

**EVALUATING SANITARY SEWERS AS A
POTENTIAL SOURCE OF SODIUM
AND CHLORIDE IN AN URBAN
AQUIFER SYSTEM**

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DISCLAIMER

The views expressed are those of the author and do not necessarily reflect the official views of the Uniformed Services University of the Health Sciences, the U.S. Army, or the Department of Defense.





BACKGROUND

Sodium and Chloride

- Detected in all Madison wells
- 2014 Water Quality Report

	MCLG	Median Level	Range	Typical Sources
Chloride (ppm)	250	22	2.4 - 120	Natural Deposits Road Salt
Sodium (ppm)	n/a	9.3	2 - 40	Natural Deposits Road Salt



POTENTIAL SOURCES



Road Salt

- Road de-icing
- Impact on surface water

Home Water Softeners

- Ion Exchange: Ca^{2+} , Mg^{2+} for Na^{+}
- Requires salt to recharge system
- Brine discharge to sewer





SEWER LEAKAGE

U.S. estimates

- up to 50% of flow

U.K. estimates

- 10% of flow

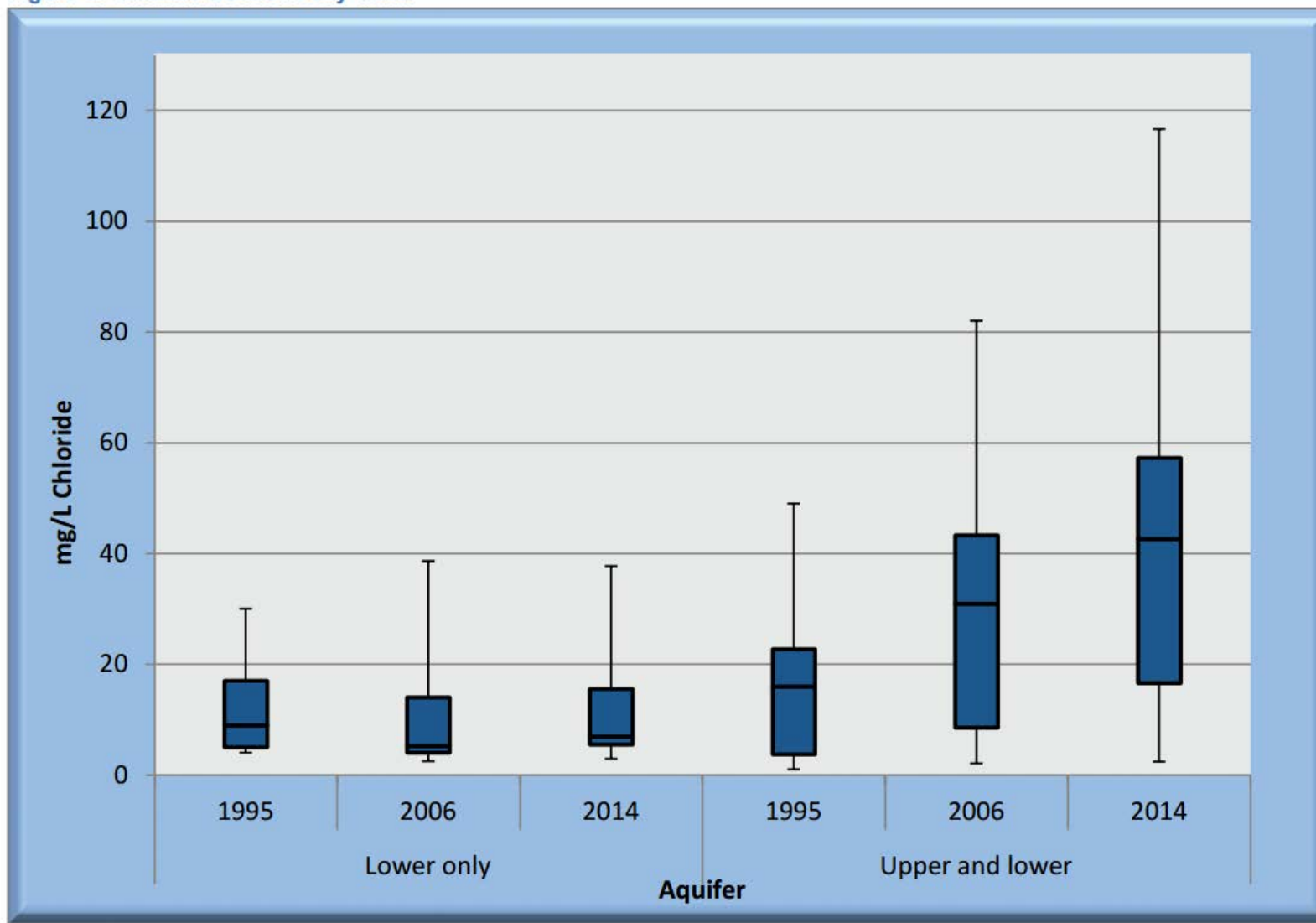
Lab experiments

- 0.01 to 0.1 L/sec/km





CHLORIDE IN MADISON WELLS



From Wenta and Sorsa, 2014

Depth (m)

0

11

29

65

monitoring wells

A B C

Unit Well 7

sanitary sewer (distributed source)

water table

Holy Hill Formation

Tunnel City Group

Upper Aquifer

Wonewoc Formation

Eau Claire aquitard

Lower Aquifer

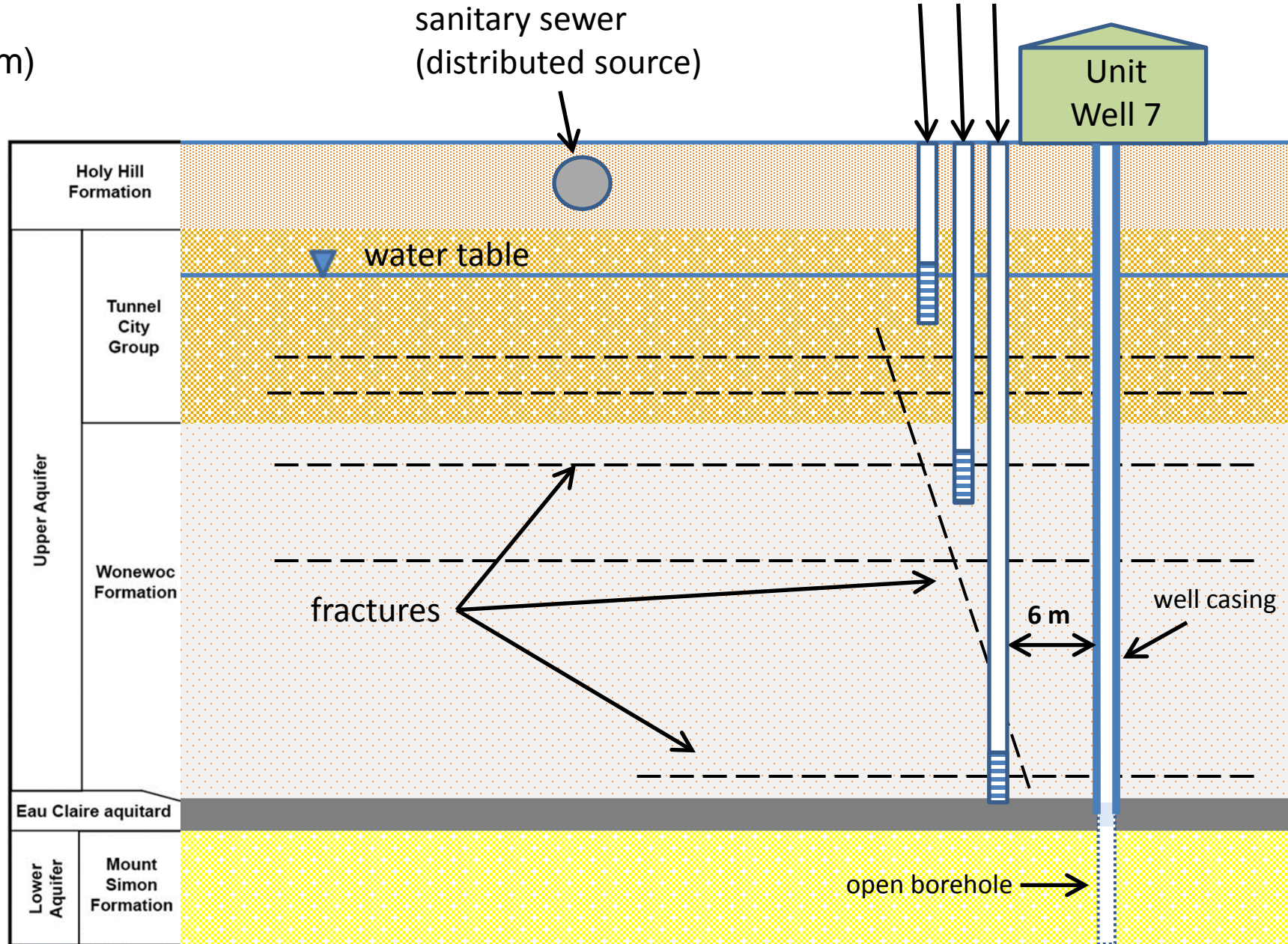
Mount Simon Formation

fractures

well casing

6 m

open borehole





GROUNDWATER CHEMISTRY

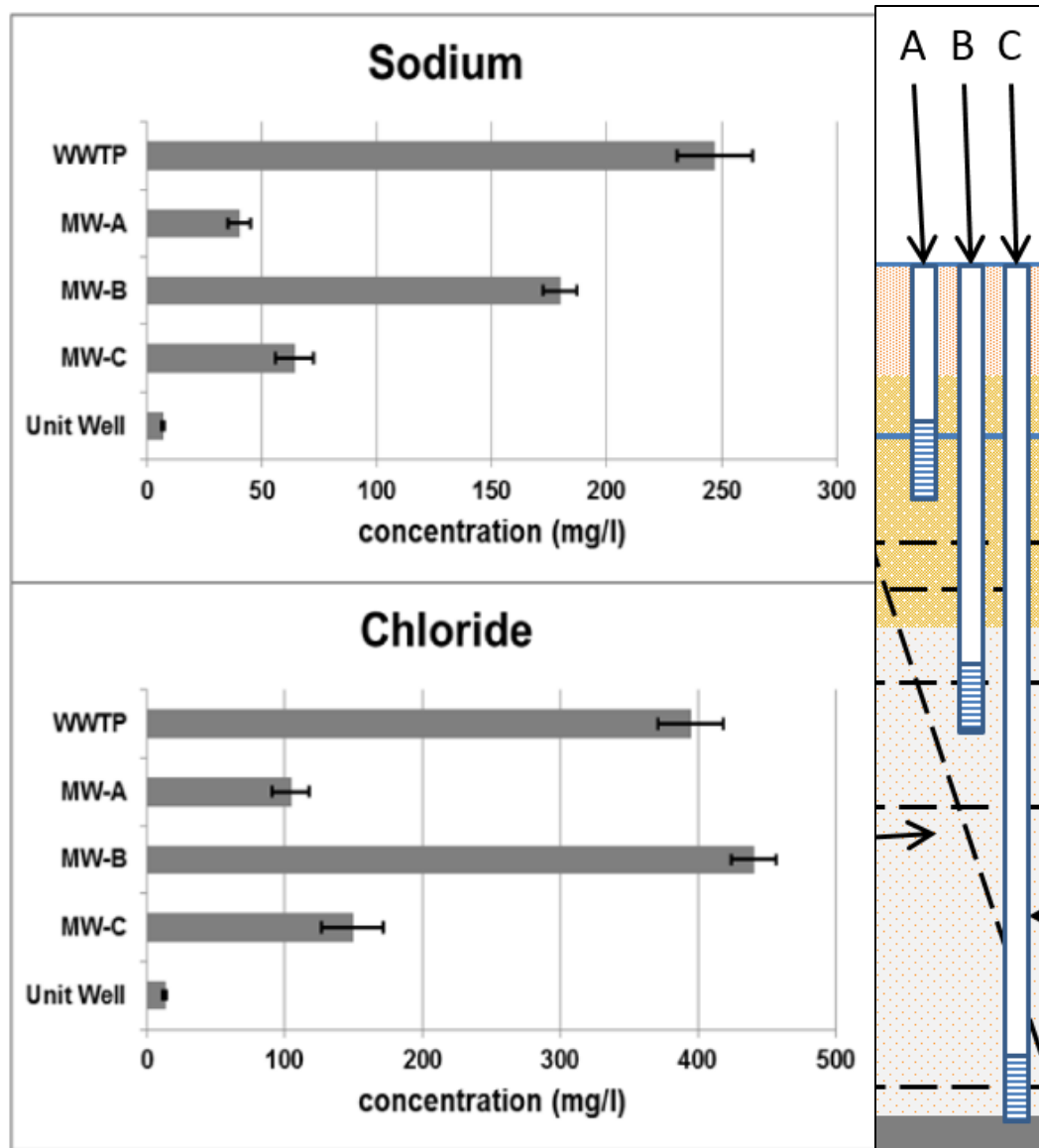
No Seasonal Trend

Chloride (mg/l)

- Sewer: 400
- Upper Aquifer: 450
- Lakes: < 100

Electrical Conductivity

Nitrogen





ROAD SALT

- 10M kg/yr applied to Madison roads
- Seasonal application
- Impervious surfaces
 - Low infiltration rates
 - High surface runoff





SANITARY SEWERS

- MMSD treats 150M liters/day sewage
- 10% leakage estimate
 - 15M liters/day loading upper aquifer
- 400 mg/l chloride: 2.2M kg/year
- 250 mg/l sodium: 1.4M kg/year



SANITARY SEWERS

- City of Madison: >1,000 km of lines
- Leakage rate: 0.1 L/sec/km
 - 8.6M liters/day loading upper aquifer
- 400 mg/l chloride: 1.3M kg/year
- 250 mg/l sodium: 0.8M kg/year



CONCLUSIONS

- Road salt impacts surface water and groundwater
- Sanitary sewers impact groundwater
 - May exceed road salt
 - Infiltration and sewer leakage rates
- Additional impact from storm sewers?



SIGNIFICANCE

- Limiting road salt application may not solve groundwater Na^+ and Cl^- problem
- Effect of sewers must be considered in Na^+ and Cl^- mitigation strategy
- Multi-aquifer wells that intersect fractures with high concentrations Na^+ and Cl^-



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