Refining Drilling Waste Compliance Option Calculations for Salts and DSTs: A Collaborative PTAC Project

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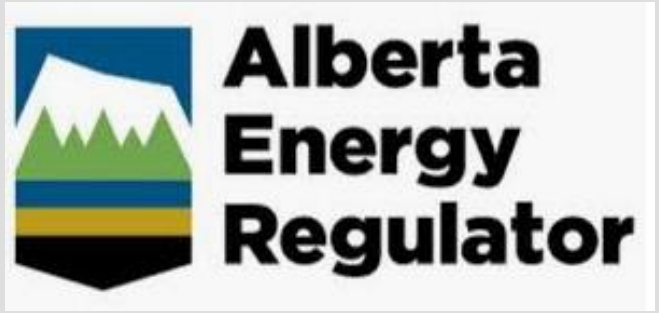
PETROLEUM
TECHNOLOGY
ALLIANCE
CANADA


cenovus
ENERGY


Canadian Natural


Husky


Alberta
Energy
Regulator


Orphan Well
Association

Stage 1 Evaluation Focus: Compliance Option 2

- Revise accuracy of PHC, Salinity and Drill Stem Test (DST) assumptions
- Pre-November 1, 2012 disposals
- During the PH2, the disposal area must be identified and characterized for PHC and salinity

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Data Sorting / Statistics

		Phase 1 ESA Condition or Calculation Trigger	
		PASS	FAIL
Phase 2 ESA Exceeds Tier 1 or D50 (1996 Version)	PASS	CORRECT	FALSE NEGATIVE
	FAIL	FALSE POSITIVE	CORRECT

Table 5: Predictor Rating Categories

Predictor Rating Category	% of Accurate Predictions	% of Inaccurate Predictions
Very Poor	<20%	>80%
Poor	20-40%	60-80%
Fair	40-60%	40-60%
Good	60-80%	20-40%
Very Good	>80%	<20%

- Spud Date
- Well Depth

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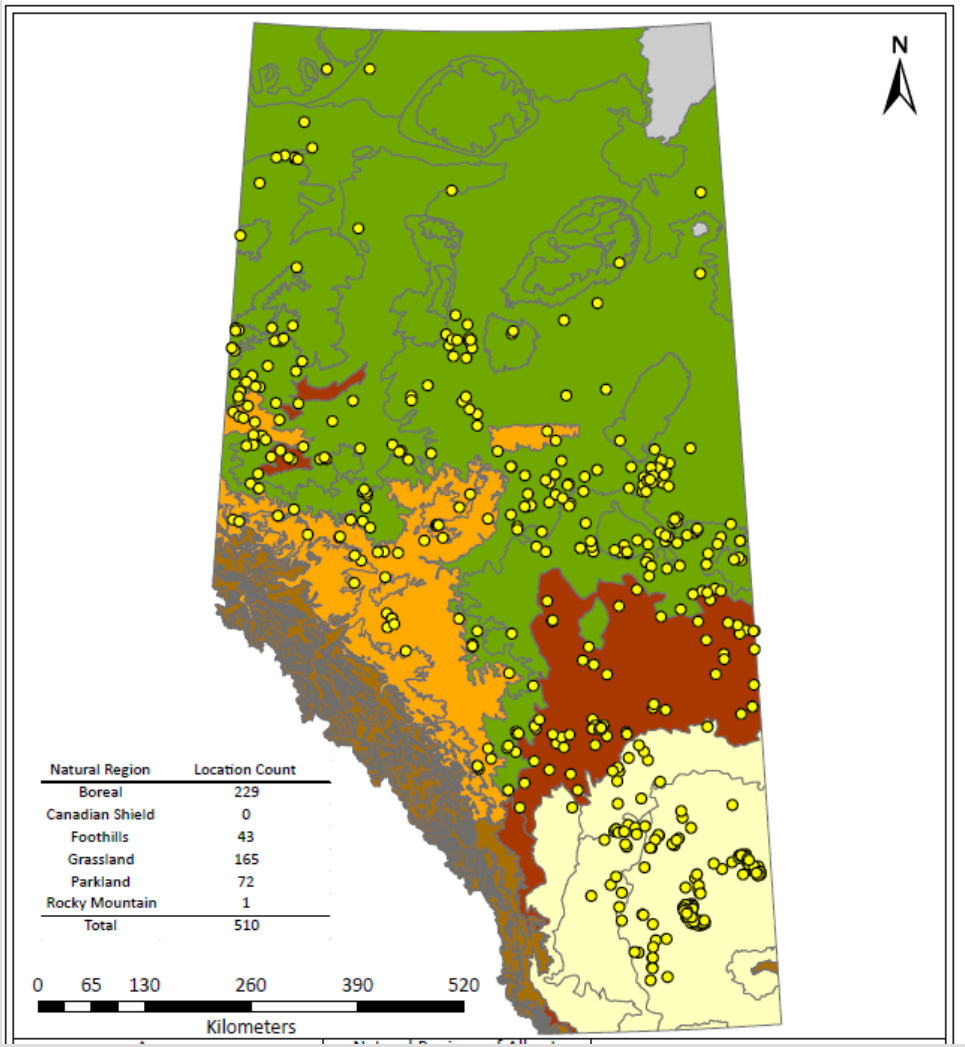
Total Number of Sites Reviewed	Total Number of Candidate Sites Identified
1681	510



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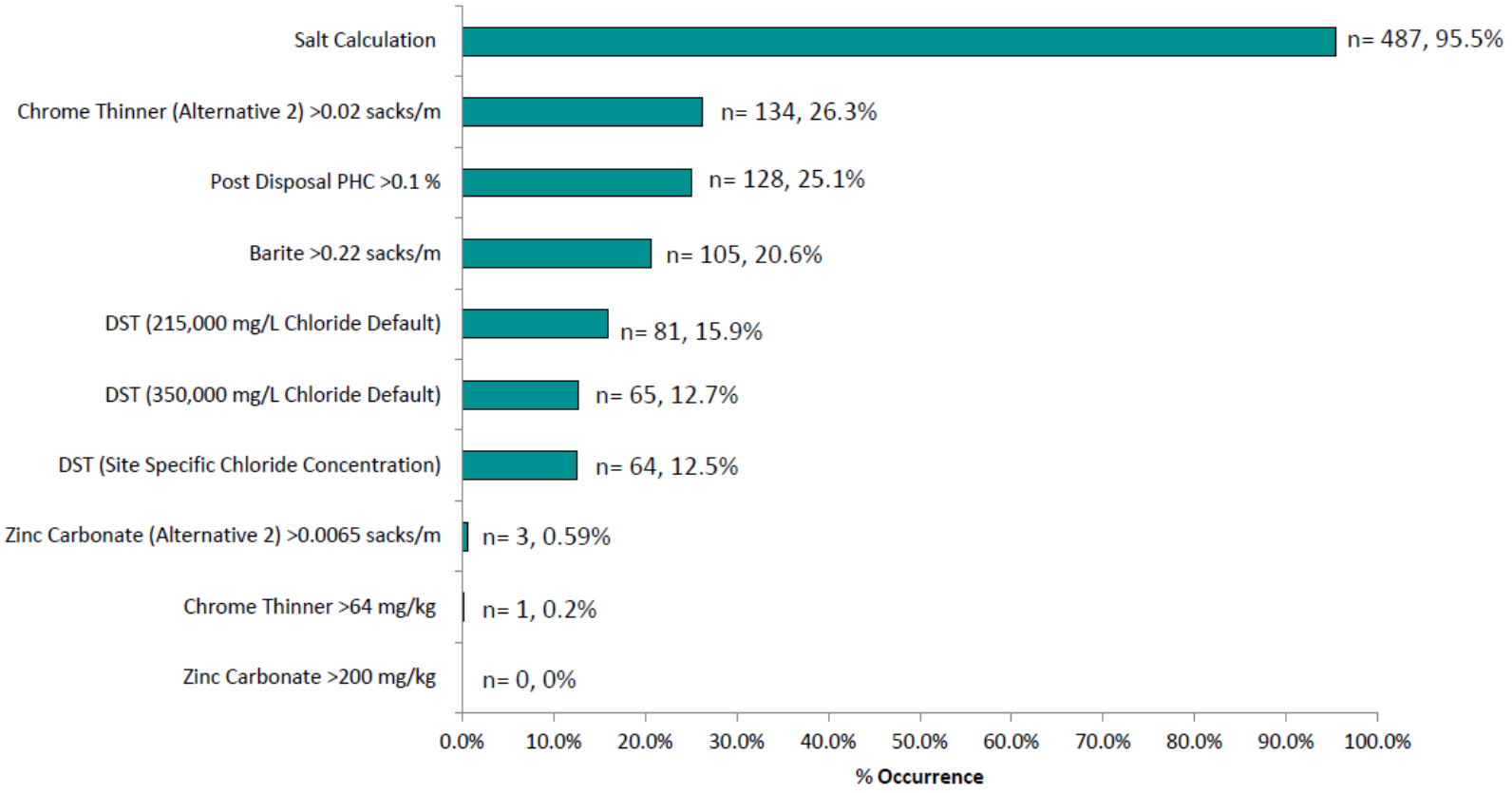
Graph 4: All Calculation Triggers - % Occurrence



Note: % Occurrence includes all sites where the calculations were completed (both passing and failing CO_2 endpoints)

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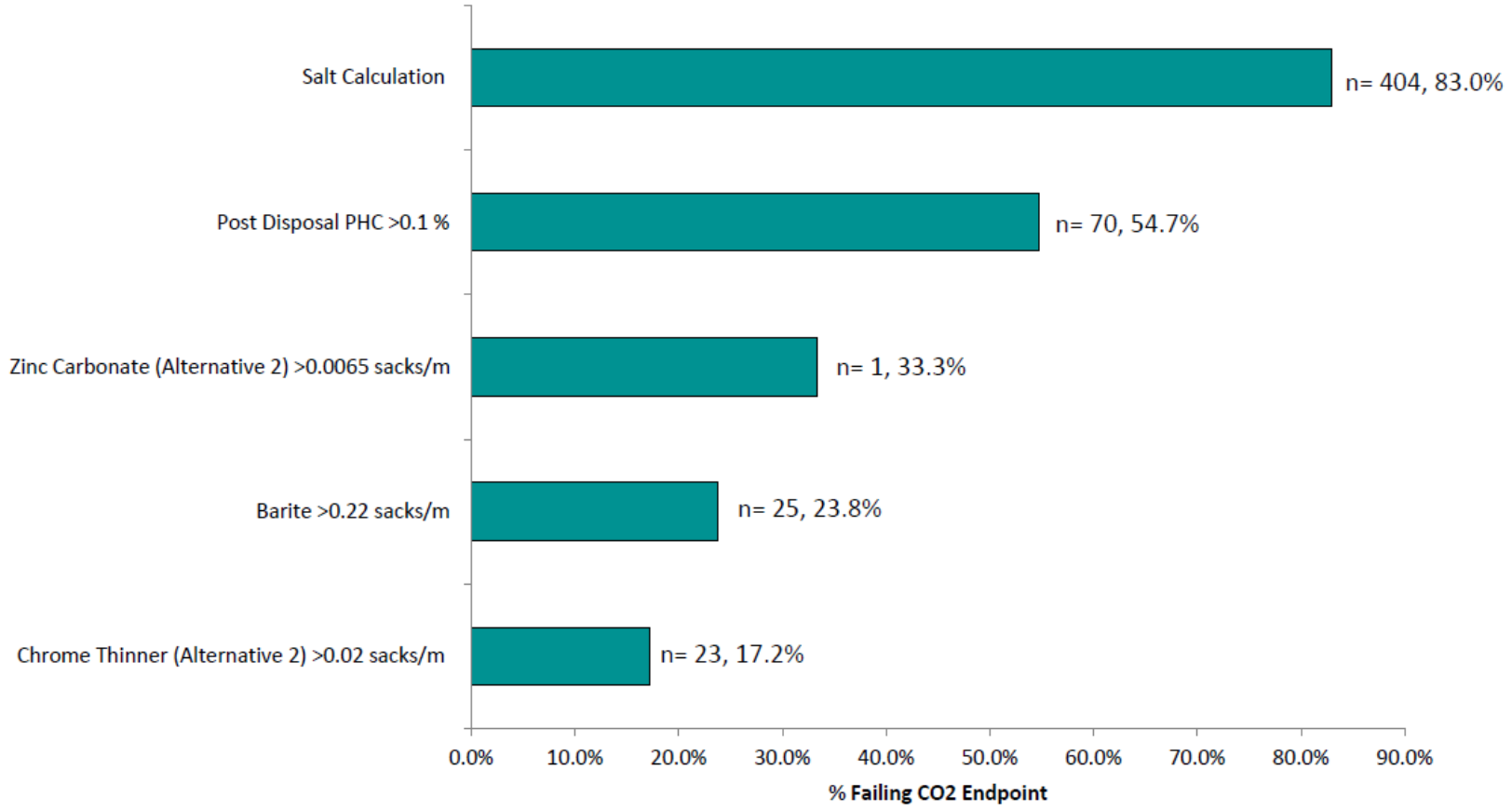
Graph 5: All Calculation Triggers - % Failing CO2 Endpoint



Note: %of sites Failing the CO2 Endpoint was calculated per total occurrences of each trigger.

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Salt Calculation

Salt Calculation (Mud Products and DST Returns Combined)

Salt Calculation – Mud Products Only

Salt Calculation – DST Returns

- >50% contribution
- 0.1-40% contribution
- 41-60% contribution
- 61-80% contribution
- 80-100%+ contribution

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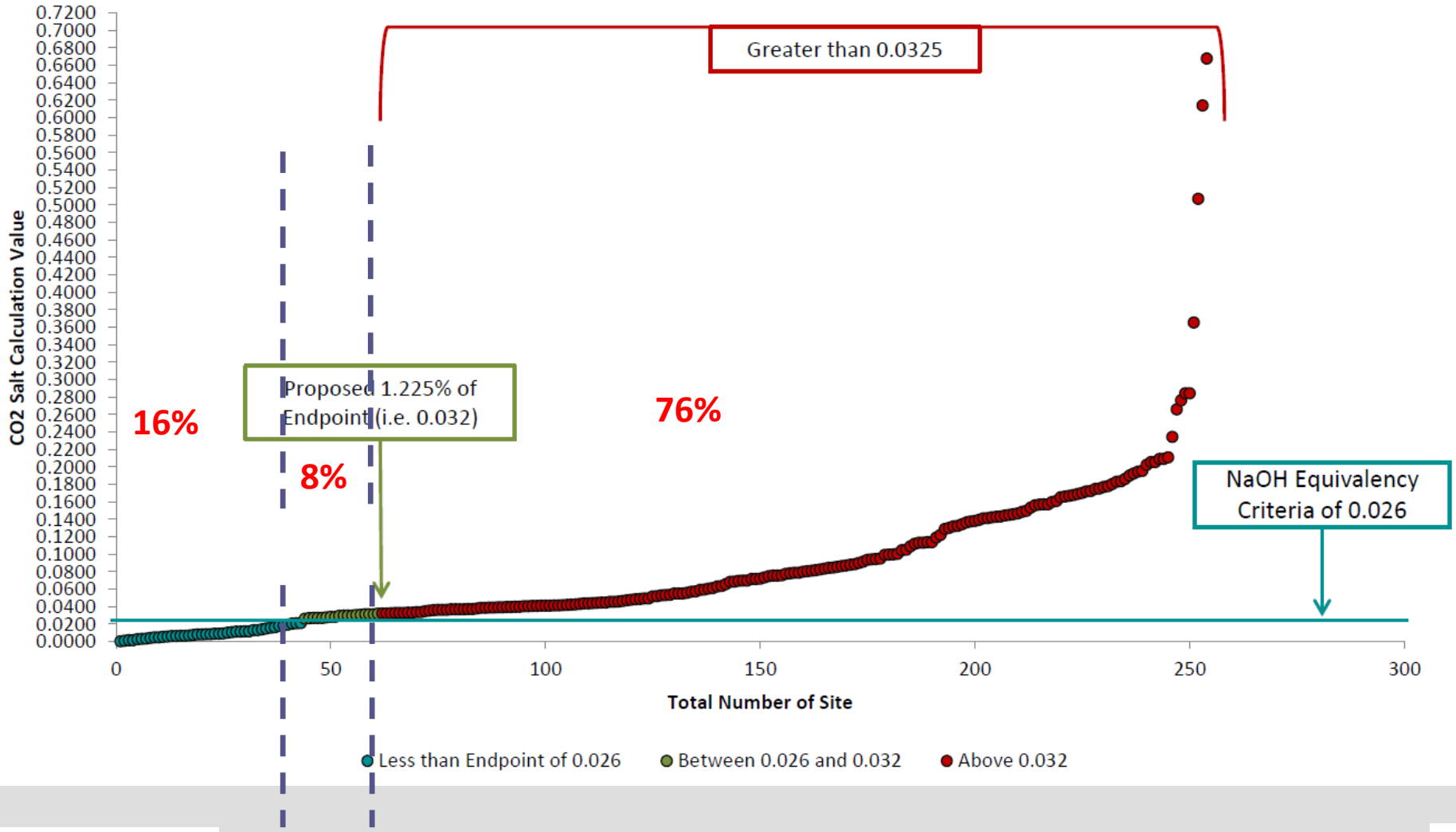
Graph 19: Salinity - CO2 Salt Calculation Values (Mud Additives Only) Divided by Different Endpoints



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Salt Calculation Overall

Compliance Option 2 – Salt Calculation and DST Returns	Recommendation	Clarification
Salt Calculation (Overall) Pre-October 22, 1996 Disposals	22.5% Increase Revise endpoint from 0.026 to 0.032	• Good Predictor Rating (77.3%) of Tier 1/D50 exceedances for sites that met CO2 endpoint of 0.026 • Fair Predictor Rating (40.5%) of Tier 1/D50 exceedances for sites that exceeded CO2 endpoint of 0.026 • A 22.5% endpoint increase was evaluated (0.026 x 1.225 = 0.032). Up to a 22.5% endpoint increase, a total of 27 sites that originally required a DWDA audit using the current D50 criteria fell into the CO2 salt calculation endpoint of 0.026 to 0.032. Of those sites, only a 14.8% Tier 1 exceedance rate was noted (n=5), suggesting the endpoint could be raised while still maintaining the same level of protection. • CO2 endpoint of 0.026 is based on increasing background EC by 2.0 dS/m. The revised endpoint of 0.032 would be based on raising the background EC by 2.5 dS/m.

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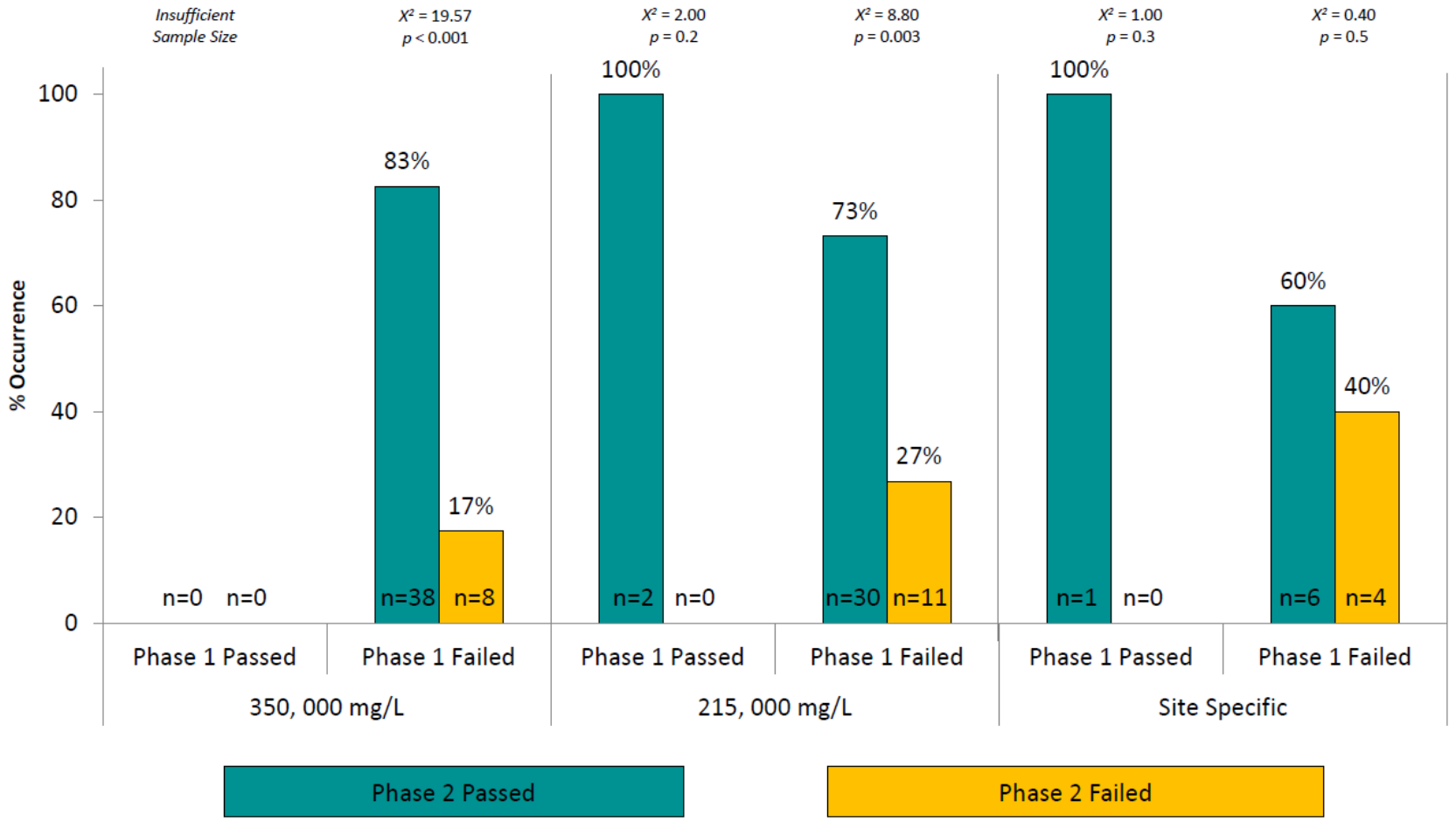
Graph 20: Salinity – DST Contribution (>50%) to CO2 Salt Calculation Compared to Phase 2 EC Outcomes (Pre-Oct 22, 1996)



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DSTs – Default Chloride Concentration 215,000 mg/L	Adopt township boundary chloride concentrations (Technical Memorandum: Default Chloride Inputs for Compliance Option Calculations. Waterline March 2022; see Appendix A)	• Historic chloride concentration default of 350,000 mg/L (Jan 2007 – July 2012) exhibited a Very Poor Predictor Rating (17%) of Tier 1/D50 exceedances for sites that exceeded CO2 endpoint (where DSTs contributed >50% to endpoint). • Chloride concentration default of 215,000 mg/L exhibited a Poor Predictor Rating (27%) of Tier 1/D50 exceedances for sites that exceeded CO2 endpoint (where DSTs contributed >50% to endpoint). • As the current default chloride concentration is set at 215,000 mg/L, this value represents a significant level of conservatism.

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Evaluation of AER provided DST water chemistry results:

- ~60,000 digital records provided (other PDF records available)
- 46,224 of those had chloride results
- 26,295 unique locations, multiple DSTs at some locations
- Joined to AER well dataset to obtain geographic location
- Interpolated over 4 M points across the province to view distribution of chloride results, taking maximum chloride at each geographic location
- Objective was to create a static map which can easily be incorporated and used

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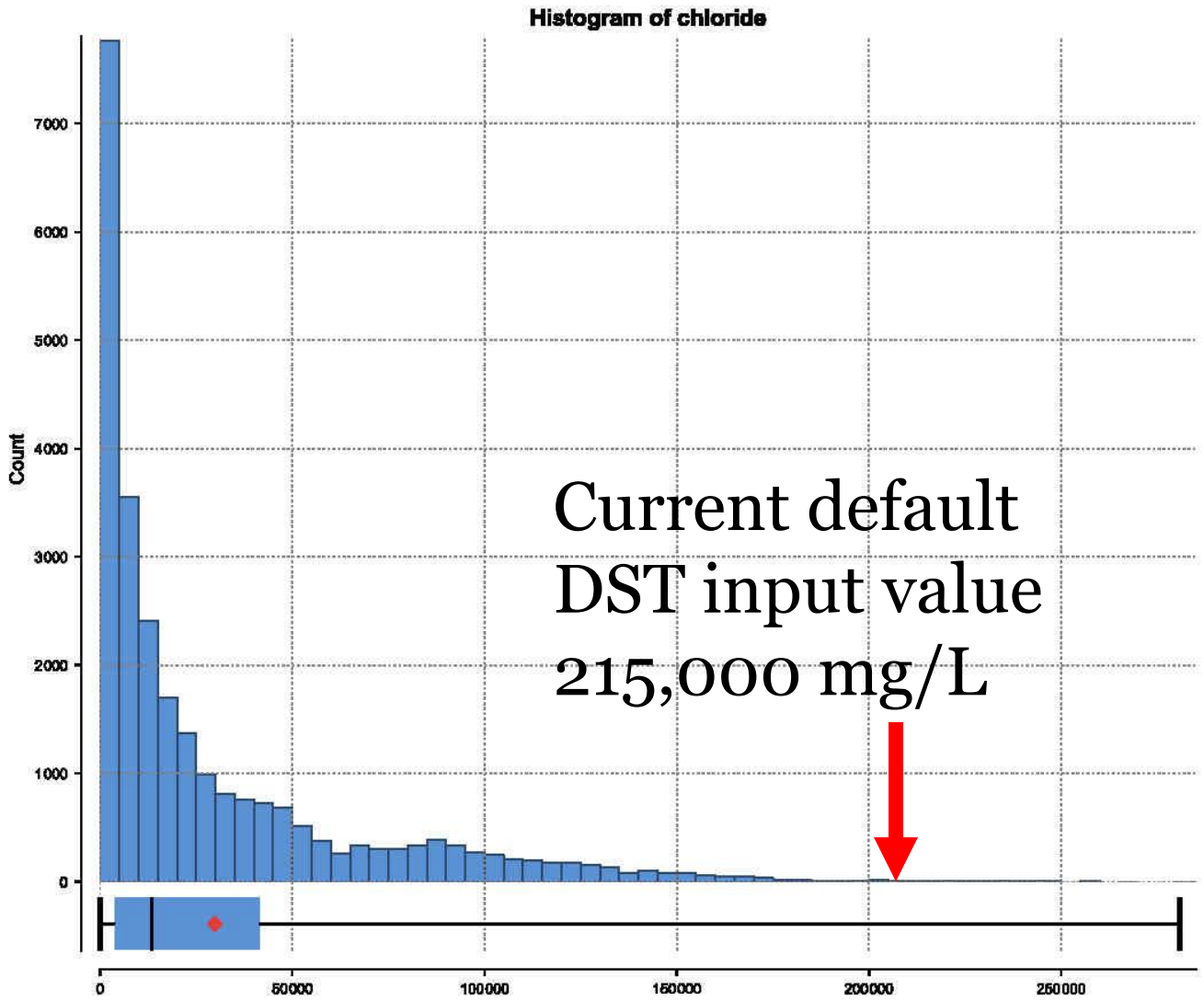

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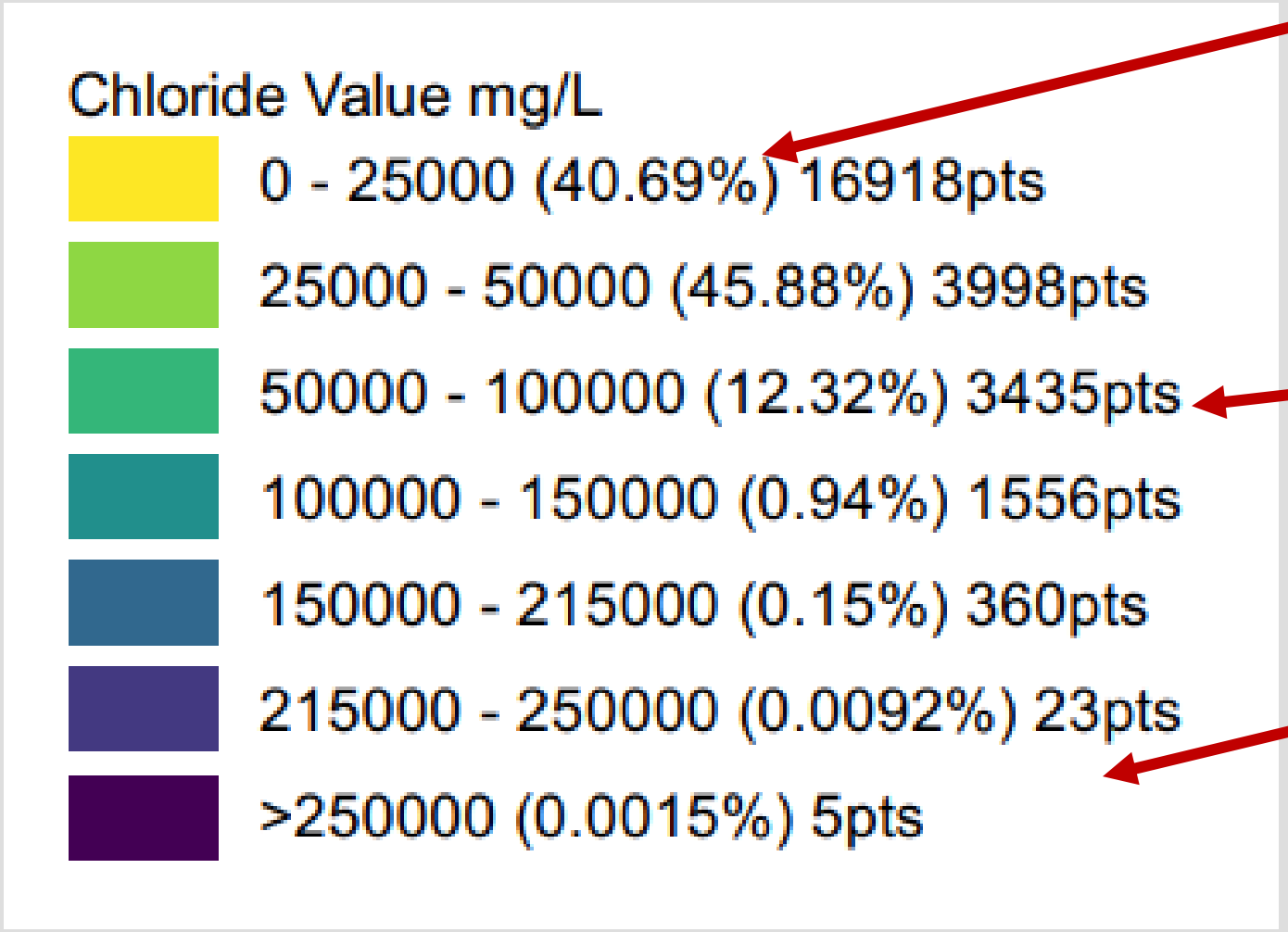
Distribution of Chloride Data:



% number represents the percentage of the 4,000,000 interpolation points that fall within this chloride concentration range

number of DST results that fall within this chloride concentration range

Only 28 total points are greater than the current DST default input value of 215,000 mg/L

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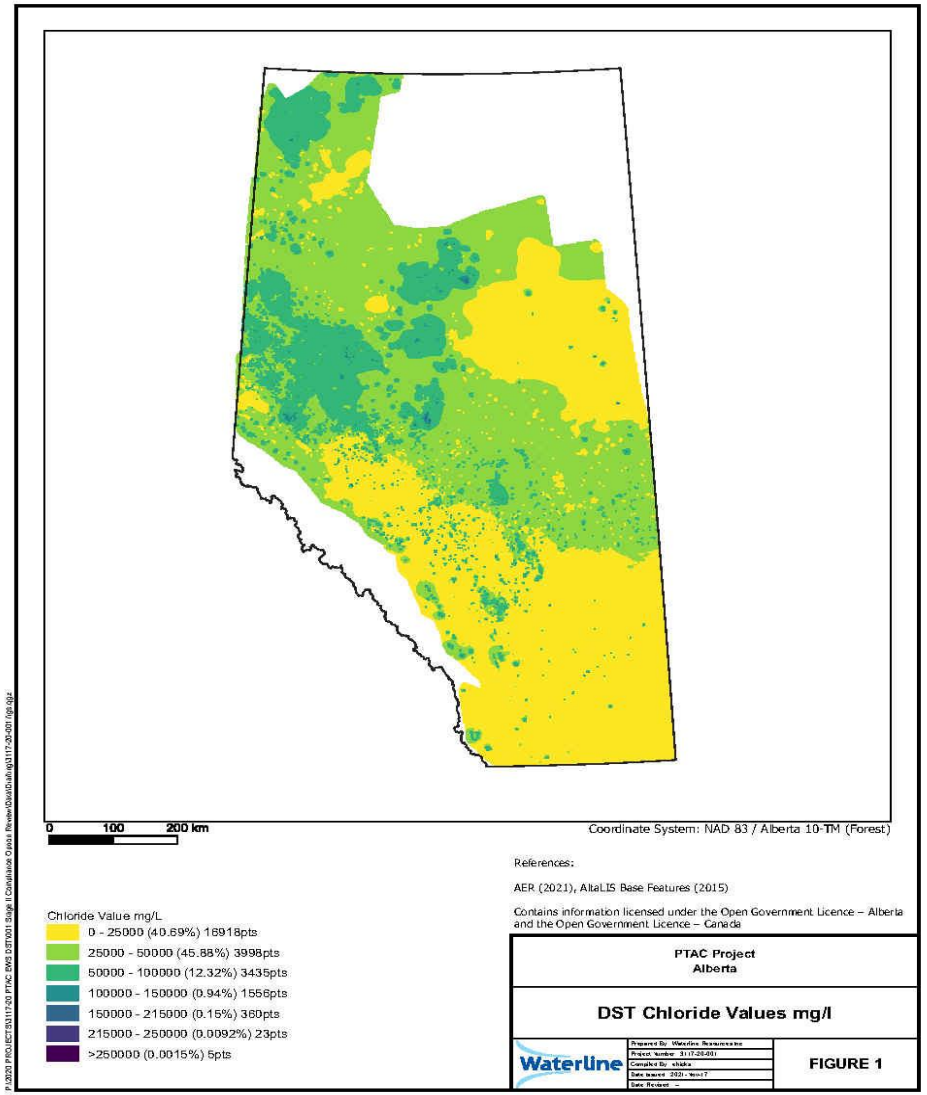

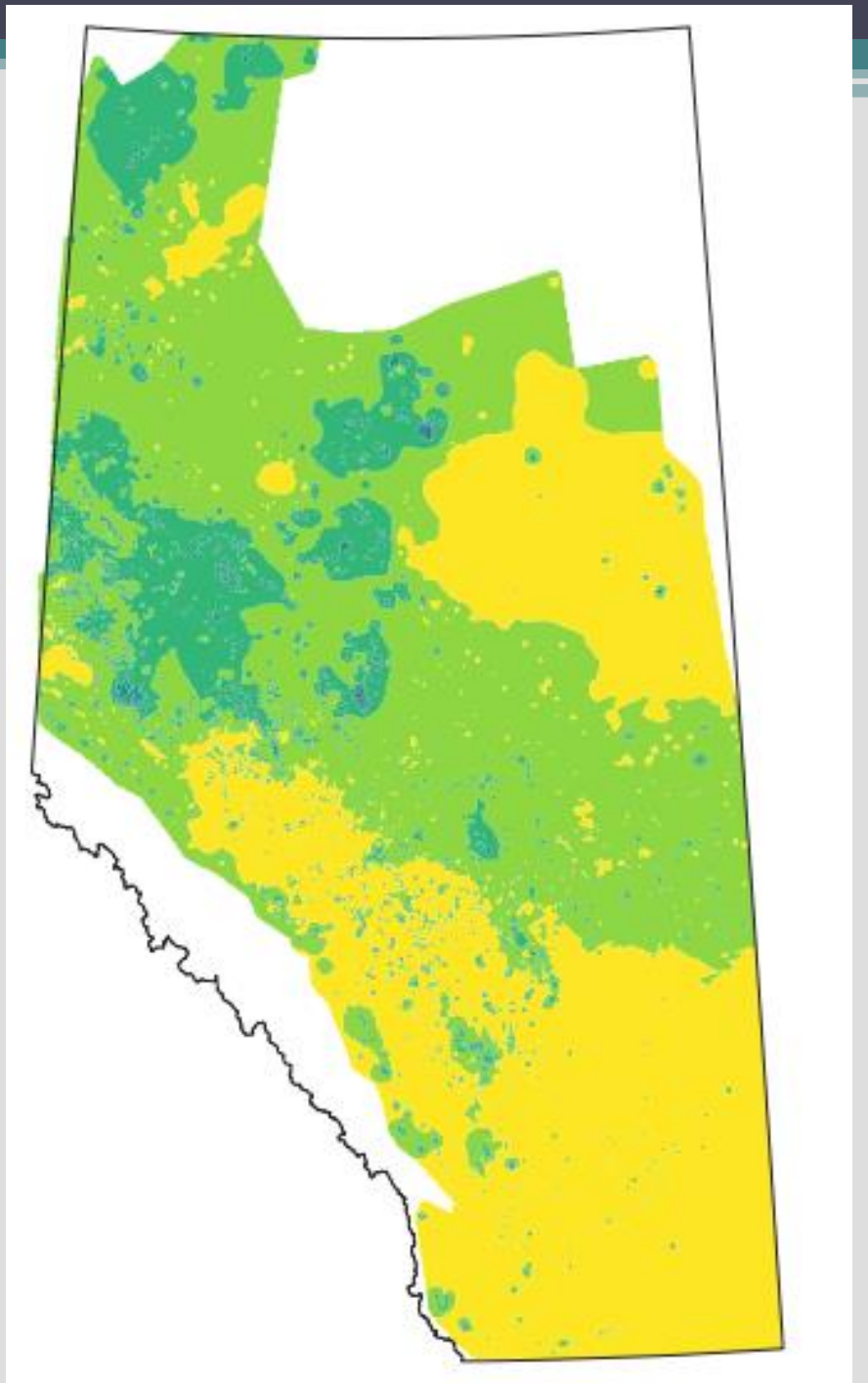

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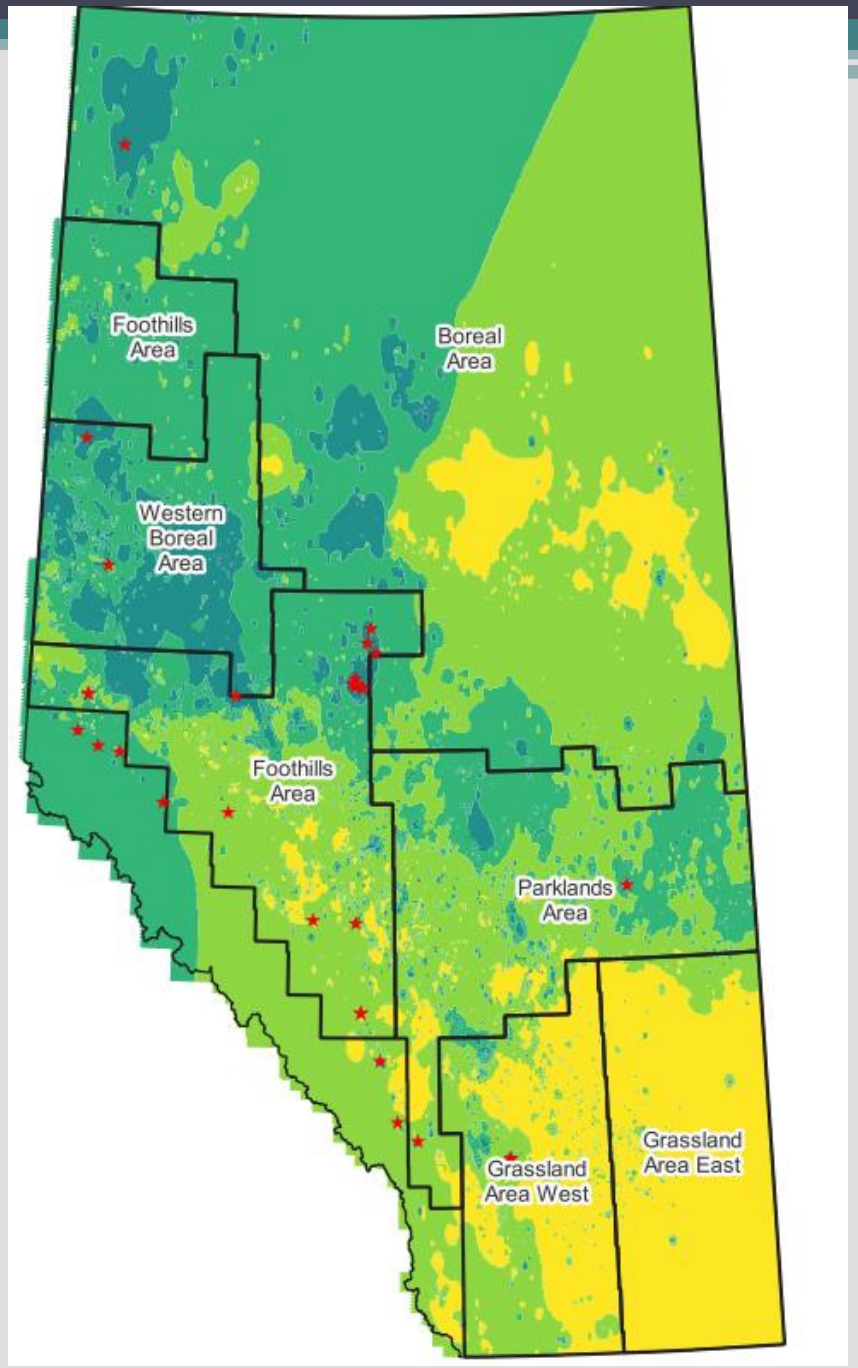
For interest, the red stars represent the 28 locations where the chloride in the DST sample was greater than 215,000 mg/L

The boundaries are the Directive 6 reclamation cost areas



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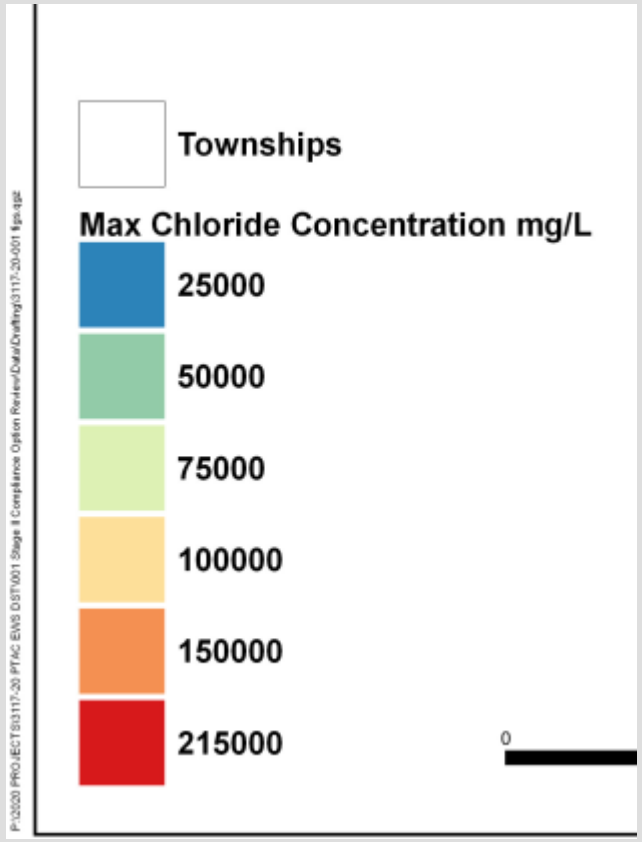

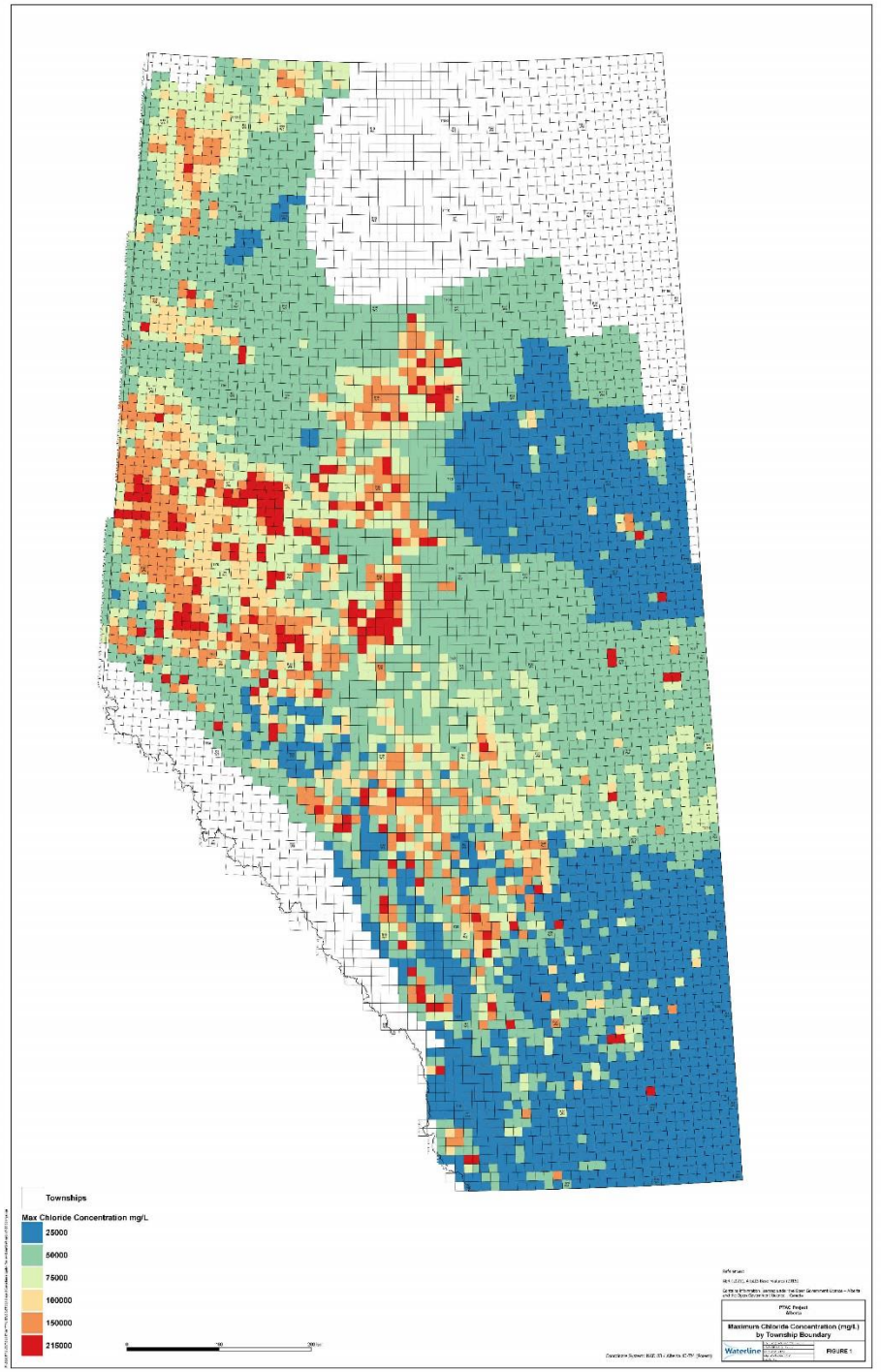

Decided on using a simple maximum chloride approach per Township/ Range and created this static map.

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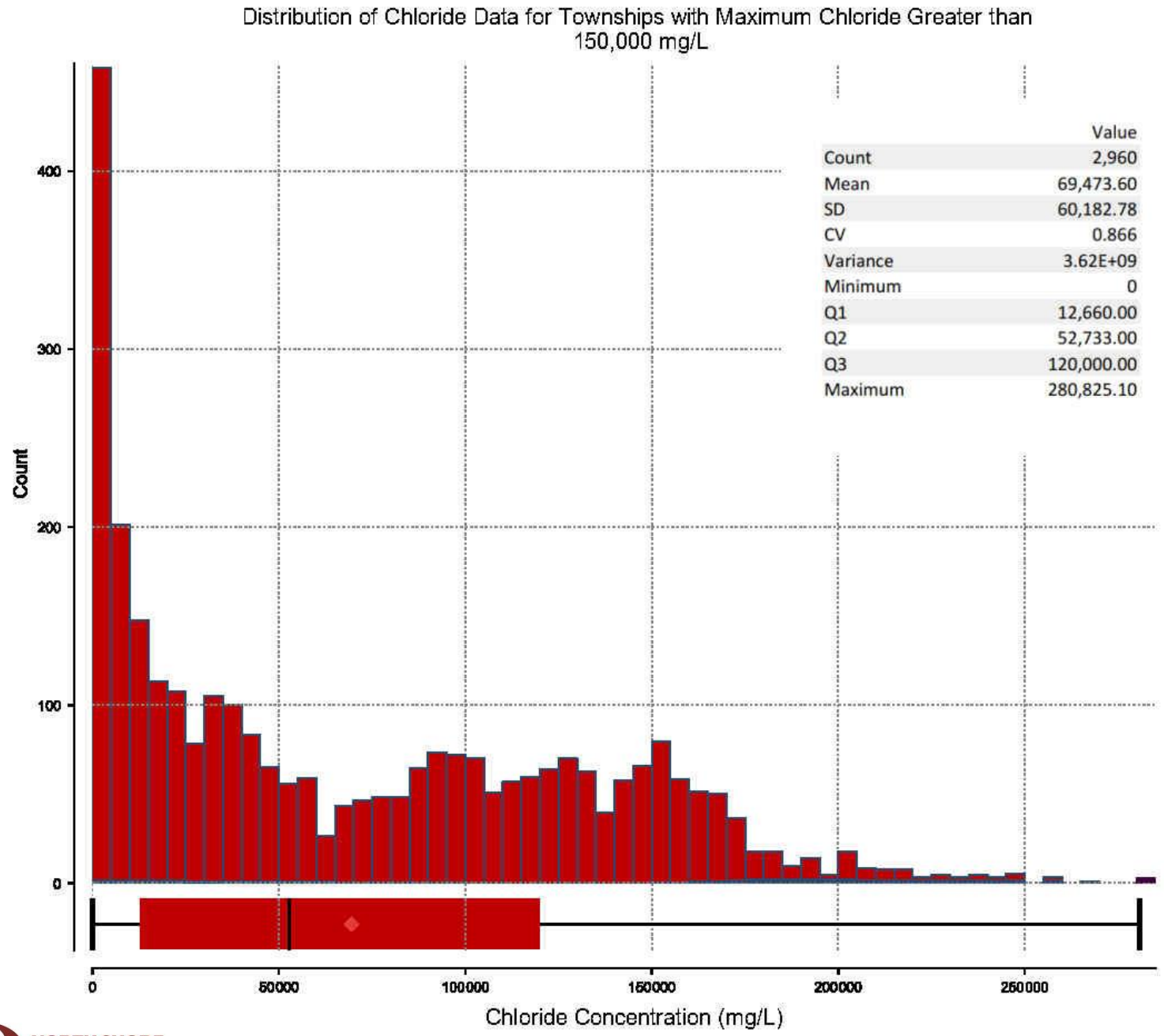

This data corresponds to Township/Ranges with a default value of 215,000 mg/L.

Significant conservatism built into approach.

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Implications of Proposed Changes: Salt Calculation

- Represents ~5% of sites which would not require a Phase 2 ESA
- Provides the same level of protection

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Implications of Proposed Changes: Default DST Chloride Concentration

- Represents ~12% of sites which would not require a Phase 2 ESA
- Increased level of calculation accuracy

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DETAILED METHODOLOGY

1. From PAS DST data provided by AER created a lookup table in PostgreSQL to be used to pair the PAS files with their associated UWI's
2. Added geometry to the lookup table using the Alberta wells layer
3. Loaded the PAS data for each UWI to the table
4. Updated any missing/inaccurate geometries using an updated copy of the Alberta wells layer
5. Extracted the chloride mg/L field from the PAS data and created a table with geometries, chloride and UWI's
6. Using PostgreSQL, identified the maximum value of chloride for each UWI and extracted to create a new table, removing the data points with multiple entries, and preserving the maximum recorded chloride at the site
7. Created a point layer from the reduced table in QGIS
8. Using the point layer created a surface of the chloride values across the province using the Inverse Distance Weighting (IDW) interpolation tool and a cell size of 200 m
9. Using a Concave Hull tool and the point file, created a boundary around the outer edge of the points to remove background noise and values that are extrapolated in areas where there are no points using a 0.1 degree buffer which is 11.1 km
10. Clipped the raster with the max chloride values using the Extract By Mask tool and the new boundary created with the Concave Hull
11. Using Zonal Statistics and the Township and Range grid, assigned the maximum chloride value in each township as the chloride value for the township
12. Created the category boxes and performed a dissolve on the boxes to create zones of each chloride value
13. Using Leapfrog, generated histograms of the points inside each category to check data validity and for additional information
14. Using the histograms, identified data points spatially located in each category with values over the maximum chloride value assigned to the township and corrected the chloride value for the township using the point information
15. Created new histograms of the dataset after the quality control process was completed
16. Created figures in QGIS to show the data distribution with the new boxes and the township and range grid

QUESTIONS??

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