EPA
United States
Environmental Protection
Agency

Net Zero Project Overviews and Progress

Office of Research and Development

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United States Environmental Protection Agency

EPA NetZero Program Mission

- To assist communities and our military achieve their sustainability and resiliency goals of Net Positive and Net Zero Energy, Net Zero Waste, and Net Zero Water in ways that protect human health and the environment while generating societal and economic benefits.

- To integrate and advance the science and demonstration of Net Zero and Net Positive strategies, approaches and technologies for a wide spectrum of partners, including Department of Defense (DoD) installations, municipalities, water utilities, developers, and communities.

What is Net Zero?

- **A Net Zero ENERGY Installation** produces as much energy on site as it uses over the course of a year.
- **A Net Zero WATER Installation** limits the consumption of freshwater resources and returns water back to the same watershed so not to deplete regional groundwater and surface water resources in quantity or quality.
- **A Net Zero WASTE Installation** reduces, reuses, and recovers waste streams, converting them to resource values with zero solid waste to landfill.
- **A Net Zero INSTALLATION** applies an integrated management approach to energy, water, and waste to capture and commercialize the resource value and/or enhance the ecological productivity of land, water, and air.

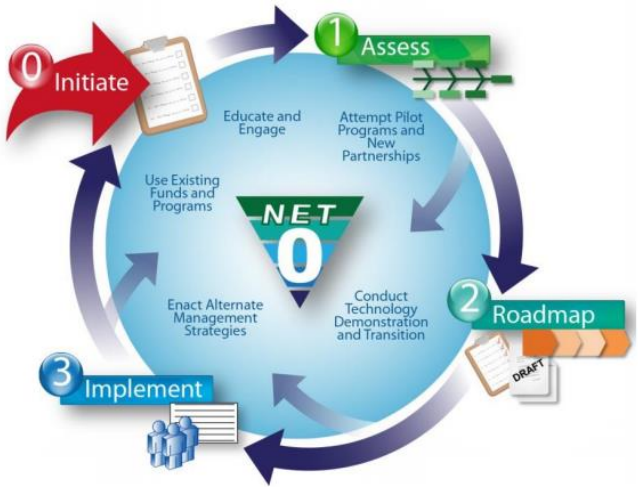
Safe and Sustainable Water Resources Research

EPA/Army Partnership:

- Army (MOU signed with ORD Nov 28, 2011):
  - to promote development and demonstration of new technologies for use on installations striving towards Net Zero water, waste, energy
  - Projects at Ft. Riley, KS support SSWR work and the Army's NetZero water goals. Projects will be implemented in Fall 2013/Summer 2015.
  - Participants include ORD, R7, OW, Army, DoE, USACE, USGS, and Kansas State University.

EPA/DoD Partnership:

- DoD (MOU signed with ORD Feb 7, 2012):
  - to advance innovative research and demonstrate cutting-edge technology solutions in support goals for increased resource efficiency, balanced resource use, and greater resource resiliency on military bases
  - In Jan. 2013: ORD and DoD jointly issued a solicitation through DoD's Environmental Security Technology Certification Program to demonstrate innovative, cost effective, energy efficient wastewater treatment technologies.
  - Awards were made in Spring 2014
  - This project supports SSWR work and participants include NERL, NRMRL, SSWR, OW, R1, and DoD.



Net Zero Installations

Safe and Sustainable Water Resources Research

Net Zero Technology Demonstration Partnerships

Decentralized Wastewater Treatment for Water Reuse and Improved Energy Efficiency

- Reduce potable water use at Fort Riley, KS via decentralized treatment and reuse of wastewater captured from sewer lines

Water Demand and Outreach

- Explore the effectiveness of education and awareness campaigns at Ft. Riley on behaviors and reducing water consumption through a social marketing campaign, competition, outreach, and outcome assessments

Green Infrastructure

- This project will assess the performance of reducing stormwater runoff and improving water quality by monitoring vertical and horizontal transport through a permeable surface parking lot .

NET ZERO
energy • waste • water

Safe and Sustainable Water Resources Research

Decentralized Wastewater Treatment for Water Reuse and Improved Energy Efficiency

What will be Solved?

- Determine utility and cost-effectiveness of decentralized waste water treatment systems for water reuse via sewer mining

What will be Learned?

- Examine effectiveness of two types of decentralized wastewater treatment systems (current and emerging technology) to treat wastewater, reduce potable water use, and decrease energy use

What will be Fixed?

- Increased energy efficiency and reduced water use
- Performance data for selecting wastewater treatment approaches
- Increased water resiliency and greater security by eliminating single point of failure hazards inherent in centralized systems

Membrane Bioreactors for Wastewater Treatment

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Aerobic MBR

Advantages

High reaction rates
Minimal sludge production
High quality effluent
Small footprint
Water reuse

Disadvantages

High energy use
Membrane Cleaning

Anaerobic MBR

Advantages

Lower energy use
Energy Production

Disadvantages

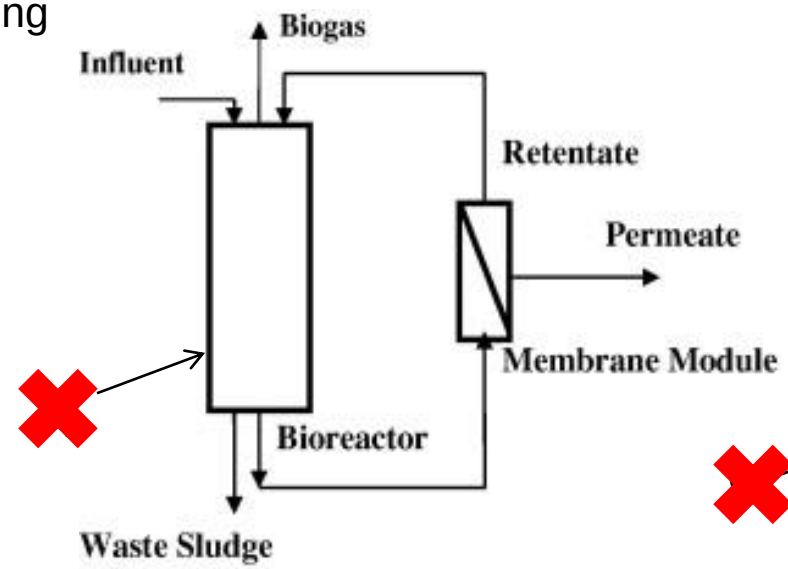
Dissolved methane
Higher nutrient in effluent

Research Activities

Aerobic MBR
On-line effluent quality monitoring

Anaerobic MBR
Demonstration of state of the art (DOD-ESTCP)

Both
Comparative Live Cycle Assessment /Costing at different scales



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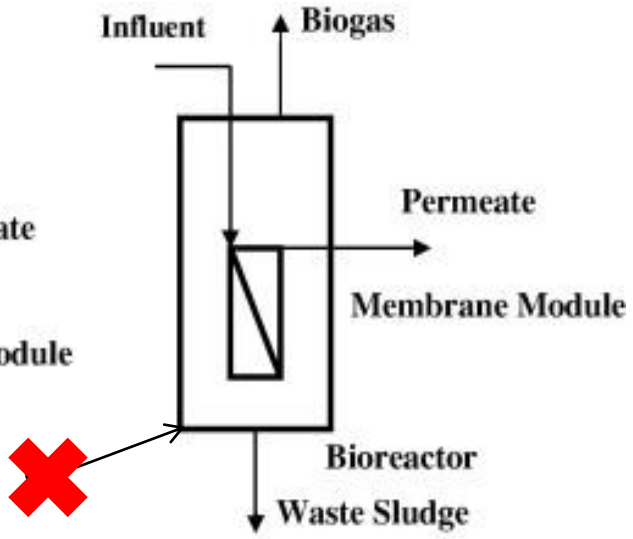

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Rationale for On-line Monitoring

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- Water Reuse
  - Rapid recycling of water
  - Decentralized approaches
- Translates to the need for speed and low cost to capture the dominant risk “events”
- Eventual dipsticks or “tricorders” for microorganisms
  - Maybe, given the revolution in microelectronics and molecular biology
  - But relevant levels of pathogens and indicators very low; challenge for on-line detection
    - Plus, pathogens levels are highly variable
- So, alternative approaches are:
  - Use non-biotic on-line monitoring
  - Test their utility as surrogates of microbiological quality

Online Event Detection

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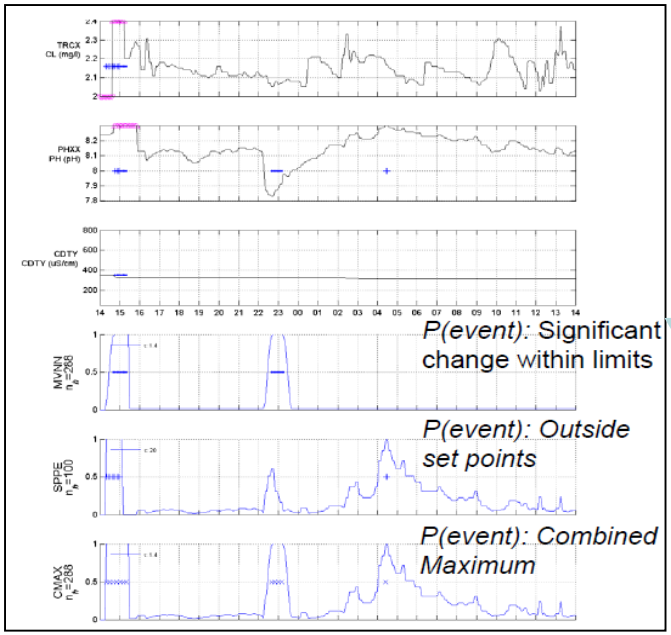
Influent



Membrane Bioreactor

Effluent

Microbiological Analysis

Fluorescence

Total Organic Carbon

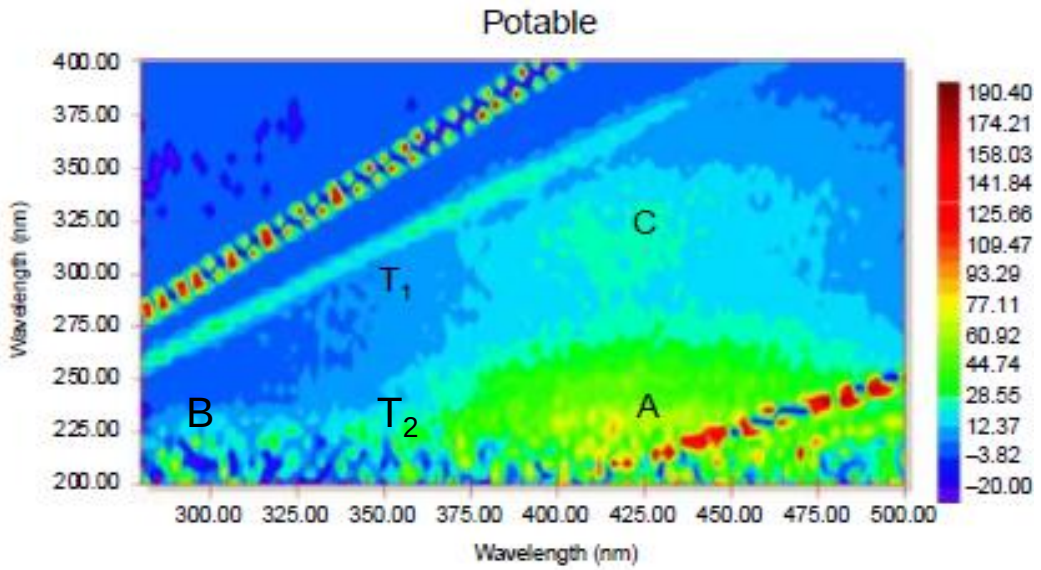
pH

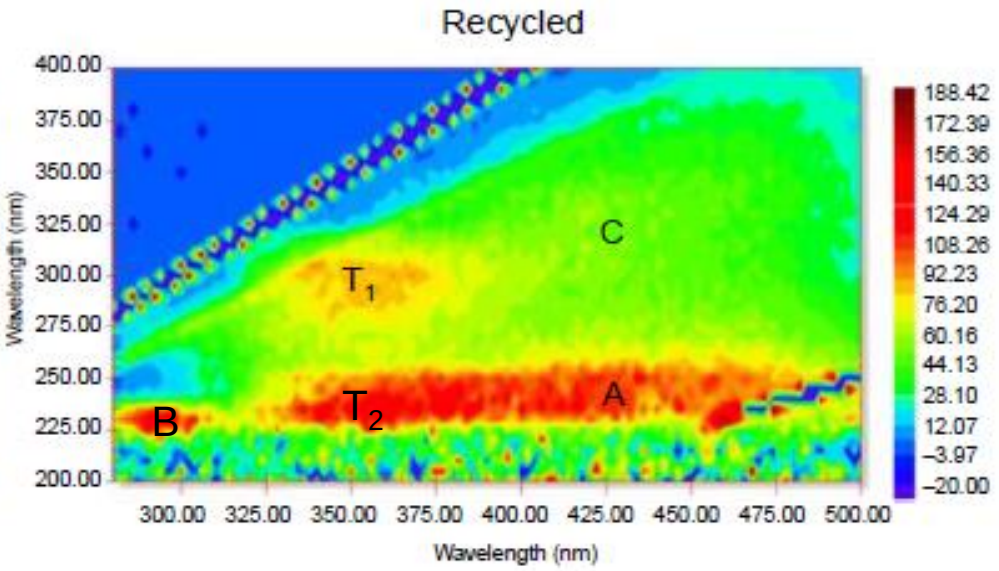
Conductivity

?

Event Signal

Multivariate Event Detection Software (e.g. CANARY)

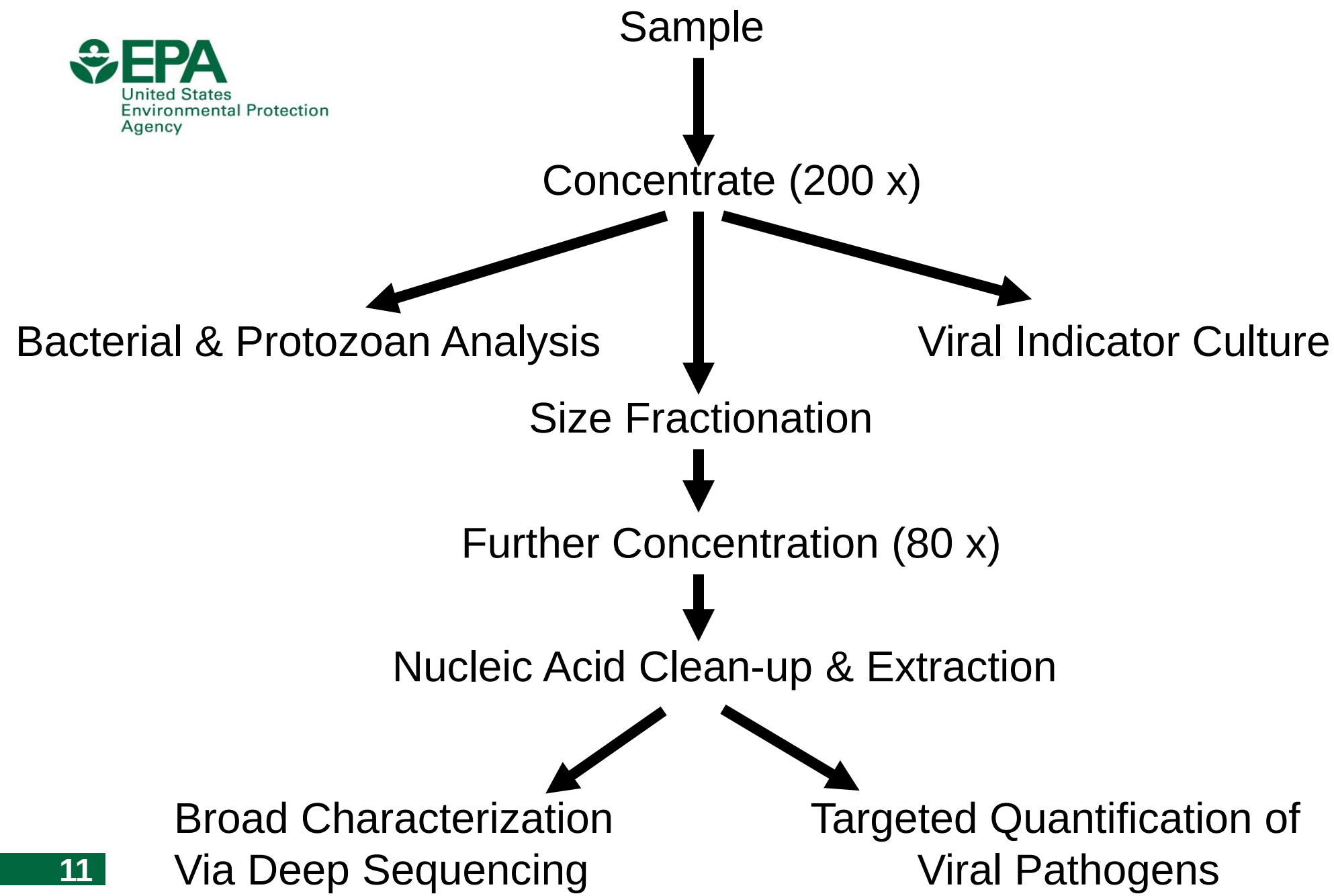




Peak definitions (Henderson, 2009)

- A: Humic-like
- B: Tryosine-like
- C: Humic-like
- T1: Tryptophan-like
- T2: Tryptophan-like

- Extracellular proteins are mainly excreted by microorganisms. Tryptophan fluorescence is the dominant part of the protein fluorescence, which has a fluorescence maximum at Peak T1 and T2 (Ni, 2009)
- Peak T2 fluorescence correlates with HB, TC, *E. Coli* (R^2 values of .81, .78, .72, respectively) from diluted river water and sewage works final effluent (Cumberland, 2012)


Sample
Concentrate (200 x)
Bacterial & Protozoan Analysis
Viral Indicator Culture
Size Fractionation
Further Concentration (80 x)
Nucleic Acid Clean-up & Extraction
Broad Characterization
Via Deep Sequencing
Targeted Quantification of
Viral Pathogens

What is the Optimal Scale of Decentralization in Several Resource Recovery Based Wastewater Systems?

- Four Systems
  - Gravity sewer connected with aerobic membrane reactors
  - Gravity sewer linked with anaerobic membrane reactors
  - Fecal matter collected by vacuum sewer and co-digested with food residue in anaerobic digesters
  - Same option, with vacuum sewer replaced with pressure sewer
- Detailed process-based life cycle assessment of different systems under various scenarios:
  - Scale (geographical footprint)
  - Distinct population densities

Safe and Sustainable Water Resources Research

Water Demand and Outreach Project

What will be Solved?

- Initiate and sustain measurable reductions in water use and establish an accurate residential water use profile

What will be Learned?

- Target areas of water (re)use and conservation and track conservation attitudes and perceptions over time
- Understand how to cost effectively target key sources of water demand using techniques such as social marketing, pledges, feedback and targeted information

What will be Fixed?

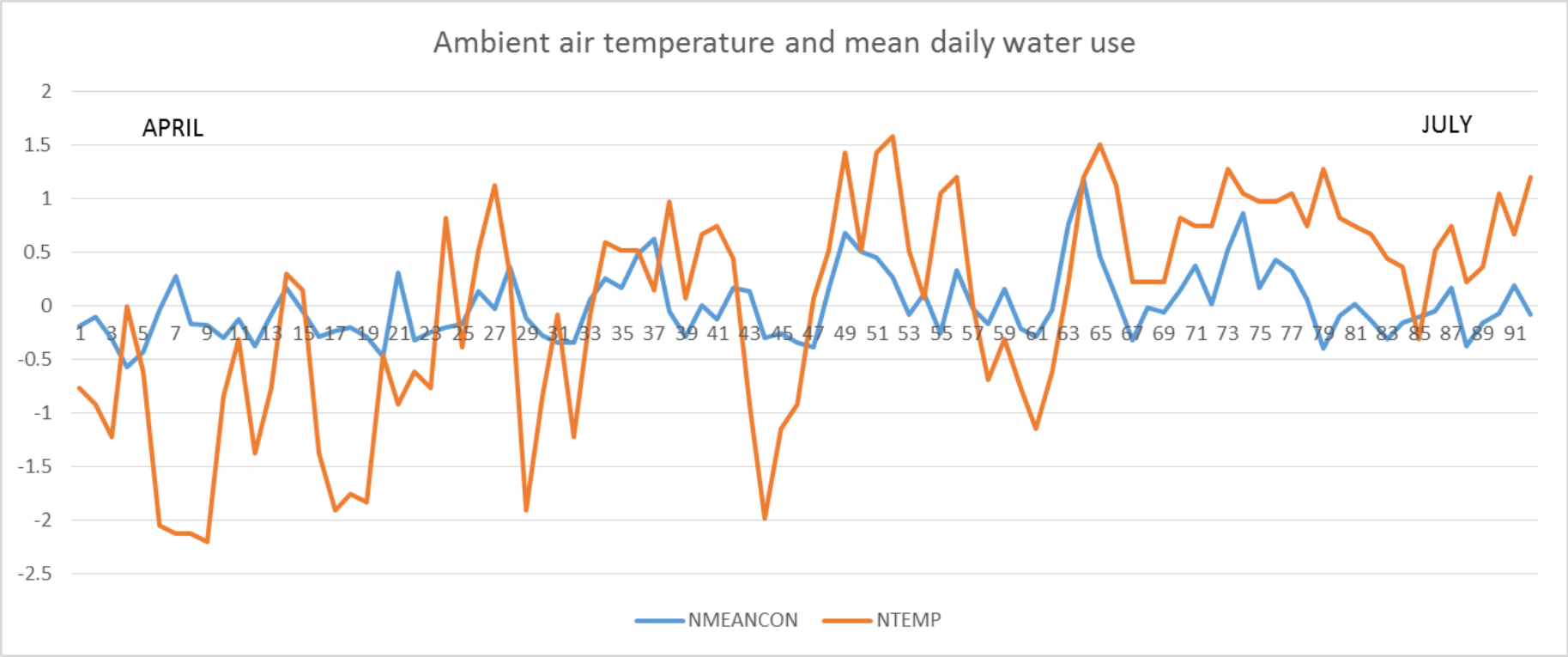
- Reduce water demand through intervention points (information and awareness, targeted outreach, installation of meter technology, and facilitation of water saving projects) aimed at key residential water use hot spots

Water Demand and Outreach Project

Impact:. EPA: will be able to demonstrate innovative water monitoring technologies and better understand the 'social' drivers of water demand in a unique residential context. Ft. Riley will gain an understanding of how to promote more sustainable water use behaviors that work within their framework.

Communities will better understand how to cost effectively target key sources of water demand using techniques such as social marketing, pledges, feedback and targeted information

Water Demand and Outreach Project



Safe and Sustainable Water Resources Research

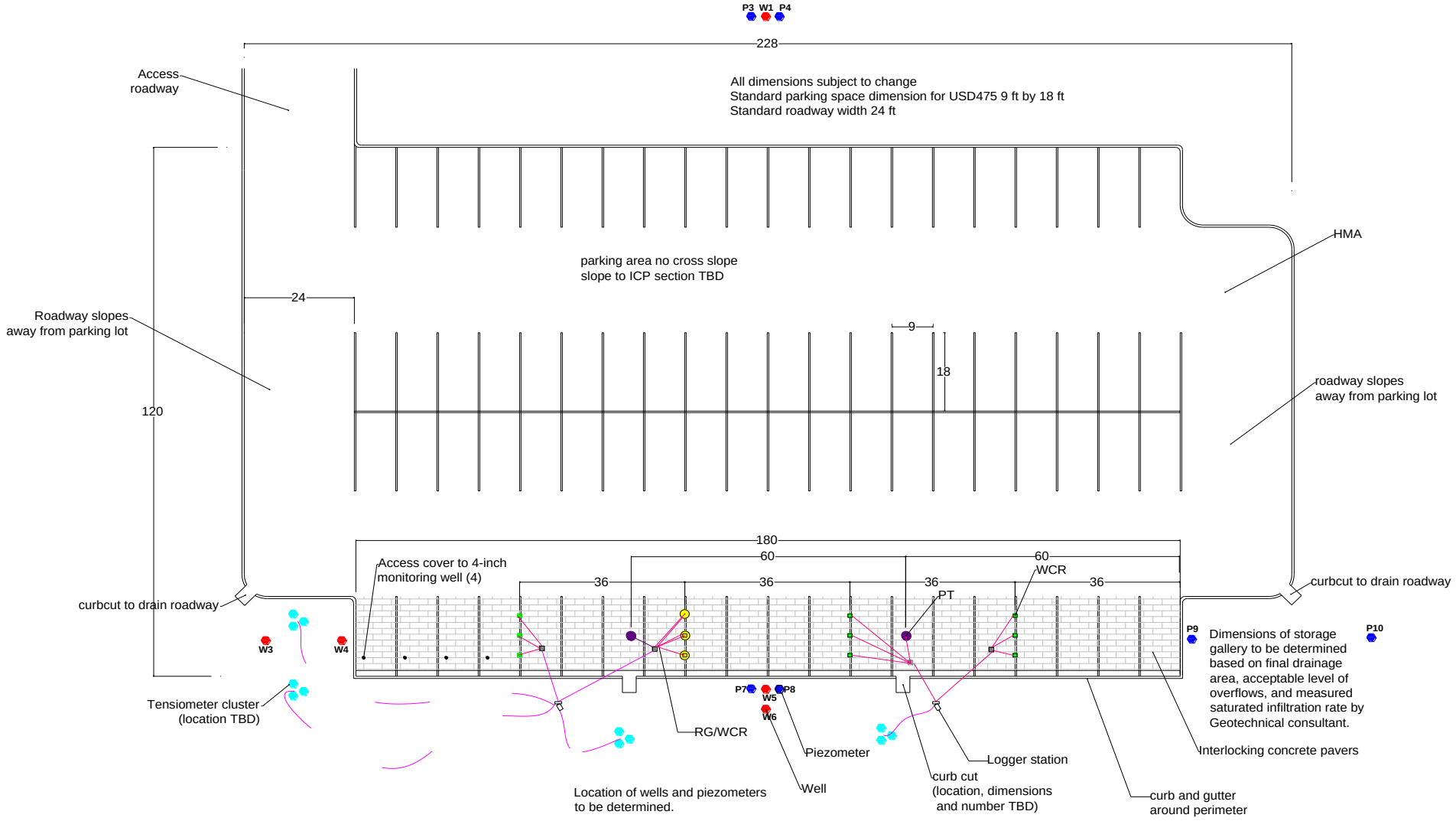
Green Infrastructure Project

- **Goal:** The project will assess the performance of reducing stormwater runoff and improving water quality by monitoring vertical and horizontal transport around a permeable surface parking lot embedded with sensor technology, and educate the community on the benefits of sustainable water resource management.

- **Impact:** The project will improve understanding of stormwater transport, water quality and the effectiveness of citizen science teams and assist Ft. Riley in meeting stormwater regulatory standards and education of water conservation and green infrastructure. The resulting data will inform stormwater management solutions through the use of sensor technology as a means of monitoring GI performance.

- Education and outreach through citizen science to the surrounding community on the benefits of sustainable water resource management is key to this project. The school district will have access to the results through a regularly updated display for students and teachers to interact with. This research project will be conducted at the Seitz Elementary School, a LEED silver certified building in the Camp Forsyth area of Fort Riley, Kansas.

Instrumentation Layout



Permeable Surface Parking Lot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