

Data Collection and Analysis of Phase 2 Environmental Site Assessments Associated with Drilling Waste Disposal Locations



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Evaluation Focus

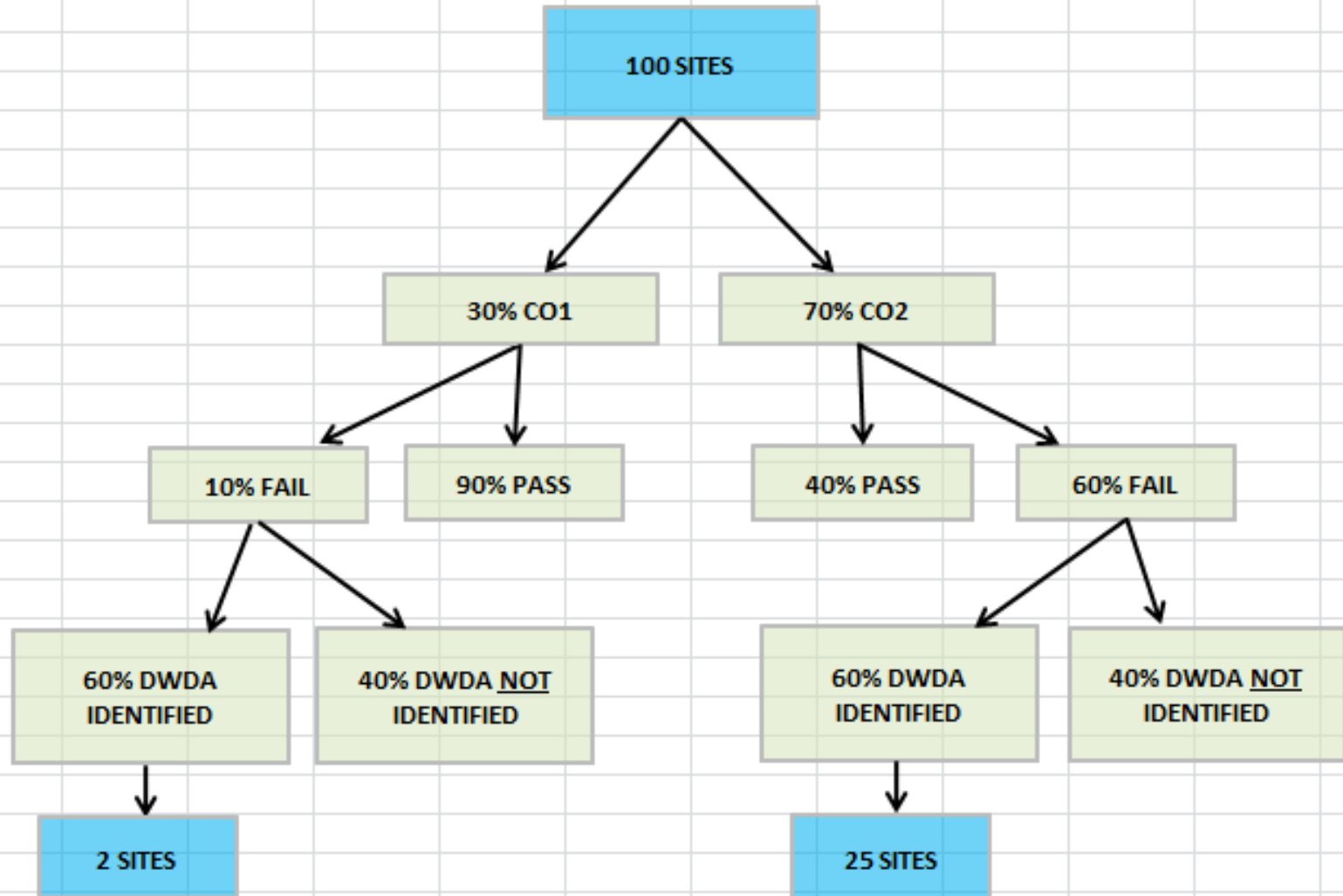
- 1996 Guide 50
(renamed to Directive 50)

- May 2, 2012 – Directive 50
****Alignment with Alberta
Tier 1 Soil and Groundwater
Remediation Guidelines****



Focus on disposals completed
prior to Nov 1, 2012

North Shore DATA -General Trending



Context

- Focused on drilling waste disposals prior to 2012
- Evaluate correlation between Compliance Option 2 triggers and actual Tier 1 exceedances during the Phase 2 ESA
- Use statistical analysis to determine relationships between the triggers
- **Identify the characteristics of low risk sites and reduce the number of unnecessary Phase 2 ESAs conducted**
- Provide recommendations for proposed guideline adjustments
- Move more sites towards reclamation certification

Major Changes Between Versions

2005

DSTs alone fail the DWDA if not disposed at a waste management facility

2007

Introduced chloride concentration for DSTs at 350,000 mg/L
Introduced post disposal PHC calculation for DSTs

2009

Barite trigger raised from 0.070 to 0.22

2012

Default DST chloride concentration reduced to 215,000 mg/L
Introduced that an EM survey with no anomalies is sufficient for a PH2 (For DSTs using the default chloride concentration)

Compliance Option Triggers

PARAMETER CALCULATIONS METALS

- Zinc Carbonate (ZnCO_3)
 - Barite (BaSO_4)
- Chrome Lignosulphonates

Linked to Tier 1 Endpoints

Compliance Option Triggers

PARAMETER CALCULATIONS PHC and CHLORIDES

- Post disposal PHC concentration
(0.5% Topsoil, 0.1% Subsoil)
- Post disposal chloride concentration
2000 mg/kg 1996 D050
800 mg/kg Compliance Option

Not Linked to Tier 1 Endpoints

Compliance Option Triggers

PARAMETER CALCULATIONS SALT and DST RETURNS

- Salts - Sodium Hydroxide Equivalency (NaOH) 0.026 and 0.035
- DST default chloride concentration
(215,000 mg/L)

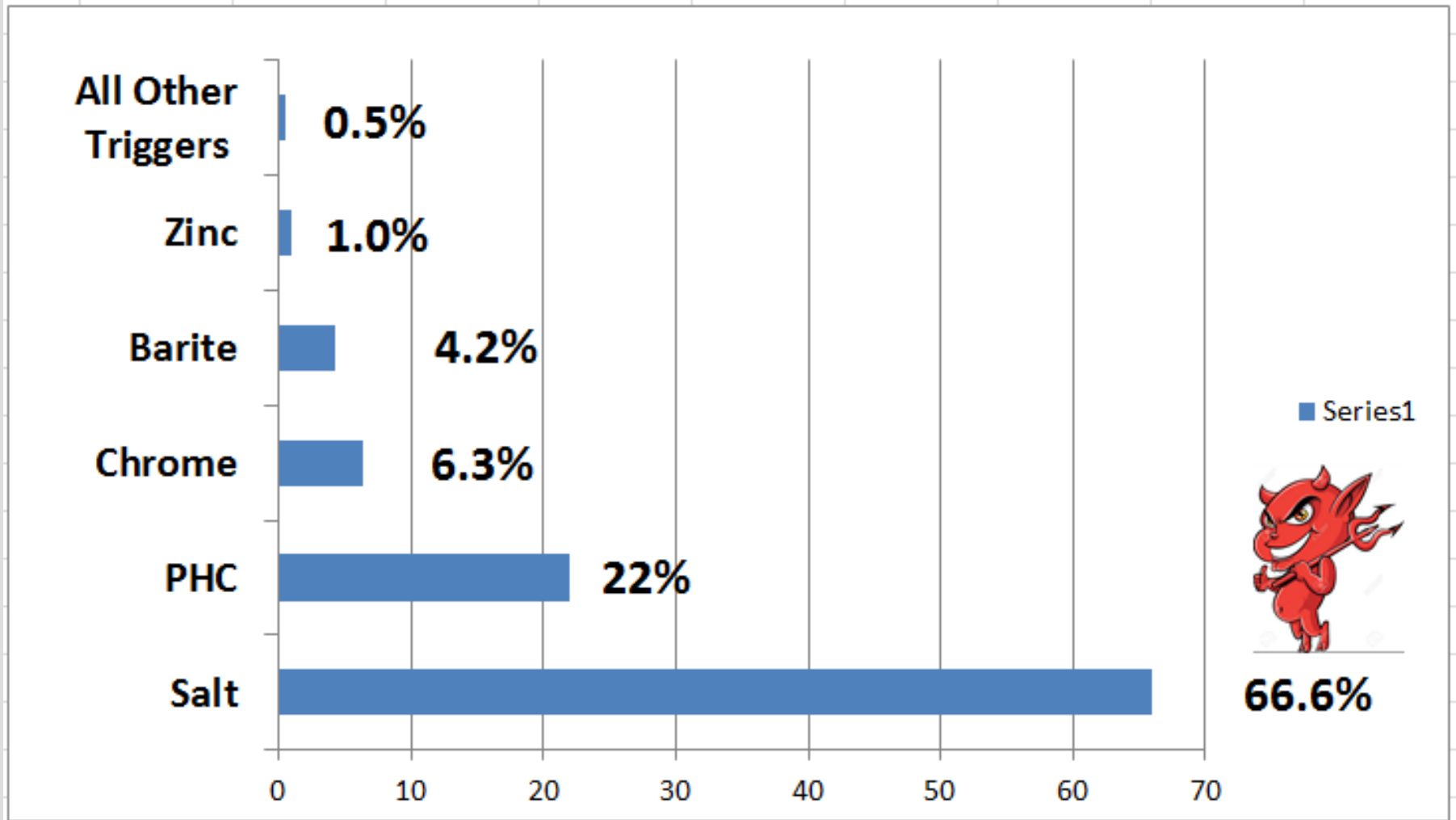
Too Conservative?

Compliance Option Triggers

CONDITIONS

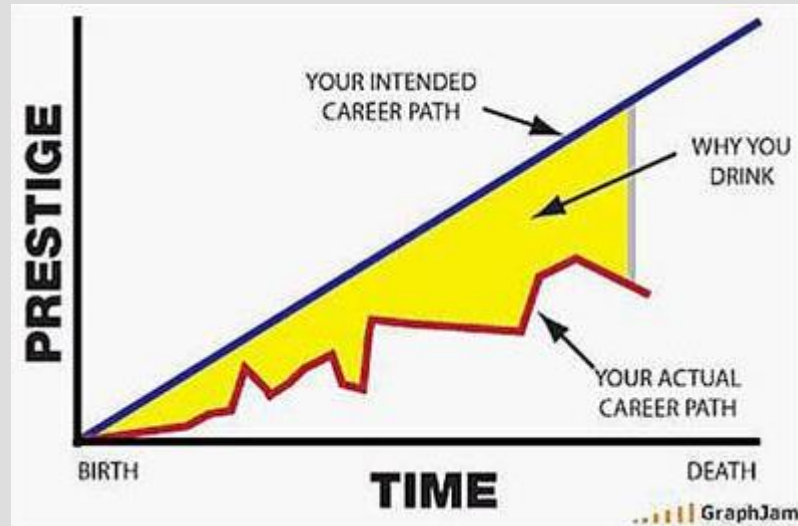
- Lack of Drilling Records
 - Unknown mud system
- Horizontal or Underbalanced well
 - Kicks, flows
 - Advanced Gel Chem
 - Salt Zone encountered
- Hydrocarbon based mud system
 - Hydrocarbon added
 - Unknown mud products

% of Compliance Option Triggers

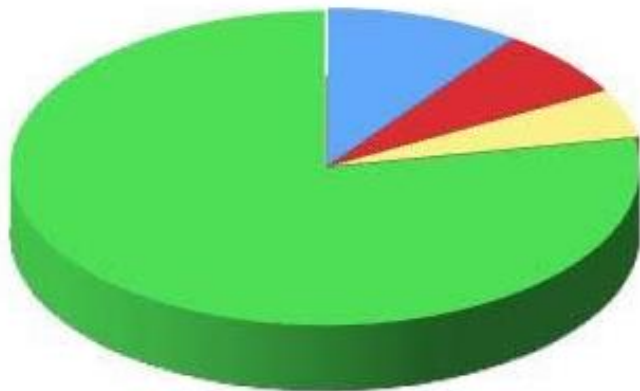


Evaluation Process

	A	B	C	D	E	F	G	H	I	J	K	L
2	New York	4,800,000	3,700,000	3,300,000	2,700,000	2,400,000	1,200,000	4,000,000	3,200,000	1,900,000	1,700,000	
3	Chicago	1,200,000	1,500,000	2,000,000	2,400,000	2,000,000	1,500,000	1,400,000	1,200,000	1,000,000	1,000,000	
4	Los Angeles	2,200,000	2,300,000	3,000,000	2,800,000	1,800,000	4,000,000	3,200,000	5,500,000	6,200,000	7,200,000	
5	San Francisco	4,800,000	3,700,000	3,300,000	2,700,000	2,400,000	1,200,000	4,000,000	3,200,000	1,900,000	1,700,000	
6	Dallas	1,200,000	1,500,000	2,000,000	2,400,000	2,600,000	2,000,000	1,500,000	1,400,000	1,200,000	1,000,000	
7	Boston	2,200,000	2,300,000	3,000,000	2,800,000	1,800,000	4,000,000	3,200,000	5,500,000	6,200,000	7,200,000	
8	Cleveland	1,200,000	1,500,000	2,000,000	2,400,000	2,600,000	2,000,000	1,500,000	1,400,000	1,200,000	1,000,000	
9	San Jose	2,200,000	2,300,000	3,000,000	2,800,000	1,800,000	4,000,000	3,200,000	5,500,000	6,200,000	7,200,000	
10	Baltimore	4,800,000	3,700,000	3,300,000	2,700,000	2,400,000	1,200,000	4,000,000	3,200,000	1,900,000	1,700,000	
11	Orlando	1,200,000	1,500,000	2,000,000	2,400,000	2,600,000	2,000,000	1,500,000	1,400,000	1,200,000	1,000,000	
12	Omaha	2,200,000	2,300,000	3,000,000	2,800,000	1,800,000	4,000,000	3,200,000	5,500,000	6,200,000	7,200,000	
13	Miami	4,800,000	3,700,000	3,300,000	2,700,000	2,400,000	1,200,000	4,000,000	3,200,000	1,900,000	1,700,000	
14	Tampa	1,200,000	1,500,000	2,000,000	2,400,000	2,600,000	2,000,000	1,500,000	1,400,000	1,200,000	1,000,000	
15	Houston	2,200,000	2,300,000	3,000,000	2,800,000	1,800,000	4,000,000	3,200,000	5,500,000	6,200,000	7,200,000	
16	Phoenix	1,200,000	1,500,000	2,000,000	2,400,000	2,600,000	2,000,000	1,500,000	1,400,000	1,200,000	1,000,000	
17	Las Vegas	2,200,000	2,300,000	3,000,000	2,800,000	1,800,000	4,000,000	3,200,000	5,500,000	6,200,000	7,200,000	

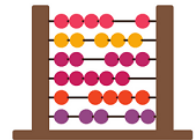


Things a Zombie Would Do



- Eat your flesh
- Eat your brain
- Moan
- Dance with Michael Jackson

$$S = \sqrt{\frac{\sum |x - \bar{x}|^2}{n - 1}}$$



Where:

X is the first, second, third, etc. data value

\bar{x} is the mean of the data set

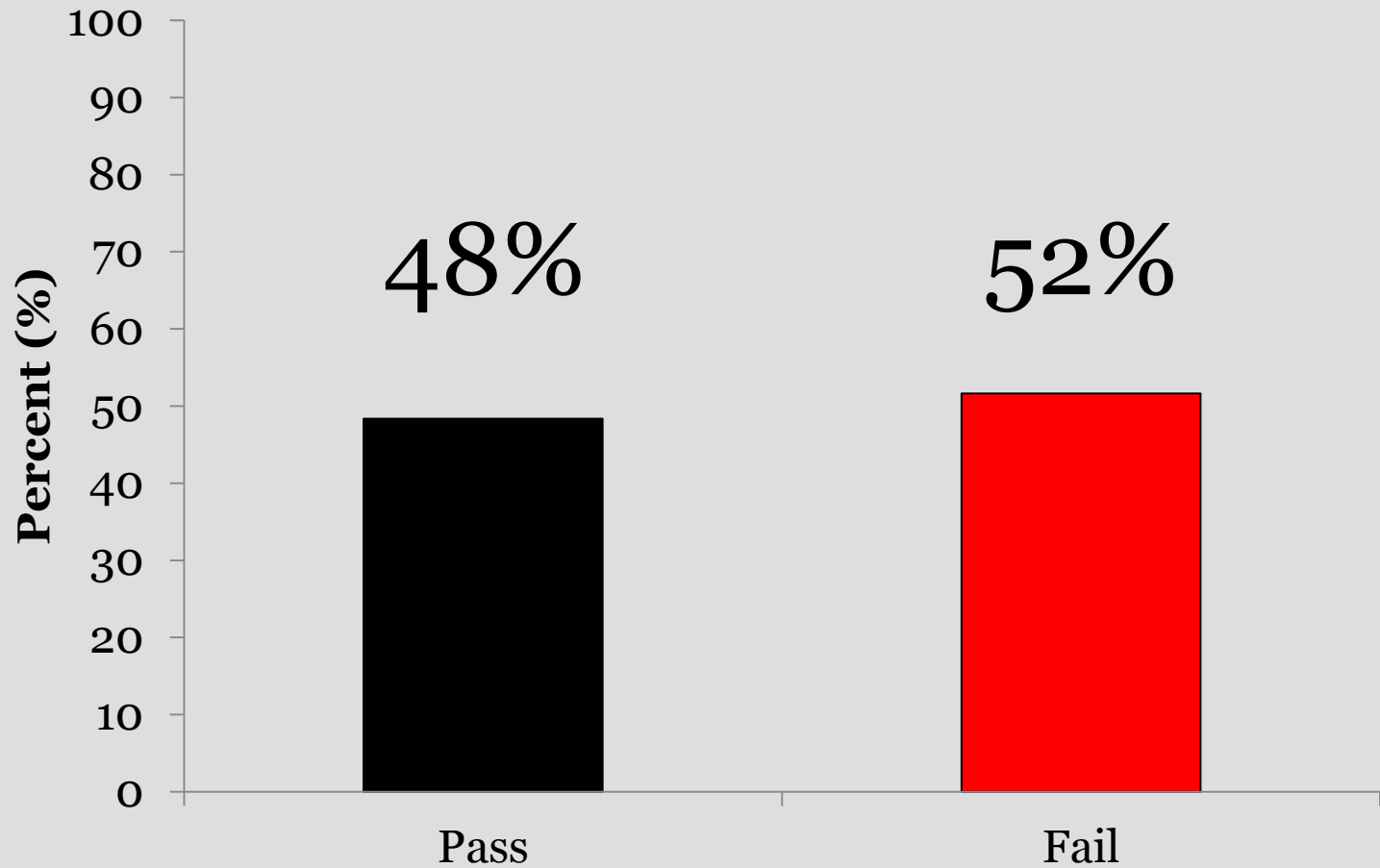
n-1 is the number of sample values decreased

$|x - \bar{x}|^2$ represents the deviation from the sample mean

False Positive and False Negative Errors

		PHASE I	
		PASS	FAIL
PHASE II	PASS	CORRECT	FALSE NEGATIVE
	FAIL	FALSE POSITIVE	CORRECT

PH2 Failures when CO2 Fails



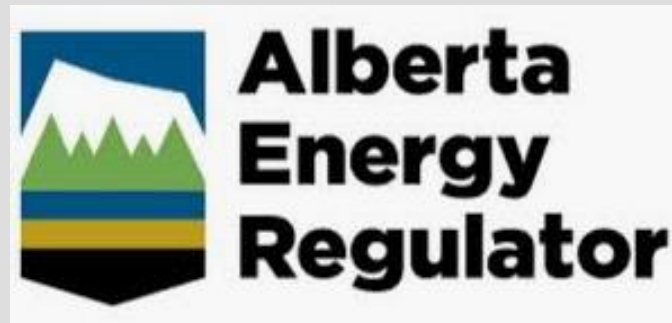
Stage 1: Data Collection and Review

- Information Review
- Data Gathering
- Data Analysis
- Assess Effect of Disposal Location on Results

Stage 1: Information Review

- Assessing Drilling Waste Disposal Areas: Compliance Options for Reclamation Certification (AER March 2014)
- **Review AER assumptions around calculation triggers**

Stage 1: Data Gathering



Stage 1: Data Analysis

- **Descriptive Statistics**
(removing data outliers)
- **Categorical Data**
(two-way contingency tables, Pearson's Chi-square and/or Fisher Exact Tests)
- **Predictive Modeling**
(Multi-variable Binominal Regression)

$$x^2 = \sum \frac{(O - E)^2}{E}$$

x^2 = The test statistic

O = Observed

E = Expected

\sum = The sum of

$$Y = B_0 + B_1X_1 + B_2X_2 + \dots + B_kX_k$$

Y = Phase 2 Pass/Fail

B_0 = Constant

B_1 = Coefficient of variable X_1

X_1 = Independent PH 1 predictor variables (production amount, salt calculation, production years... etc.)

Stage 1: GIS Data Spatialization

- Assess Effect of Disposal Location on Results
- The collected drilling waste source locations will be mapped using the web-based application EWS (www.envirowebservices.com) and cross referenced with well-specific data to determine if there are any geographic trends. EWS is already pre-populated with the AER energy well information and DST testing information can be obtained and spatialized.

Stage 2: Recommendations and Proposed Guideline Adjustments

- Evaluate the options for changes and discuss with the PTAC steering committee
- Focus on salinity calculations and hydrocarbons
- Is the current DST default of 215,000 mg/L reasonable?
- Effect of spud date – evaluate current effectiveness of mix ratio calculations
- Professional judgement – is there a reasonable place for justification to determine if a Phase 2 is necessary?

Stage 3: Project Conclusion

Components of a Technical Report:

- Executive Summary
- Introduction
- Methodology
- Results/Analysis
- Conclusions
- References
- Abstract
- Background
- Appendices
- Figures and Tables



Complications with the Data

- Evaluating PH₂ results that are potentially based on unknown multiple disposal methods
- Compliance calculations are for TOTAL waste MBC while in many cases, fluids were offsite pumpoff
- So how do we evaluate parameters that have high or low solubility?
- How much is within the solids?
- How much is in the fluids?

Focus for Improvement

CONDITIONS

- Lack of Drilling Records
 - Unknown mud system
- Horizontal or Underbalanced well
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Compliance Option Triggers

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Linked to Tier 1 Endpoints

PHC Opportunities

- PHC added to mud system and Post-Disposal PHC concentration
- Compliance Option endpoints measured as TOTAL Hydrocarbons vs Tier 1 compliance broken out into BTEX and F1-F4

Salt and DST Opportunities

- **Revisiting the SALT Calculation triggers offer the biggest bang for your assessment buck**
- Default Chloride DST concentration are likely too conservative (215,000 mg/kg)
- Research chloride concentrations based on formation that the DST return was taken from
- Using formation specific DST chloride concentrations that more accurately reflect risk associated with your site
- EM surveys are already reasonable – cost wise - to guide in decision making

A young boy with light brown hair, wearing a brown coat, is holding a metal bowl and a wooden spoon. He has a sad expression on his face. The background is dark and blurry, suggesting an outdoor setting. The text "PLEASE SIR" is overlaid in large, white, bold letters with a black outline at the top of the image.

PLEASE SIR

I WANT SOME MORE DATA

A small watermark "quickmeme.com" is visible in the bottom right corner of the image.

QUESTIONS??



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