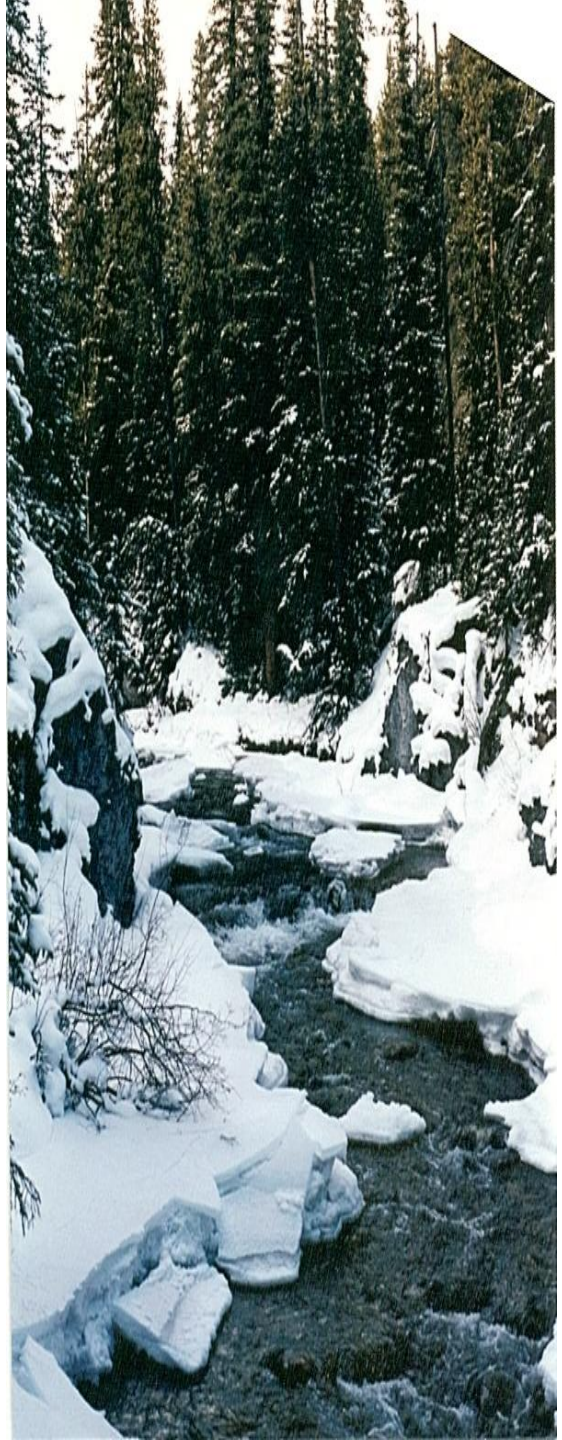


Equilibrium Environmental Inc

Subsoil Salinity Tool (SST) Version 3.0.2 and Beyond:

Expanding Applicability for Salinity Assessment

Greg Huber, M.Sc., P.Eng., PMP
Anthony Knafla, M.Sc., P.Biol, DABT

RemTech 2026

October 16, 2026 - Banff

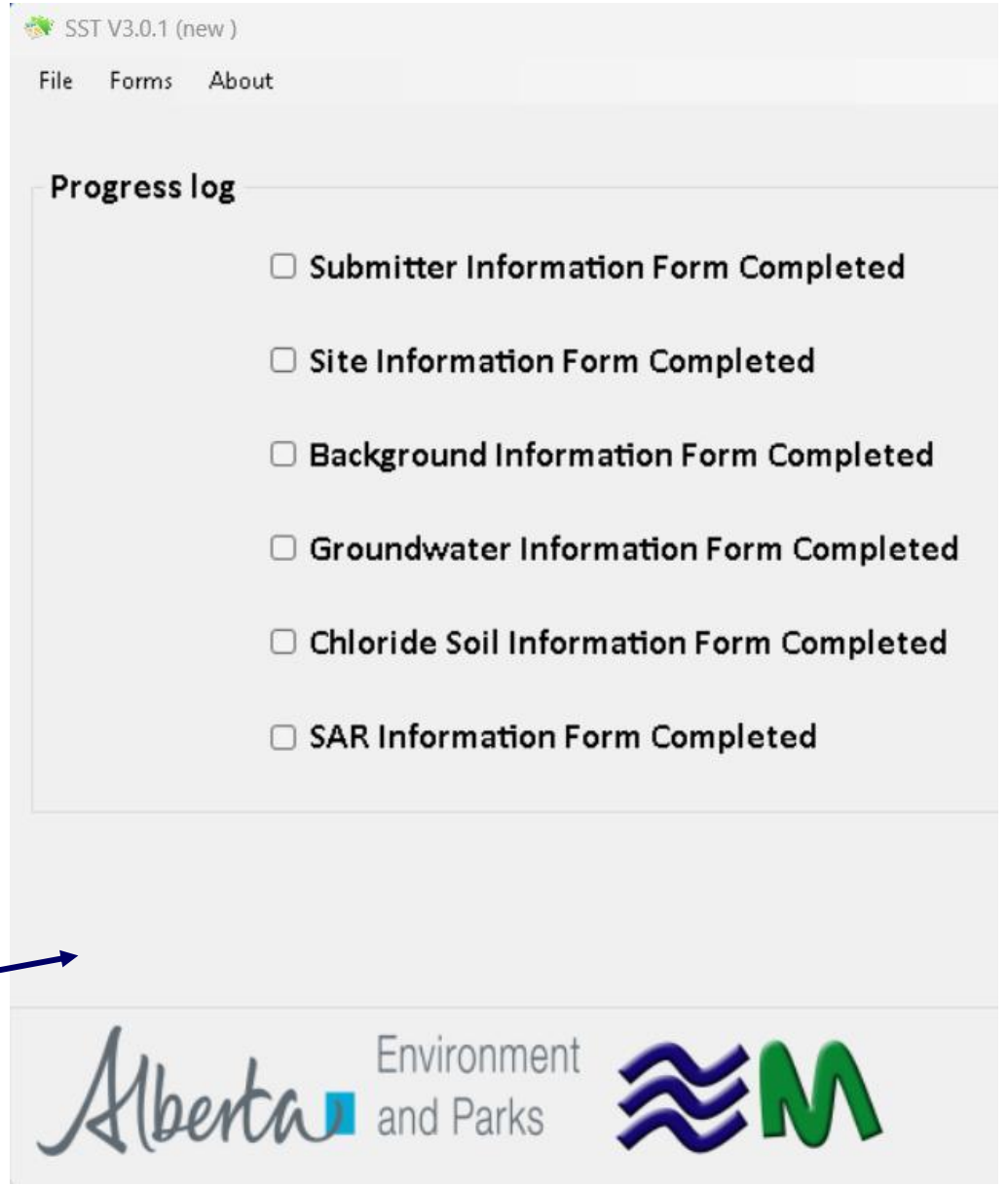
Presentation Overview

- **Subsoil Salinity Tool (SST)**
  - **Brief overview and version history**
- **Version 3.0.2**
  - **Implemented updates**
- **Version 3.5**
  - **Planned updates and upgrades**
- **SST Courses**

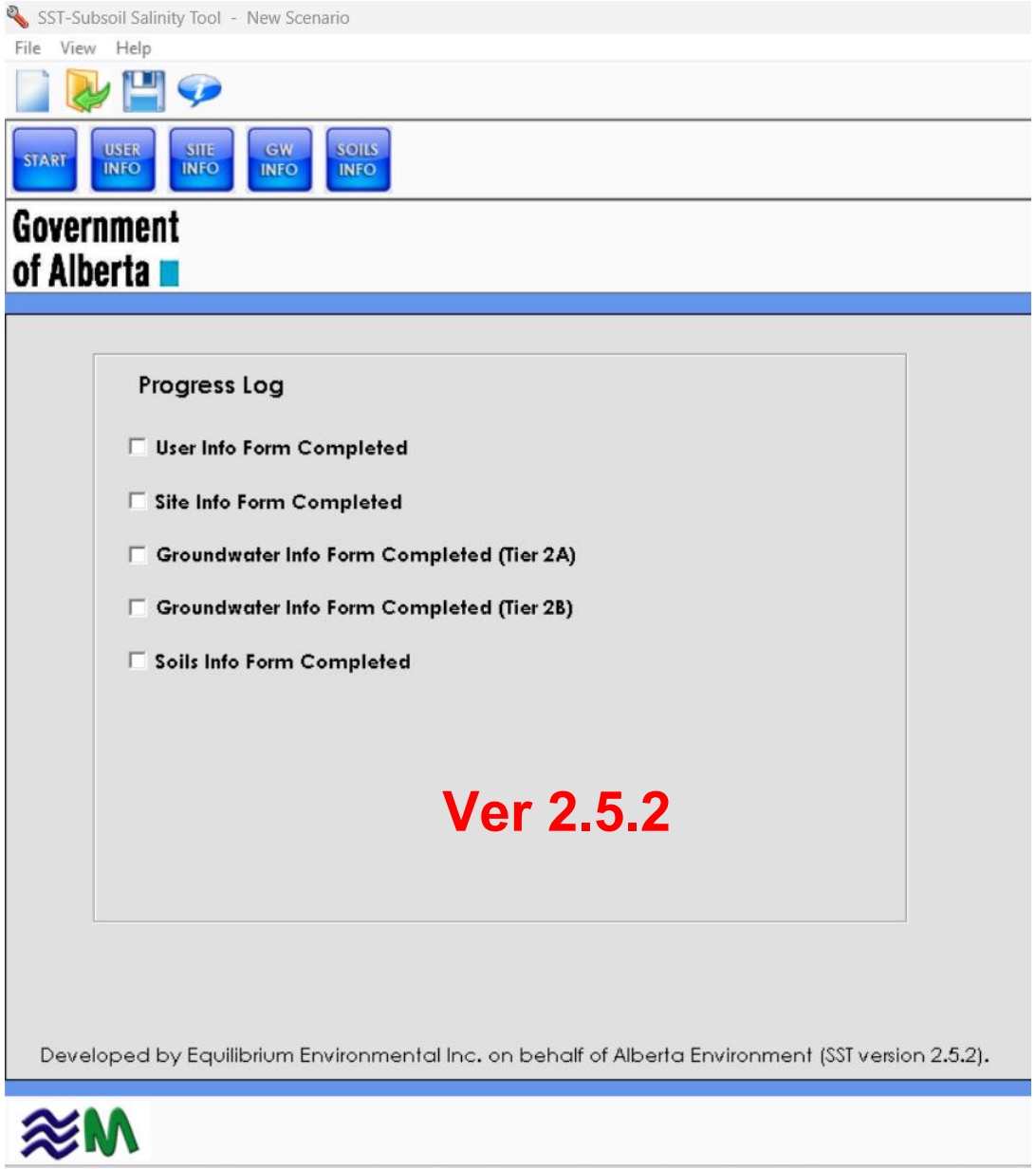
SST Overview and Version History

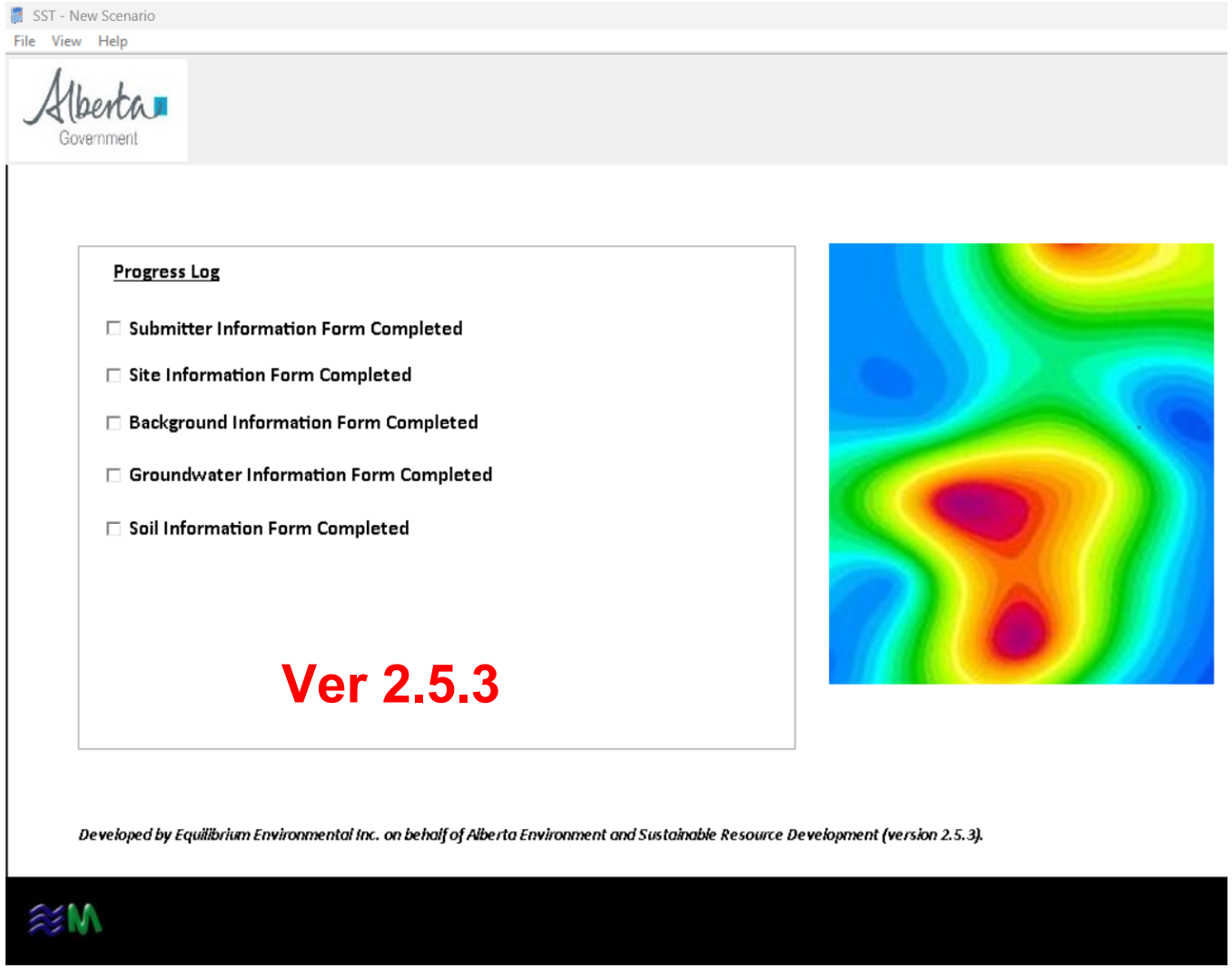
SST Overview

- An Alberta-made software tool to create Tier 2 chloride and SAR/sodium guidelines for subsoil below the root-zone
- Highly collaborative project, with input and guidance from Alberta regulators and industry
- Work started in the mid 2000's, based heavily on experience with salt risk assessment and modeling
- First version of the tool released ~2009, with several updates since then
- Current version is 3.0.1
  - Has been in use for more than 5 years



SST "Museum"


SST-Subsoil Salinity Tool - New Scenario
File View Help
START
USER INFO
SITE INFO
GW INFO
SOILS INFO
Government of Alberta
Progress Log
User Info Form Completed
Site Info Form Completed
Groundwater Info Form Completed (Tier 2A)
Groundwater Info Form Completed (Tier 2B)
Soils Info Form Completed
Ver 2.5.2
Developed by Equilibrium Environmental Inc. on behalf of Alberta Environment (SST version 2.5.2).


SST - New Scenario
File View Help
Alberta Government
Progress Log
Submitter Information Form Completed
Site Information Form Completed
Background Information Form Completed
Groundwater Information Form Completed
Soil Information Form Completed
Ver 2.5.3
Developed by Equilibrium Environmental Inc. on behalf of Alberta Environment and Sustainable Resource Development (version 2.5.3).

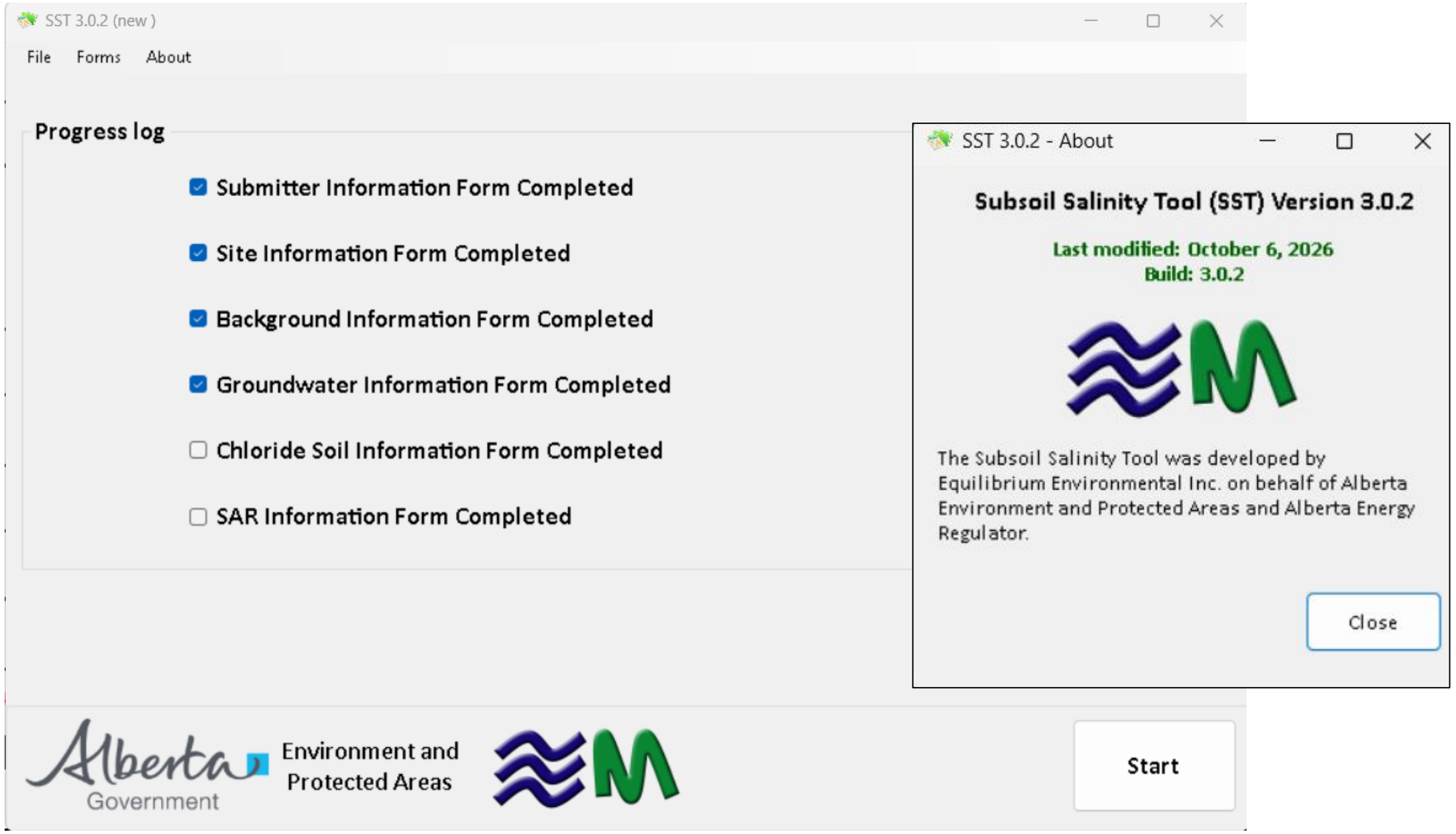
SST Version History

- 2009 Initial version and updates through Ver 2.5
  - Beta versions, courses commenced in late 2009
- 2010: Version 2.5.1 released
  - First ‘official’ version
- 2011: Version 2.5.2 released
  - Interface upgrades, some technical / modeling upgrades
- 2014: Version 2.5.3 released
  - Interface upgrades, some technical / modeling upgrades
- Nov 2020: Version 3.0 released
  - Interface upgrades
  - MAJOR technical / modeling upgrades
- July 2021: Version 3.0.1 released
  - Minor bug-fixes and speed/security update
- Help files / user manuals accompanied each substantial update

SST Version 3.0.2

Overview of SST Version 3.0.2

- Like any software, updates are needed periodically to keep up with evolving security protocols, operating system versions, supporting modules, etc
- Current version (3.0.1) is generally stable and compatible with most systems, but in some cases will not function in certain environments
  - Some repair tools for various Microsoft Office dependencies are provided in the SST FAQ, but do not have 100% success rate www.eqm.ca/faq
- Uncertainty around whether these incompatible environments will get more or less common with various Windows/Office updates was a primary driver for Version 3.0.2
- Version 3.0.2 is in final testing stages / regulatory review process
- Guidelines remain essentially unchanged, except in rare targeted cases
  - Focus is on various IT upgrades, bug fixes, robustness enhancements

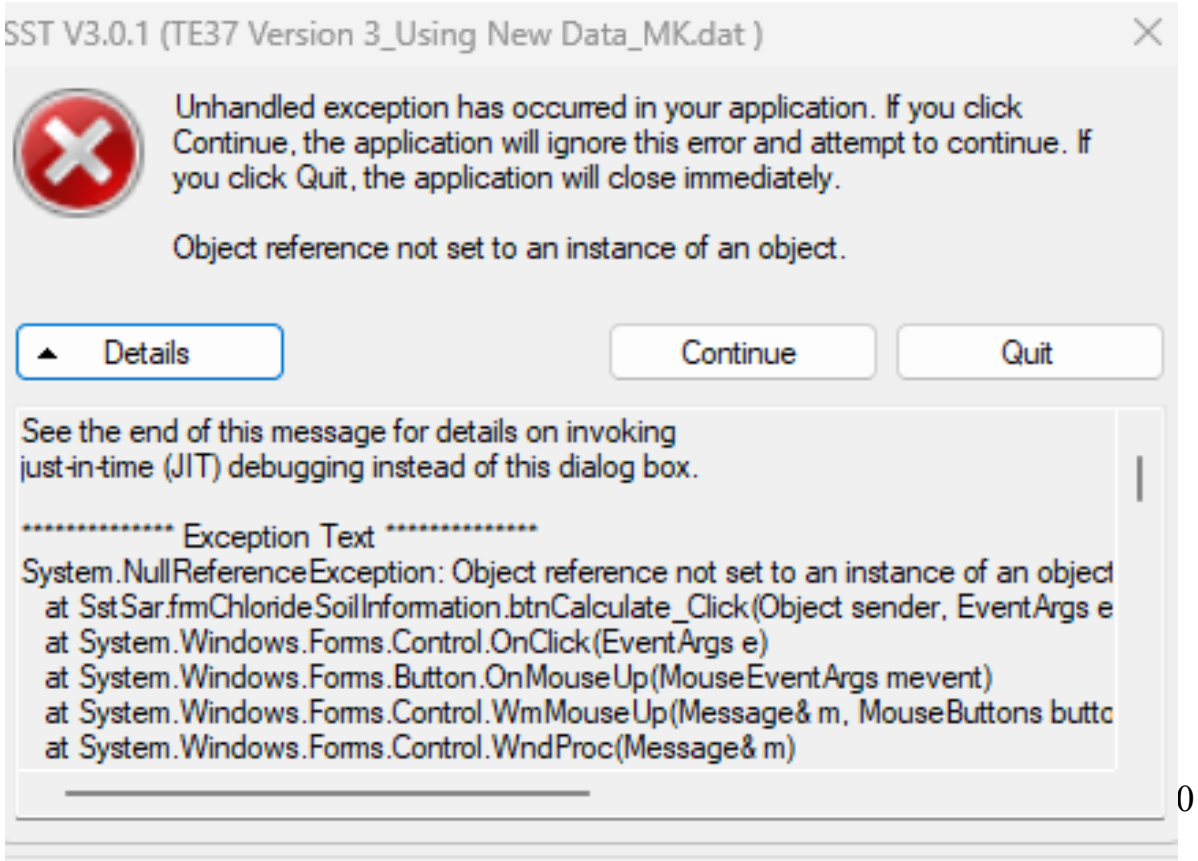


Layout and feel is very similar to Version 3.0.1

Improved Robustness

- The occasional (but persistent if it occurs) “Unhandled Exception” during guideline calculation observed in some systems in Version 3.0.1 has been addressed
  - Removed dependency on unreliable third-party Office updates which sometimes lead to registry issues

No longer occurs!→



Guideline Consistency

- No guideline protocols changed in Version 3.0.2. vs 3.0.1, though some implementation details were modernized. Goal is guideline consistency with 3.0.1
- Initial verification process involved manual comparison of several dozen SST runs comparing all guidelines and breakthrough times in Version 3.0.1 vs 3.0.2
- Once manual comparisons passed, expanded to automated comparisons of ~1800 pre-existing SST runs
  - Performed using an automated scripting process to greatly accelerate the process
- Data files maintain compatibility for both 3.0.1 and 3.0.2
  - Maximize QA/QC processes and user convenience
- Primary guideline differences caused by occasional 'stale' EC buffer in Version 3.0.1 (and corrected in Version 3.0.2 with automatic buffer updates)

Example 1

3.0.1

Example of all guidelines matching (most typical)

Pathway	SubArea 1		SubArea 2		SubArea 3		SubArea 4		SubArea 5	
	Guideline (mg/kg)	Time to peak breakthrough (Year)	Guideline (mg/kg)	Time to peak breakthrough (Year)	Guideline (mg/kg)	Time to peak breakthrough (Year)	Guideline (mg/kg)	Time to peak breakthrough (Year)	Guideline (mg/kg)	Time to peak breakthrough (Year)
Root Zone	1000	~ 300	990	~ 250	1000	~ 250	1100	~ 60	2300	~ 1000
Livestock Watering	NA WT >6 m	NA	NA WT >6 m	NA	NA WT >6 m	NA	NA WT >6 m	NA	NA WT >6 m	NA
Irrigation Watering	NA WT >6 m	NA	NA WT >6 m	NA	NA WT >6 m	NA	NA WT >6 m	NA	NA WT >6 m	NA
Aquatic Life	930	~ 50	1300	~ 170	2300	~ 170	ML (9300)	~ 400	400	~ 50
DUA	ML (34000)	~ 1000	ML (34000)	~ 1000	ML (34000)	~ 1000	ML (34000)	~ 1000	ML (34000)	~ 1000
Minimum Chloride Guideline (mg/kg)	930		990		1000		1100		400	
Groundwater Guideline (mg/L)	4400		NA-vadose		NA-vadose		NA-vadose		1900	

3.0.2

Root Zone	1000	~ 300	990	~ 250	1000	~ 250	1100	~ 60	2300	~ 1000
Livestock Watering	NA WT >6 m	NA	NA WT >6 m	NA	NA WT >6 m	NA	NA WT >6 m	NA	NA WT >6 m	NA
Irrigation Watering	NA WT >6 m	NA	NA WT >6 m	NA	NA WT >6 m	NA	NA WT >6 m	NA	NA WT >6 m	NA
Aquatic Life	930	~ 50	1300	~ 170	2300	~ 170	ML (9300)	~ 400	400	~ 50
DUA	ML (34000)	~ 1000	ML (34000)	~ 1000	ML (34000)	~ 1000	ML (34000)	~ 1000	ML (34000)	~ 1000
Minimum Chloride Guideline (mg/kg)	930		990		1000		1100		400	
Groundwater Guideline (mg/L)	4400		NA-vadose		NA-vadose		NA-vadose		1900	

Example 2

3.0.1

Pathway	Guideline SubArea 1	Guideline SubArea 2	Guideline SubArea 3	Guideline SubArea 4	Guideline SubArea 5
Rooting Zone (mg/kg Sodium)	170	170	170	160	160
Irrigation Watering (mg/kg Sodium)	NA WT >6 m	NA WT >6 m	NA WT >6 m	NA WT >6 m	NA WT >6 m
Constraining Pathway for Sodium	Root Zone	Root Zone	Root Zone	Root Zone	Root Zone
Constraining Guideline for Sodium (mg/kg Sodium)	170	170	170	160	160
SAR Guideline for Soil Structure	28	28	28	28	28

Example of all guidelines matching (most typical)

3.0.2

Rooting Zone (mg/kg Sodium)	170	170	170	160	160
Irrigation Watering (mg/kg Sodium)	NA WT >6 m	NA WT >6 m	NA WT >6 m	NA WT >6 m	NA WT >6 m
Constraining Pathway for Sodium	Root Zone	Root Zone	Root Zone	Root Zone	Root Zone
Minimum Sodium Guideline (mg/kg)	**170**	**170**	**170**	**160**	**160**
SAR Guideline for Soil Structure	28	28	28	28	28

Some slight reformatting for SAR report in 3.0.2 for consistency with chloride

Example 3

3.0.1

Pathway	SubArea 1		SubArea 2		SubArea 3		SubArea 4		SubArea 5	
	Guideline (mg/kg)	Time to peak breakthrough (Year)	Guideline (mg/kg)	Time to peak breakthrough (Year)	Guideline (mg/kg)	Time to peak breakthrough (Year)	Guideline (mg/kg)	Time to peak breakthrough (Year)	Guideline (mg/kg)	Time to peak breakthrough (Year)
Root Zone	3000	~ 120	970	~ 70	2300	~ 70	9700	~ 260	2300	~ 70
Livestock Watering	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Irrigation Watering	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aquatic Life	2300	~ 1000	2600	~ 1000	2600	~ 1000	3900	~ 1000	3500	~ 1000
DUA	3300	~ 1000	2600	~ 1000	1700	~ 1000	1100	~ 1000	2600	~ 1000
Minimum Chloride Guideline (mg/kg)	**2300**		**970**		**1700**		**1100**		**2300**	
Groundwater Guideline (mg/L)	6900		2900		5100		3300		6900	

Example of single mismatch due to 'stale' EC buffer in 3.0.1

3.0.2

Root Zone	3000	~ 120	1600	~ 70	2300	~ 70	9700	~ 260	2300	~ 70
Livestock Watering	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Irrigation Watering	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aquatic Life	2300	~ 1000	2600	~ 1000	2600	~ 1000	3900	~ 1000	3500	~ 1000
DUA	3300	~ 1000	2600	~ 1000	1700	~ 1000	1100	~ 1000	2600	~ 1000
Minimum Chloride Guideline (mg/kg)	**2300**		**1600**		**1700**		**1100**		**2300**	
Groundwater Guideline (mg/L)	6900		4800		5100		3300		6900	

Automatic Buffer Update

- One rare issue in Version 3.0.1 can occur when entering background root-zone statistics, then populating information for an 'excavate and backfill' or 'impacted root-zone scenario', and then going back and changing background statistics (resulting in different Tier 1 guideline and EC buffer)

- In Version 3.0.1, the EC buffer does not automatically update on final chloride page after such a change
  - may result in erroneous guidelines being generated if not refreshed

- Relies on practitioner noticing the EC buffer mismatch and correcting it
  - Such as via re-entering backfill EC or impacted root-zone chloride

- Version 3.0.2 introduces an automatic buffer update process instead

Stale EC Buffer Example in 3.0.1

SST V3.0.1 (new)

60 ?

Original EC Buffer (dS/m): 2.0

Water Table Depth Range (m): 2 to 4 m

Type of Root Zone Analysis	95th Percentile Chloride Impacted Root Zone (mg/kg)	[Calculated] New EC Impacted Root Zone (dS/m)	[Calculated] New EC Buffer Impacted Root Zone (dS/m)	Average EC of Backfill (dS/m)	Average Saturation Percent of Backfill (%)	[Calculated] New EC Buffer of Backfill (dS/m)
Excavation and Backfill				1	50	2.0

- Correct EC buffer with original background statistics
- Incorrect (stale) EC buffer after changing background statistics (3.0.1)

- Need to re-enter backfill EC or impacted RZ chloride to refresh buffer in Ver 3.0.1

caution!

60 ?

Original EC Buffer (dS/m): 7.2

Water Table Depth Range (m): 2 to 4 m

Type of Root Zone Analysis	95th Percentile Chloride Impacted Root Zone (mg/kg)	[Calculated] New EC Impacted Root Zone (dS/m)	[Calculated] New EC Buffer Impacted Root Zone (dS/m)	Average EC of Backfill (dS/m)	Average Saturation Percent of Backfill (%)	[Calculated] New EC Buffer of Backfill (dS/m)
Excavation and Backfill				1	50	2.0

Automatic Buffer Update in 3.0.2

SST 3.0.2 (new)

60 ?

Original EC Buffer (dS/m): 2.0

Water Table Depth Range (m): 2 to 4 m

Type of Root Zone Analysis	95th Percentile Chloride Impacted Root Zone (mg/kg)	[Calculated] New EC Impacted Root Zone (dS/m)	[Calculated] New EC Buffer Impacted Root Zone (dS/m)	Average EC of Backfill (dS/m)	Average Saturation Percent of Backfill (%)	[Calculated] New EC Buffer of Backfill (dS/m)
Excavation and Backfill				1	50	2.0

- Correct EC buffer with original background statistics
- Correct EC buffer after changing background statistics (3.0.2)

- Buffer automatically refreshed in Version 3.0.2

60 ?

Original EC Buffer (dS/m): 7.2

Water Table Depth Range (m): 2 to 4 m

Type of Root Zone Analysis	95th Percentile Chloride Impacted Root Zone (mg/kg)	[Calculated] New EC Impacted Root Zone (dS/m)	[Calculated] New EC Buffer Impacted Root Zone (dS/m)	Average EC of Backfill (dS/m)	Average Saturation Percent of Backfill (%)	[Calculated] New EC Buffer of Backfill (dS/m)
Excavation and Backfill				1	50	9.0

Various Minor Fixes

- **Some minor display corrections made in Ver 3.0.2**
  - **Occasional issues how management limits / guidelines caps are displayed (Corrected)**
  - **Occasional display of time greater than the 1,000 year time horizon (Corrected) ↓**

Version 3.0.1

Pathway	SubArea 1		SubArea 2	
	Guideline (mg/kg)	Time to peak breakthrough (Year)	Guideline (mg/kg)	Time to peak breakthrough (Year)
Root Zone	7400	~ 70	3300	~ 40
Livestock Watering	ML (54000)	~ 90	ML (54000)	~ 130
Irrigation Watering	ML (54000)	~ 90	ML (54000)	~ 130
Aquatic Life	ML (54000)	~ 4655	ML (54000)	~ 4685
DUA	7500	~ 1000	2800	~ 1000
Minimum Chloride Guideline (mg/kg)	7400		2800	
Groundwater Guideline (mg/L)	NA-vadose		NA-vadose	

Version 3.0.2

SubArea 1		SubArea 2	
Guideline (mg/kg)	Time to peak breakthrough (Year)	Guideline (mg/kg)	Time to peak breakthrough (Year)
7400	~ 70	3300	~ 40
ML (54000)	~ 90	ML (54000)	~ 130
ML (54000)	~ 90	ML (54000)	~ 130
ML (54000)	~ 1000	ML (54000)	~ 1000
7500	~ 1000	2800	~ 1000
7400		2800	
NA-vadose		NA-vadose	

Reporting Updates

- Some minor formatting and clarity issues in pdf report improved in 3.0.2
- In 3.0.1, adjacent agricultural land not displayed if “No”, no site location displayed

Version 3.0.1

Site Information

Tier selected:	Tier 2B		
Land Use:	Natural Area		
Dugout in Natural Area:	No		
Overall Soil Lithology:	Fine		
Site-Specific Vertical Gradient (m/m):	Yes	Downward gradient + Upward gradient -	0.015
Hydraulic Conductivity Relevant to Drainage (m/s):	Yes		1.6E-7
Nearby dugout used as Fish Farm (within 500 m):	No		
Natural Subregion:	Central Mixedwood		
Climate Moisture Index Category:	Moist/Semi-Humid		
Root Zone drainage:	3 mm/yr recharge		
DUA drainage:	6 mm/yr recharge		

Reporting Updates

- **Cleaner formatting, more complete information in report for 3.0.2**

Version 3.0.2

Site Information

Tier selected:	Tier 2B	
Land Use:	Natural Area	
Site is Non-Agricultural Adjacent to Agricultural?	No	Distance to Agricultural Land (m): N/A
Dugout In Natural Area:	No	
Overall Soil Lithology:	Fine	
Site Specific Vertical Gradient (m/m):	Yes 0.015 [Down +, Up -]	
Hydraulic Conductivity Relevant to Drainage (m/s):	Yes 1.6E-7	
Nearby dugout used as Fish Farm (within 500 m):	No	
Township-Range-Meridian:	116-6-W6M	
Natural Subregion:	Central Mixedwood	
Climate Moisture Index Category:	Moist/Semi-Humid	
Root Zone Drainage:	3 mm/yr recharge	
DUA Drainage:	6 mm/yr recharge	

Reporting Updates

- **Issue of background Mg and Na column headers swapped in Ver 3.0.1 corrected**
  - **Did not affect any guidelines or calculations, but created potential for confusion**

Version 3.0.1

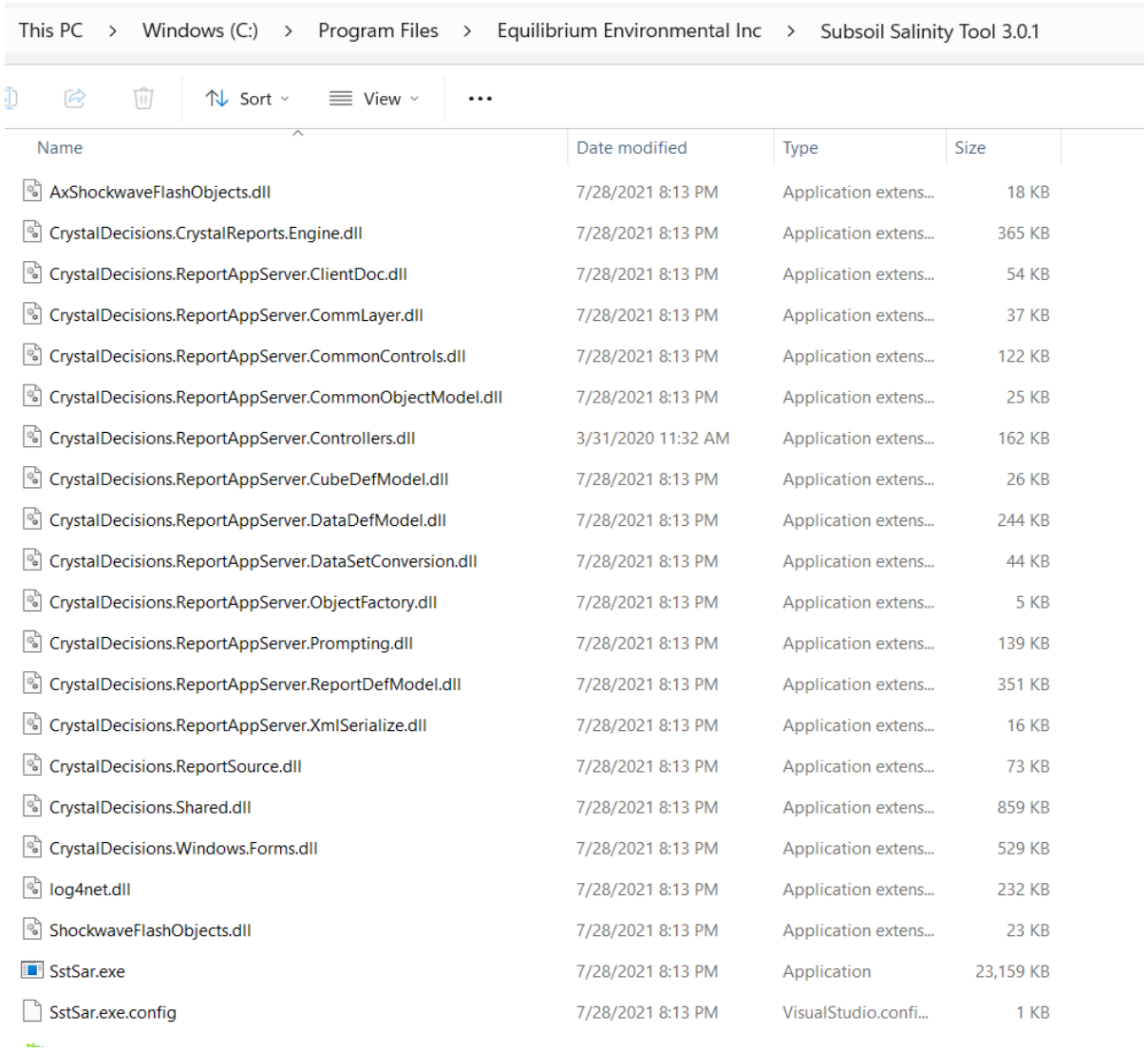
Borehole No.	Depth (m)	Mg (mg/kg)	Ca (mg/kg)	Na (mg/kg)	K (mg/kg)
S13-BH404	1.25	180	340	260	14
S15-BH501	1.25	367	436	424	4
S15-BH503	1.25	163	322	341	5
BH19-03	1.45	208	496	487	3
BH19-04	1.15	138	182	178	6
BH19-04	1.45	98	609	318	5
BH19-05	1.45	226	212	234	4
;08-W CONTRO	1.25	98	390	150	12
S08-BH-61	1.25	150	320	86	9
S08-BH-72	1.25	130	310	90	9
BH19-01	1.45	140	591	344	5

Version 3.0.2

Na (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	K (mg/kg)
180	340	260	14
367	436	424	4
163	322	341	5
208	496	487	3
138	182	178	6
98	609	318	5
226	212	234	4
98	390	150	12
150	320	86	9
130	310	90	9
140	591	344	5

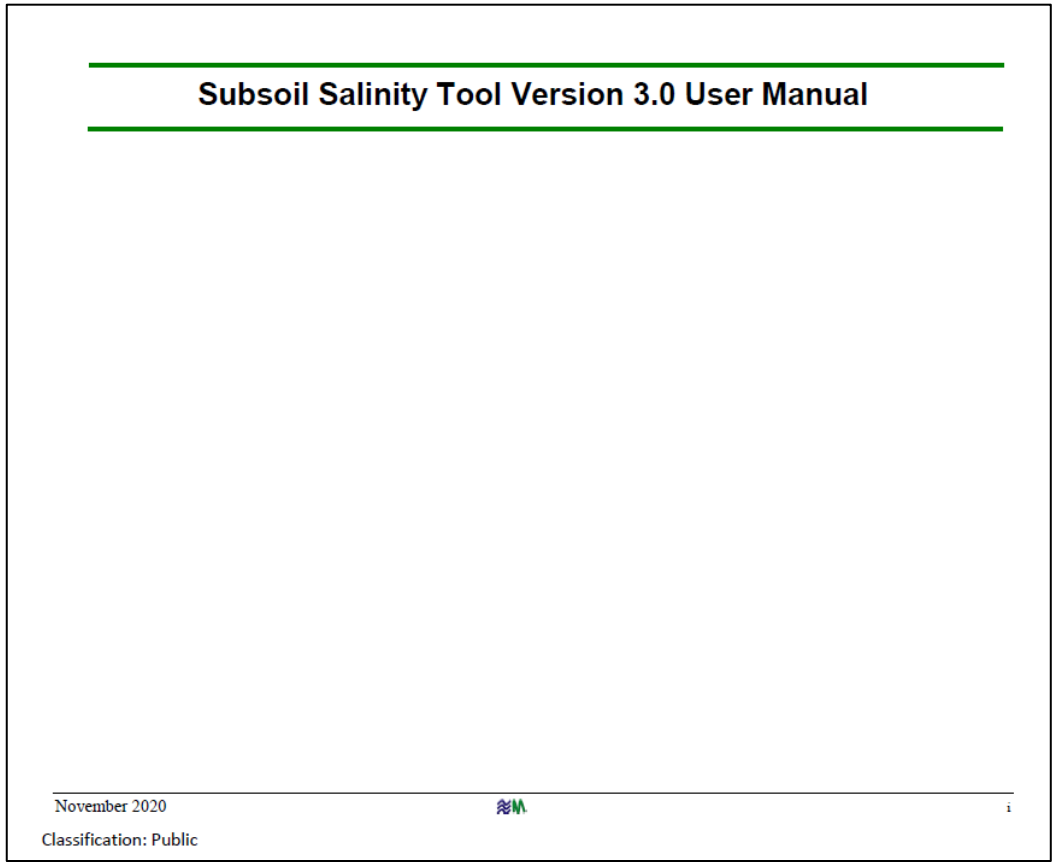
Reduced Dependencies

- Version 3.0.2 has reduced / removed dependencies on sensitive or out-of-date third-party components
- Removed “Crystal Reports” dependency
  - Part of pdf reporting feature in Version 3.0.1
- Removed requirement for Microsoft Excel to be installed
  - Part of guideline calculation requirements in Version 3.0.1
- More streamlined, modernized installer and execution package in Version 3.0.2



Documentation

- Basic functionality and instructions remain the same in Version 3.0.2 as 3.0.1
- Same in-line context-dependent help as in Version 3.0.1
- Same “SST User Manual” as originally released for Version 3.0 and maintained for Version 3.0.1 remains valid for Version 3.0.2



- Updated “User Manual” will be required for eventual Version 3.5 since it will have substantially different features and parameters

The Future: Version 3.5

Version 3.5

- After Version 3.0.2 is released, a more substantial SST update is planned over next year which upgrades and expands the range of scenarios supported by the SST

  all details below subject to further regulatory discussions / confirmation

- To be called Version 3.5, representing a substantial advancement on Version 3.0 series
  - First substantial feature/ modelling upgrade since Version 3.0 in 2020

- Updates / upgrades will likely be divided into two categories:
  1) Direct extensions of existing protocols to higher ranges
  2) More substantial modifications/additions to existing protocols

- Since a more substantial update, an updated User Manual will be required
  - May also need to reference updated Tier 1 document by that point

Version 3.5

1) **Direct extensions of existing protocols to higher ranges could include:**
   - Expansion of maximum impact depth from 15 to 20 m
   - Expansion of maximum DUA Depth from 25 to 40 m
   - Expansion of maximum water table depth from 15 m to 25 m
   - Increased maximum FAL receptor distance from 1,000 m to 2,000 m
   - "Smoothing" of shallow groundwater velocity behavior rather than "buckets"

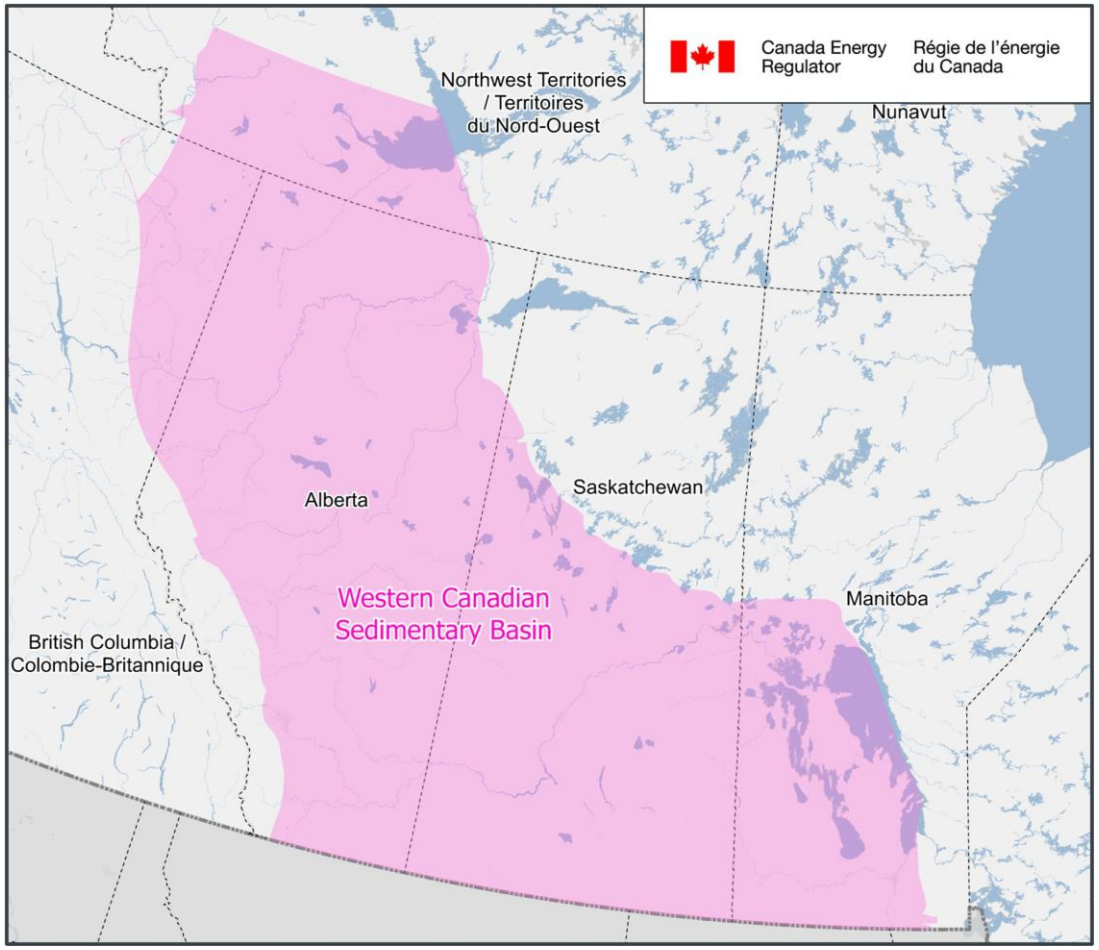
2) **More substantial modifications/additions to existing protocols could include:**
   - Increased subarea dimensions
   - Increased total impact footprint
   - Increased total source length for entire site
   - Increased number of subareas
   - Potential adjustments to selected default groundwater properties

- **These changes would generally allow application of the SST to more complex sites**
  - Some features could potentially be implemented under the Tier 2C umbrella rather than the standard Tier 2A/2B to ensure sufficient protection and regulatory oversight

SST-Related Topics

Other Jurisdictions (eg, IOGC)

- SST-like tools+techniques can be adapted to other jurisdictions where useful
- For example, some approaches currently being considered to apply the SST to Indian Oil and Gas Canada (IOGC) sites
  - Majority of relevant sites (though not all) located in Western Canadian Sedimentary Basin (possibly outside Alberta)
- IOGC draws heavily on CCME guidelines, with additional considerations for First Nation sites
  - Generally more conservative of provincial and federal guidelines used
- May involve additional conservatism being incorporated via post-adjustments to SST guidelines and protocols



SST Web Application

- SST Version 3.0.2 will remain a free, downloadable desktop app
  - Consistent with all previous SST versions
  - Will be available on EPA website once finalized / approved
- As part of the development process, an alternative web-based platform was developed with matching functionality and guidelines
  - Internal beta version, currently not for public release
- Could be of value in the future for companies or organizations that have restrictions on downloading and directly installing desktop apps
  - In such cases, web apps are often preferred by IT departments and users
- Feel free to contact Equilibrium if such an option would be of value

Tier 2 Organic Contaminant Guidelines

- One additional use of this SST web app platform is a Tier 2 guideline calculator for organic contaminants
- Includes standard BTEX and F1-F4 fractions, along with a range of other organic contaminants
  - PAH's, glycols, methanol, chlorinated compounds, miscellaneous other organics
- Also incorporates some other SST-like modifications to the standard Tier 2 model in non-standard cases where appropriate
- Includes options for non-standard Tier 2 adjustments such as:
  - Consideration of groundwater / saturated soils not necessarily representing a DUA (analogous to "Shallow groundwater" in SST)
  - Consideration of vertical transport (DF2) potentially through saturated soils rather than unsaturated soils (analogous to saturated vertical transport in SST)
- Additional technical details provided at Equilibrium website (www.eqm.ca) under "Scientific Advancements" →"Conferences and Presentations"→

  Considerations, Complications, and Advanced Techniques for the Derivation of Tier 2 Hydrocarbon Guidelines to Optimize Remediation Approaches (CLRA, 2026)

SST Courses

SST Courses

All SST courses will involve pre-release (non-official) Version 3.0.2 for maximum future relevance

Full Certification Course (4-day)

October 27-30, 2026

SST Overview Course (1-day)

November 3, 2026

Advanced SST Techniques Course (1-day)

November 5, 2026

Tier 2 Organic Contaminant Guidelines Course (1-day)

November 12, 2026 *New*

For further information:

Visit our webpage at www.eqm.ca

Or contact SSTinfo@eqm.ca

Or visit our LinkedIn page

Acknowledgements

- Alberta Environment and Protected Areas
- Alberta Energy Regulator
- Petroleum Technology Alliance of Canada (PTAC)

Thank you!

SSTinfo@eqm.ca