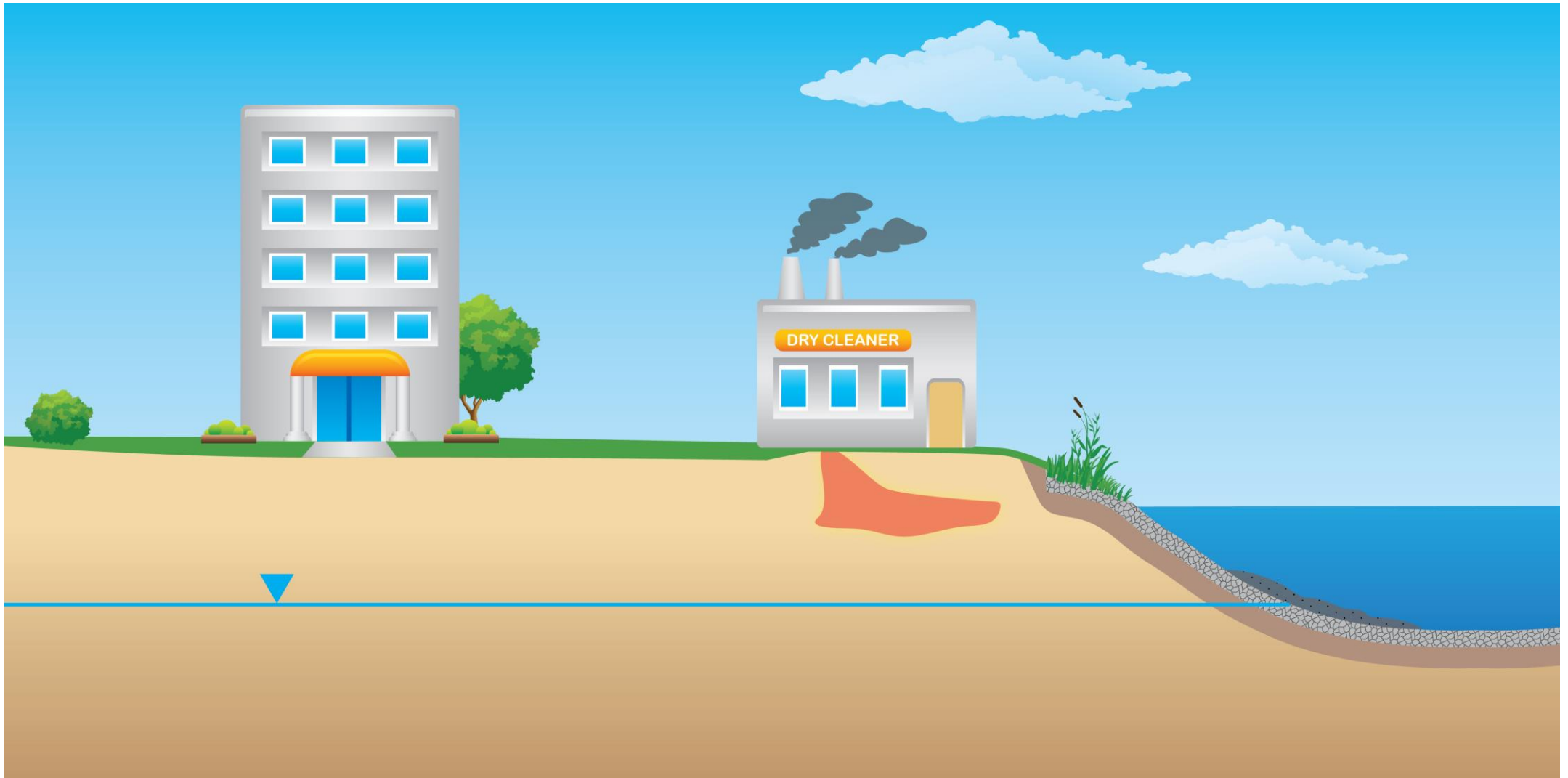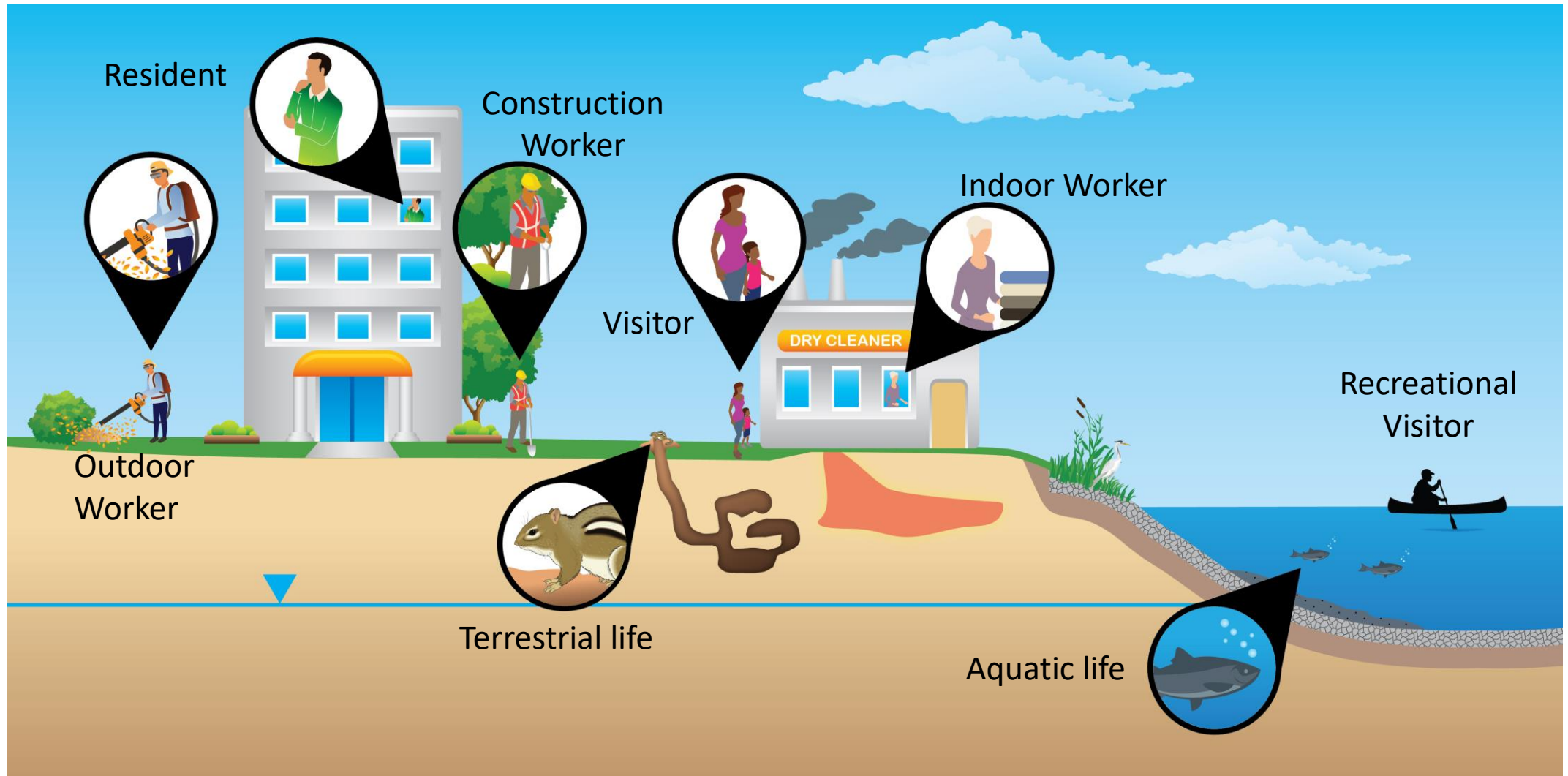
— Oxford Dictionary

Risk Assessment Process Overview

Collect Data and Compare to Generic Standards

Develop Human Health & Ecological CSM

Secondary Screening/ Pathway Evaluation

Calculate Exposures and Evaluate Risk

Recommend Risk Management Measures or Derive Target Clean Up Levels
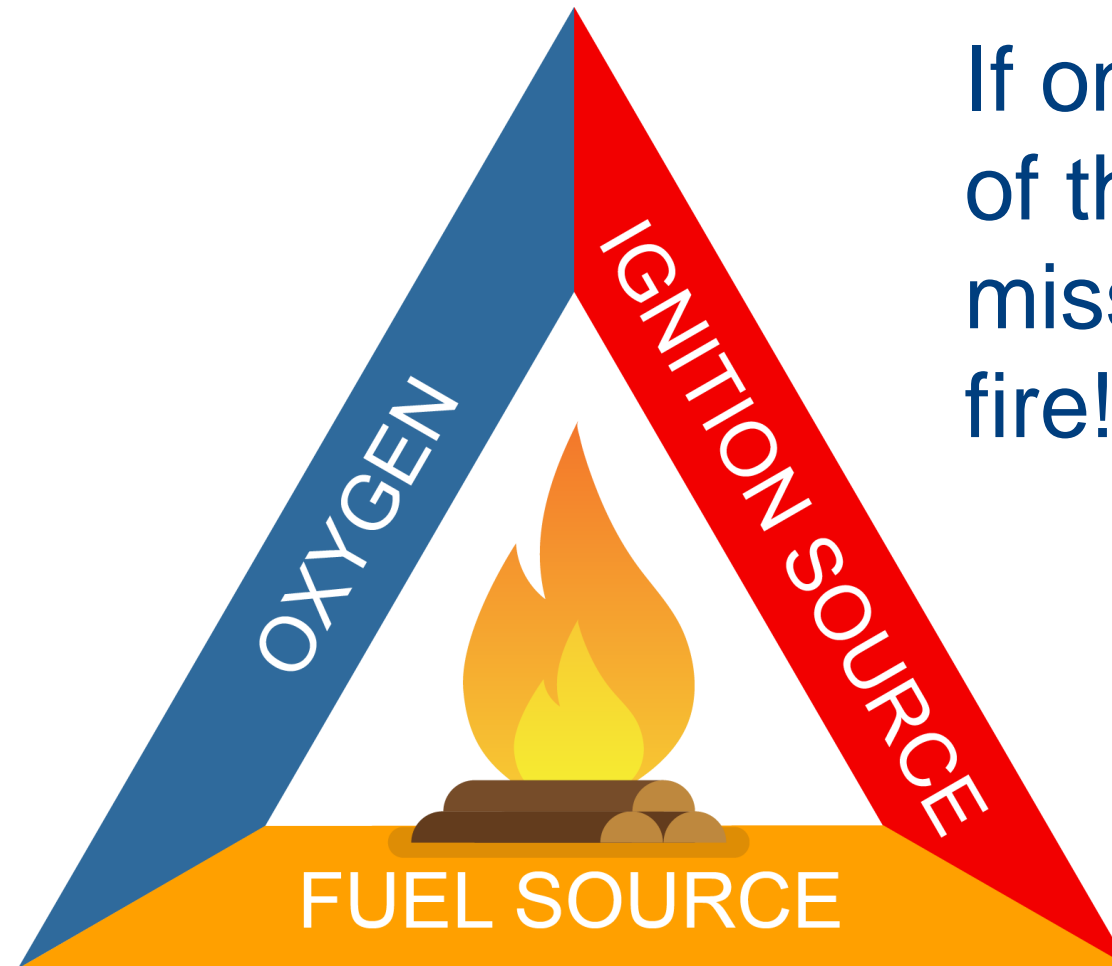
Conceptual Site Model (CSM)

RA Conceptual Site Model (CSM)

Analogy of Fire Triangle to Risk

If one or more parts of the triangle are missing, there is no fire!

OXYGEN

IGNITION SOURCE

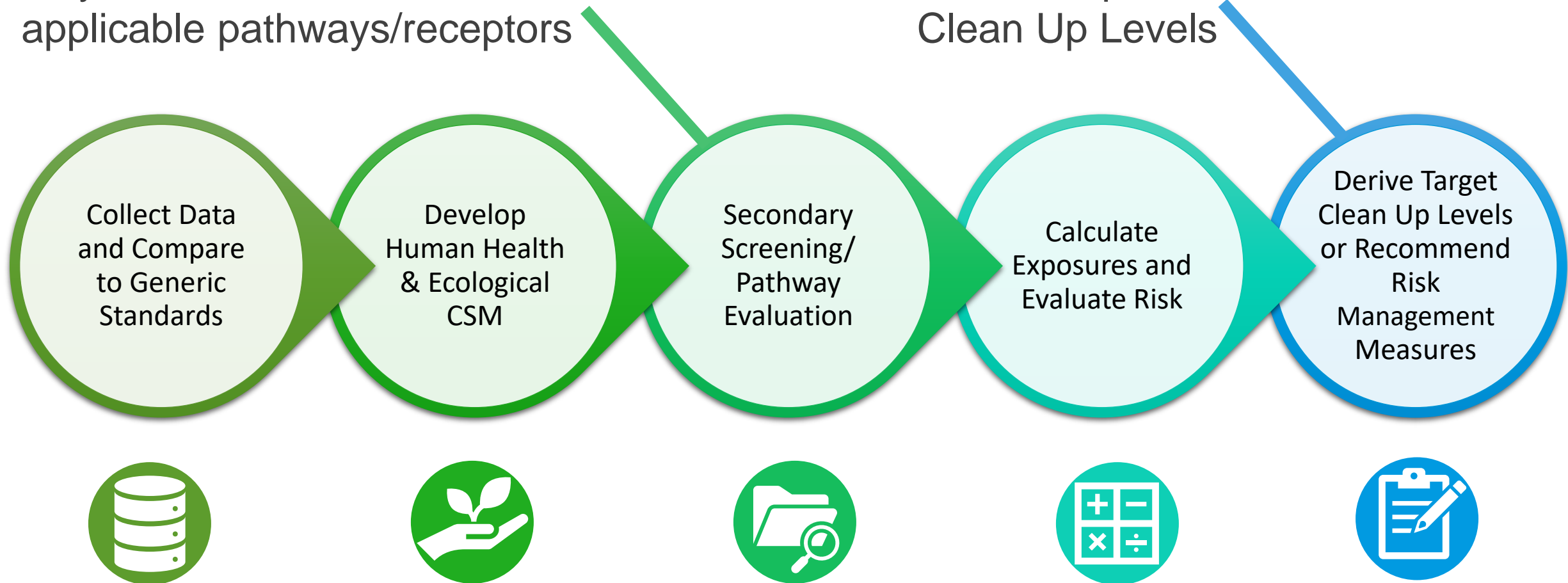FUEL SOURCE

Risk Triangle

If one or more parts of the triangle are missing, there is no risk!

RAs Support Development of Remediation Goals

May reduce COC list based on applicable pathways/receptors

Site-specific Clean Up Levels

Collect Data and Compare to Generic Standards

Develop Human Health & Ecological CSM

Secondary Screening/ Pathway Evaluation

Calculate Exposures and Evaluate Risk

Derive Target Clean Up Levels or Recommend Risk Management Measures

DIFFERENCES IN REGIONAL RA APPROACHES
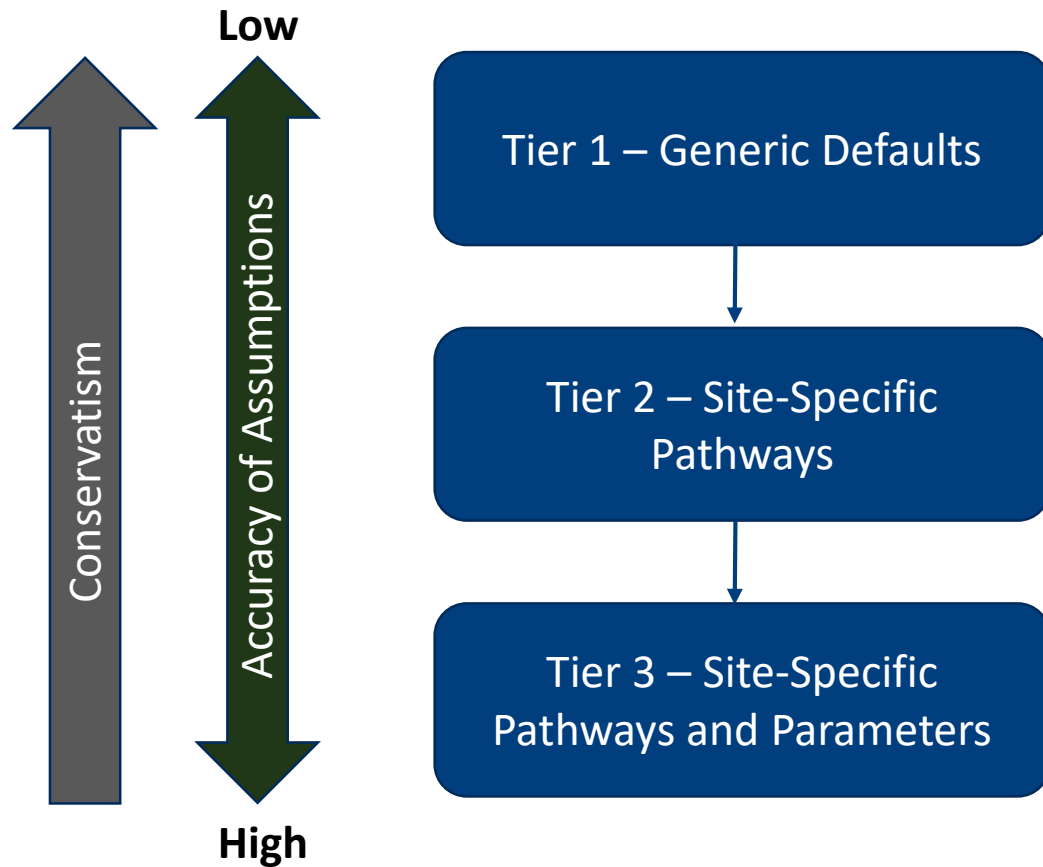
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Regulatory Jurisdiction

- Potential for 'concurrent' jurisdiction
  - October 1996 Accord for the Protection of Species at Risk (www.speciesatrisk.gc.ca)
- Often provincially led
  - Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, and Newfoundland and Labrador – legislation to protect species at risk
- Municipalities – bylaws
- Indigenous rights (i.e. unresolved land base claims, potential and/or established Indigenous or treaty rights)
- Qualified Professional designation

Tiered System – Risk Evaluation

Low

Conservatism

Accuracy of Assumptions

High

Tier 1 – Generic Defaults

↓

Tier 2 – Site-Specific Pathways

↓

Tier 3 – Site-Specific Pathways and Parameters

- Ontario and BC have more prescribed RA guidance documents that differ slightly from Federal

- Most other Provinces follow Federal (Health Canada and ECCC approach)

Differences in Value Assessed in RA

Conservatism ↑
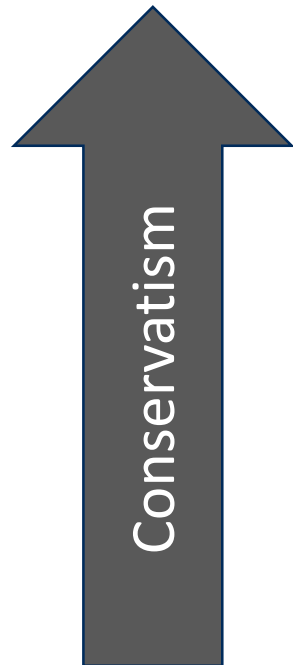
- Maximum concentration + 20% (Ontario RSC)

- Maximum concentration (Federal)

- Statistical approach (Federal, USA)

Value assessed in RA could affect the extent of media requiring remediation.

Acceptable Risk Levels

Conservatism

Low → High

Clean up target

Acceptable Cancer Risk Levels

- 1 in 1,000,000 (i.e. Ontario, Quebec)

- 1 in 100,000 (Canada federal, BC, Atlantic)

- 1 in 10,000 (USA) or as a line of evidence

Acceptable Hazard Risk Levels

- 1 (summative → Federal/BC/Quebec)
- 0.2/0.5 (by pathway) (Ontario, Alberta)

CHALLENGES WITH MEETING GUIDELINE VALUES USING REMEDIAL APPROACHES

Challenges meeting generic standards

- Contaminant type & scale
- Technology limitations
- Geographic location
- Cost & Schedule
- Physical constraints
  - Clay/bedrock
- Background concentrations
  - Statistical analysis
- Access Issues
- Future Development Requirements
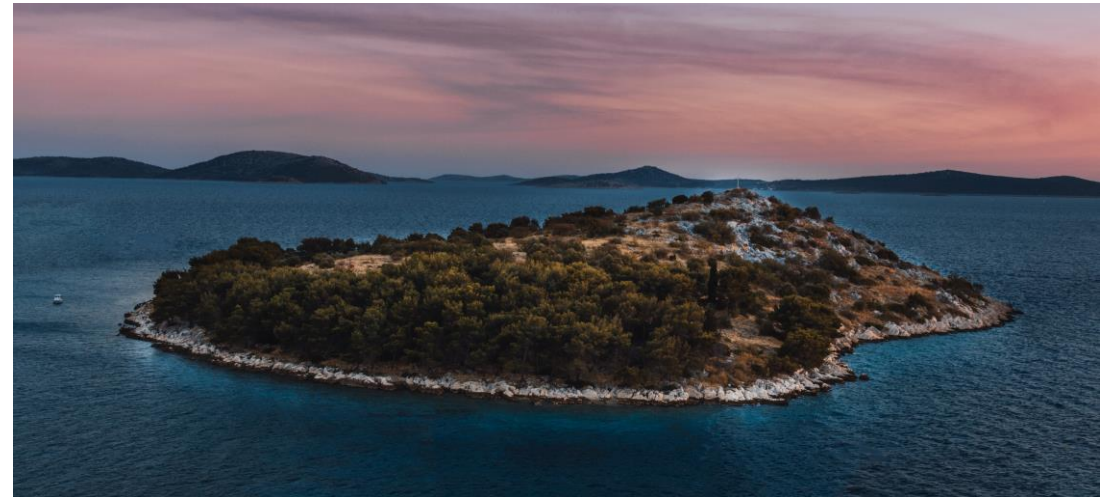
RA as a Tool to Develop Cleanup Targets

- RA can determine what pathways are driving risk at a site and adjust standards by using site-specific parameters

- Soil leaching to groundwater & migration of groundwater to surface water body (Ontario example S-GW3)
  - Assumes site is 30 m from surface water
  - Actual distance <5 km from surface water

Parameter	Tier 2 (Pathway Specific Value) (mg/kg)	Tier 3 (Site-Specific Calculated Pathway Value) (mg/kg)
Acenaphthylene	0.15	16
Acetone	16	1,700
Ethylbenzene	17	34
PHC F1	55	5,600

RA as a Tool to Develop Remedial Targets

- Site risk driven by petroleum hydrocarbon exceedances of free phase threshold
  - Assumes site soils have fraction of organic carbon of 0.005
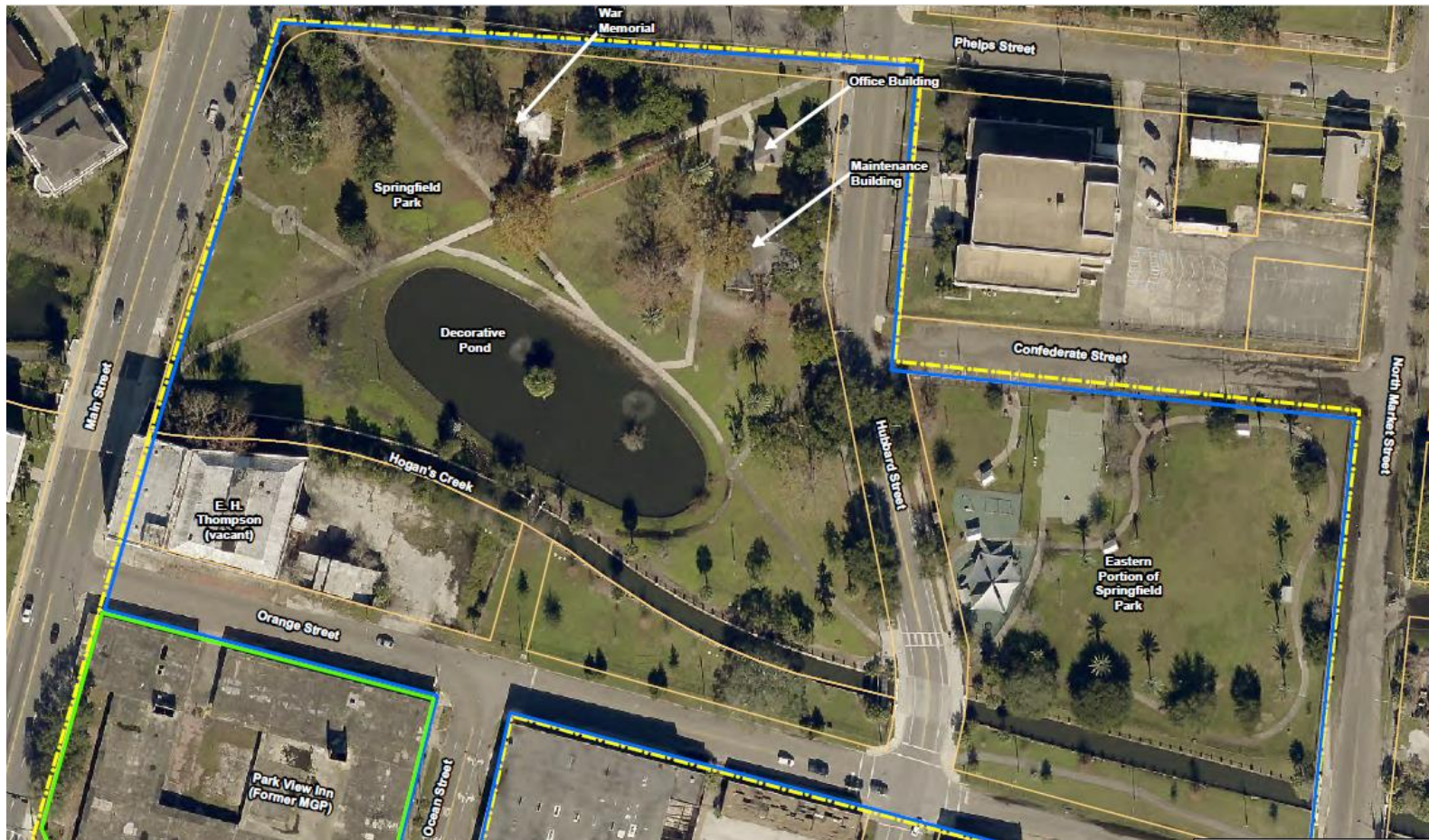 - Actual site soils have fraction of organic carbon of 0.01

Parameter	Free Phase Threshold Value Based on Default Assumptions (mg/kg)	Free Phase Threshold Based on Site-Specific Assumptions (mg/kg)
PHC F1	1,700	2,000
PHC F2	2,700	3,100
PHC F3	5,800	8,400
PHC F4	6,900	12,000

CASE STUDIES

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Case Study #1: Former MGP Site

- Late 1800- early 1900s: MGP industrial waste discharged

- 1912 – Purchased by City for public park

- 1929 – Creek Improvements

- 1991 – Decorative pond added and contamination discovered

- 2011 – Site Assessment Report (polycyclic aromatic hydrocarbons, volatile organic compounds, and metals)
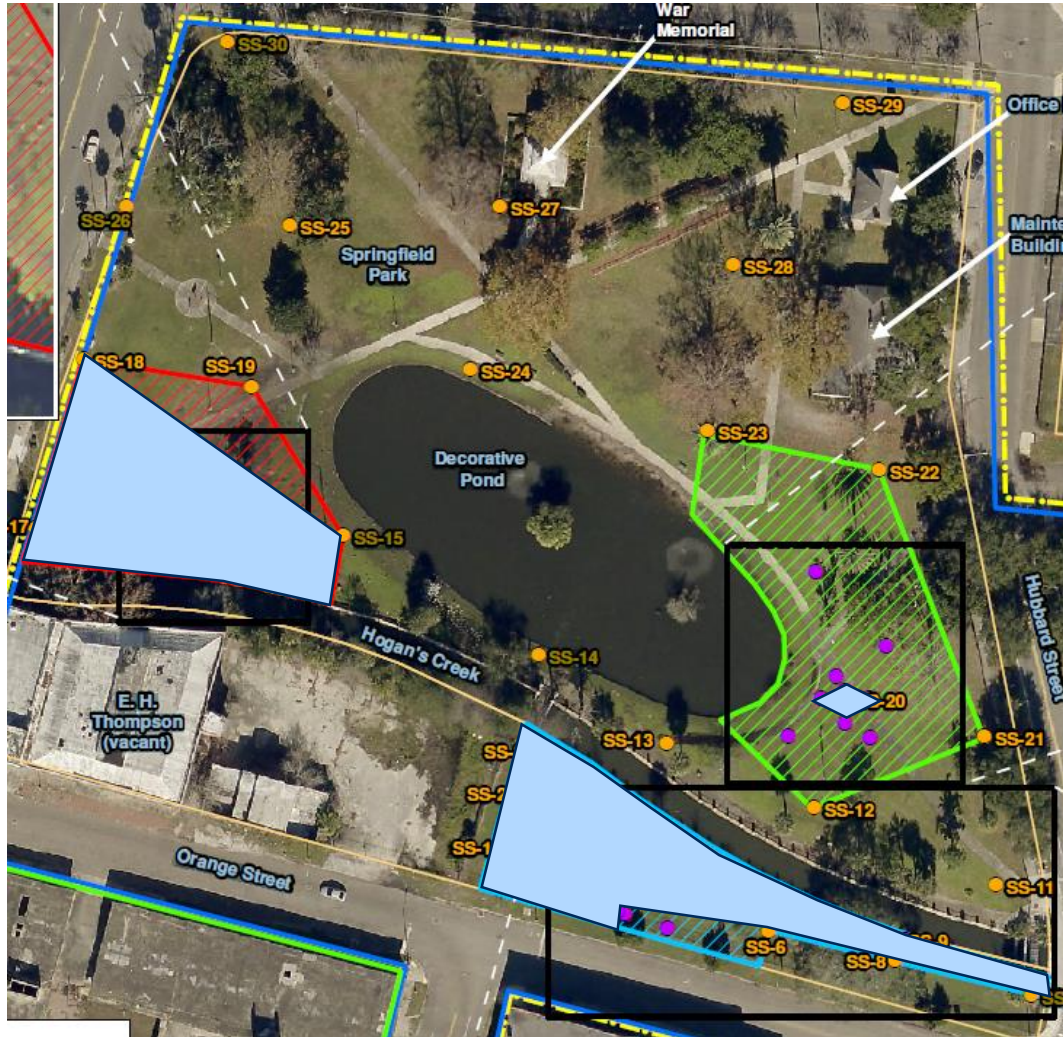
Case Study #1: Former MGP Site

- Max concentrations exceeded generic screening levels

Constituent	Maximum	Residential Soil Cleanup Target Level	Recreational User, Site-Specific Alternative Soil Cleanup Target Level
Benzo(a)pyrene TEQ (BaP)	15.4	0.1	0.7
Arsenic (As)	24	2.1	5.5
Lead (Pb)	680	400	400

- Statistical analysis removed lead as COC (268 mg/kg)

- Paired development of site-specific soil cleanup target levels with statistical analysis to reduce size of remediation for BaP/ As

- Additional sampling reduced area for remediation even further

Legend

- BAP Removal Areas
- Arsenic Removal Area
- Proposed Step-Out Sample Location
- Surficial Soil Sample Location
- Reduced removal area

| Soil Removal Budget	Cubic Meters	Reduction from Original Budgeted
Original	5,810	100%
First Iteration	3,820	66%
Refined Iteration	2,000	34%

Case Study #2: Historical Manufacturing Facility

- Chlorinated solvents (PCE, TCE, DCE, 1,1,1-TCA) & petroleum hydrocarbons in weathered bedrock beneath the site

- High concentrations of chlorinated solvents meant remediation alone = $$$ and RA + RMM alone = $$$
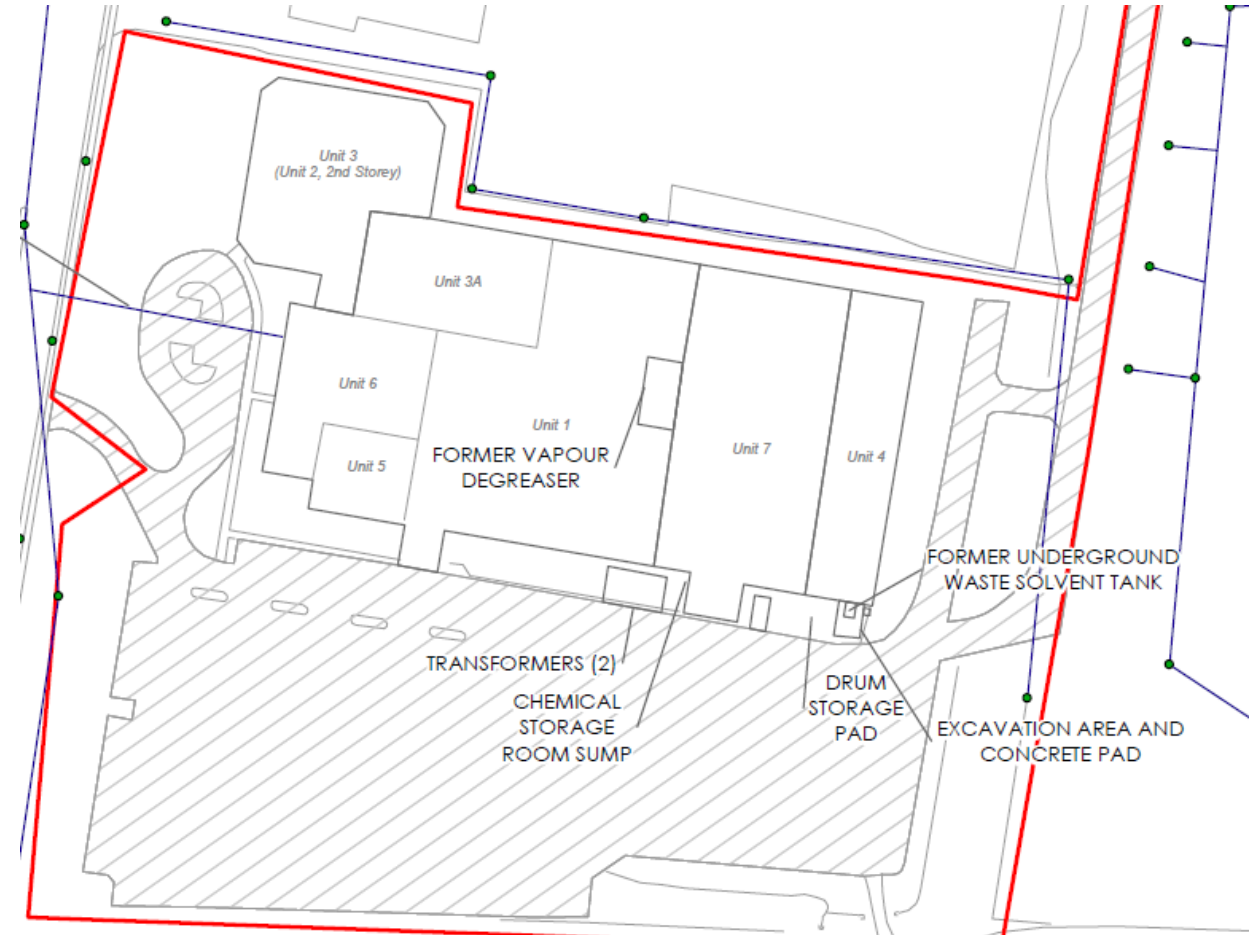
Risk-based remediation goals:

- Reduce soil concentrations showing risk of soil vapours to indoor air and off-site migration

  – Targeted Soil Excavation of former UST area

- Reduce groundwater concentrations showing risk of off-site migration and indoor air

  – In-situ chemical oxidation (modified Fenton's Reagent)

- Reduce soil concentrations showing risk to outdoor worker

  – Excavation of PCBs in Transformer Area
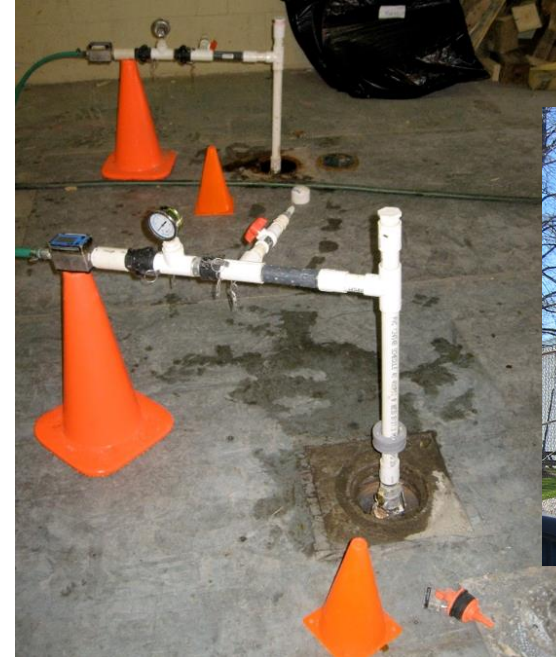
Case Study #2: Historical Manufacturing Facility

>indoor air and off-site migration pathway values

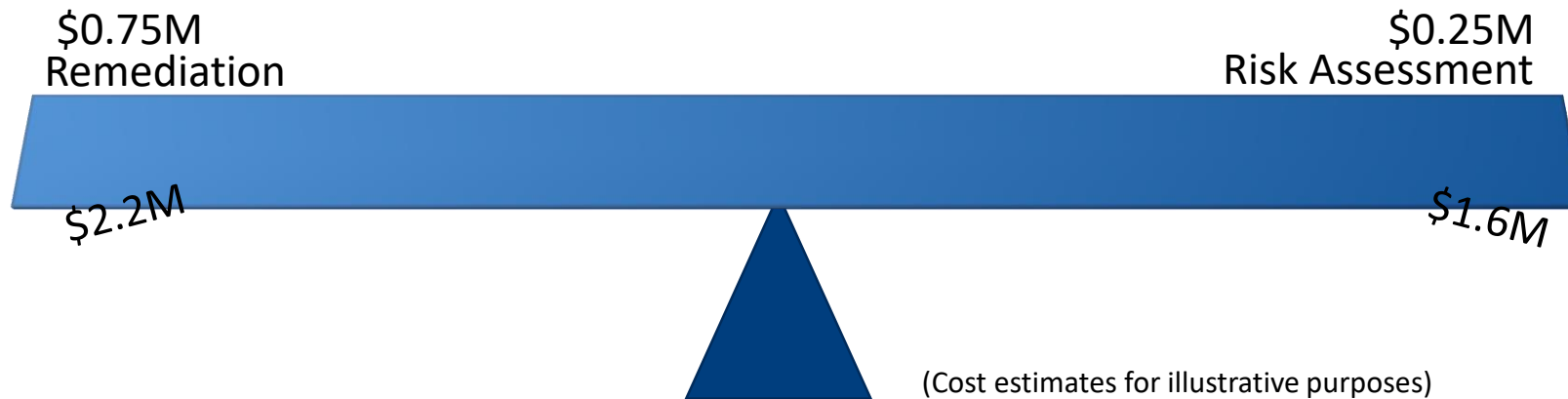<off-site migration pathway values, decreased indoor air exceedance area to 12m x 12m

Contaminant of Concern	Maximum Measured Concentration (ug/L)		Applicable Standard
	Pre-Remediation	Post-Remediation	
1,1,1 – TCA	45,000	4,400	200
1,1 – DCA	3,100	2,100	5
1,1-DCE	2,000	480	14
PCE	10,000	1,700	17
TCE	5,000	2,490	5
cDCE	30,000	4,140	17

Case Study #2: Historical Manufacturing Facility

- Balanced risk-based remediation goals with RA defined RMMs to save the Client $

- Targeted remediation narrowed the focus for RMMs

$0.75M
Remediation

$0.25M
Risk Assessment

$2.2M

$1.6M

(Cost estimates for illustrative purposes)

THANK
YOU!

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