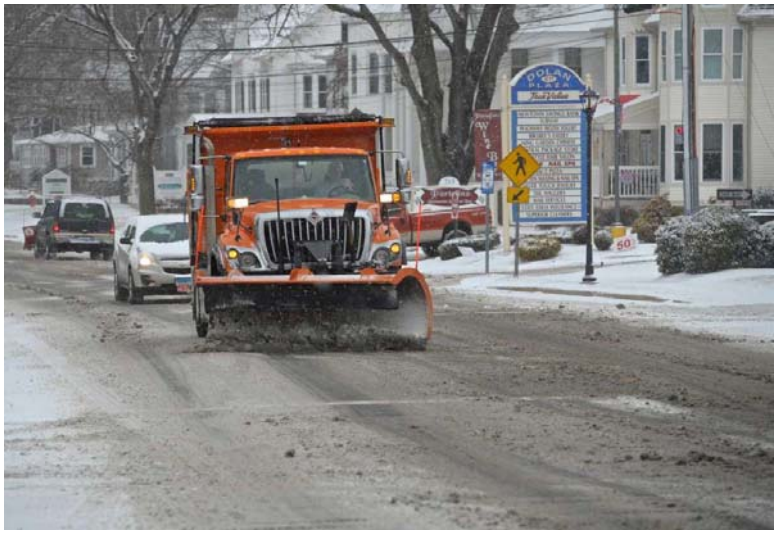
Road Salt Use in Connecticut: Understanding the Consequences of the Quest for Dry Pavement



Michael Dietz, Ph.D. and Lukas McNaboe

February 14, 2017

2pm

CLEAR
Center for Land Use Education & Research

UCONN | COLLEGE OF AGRICULTURE, HEALTH AND NATURAL RESOURCES

Welcome to the CLEAR Webinar Series!

This is the second in the 2017 series

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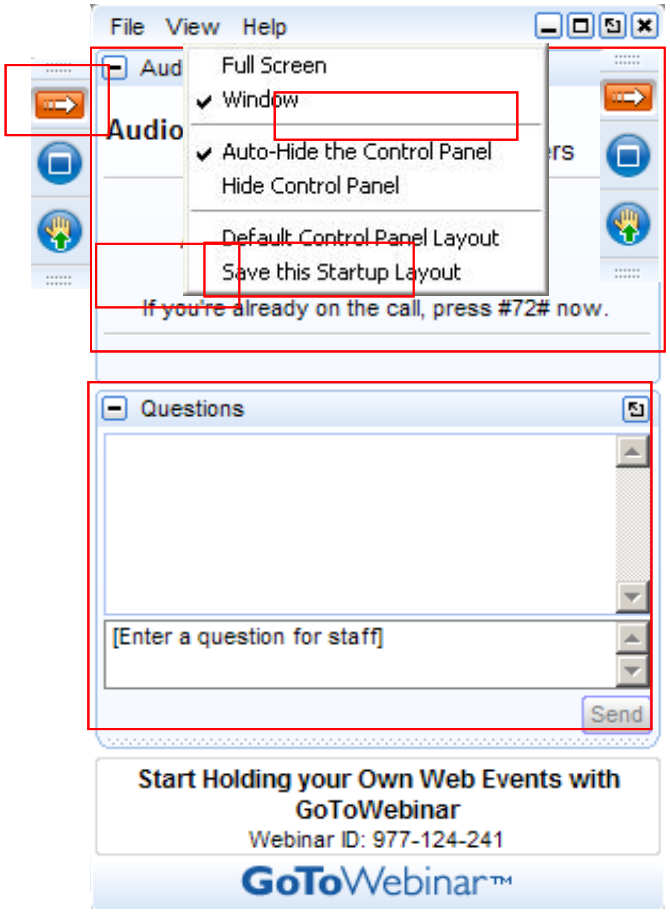


Center for Land Use Education and Research

CLEAR's Mission:

To provide information, education and assistance to land use decision makers in support of balancing growth and natural resource protection.

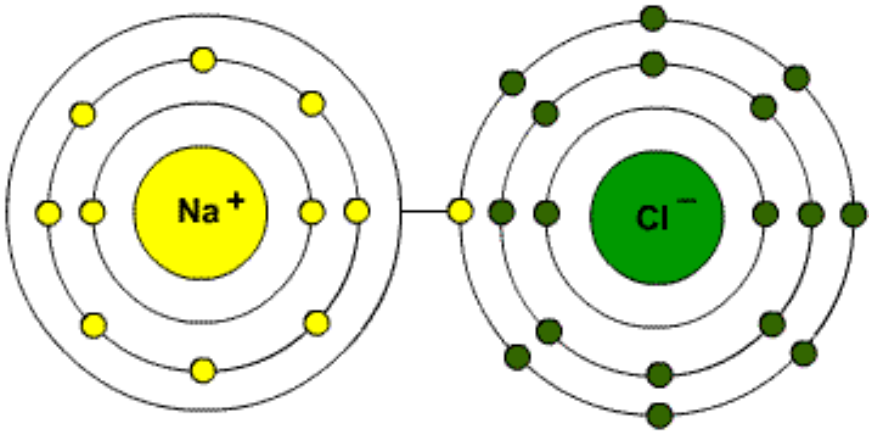
University of CT

- College of Ag., Health & Nat. Res., Dept. of Extension
- College of Ag., Health & Nat. Res.,, Dept. of Natural Resources & the Environment
- Connecticut Sea Grant

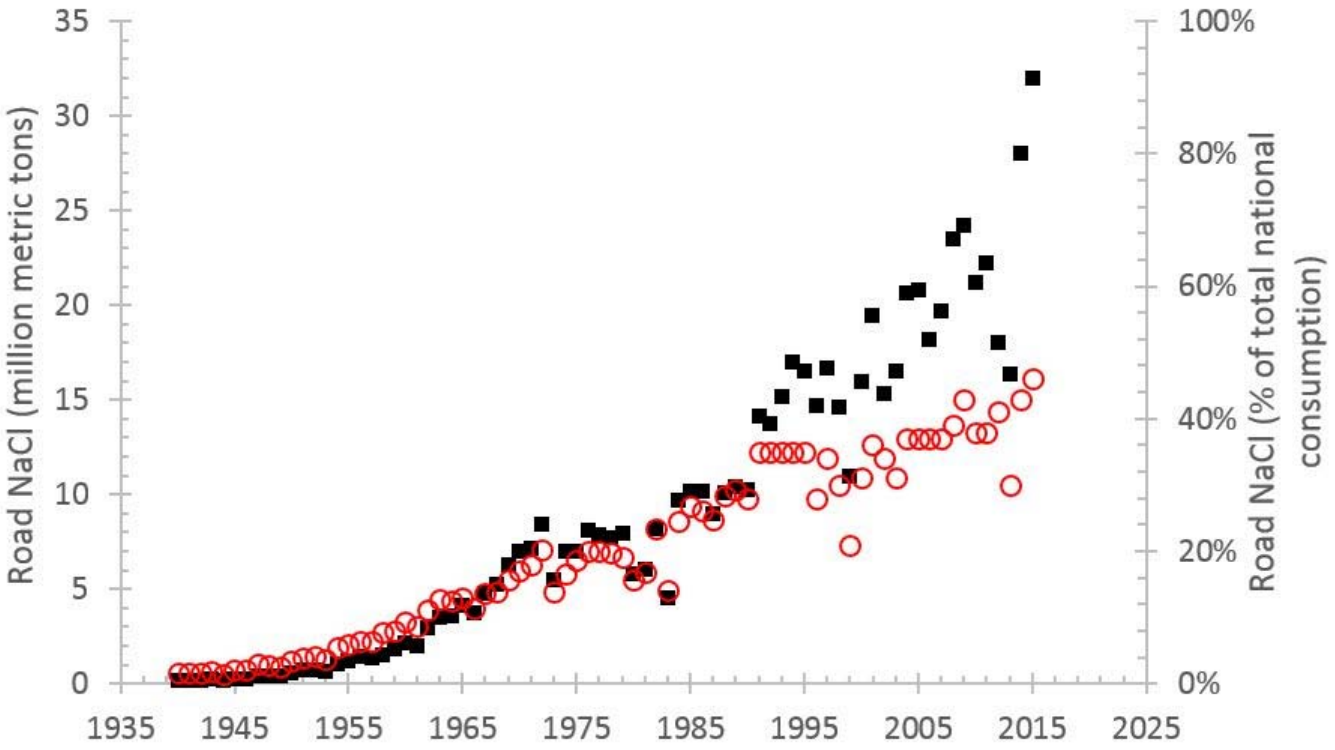
- Connecticut NEMO
- National NEMO Network
- Geospatial Training Program
- Land Use Academy
- Extension Forestry Program

Sodium chloride

- Ionic bond
- Dissociates in water
- Chloride is highly mobile in soil due to negative charge



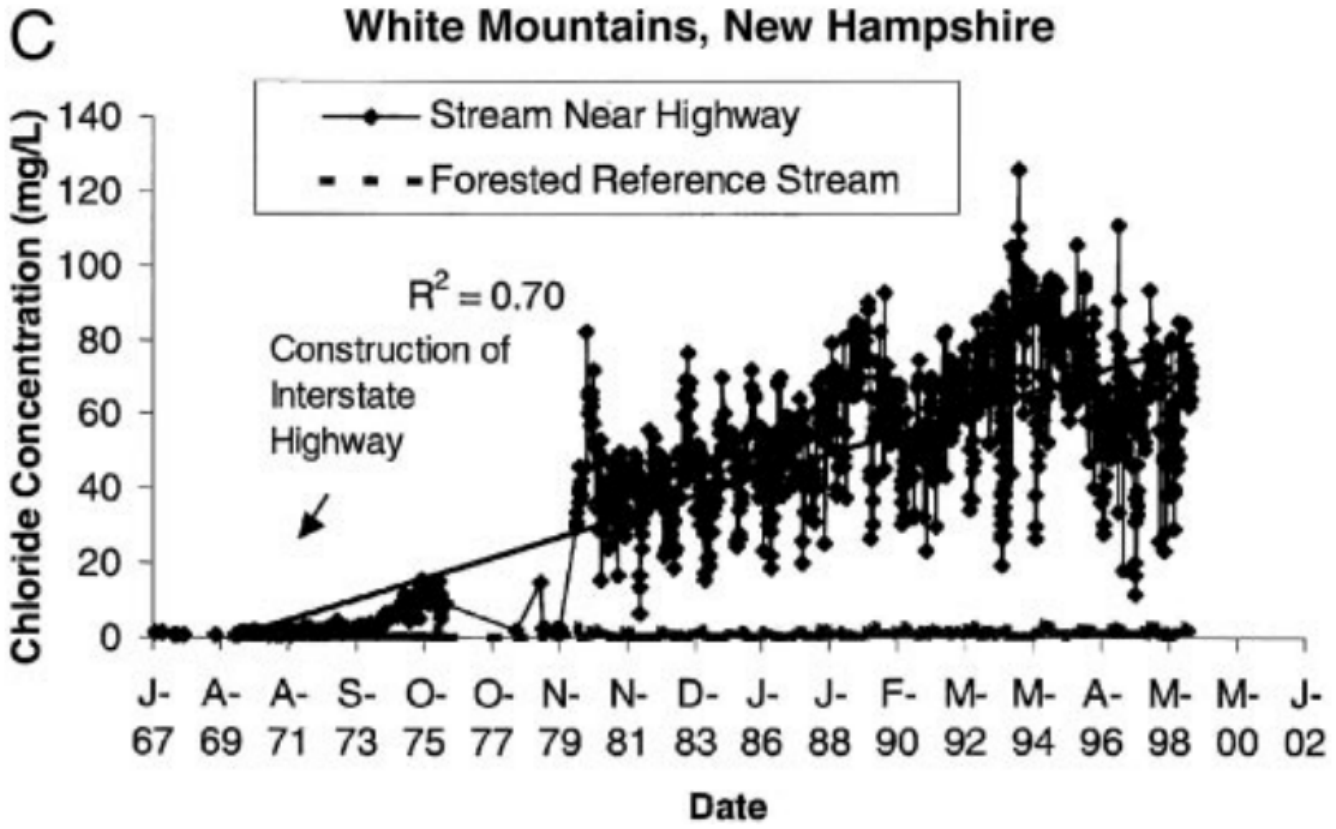
Road salt use in US has increased



Annual road salt use in million metric tons

USGS Mineral Yearbooks, 1940-present

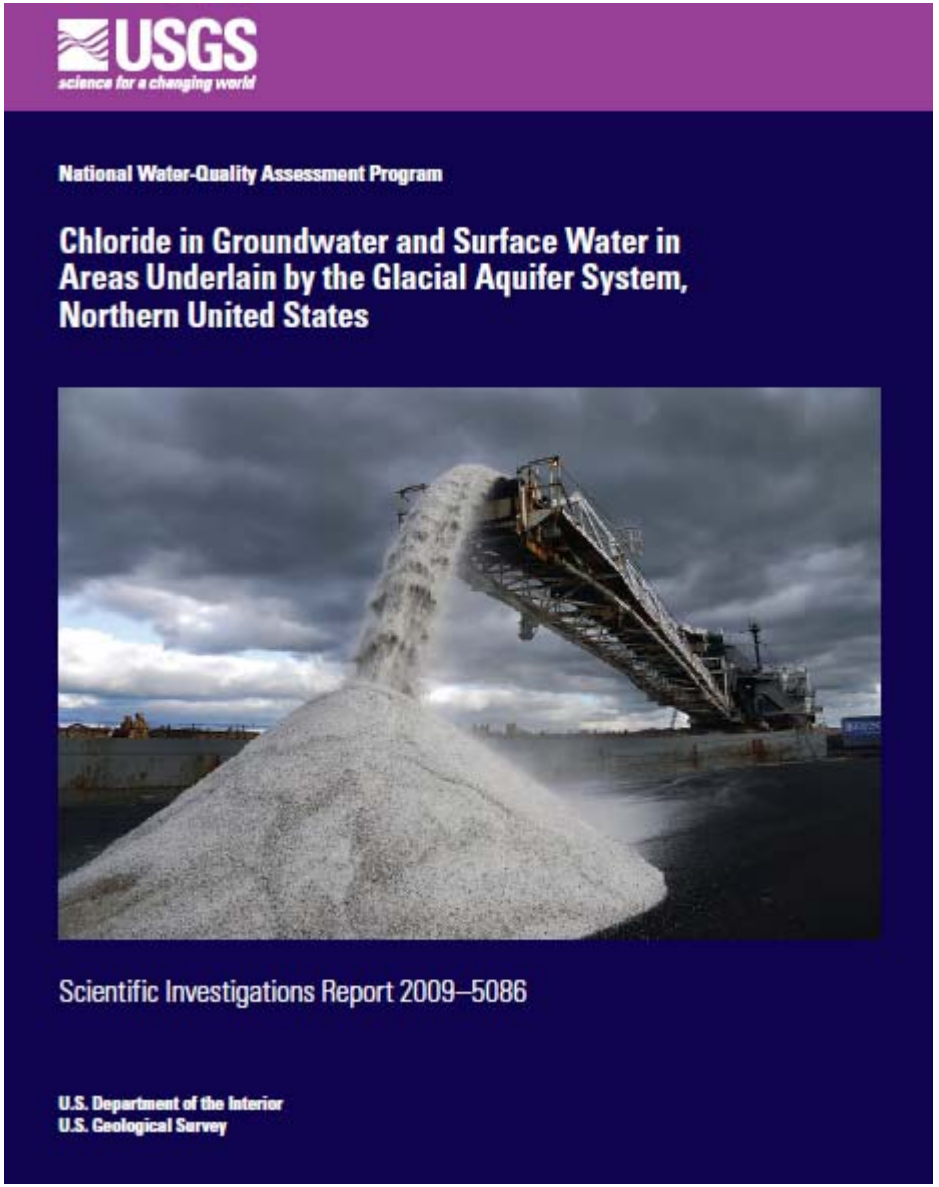
Increasing trends in surface waters



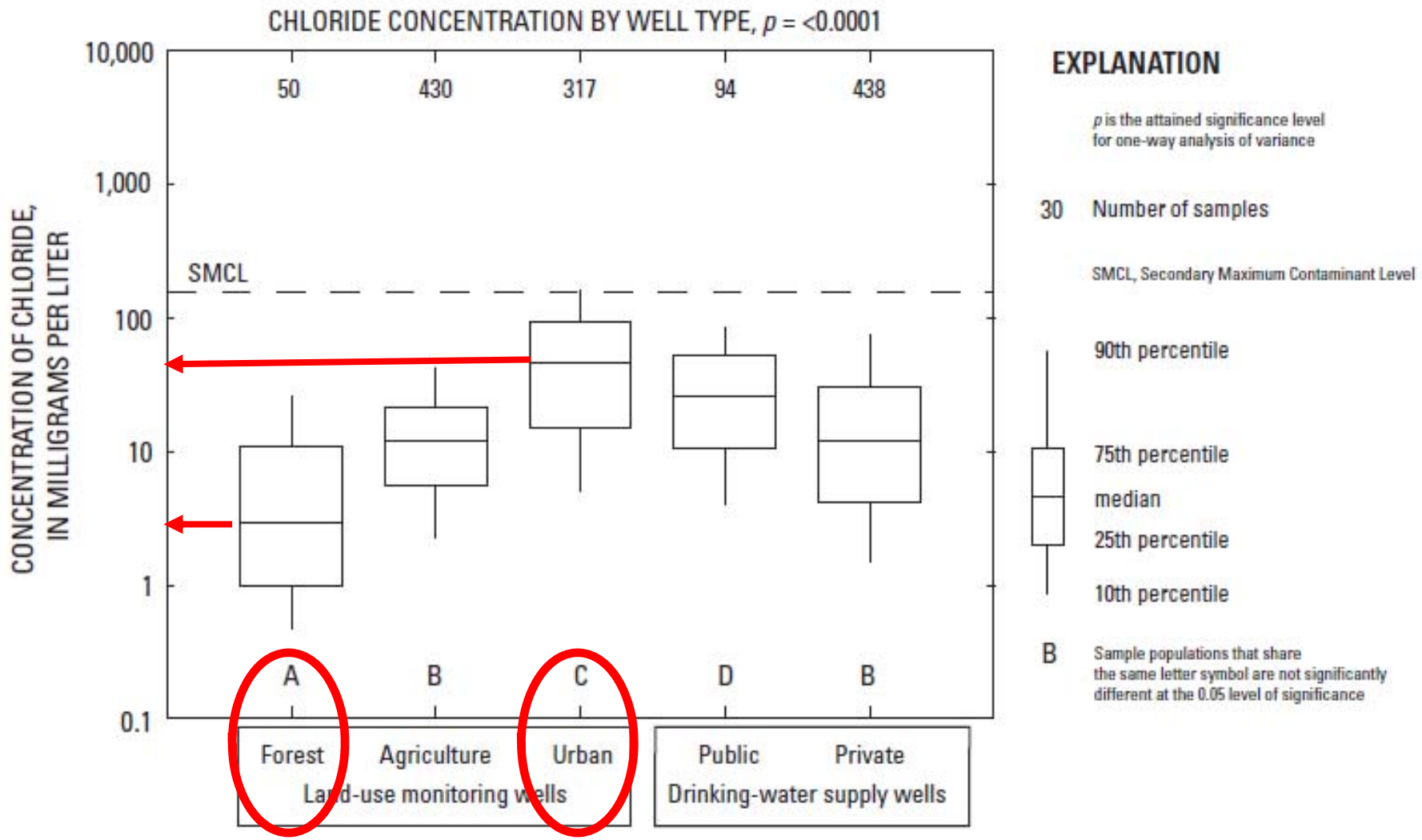
From Kaushal et al. 2005 (fig. 1c)

USGS study in northern states

- Analysis of surface and groundwaters in deicing regions of the US
- John Mullaney, David Lorenz, and Alan Arntson
- https://pubs.usgs.gov/sir/2009/5086/

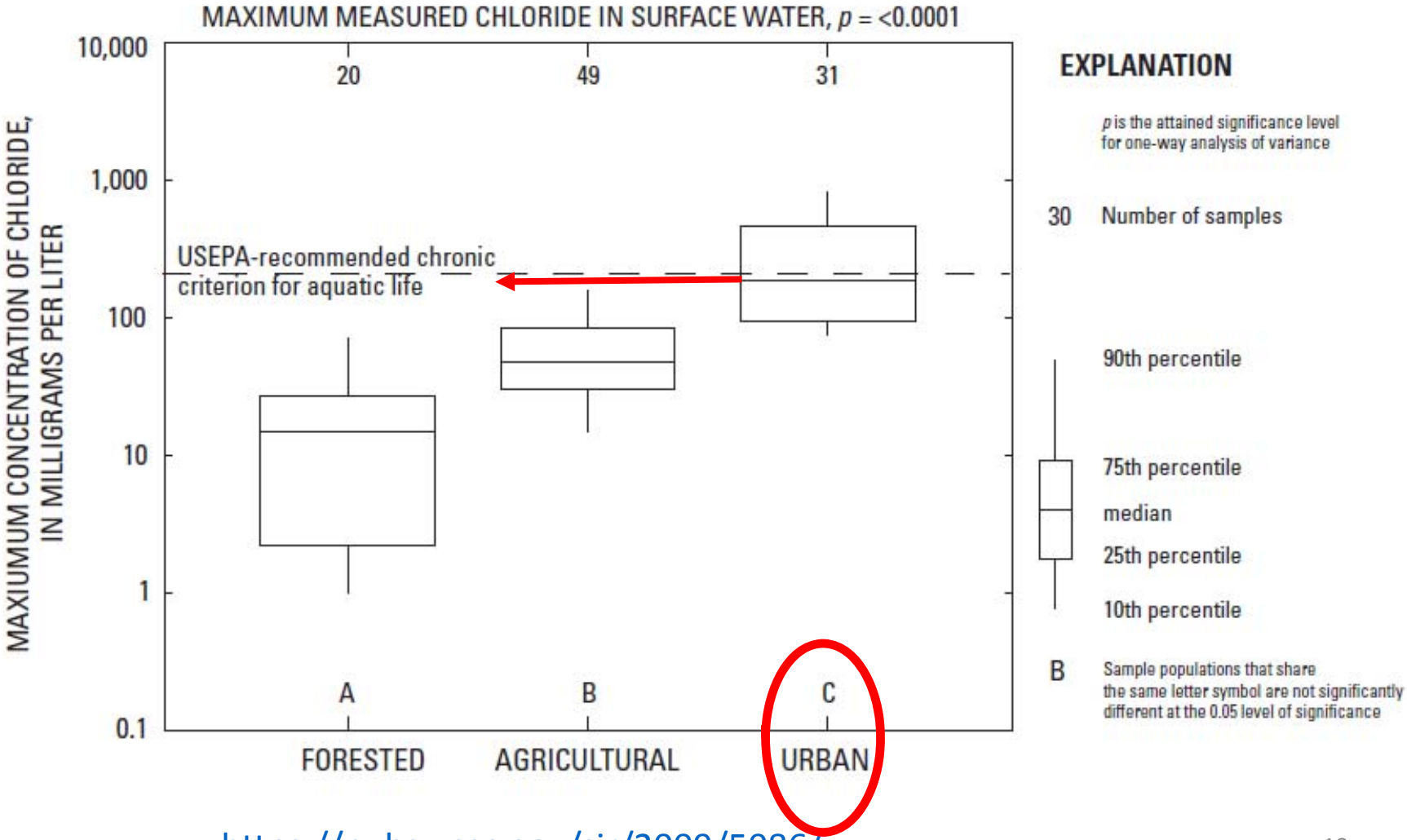


Chloride in groundwater related to land use



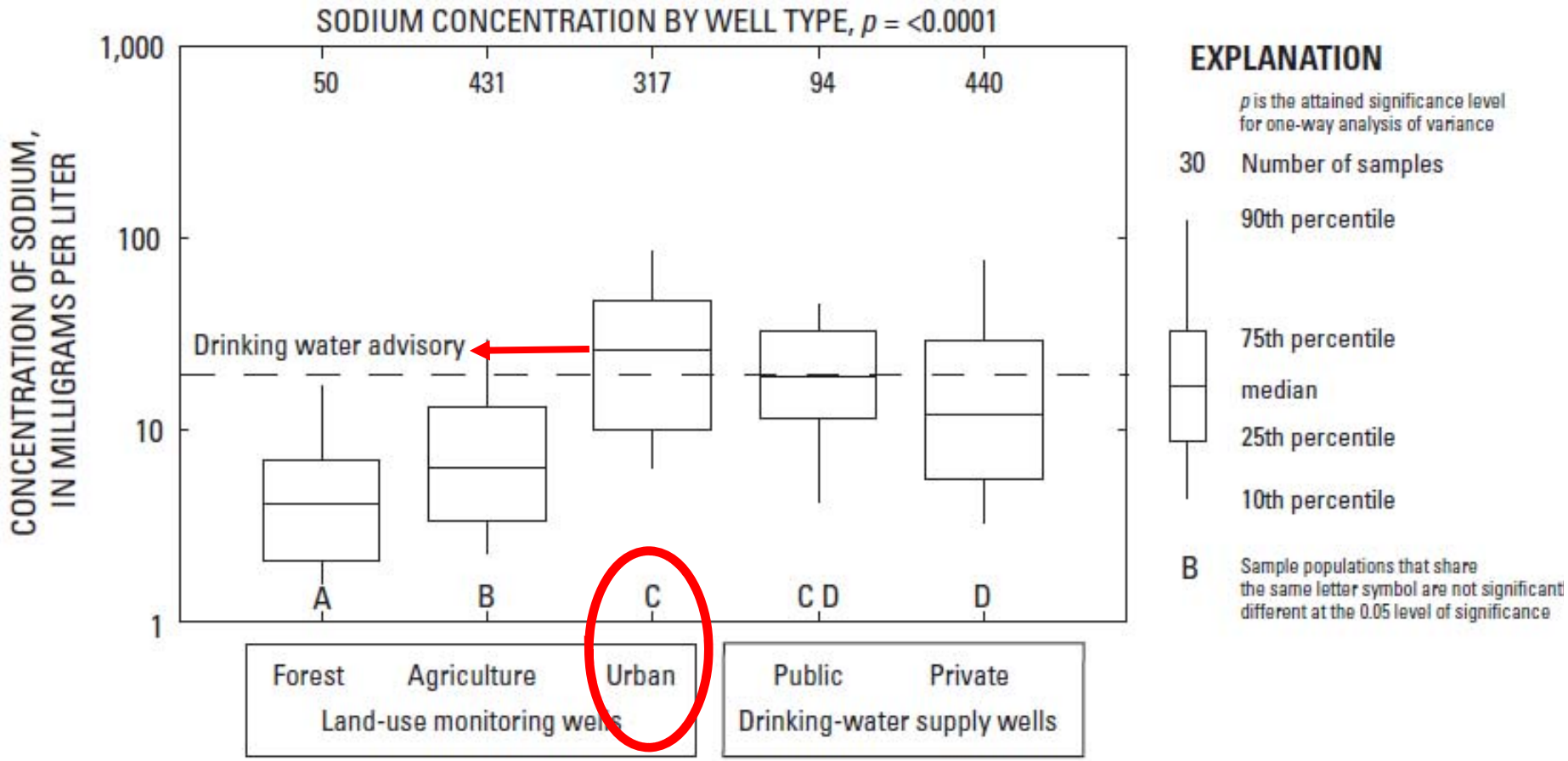
https://pubs.usgs.gov/sir/2009/5086/

Chloride in surface water related to land use



https://pubs.usgs.gov/sir/2009/5086/

And sodium too…



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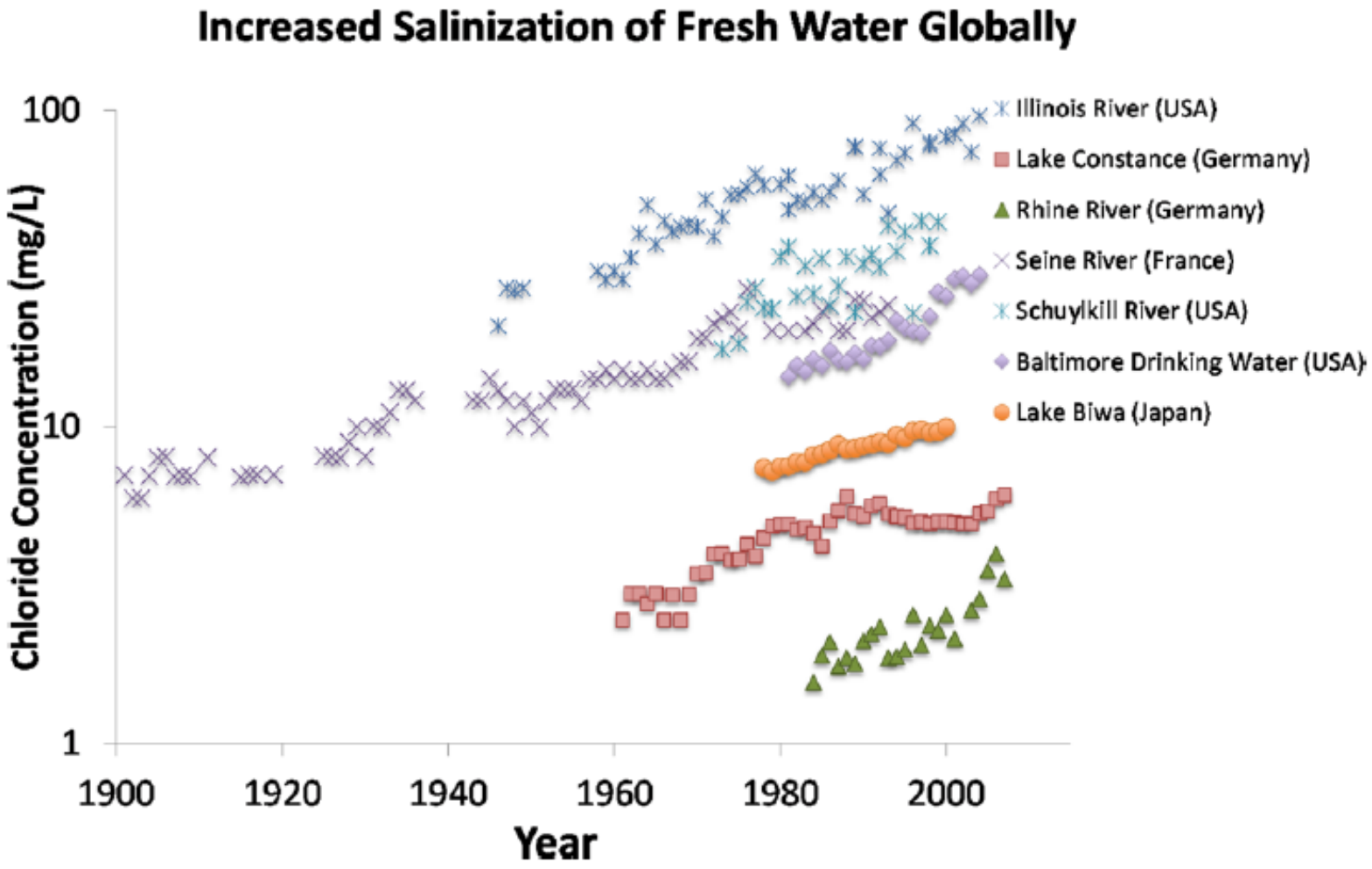
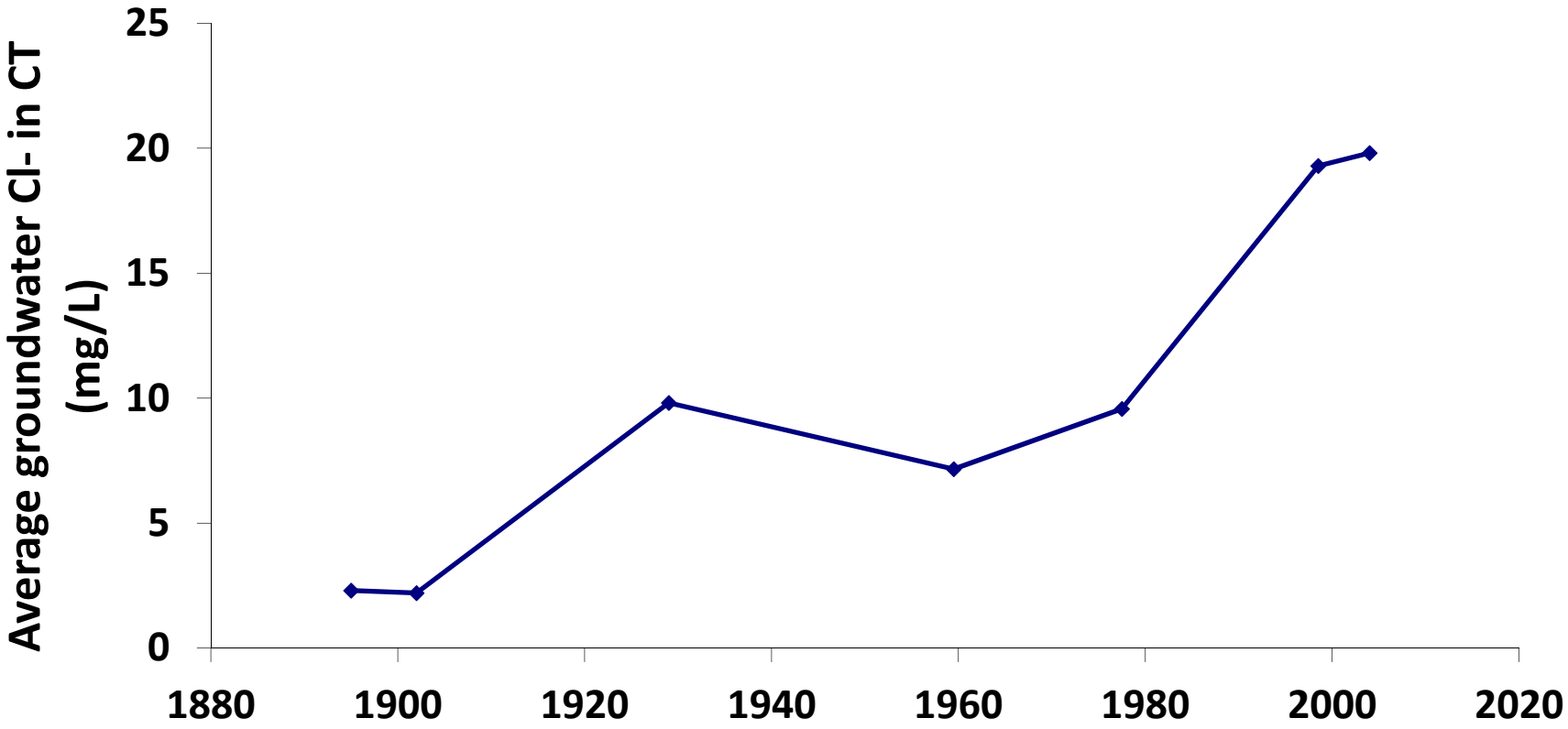
Increasing trends in surface waters



(Kaushal, 2016), fig. 1

Average groundwater Cl concentration increasing in CT



From Cassanelli & Robbins, 2013

2015 CASE Report

- "Winter Highway Maintenance Operations: Connecticut"
- Conducted by Connecticut Academy of Science and Engineering (CASE)
- Covers many aspects of winter deicing history, trends, impacts and actions in Connecticut
- Available on CT DOT website

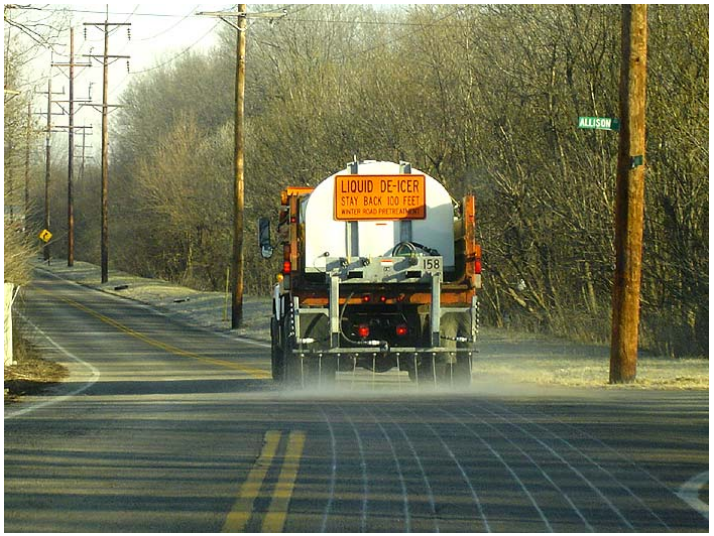
Authors: Jim Mahoney, Eric Jackson, Donald Larsen, Timothy Vadas, Kay Willie, Scott Zinke

CT DOT Winter Maintenance

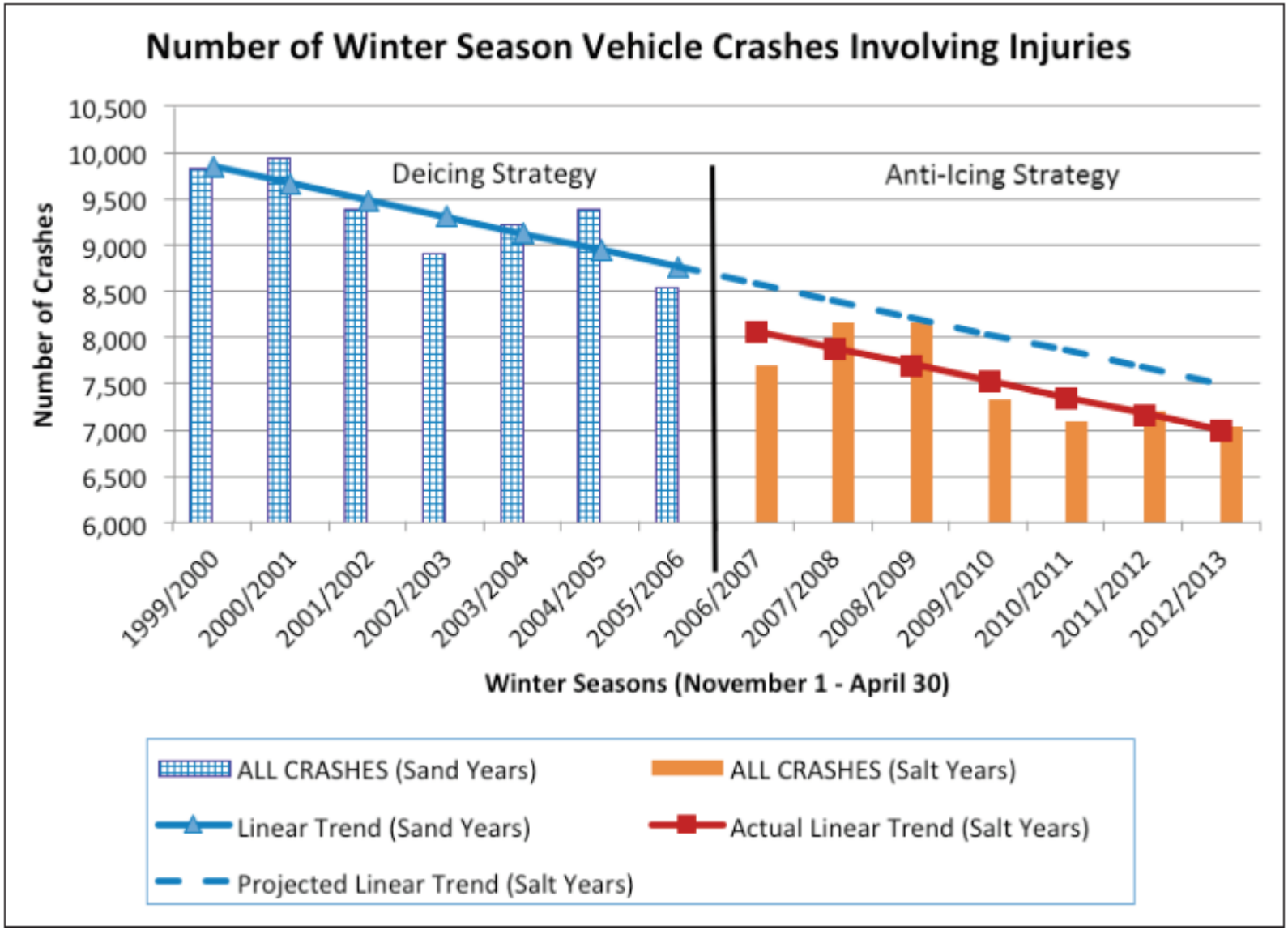
- Prior to 2006: Deicing with sand/salt blend

- 2006-2013: Anti-icing
  - Pretreatment with sodium chloride brine
  - Pre-wetting of rock salt with calcium chloride, magnesium chloride

- 2014-on: Anti-icing
  - Pretreatment with sodium chloride brine
  - Pre-wetting of rock salt with magnesium chloride

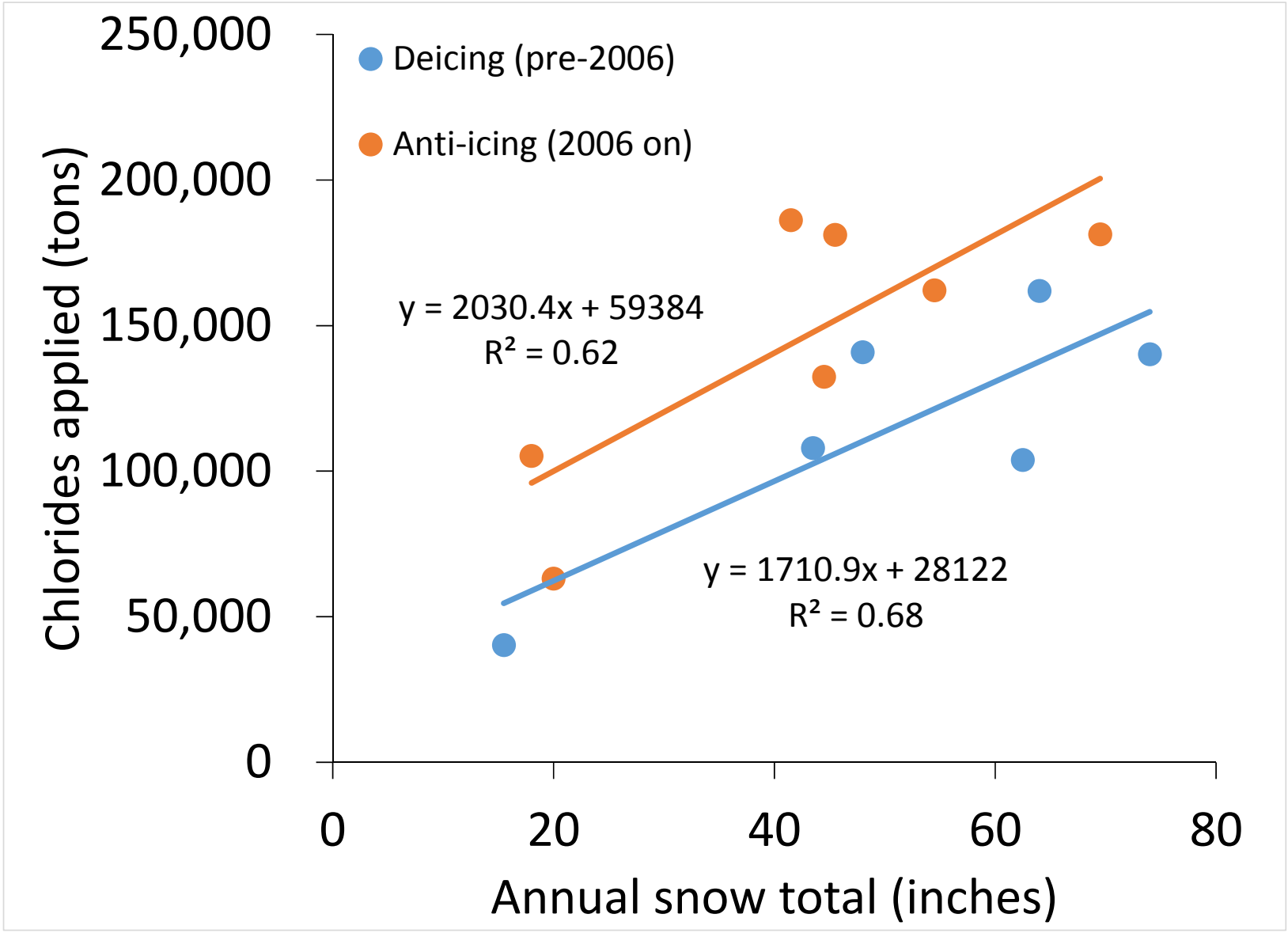


Anti-icing strategy seems to work



From CASE Report (2015)

Anti-icing = MUCH less sand, but 25% more salt



Quick poll

Survey of Municipal DPWs (CASE Report)

- Around 50% of municipalities still report using sand
- Sodium chloride or treated sodium chloride are the primary solid deicers
- 13% of municipalities pretreat with liquid deicers
- 56% of municipalities pretreat with solid deicers

Best management practices

- CT DOT (and many municipalities) using technology and training to optimize road salt application
  - Detailed in CASE report

- Economics of this implementation is an important consideration (and beyond the scope of this talk)

Road salt application rates in CT

	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
Est. Municipal & CT DOT, from CASE (tons)	452,373	560,330	282,113	511,657	710,511
Est. total salt application* (tons)	876,700	1,085,900	546,700	991,600	1,377,000

*Based on NH study that showed municipal and state road salt loads were 51.6% of total

Alternative deicers?

- Alternative products such as beet juice and molasses act as wetting agents, and still rely on sodium chloride as the primary deicing agent

- Many proprietary products available
  - Some form of treated salt (see CASE report)

- Sodium chloride is currently the most cost-effective chemical deicer

Drinking water and surface water limits

- Neither sodium nor chloride are listed for human health concerns
- Sodium recommended level is 20 mg/L (national) and notification level is 28 mg/L (Connecticut)
- Chloride secondary maximum concentration is 250 mg/L
- Aquatic life criterion (CT) is 230 mg/L (chronic) and 860 mg/L (acute)

From CT DPH (Eric McPhee, 2014)

- Approx. 1100 of the 2500 public water systems are required to test for sodium and chloride
  - **39 PWSs (3.5%) exceeded 28 mg/l sodium notification level in the last 5 years**
  - **45 (4%) PWSs with chloride MCL violations in the last 5 years**
- Annual reports are available from public water suppliers

Biological/ecological impacts

- Chlorides (from all sources) are highly mobile in water and soil
- Vegetation damage along roadsides, long-term impacts on vegetation due to high salt levels in groundwater
- Impacts plant communities in wetlands and riparian areas (Kaushal et al. 2005)

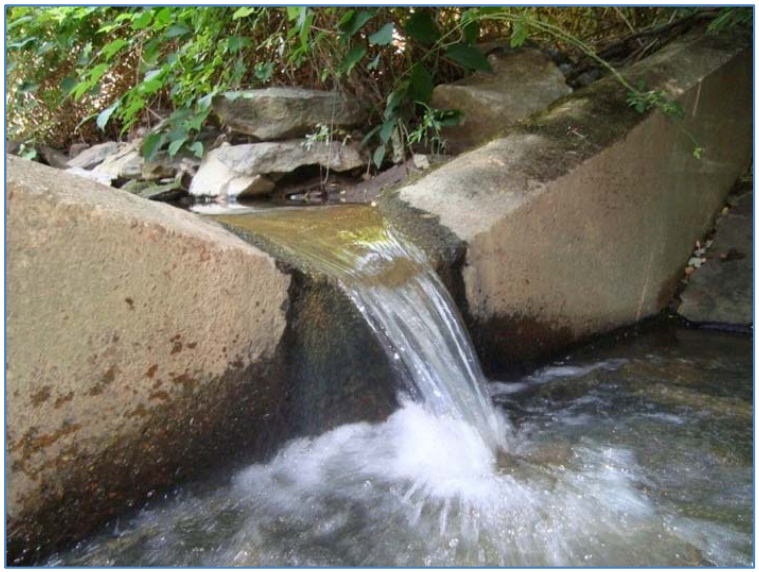
Biological/ecological impacts

- Negative impacts on amphibians in salt-affected systems (Brady, 2012; Karraker et al., 2008)

- Other potential impacts on fish, macroinvertebrate populations
  - High Cl coming out in summer low flows (Kaushal et al., 2005)

Real-time data collection on Eagleville Brook at UConn

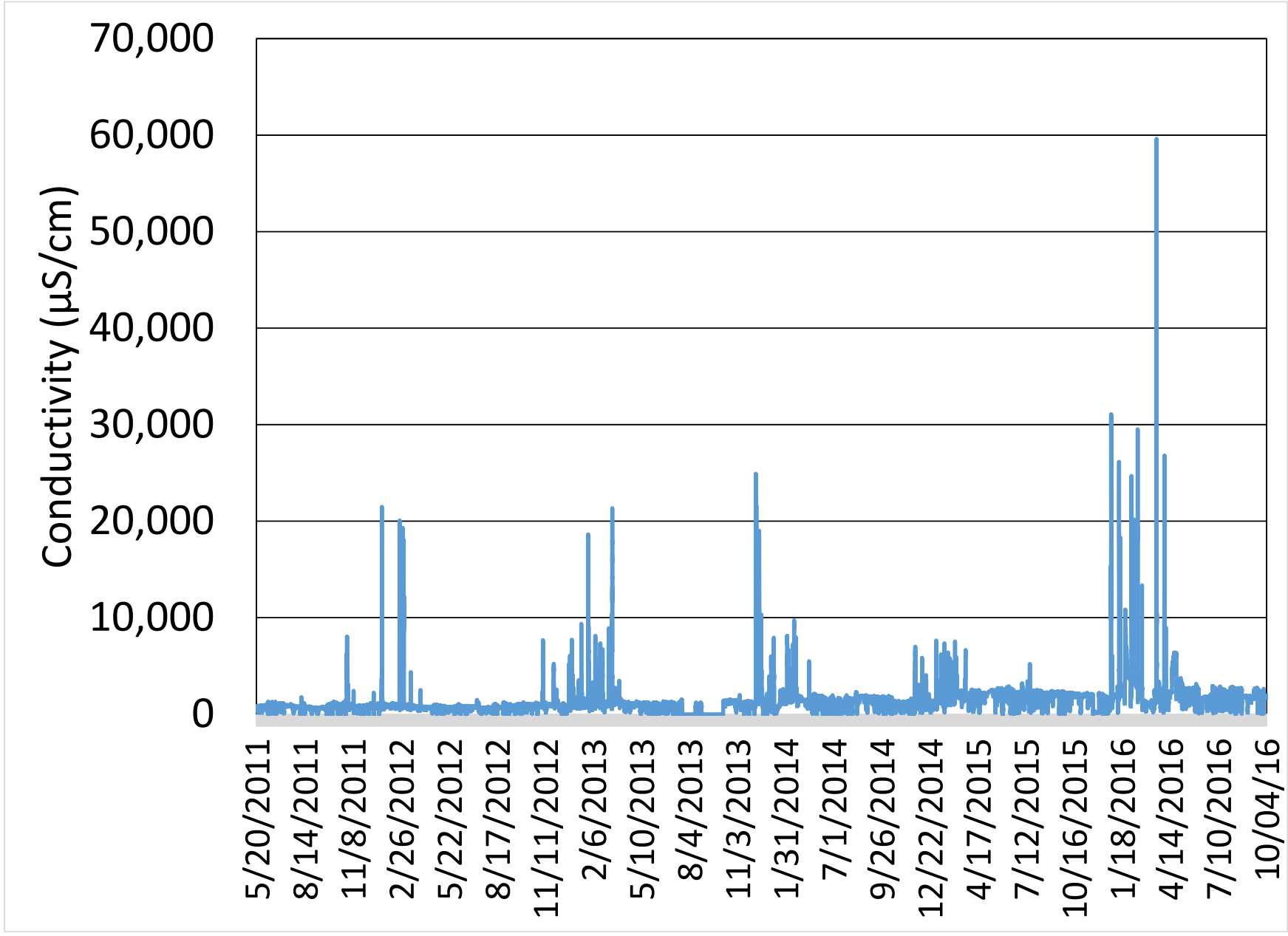
- Collaborative effort with Jack Clausen in Natural Resources and the Environment Dept. at UConn



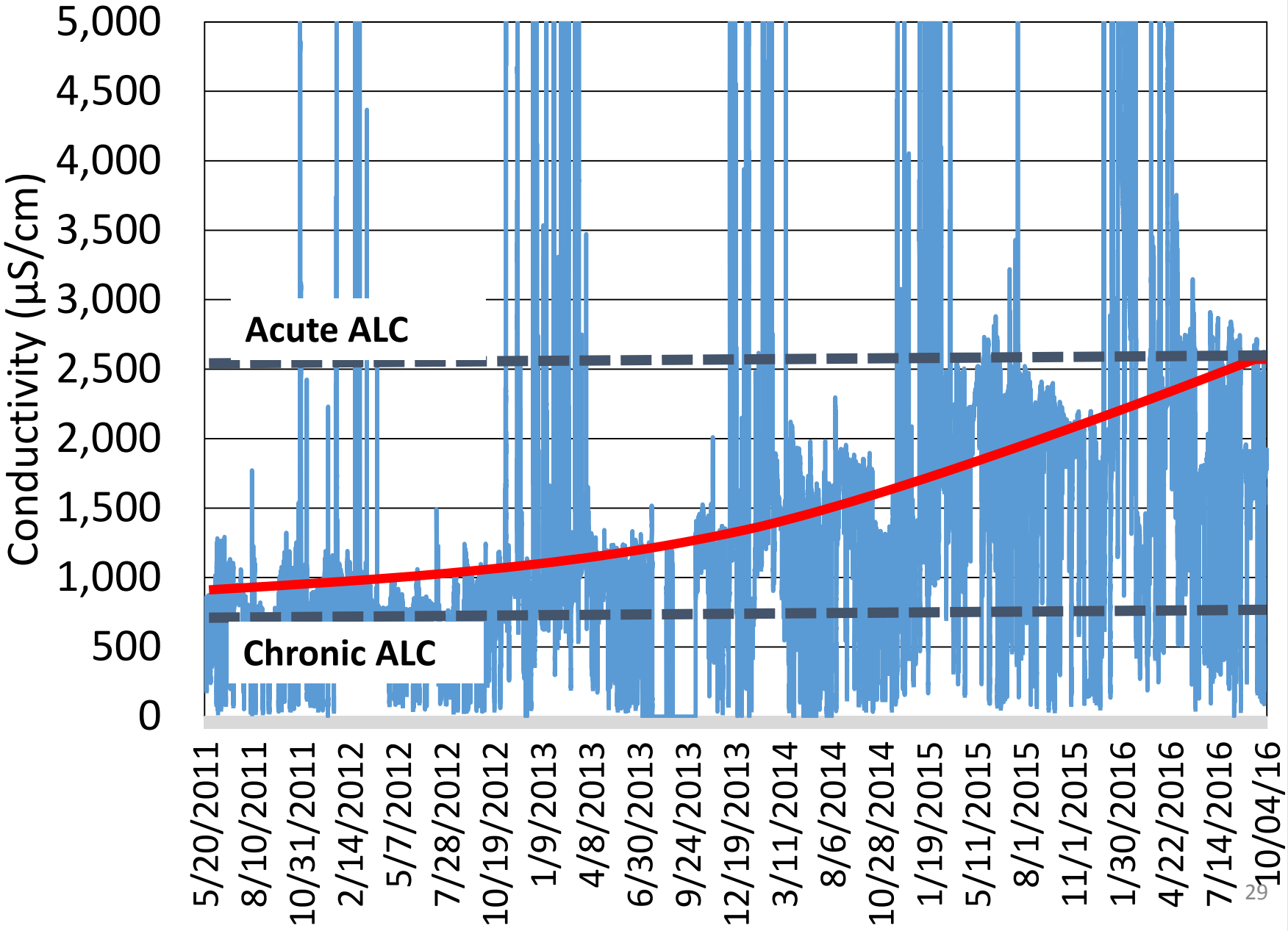
- 7 year record of discharge, 6 year record of conductivity

http://clear.uconn.edu/projects/eagleville

Eagleville Brook-UConn Storrs



Eagleville Brook- UConn Storrs



Research at pervious pavement parking lot, UConn Storrs

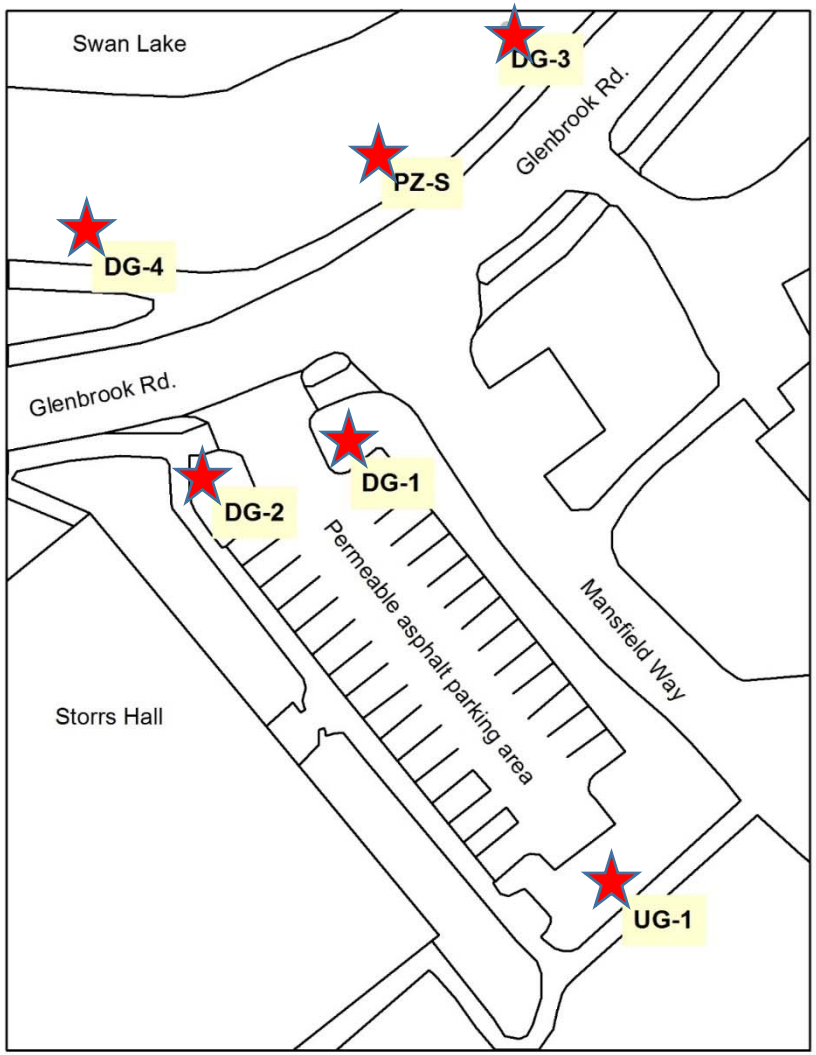
- Began in October 2014
- Collaboration with Gary Robbins in NRE at UConn
- Three groundwater wells initially installed, added 5 more in 2015
- Continuous measurement of water level, conductivity in groundwater
- Measured samples for chloride to establish relationship with conductivity
  - Gives continuous chloride measurements

Location on Storrs campus

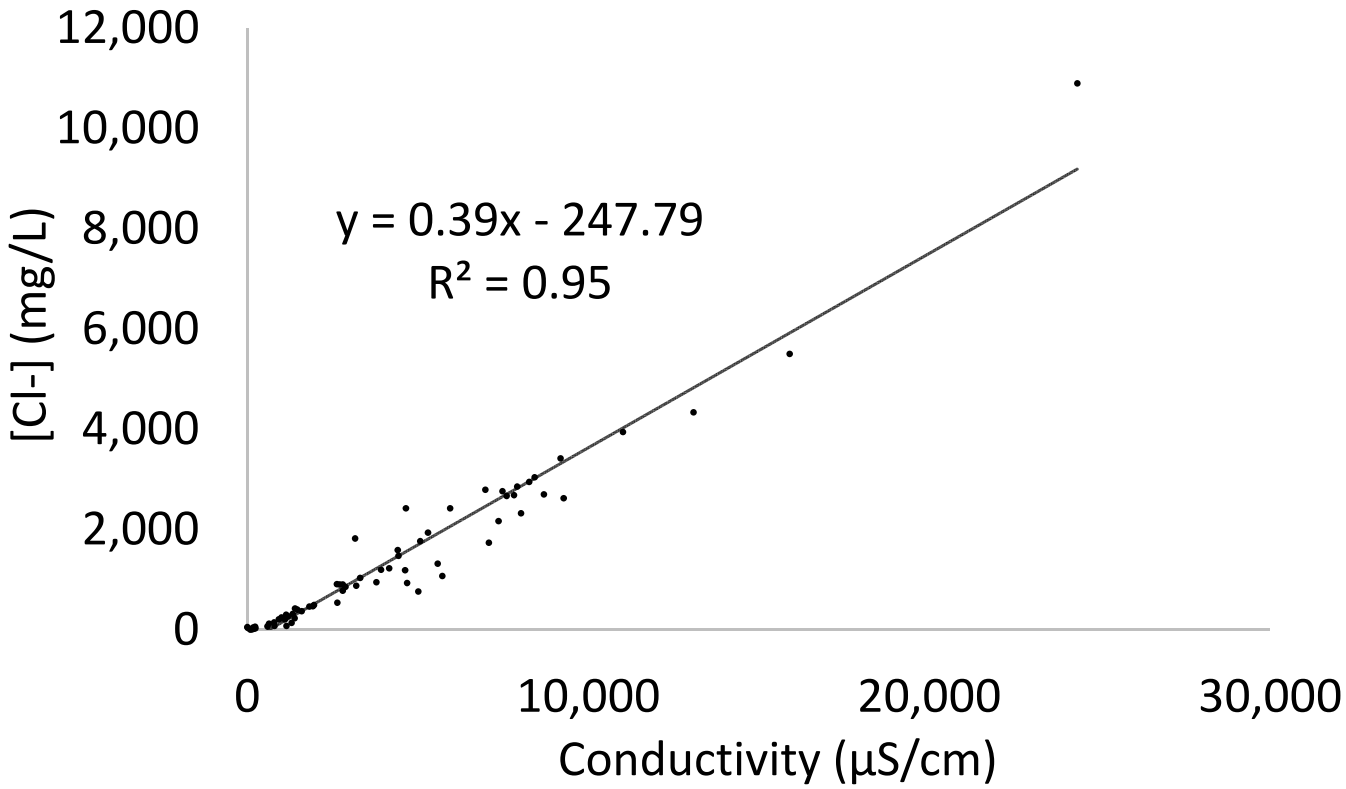
Winter treatments

- Same plowing/salting as regular lots

Monitoring well locations

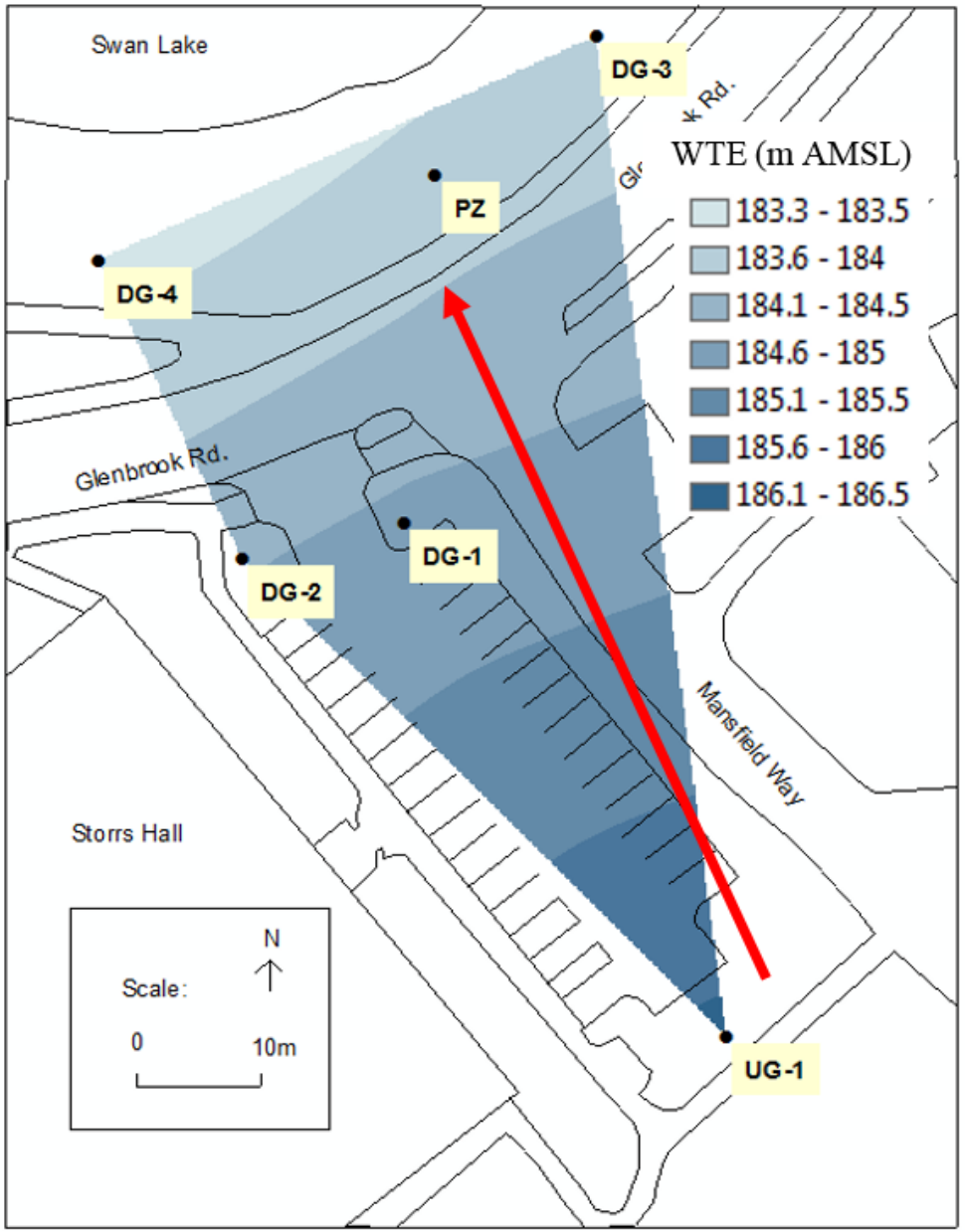


Strong Cl/conductivity relationship

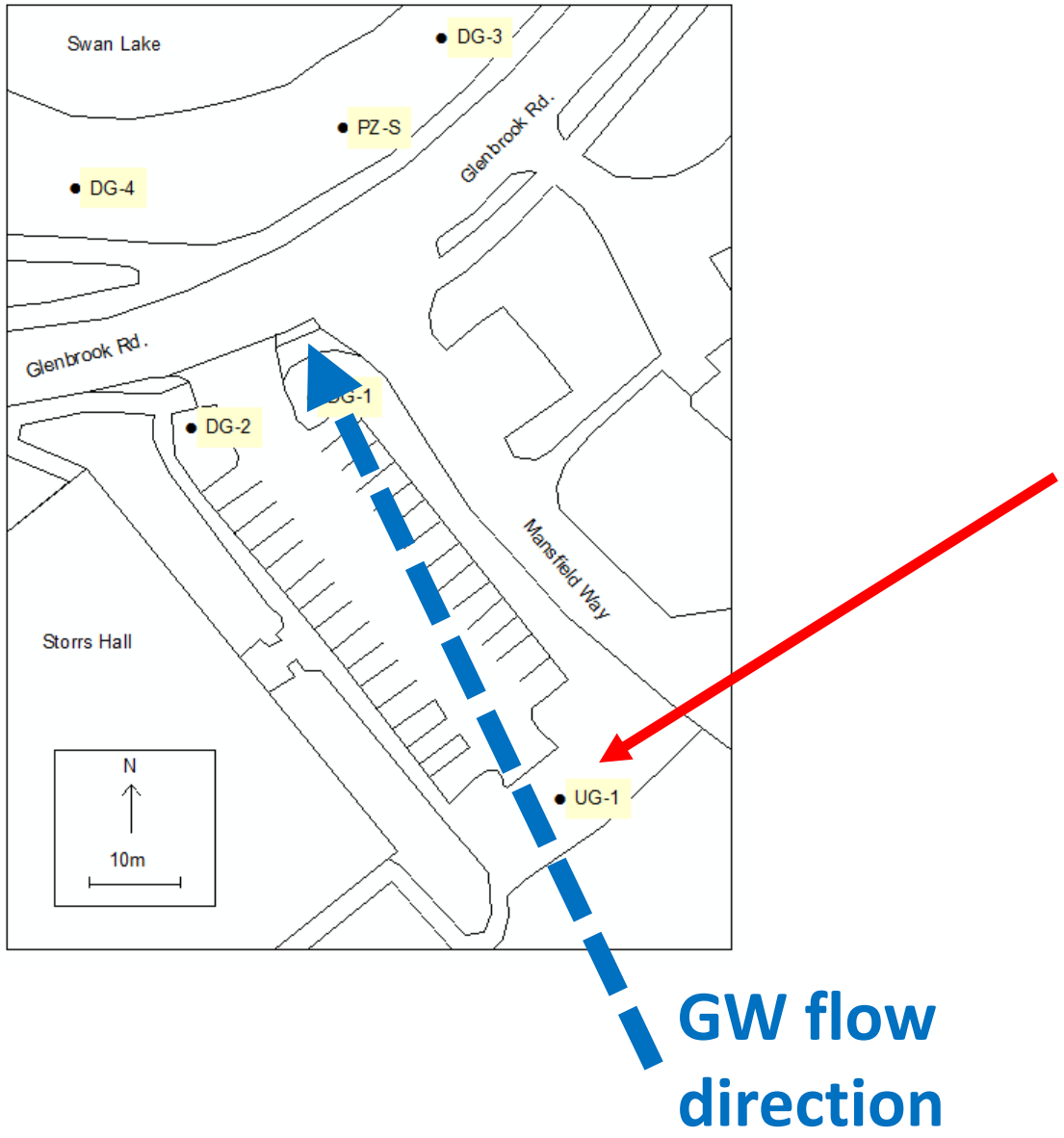


Water table elevation

- Groundwater flow generally in north-northwest direction



Upgradient chloride concentration



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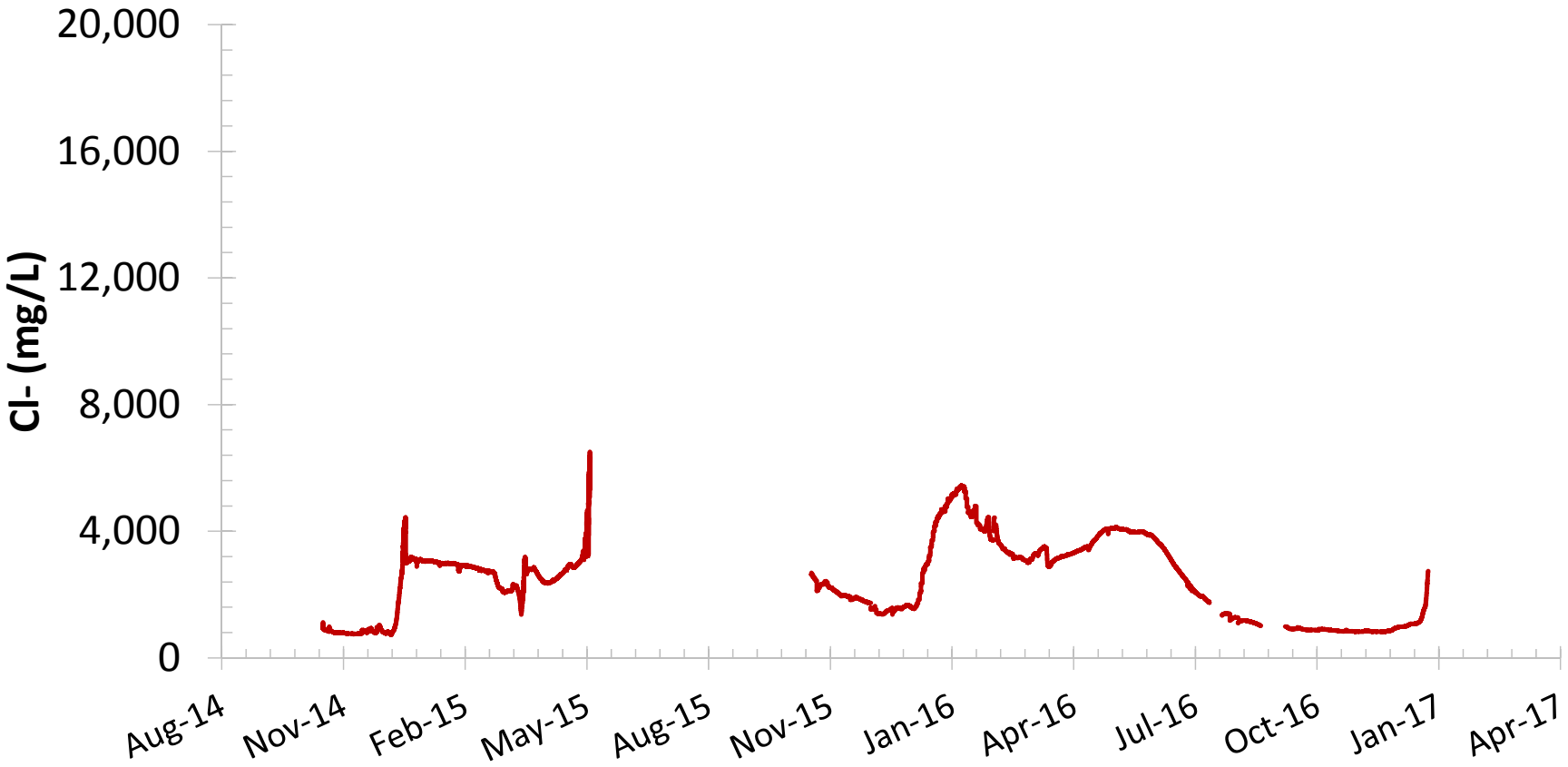
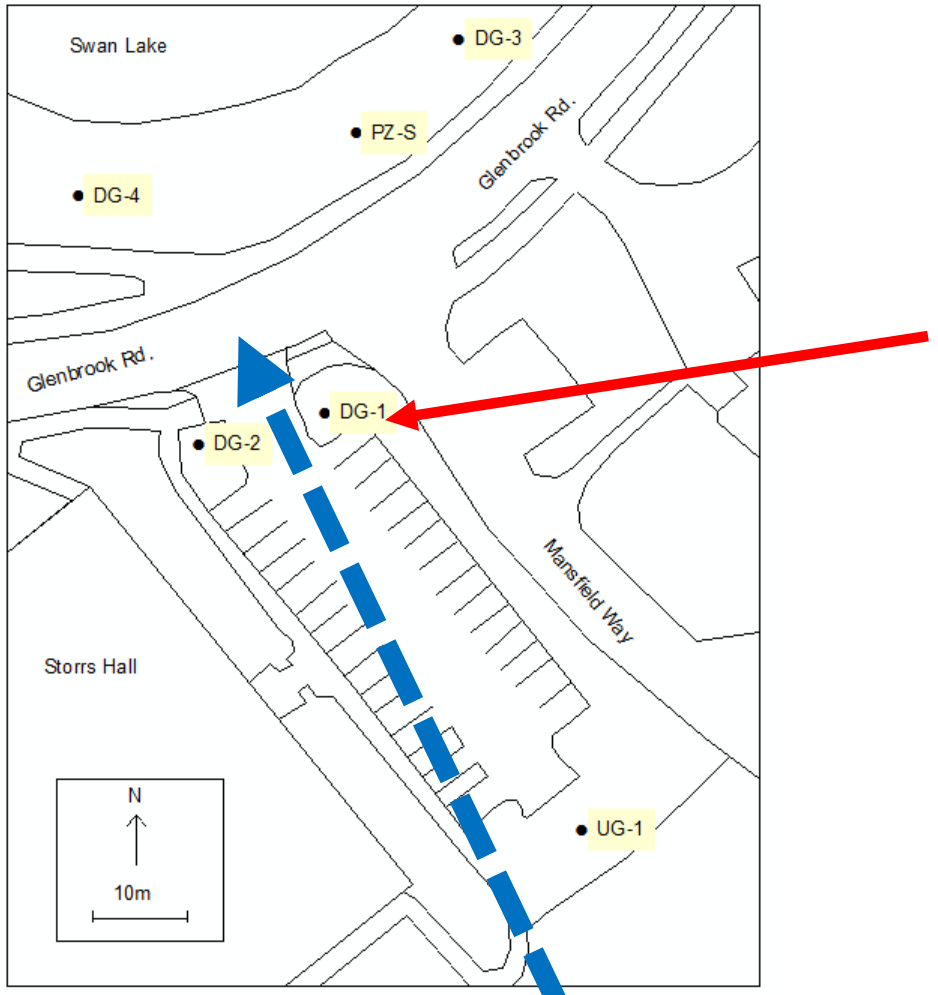


Down gradient 1 (sand, close to lot)



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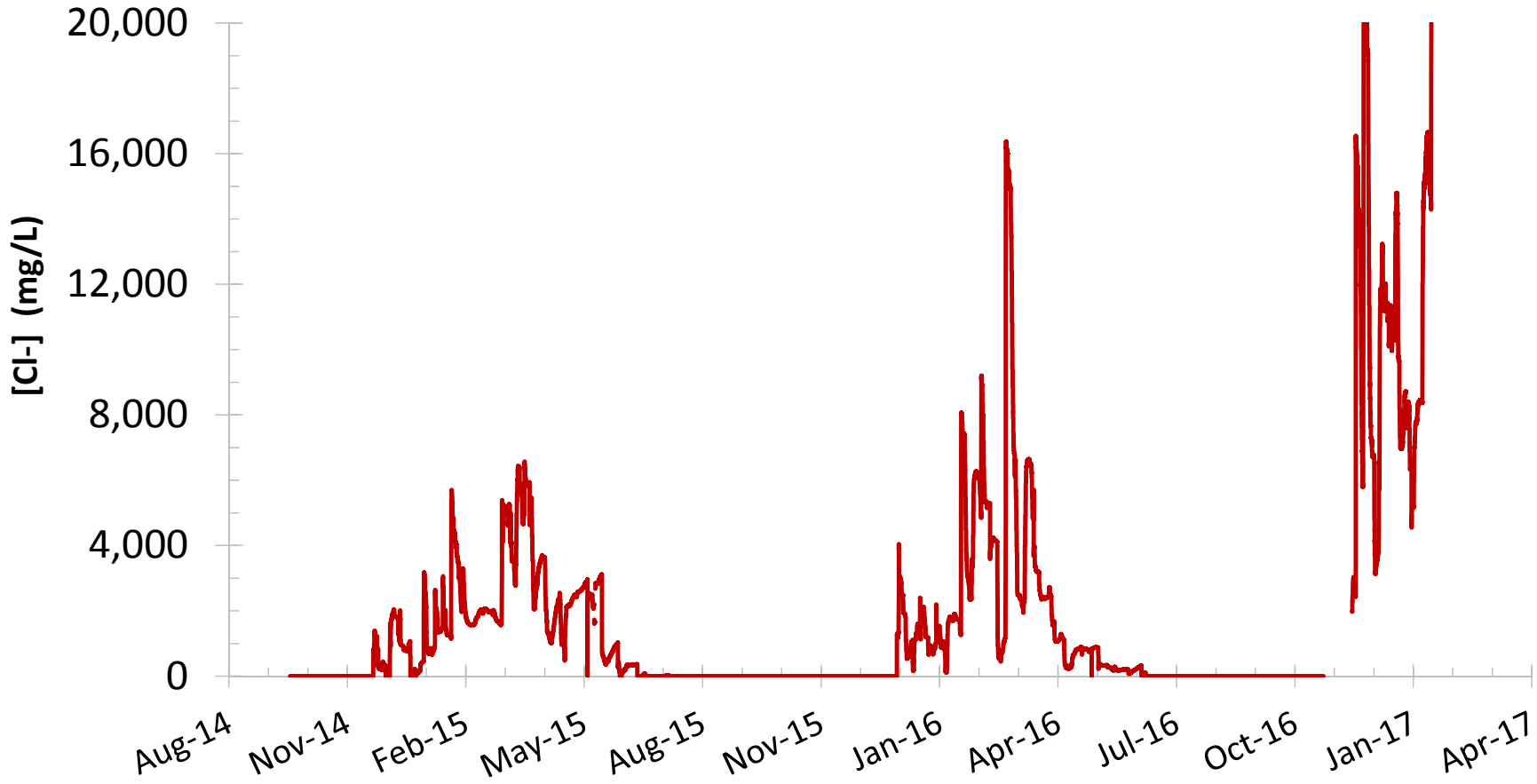
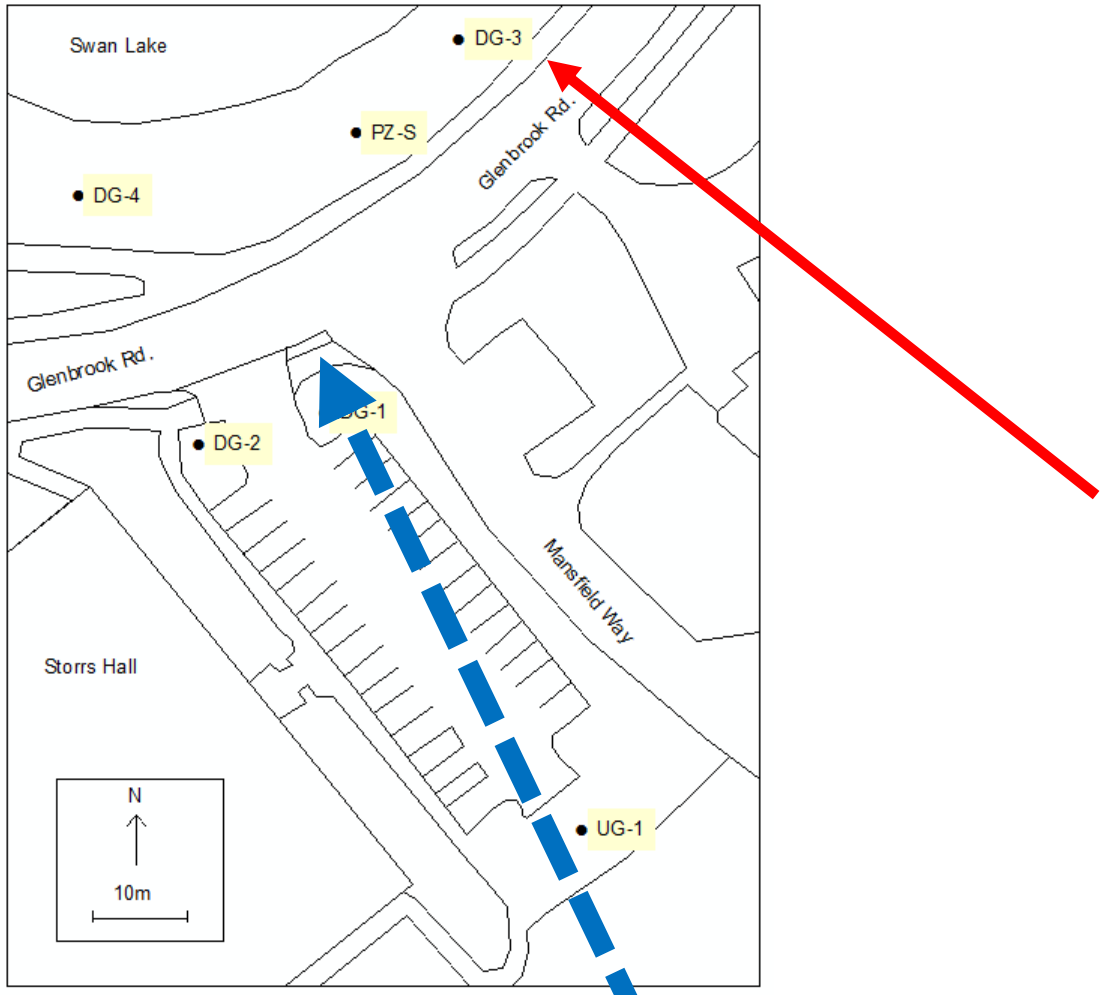


Down gradient 3 (till, 185 feet away)



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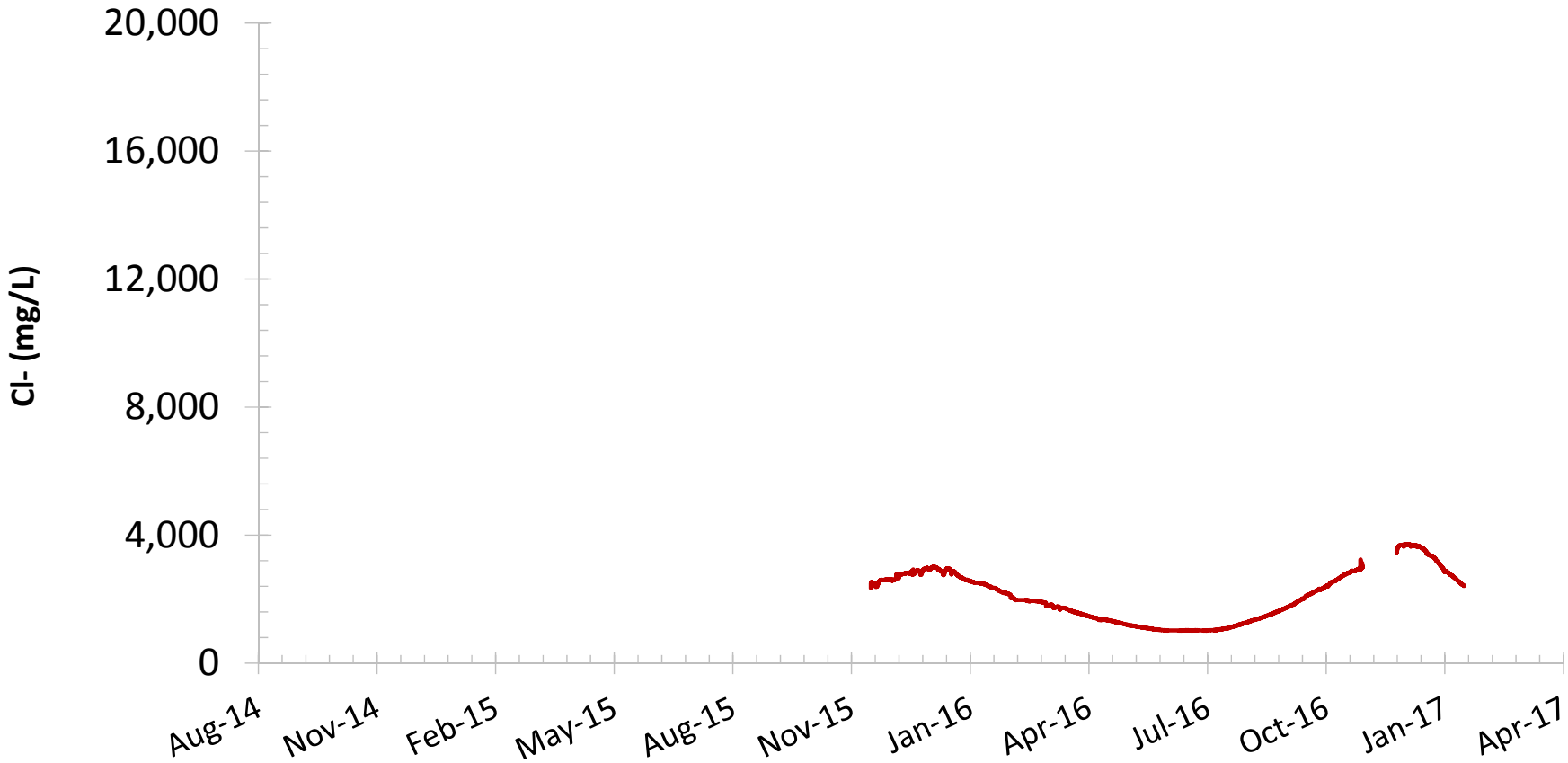
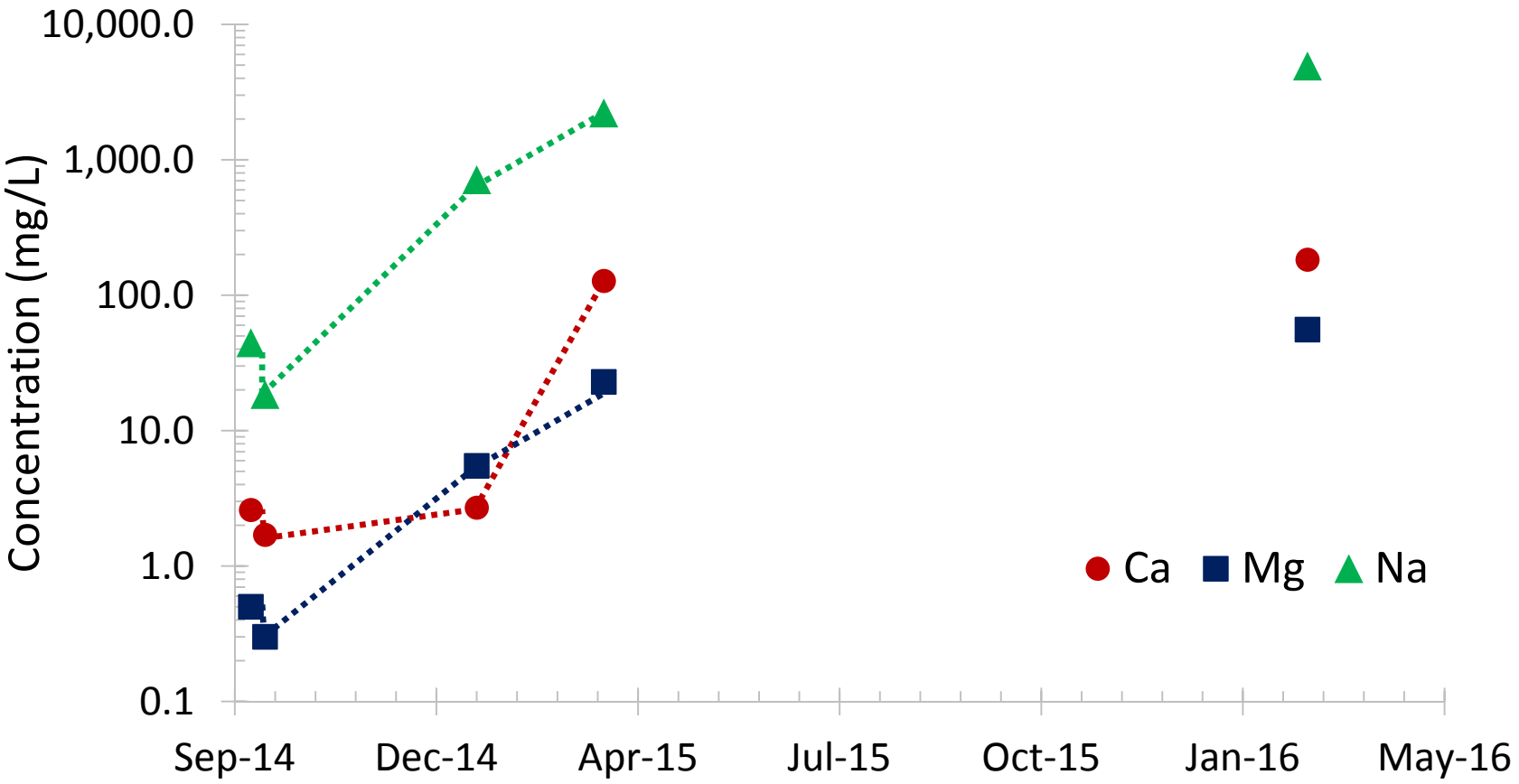


High NaCl increases mobility of metals in groundwater.

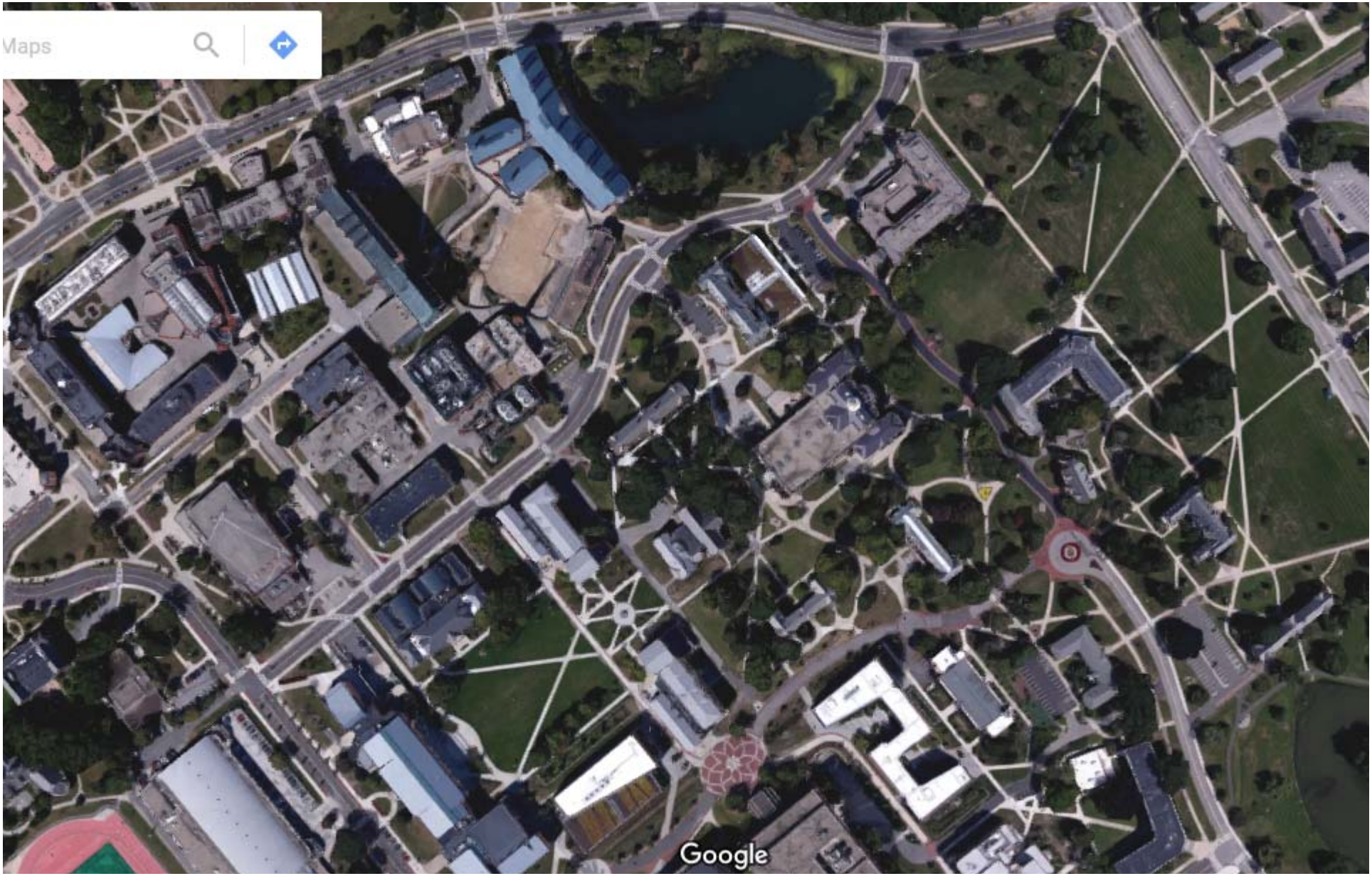


Why are background Cl concentrations so high in this area?

- Sidewalks heavily salted due to high pedestrian traffic and safety concerns

- Typically drain to turf areas, where highly saline meltwater enters shallow groundwater

Impervious surfaces: sidewalks



Summary of UConn study

- Despite seasonal salting, this urban aquifer remains salty throughout the year
- This could serve as a perennial input of salinity to surface water bodies (e.g. Eagleville Brook, Swan Lake)
- Despite adding salt to groundwater in winter, rainfall on pervious asphalt helps to dilute background Cl^- concentrations during non-winter months
- These findings are consistent with other research across the country

So what can be done?

- Chlorides will continue to be used for deicing into the foreseeable future
- It is not practical to remove it from surface and groundwaters
- Application reductions are the only way to lessen the load
  - CT DOT and others using technology and driver training

Innovative program in New Hampshire

- New Hampshire salt applicator certification program goals:
  1. Improve efficiency in salt use, such that the least amount of salt is used to ensure safe conditions
  2. Reduce the amount of salt used by commercial applicators over time while maintaining safe conditions for pedestrians and vehicles
  3. Establish a voluntary system to track salt use

http://www.des.nh.gov/organization/divisions/water/wmb/was/salt-reduction-initiative/salt-applicator-certification.htm

NH voluntary salt applicator certification program

- The key is that property owners who hire certified by NH DES are granted liability protection against damages arising from snow and ice conditions

Other program benefits

- Applicators are requested to report how much salt they are applying

Conclusions

- Deicing salt use continues to increase, along with chloride concentrations in surface and groundwaters

- CT DOT is using numerous BMPs to minimize salt application rates while providing for public safety
  - Fewer accidents are occurring

- Sidewalk deicing is a potentially large source of salt loading to shallow groundwater

Conclusions

- There is no cost-effective salt alternative at this point
- Application reductions are the only way to reduce loading to the environment
  - Technology and education
- Programs like the NH Certification are showing promise in educating applicators and reducing application rates

Conclusions

- If you have a shallow well in a developed area or near a road, get your water tested

- CT DPH certified labs for water testing
  - http://www.ct.gov/dph/cwp/view.asp?a=3139&q=387286

References

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- Perera et al. 2013. "Groundwater chloride response in the Highland Creek watershed due to road salt application: A re-assessment after 20 years." *Journal of Hydrology* 479: 159-68.
- USGS Mineral Yearbooks 1935-2015 Salt: Mineral Yearbook Archive

Thank you!

QUESTIONS??

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