

***Dust Suppressant Impacts During
Pipeline Construction –
Implementation of a RMP and MNA
Program in Jasper National Park***

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Introduction

- Kinder Morgan Canada completed pipeline expansion and construction activities at two yards north of the Jasper transfer station in 2007/2008
- Main Yard & Staging area lease from Parks Canada, cleared, and used for construction/equipment lay down areas
- Dust suppressant application in 2007



2008



Contaminant of Concern

- CaCl_2 - Dust suppressant
- ~31,000 L of brine solution at 32%
 - 27-28% CaCl_2
 - 3-4% NaCl & KCl
- Hygroscopic-attracts moisture

Regulatory Framework

- CCME applicable based on site within National Park and NEB regulation of pipeline
- Agricultural land use required by Parks Canada to account for protection of flora and fauna
- Soil guidelines for EC (2 dS/m), SAR (5), pH (6-8)
- Groundwater guidelines for DW (250mg/L) and FWAL (230/120 mg/L)

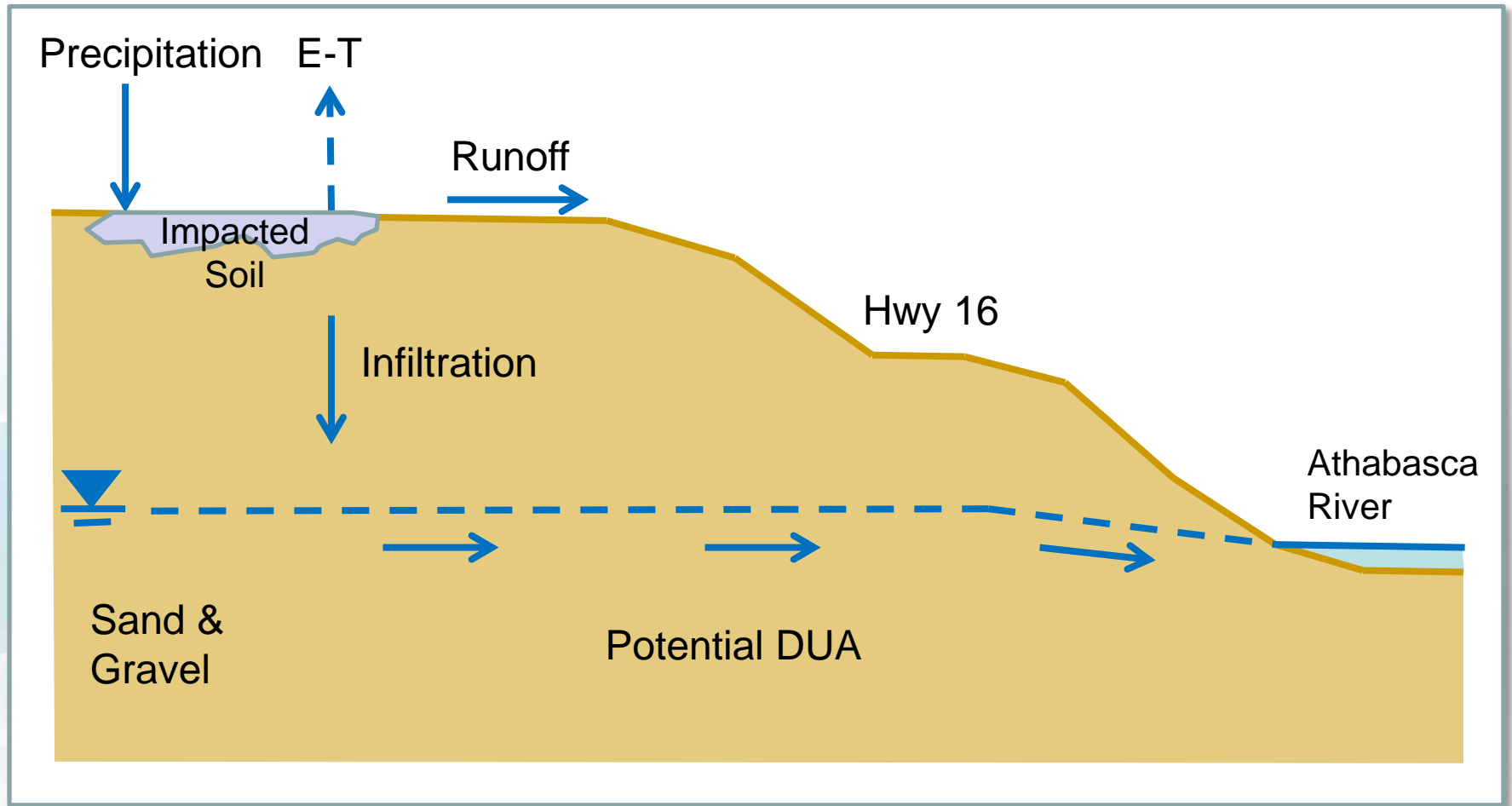
Initial 2009 Phase II ESA

- EC & SAR > CCME AG guidelines at Main Yard and Staging Area
- Max EC – 28.7 dS/m (background <1.0)
- Max SAR – 14.4 (background <2.5)
- Max chloride - 2,540 mg/kg (background (10-30))
- Estimated 16,000 m² area impacted up to maximum 1.5 m depth

Risk Management Plan

- Conceptual site model
- Contaminant transport model
- Surface runoff control
- Monitoring
 - EM survey
 - Soil monitoring
 - Groundwater monitoring
- Reclamation

Conceptual Site Model



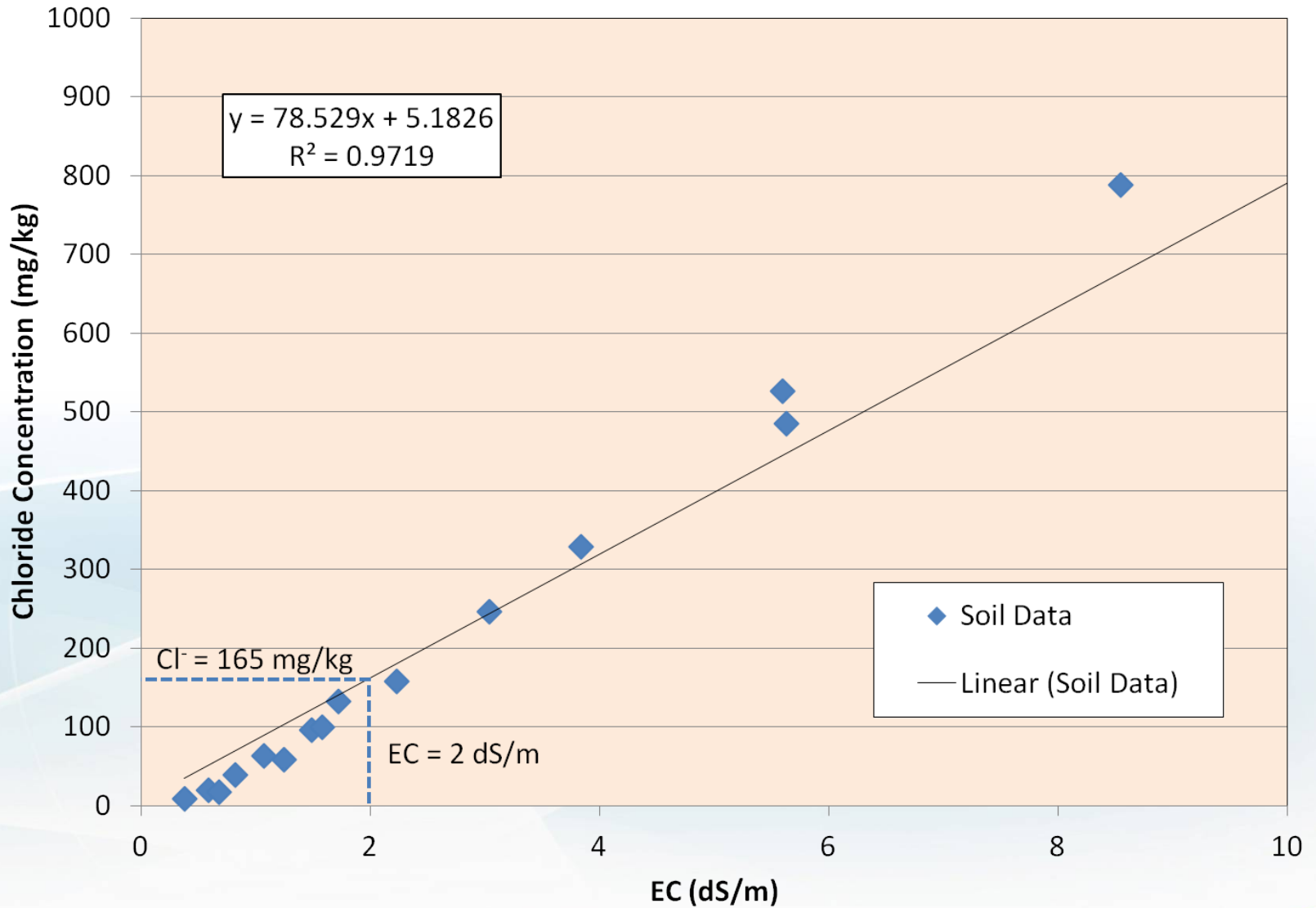
Contaminant Transport Modelling

- Objectives:
 - Model chloride behaviour in subsurface
 - Assess the mobility and behaviour of the chloride impacts at the two sites
 - Estimate potential chloride concentrations at the groundwater table in the future
 - Estimate the chloride concentrations in the soil in the rooting zone (upper 1 m) with time as a surrogate for EC

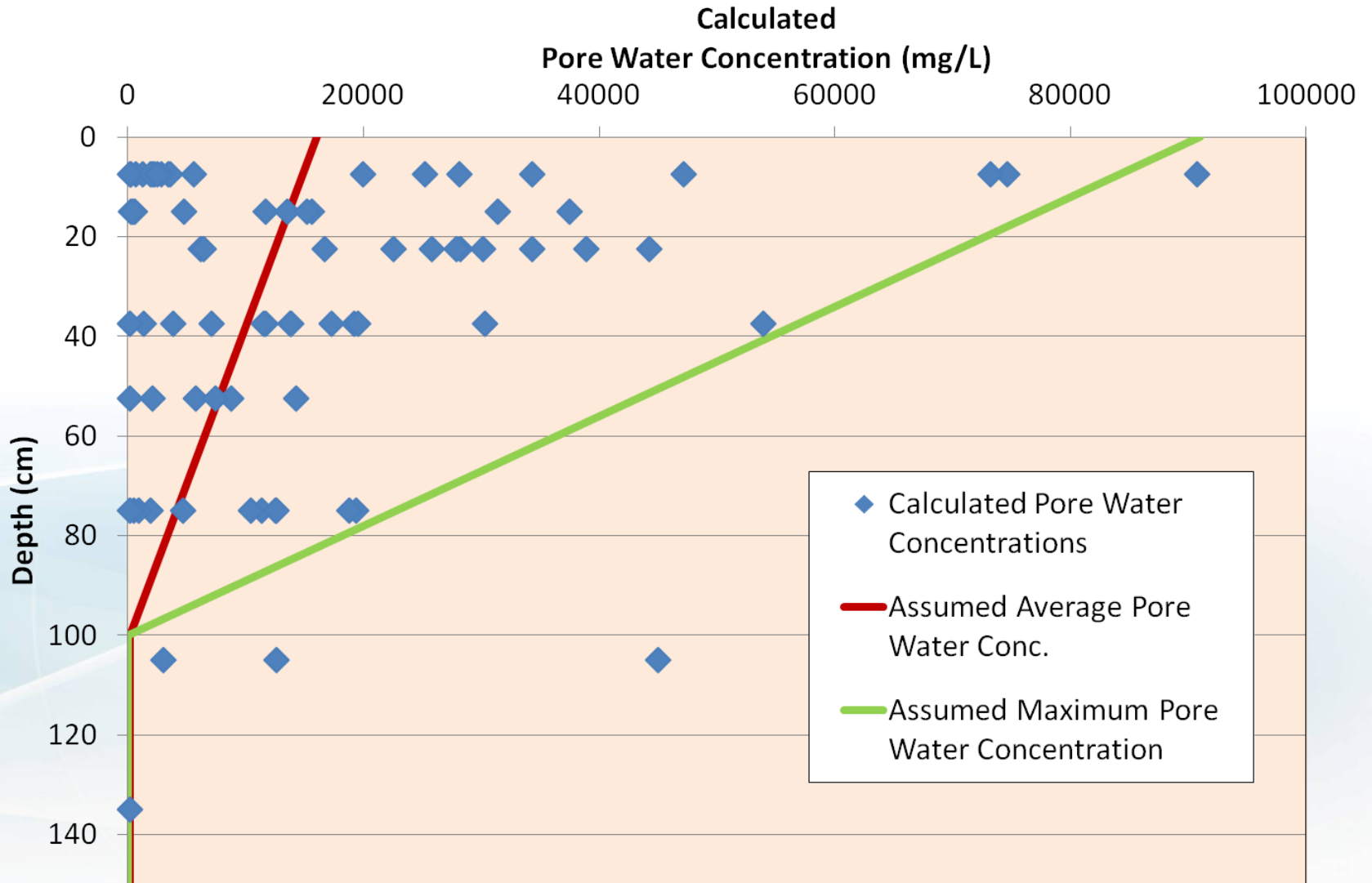
CT Modelling Methodology

- Used VS2DTI developed by USGS
- Simulates fluid flow and solute transport in saturated-unsaturated porous media using Richard's Equation
- Adopted a 1-dimensional model domain assuming vertical flow through unsaturated zone
- Estimate of soil water characteristic curve developed for SLR by SoilVision Systems Ltd.

Chloride Concentration as a Function of EC

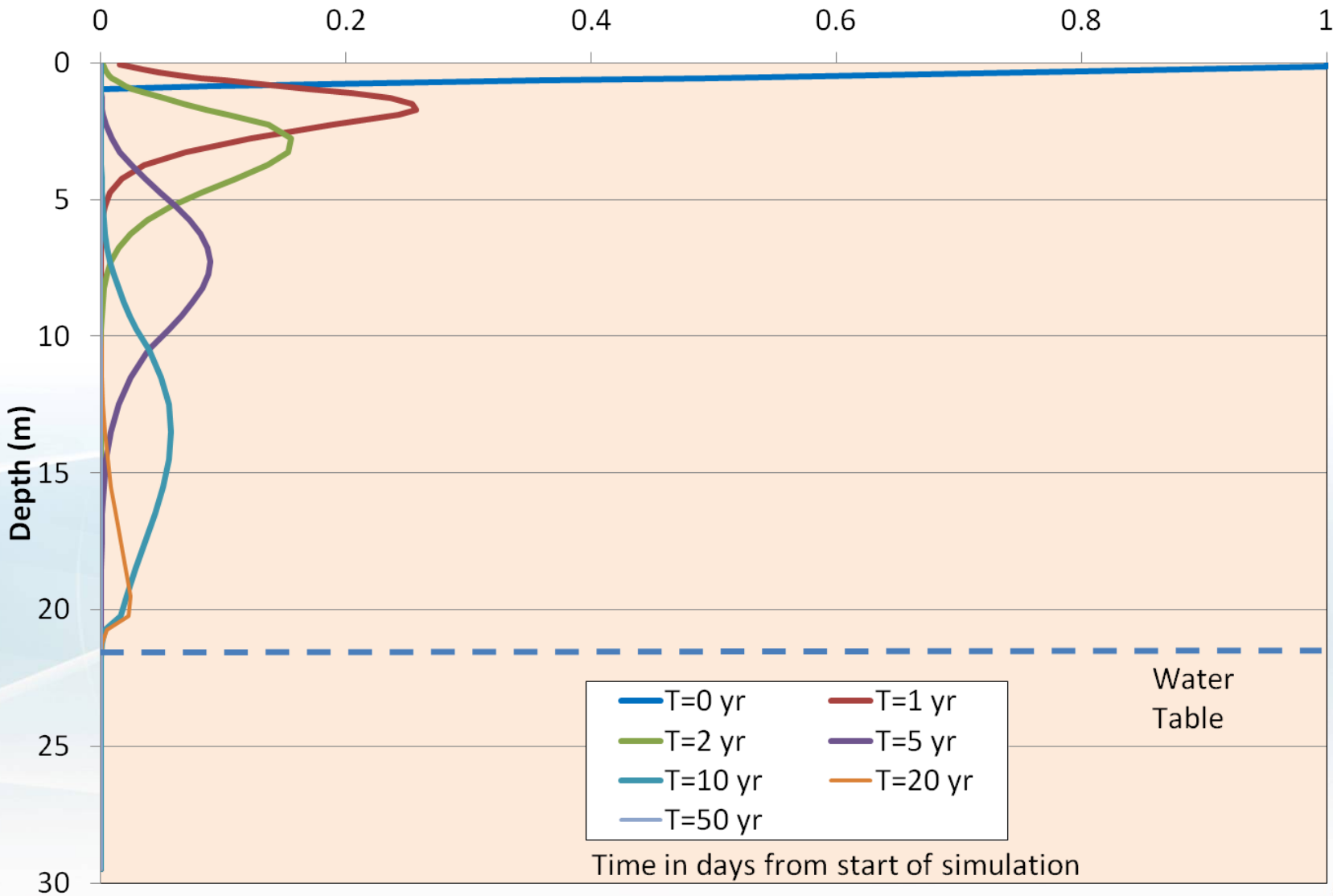


Initial Conditions



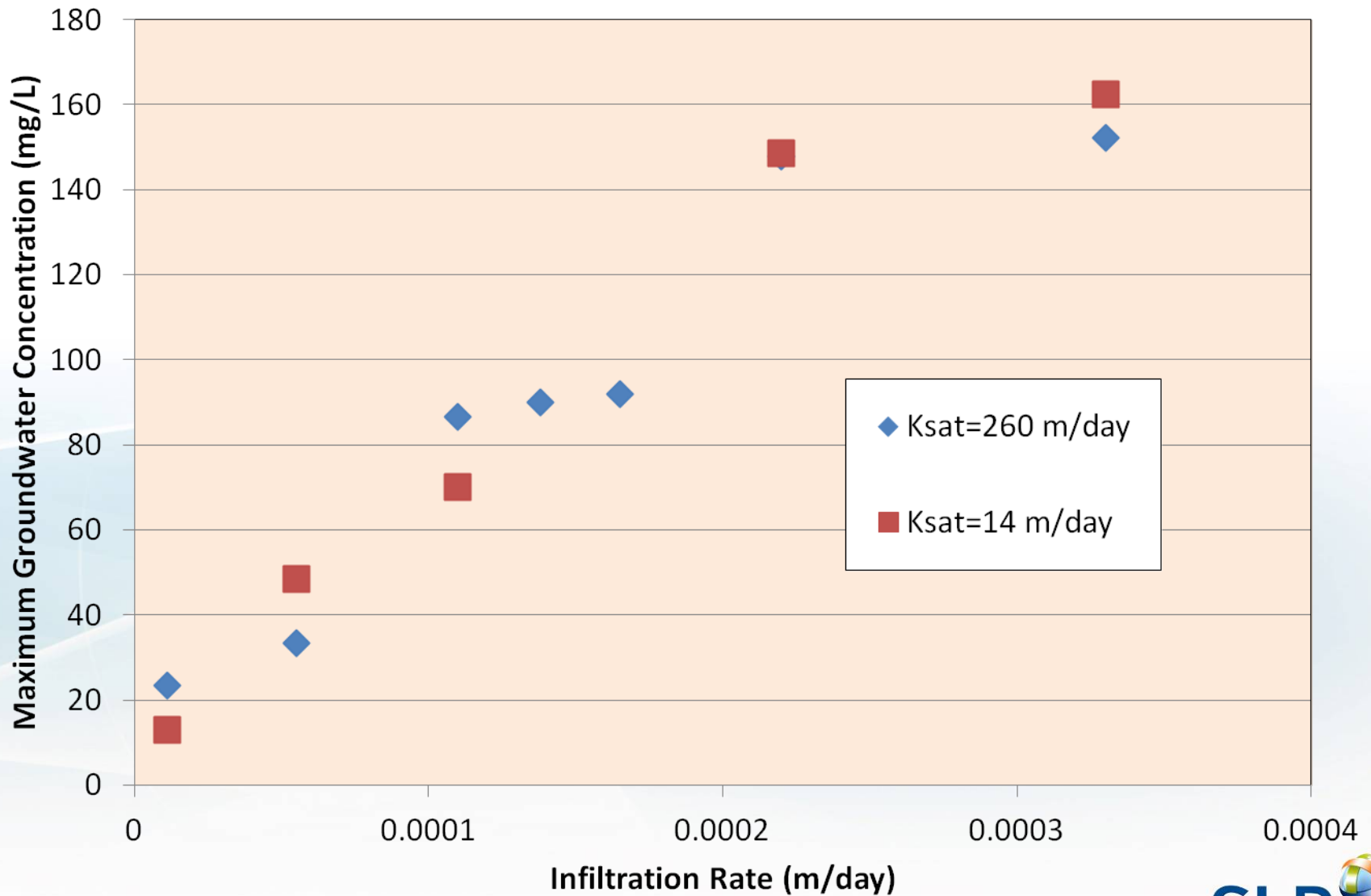
Example Model Output

C/C_0



Time in days from start of simulation

Estimated Groundwater Concentrations from Sensitivity Analysis



Model Conclusions

- EC in upper 1 m predicted to decrease below 2 dS/m within 5 years
- Predicted maximum chloride concentration at water table was 70 mg/L based on most realistic model inputs
- Time for peak concentration at water table estimated to be greater than 17 years for all likely scenarios assessed

Monitoring Program

- Objective to determine how well monitored natural attenuation is occurring
- Two methods used for temporal comparison to 2008-2009 initial results:
 - EM31 (5 m) /38 (1.5 m) survey – 2 more events
 - Soil and groundwater chemistry - 3 more events
 - Total of nine boreholes chosen for repeat assessment based initial 2008 EM survey and 2009 soil chemistry

Soil and Groundwater Monitoring

Soil

- Drilling locations chosen based on historic elevated soil chemistry and EM apparent conductivity
- 6 Borehole locations in Main Yard
- 3 Borehole locations in Staging Area
- Detailed salinity, 1:2 EC screening

Groundwater

- 8 wells in each of Main Yard and Staging Area for 2009-2011
- Reduced to 4 in each area for 2012 based on initial results confirming modelling results
- Wells already existing based on adjacent TMP pump station.
- Routine potability, Fe, Mn

Consistency is key

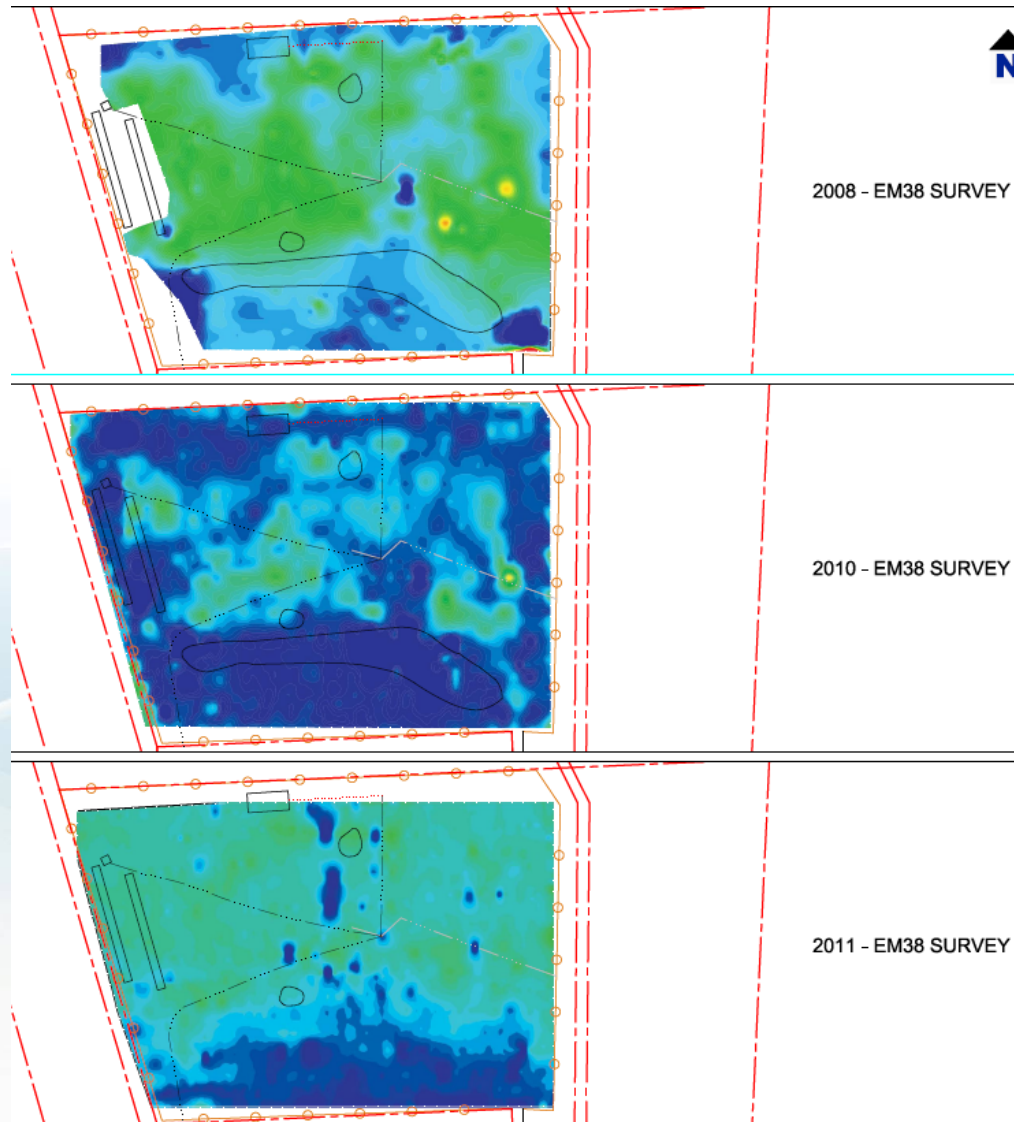
EM31/38

- 2008, 2010 and 2011 on both yards
- Datasets were calibrated & normalized with each set of previous result ranges to allow for a direct comparison of the temporal changes observed
- Based on decreases by 2011, was excluded from work in 2012

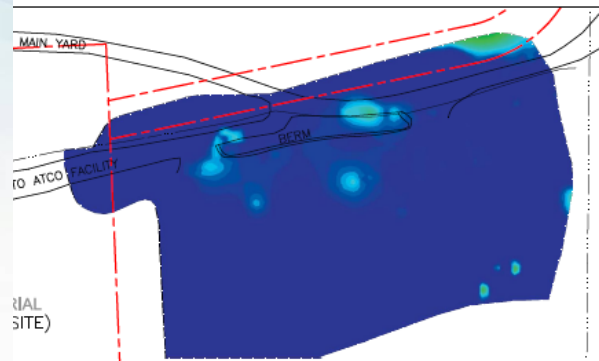
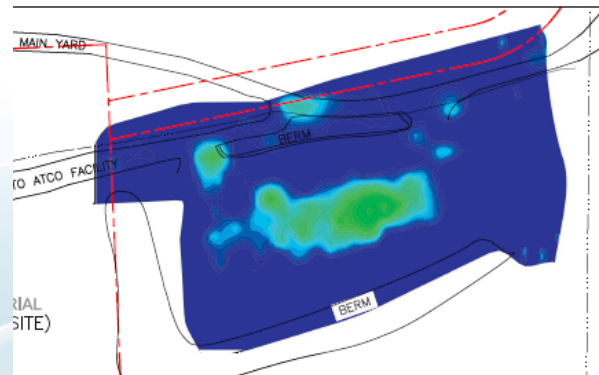
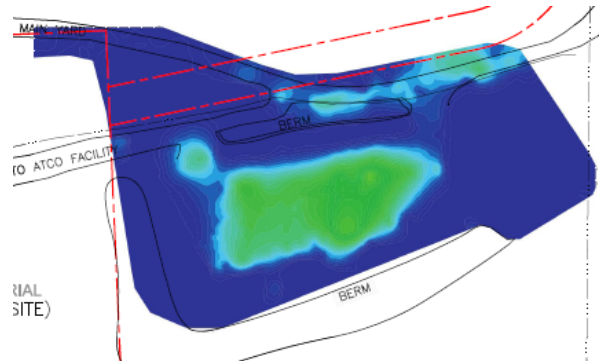
Soil Chemistry

- Direct push geoprobe rig used for accurate depth logging
- High accuracy GPS unit and borehole markers used to allow repeat drilling within 0.3 m radius of original borehole
- Timing of field work consistent each year

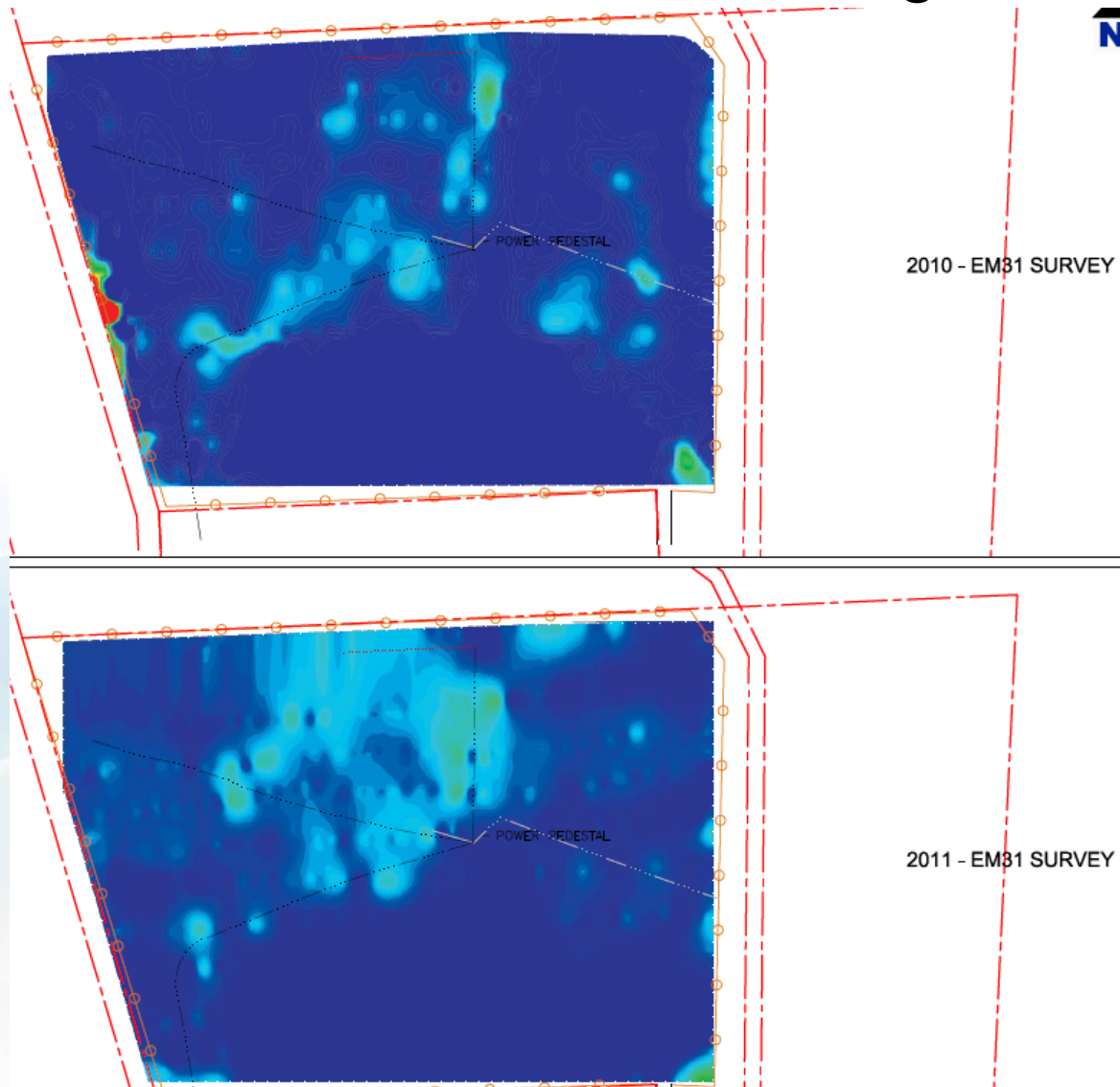
EM 38 –Main Yard Progress



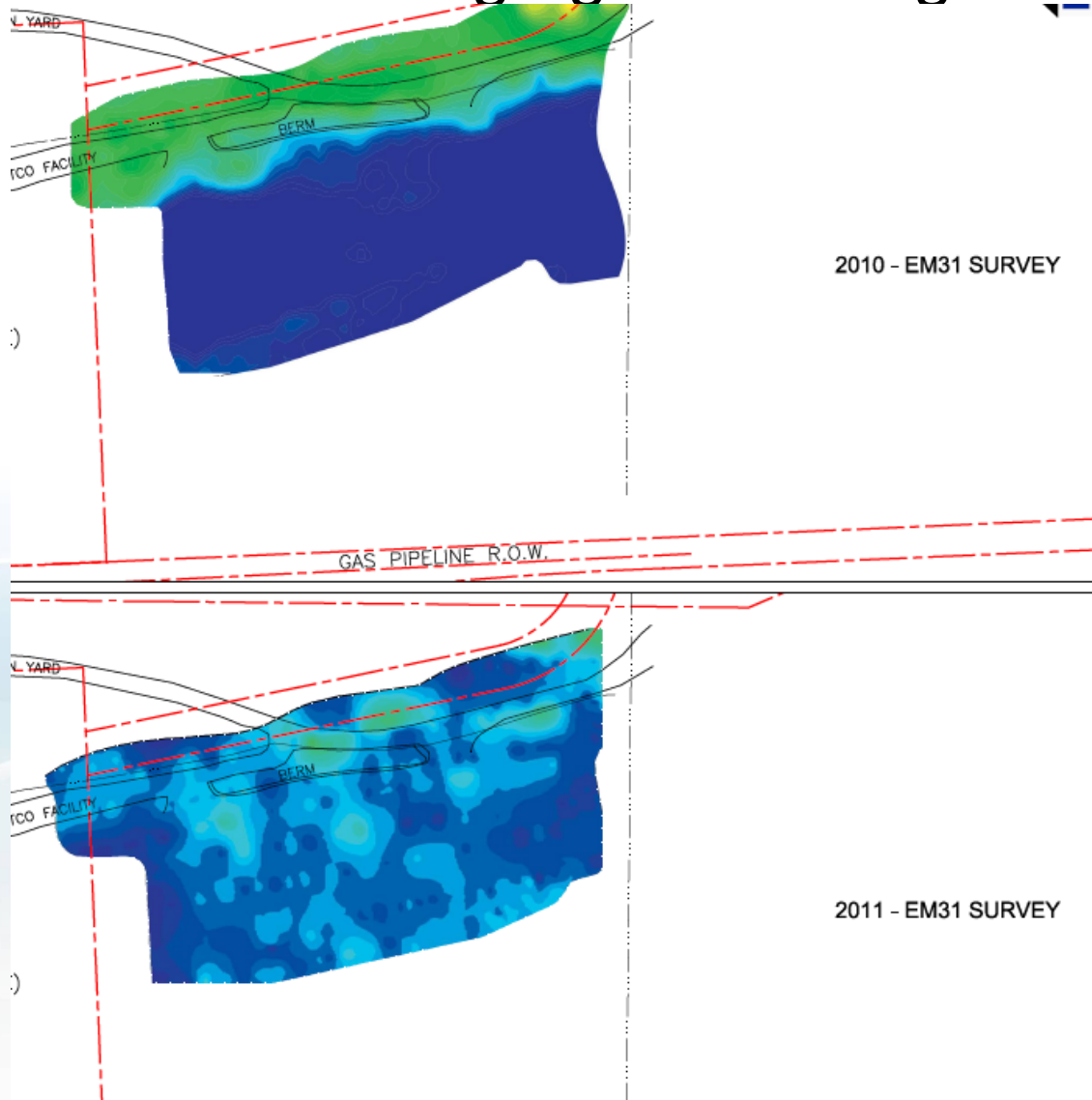
EM38 – Staging Area Progress



EM31 – Main Yard Progress



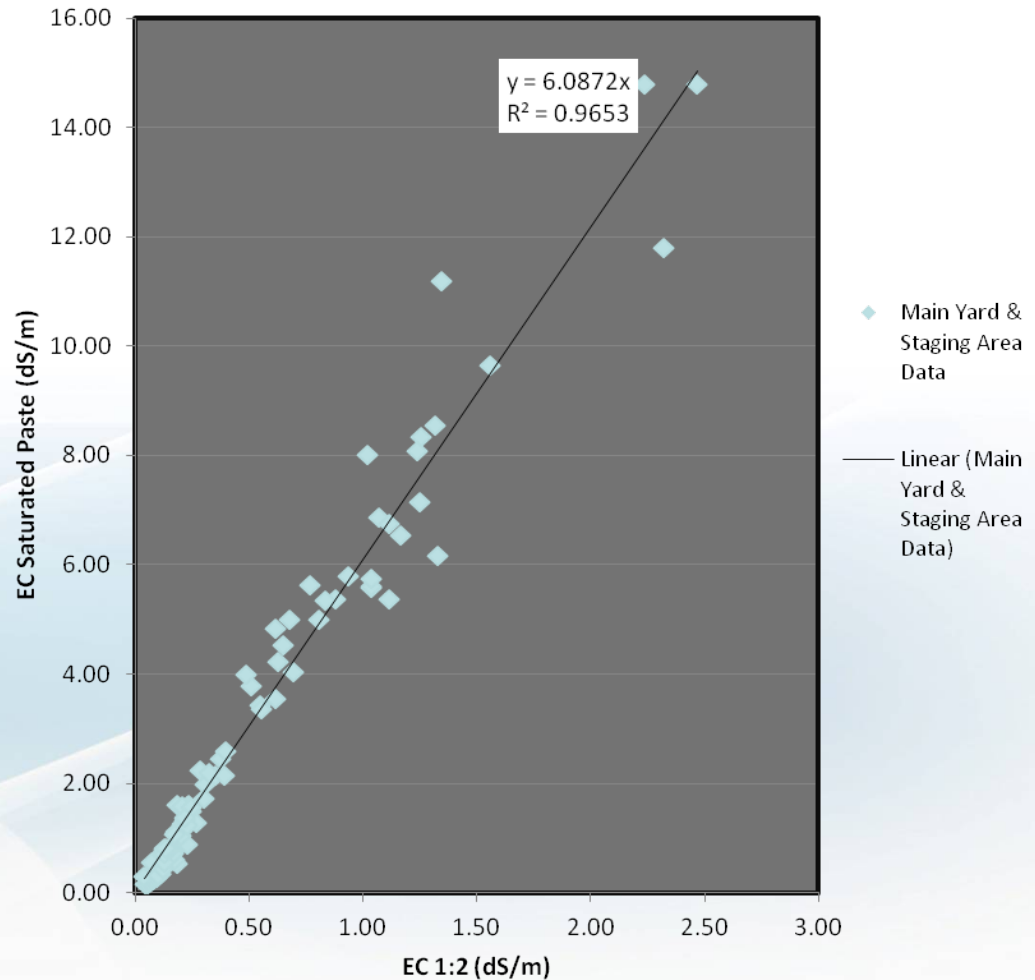
EM31- Staging Area Progress



Soil Evaluation

- Full borehole sampling length at each location for 1:2 EC screening
- Subsequent results used for full detailed salinity analyses to confirm saturated paste EC values
- Correlation of 1:2 EC and saturated paste results from over 100 sample points in both yards

Chart 1
Correlation of EC Laboratory Analytical Methods



EC Correlation Use

- Create vertical soil profiles from full borehole length of 1:2 EC and saturated paste EC results
- Correlation of EC with chloride ($R^2=0.97$) in the CTM report was indicative that the overall EC vertical soil can be used to comment on relative levels of chloride concentration changes over time

Chart 2

Temporal Changes in EC Concentration and Depth - BH107

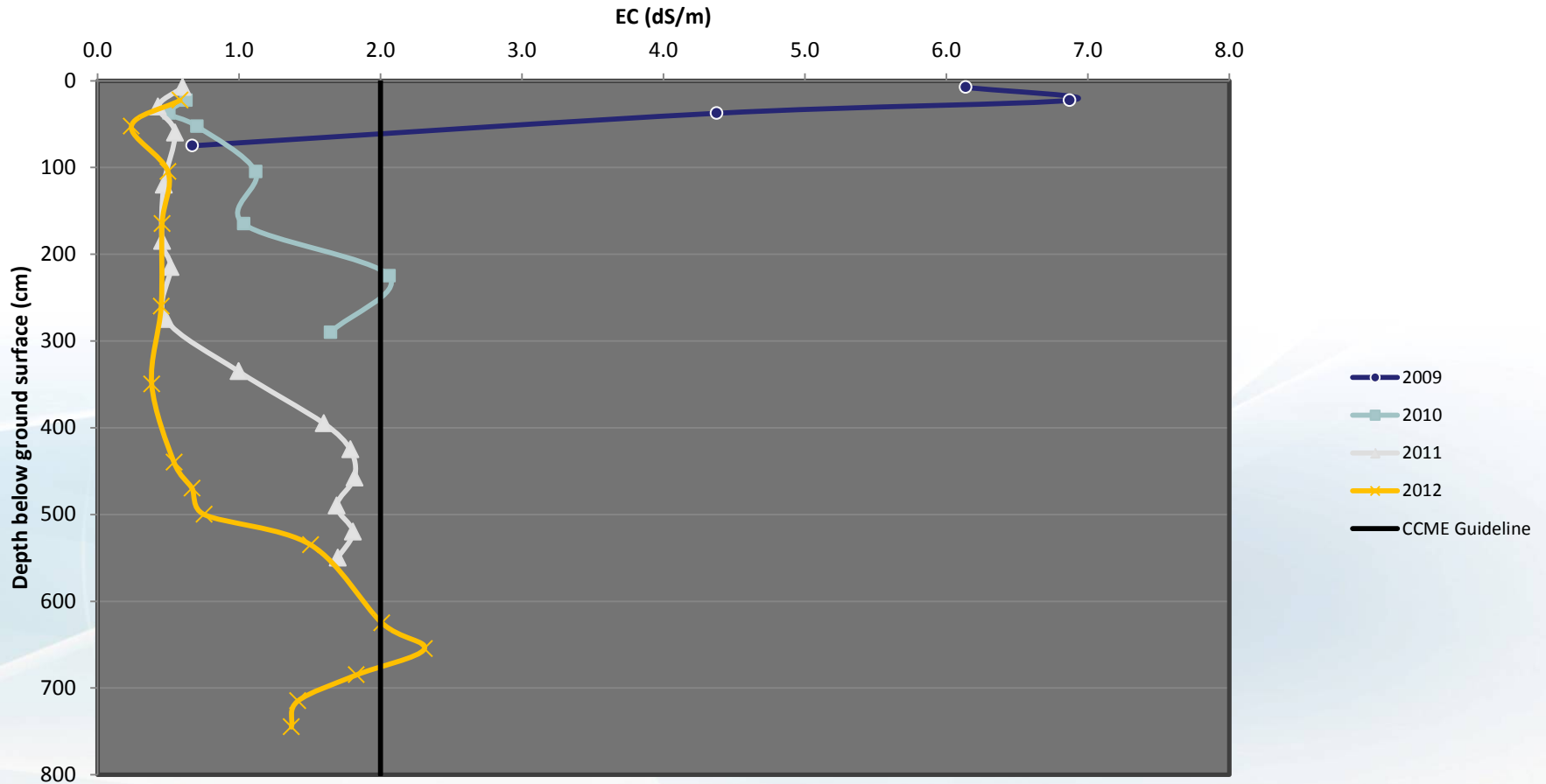


Chart 6

Temporal Changes in EC Concentration and Depth - BH128

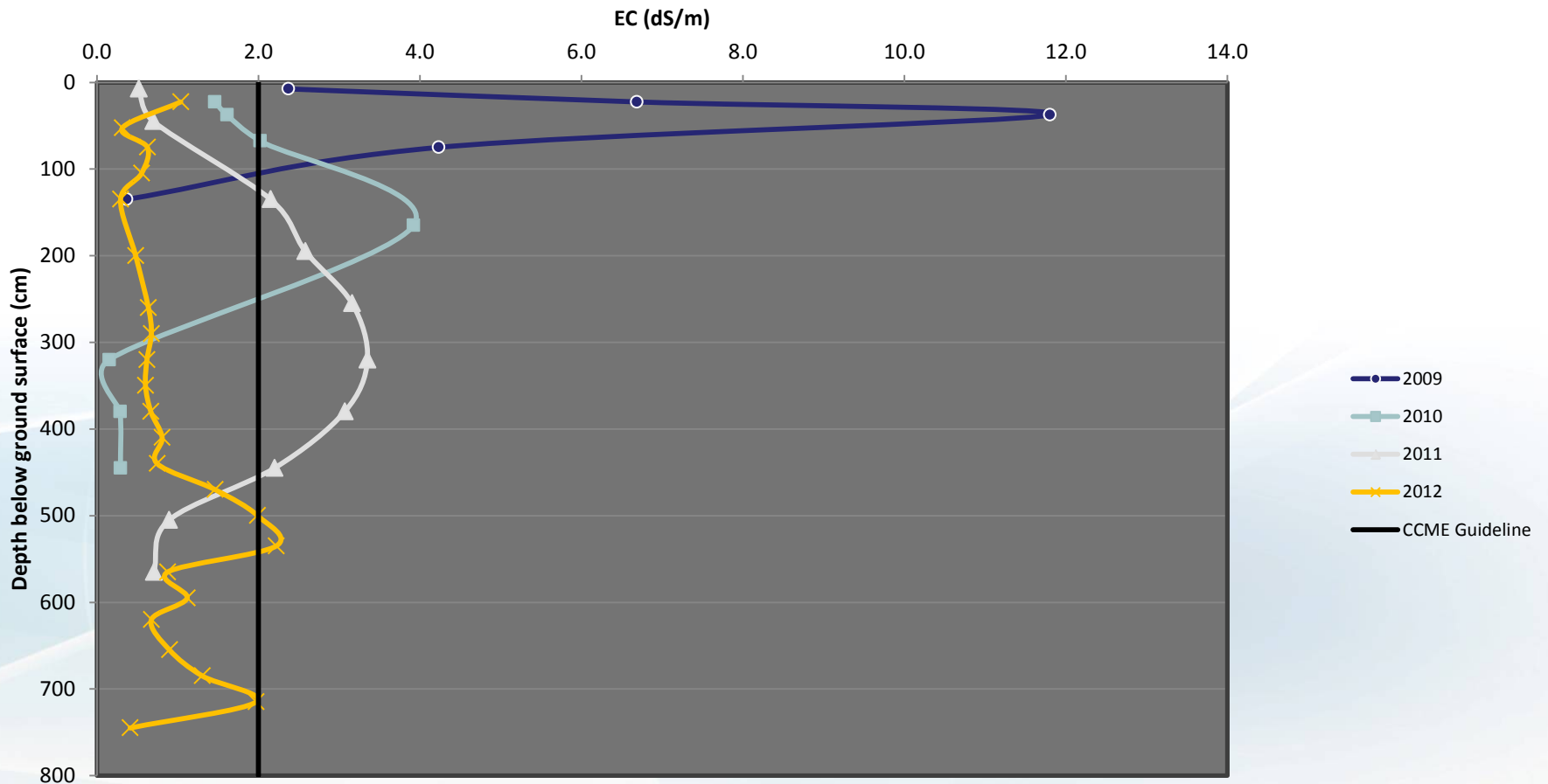


Chart 9

Temporal Changes in EC Concentration and Depth - BH211

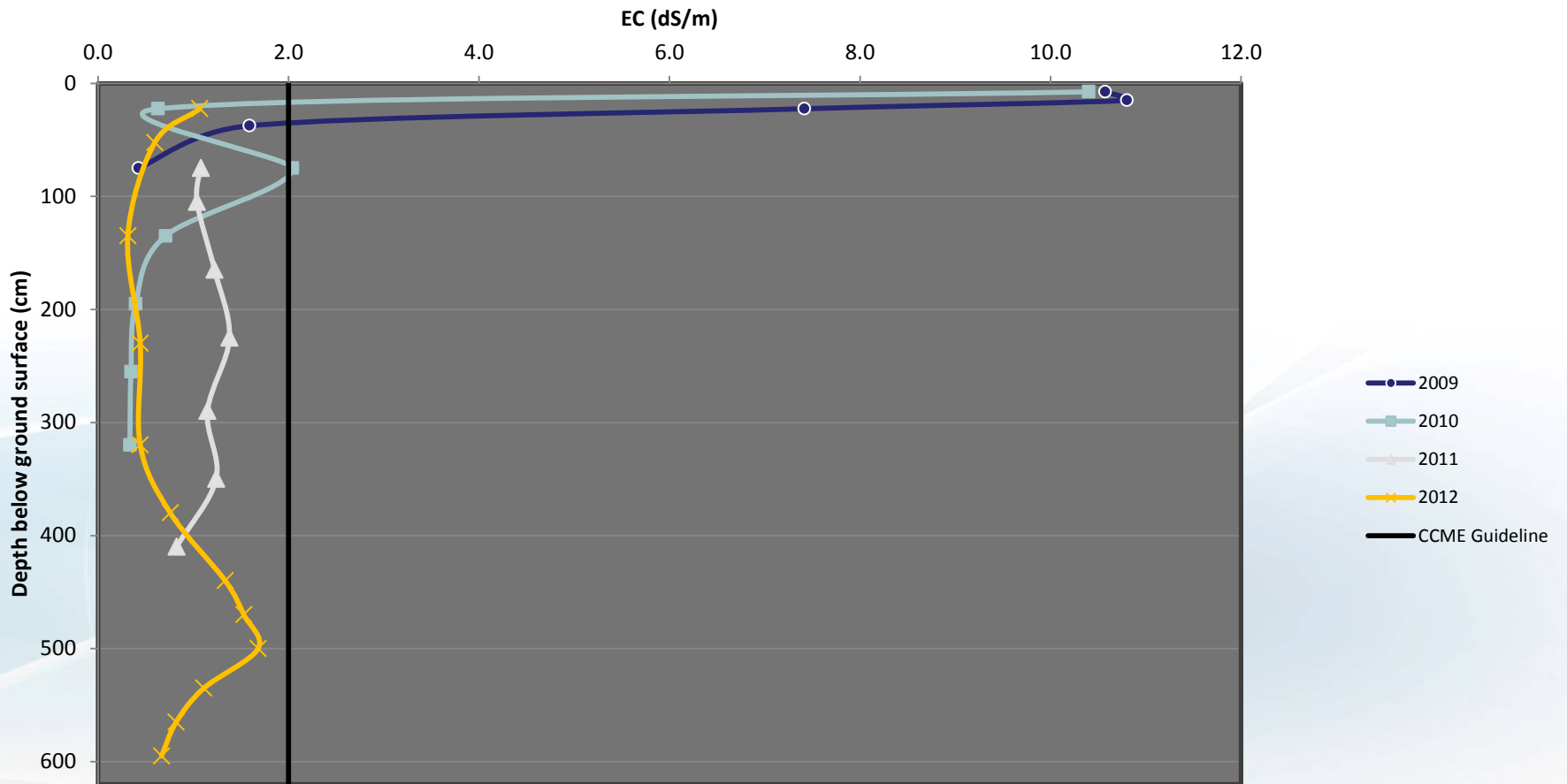
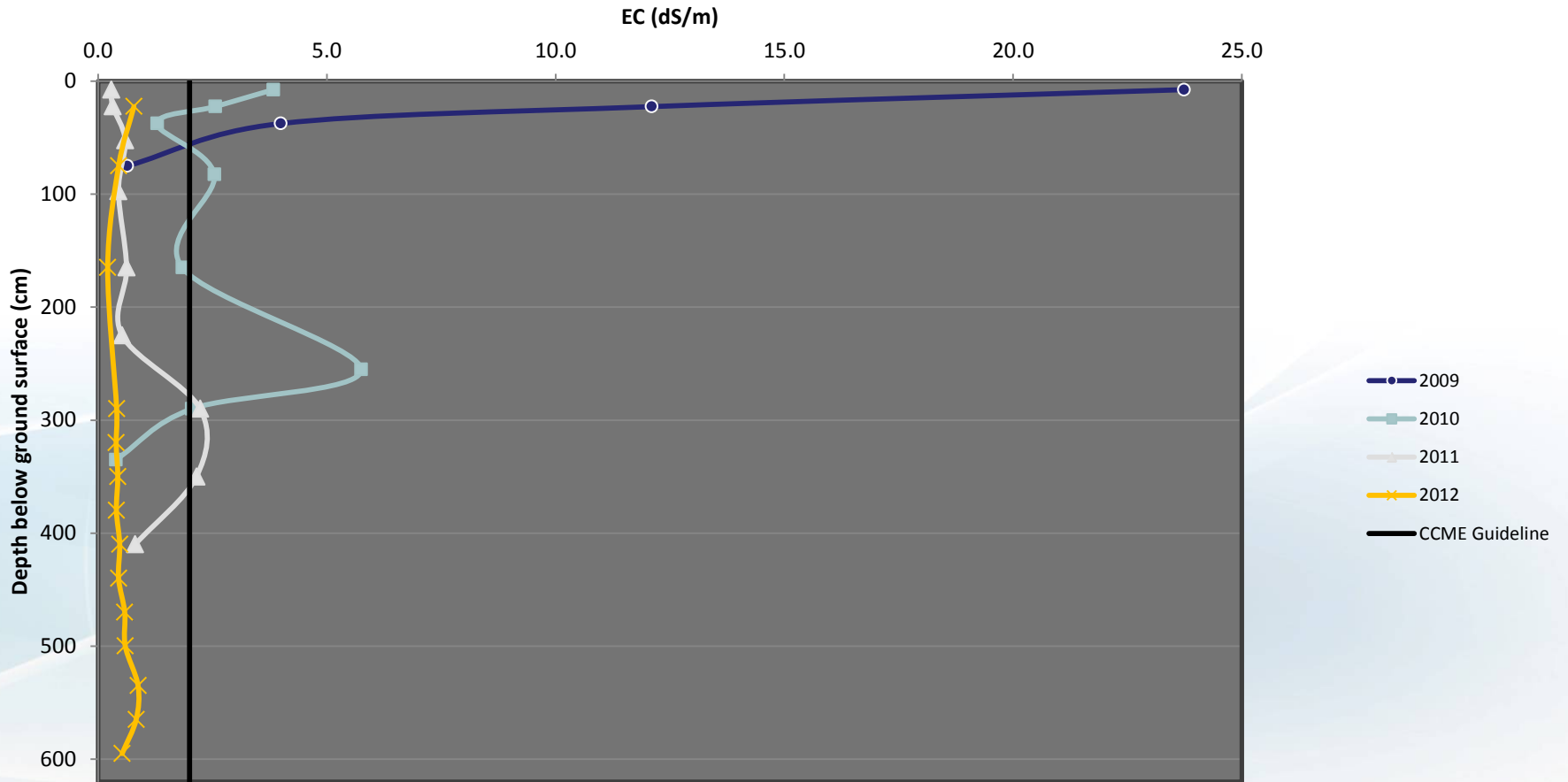


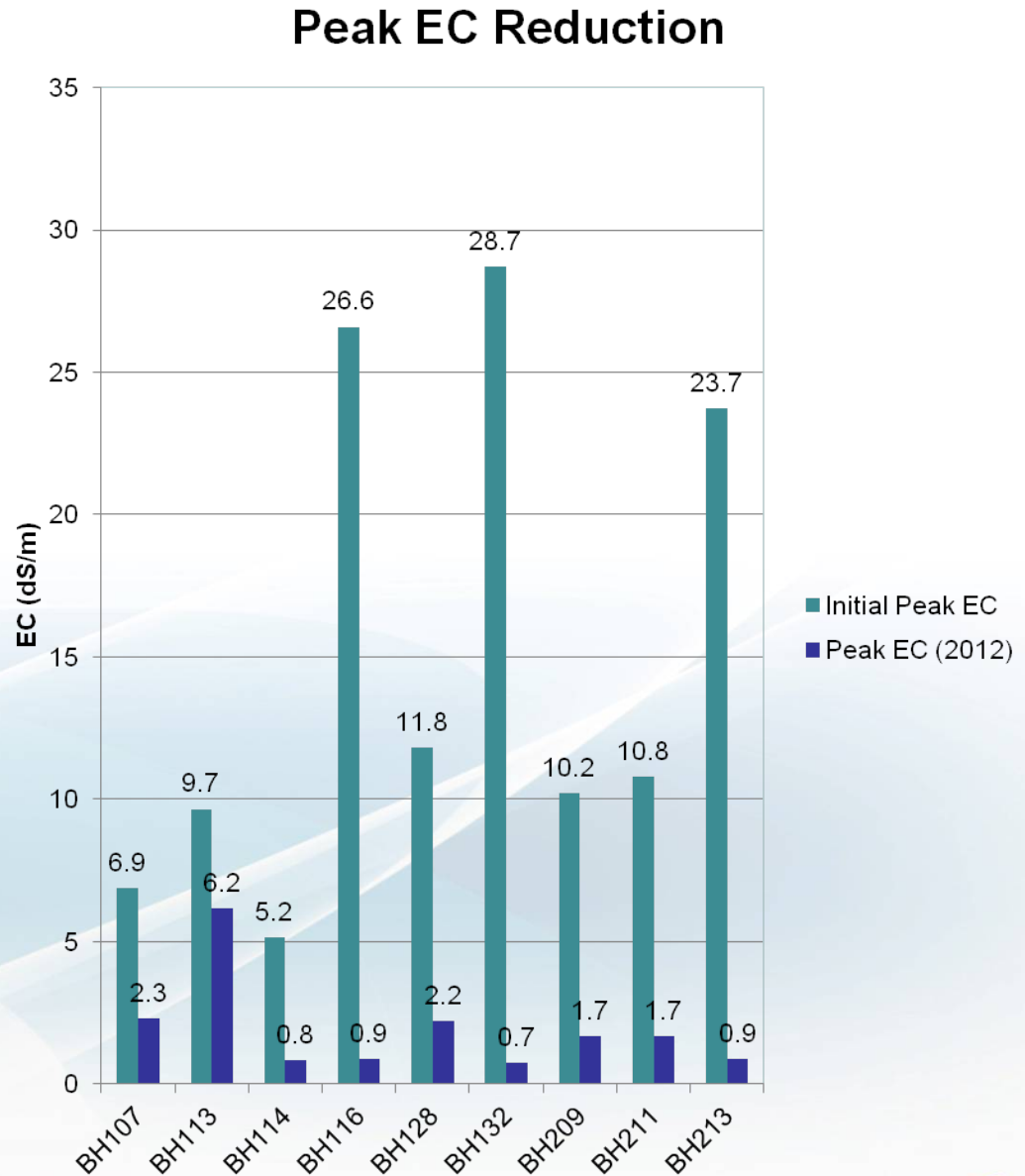
Chart 10

Temporal Changes in EC Concentration and Depth - BH213



Results Evaluation

- Initial CaCl_2 concentrations unknown in 2007/2008 during application
- 2009 initial soil data assumed as time ($T_0=0$) and concentration baseline ($C_0=1$)
- Comparison of C_{yr}/C_0 used to evaluate peak EC concentration ratios at each borehole



Reduction Success

Main Yard

- C_{2012}/C_0 ranged from 0.03 to 0.64
- Average of 0.23 indicated 77% reduction in average peak concentration
- Average peak EC depth increasing
 - ❖ 2009 – 0.2 mbgs
 - ❖ 2010 – 1.4 mbgs
 - ❖ 2011 – 3.0 mbgs
 - ❖ 2012 – 5.8 mbgs

Staging Area

- C_{2012}/C_0 ranged from 0.04 to 0.16
- Average of 0.12 indicated 88% reduction in average peak concentration
- Average peak EC depth increasing
 - ❖ 2009 – 0.2 mbgs
 - ❖ 2010 – 1.6 mbgs
 - ❖ 2011 – 2.2 mbgs
 - ❖ 2012 – 5.0 mbgs

Results by end of 2012

- All EC, SAR and chloride concentrations below applicable criteria and derived target in upper rooting zone
- All soil in Staging Area meets criteria at all locations/depths
- EC, chloride targets above final criteria/targets at depths e 5.2 mbgs

Groundwater Monitoring Program

- Results consistently demonstrated no change over 3 year monitoring period
- Maximum concentration observed during 3 year period was 29.7 mg/L with average 8.8 mg/L
- Peak concentrations expected to reach deep water table at >17 years for all model outcomes

Reclamation Progress

KMC contractor implementing steps for all sites as part of TMX Anchor Loop

2012: Pine tree planting

2015: Additional tree & shrub planting

2011: Native seeding mix/weed control

2014: Fence removed & access road reclaimed, native encroachment in progress

2010



2011



2012



Future Steps

Soil

- Confirm attenuation of final locations at depth below applicable criteria
- Re-drill the locations in 2015
- Monitor vegetation for growth and signs of stress

Groundwater

- Carry on with monitoring of CTM modelling outcome at 3 year intervals to confirm peak values at water table

Keys to Success

- RMP to guide process and allow 3rd party/stakeholder assurance
- KMC commitment
- NEB & Parks Canada follow up/comments up each annual report
- Up to maximum ~22,000 m³ soil in ecologically sensitive area left in place with no further disturbance

Acknowledgements



Parks
Canada

Parcs
Canada

Questions?