

ROAD SALT

FATE AND TRANSPORT CONCEPTUAL MODEL

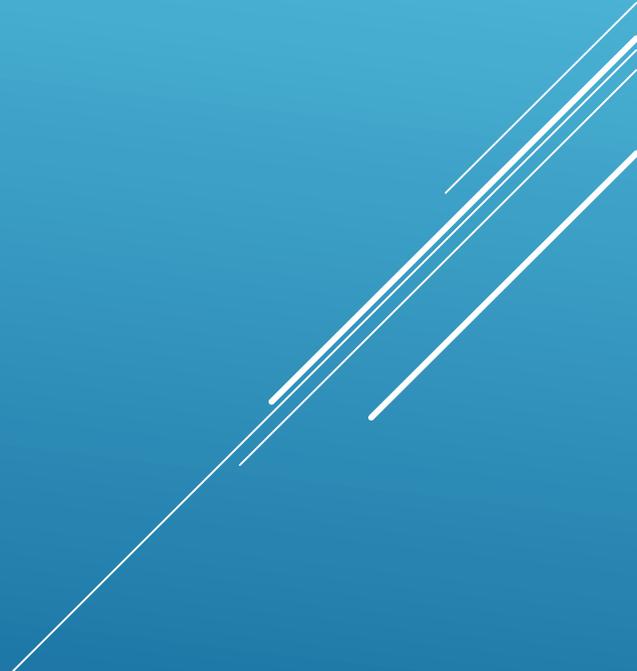
Presented on February 14, 2019

Water Quality Monitoring and Research
Workgroup

CONCEPTUAL SITE MODEL: DEVELOPMENT OBJECTIVES

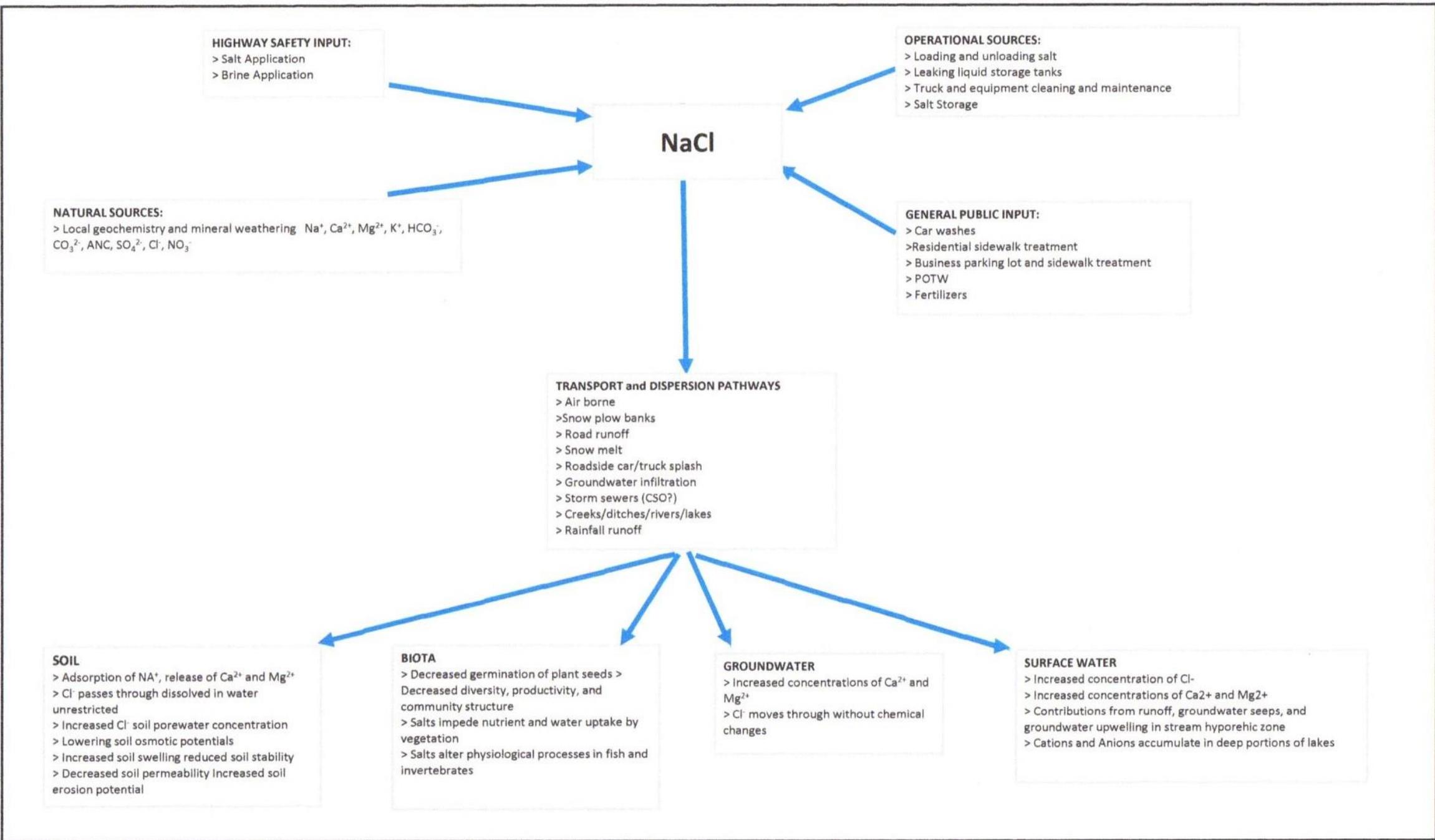
- Gain understanding of deicing compound inputs and fate
 - Identify primary and secondary sources
 - Define preferential flow pathways
 - Determine dispersion and distribution of compounds
 - Support development of framework for monitoring program and potential quantitative benchmark tracking
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CONCEPTUAL MODEL DEVELOPMENT BACKGROUND

- ▶ Obtained 8 main references (2 Canadian and 6 US) – 2 were published articles and required contacting primary authors for a copy
 - ▶ Sources included – Minnesota, New York, Maryland, Massachusetts, City of Toronto, and Town of Penetanguishene
 - ▶ Most sources date from 2016 although a Minnesota Pollution Control Agency document was prepared in 2009
 - ▶ Published articles contain excellent details of data collection, assessment, and interpretation to support water quality trend analysis
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CONCEPTUAL SITE MODEL: IMPORTANT FACTORS TO DISCUSS

- ▶ Natural and background concentrations of ions
 - ▶ Identification of local primary and secondary deicing compounds
 - ▶ Selection of key local environmental conditions
 - ▶ Factors contributing to mass balance
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HIGHWAY SAFETY INPUT:

- > Salt Application
- > Brine Application

OPERATIONAL SOURCES:

- > Loading and unloading salt
- > Leaking liquid storage tanks
- > Truck and equipment cleaning and maintenance
- > Salt Storage

NaCl

NATURAL SOURCES:

- > Local geochemistry and mineral weathering Na⁺, Ca²⁺, Mg²⁺, K⁺, HCO₃⁻, CO₃²⁻, ANC, SO₄²⁻, Cl⁻, NO₃⁻

GENERAL PUBLIC INPUT:

- > Car washes
- > Residential sidewalk treatment
- > Business parking lot and sidewalk treatment
- > POTW
- > Fertilizers

TRANSPORT and DISPERSION PATHWAYS

- > Air borne
- > Snow plow banks
- > Road runoff
- > Snow melt
- > Roadside car/truck splash
- > Groundwater infiltration
- > Storm sewers (CSO?)
- > Creeks/ditches/rivers/lakes
- > Rainfall runoff

SOIL

- > Adsorption of NA⁺, release of Ca²⁺ and Mg²⁺
- > Cl⁻ passes through dissolved in water unrestricted
- > Increased Cl⁻ soil porewater concentration
- > Lowering soil osmotic potentials
- > Increased soil swelling reduced soil stability
- > Decreased soil permeability increased soil erosion potential

BIOTA

- > Decreased germination of plant seeds
- > Decreased diversity, productivity, and community structure
- > Salts impede nutrient and water uptake by vegetation
- > Salts alter physiological processes in fish and invertebrates

GROUNDWATER

- > Increased concentrations of Ca²⁺ and Mg²⁺
- > Cl⁻ moves through without chemical changes

SURFACE WATER

- > Increased concentration of Cl⁻
- > Increased concentrations of Ca²⁺ and Mg²⁺
- > Contributions from runoff, groundwater seeps, and groundwater upwelling in stream hyporehic zone
- > Cations and Anions accumulate in deep portions of lakes

CONCEPTUAL SITE MODEL FUTURE CONSIDERATIONS

- ▶ Is a quantitative fate and transport model necessary?
 - ▶ What level of effort required to effectively determine the mass balance and minimize uncertainties?
 - ▶ What metrics and locations are important to assess trends in ion concentrations?
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