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Afternoon Speaker August 1

Examining Chloride in an Agricultural Watershed Using a Mass Balance and Simple Hydrologic Model

SALT SYMPOSIUM

Examining Chloride in an Agricultural Watershed Using a Mass Balance and Simple Hydrologic Model

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DEPARTMENT OF HEALTH

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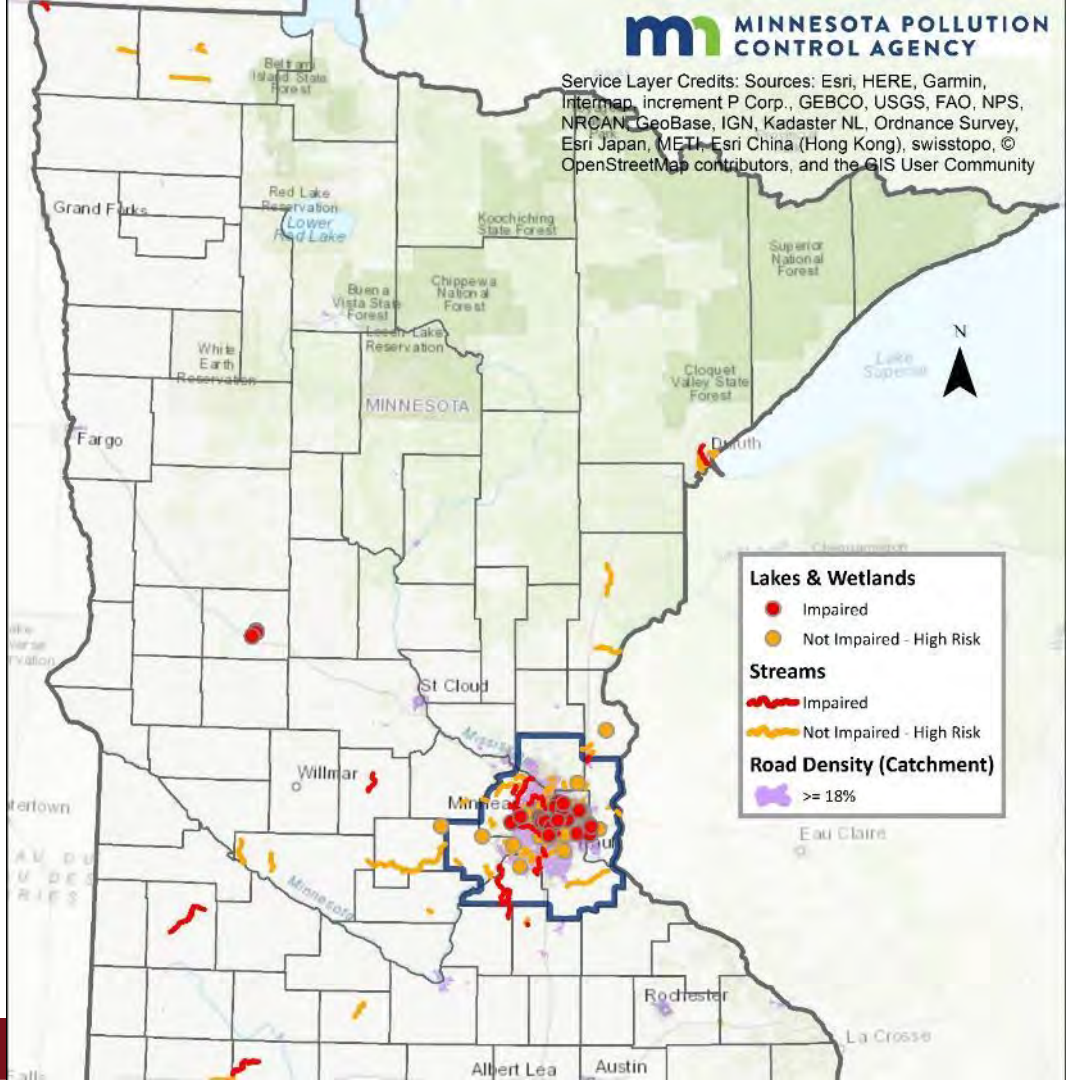
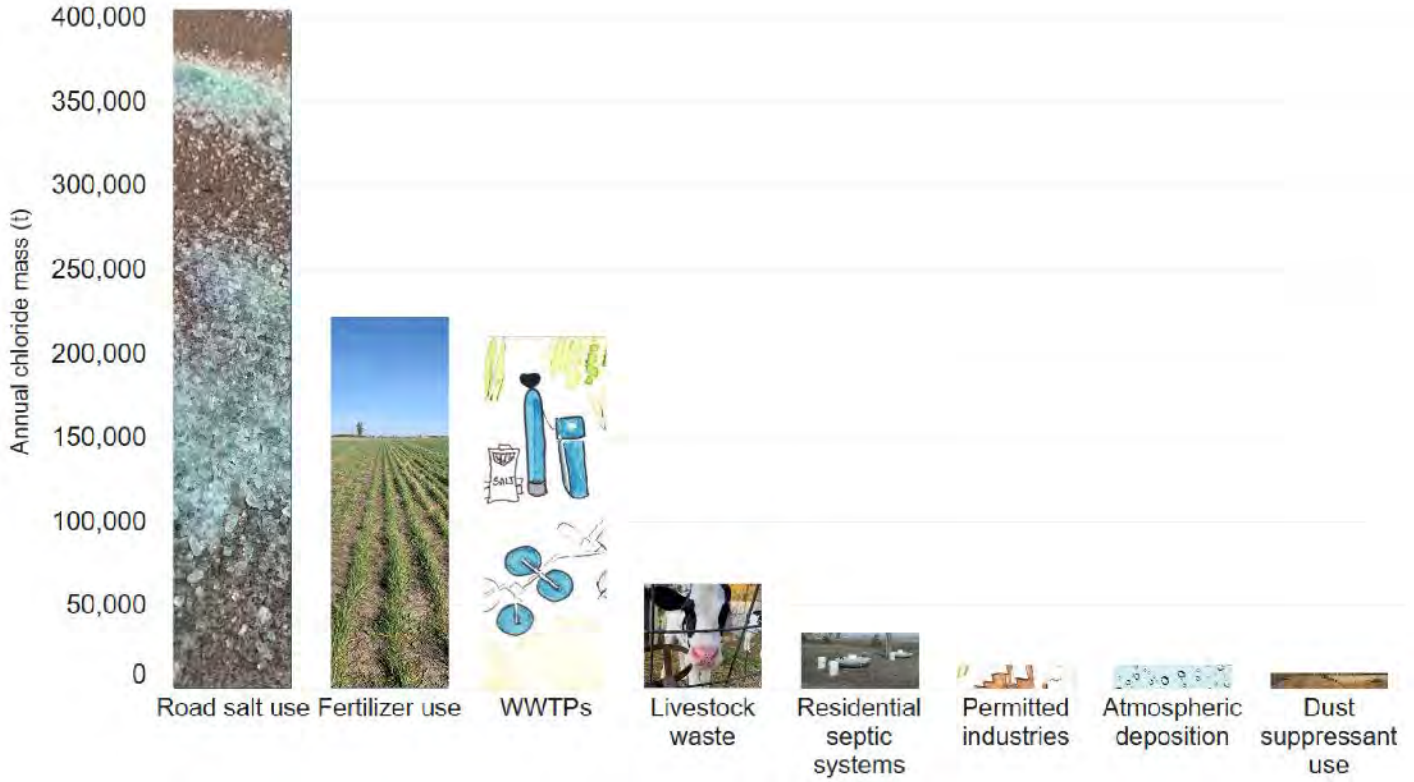
In Minnesota, most chloride impairments are concentrated in urban areas



Chloride has largely been studied in more urban watersheds

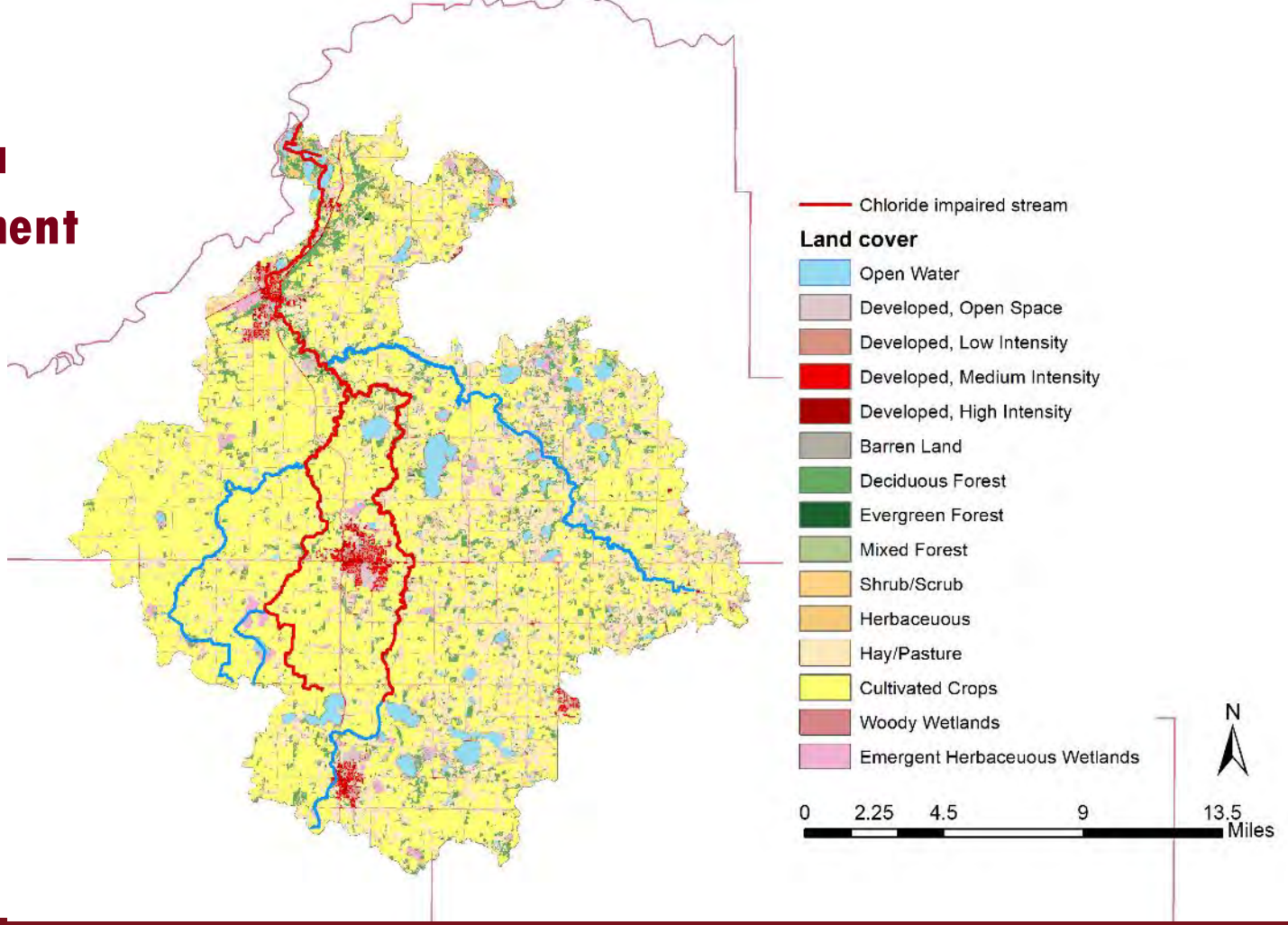
Wastewater treatment plants (WWTPs) and agriculture are also major chloride sources in Minnesota



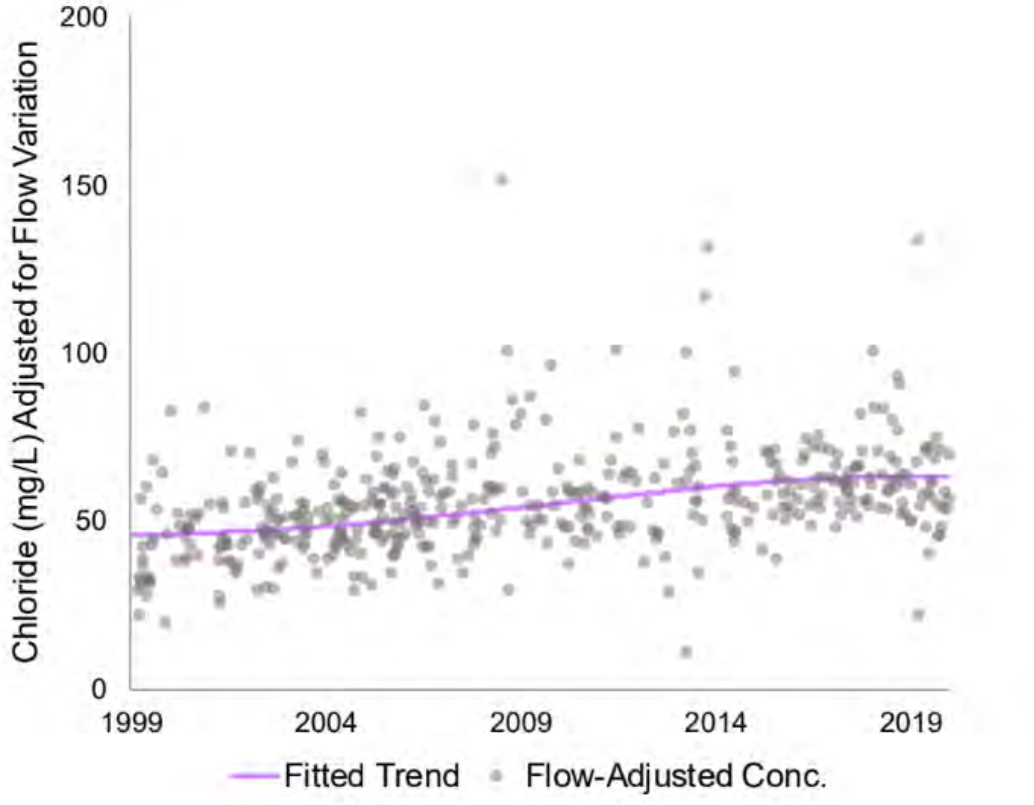
(Overbo et al. 2021)

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

Sand Creek Watershed has a chloride impairment but has mixed land use

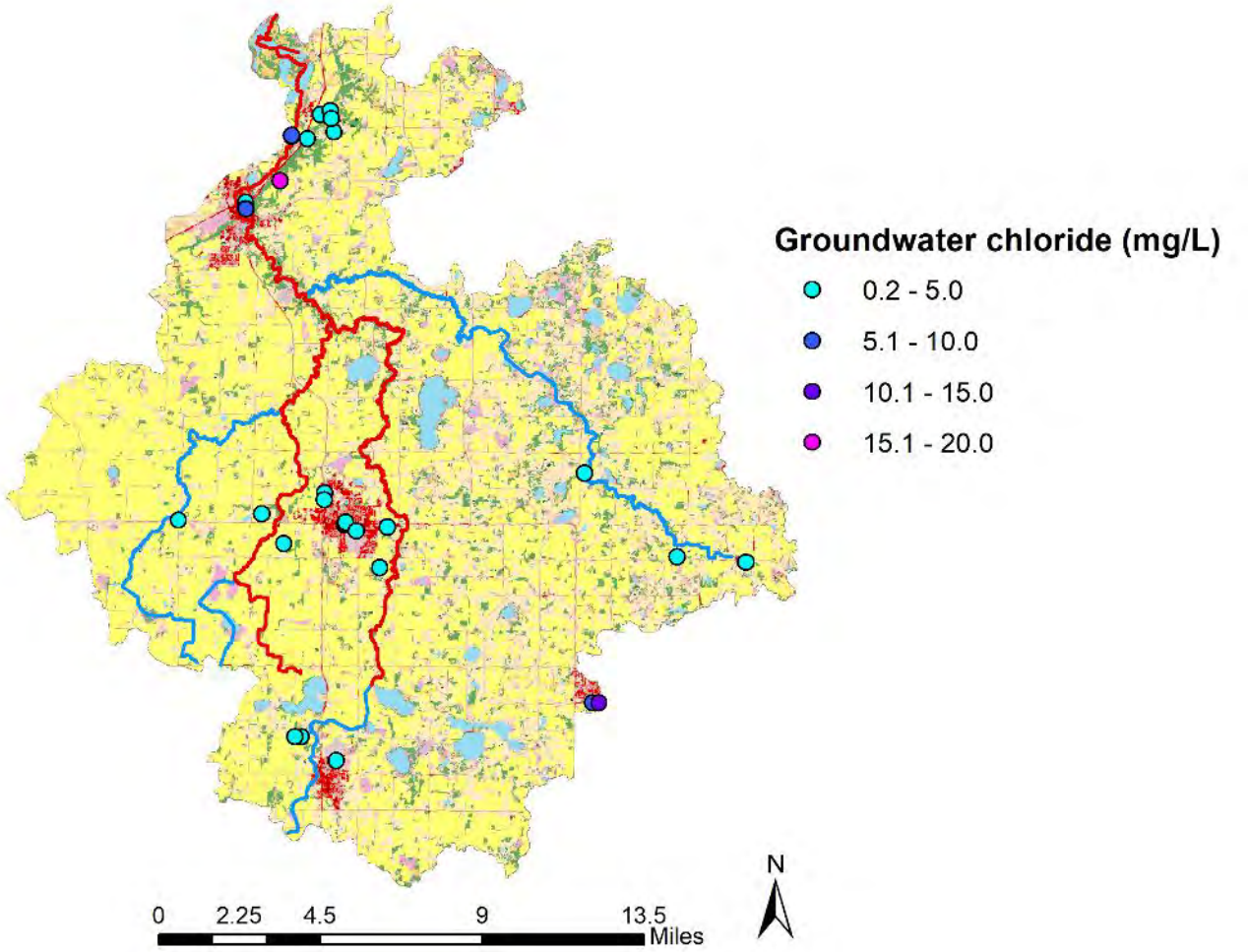


Adjusted for flow, chloride levels in Sand Creek have increased by 37% from 1999-2019



(MCES 2021)

Groundwater chloride levels in the watershed are relatively low



What are the important chloride sources in Sand Creek?

Can we use a simple model to assess chloride sources and levels?

Point sources:

- Wastewater treatment plants
- Industry

Non-point sources:

- KCl fertilizer
- Deicing salt
- Atmospheric deposition
- Dust suppressant use
- Livestock excreta
- Residential septic systems

Major sources of chloride in wastewater:


Excreta


Household products


Drinking water background & chlorination


Wastewater chlorination


Deicing salt infiltration/inflow (I&I)


Water softening

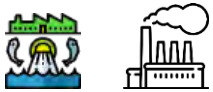

Commercial organizations


Industry

Data sources for chloride budget

Research literature, survey of water softening professionals

Wastewater effluent monitoring data, groundwater pumping data



Cropland Data Layer, NASS, Discovery Farms

MPCA permit records, research literature

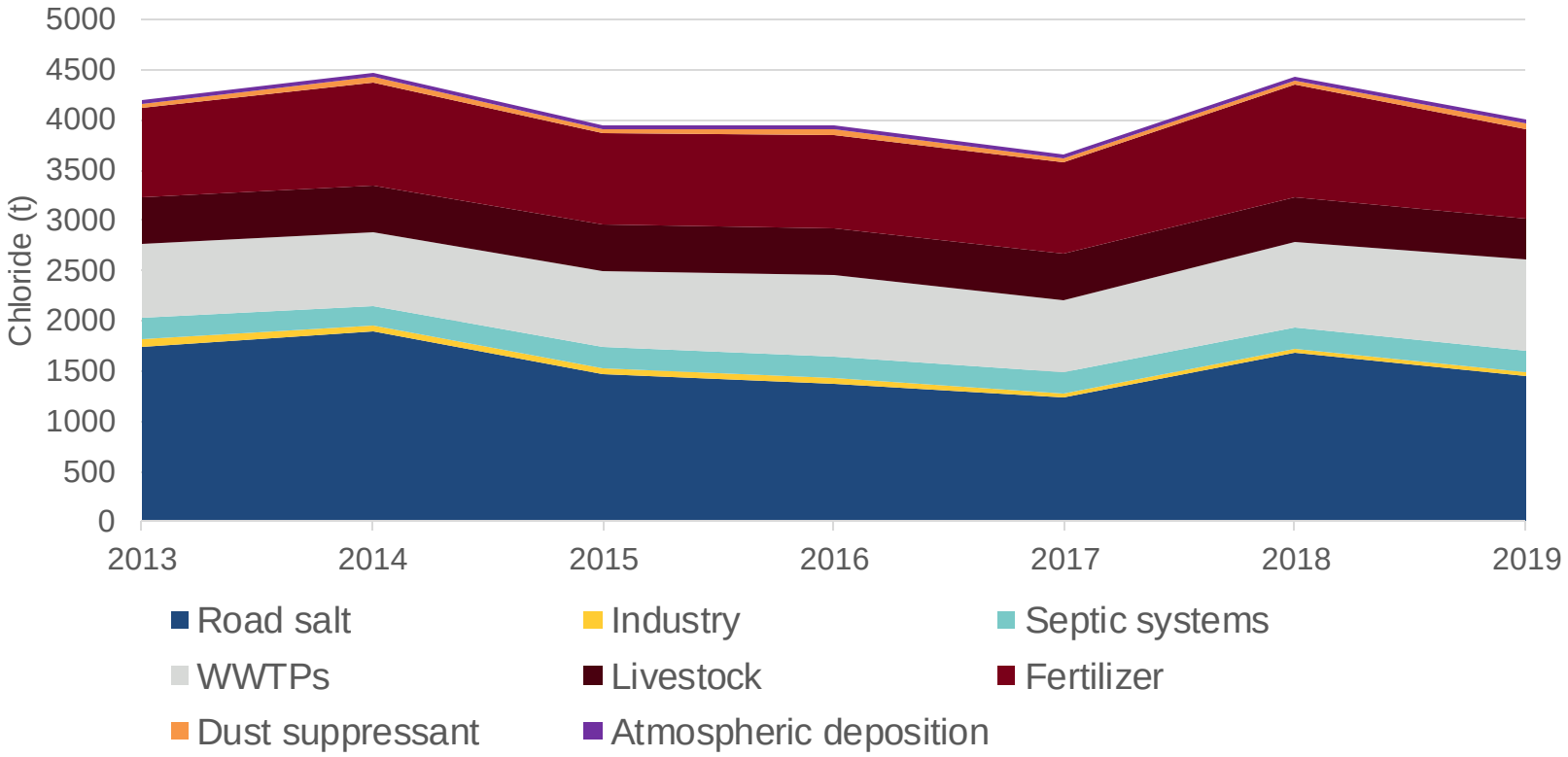
MnDOT and County data

County, MPCA, and Census data

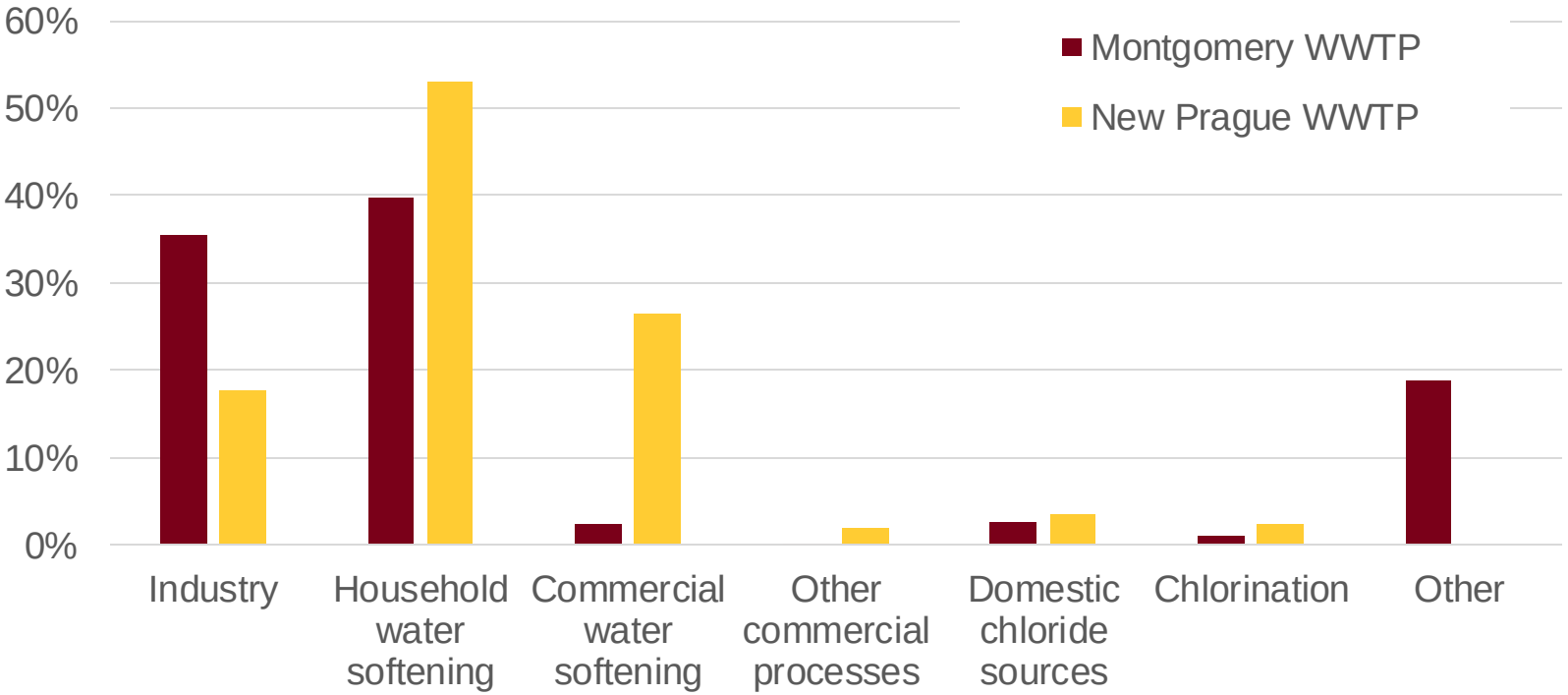
County public works

(Overbo et al. 2021)

Estimated annual chloride inputs to watershed



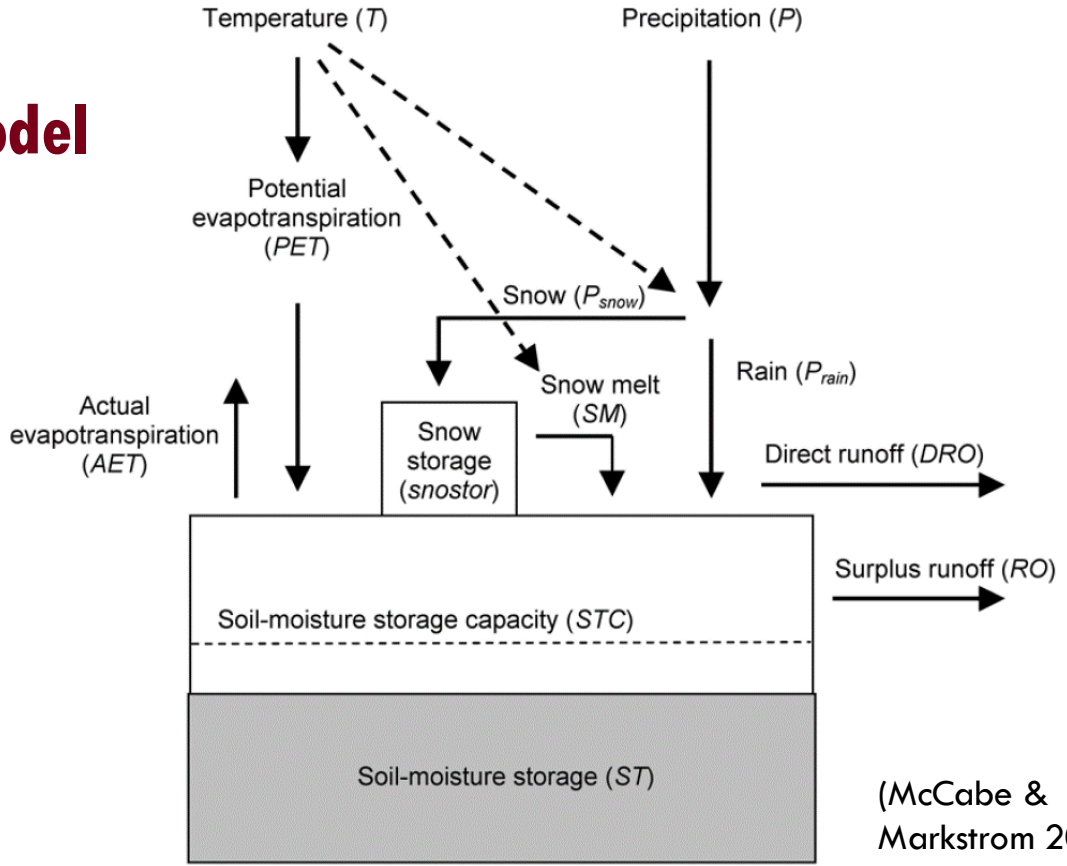
Chloride contributions to WWTPs in watershed



Simple chloride model

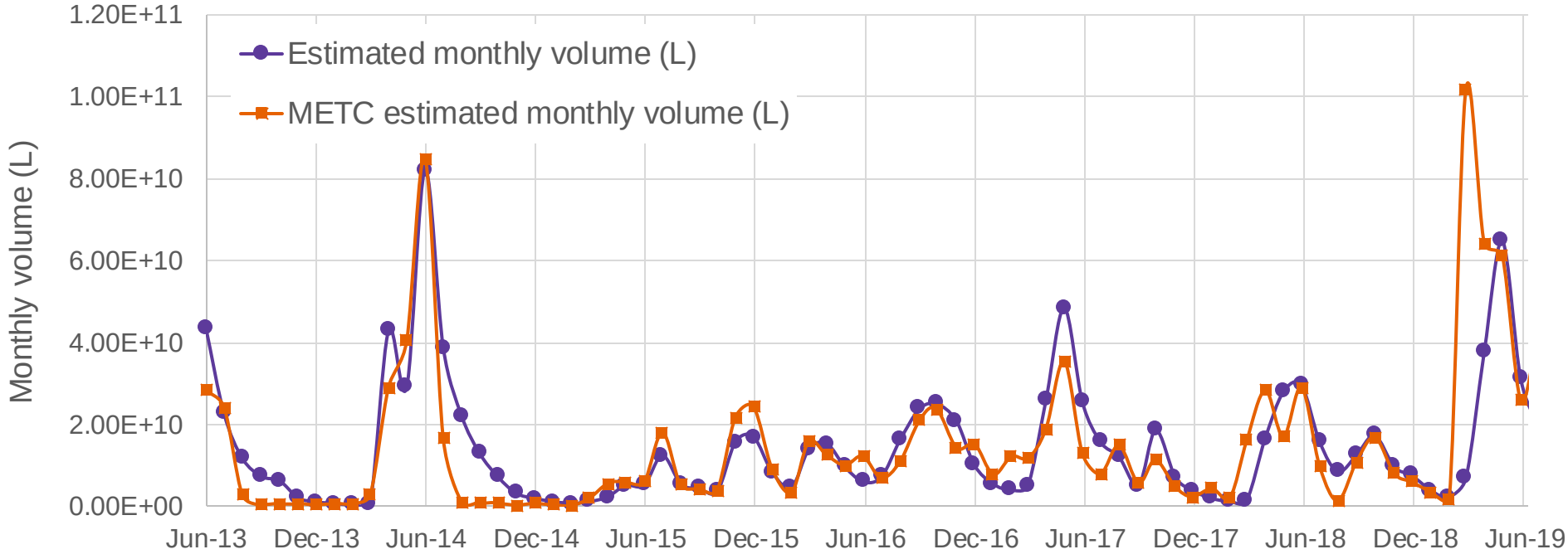
USGS Thornthwaite model

- Data inputs:
  - Monthly mean temperature (MDNR 2018)
  - Monthly total precipitation (MRCC 2018)
  - Input parameters (McCabe & Markstrom 2007)



(McCabe & Markstrom 2007)

Comparison of modeled total runoff vs METC monthly volume



Timing of chloride contributions in simple analysis

Point source chloride is exported within month

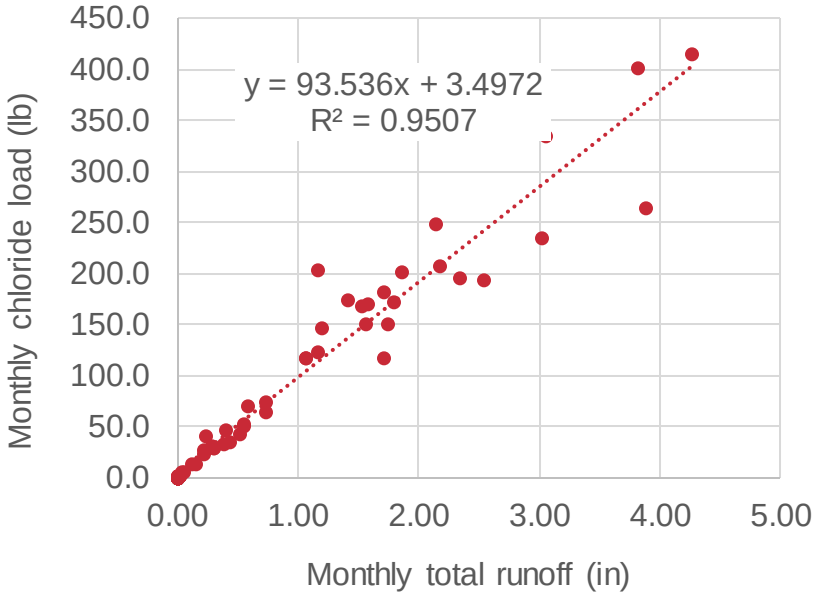
Drain tile contributions exported within month based on runoff

Nonpoint source chloride is mixed and exported over year based on monthly runoff

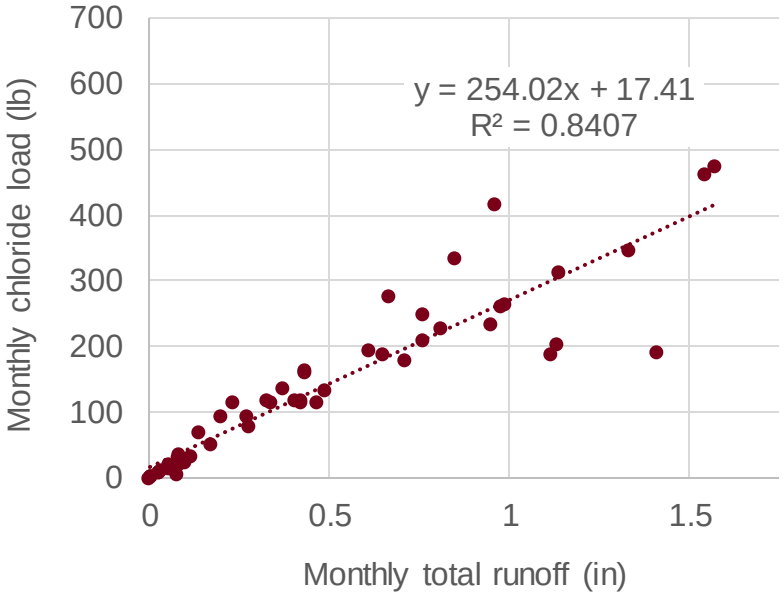
Baseflow contributions consistent year-round

Using Discovery Farm data to estimate the chloride loading from tile drainage

Blue Earth site – potash application



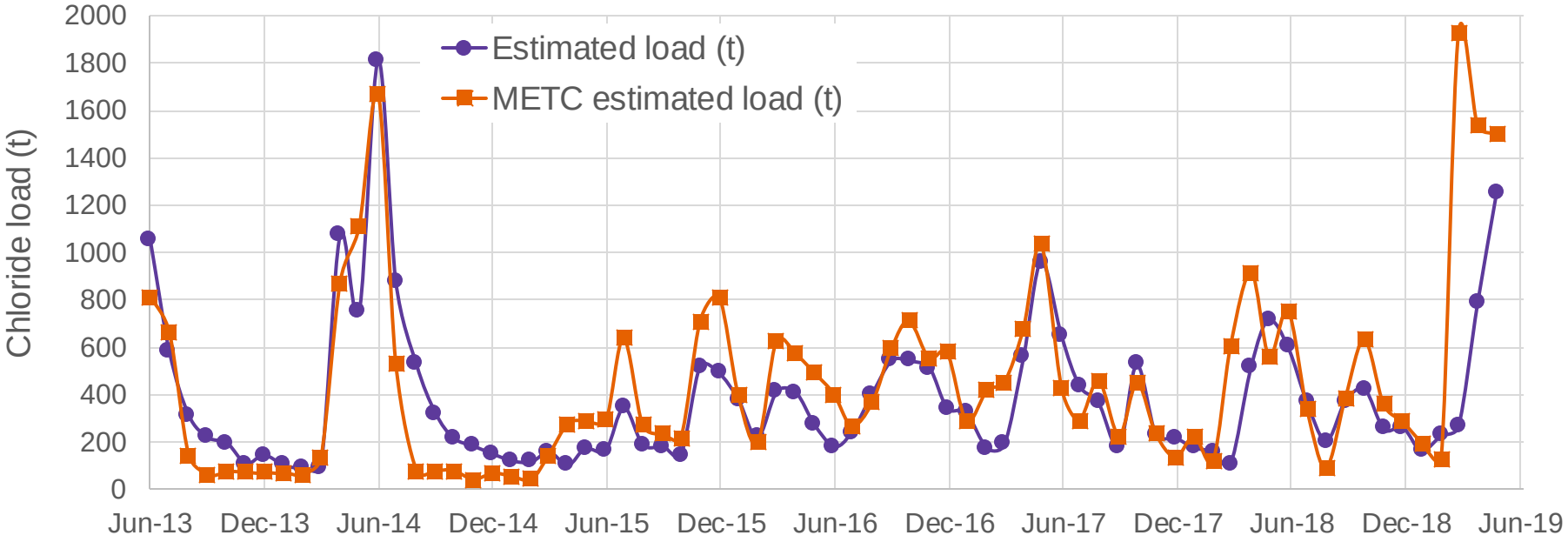
Renville site – manure application



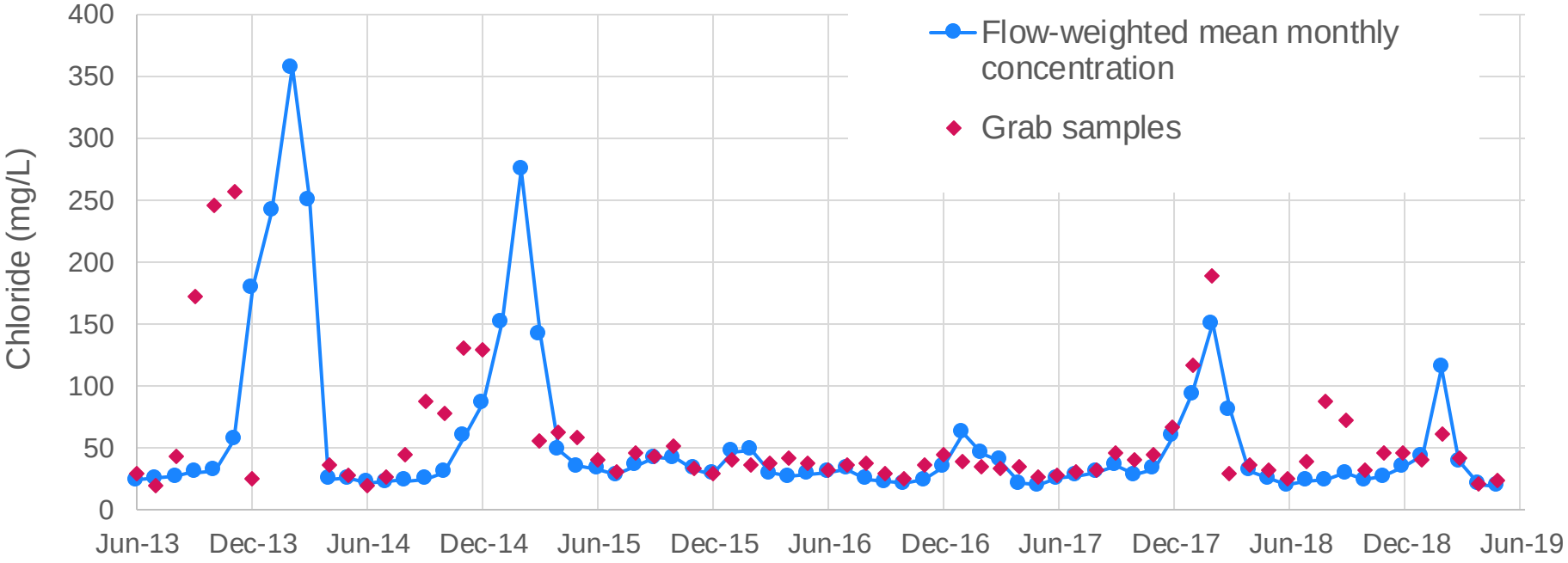
Chloride nonpoint estimates

- Sum remaining nonpoint loads for calendar year
- Annual chloride loading divided by total annual runoff to estimate average annual concentration in runoff

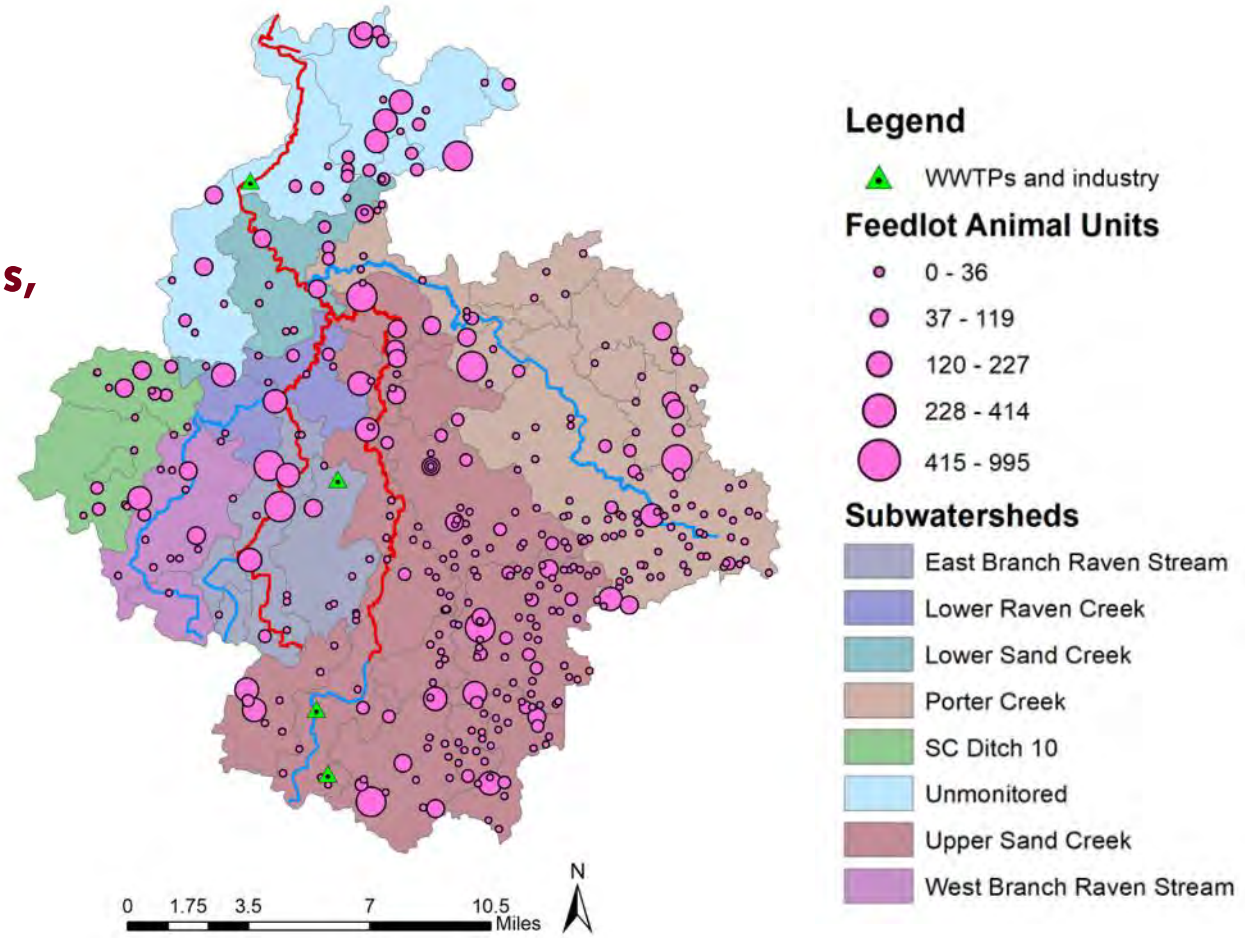
Comparison of estimated chloride loading



Comparison of results with grab sample data



Impaired reaches of Sand Creek had monitored WWTPs, industry, and generally greater concentration of livestock animal units



Take-aways from analyses

- Agriculture estimated to be a major chloride source, along with road salt and WWTPs
- Chloride loading driven by runoff and concentrations influenced by low-flow conditions
- Supports previous research findings on chloride retention in watersheds

Acknowledgements

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- Minnesota Pollution Control Agency
- Minnesota Department of Agriculture
- Minnesota Department of Health

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Thank you! Questions?

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