

# New Developments for the Subsoil Salinity Tool

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# Outline

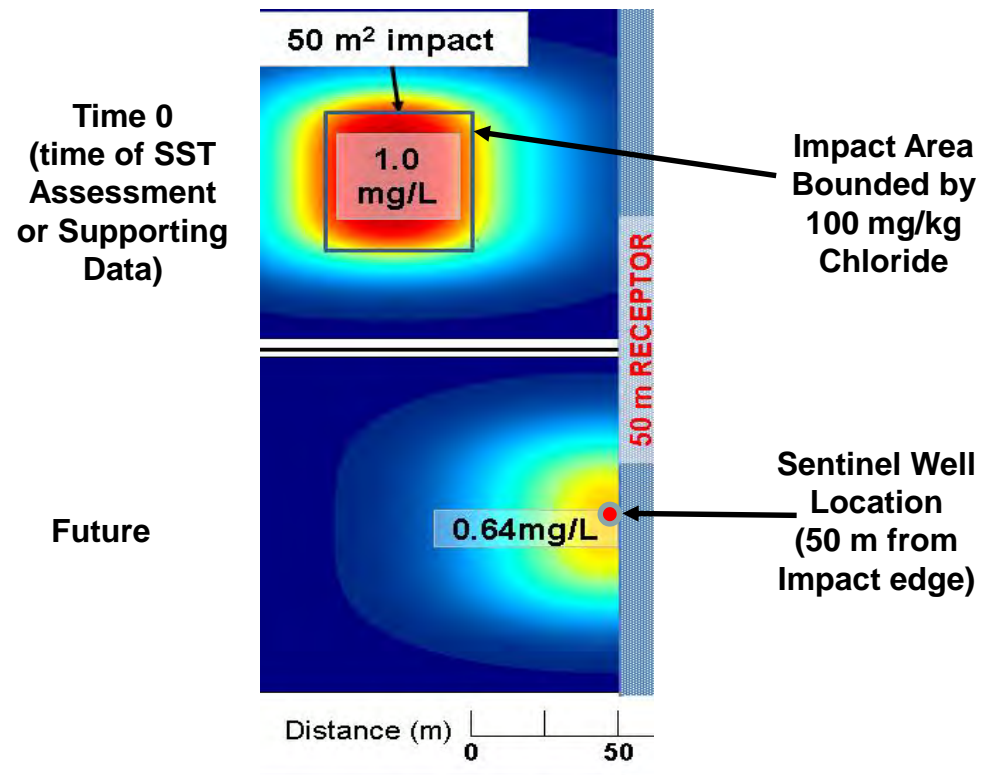
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- **Upgrades to existing chloride-based module**
- **Development of a SAR/sodium module**

# Upgrades to the Chloride-Based Module

# Sentinel Wells

- Provides groundwater guideline for sentinel wells
  - Monitor and verify model predictions at locations between the source and receptor



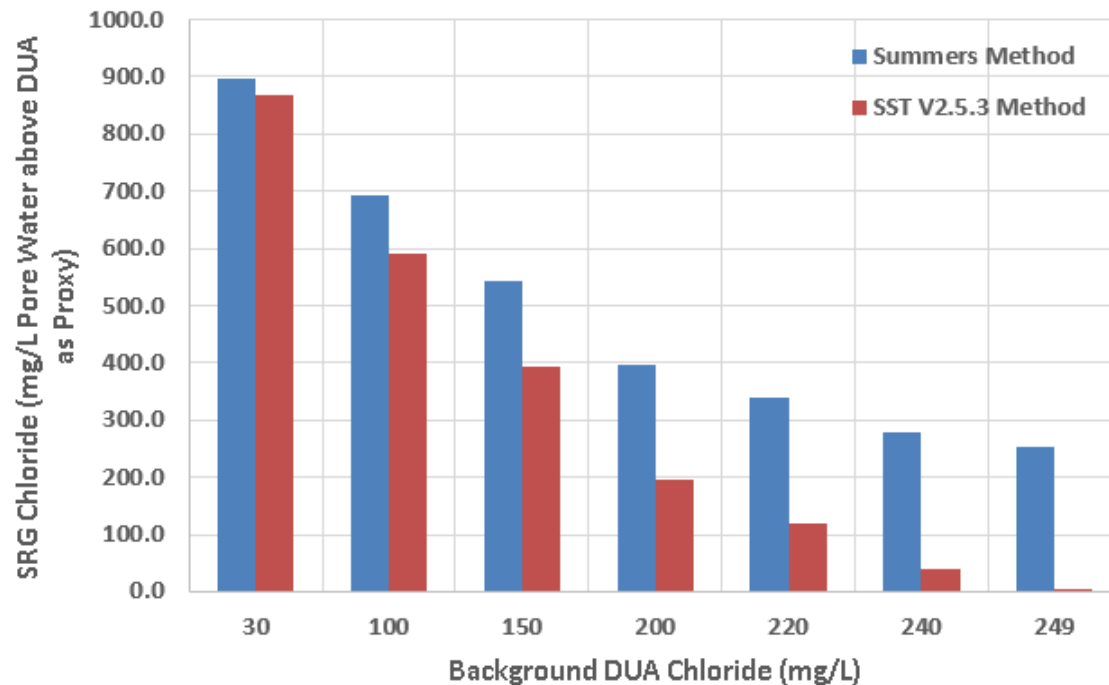
# Source Dimensions

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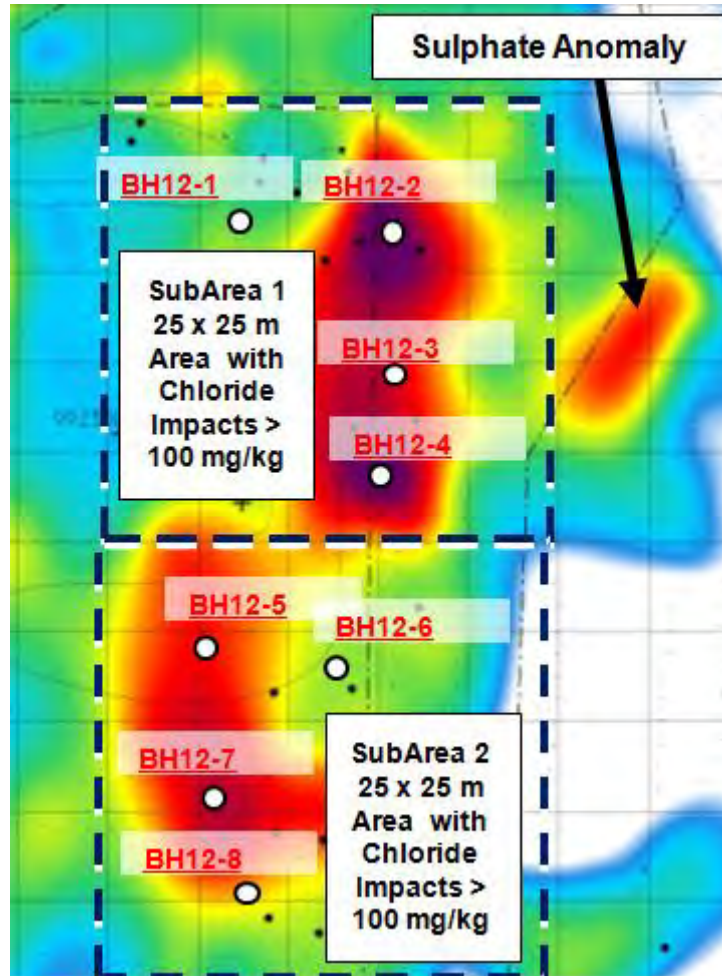
- **Actual site length will be used to calculate guidelines**
  - **Current version uses a specific set of site lengths**
    - 15x15m
    - 25x25m
    - 50x50m
    - 75x75m
    - 100x100m
- **Maximum depth of contamination increased from 10m to 15m**

# Mixing model for dugout and DUA scenarios

- Current version is overly conservative where elevated background concentrations occur
- New version will account for background chloride using a simple mixing model (Summers method)



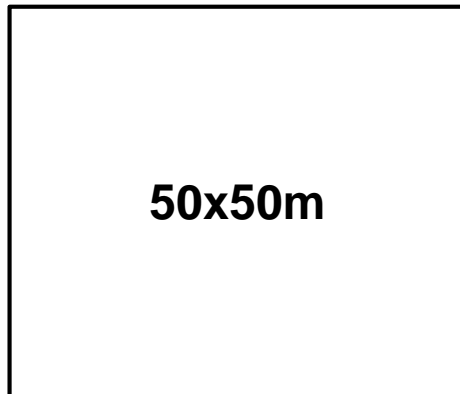
# Subareas and Buffer Allocation Factors



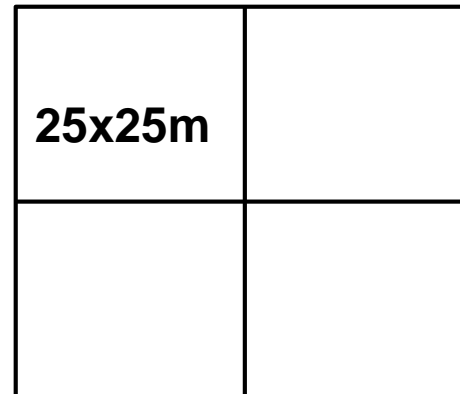
- Subareas allow more accurate representation of chloride mass
- Subareas provide more flexibility for remediation

# Subareas and Buffer Allocation Factors

- Current implementation causes overly conservative guidelines under some scenarios
  - Aquatic life and DUA pathways only
- Example Scenario:



**AL = 3900 mg/kg**  
**DUA = 2800 mg/kg**

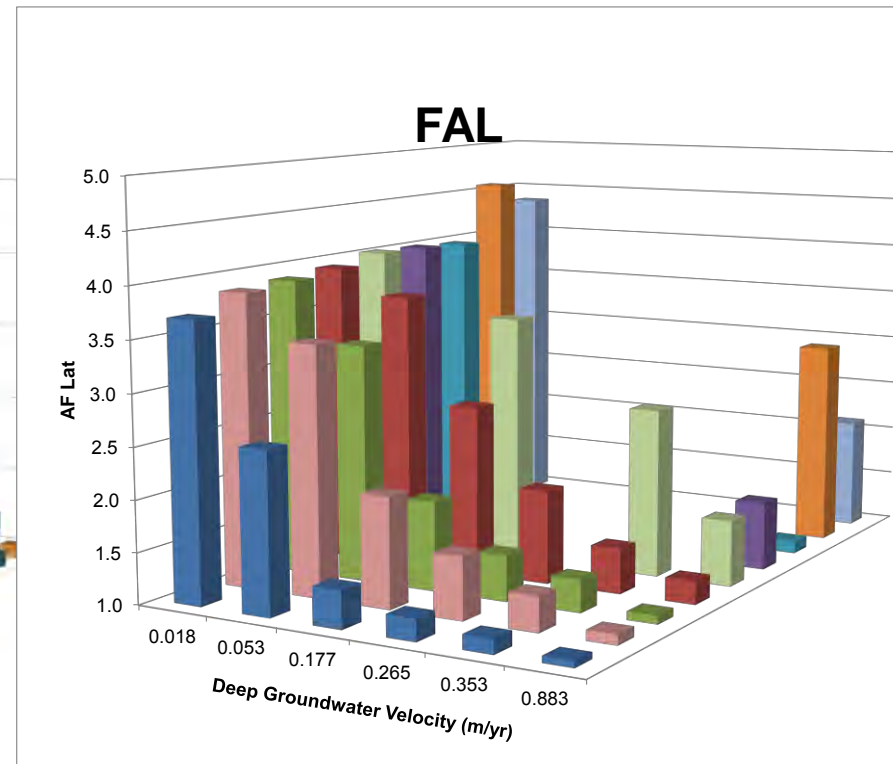
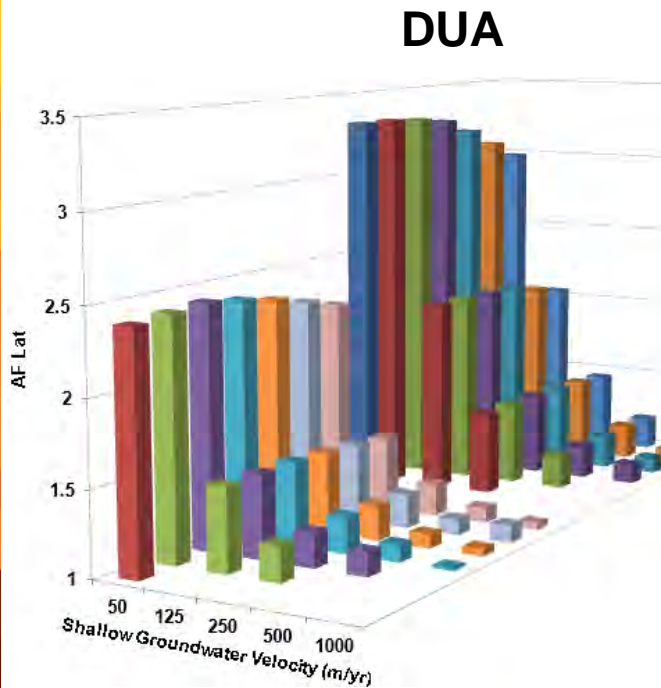


**AL = 3000 mg/kg**  
**DUA = 1300 mg/kg**



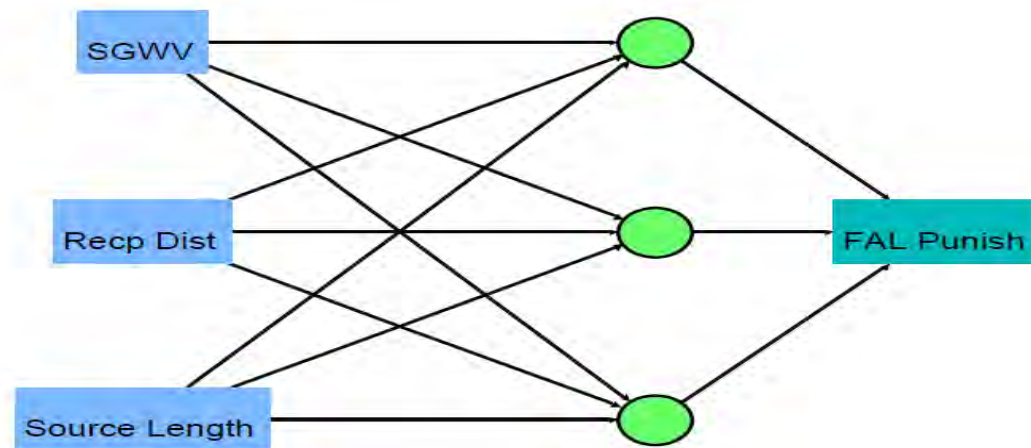
# Subareas and Buffer Allocation Factors

- Degree of conservatism depends on site characteristics



# Subareas and Buffer Allocation Factors

- Degree of over conservatism was a function of groundwater velocity, distance to receptor and source length
- Neural network modelling used to correct subareas modelling

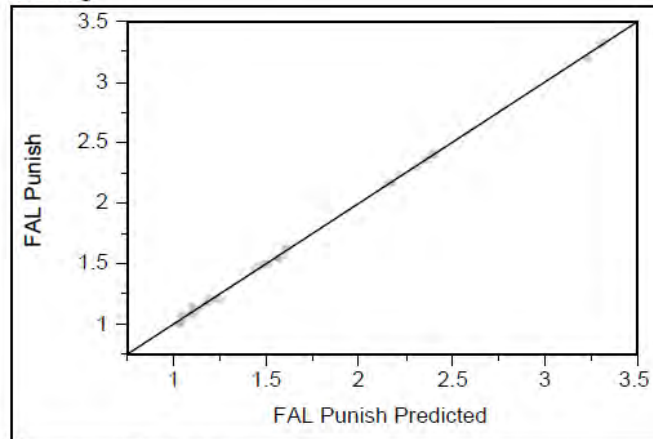


# Subareas and Buffer Allocation Factors

- Model was able to accurately estimate the degree of conservatism

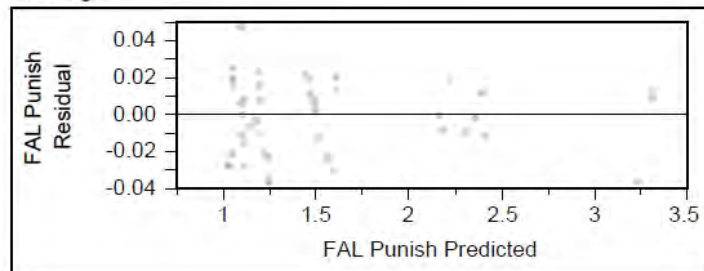
Actual by Predicted Plot

Training



Residual by Predicted Plot

Training





# Additional Revisions

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- **New version will align with default assumptions used for Tier 1 guidelines**
  - **Infiltration rates**
  - **Soil physical properties (bulk density, porosity)**
- **Software updates**
  - **Run all five subareas at once**
  - **Some restructuring of data entry**

# SAR/Sodium Module

# Context

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- Sodium is the most common cation associated with chloride at salt contaminated sites
- Residual sodium impacts often remain after chloride has leached
  - Sodium moves more slowly than chloride, largely due to cation exchange
- Elevated Na concentrations relative to Ca and Mg lead to structural changes in the soil
- Sodium adsorption ratio is commonly used to evaluate the potential for structural degradation

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

# Sodium Risks

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- **Negative effects of elevated SAR include:**
  - **Soil clays swell, reducing pore size**
  - **Soil aggregates disperse and plug pores**
  - **Soil crusting at surface and poor root growth**
  - **Reduces hydraulic conductivity**
- **Damage to soil structure at elevated SAR is mitigated by salinity**
  - **High SAR + low EC is the most damaging combination**



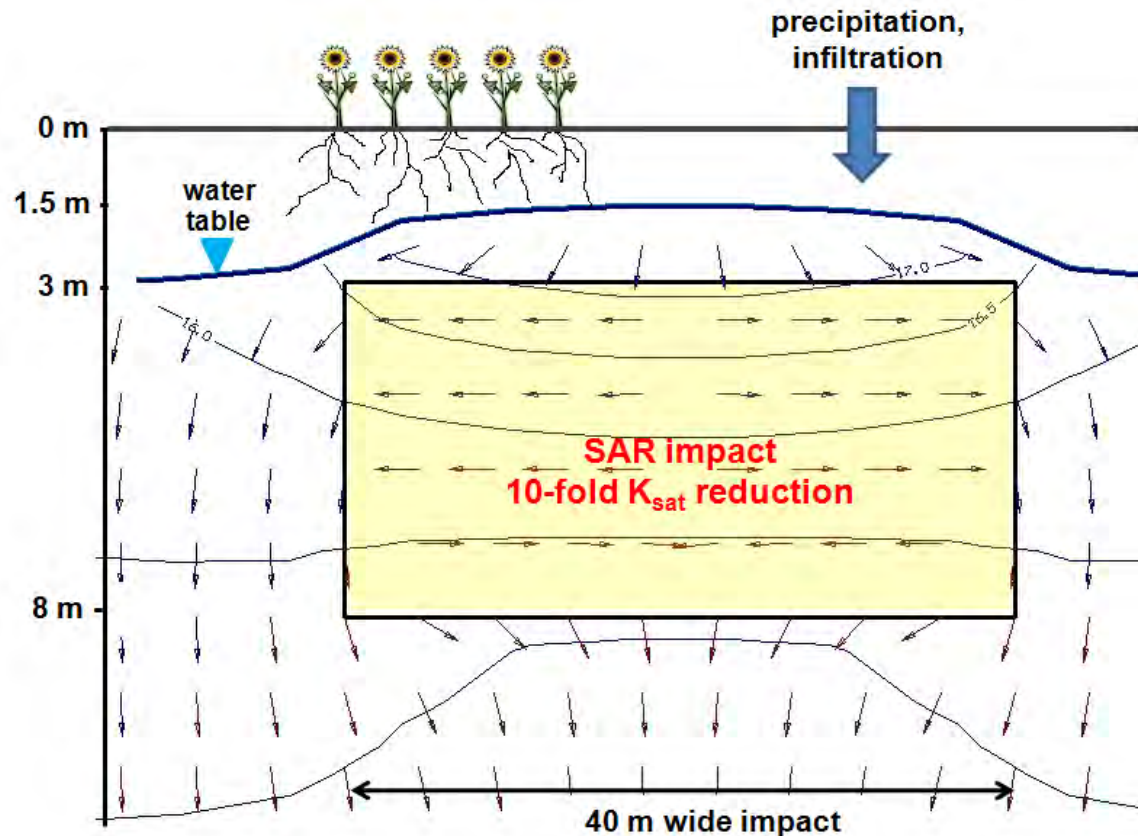
# SAR/Sodium module

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- Like chloride, the SST SAR/sodium module will calculate guidelines for soil below the root zone
  - Soil in the root zone must meet Alberta Tier 1 guidelines or site-specific alternatives developed independently from the SST
- Chloride guidelines are protective for DUA, Aquatic Life and Livestock Watering pathways, Na guidelines not needed
- Na concerns below the root zone are related to:
  - Upward movement into the root zone
  - Transport into irrigation water source
  - Soil structure below the root zone
- Transport and mixing protocols used for the root zone and irrigation pathways are the same as for chloride

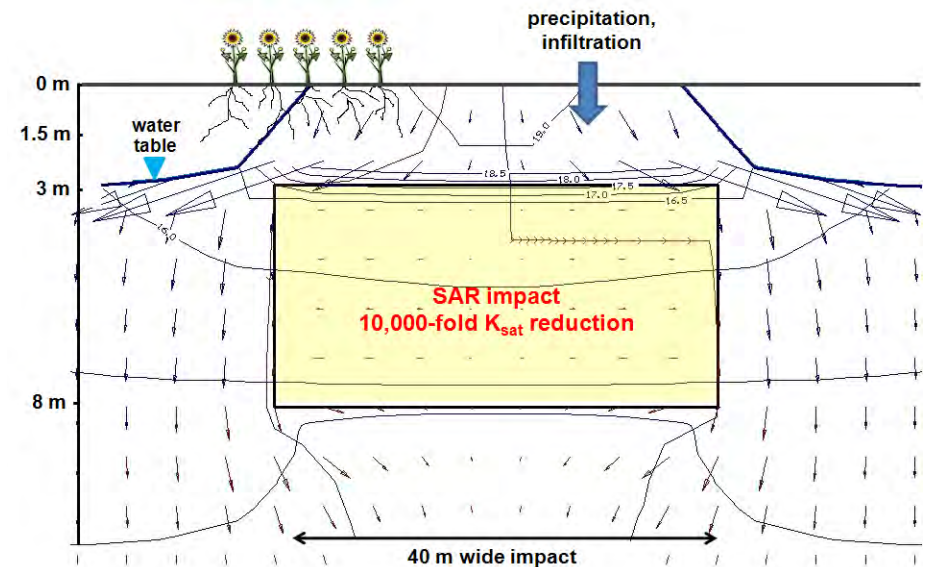
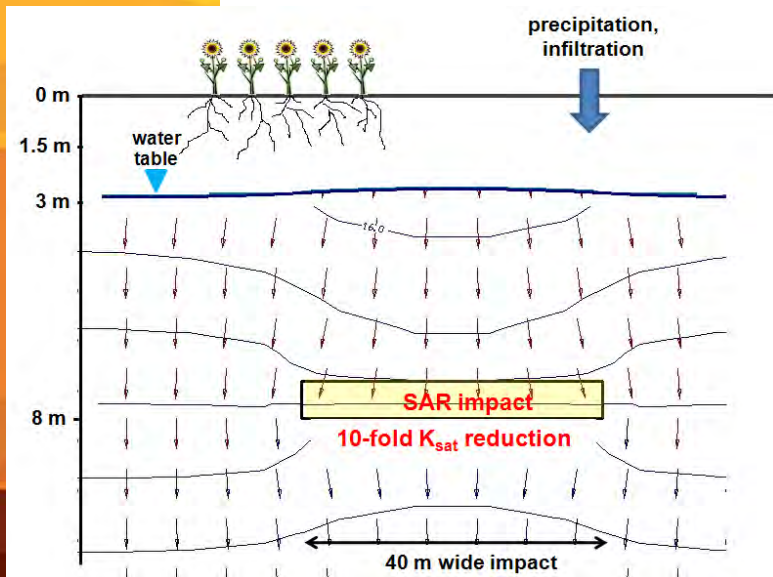
# Sodium Impacts on Water Movement

- Soil structure module focusses on hydraulic conductivity below the root zone and perched water table formation



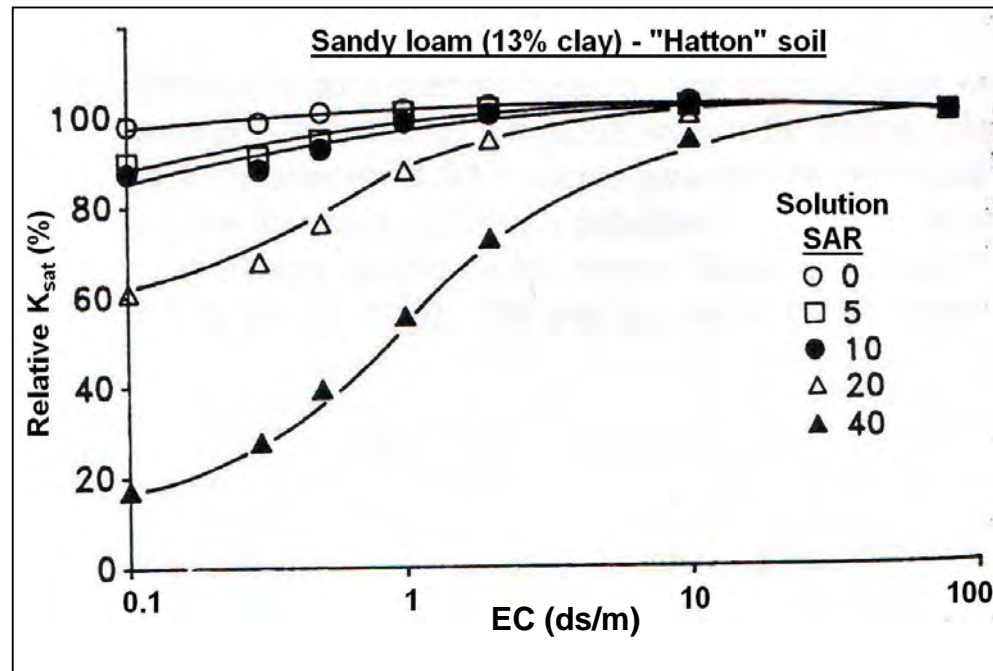
# Sodium Impacts on Water Movement

- Modelling results indicate that the potential to cause a perched water table in the root zone depend on:
  - Depth and areal extent of contamination
  - Magnitude of change in hydraulic conductivity



# Sodium Impacts on Water Movement

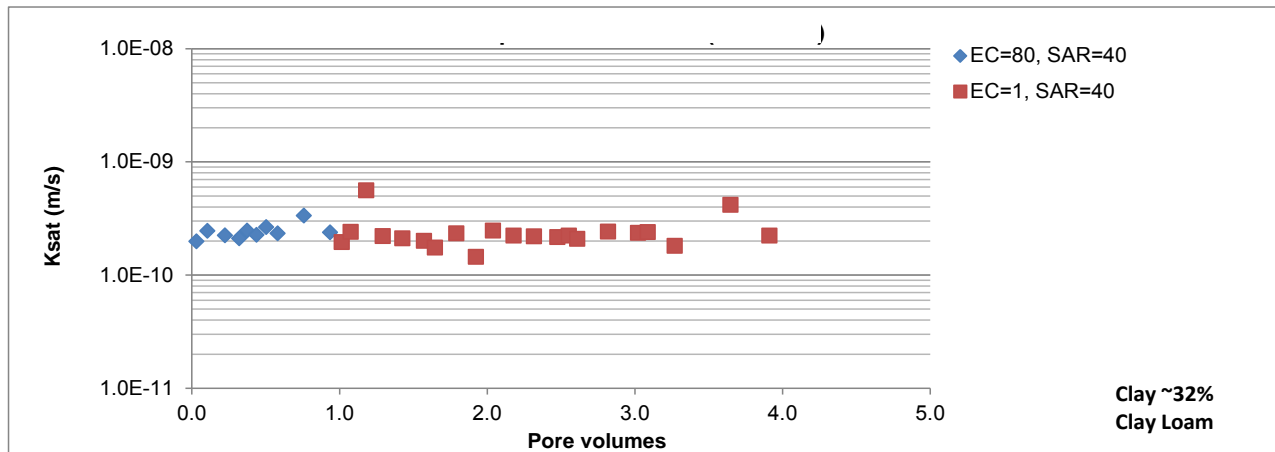
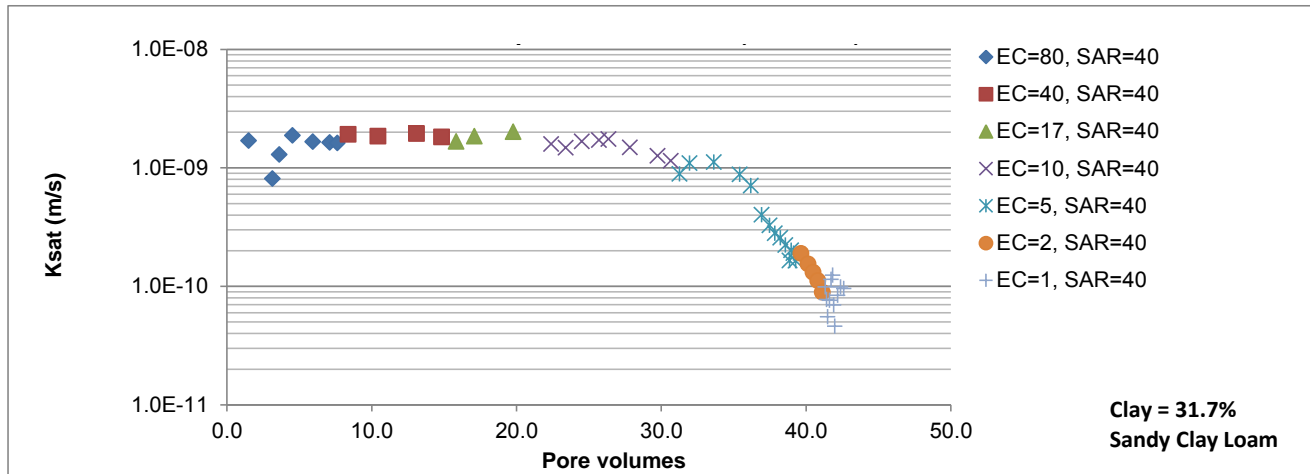
- Magnitude of hydraulic conductivity change is related to:
  - SAR
  - EC



Adapted from  
Curtin et al, 1994

# Sodium Impacts on Water Movement

- Soil characteristics (e.g. clay mineral type, organic matter)



# Status of SST Version 3.0

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- **Currently finalizing**
  - **Threshold curves for the soil structure component**
  - **Role of background salinity**
  - **User manual**
- **Programming largely complete**
- **Developing a technical manual that will describe the assumptions and models used to develop the SST**
  - **Assist users in properly applying the model**
  - **Provide more confidence in model results**
- **Possible release winter or spring 2017**

# SST Checklist (Bulletin 2016-14)

- Alberta Energy Regulator has developed a checklist to help ensure SST reports are complete
- All SST submissions to the AER must be accompanied by SST checklist



## Bulletin 2016-14

www.aer.ca

May 13, 2016

### Release of New Subsoil Salinity Tool Assessment Checklist

The Alberta Energy Regulator (AER) has implemented a new process for accepting Subsoil Salinity Tool (SST) assessments for review. As part of this change, the AER has created the Subsoil Salinity Tool Assessment Checklist. Effective immediately, companies are to include this checklist with their SST assessment submission to the AER. The checklist is available on the AER website, [www.aer.ca](http://www.aer.ca), under Abandonment & Reclamation > Reclamation & Remediation > Upstream Oil and Gas Reclamation & Remediation Program.

Deficiencies in SST assessments affect the AER's ability to review them in a timely manner. This checklist covers the minimum information that must be included in an SST assessment and should decrease the number of deficient SST assessments that the AER receives. Upon reviewing an SST assessment that meets the minimum information requirements, the AER may require additional information.

If deficiencies are identified in an SST assessment, the SST assessment will be rejected. The AER will notify the filer via e-mail of the deficiencies and SST assessment rejection.

This process is effective immediately. All SST assessments submitted before May 13, 2016, will be reviewed; however, if more than two deficiencies are found the assessment will be rejected. The AER recommends that industry assess any SST assessments previously submitted for review and, if deficiencies are found, withdraw the assessments and resubmit them following the checklist.

For questions about this bulletin, contact [csusubmissions@aer.ca](mailto:csusubmissions@aer.ca).

<original signed by>

Jil Macdonald  
Vice President  
Closure & Liability Branch

# Acknowledgments

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- **Daniel Pollard and Sara Ito, AER**
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