Evaluating Options for Wastewater Treatment at Rest Areas & Truck Stations

Dr. Sara Heger and Dan Wheeler

University of Minnesota
Onsite Sewage Treatment Program

University of Minnesota
Driven to Discover®
Center for Transportation Studies

Department of Transportation

- The program began in mid-1970s due to impacts on water quality
- Training program developed in partnership with the MPCA, mandatory since 1996
- Blends expertise in soil science and engineering
- Supporting research activities

UNIVERSITY OF MINNESOTA

ONSITE SEWAGE TREATMENT PROGRAM

Agenda

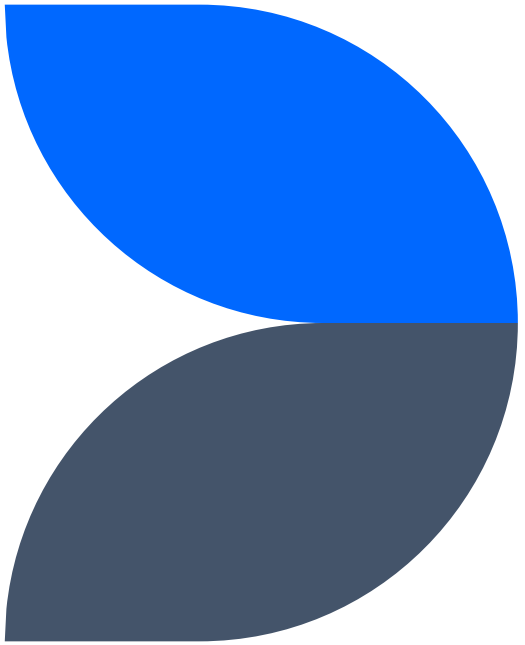
1. Overview of safety rest areas (SRA) and truck stations (TS) in relation to wastewater treatment
2. Evaluation and risk assessment
3. Ongoing research

Introduction - SFA

- MnDOT operates 52 safety rest areas and truck stations across Minnesota that are served with subsurface sewage treatment systems (SSTS)
- Due to their locations, most are not connected to municipal water/sewer
- Aging SSTS with many systems 30+ years old

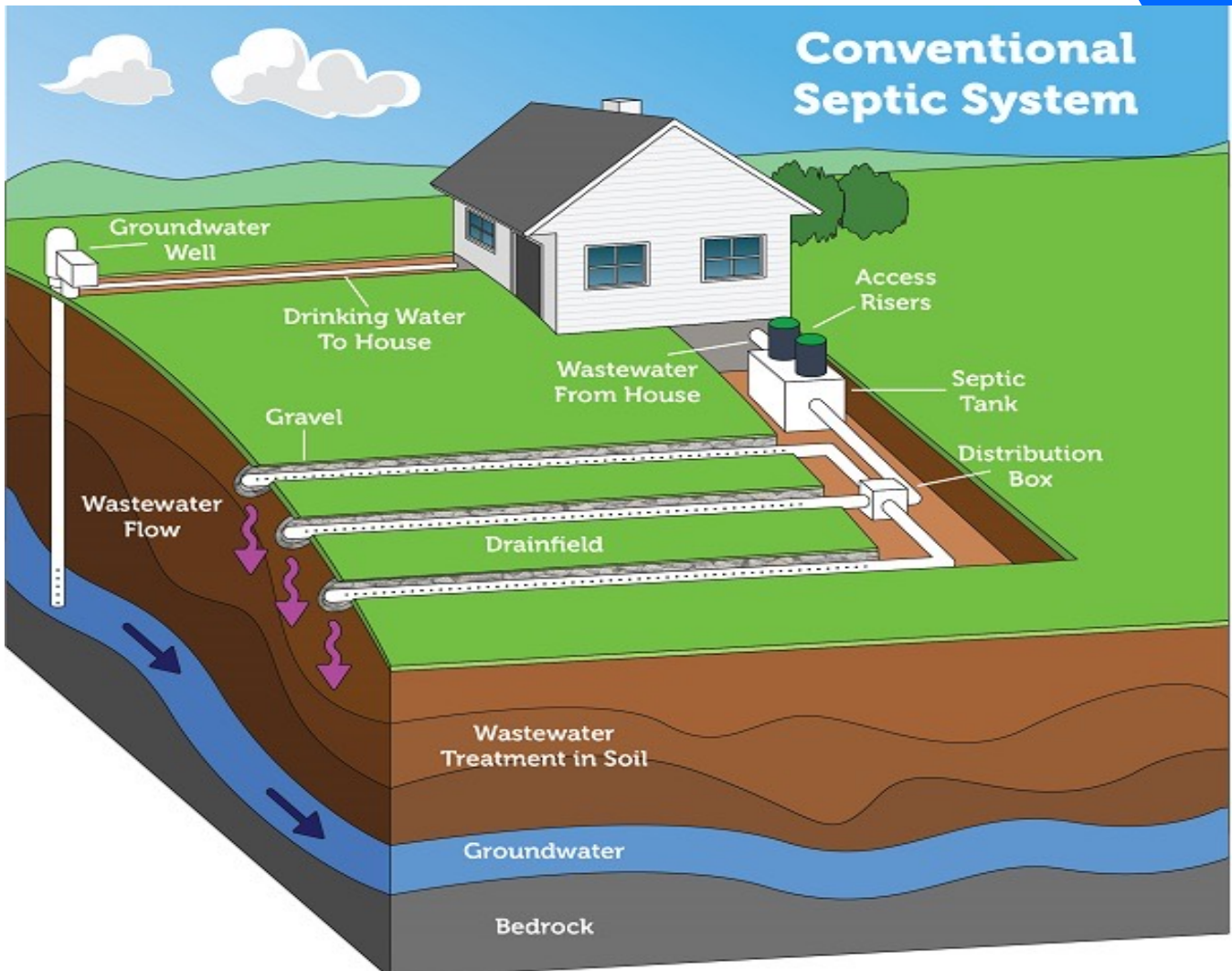
Primary goals

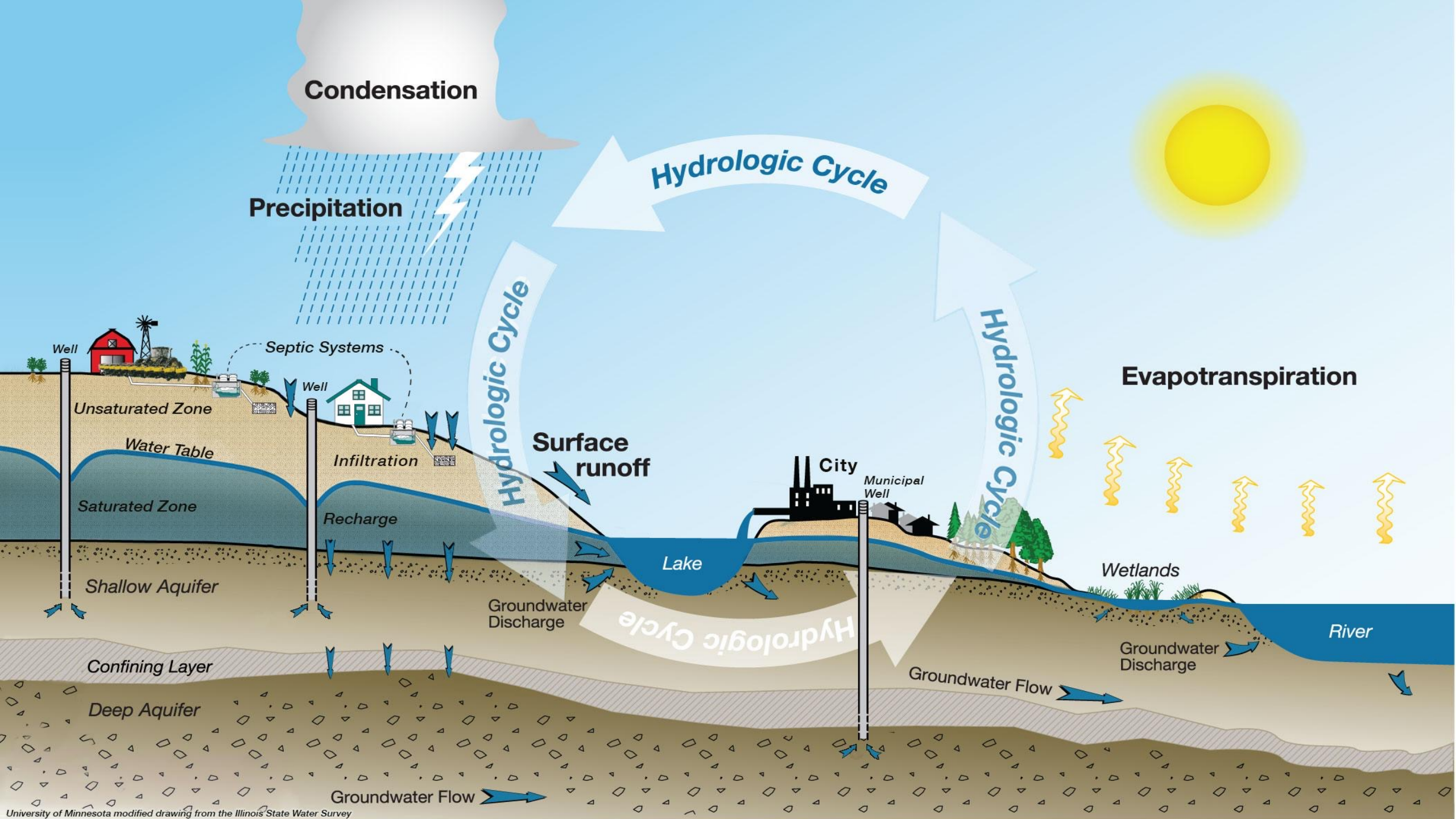
- Evaluate each SSTS and develop risk framework to prioritize upgrades
- Decision support tool
- Budget planning
- Continued research into system design, functioning, and maintenance



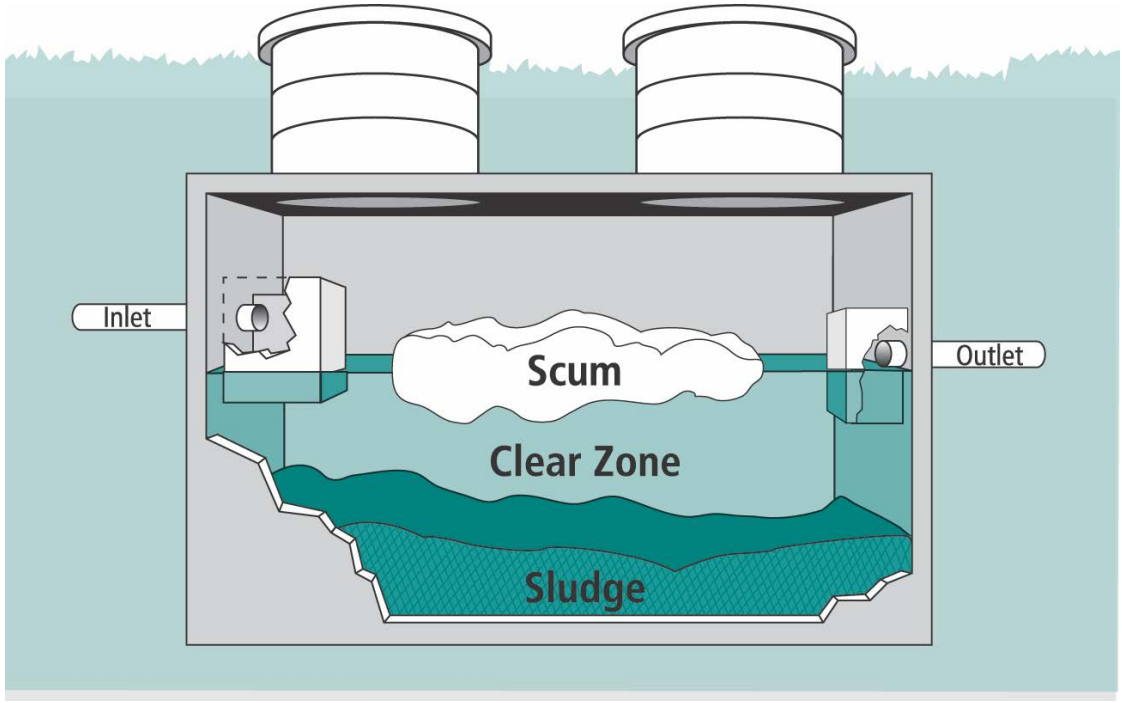
Importance of SSTS in Minnesota

- Over 630,000 SSTS in Minnesota
- 43 billion gallons of wastewater treatment
- 74% of Minnesota's drinking water comes from groundwater




Condensation
Precipitation
Hydrologic Cycle
Hydrologic Cycle
Hydrologic Cycle
Hydrologic Cycle
Evapotranspiration
Well
Septic Systems
Well
Unsaturated Zone
Water Table
Saturated Zone
Shallow Aquifer
Infiltration
Recharge
Surface runoff
City
Municipal Well
Lake
Wetlands
River
Groundwater Discharge
Groundwater Discharge
Groundwater Flow
Confining Layer
Deep Aquifer
Groundwater Flow
University of Minnesota modified drawing from the Illinois State Water Survey

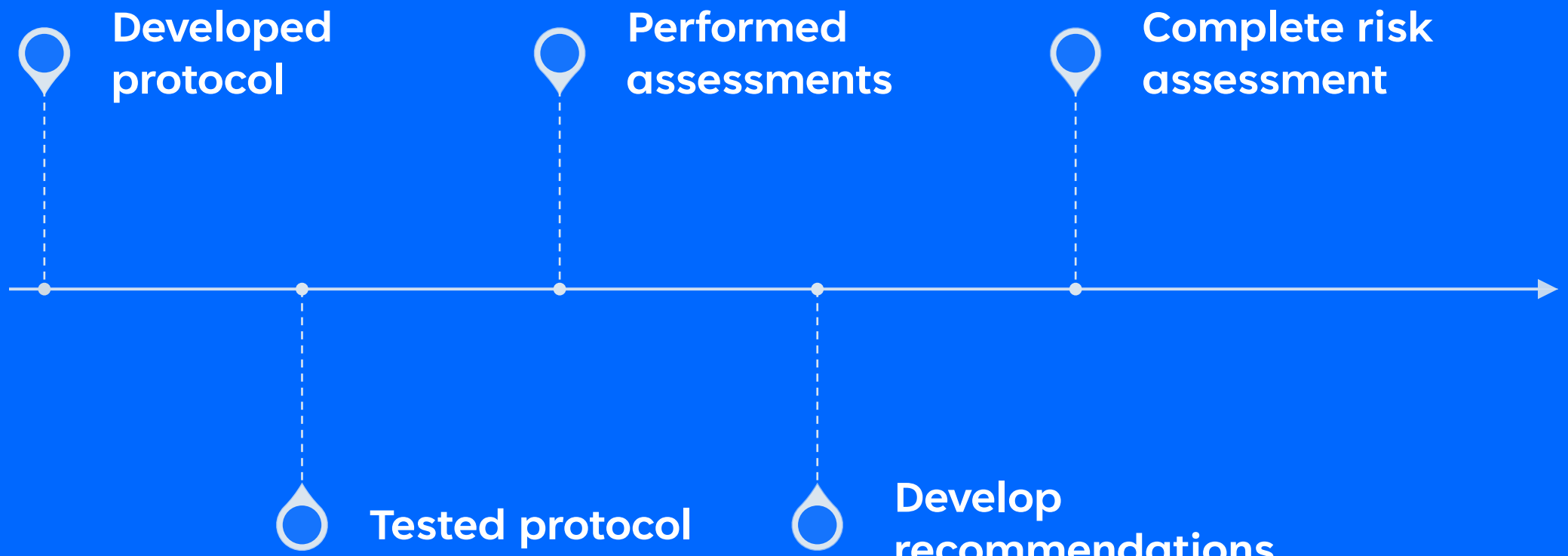
Typical Decentralized Wastewater Treatment



- Primary treatment/anaerobic digestion in a septic tank
- Final treatment/disinfection in a subsurface soil treatment system (SSTS) with 3 feet of unsaturated soil
- Options exist for advanced treatment with challenging site/soil conditions or larger SSTS

How are MnDOT facilities Different?

Timeline – 2014 – 2016



Interior Data Gathered During Assessments

- Toilet gallons per flush
- Sink manual vs automatic
- Water conditioning/ treatment
- Chemical usage

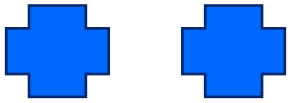
Wastewater Quality Data Gathered

- Flows (daily water meter data)
- Organics (BOD5, COD and TSS)
- Nutrients (nitrogen and phosphorous)

SSTS Data Gathered

1. Septic tank pumping frequency
2. Problems and challenges
3. Type and number of septic tanks
4. Method of conveyance (gravity, siphon, or pump)
5. Size and status of SSTS
6. Vegetative growth over the SSTS

Risk Assessment – Rating & Weighting

1. Rating - Combine 1-5 rating scale with an importance factor (weighting)
2. Weighting value determined by case-based reasoning (CBR) of risk to system function
   - Low 
   - Medium 
   - High 

Risk Rating

Based on MN DOT existing rating scale (1-5)

18 properties that best differentiated and indicated risk selected

Expert knowledge utilized to rate each property

Risk Assessment

Example– Average Daily Flow

Flow Value (gpd)	Number of Systems	Risk Factor
0 - 999	8	5
1,000 – 2,499	6	4
2,500 – 4,999	14	3
>5,000	2	1

Risk Assessment CBR Examples

Property	CBR
Average flow	1.5
Surfacing of effluent	2
Aquifer sensitivity	1.5
Amount of separation	2

Results

High risk systems (2) = 7 SSTS

Medium risk systems

- (3) – 26 SSTS
- (4) – 14 SSTS

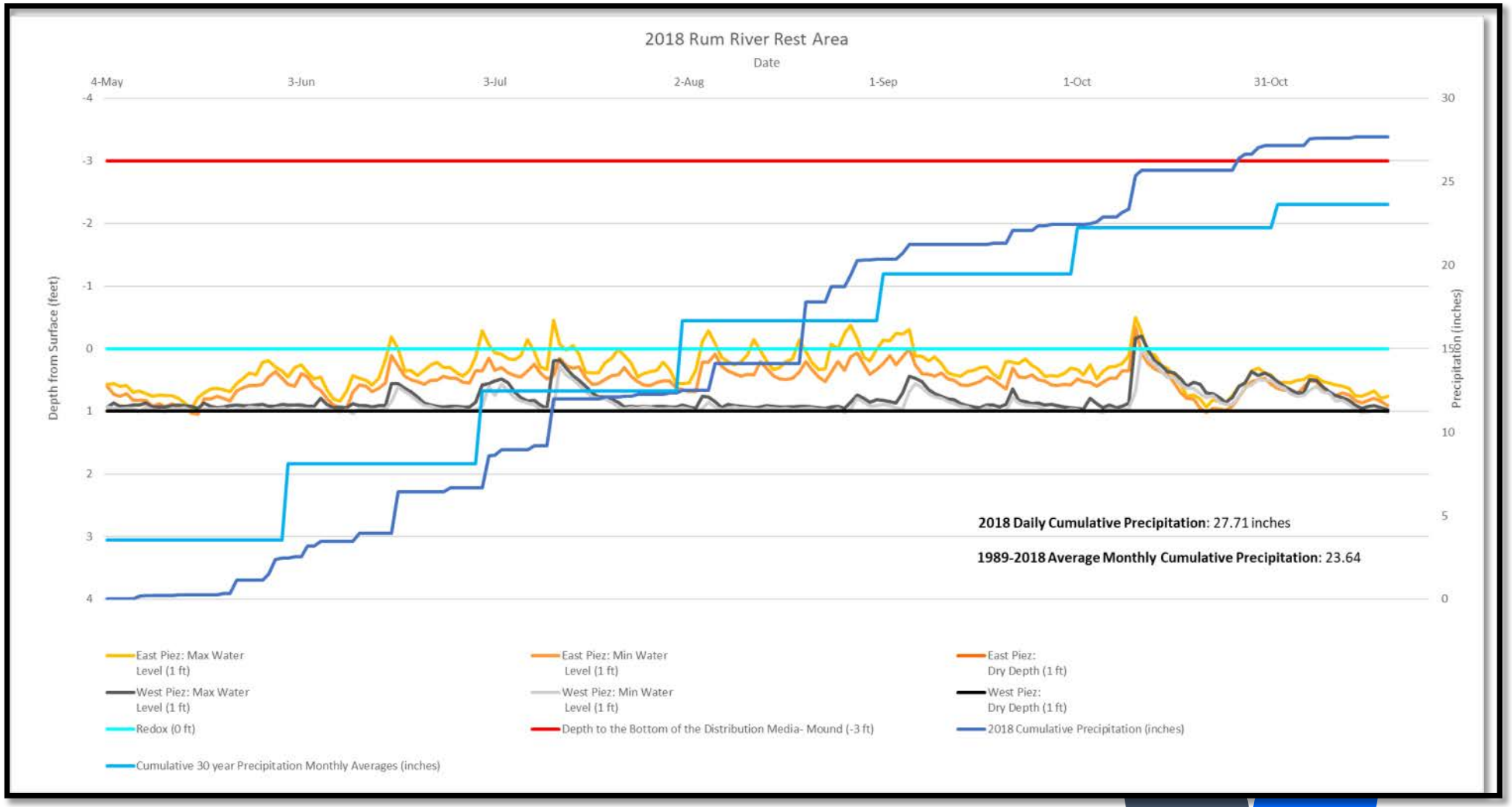
Low risk (5) = 5 SSTS

Follow up Research

2016 – 2019 Research

1. Water table monitoring – ongoing*
2. Education display design and installation*
3. Sampling of flammable waste traps at truck stations – phase I*
4. Development of O&M manuals
5. Water use study*
6. Toilet paper analysis
7. Water softener analysis

Example of Water Table Monitoring



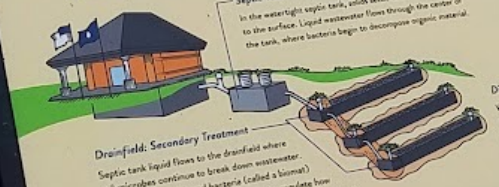
Rest Easy: Septic System at Work

This rest area sits on a small sewage treatment plant, also known as a septic system. Septic systems treat wastewater at sites that aren't connected to a regional sewer system. Their proper use and maintenance protects our shared health and our natural environment.

Septic systems rely on bacteria in the tank and soil to break down wastewater. But when systems are overloaded by too much water or by non-biodegradable solids, backups and overflows can contribute to water pollution and create public health concerns.

About 25 percent of Minnesota homes use septic systems to treat wastewater.

How does treatment work?



Septic Tank: Primary Treatment
In the watertight septic tank, solids settle while oil and grease rise to the surface. Liquid wastewater flows through the center of the tank, where bacteria begin to decompose organic material.

Drainfield: Secondary Treatment
Septic tank liquid flows to the drainfield where soil microbes continue to break down wastewater. A layer of fine solids and bacteria (called a biomat) forms where sewage meets soil. This helps regulate how fast liquid moves into the ground and ensures good treatment.

Did you know?
Wastewater is a mix of toilet (black) water and bathing, laundry or dish-washing (grey) water.

Keeping Waterways Clean

Minnesota's 590,000 septic systems treat 37 billion gallons of wastewater annually. Unlike most regional sewer systems that discharge treated wastewater into our state's lakes and rivers, septic systems treat water locally and recharge our aquifers. Properly maintained septic systems can be more environmentally friendly than sewer systems. They also lessen the flow of nutrient-rich water into the Mississippi River, which has created a growing Dead Zone of low-oxygen water in the Gulf of Mexico.

Going High to Conserve

MnDOT continues to reduce water consumption across the state by managing wastewater on-site at rest areas and by moving toward ultra high-efficiency toilets and faucets.

Compare the Savings!

Toilet flushing is the main source of indoor water use at home, followed by faucets, showers, and clothes washers. You can reduce water use by over 20 percent when you install efficient models and low-flow fixtures.

Water Use Study

- In 1979, MnDOT collected data for design of rest area water supply and sewage treatment designs with water-conserving devices people used 2.8 gallons, while non-water-conserving devices used 4.5 gallons
- In 2016 we evaluated use per person at 12 rest areas - interstate or non-interstate all with water-conserving devices:
- Results
  - Interstate – 2.7 +- 0.6 gallons
  - Non-Interstate – 1.8 + - 0. 7 gallons
- Less cleaning or water treatment on the noticeable difference

Investigating Wastewater Reuse at Truck Stations

1

Evaluate the potential and effectiveness of wastewater reuse at MnDOT facilities

2

Evaluate when reuse makes sense from a regulatory, environmental, economic and management perspective at truck washing/storage facilities and safety rest areas

3

Provide recommendations on the most appropriate applications for reuse and the challenges with implementation

Sampling of Wash Down Water from Truck Stations

- Goal – determine if washdown water from salt trucks can be reused for brine production
- Findings
  - Organics – Organics will need to be dealt with
  - Chloride levels do exceed the allowable discharge standard, but because the likely reuse will be to make chloride brine, this is not of concern

→ MnDOT has installed two pilot reuse facilities to create brine from truck washing wastewater

2019 – 2022 Research

1. Water table monitoring – ongoing*
2. Flammable waste traps – Phase II*
   → Reuse demonstration
3. Soil properties – per post installation – Phase I
4. Contaminants of emerging concern (CEC) - Phase I*

Chemicals of Emerging Concern (CEC) & Treatment in SSTS

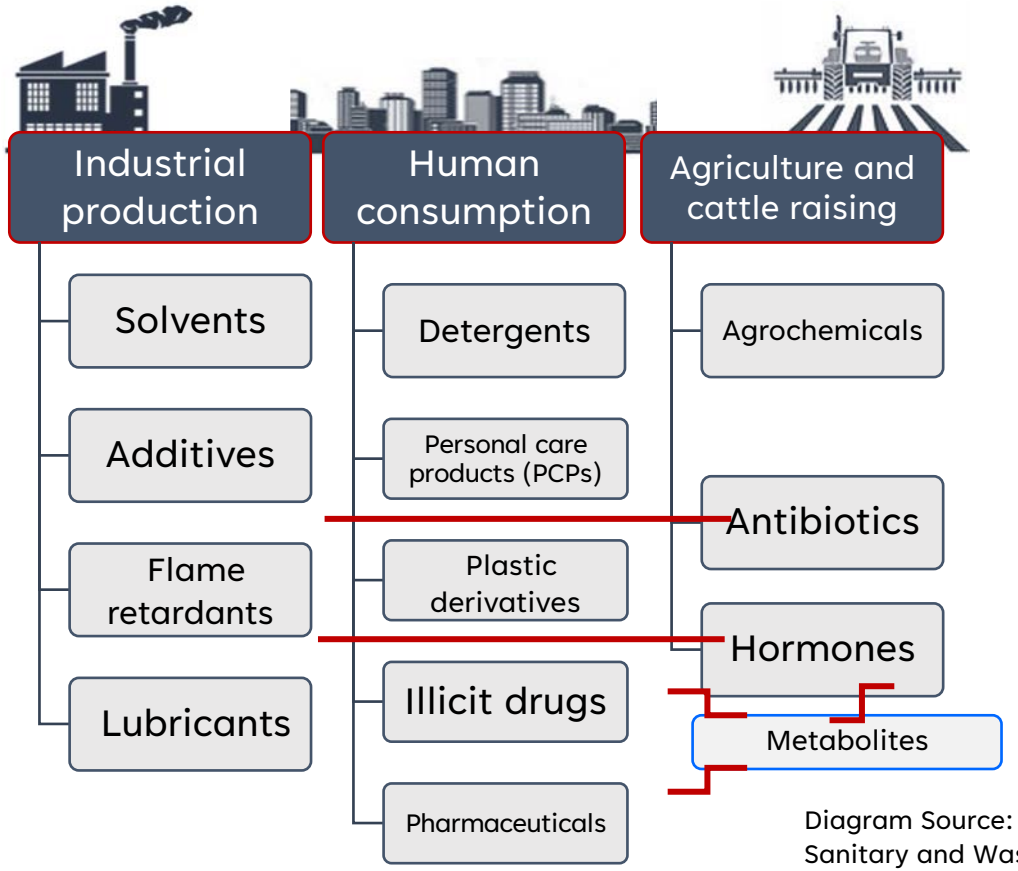


Diagram Source: Maria Clara Starling, Department of Sanitary and Wastewater Engineering, UFMG Brazil

Treatment Mechanisms

- Physical
  - Adsorption
  - Sorption
- Biological
  - Biodegradation
- Chemical
  - Photolysis
  - Oxidation

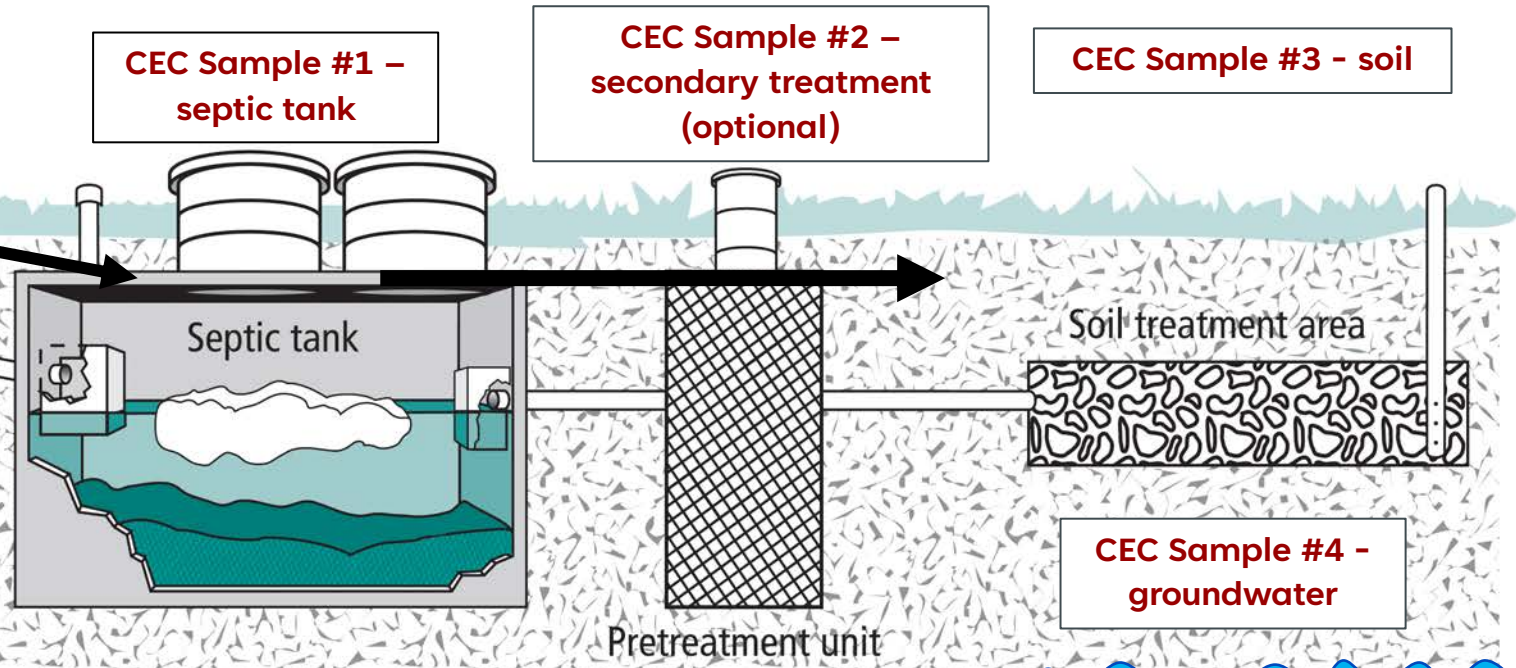
Research on CECS at SFA

CEC

Understanding how CECs move through a SSTS:

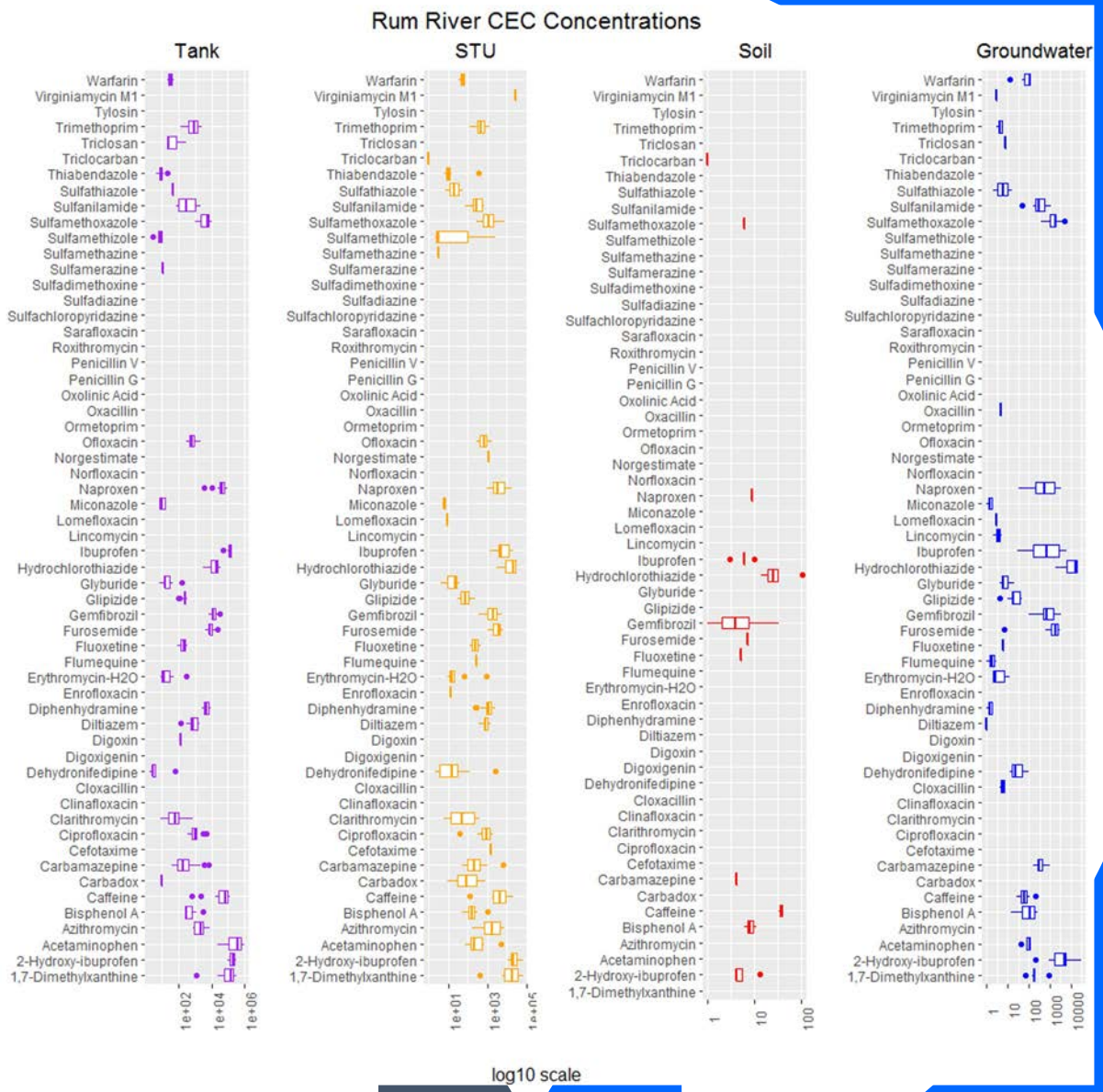
1. Are there CECs present at each sampling area?

2. If so, at what concentration do they occur and how are they reduce?



Field Study Results

- 6 CEC undetected
- 15 CEC in Effluent/Septage, but not groundwater
- Site #1 - 14 detects in soil, Site #2 - 12, Site #3- 1, Site #4 - 0
- Septage/Tank Effluent > Groundwater > Soil



2022 – 2025 Research

1. Water table monitoring – ongoing
2. Temperature monitoring
3. Flammable waste trap – Phase III
4. CEC Phase II*
5. Groundwater mounding
6. Soil properties – per post installation – Phase II
7. Septage – Characteristics and disposal options*
8. Septic tank performance modifications

Research on Septage Objectives

- Primary: Characterize rest area septage
- Determine whether current maintenance practices (e.g., pumping frequency) could be made more efficient
- ‘Exploratory’ investigation of PFAS in rest area septage

MnDOT research projects

Flammable waste trap solids

- Investigating flammable waste trap solids at MnDOT truck stations (PDF)
- Investigating flammable waste trap solids at MnDOT truck stations (Year two report) (PDF)

MnDOT truck stations

- Investigating wastewater reuse at MnDOT truck stations (Technical report) (PDF)
- Investigating wastewater reuse at MnDOT truck stations (Full report) (PDF)
- Septic system evaluation at rest stops, truck station, and weigh scales (Final report) (PDF)

Additional studies

- Truck wash water reuse for brine production (Final report) (PDF)
- Characteristics of rest area water softeners and their effects on chloride in septic systems (PDF)
- Water use study at rest stops (Task report) (PDF)

Septic.umn.edu/mndot

UNIVERSITY OF MINNESOTA

ONSITE SEWAGE TREATMENT PROGRAM

Thank you

Sara Heger

sheger@umn.edu

www.septic.umn.edu

UNIVERSITY OF MINNESOTA
Driven to Discover℠