Navigating Complexity: A Case Study on the Execution of a Sampling Program Addressing Persistent Organic Pollutants

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AGAT Laboratories

ALTALINK

AltaLink

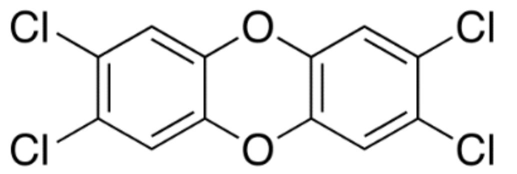
- AltaLink owns and operates 60% of Alberta's electricity transmission system
  - 13000 km of Transmission Lines and 300 substations

Overview

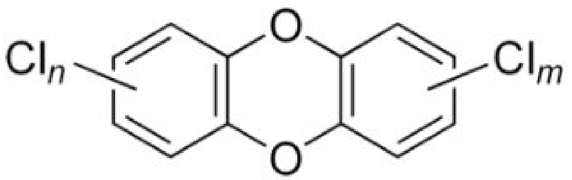
- Dioxins and Furans background
  - What are they?
  - Why are they important?
  - US EPA Method 1613
- AltaLink Sampling Program
  - History
  - Methodology
- Analysis
  - Method Optimization
  - Benefits & Advantages

Dioxins and Furans

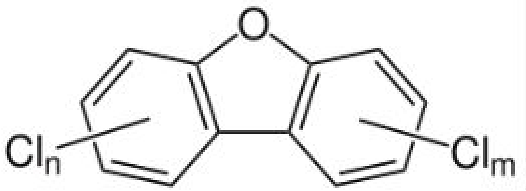
- Dioxins and furans are a group of compounds (congeners) that share similar chemical and physical properties. They are the by-products of various chemical processes such as:
  - Smelting
  - PVC (polyvinylchloride) production
  - Bleaching processes for pulp and paper
  - Industrial burning and medical incinerators
  - Synthesis of chlorinated compounds
  - Wood preservative



2378-tetrachlorodibenzo-*p*-dioxin

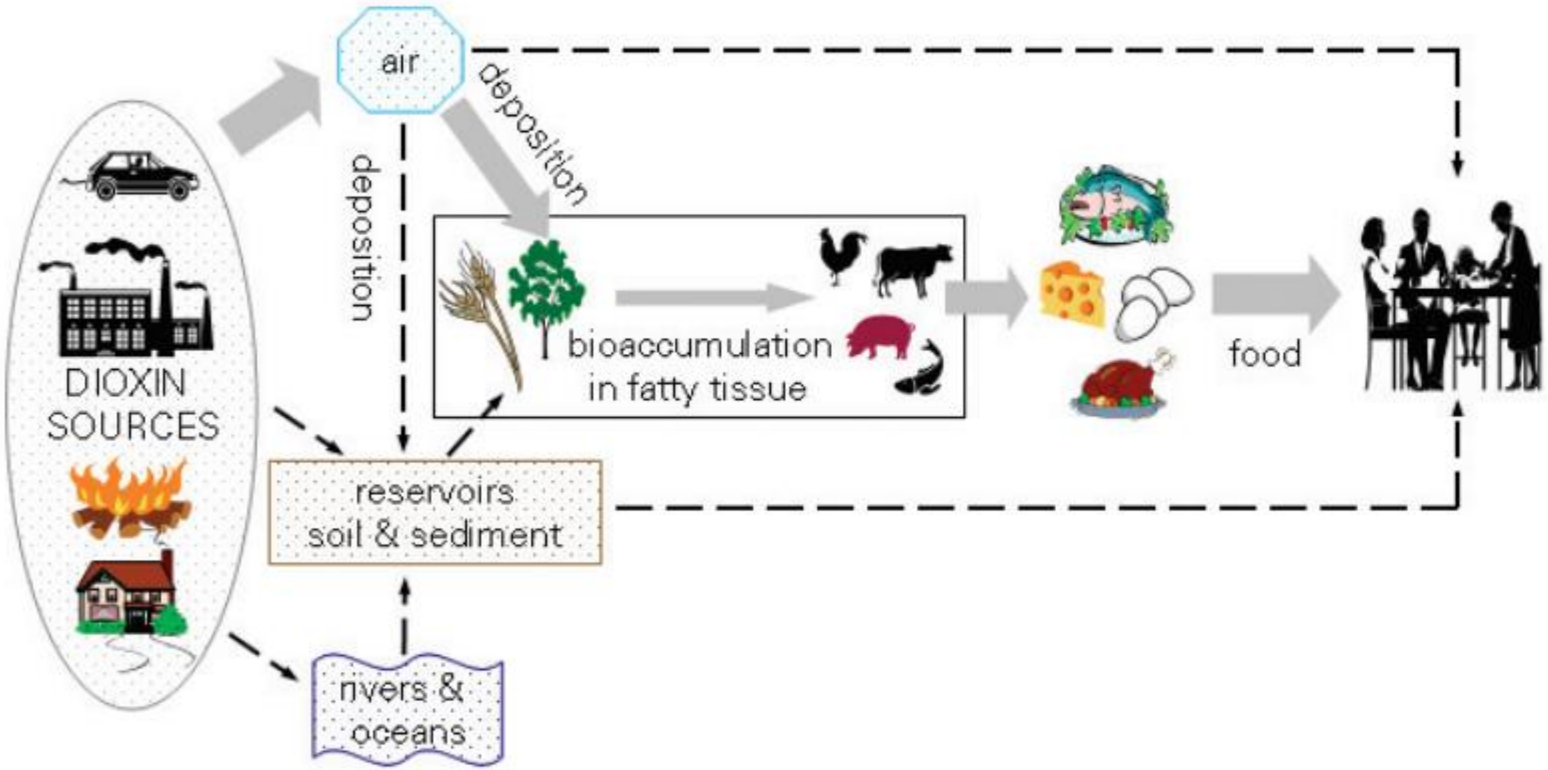


Polychlorinated dibenzo-*p*-dioxins

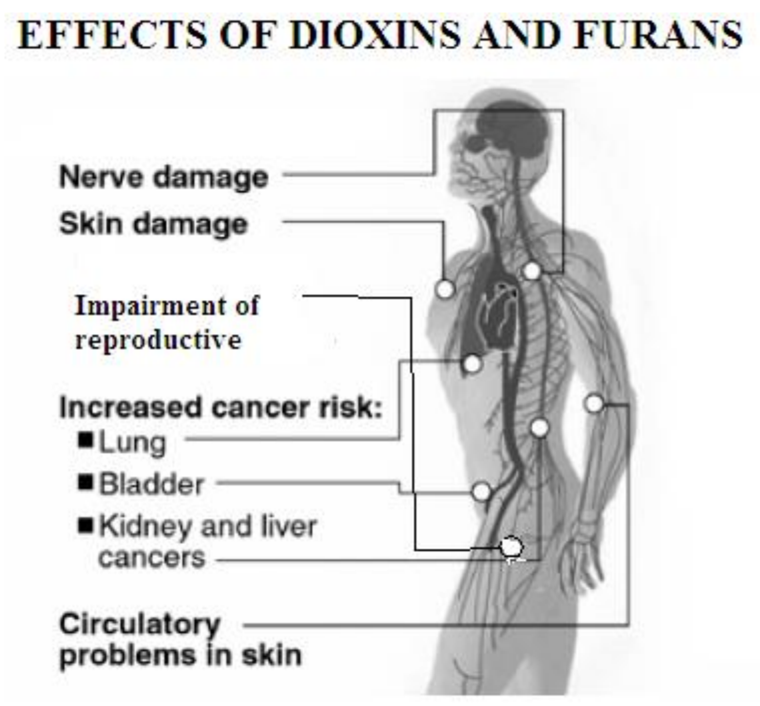


Polychlorinated dibenzofurans

Dioxin and Furans in the Ecosystem



Why are they important?



- Persistent organic pollutants have been known to accumulate in the environment.
- They can cause adverse health effects such as cancer in animals, suppression of the immune system, adverse reproductive effects and endocrine disrupting effects.
- Guidelines and regulations have been put in place in an effort to reduce and control levels found in the environment.
- 2378-TCDD has been labeled as the most toxic of the EPA Method 1613 congeners.

What are the TEQ and TEF?

	WHO 2005 TEF	WHO 1998 TEF	NATO 1988 TEF
Chlorinated dibenzo-p-dioxins			
2,3,7,8-Tetra CDD	1	1	1
1,2,3,7,8-Penta CDD	1	1	0.5
1,2,3,4,7,8-Hexa CDD	0.1	0.1	0.1
1,2,3,6,7,8-Hexa CDD	0.1	0.1	0.1
1,2,3,7,8,9-Hexa CDD	0.1	0.1	0.1
1,2,3,4,6,7,8-Hepta CDD	0.01	0.01	0.01
Octa CDD	0.0003	0.0001	0.001
Chlorinated dibenzofurans			
2,3,7,8-Tetra CDF	0.1	0.1	0.1
1,2,3,7,8-Penta CDF	0.03	0.05	0.05
2,3,4,7,8-Penta CDF	0.3	0.5	0.5
1,2,3,4,7,8-Hexa CDF	0.1	0.1	0.1
1,2,3,6,7,8-Hexa CDF	0.1	0.1	0.1
2,3,4,6,7,8-Hexa CDF	0.1	0.1	0.1
1,2,3,4,7,8,9-Hexa CDF	0.1	0.1	0.1
1,2,3,4,6,7,8-Hepta CDF	0.01	0.01	0.01
1,2,3,4,7,8,9-Hepta CDF	0.01	0.01	0.01
Octa CDF	0.0003	0.0001	0.001

- What is the Toxic Equivalency Factor (TEF)?
  - Describes the toxicity in comparison to the most toxic dioxin 2378-TCDD.
  - Each concentration is calculated against a specified TEF. International and WHO TEFs can be reported as requested.
- What is the Toxicity Equivalency (TEQ) value?
  - The sum of the toxicity of each Dioxin like compound against each TEF providing an exposure concentration

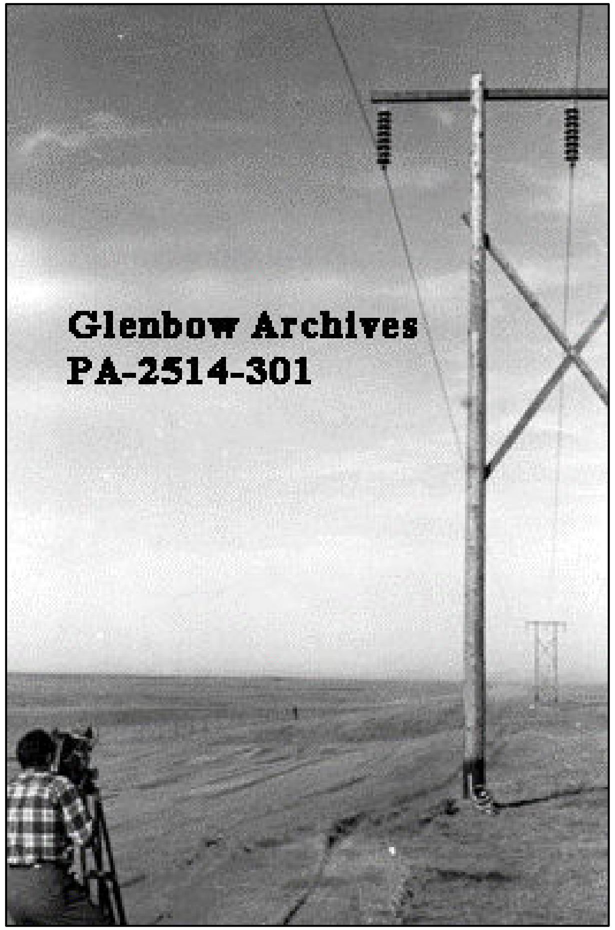
$$TEQ = \sum_{i=1}^{n} C_i \; x \; TEF_i$$

- TEQ’s are often used in risk assessments, managing contaminated sites, and by toxicologists.

Regulated Surface Operation

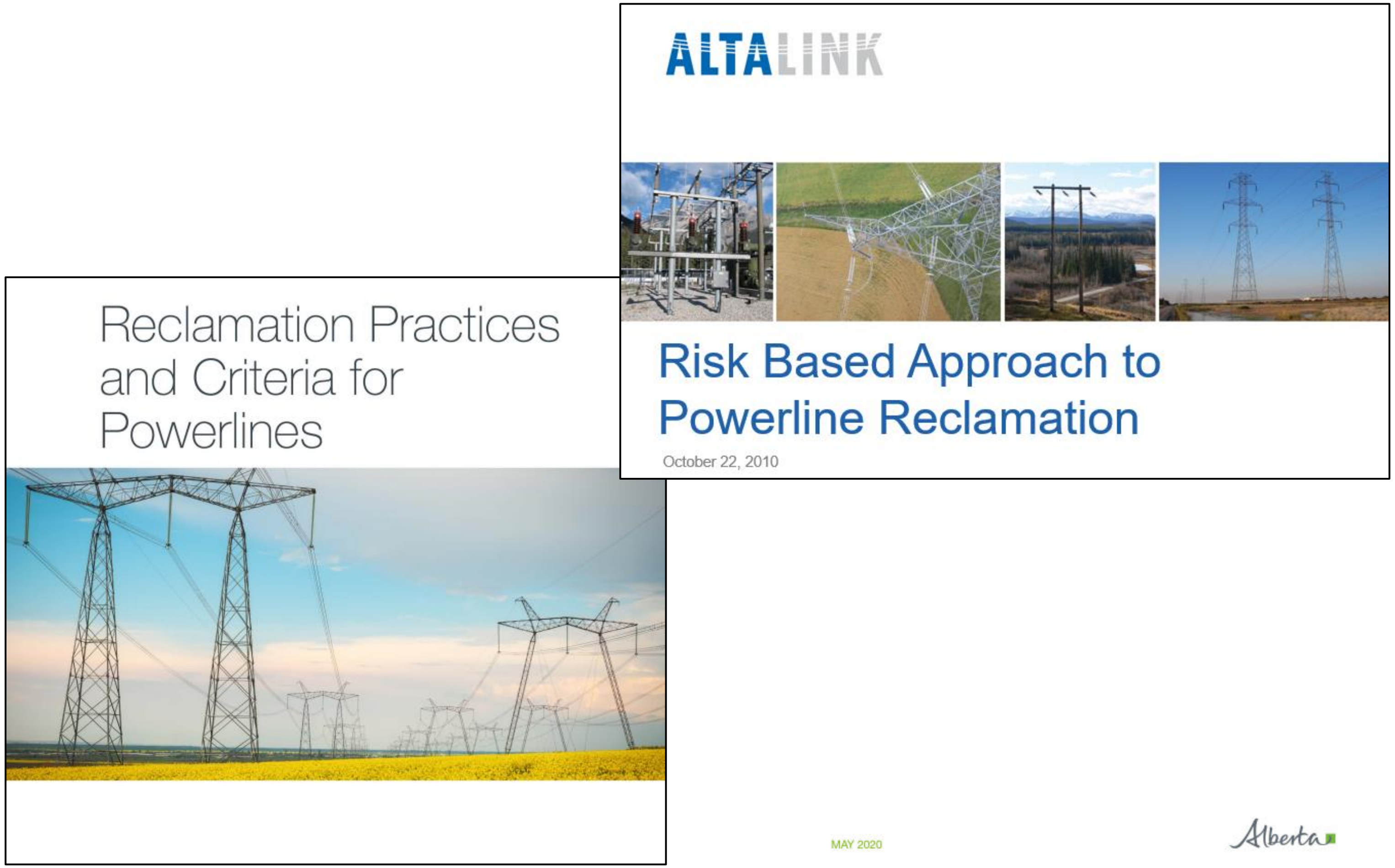
- Specified Land

  "Transmission lines on both private and public land must be reclaimed and obtain a Reclamation Certificate for regulatory closure"



History

- Investigations 2007
- Risk Assessment 2010
- RemTech 2010
- Reclamation Guideline 2019
- Remediation Guideline ????



Media Attention

Global NEWS

Soil tests confirm hazards to human health at former Edmonton Domtar site: province

The tests found 183 samples have "levels of contamination that exceed human health guidelines for dioxins and furans," the province said Thursday.

HEALTH | MAR 7, 2019

D/F and PCP Utility Poles

- Does AltaLink have D/Fs?
- 6.8 Million PCP Poles
- D/F Emissions from PCP Poles
  - 1% of Total Air Emissions
  - 47% of Total Soil Emissions
- Emissions to soils poorly studied

Early Investigation & Challenges

- Hap Hazard Sampling Methods
- Expensive and Slow Analytical TAT
- Outdated soil quality guidelines (CCME 2002)
    - 1980-90s EDI & TDI data
    - 4 ng TEQ/kg = Background

Path Forward – Ongoing Innovative Approach

- Working Group Re-established
- T-Line D/F Risk Assessment
- T-lines are being decommissioned with or without guidelines
- Streamlined Analytical

Matrix Solutions Inc.
A Montrose Environmental Company

wsp

ATCO

NORTH SHORE
Environmental Consultants

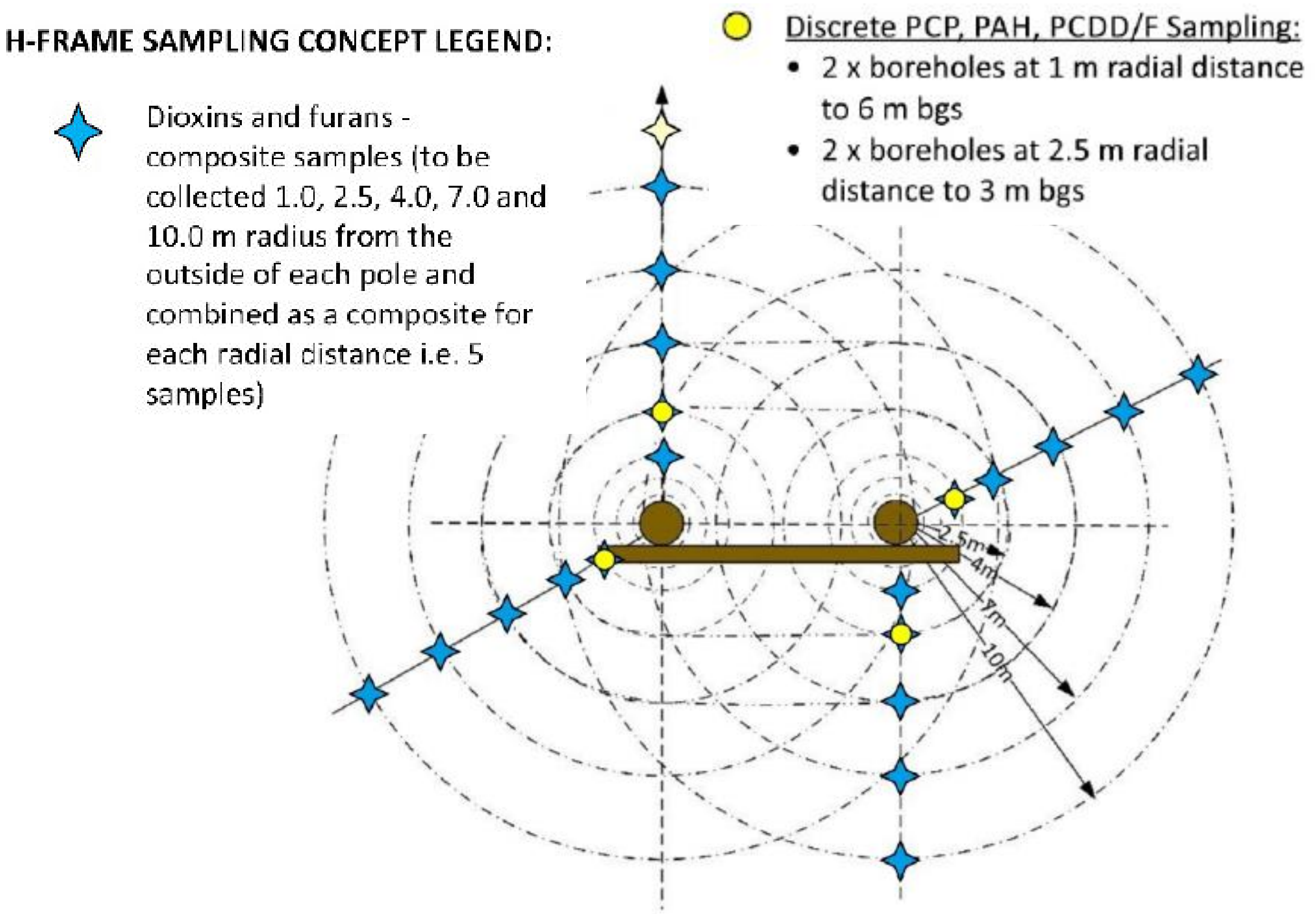
Stantec

Alberta*

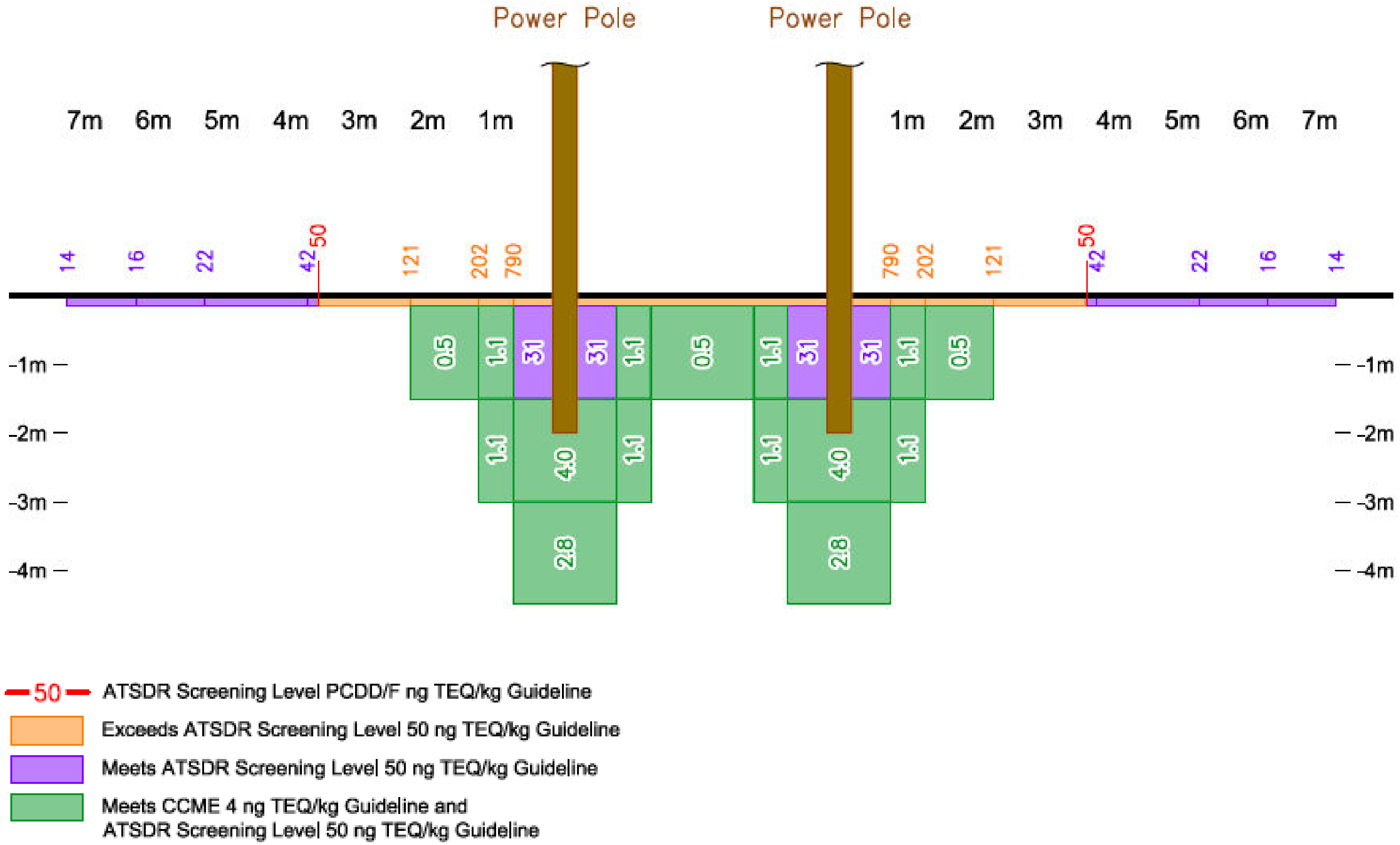
*This innovative approach has not received regulatory acceptance at this time.

Assessment Methodology

- Best way to sample for D/F?
- Composite Sampling?
- 2023 Revised Sampling Strategy
    - 100+ poles to be assessed
    - Composite sampling in rings
- Delineation achieved



Preliminary Results



Distance From Pole Centre (m)	Calculated Statistic PCDD/F (ng TEQ/kg)
	95% CL
0.75	790
1.25	202
2.25	121
3.75	42
5.25	22
6.25	16
7.25	14

Depth Range	Mean or CL	ng TEQ/kg at Distance from Pole (m)		
		0.75	1.25	2.25
0 to 0.15 m	95% CL	Same as plan view concentrations		
0.15 to 1.5 m	95% CL	31	1.1	0.50
1.5 to 3.0 m	Mean [1]	4.0	1.1	
3.0 to 4.5 m	Mean [1]	2.8		

[1] – Insufficient data for 95% CL

EPA Method 1613

- Traditional method for the analysis of Dioxins and Furans by Isotope Dilution High Resolution Gas Chromatography Mass Spectrometry (HRGC/HRMS)

- Seventeen of the most toxic congeners are analyzed using the 1613 Method which recognizes there are advances in new and emerging technology that can improve analysis

- Long extraction time and multiple cleanup steps

Method Optimization

- TAT comparison for Dioxin and Furans in soil: 20 sample batch + QC

	Traditional EPA Method 1613	Optimized method
Extraction	18 - 24 hours	0.5 hours
Cleanup and preparation for instrument	5+ days	1 - 2 days
Total in lab	**6+ days**	**2 days**

Result Comparison – problematic soils

Samples run both by **Montreal** and **Calgary** locations for comparison

Even against the most troubling samples good repeatability was observed using the optimized method!

	Traditional EPA 1613 method	Optimized Method	Traditional EPA 1613 method	Optimized Method	Traditional EPA 1613 method	Optimized Method
CDD/CDF	HRMS Soil Sample A	GCMSMS Soil Sample A	HRMS Soil Sample B	GCMSMS Soil Sample B	HRMS Soil Sample C	GCMSMS Soil Sample C
	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg
2378-TCDD	0.3	<1	0.8	1	0.1	<1
12378-PeCDD	9	7	17	20	1	<2
123478-HxCDD	26	18	52	63	3	3
123678-HxCDD	149	142	382	490	9	10
123789-HxCDD	55	39	108	130	6	6
1234678-HpCDD	5710	4660	12900	14100	314	467
OCDD	57400	50500	126000	131000	2330	3250
2378-TCDF	0.3	<1	0.4	<1	0.1	<1
12378-PeCDF	<0.1	<2	<0.2	3	0	<2
23478-PeCDF	1	<3	2	4	0	<3
123478-HxCDF	22	22	77	98	2	<3
123678-HxCDF	15	10	29	37	2	<3
234678-HxCDF	33	23	70	86	3	<3
123789-HxCDF	4	4	19	25	0	<3
1234678-HpCDF	1220	1060	2860	3420	77	72
1234789-HpCDF	82	80	214	273	5	5
OCDF	6110	5930	11300	10900	194	236

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Result Comparison – wet soil samples

The optimized method still came out ahead with these difficult samples

Good repeatability and excellent surrogate recoveries continue to be produced!

	Sample D		Sample E		Sample F	
% moisture	75		68		66	
Method	Traditional 1613	Optimized AGAT	Traditional 1613	Optimized AGAT	Traditional 1613	Optimized AGAT
2378-TCDD	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
12378-PeCDD	<0.1	<0.1	<0.1	<0.1	0.3	0.3
123478-HxCDD	<0.1	<0.1	<0.1	<0.1	0.5	0.5
123678-HxCDD	<0.1	<0.1	0.1	<0.1	0.9	1
123789-HxCDD	<0.1	<0.1	0.2	<0.1	1	1
1234678-HpCDD	1.4	1.5	2.7	2.8	38	47
OCDD	12	14	18	22	523	716
2378-TCDF	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
12378-PeCDF	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
23478-PeCDF	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
123478-HxCDF	<0.1	<0.1	<0.1	<0.1	0.2	0.2
123678-HxCDF	<0.1	<0.1	<0.1	<0.1	0.1	0.2
234678-HxCDF	<0.1	<0.1	<0.1	<0.1	0.3	0.2
123789-HxCDF	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1234678-HpCDF	0.5	0.5	0.6	0.7	5	6
1234789-HpCDF	<0.1	<0.1	<0.1	<0.1	0.5	0.7
OCDF	0.8	1.0	1	1	29	41
13C-2378-TCDF	41	88	43	94	74	93
13C-12378-PeCDF	54	91	58	95	81	95
13C-23478-PeCDF	57	95	62	101	82	99
13C-123478-HxCDF	62	98	68	103	81	96
13C-123678-HxCDF	63	100	69	106	80	97
13C-234678-HxCDF	65	101	69	106	78	105
13C-123789-HxCDF	65	95	72	100	82	99
13C-1234678-HpCDF	62	98	67	104	75	97
13C-1234789-HpCDF	67	97	71	104	80	103
13C-2378-TCDD	44	93	47	100	79	98
13C-12378-PeCDD	57	96	63	101	82	100
13C-123478-HxCDD	65	101	71	106	82	103
13C-123678-HxCDD	67	104	73	111	83	106
13C-1234678-HpCDD	68	103	71	110	80	108
13C-OCDD	63	103	62	115	73	112

Benefits and Advantages of Our Combined Approach

1. Ability to create a **improved analytical method** that optimized turnaround times while still providing consistent and accurate results.

2. Program involved **multiple stakeholders** and a substantial amount of data.

   ✓ **Reduced turnaround times** provided the ability to make quick decisions.

3. Absence of specific **regulatory guidelines** allowed us freedom to tailor the program strategies and methodologies.

4. **Streamlined communication** created efficiencies for all parties such as timely responses to unforeseen challenges with the site program.

5. Set **new path forward**, to again develop a powerline-specific assessment and remediation criteria for D/Fs.

Questions?

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