Optimization of Detection Monitoring Programs for Oregon Landfills

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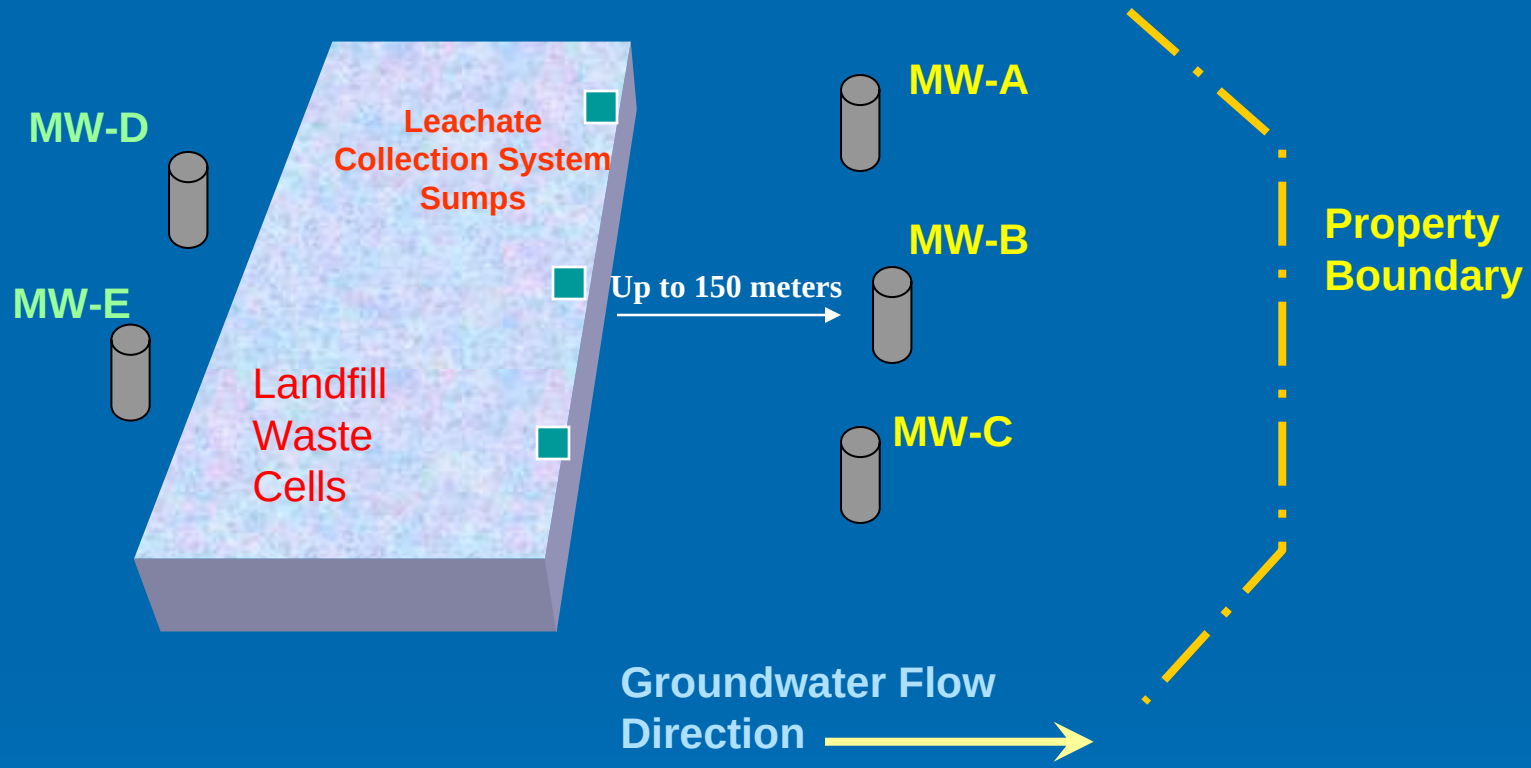
Primary Elements of Effective Detection Monitoring Program

- **Perform thorough site characterization and develop hydrogeologic model**
- **Design effective monitoring network**
  - **Understanding of preferential flow paths**
  - **Placement of monitoring wells downgradient of potential landfill (leachate) sources**
- **Characterize background groundwater and leachate**
- **Determine sub-set of effective long-term monitoring parameters for developing statistical limits**

Hypothetical Site Setting



Legend:

MW-A, B, C — Compliance Monitoring Well

MW-D, E — Upgradient (Background) Monitoring Well

State of Oregon Background Monitoring Parameter List

- **Major Anions and Cations**
  - Na, K, Ca, Mg, Cl, HCO_3, SO_4 , Mn, Fe
- **Leachate Indicators**
  - COD, TOC, TDS, Ammonia, Nitrate, Hardness, Lab Conductance
- **Trace Metals (15)**
  - Ag, As, Be, Ba, Cd, Co, Cr, Cu, Pb, Ni, Se, Sb, Tl, V, Zn
- **VOCs**

Note: Collect background groundwater samples quarterly for two years; collect leachate samples from multiple sumps over time

Transition from Background to Detection Monitoring

- How do you select effective monitoring parameters?
- Why don't we monitor for everything parameter required as part of background monitoring?

More is not always Better!!!

Key Goals and Advantages of Parameter Optimization

- Select effective inorganic parameters for early detection of potential releases
- Eliminate parameters not characteristic of source (leachate)
- Reduce false positives, minimize data management and eliminate unnecessary regulatory responses
- Eliminate unnecessary laboratory costs

Regulatory and Technical Basis for Establishing Site-Specific Parameter Lists

- Federal regulations (40 CFR 258.54[a][2]) allow for alternate inorganic parameter list that provides reliable indication of release from facility
- Oregon DEQ adopting parameter optimization through Internal Management Directive (IMD) process consistent with principals, goals and strategies of "Core Group" advisory committee
- ASTM Standard (D7045-04): "Optimization of Groundwater Monitoring Constituents for Detection Monitoring Programs For RCRA Waste Disposal Facilities"

Criteria in Federal Regulations Allowing for Establishing Site-Specific Parameter List

- The types, quantities, and concentrations of constituents in wastes
- The mobility, stability, and persistence of constituents in the unsaturated zone
- The concentration of parameters or constituents in background ground water

Federal Regulation - 40 CFR 58.54[a][2](i-iv)

Parameter Selection Process

- Analysis of VOCs
- Inorganic parameter optimization process
  - Contrasting leachate/groundwater chemistry
  - Parameter mobility and persistence
  - Parameter redundacy

End results of process is selection of effective parameters for early detection of potential releases

Step 1: Characterize & Compare Source (Leachate) and Groundwater Chemistry

- Calculate concentration limits for background groundwater
- Determine mean or maximum parameter concentrations in leachate
- Eliminate parameters not detected above RL in leachate or detected in leachate at concentrations below groundwater levels
- Compare parameter concentrations in leachate and groundwater to determine if significant contrast exists (C_L/C_{GW})

Step 1 (cont): Characterize & Compare Source Chemistry and Groundwater Chemistry

- **Eliminate parameters that exhibit insufficient concentration contrast (EPA/540/R-95/128)**
  - **Lined facilities with leachate collection (C_L/C_{GW}=20)**
  - **Unlined facilities (C_L/C_{GW}=10)**

At this point in the process, often there is an "obvious" set of "good" indicator parameters

Step 2: Consider Parameter Mobility and Analytical Redundancies

- **Eliminate inorganic parameters with low mobility (*ability of given parameter to migrate through the hydrogeologic system*)**
  - **Trace metals (strongly attenuated by chemical processes, e.g., sorption and precipitation)**
- **Eliminate inorganic parameters exhibiting analytical redundancies**
  - **TDS and lab conductance**
  - **Total and bicarbonate alkalinity**
  - **Hardness and Ca, Mg**

Parameter Optimization
Case Study

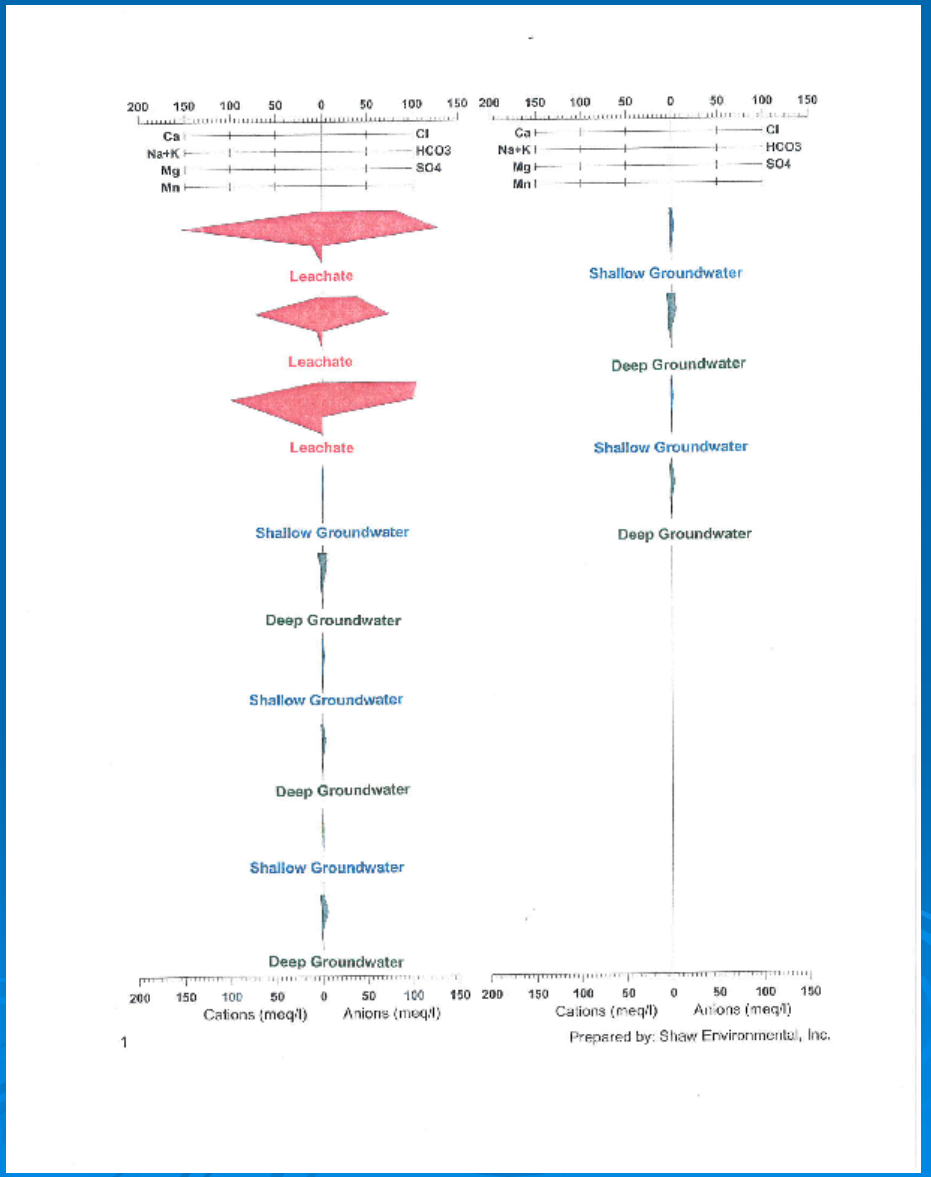
Riverbend Landfill

Municipal Solid Waste Landfill, Yamhill County

Results of parameter optimization incorporated into updated site Environmental Monitoring Plan approved by the Oregon DEQ

Comparison of Groundwater and Leachate Chemistry (Stiff Diagrams)

- Leachate is geochemically distinct from groundwater
- Groundwater results are generally tightly grouped and show similar geochemistry



Contrasting Leachate and Groundwater Chemistry

Leachate Indicator Parameters
Anions and Cations

Analyte	Leachate		Shallow Groundwater		Deep Groundwater	
	Detection Frequency (percent)	Maximum Concentration (mg/L)	Prediction Limit (mg/L)	Contrast Factor (C_L/C_{GW})	Prediction Limit (mg/L)	Contrast Factor (C_L/C_{GW})
Leachate Indicator Parameters						
TOC	100	2510	6	436	4	607
TDS	100	11600	608	19	917	13
Anions and Cations						
Ammonia	100	2370	0.3	6971	1	3537
Bicarbonate	100	6360	379	17	502	13
Chloride	100	2300	110	21	340	7
Silicon, Total	100	64	40	2	53	1
Sulfate	71	1200	202	6	25	48
Calcium	100	399	68	6	140	3
Iron	100	32	2	17	9	4
Magnesium	100	530	30	18	42	13
Manganese	100	13	5	3	4	3
Potassium	100	580	3	176	1	483
Sodium	100	1900	83	23	80	24

Contrast Factor in Red = Parameter concentration elevated in leachate relative to groundwater (C_L/C_{GW} >10) and retained for statistical analysis

Contrasting Leachate and Groundwater Chemistry

Total Trace Metals

Analyte	Leachate		Shallow Groundwater		Deep Groundwater	
	Detection Frequency (percent)	Maximum Concentration (mg/L)	Prediction Limit (mg/L)	Contrast Factor (C_L/C_{GW})	Prediction Limit (mg/L)	Contrast Factor (C_L/C_{GW})
Trace Metals (total)						
Antimony	80	0.071	0.01	5	0.01	12
Arsenic	100	0.32	0.08	4	0.01	64
Barium	100	1.4	0.75	2	0.10	14
Chromium	100	0.240	0.03	9	0.04	5
Cobalt	92.3	0.067	0.03	3	0.02	3
Copper	82.6	0.14	0.06	2	0.03	5
Lead	53.8	0.0150	0.03	1	0.01	2
Nickel	100	0.20	0.03	6	0.01	14
Vanadium	100	0.37	0.05	7	0.05	7
Zinc	75	3.8	0.24	16	0.18	21

Subset of trace metals (Be, Cd, Se, Ag, Tl) were not retained for long-term monitoring because their detection frequency in leachate were typical less than 25 percent.

Note : Often times metals are either not detected in leachate or detected at concentrations similar to background groundwater levels

Long-Term Compliance Monitoring Program

- **Statistically-derived concentration limits (PSCLs) established for inorganic parameters selected through optimization process**
- **Routine analysis of VOCs**
- **Routine analysis of cations and anions for QC purposes and geochemical analysis**
- **Five-year comprehensive monitoring event** ***(at 5 year point assess the effectiveness of the EMP and modify is appropriate)***

Conclusions

- Selection of effective parameters provides for early and reliable detection of a potential release
- Parameter optimization achieves the following:
  - Eliminates parameters not characteristic of (leachate) source
  - Reduces false positives, minimizes data management and eliminates unnecessary regulatory responses
  - Eliminates unnecessary laboratory costs