The Decontamination Effluent Treatment System (DETS): Mass Personnel Decontamination, Road Testing, and Integration





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Engineer Research and Development Center (ERDC)

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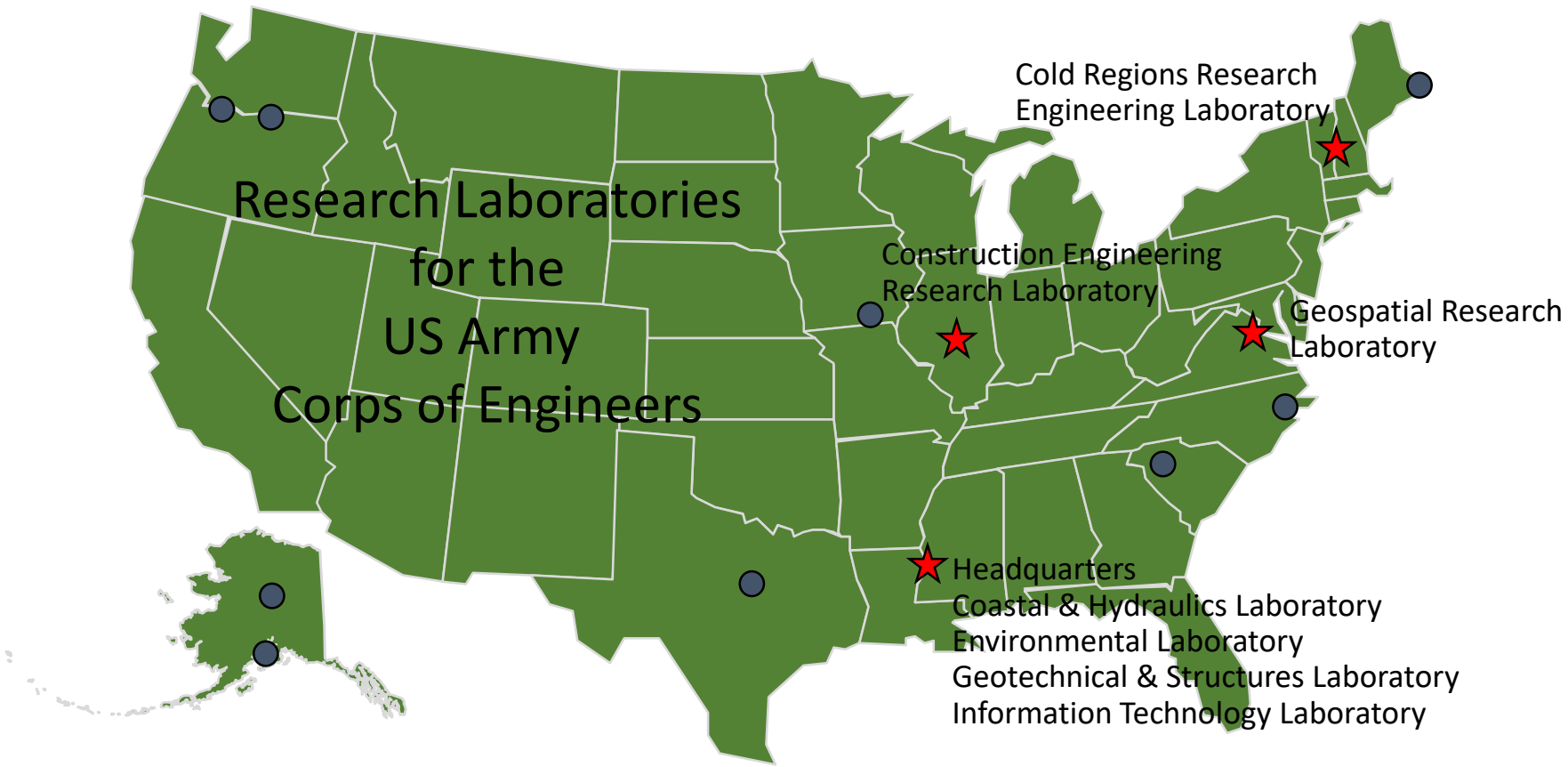
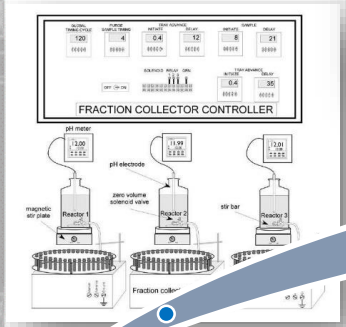
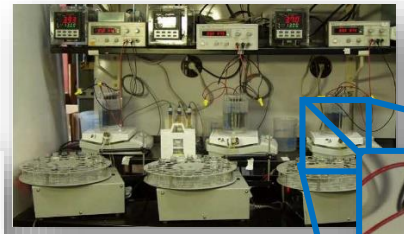


Environmental Engineering Branch

- Integrate science, engineering, and technology to solve environmental problems,
- Research and develop bench, pilot, and full-scale field systems, and
- Promote understanding through technology transfer.





Evolution of Electrochemical Destruction of RDX in Process Waste Water

Concept

Prototype

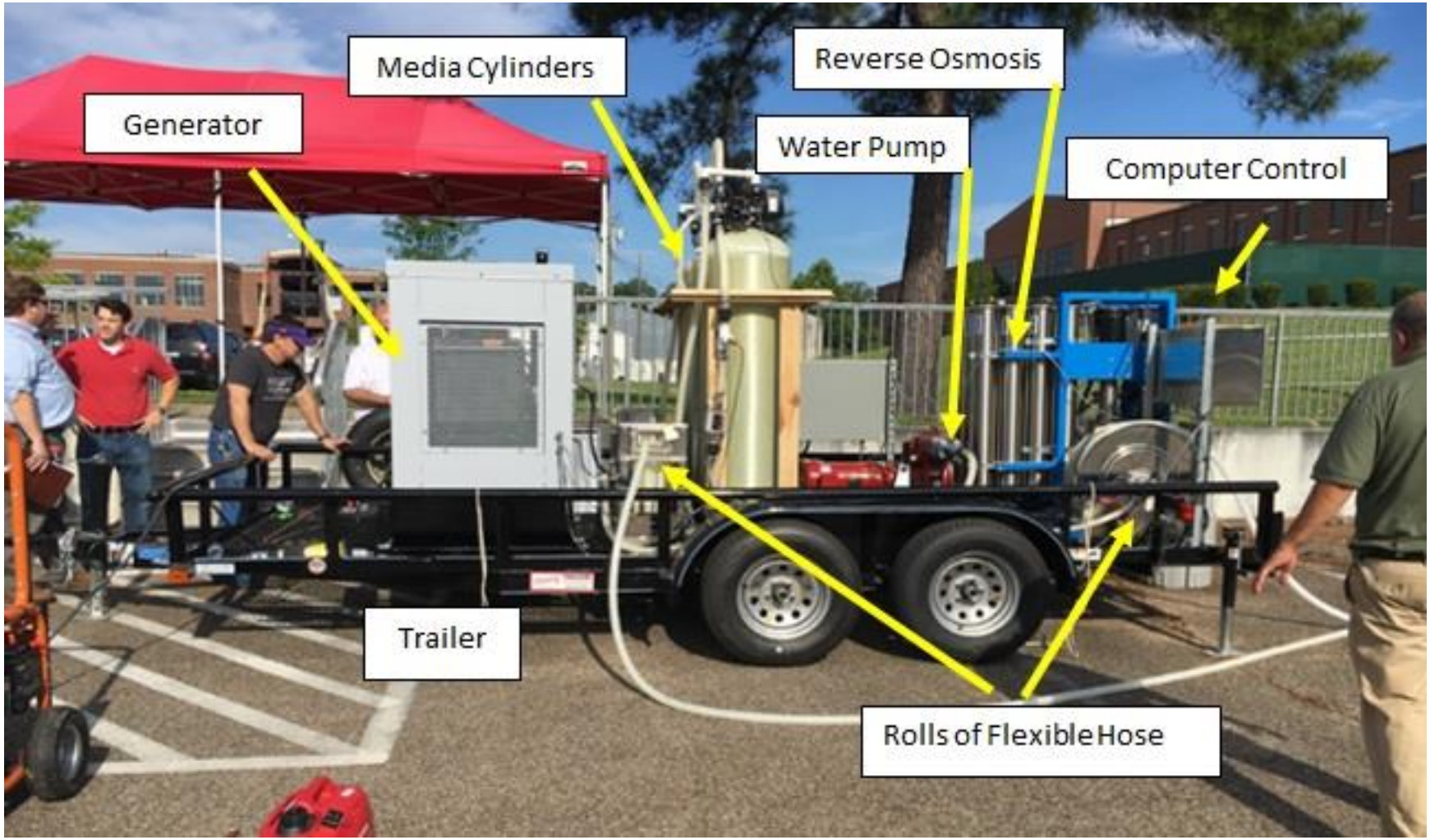
Pilot / Field Demonstration

The Problem

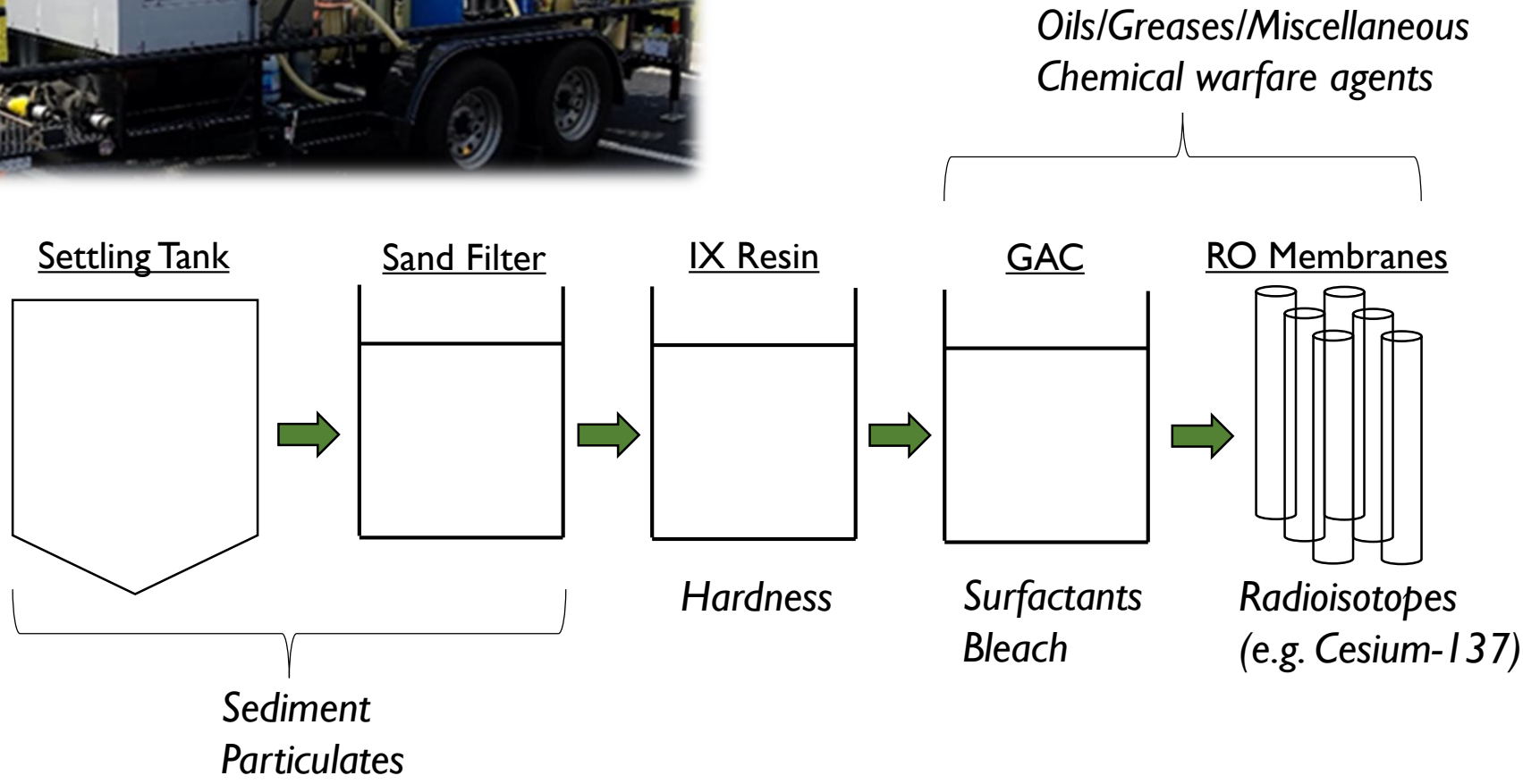
- The Army has no capability to treat and/or recycle the effluent from its aqueous based chemical, biological, radiological and nuclear (CBRN) decontamination operations. This effluent is still very hazardous and a major handling, logistical, and potentially a political burden.



The Solution:
The Decontamination Effluent Treatment System (DETS)



DETS Treatment Strategy



Process control and power supply

- Control architecture: EZAutomation EZ-Touch HMI/PLC
  - Customizable and programmable interface with ladder logic control
  - Data recording
  - Modular I/O
  - Pressure sensitive touch screen – compatible with heavy gloves

- Kubota Diesel 9875 240 V, 40 amp Watt Generator
  - 60 gallon subbase fuel tank and a two-wire auto start control.
  - Sound enclosure keeps noise at 68 dB(A) at 7 m (23 ft), which is helpful for communications.
  - The system is also designed to be suitable for operation of sensitive electronic equipment.
  - Fuel consumption varies from 0.41 to 0.84 gal/hr.
  - The system can also simply be plugged into a 240 V, 60 Hz, single phase, 40 amp source.

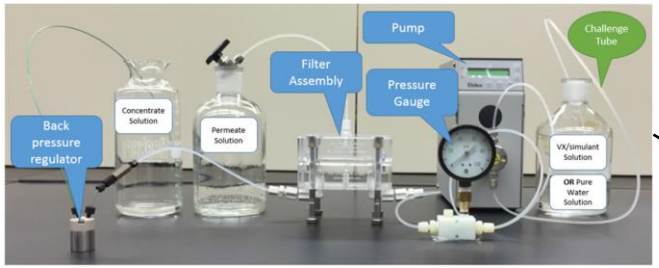
Cost

Unit	Cost	Comment
Reverse osmosis unit with pump and prefilter Cleaning units for scale and organics Sand filter media unit Carbon filter media unit Water softener media unit Ultraviolet sterilization unit (not used in these studies)	$13,621.44	Price is for all the units described
Kubota Generator	$9,922.45	
Bredel pumps with mounting equipment and hoses	$13,283.09	We purchased 2, but only 1 was used. Cost is for 1 unit.
Flanges	$1,066.00	
Hose reels	$8,939.92	
Trailer Trailer upgrades	$5,000.00 $1,000.00	We determined upgrades were needed after the initial demonstration
EZ Touch Control units with associated software	$1,800.00	
Pressure gauges	$1,000.00	Estimated
Wiring	$500.00	Estimated
Total	$56,632.90	

- Table to the left summarizes costs of elements of the system
- The equipment costs were less than $60,000
- Keeping costs low allows for a unit to be disposed of in its entirety if it gets highly contaminated during treatment
- Enhancement of monitoring equipment is the greatest estimated additional cost

Alpha Version of Mobile Treatment System

Our system treated a simulated effluent with soap, bleach, clay and cesium. The removal was >99 percent of each constituent.

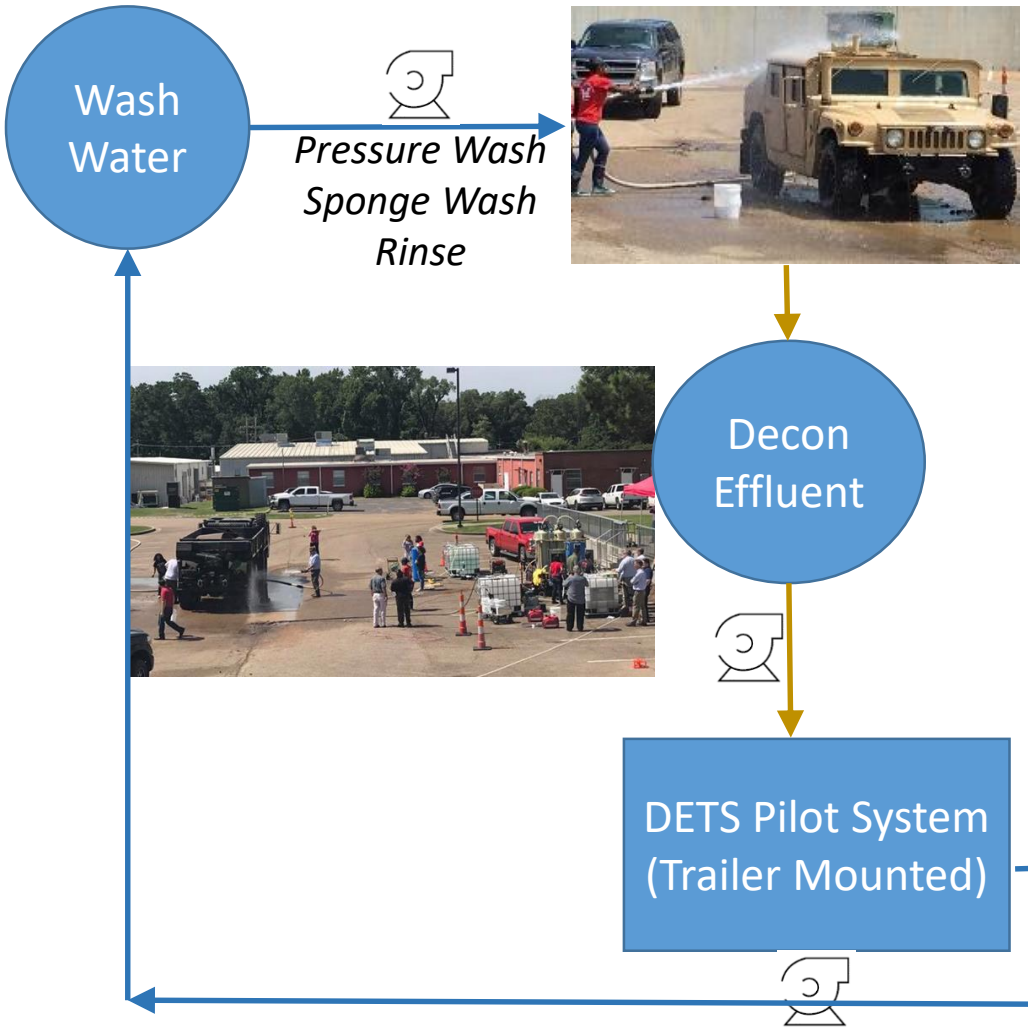


Our pilot reactor capable of treating aqueous effluent from decontamination of 200 people and 10 large vehicles per day for 3 to 5 days.

Flow Rate

- Battalion Sized Event
- Adapted from planning factors of operational DECON (Army G3/5/7 Decontamination Planning factors)
- 10 gpm

ERDC Demonstration: Simulated Decontamination



Details

- 27 June 2017
- 6 hours of total activity
- DETS operation 2 hours
- 10 large military vehicles & 20 cars, trucks, minivans were washed w/ soapy water & rinsed.
- 1200 gallons collected and spiked with Malathion, cesium, and bleach.
- Observers from JPM-P, Army MSCoE, JPdM A&RS, ECBC, DTRA, & USEPA

ERDC Demonstration: Results

Constituent	Analytical Method	Influent Concentration (mg/L)	Effluent Concentration (mg/L)	Removal
Hardness	Summation of Ca^{2+} and Mg^{2+} concentrations as measured by ion chromatography	82.36 ± 40.79	0	100.0%
Total Chlorine	Standard Method 4500-Cl G	0.26 ± 0.07	0	100.0%
Surfactants	Spectrophotometric method as given in Kloos (2015)	1.422 ± 0.359	0.019 ± 0.017	98.7%
Total Organic Carbon	USEPA 5310B	58.23 ± 29.7	1.18 ± 0.84	98.0%
Malathion	Phosphorus balance	26.71 ± 12.16	0.08 ± 0.05	99.7%
Malathion	USEPA 8141A	24.7	0.000097	100.0%
Cesium	USEPA 6020A	2.97 ± 4.21	0	100.0%
Turbidity	USEPA Method 180.1	>4200 (NTU)	1.825 ± 1.145	100.0%

All measurements indicate that the DETS is highly effective at treating constituents found in decontamination wash water (98% removal or greater).

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Mass Personnel Decontamination Field Evaluation

Details

- 24 May 2018
- DETS operation 2.5 hours at 12 gpm
- 1800 gallons collected and spiked with Malathion, cesium, surfactants, and sediment/ash.

Contaminant	Target Concentration (mg/L)
Malathion	1
Cesium (CsCl)	5
Surfactants	20
Sediment	5
Ash	6

Mass Personnel Decontamination Field Evaluation: Results

Figure 7. Removal of surfactant (as LAS) during the MPD evaluation.

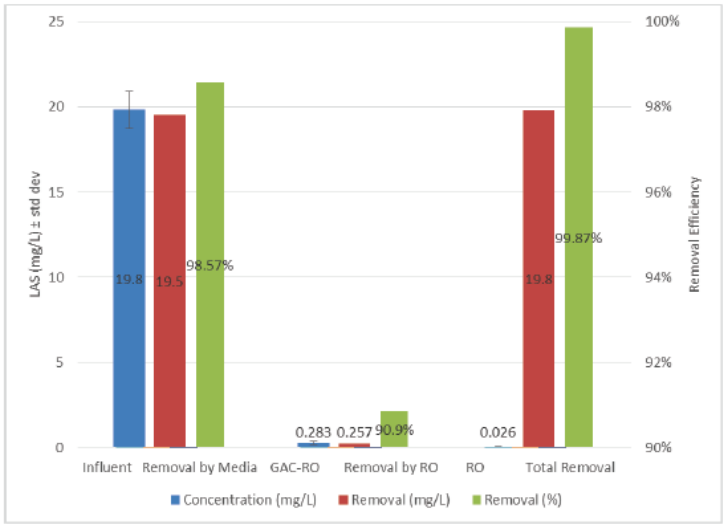


Figure 8. Removal of cesium during the MPD evaluation.

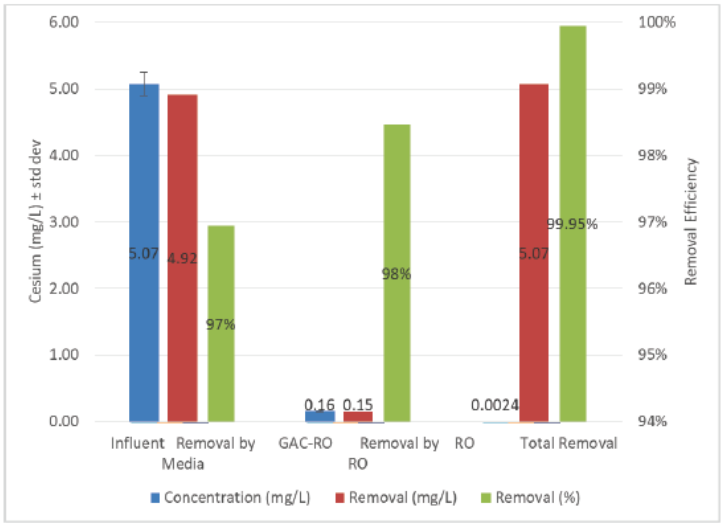
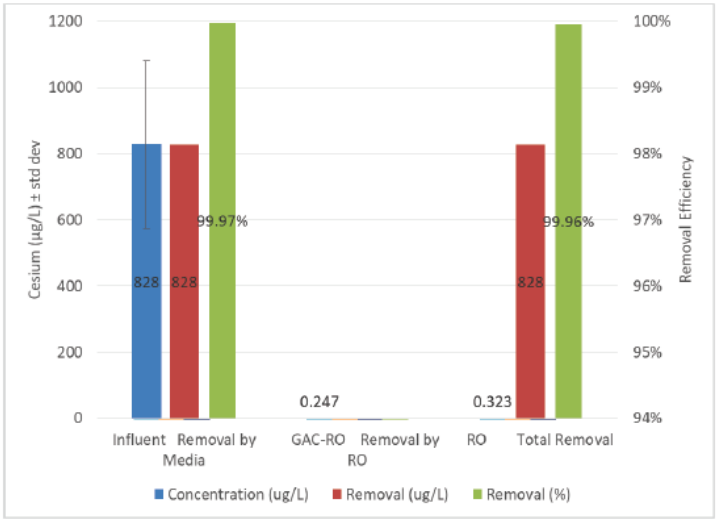


Figure 9. Removal of Malathion during the MPD evaluation.



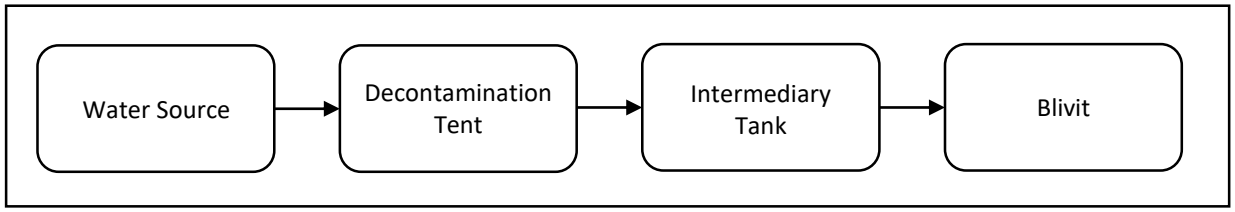
Treatment of target constituents exceeded 99.8%

Pretreatment step (i.e., sand/GAC filtration) removed >97% of contaminants

RO proved to be an effective polishing step for surfactant and cesium removal

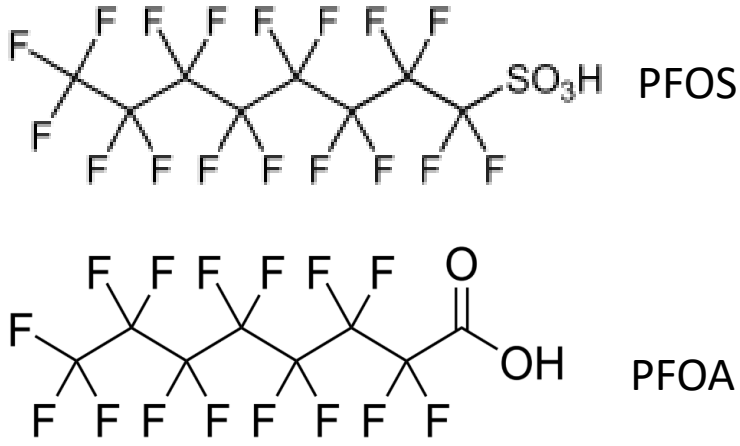
LA National Guard Demonstration

- 10 January 2019
- Integrate DETS into National Guard CBRNE Enhanced Response Force Package (CERFP)



Schematic of water flow in current CERFP shower system

Future Work: Adapting DETS to PETS for PFAS
Pilot System Construction and Application



- Found in Aqueous Firefighting Foams (AFFF)
- Very challenging to degrade, particularly PFOS
- EPA Drinking Water Health Advisory: 70 ppt

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Future Work: Adapting DETS to PETS for PFAS
Pilot System Construction and Application

- PFAS Treatment Systems
  - Media filter treatment train
  - Primary filtration/ GAC/ RO
  - Mobile trailer 10-30 GPM
  - Recovers over 90% of the influent water
  - Treatment of concentrate approaches zero discharge
  - Goal will be to produce effluent with total PFAS measurements of 70 ppt or less

74,000 gallons (2 sites) with C6 AFFF

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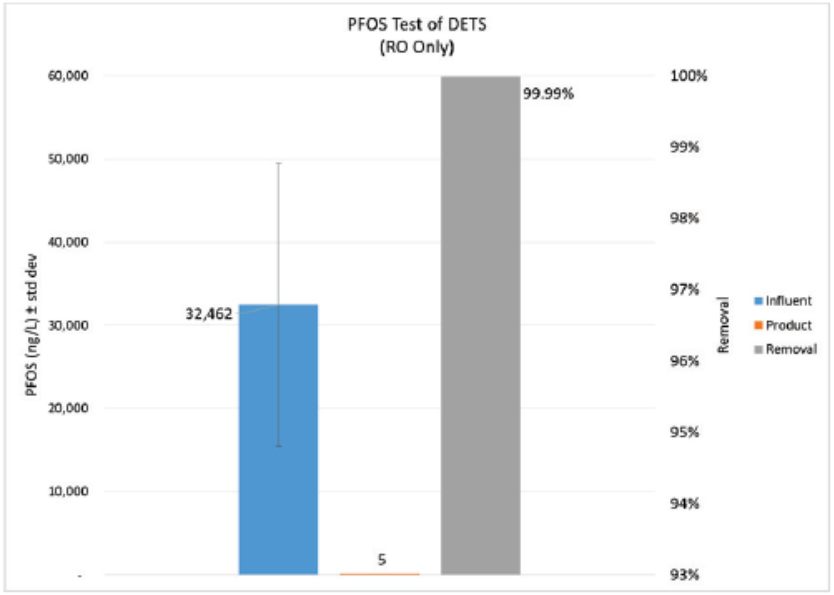
Future Work: Adapting DETS to PETS for PFAS
Preliminary Results

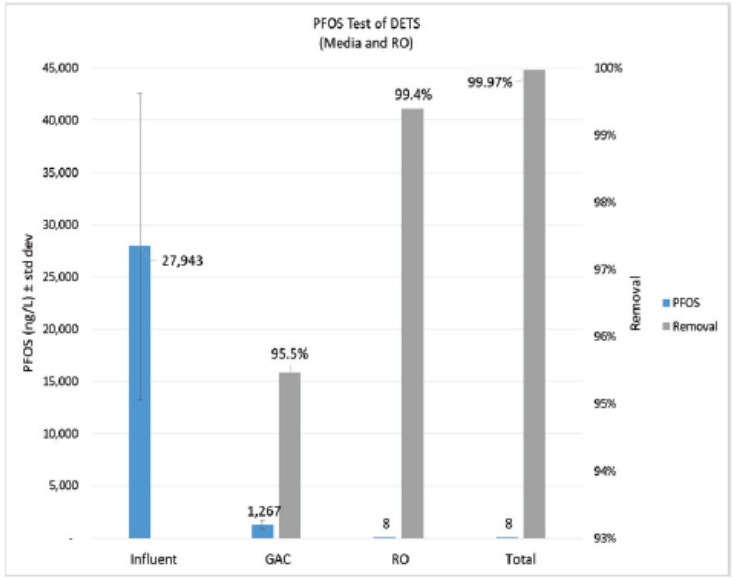
RO Only

Figure 14. Results of PFAS removal by the DETS using the RO process only.



Sand/GAC Filtration & RO

Figure 15. Results of PFAS removal by the DETS using the pretreatment steps up to the GAC process and the RO process.



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Conclusion

- DETS is a low cost treatment system, the first of its kind to treat and recycle decontamination effluent
- An effective means of capturing wash water from vehicle decontamination and MPD was demonstrated
  - The process was effective at 98% removal of all constituents tested
- The system was easily integrated into the National Guards CERFP decontamination practices
- Early studies have demonstrated effectiveness at removing PFAS

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We are interested in collaborating to develop the best solutions for clean water!

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