TECHNICAL REPORT
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SUSTAINABILITY LOGISTICS BASING – SCIENCE & TECHNOLOGY OBJECTIVE – DEMONSTRATION; INDUSTRY ASSESSMENT AND DEMONSTRATION FINAL REPORT

by
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August 2017

Final Report
December 2014 – February 2016

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U.S. Army Natick Soldier Research, Development and Engineering Center
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14. ABSTRACT
Materiel solutions from industry, academia, and other military partners were sought. This document records efforts to seek materiel solutions from industry and academia. The specific findings of the aforementioned efforts were: a) The Request for Information (RFI) yielded only 24 submissions, 4 of which were applicable to the goals and objectives of the SLB-STO-D. The small number of relevant technology solutions was due to the criteria developed by the Technology Maturation and Integration Team (TMIT), which was based on a database of current technologies, gaps in basecamp needs, and future predictions of fuel, water, and waste reduction; b) Due to the small number of recommended technologies for assessment and demonstration, SLB-STO-D leadership and panel members decided that a physical, consolidated event would not take place; c) Site visits took place for two of the candidate technologies, T-SERIES by ZeroBase and Sol-Char by the University of Colorado, within the planned timeframe of the industry demonstration. The other two demonstrations did not take place, because the systems were not available for demo/site visits during the planned timeframe within the SLB-STO-D master plan; d) The T-Series by Zero-Base appears to be the most mature of all the industry technologies investigated in this report based on the site visit conducted. It should be further investigated to obtain data that could be analyzed by the Modeling, Simulations and Analysis Team of the SLB-STO-D. Sol-Char is early on in the developmental cycle and needs to further matured to be a viable candidate for use in base camps.

15. SUBJECT TERMS

FUELS	SAVINGS	SOLID WASTES	REDUCED FOOTPRINT	SUSTAINABILITY
POWER	INDUSTRY	ENVIRONMENT	CONTINGENCY BASES	CAPABILITY GAPS
WASTE	ACADEMIA	DATA COLLECTION	CONTINGENCY BASING	ARMY PERSONNEL
WATER	BASE CAMPS	DEMONSTRATIONS	FORWARD OPERATING BASES	
ENERGY	WASTE WATER	WASTE REDUCTION	ENVIRONMENTAL MANAGEMENT	

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EXECUTIVE SUMMARY

In 2010, the Army recognized the need to reduce sustainment demands at contingency bases. Contingency bases are highly dependent on resupply, which can be unpredictable, put Soldiers at risk in convoys, and impact mission completion. It is too costly and labor intensive for a small unit (platoon, company, battalion) to transport and maintain all required consumables (fuel and water) to last for weeks or months at small basecamps. In 2011, the US Army Office of the Assistant Secretary of the Army for Acquisition, Logistics, and Technology charged the Research Development and Engineering Command (RDECOM) with conducting a Technology Enabled Capability Demonstration (TECD) 4a - Sustainability/Logistics—Basing (SLB), now programmed as a Science & Technology Objective – Demonstration (STO-D) to develop, collaborate, and execute a program that would address these sustainment challenges.

> *The Army needs improved capability to enable sustainment independence by reducing resupply and backhaul demand at contingency basecamps. The FY12 through FY17 objective is to reduce the need for fuel resupply by 25%, reduce the need for water resupply by 75%, and decrease waste generation/backhaul by 50% while maintaining a Force Provider like Operational Quality of Life (QoL-(O)) at these basecamps.*

Current Army maneuver units have limited or no organic basing capability and rely on theater provided support. Except for Force Provider, the majority of theater provided equipment/support is not standardized, integrated, or optimized to be easily deployed, transported, or erected and is inherently inefficient. The problem mentioned above forms the basis for the program and lays the foundation for the formulation of the program execution plan and is pervasively present in the program baseline.

The challenge is to formulate an integrated Model Based Systems Engineering approach for both technologies and non-materiel solutions to address current Army contingency basing barriers. The SLB-STO-D program uses modeling, simulation and analysis to show a reduction in fuel resupply by 25%, a reduction in water resupply by 75%, and a reduction of 50% in waste generated for backhaul at basecamps compared to an established technical and operational baseline, while maintaining a Force Provider-like QoL (O). The focus of the SLB-STO-D program is on the 50, 300, and 1,000 personnel basecamps, on which the Army's Science and Technology (S&T) efforts are most likely to have a greater impact in resource reduction.

The work was performed in collaboration with:

- RDECOM
    - US Army Natick Soldier Research, Development and Engineering Center (NSRDEC)
    - Communications-Electronics Research, Development and Engineering Center (CERDEC)
    - Tank and Automotive Research, Development and Engineering Center (TARDEC)
    - Army Research Laboratory (ARL)

    - Armament Research, Development and Engineering Center (ARDEC)
- US Army Corps of Engineers
    - Engineer Research and Development Center (ERDC), Construction Engineering Research Laboratory (CERL)
- Program Executive Office Combat Support and Combat Service Support (PEO CS & CSS)
    - Program Manager Expeditionary, Energy and Sustainment Systems (PM E2S2)
    - Product Manager Force Sustainment Systems (PdM FSS)
    - Product Manager Petroleum and Water Systems (PdM PAWS)
    - Product Directorate Manager Contingency Basing Infrastructure (PdD CBI)
- Training and Doctrine Command (TRADOC)
    - Maneuver Support Center of Excellence (MSCoE)
    - Combined Arms Support Center (CASCOM)
    - Sustainment Center of Excellence (SCoE)
- Army Materiel Systems Analysis Agency (AMSAA)

The first step to addressing the programmatic goals and challenges was to look at the developmental technology solutions from across the Army that aligned to the aforementioned problem space. Another step was to look at the materiel solutions from industry, academia and other military partners.

This document records specific efforts that took place between December 2014 and February 2016 to seek materiel solutions from industry and academia.

The specific findings of the aforementioned efforts are summarized below:

- The Request for Information (RFI) yielded only 24 submissions, 4 of which were applicable to the goals and objectives of the SLB-STO-D. The small number of relevant technology solutions was due to the criteria developed by the Technology Maturation and Integration Team (TMIT) which was based on a database of current technologies, gaps in basecamp needs as well as future predictions of fuel, water and waste reduction.
- Due to the small number of recommended technologies for assessment and demonstration, SLB-STO-D leadership and panel members decided that a physical, consolidated event would not take place.
- Site visits took place for two of the candidate technologies, T-SERIES by ZeroBase and Sol-Char by the University of Colorado, within the planned timeframe of the industry demonstration. The other two demonstrations did not take place because the systems were not available for demo/site visits during the planned timeframe within the SLB-STO-D master plan.
- The T-Series by Zero-Base appears to be the most mature of all the industry technologies investigated in this report based on the site visit conducted, and should be further investigated to obtain data that could be analyzed by the Modeling, Simulations and Analysis Team of the SLB-STO-D. Sol-Char is early on in the developmental cycle and needs to further mature to be a viable candidate for use in basecamps.

SUSTAINABILITY LOGISTICS – BASING SCIENCE & TECHNOLOGY OBJECTIVE – DEMONSTRATION; INDUSTRY ASSESSMENT AND DEMONSTRATION FINAL REPORT

1. INTRODUCTION

This technical report documents the work to bridge capability gaps discovered within the Sustainability Logistics Basing - Science and Technology Objective - Demonstration (SLB-STO-D) technical portfolio. The SLB-STO-D is a Department of the Army-approved program that seeks to enable independence/self-sufficiency and reduce sustainment demands at contingency bases. A drive to minimize the number of resupply convoys and the consequent ground and air protection has led to a need to reduce sustainment demands at contingency bases. Costs of fuel and water consumption and waste generation also need to be reduced.

The programmatic goals of SLB-STO-D are to reduce fuel consumption by 25%, water consumption by 75%, and waste generation by 50%, while maintaining or improving the quality of life of Soldiers at expeditionary bases in the size range of 50-1000 personnel.

The work was performed in collaboration with:

- RDECOM
    - US Army Natick Soldier Research, Development and Engineering Center (NSRDEC)
    - Communications-Electronics Research, Development and Engineering Center (CERDEC)
    - Tank and Automotive Research, Development and Engineering Center (TARDEC)
    - Army Research Laboratory (ARL)
    - Armament Research, Development and Engineering Center (ARDEC)
- US Army Corps of Engineers
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- Program Executive Office Combat Support and Combat Service Support (PEO CS & CSS)
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- Training and Doctrine Command (TRADOC)
    - Maneuver Support Center of Excellence (MSCoE)
    - Combined Arms Support Center (CASCOM)
    - Sustainment Center of Excellence (SCoE)
- Army Materiel Systems Analysis Agency (AMSAA)

From December 2, 2014 to February 4, 2016, materiel solutions were sought from industry, academia, and military partners. These solutions, in addition to the large number of currently funded and tracked Army Research, Development and Engineering Command (RDECOM) and Engineer Research and Development Center (ERDC) Science and Technology (S&T) projects, were intended to increase the likelihood of program success.

Industry solutions were originally envisioned for inclusion within a separate but complementary "Industry Demonstration and Assessment". This event would be similar to the incremental demonstration concept described within the SLB-STO-D Demonstration Strategy document (Unknown Authors, 2012). However, it would focus on mature industry technologies with the ability to enhance existing infrastructure or materiel solutions in meeting overall program objectives. The purpose of this event was to identify, evaluate and showcase potential technologies outside of the SLB-STO-D government funded technologies portfolio that would aid in the overall achievement of the SLB-STO-D goals. These goals involve improvements in the management of fuel, water, and waste at expeditionary basecamps with a specific objective of reducing the need for fuel resupply by 25%, water resupply by 75% and decrease waste by 50%, while optimizing quality of life factors at contingency bases ranging in size from 50-1000 PAX (personnel). The assessment would have assisted in the identification of mature, desirable systems while the demonstration would have provided an opportunity to highlight technology benefits to interested technology transition partners.

2. INDUSTRY SOLUTION IDENTIFICATION

The inception of the SLB-STO-D began with many tasks. One of these tasks related to the development of a technical portfolio used to identify and track applicable, government-funded materiel solutions. This portfolio contains a variety of technologies along with pertinent details such as: capabilities, metrics, logistic concerns, physical properties, etc. In addition to the SLB-STO-D technical portfolio, an industry portfolio was also created. The industry portfolio is a scaled-down version of the technical portfolio and its purpose is to document and categorize industry solutions that may assist the SLB-STO-D in realizing the program objectives.

2.1 CAPABILITY GAPS NOT COVERED BY GOVERNMENT SPONSORED PROJECTS

As the SLB-STO-D technical portfolio became more established, specific capability gaps were discovered. These gaps represent desired areas of potential improvement that are not (or are minimally) covered by government sponsored projects.

The capability gaps discovered were as follows:

- Supply Side Water Generation
- Supply Side Water Quality Monitoring
- Demand Side Organizational Water
- Demand Side Head, Ventilation, and Air Conditioning (HVAC)
- Waste Reduction and Stabilization
- Waste Repurposing

2.2 DESIRED TECHNOLOGIES TO BRIDGE CAPABILITY GAPS

Based on each gap area, subject matter experts generated specific descriptions of desired technology products along with baseline scenarios for better understanding of how these products were anticipated for use in Sustainment/Logistics-Basing scenarios. The desired technologies were broadly categorized in the areas of Fuel, Water, and Waste (FWW) reduction. These categories align with the SLB STO-D objectives to reduce the consumption of fuel and water and to reduce the generation of waste in basecamps for expeditionary forces. The FWW reduction technologies with potential to bridge capability gaps are discussed below.

2.2.1 Water Reduction

Technologies sought in the Water Reduction category aim at reducing the use of water resources or enabling the generation of water on-site.

Illustrations of technologies sought are:

- Compact Mobile Well Drilling Rig
- Passive Water Collection
- Organizational Water Demand Reduction Technologies

2.2.2 Fuel Reduction

Technologies being pursued in the Fuel Reduction category intend to reduce the consumption of fuel.

Examples of Fuel Reduction technologies are:

- Improved HVAC systems exhibiting higher efficiency than the baseline described in APPENDIX A, *Request for Information*. (For example, systems including energy recovery or co-generation technology)
- Co-Generation Systems
- Split (mini-split, ductless split, duct-free) air-conditioning systems
- Evaporative cooling systems (closed or open-loop)

2.2.3 Waste Reduction

Technologies wanted in the Waste Reduction category endeavor to reduce the generation of waste and concomitant backhaul.

Examples of Waste Reduction technologies are:

- Waste to Energy – Technologies that convert collected waste products into useful energy; e.g., gasification for electrical power generation.
- Waste Reduction and Stabilization – Technologies that reduce and/or stabilize collected waste; e.g., fuel-efficient incineration, compaction, rapid composting, and stabilizing putrescible food waste.
- Waste Repurposing – Technologies that repurpose or reuse expendable materials for the same or a different purpose; e.g., repurposing of wood waste, packaging, fuel drums, waste oils from generators or vehicles, and waste combustion char/ash.
- Waste Sorting – Technologies that automate or simplify segregating, sorting, or otherwise categorizing waste streams, such as for a follow-on waste reduction process.
- Blackwater Sludge Processing – Technologies that dry the wet sludge that is a byproduct of the black water remediation processes.

2.3 RFI FROM INDUSTRY

The descriptions of desired technology products were incorporated into an RFI including details of the SLB-STO-D Industry Demonstration and Assessment event. The RFI in its entirety is contained in APPENDIX A. The RFI was utilized as a means by which to gather additional and necessary information from potential industry partners. Each potential participant was asked to complete an identical “submission form” along with the submission of a white paper to provide additional pertinent information. It also aided in recognition of the event while expanding the existing industry portfolio. The RFI was released on 2 December 2014, and closed on 30 January 2015. To assist in generating awareness, the RFI was also announced through the Interagency Advanced Power Group (IAPG) – a federal membership organization dedicated to the facilitation of information exchange in areas of advanced power technology. Additionally, all points of contact within the industry portfolio were informed of the RFI and encouraged to submit applications for their relevant products

3. DETERMINATION OF INDUSTRY TECHNOLOGIES TO SEEK ADDITIONAL INFORMATION

This chapter provides details of the technologies submitted by Industry, the selection panel composition, and the selection criteria used to determine the technologies of interest about which to seek additional information.

3.1 TECHNOLOGY SUBMISSIONS BY INDUSTRY

The RFI called resulted in 24 technology submissions. The submitted technologies were categorized by the thrust areas of fuel, water and waste (TABLE 1)

Table 1: RFI Technology Submissions per Thrust Area

Fuel
Microgrid Storage and Distribution Unit (MSDU)
42k ECU
FORGE
T-Series
INI Flex Fuel Generator / Trinity ALLY Hybrid Solutions
Novel Deployable Origami Shelters with Integrated Energy Planning and Management
Water
Atmospheric Water Generation Technology
WaterQore
Expeditionary Waste Water Processing System (EW2PS)
Water Treatment Unit for Environmental Control Units
Expeditionary Wastewater Recycling System (EWRS)
Atmospheric Water Generators
Ferrator
Atmospheric Water Generators, Deployable Ice Plant System
Energy and Water Conservations System (EWCS)
Greywater Advanced Treatment System (GRE-AT)
Mobile, Mechanical Vapor Recompression Waste Water Recycling System
Waste
Tactical Plasma Arc Waste Destruction System (T-PAWDS)
DWEC-HERS (Deployable Waste to Energy Conversion System - Heat Energy Recovery and Storage)
Battalion Scale Waste to Energy Converter (BWEC)
Plasma DC Arc Furnace
Gasplasma
Sol-Char Toilet
Eco-Safe Digester

3.2 SELECTION PANEL COMPOSITION

In order to effectively determine the technologies best suited for assessment and demonstration, an evaluation panel of nine personnel was created to thoroughly review each submission. The panel was composed of SLB-STO-D, Technology Maturation and Integration Team (TMIT) leadership along with subject matter experts in the areas of energy, water and waste. Information on panel members is contained in APPENDIX B.

3.3 INDUSTRY TECHNOLOGIES SELECTED

Of the 24 submissions, 4 technologies were already being tracked within the government portfolio; therefore, these technologies were immediately disqualified as potential industry participants. Of the remaining submissions, only three technologies were identified as applicable to the RFI, while having the maturity required for proper assessment. In addition, a grey water treatment and recycling system was also identified as an industry solution having an ideal form factor and capability useful for comparison against current government tracked systems. A total of four “technologies of interest” (APPENDIX C) were identified and selected for further assessment and demonstration:

These technologies are:

- T-SERIES Mobile Hybrid Power System by Nano Global Corp/ZeroBase
- Sol-Char Toilet by University of Colorado
- Water Treatment for Environmental Control Units by Mistral Water
- Energy and Water Conservation System by Marine Design Dynamics, Inc.

The submissions outside of the four listed above lacked in either their applicability to the specific requirements outlined within the RFI, overall maturity, or expeditionary capability.

4. INDUSTRY ASSESSMENT AND DEMONSTRATION

This chapter portrays the methodology approach to assess industry technologies and summarizes the findings due to personal observations during visits or through examination of facts and/or data on the selected industry technologies.

4.1 METHODOLOGY APPROACH

Due to the small number of recommended technologies for assessment and demonstration, SLB-STO-D leadership and panel members decided that a physical, consolidated event would no longer take place. In lieu of a demonstration, technologies of interest were tracked and site visits were done in the Fall of 2015 that provided the information for the technical assessment of the technologies.

4.2 OBSERVATIONS AND FINDINGS

The observations and findings in the following subsections are based on personal visits and/or the examination of factual data on the selected industry technologies for further assessment.

4.2.1 T-SERIES by ZeroBase, LLC

On 25 August 2015, SLB-STO-D members visited ZeroBase, LLC in Ferndale, Michigan for a company and technology overview to determine if the T-SERIES system would be able to contribute to the SLB-STO-D's objectives. Visiting ZeroBase, LLC included discussion on the background, purpose, vision, and current efforts as well as viewing military technology that falls in line with the SLB-STO-D's fuel reduction technology portfolio. The company offers a range of mobile power technologies; however, the focus area was on the trailer-mounted T-SERIES (Figure 1), which is a mobile hybrid power system that reduces the fuel to power shelters, operations and/or Intelligence, Surveillance, and Reconnaissance (ISR) equipment. Due to previous work and collaboration, the team at ZeroBase, LLC was also able to provide linkages and prospective opportunities for NSRDEC to collaborate with other ongoing basing efforts. This system has been investigated by other military organizations and fielded in operational test scenarios, meaning the system has more applicability and transferability into the SLB-STO-D; however, there will not be a demonstration solely dedicated to industry technologies due to a number of factors to include time, cost, and the number of relevant submissions to the RFI.

Figure 1: T-Series mobile hybrid power system

4.2.2 Sol-Char Toilet System by University of Colorado-Boulder

On 29 September 2015, members of the SLB-STO-D team went to the University of Colorado in Boulder for an overview of the Sol-Char Sanitation System (Figure 2). The purpose of the trip was to visit the university and discuss the purpose and objectives of the SLB-STO-D and the potential for the University of Colorado to be involved in future technology demonstrations or events. In conjunction with the Bill and Melinda Gates Foundation, the University of Colorado developed and designed the first generation prototype toilet system that utilizes solar collectors to concentrate solar energy for the pyrolysis of human waste into useful and safe-to-dispose bio-char. The visit included an overview of the background of the first phase, demonstration of the technology capabilities, and a discussion about the path forward for Phase II of the system. The university plans on collaborating with BrightSpace Technologies to decrease the cost and increase the system functionality in the second iteration of the effort. The aforementioned visit also yielded the opportunity to see the current efforts of the BrightSpace Technologies small business. With some redesign and military hardening/adaptation, the latrine system has the ability to be integrated into a basecamp environment for water and waste reduction. However, in the current state, the technology is not sufficiently mature and additional funding is required to make the extensive modifications and technical advancements.

Figure 2: Sol-Char

4.2.3 Water Treatment for Environmental Control Units by Mistral Water

The Water Treatment for Environmental Control Units (WTU-ECU) (Figure 3) system demonstration was slated to take place at one of the Association of United States Army (AUSA) exhibitions in the Fall of 2015. However, due to unforeseen circumstances Mistral was unable to hold a technology demonstration. Through further discussion in August of 2015, the project lead had intended to also get the system back to the Mistral Water facility in Maryland for an October timeframe but there was an issue with delivery and the demonstration was delayed. Once the system was received, the SLB-STO-D was notified that Mistral did not have an ECU to properly demonstrate the system. The implication was that Mistral would need Government Furnished Equipment (GFE) to properly demonstrate the WTU-ECU. TMIT reached out to Clinton McAdams of Expeditionary Basing and Shelter Protection to borrow an ECU for demonstration purposes at NSRDEC. Due to the time of year (winter) and relative humidity, the technology would not be in an optimal environment for proper functionality.

Figure 3: WTU-ECU

4.2.4 Energy and Water Conservation System by Marine Design Dynamics, Inc.

The Energy and Water Conservation System (EWCS) (Figure 4) was developed in conjunction with the United States Marine Corps (USMC) and designed to operate within the USMC and Army Forward Operating Base (FOB) water distribution system. According to the project officers, a technology demonstrator of the EWCS was built and tested, and was found to exceed the water quality requirements for military use. In June of 2015, they were preparing a prototype for in-service test and evaluation in preparation for potential requirement from the USMC or Army to field a FOB-size graywater recycling system. However, there was an issue coordinating with the USMC sponsor to have the system demonstrated in the early Fall of 2015.

Figure 4: EWCS

5. CONCLUSIONS

The conclusions contained in this chapter were garnered from facts and inferences encountered during visits, conversations, and data analysis related to the four selected industry technologies.

The conclusions are presented for each of the technologies as follows:

T-SERIES by ZeroBase, LLC.

- The mobile hybrid electric power technology that ZeroBase offers has the potential to significantly reduce fuel consumption in basecamps. It also offers the added benefit of reducing noise signatures in basecamps.
- This technology seems to be fairly mature and at least at TRL 5.
- Due to the interest of other military organizations, there is a potential for the SLB-STO-D to collaborate and obtain test data that could be useful in ascertaining the performance of this technology. The data could be used to verify the contributions of this technology to the SLB-STO-D using a Model-Based System Engineering approach.

Sol-Char Toilet System by University of Colorado-Boulder

- The Sol-Char technology has the potential to alleviate water and waste/backhaul issues in basecamps.
- The first generation prototype seems to be at a TRL below 5 and its present configuration may need further maturation to be useful in a military basecamp environment.

Water Treatment for Environmental Control Units by Mistral Water

- The WTU-ECU is a water treatment technology that has the potential to recover and make potable the water that condenses on the evaporator side of environmental control units.
- This technology has the potential to contribute to the potable water supply of basecamps and provide self-sustainment capabilities that would enable a basecamp to require less water resupply.
- The potability qualities of water treated by the WTU-ECU needs to be verified, as this is a major factor that would determine the contributions of this technology to the overall objectives of the SLB-STO-D.
- The SLB-STO-D was not able to physically verify the status of the WTU-ECU technology. Therefore, the TRL cannot be confirmed, as much of the information garnered for this report is based on verbal communications and electronic media research.

Energy and Water Conservation System by Marine Design Dynamics, Inc.

- The Energy and Water Conservation System is a gray water treatment and recycling system that has the potential to assuage the non-potable water requirements of a basecamp. Therefore, it has the potential to assist the SLB-STO-D in achieving its programmatic goals.
- The EWCS is apparently sponsored by the USMC but has not been able to coordinate a proper venue to demonstrate its capabilities.
- The SLB-STO-D team was not able to physically observe the EWCS due to its unavailability within the scheduled timeframe and its TRL cannot be ascertained.

6. RECOMMENDATIONS

The recommendations contained in this chapter are based on observations, findings, and conclusions contained in previous sections of this report.

Recommendations are as follows:

1. The T-Series by Zero-Base seems to be the most mature of all the industry technologies investigated in this report and should be further investigated to obtain data that could be analyzed by the MSAT functional team of the SLB-STO-D.

2. The Sol-Char needs to further mature to be a viable candidate for use in base camps. The technology may need to be periodically monitored but not on a priority basis as it not envisioned that it would be sufficiently matured before the completion of the SLB-STO-D program.

3. The WTU-ECU has the potential to contribute to the objectives of the SLB-STO-D program. Further monitoring may be of value and the provision of a GFE ECU to Mistral to contribute to further evaluation may be of value to the SLB-STO-D.

4. The EWTC technology is worth monitoring as it progresses through its developmental cycle. Further coordination with the USMC should be established to ascertain the suitability of this technology to assist the SLB-STO-D program to achieve its goals.

This document reports research undertaken at the U.S. Army Natick Soldier Research, Development and Engineering Center, Natick, MA, and has been assigned No. NATICK/TR- 17/019 in a series of reports approved for publication.

GLOSSARY

AMSAA	Army Materiel Systems Analysis Activity
AOR	Area of Responsibility
AUSA	Association of the United States Army
BTUH	British Thermal Unit per Hour
CAD	Computer Aided Design
CAN-BUS	Controller Area Network bus
COTS	Commercial-Off-The-Shelf
D.C.	District of Columbia
ECU	Environmental Control Unit
EMI	Electro-Magnetic Interference
ERDC	Engineer Research and Development Center
EWCS	Energy and Water Conservation System
FOB	Forward Operating Base
FP	Force Provider
FWW	Fuel, Water and Waste
GFE	Government Furnished Equipment
HVAC	Heating, Ventilation and Air Conditioning
IAPG	Interagency Advanced Power Group
JMIC	Joint Modular Intermodal Container
kW	Kilo Watt
LLC	Limited Liability Company
MOD-BUS	Modicon serial communication protocol
NSRDEC	Natick Soldier Research, Development and Engineering Center
ODP	Ozone Depletion Potential
PAX	Personnel
PdM FSS	Product Manager Force Sustainment Systems
PdM PAWS	Product Manager Petroleum and Water Systems
RDECOM	Research, Development and Engineering Command
RFI	Request for Information
RFQ	Request for Quote
S&T	Science and Technology
SLB-STO-D	Sustainability Logistics - Basing Science and Technology Objective - Demonstration
TECD 4a	Technology Enabled Capability Demonstration 4a
TEMPER	Tent, Extendable, Modular, Personnel
TMIT	Technology Maturation and Integration Team
TRL	Technology Readiness Level
UGR-A	Unitized Group Ration Type A
USMC	United States Marine Corps
VAC	Volts Alternating Current
VFD	Variable Frequency Drives
VoIP	Voice over Internet Protocol
WTU-ECU	Water Treatment for Environmental Control Unit

APPENDIX A: REQUEST FOR INFORMATION

(*Reprint of original)*

REQUEST FOR INFORMATION (RFI)
United States Army

Sustainability/Logistics Basing Science and Technology
Objective-Demonstration (SLB-STO-D)
(Formerly Technology Enabled Capability Demonstration 4a -TECD 4a):

Industry Assessment and Demonstration

OVERVIEW:

This announcement constitutes a Request for Information (RFI) notice for event described below.

Sustainability/Logistics Basing Science and Technology Objective - Demonstration (SLB-STO-D) will conduct an Industry Assessment of Commercial off the Shelf (COTS) technology in September 2015. This assessment will be based on emerging technologies that ***reduce sustainment requirements for small contingency base operation. The implementation of the technologies under consideration will lead to a reduction in the delivery of water and fuel to base camps, while lessening the burden of waste collection, management, and disposal.***

Specific details on technologies of interest are provided below and should be thoroughly reviewed *before* responding.

The SLB-STO-D team will review all RFI documents and will select candidate technologies based on their relevance and technology readiness level to reduce sustainment requirements for small contingency basing. Candidate technologies of interest will be invited to participate in the Industry Assessment and Demonstration event.

The due date for responses to this RFI is **midnight EST on 16 Jan 2015. (Extended to 30 Jan 2015)**

ABOUT SLB-STO-D

In February 2012, the Department of the Army approved SLB-STO-D, a 6-year major science and technology (S&T) program to demonstrate integrated solutions for improving the management of fuel, water, and waste at expeditionary base camps. The program objective is to reduce the need for fuel resupply by 25%, water resupply by 75% and decrease waste by 50%, while optimizing quality of life options at contingency bases ranging in size from 50-1000 PAX (personnel).

The focus of the program is the following problem statement:

"The Army needs improved capability to enable sustainment independence/self-sufficiency and to reduce sustainment demands at expeditionary basing level contingency bases. It is too costly, too unpredictable, and too labor intensive for a Small Unit to carry all required consumables to last for weeks or months at a Combat Outpost/Patrol Base (COP/PB). Storage facilities and systems do not meet needs of these small bases, and resupply efforts are highly unpredictable."

To put the problem in perspective, in 2011 contingency bases (all Services) consumed approximately 254,000,000 gallons of fuel, which is equal to that of ground and air platforms combined (according to the Assistant Secretary of Defense for Operational Energy Plans and Programs (ASD, OEPP)). At a conservative fully burdened cost of fuel of $10 per gallon, this represents a significant cost of $2.54B. Even more significant is the risk to Soldiers who conduct tactical resupply to these bases on ground vehicle convoys.

Industry Assessment Concept: SLB-STO-D has adopted an incremental demonstration concept to accommodate a large number of currently funded, Army RDECOM Science &Technology (S&T) projects. These projects will feed into multiple demonstrations having independent schedules and technology maturation paths. The incremental approach provides the opportunity to move early successes to the appropriate transition path as soon as possible. The SLB-STO-D demonstration concept also includes an Industry Assessment to ensure capability gaps are met and innovative technologies are identified from industry (in addition to government-sponsored programs). This RFI seeks candidate technologies specifically for the SLB-STO-D Industry Assessment.

SLB-STO-D will coordinate an initial, user-based Industry Assessment of selected technologies followed by a brief demonstration. The assessment will assist in the identification of mature, desirable systems while the demonstration will provide an opportunity to highlight technology benefits to interested technology transition partners. Formal transition partners include: Product Manager Force Sustainment Systems (PdM FSS), Project Manager Expeditionary Energy and Sustainment Systems (PM E2S2) and Product Manager Petroleum and Water Systems (PdM PAWS). Representatives from our transition partners will be on-site during the Industry Assessment.

Additionally, as mentioned above, the planned assessment will focus on specific areas for fuel, water and generated waste reduction technologies outlined further in this document. Industry will be invited to demonstrate technology capabilities in addressing these areas. Knowledge gained as a result of this assessment may be used to refine inputs for on-going base camp modeling efforts.

SUBMISSION PROCESS AND DUE DATE:

To respond to this RFI, please complete the attached SLB-STO-D Submission Form and a white paper, NOT TO EXCEED 3 PAGES, with additional pertinent information (details for the white paper submission can be found under "Information of Interest" within each section below). Send submissions and white papers via e-mail to:
benjamin.j.campbell26.civ@mail.mil and elizabeth.d.swisher.civ@mail.mil

Please do not attach marketing brochures, test reports, or other extraneous materials to your Submission Form as they will not be reviewed. The due date for responses to this RFI is midnight EST on 16 Jan 2015 (Extended to 30 Jan 2015).

If your technology is of interest, the SLB-STO-D Team will contact you with an invitation to participate in the Industry Assessment that will occur at Contingency Basing Integration and Technology Evaluation Center (CBITEC), Ft. Leonard Wood, in September 2015.

All companies will be notified of invitation/non-invitation decisions by late-February 2015. Additional details regarding the Industry Assessment will be provided to invited candidates at an Information Session held in March, 2015.

IMPORTANT NOTICE: This RFI is issued for the purpose of determining market capability of sources and does not constitute an Invitation for Bid (IFB), a Request for Proposal (RFP), a Request for Quote (RFQ) or an indication that the Government will contract for any of the items and/or services contained in this notice. No solicitation document exists at this time. All information received in response to this notice that is marked Proprietary will be handled accordingly. Responses may not include Classified material. Responses to this notice will not be returned. No reimbursement will be made for any costs to provide information in response to this announcement or any follow-up information requests. Information contained herein is based on the best information available at the time for publication, is subject to revision, and is not binding upon the Government.

TOPIC AREAS UNDER CONSIDERATION:

FUEL DEMAND REDUCTION

The purpose of this effort is to address the Army's Environmental Control Systems Technology Gap. Environmental Control technology is one of the key research and development candidates within the U S Army. Environmental Control Units (ECUs) have been known to utilize as much as fifty percent (50%) of the available generator power on the tactical battlefield. This demand translates into millions of gallons of fuel and a concomitant high number of fuel delivery sorties. The U S Army is interested in basic and applied research, development, and demonstration of small, lightweight, efficient environmental control technology and associated components for use in various applications. The Army is also interested in research and development of environmental control components such as heat exchangers, fans, thermal expansion valves, electronic controls and other technologies that improve the efficiency of environmental control units (ECUs).

DESCRIPTION OF PRODUCTS SOUGHT:

Improved Heat, Ventilation, and Air Conditioning (HVAC) systems exhibiting higher efficiency than the baseline described below (For example, systems including energy recovery or co-generation technology)
Co-Generation Systems
Split (mini-split, ductless split, duct-free) air-conditioning systems
Evaporative cooling systems (closed or open-loop)

BASELINE TECHNOLOGY AND SCENARIO:

For this assessment, considered technologies must integrate with PdM FSS Force Provider Standard Tent System composed of a 20'x 32' TY XXXI Tent, Extendable, Modular, Personnel (TEMPER) Air-Supported tent (or size equivalent). These shelter systems also include an insulated liner, power distribution box, convenience outlets; fluorescent lights; and are typically supplied with a F100-60K (HVAC) and MTH-150 Heater. (NOTE: There will be no formal test conducted. Results of the assessment will not substitute government sanctioned developmental or operational test and evaluation nor will they serve as a Government Endorsement.)

Currently, ECU minimum capacity requirements and coefficients of performance are determined at the maximum required operational temperature (125 degrees F). Preliminary analysis and previous modeling by the Army’s Material Systems Analysis Activity (AMSAA) seems to show that a high percentage of ECU operation occurs at temperatures well below the current maximum operational temperature. Therefore, it could be beneficial for Department of Defense to consider ECU technologies that focus on maximizing operational efficiency at temperatures which occur for the longest operational duration in lieu of at the highest operational temperature. If this supposition were shown to be correct, then studying technologies that allow operation at the maximum temperature, yet are most efficient at lower temperatures, would be beneficial.

Technologies that lend themselves to the above scenario would include the utilization of true variable capacity ECUs. Current ECUs may have variable speed fans and/or compressors but may not have the electronic controls necessary to allow a true reduction in capacity and corresponding increase in efficiency (i.e. simultaneously reduce refrigerant flow to the heat exchangers while reducing air velocity across the condenser and evaporator).

In addition to exploring true variable capacity compressors, the Government is interested in researching the applicability of smart electronic controls. In addition to these controls being able to vary the capacity (and efficiency) of the unit and meet and exceed all EMI requirements; consideration should also be given to electronic technologies that would allow for external operation of the units in a “smart grid” scenario. In this scenario, a Commander or designee would have the ability to remotely manage the operation of the ECU and other power consumers (and power producers) available in the Area of Responsibility (AOR). Therefore, standard communications protocols should be considered and utilized (e.g. CAN-BUS, MOD-BUS, VoIP, etc.)

Improved HVAC, System Requirements/Metrics:

The table below represents approximate benchmark metrics the DoD/Army has been able to achieve. For a proposed system of given size to be considered, it must meet each of the requirements in Table 1 (size, weight, and power consumption) while exceeding at least one of these requirements:

ECU Capacity Nomenclature (BTUH)	9k	*18k	18k	*36k	*60k
Electrical Requirements (VAC/Phase/Hz)	115/1/60	208/3/60	230/1/60	208/3/60	208/3/60
Dimensions (in.)	23W x 26D x 16H	30W x 28D x 20H	30W x 28D x 20H	38W x 35D x 27H	42W x 35D x 46H
Volume (cu. ft.)	5.7	9.7	9.7	20.8	38.2
Weight (lbs)	141	205	201	317	552
Max. Power Consumption (kW)	2.6	3.4	3.4	6.3	10.6

*Mostly interested in HVAC/ECU systems of this size

Table 1: Benchmark Metrics

The system shall include all additional accessories, operational equipment and connectivity for integration with existing shelters, power grids, and other infrastructure.
Technologies shall utilize environmentally approved refrigerants with a zero (0) Ozone Depletion Potential (ODP).
The system shall be capable of accepting commercial power or power from a military generator set. (Class L connector preferred).
The system shall operate in temperatures ranging from -50°F – 125 °F.
The system shall reduce humidity as much as possible.
The system shall have the ability to support use of existing military ducting (60K ECUs shall utilize sixteen-inch diameter ducts for supply and return air).
Systems consisting of Variable Frequency Drives (VFDs) – to control the speed of the compressor, evaporator fan motor, and condenser motors – are desired as are true “variable capacity” units.

Co-Generation System Requirements:

Proposed systems of given size must meet each of the requirements (size, weight, and power consumption per Table 1) while exceeding at least one of these requirements.
Proposed systems may leverage Co-generation or energy recovery such as:
Power generation technology which can be incorporated with the environmental control technology to form a self-powered capability and provide output exportable power that meets MIL-STD 1332 for power quality while simultaneously operating at full heating or cooling capacity.
Heat actuated cooling technologies utilizing waste heat from a power source or direct combustion of diesel fuel.
Systems exhibiting energy recovery ventilation by repurposing energy from exhausted air to precondition incoming ventilation air.
Systems shall operate within an ambient air temperature from -25 to +125 degrees Fahrenheit and shall be capable of providing cooling above 40 degrees Fahrenheit.
Systems shall use environmentally approved refrigerants with a zero (0) ODP.

NOTE: Efficiency of co-generation units shall be based on direct cooling from waste heat recovery or from burning the fuel directly. If we assume the generator is 25% efficient and the ECU COP is 1.5 at the 125 F operating conditions. The Maximum fuel heating value would be 9kBTUh ECU - 6.9 kW(23,5 KBTUh), 18 kBTUh ECU - 9.1 kW(31 kBTUh), 36kBTUh ECU - 16.8 kW(57.3 kBTUh), 60 kBTUh ECU - 28.3 kW(96.6 kBTUh).

Split Air-Conditioning, System Requirements –

The system shall meet each of the requirements (size, weight, and power consumption per Table 1) while exceeding at least one requirement. The total system volume and weight must include the sum of all of the individual components.
The system shall include all additional accessories, operational equipment and connectivity for integration with existing shelters, power grids, and other infrastructure.
The system shall be capable of accepting commercial power or power from a military generator set. (Class L connector preferred).
The system shall include flexible refrigerant hoses to accommodate mobility and varying shelter types.
The system shall operate in temperatures ranging from -50°F – 125 °F.
The system shall have the ability to support the use of existing military ducting (when required, ECUs shall utilize sixteen-inch duct diameter openings for supply and return air).
Technologies shall utilize environmentally approved refrigerants with a zero (0) Ozone Depletion Potential (ODP).
Goal Seasonal Energy Efficiency Rating (SEER) of > 20.
Minimal set-up and maintenance preferred.

Evaporative Cooling, System Requirements:

Open or closed systems will be considered (closed systems desired to reduce humidity).
The system shall include all additional accessories, operational equipment and connectivity for integration with existing shelters, power grids, and other infrastructure.
The system shall be capable of accepting commercial power or power from a military generator set. (Class L connector preferred).
The system shall operate in temperatures ranging from -50°F – 125 °F.
The system shall have the ability to support the use of existing military ducting (when required, ECUs shall utilize sixteen-inch duct diameter openings for supply and return air).
Technologies shall utilize environmentally approved refrigerants with a zero (0) Ozone Depletion Potential (ODP).
Minimal set-up and maintenance preferred.

INFORMATION OF INTEREST (to be included with optional white paper submission)

The US Army seeks Commercial-Off–The-Shelf (COTS) or emerging technologies of Technology Readiness Level 7 (TRL 7) or higher (See definitions at the end of this document) that represent the state of the art. Contractors are requested to provide the following information for consideration within a white paper (not to exceed 3 pages):

Narrative and graphical depiction of the proposed system (please see submission form).
Applicable physical attributes (power density, energy density, dimensions, weight).
Performance metrics with a brief description on how your system meets the above listed requirements.
If available/applicable, computer analyses and modeling of operational scenarios and corresponding run and down times for ECUs during tactical engagements.

WATER DEMAND REDUCTION

This topic area is seeking solutions to reduce water resupply requirements for contingency bases. Specific areas of interest for this RFI include Water Generation and Organizational Water Demand Reduction. For the purposes of this activity water generation should focus on; (1) expeditionary, rapid well drilling, (2) passive water collection (3) approaches that use little or no power, and (4) water collection from organizational equipment (humidity from laundry and shower activities, ECUs). Organization water demand reduction includes a broad spectrum of approaches to reduce the water requirements of water consuming systems on contingency bases.

DESCRIPTION OF PRODUCTS SOUGHT:

Compact Mobile Well Drilling Rig
Passive Water Collection
Organization Water Demand Reduction Technologies

BASELINE TECHNOLOGY AND SCENARIO:

The baseline scenario for this focus area is a Force Provider (FP) 300 soldier contingency base consisting of equipment organic to the Army. The water activities on this base include field feeding, laundry, showers, latrines, medical aid station and a wash rack. The water use for these activities is as follows. Field feeding activities use 0.46 gal/PAX/meal for Kitchen Sanitation, 0.35 gal/PAX/meal for Meal preparation for a 0.81 gal/PAX/meal water demand for UGR-A and 0.13 gal/PAX/meal for MRE. Based on 2 x UGR-A and 1 MRE feeding plan total field feeding water requirements are 1.75 gal/PAX/day or 525 gallons per day. The shower system includes the shower and a shower sink. The showers use 12.5 gallons/PAX/Day and the sinks use 1 gallon/PAX/Day for a total daily consumption of 4050 gallons. For the latrines the toilets use 3.5 gallons/PAX/Day and the urinals use 1.1 gallon/PAX/Day for a total daily consumption of 1380 gallons. The laundry system uses 68.7 gallons per washer 3 loads per wash for 22.9 gallons per load, one load per soldier per week, which leads to 3.27 gallons/PAX/day for a total daily consumption 981 gallons. Medical aid station use includes 0.55 gallons/patient/day for direct patient care provider hand washing and 0.28 gallons/patient/day for medical instrument wash. Assuming that all camp tenants visit the aid station approximately once per month the aid station usage would average of 8.3 gallons of potable water per day. The wash rack is used 4 hours per day at 120 gallons per hour for a total daily consumption of 480 gallons. Therefore, the total daily water consumption for the baseline FP 300 soldier contingency base is 7424 gallons.

BASELINE COMPONENT INFORMATION:

Water Well Drilling Rig: Three piece system consisting of a Drill Rig with Air Compressor, a Support/Tender Truck, and a Mud Trailer. The system is capable of mud and air rotary drilling, rotary percussion, or down-hole hammering drilling to a depth of 1,700 ft (threshold) to 2,000 ft (objective).

Drill Rig with Air Compressor. Mounted on a 6x6 all-wheel-drive prime mover consisting of a well drill platform (mast, main hoist, utility hoist, rod loader, and top head drive), drilling station (operator platform, instruments, and controls), hydraulic system, air compressors, hydraulic leveling jacks, night operation lighting system, drill pipe holding box, and 500 feet of drill pipe.

Support/Tender Truck. Mounted on the same 6x6 all-wheel-drive prime mover consisting of a fuel tank, water tank, toolboxes, night operation lighting system, a hydraulic system, utility crane, water and grout pumps, and welder.

Mud Trailer. Pulled by the Support/Tender Truck it will contain all of the components necessary to complete mud mixing and cleaning operations.

Latrines (FP Baseline):

Toilets: 1 to 1.25 gals per flush.

Urinals: 0.3 gals per flush.

Showers (FP Baseline): 1 to 1.25 gals per minute.

Laundry (FP Baseline): 68.7 gals per 45 lbs clothing load.

System Requirements:

Compact Mobile Well Drilling Rig:
Depth Rating: 300 feet Minimum, 800 feet Objective.
Weight <6500 pounds.
Trailer or skid mounted, cross country transportable.
Includes mud pump.
Ground formations: sand, clay, gravel, sandstone, limestone.
Self-powered with diesel engine.

Passive Water Collection:
Includes technologies such as: fog nets, geothermal, rain water, and additional innovative approaches

Organization Water Demand Reduction:
Examples of these approaches includes, No-flush latrines; Water efficient latrines; laundry spinning cycles water recovery that also reduces drying time/energy; manual low water laundry systems; passive, ion water, energy/water-efficient laundry systems; low flow or high efficiency shower systems, efficient kitchen appliances, dishwashing, alternative material plates & cookware, "super slippery" surfaces requiring less rinsing, cooking methods with less water.

Goal Metrics Objectives:
Latrines:
Toilets: 0.7 to 0.9 gals per flush.
Urinals: Waterless.

Showers: 0.5 to 1 gal per minute.

Laundry: 48 gals per 45 lbs clothing load.

INFORMATION OF INTEREST (to be included with white paper submission)

The intent of this synopsis is to identify systems/technologies that have already been shown to meet many of the performance requirements listed above and could be demonstrated near term and subsequently be developed into a mature technology demonstration prototype system within two years, ready for demonstration/validation and subsequent engineering and manufacturing development. The white paper should include physical and functional descriptions of the proposed system, including:

Performance – Discuss ability to meet the requirements specified above and the system product water quality.
Water sources – Discuss acceptable and problematic water sources.
Throughput – Discuss water production rate, acceptable duty cycles, and turndown capability.
Energy Requirements – Discuss system electrical and/or fuel requirements. Keep in mind that this product should be more efficient than currently available systems.
Narrative and graphical depiction of the proposed system including core technologies and important subsystems. Assess Technology Readiness Level / maturity.
Applicable Physical attributes (power density, energy density, dimensions, weight)
Consumables – Discuss all system consumables, including maintenance items.
Cost – Discuss pricing and, if applicable, estimate additional funding (rough order of magnitude) required to adapt to fully meet the performance requirements.

WASTE REDUCTION

The purpose of this focus area is to address the burden of waste disposal for small contingency bases. A large percentage of basing supplies become waste (such as food, packaging, broken or damaged items, batteries, black water) and the current methods of waste management have a negative impact on fuel, safety, health, and the environment. As previously mentioned, SLB-STO-D has an objective to achieve for bases sized 100-1000 personnel - a 50% reduction in the waste burden that would require subsequent backhauling, landfilling, or burning.

The US Army is interested in demonstrating novel, energy efficient solutions for onsite solid waste disposal through waste to energy, waste stabilization, or waste repurposing as an alternative to burn pits or small incinerators. The target scale for this focus area is extra-small to small contingency bases (i.e., 50-2000 personnel) with an emphasis on systems or technology suitable for 150-personnel size bases. The overall objective is to reduce the solid waste weight and volume by more than 50% (objective 90%), require minimal manpower, produce only benign residues and emissions, be packaged for rapid deployment (e.g., 6.5’×8’×8’ triple container), and require minimal energy expenditure in terms of JP-8 fuel and/or electrical power.

DESCRIPTION OF PRODUCTS SOUGHT

Products sought include technologies or systems that use physical, biological, or chemical methods to reduce waste disposal burden for small contingency bases, addressing the following general thrust areas:

Waste to Energy – Technologies that convert collected waste products into useful energy; e.g., gasification for electrical power generation.
Waste Reduction and Stabilization – Technologies that reduce and/or stabilize collected waste; e.g., fuel-efficient incineration, compaction, rapid composting, and stabilizing putrescible food waste.
Waste Repurposing – Technologies that repurpose or reuse expendable materials for the same or different purpose; e.g., repurposing of wood waste, packaging, fuel drums, waste oils from generators or vehicles, waste combustion char/ash.
Waste Sorting – Technologies that automate or simplify segregating, sorting, or otherwise categorizing waste streams, such as for a follow-on waste reduction process.
Blackwater Sludge Processing – Technologies that dry the wet sludge that is a byproduct from blackwater remediation processes.

Products of highest interest will be those that do not add significant new burdens in terms of fuel, power, consumables, manpower, etc., and produce only safe and stable byproducts.

BASELINE TECHNOLOGY AND SCENARIO

The primary scenario for this focus area is a 150-personnel contingency base with minimal contract support. Baseline waste disposal is destruction of paper and wood materials in a burn pit with the remainder backhauled, burned in an air curtain destructor, or incinerated in a commercial batch load modular incinerator.

In this scenario, basic solid waste generation is about 4 lbs per person each day of principally foodservice waste plus, depending on the base's mission, additional unspecified materials adding to a total of 6 to 10 lbs per person each day. The foodservice portion can be expected to contain substantial moisture from prepared foods and partially consumed beverages. It is considered impractical to manually segregate the solid waste stream.

For blackwater sludge, current blackwater remediation systems produce a liquid sludge with 2% solids. In this scenario, sludge is generated at a rate of 1.6 gallons per person each day, which includes solids at 0.265 lbs per person each day.

Integration with other base camp systems for energy recovery is not a priority for this focus area. Although energy recovery in the form of heated air or water may be possible, and baseline habitation systems for a 150-personnel base require significant fuel and electrical power for heating and cooling, there are no systems currently in place that can utilize such hot air or water. It is also unknown whether doctrine will be changed to allow waste processing equipment to operate in close proximity to habitation energy demands to make such integration viable.

System Requirements

For the purposes of this RFI, some of the desired system characteristics are described in the following preliminary performance requirements. Products of highest interest will be those that already meet these requirements or could be made to with minimal additional time.

Complete System – The waste reduction system shall be a complete standalone system that includes all necessary equipment to process the target waste. It shall be rugged and low-maintenance to minimize operational costs, and shall have few consumables to minimize logistical requirements.
Throughput – The waste reduction system shall have suitable capacity and throughput to process the target waste (e.g., 900-1,400 lbs of mixed solid waste per day for a Waste to Energy technology for a 150-personnel base).

Transportability – The waste reduction system shall be packaged or containerized in 8×8×6.5-foot TRICON shipping containers weighing less than 10,000 lbs for rapid deployment and compatibility with existing transportation assets. The system shall be packaged in as few containers as possible. The system should be capable of achieving Container Safety Convention (CSC) certification and passing rail impact and rough terrain transportation tests.
Manpower – The waste reduction system shall have automated control and operation and shall require minimal manpower (objective 1 part time operator), including any waste handling or segregation.

Residues and Emissions – The waste reduction technology shall produce only non-hazardous residuals (e.g., no solid, liquid, or gaseous byproducts that require special handling or disposal). Any residues or emissions shall be benign to the environment and safe for equipment operators.

Smoke and/or Odors – Because it is intended for use in the camp potentially near trash generation and/or energy demands, the waste reduction system shall produce no smoke or objectionable odors during operation, including startup, shutdown, and unexpected power interruptions.

Fuel – The waste reduction system shall be able to use either JP-8 or DF-2, whichever is available, for any fuel requirements (e.g., startup, operation, or power generation).

INFORMATION OF INTEREST (to be included with white paper submission)

The intent of this RFI is to identify systems/technologies that have already been shown to meet many of the performance requirements listed above and could be demonstrated near term and subsequently be developed into a mature technology demonstration prototype system within two years, ready for demonstration/validation and subsequent engineering and manufacturing development. The white paper should include physical and functional descriptions of the proposed system, including:

Performance Requirements – Discuss ability to meet the requirements specified above.

Technology – Discuss technologies used, including primary processor or reactor and important subsystems. Assess Technology Readiness Level / maturity.

Packaging – Discuss system size and weight when configured for transportation as well as setup procedures and operational configuration.

Feedstock – Discuss acceptable and problematic feedstock and any manual segregation or separation requirements.

Throughput – Discuss waste processing rates, acceptable duty cycles, and turndown capability.

Energy Requirements – Discuss system electrical and/or fuel requirements. Keep in mind that this product should be more efficient than currently available commercial batch load modular incinerators.

Consumables – Discuss all system consumables, including maintenance items.

Cost – Discuss pricing and, if applicable, estimate additional funding (rough order of magnitude) required to adapt to fully meet the performance requirements.

SLB-STO-D Submission Form

Submission Instructions: Complete the SLB-STO-D Submission Form and save as a Microsoft Word document. Send the .doc and a .jpg photo of your technology to: benjamin.j.campbell26.civ@mail.mil and elizabeth.d.swisher.civ@mail.mil
.The completed Submission Form must be received by midnight EST on 16 Jan 2015 (Extended to 30 Jan 2015).

PART A - Name and Contact Information

Technology Name:
Company Name:
Company Address:
POC Name:
POC E-mail:
POC Phone:

Company Website:

PART B – Thrust Area Category

__ Fuel	__ Water	__ Waste

PART C - Technology Description

Describe your technology and how it can reduce SLB-STO-D base camp sustainment energy, water, and decrease waste requirements.
Provide a physical description of your technology (size, weight, cube).
Summarize the technical specifications of your technology (power, voltage, efficiency, etc).
Indicate the Technology Readiness Level (TRL) of your technology. Department of Defense TRL definitions are included below as reference. Note: You must have a working prototype.

__ 1 __2 __3 __4 __5 __6 __7 __8 __9
Have you shown/discussed your technology with anyone in federal/state government or the military services? If yes, provide POC name/phone/e-mail.
Has your technology been tested in a military operational environment (training or deployment)? If yes, describe the nature of the test, date, location, military office(s) involved, and military POC name/phone/e-mail.
Do you foresee any issues integrating your technology into military platforms and/or an operational environment (i.e. extreme temperatures, water, sand etc.)?
Is your technology currently being used in the private sector? If yes, describe - to include cost estimates.
Summarize relevant test data for your technology, emphasizing projected fuel/water/waste reduction and/or efficiency improvement over existing Army technology. DO NOT ATTACH COPIES OF TEST REPORTS.

Describe how you will demonstrate your technology at the SLB-STO-D Industry Assessment. A dynamic demonstration is required. Include information regarding space (sq. ft.) and equipment required. NOTE: The SLB-STO-D location is remote and shore power may not be available. Generators may be provided for companies demonstrating on a limited basis. However, permanent modifications to Government Furnished Equipment WILL NOT be permitted.
Attach a .jpg photo of your technology. (CAD drawings and computer simulations are not sufficient).

Department of Defense Technology Readiness Levels, Defined*

Technology Readiness Level	Description
1. Basic principles observed and reported.	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.
2. Technology concept and/or application formulated.	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
3. Analytical and experimental critical function and/or characteristic proof of concept.	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Component and/or breadboard validation in laboratory environment.	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.
5. Component and/or breadboard validation in relevant environment.	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.
6. System/subsystem model or prototype demonstration in a relevant environment.	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment.
7. System prototype demonstration in an operational environment.	Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment such as an aircraft, vehicle, or

	space. Examples include testing the prototype in a test bed aircraft.
8. Actual system completed and qualified through test and demonstration.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system proven through successful mission operations.	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.

DEFINITIONS:

BREADBOARD: Integrated components that provide a representation of a system/subsystem and which can be used to determine concept feasibility and to develop technical data. Typically configured for laboratory use to demonstrate the technical principles of immediate interest. May resemble final system/subsystem in function only.

"HIGH FIDELITY": Addresses form, fit and function. High-fidelity laboratory environment would involve testing with equipment that can simulate and validate all system specifications within a laboratory setting.

"LOW FIDELITY": A representative of the component or system that has limited ability to provide anything but first order information about the end product. Low-fidelity assessments are used to provide trend analysis.

MODEL: A functional form of a system, generally reduced in scale, near or at operational specification. Models will be sufficiently hardened to allow demonstration of the technical and operational capabilities required of the final system.

OPERATIONAL ENVIRONMENT: Environment that addresses all of the operational requirements and specifications required of the final system to include platform/packaging.

PROTOTYPE: A physical or virtual model used to evaluate the technical or manufacturing feasibility or military utility of a particular technology or process, concept, end item or system.

RELEVANT ENVIRONMENT: Testing environment that simulates the key aspects of the operational environment.

SIMULATED OPERATIONAL ENVIRONMENTAL: Either 1) a real environment that can simulate all of the operational requirements and specifications required of the final system, or 2) a simulated environment that allows for testing of a virtual prototype; used in either case to determine whether a developmental system meets the operational requirements and specifications of the final system.

**Source: DoD Deskbook 5000.2-R, Appendix 6, Technology Readiness Levels and Their Definitions.*

APPENDIX B: PANEL MEMBERS — SPECIAL ACKNOWLEDGEMENT

Leigh Knowlton
SLB-STO-D, TMIT Lead
DoD Combat Feeding Equipment & Energy Technology Team
U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC)

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U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC)

Benjamin Campbell
SLB-STO-D, Lead Systems Engineer
U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC)

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APPENDIX C: TECHNOLOGIES OF INTEREST

T-SERIES by ZeroBase

The T-SERIES is a mobile, hybrid power management system that greatly reduces or eliminates the fuel consumption and running time of 5, 10, and 15 kW generators. The hybrid power systems eliminate or significantly reduce generator fuel consumption and running time. This hybrid system uses multiple power sources to provide operational continuity, extend the fuel supply, and operate silently all while allowing a decrease in demand for fuel consumption. The T-SERIES comes complete with an off-road chassis that is towable by defense or commercial vehicles to allow for quick and easy deployment over long distances. The platform is designed for the integration with critical sensor, communications, lighting, and power generation assets.

The main measure for the effectiveness of the T-SERIES system is a reduction in resources required and primarily diesel fuel used in generators. The system controls the generators to maximize efficiency and minimize run time. A secondary effect from this control is decreased generator maintenance and increased generator life span.

Sol-Char Toilet by University of Colorado

The Sol-Char Toilet is an affordable innovative solar toilet that operates off the electrical grid, without external water or power inputs, and creates useful products out of human waste. In a period of 18 months, an operational Phase I proof of concept prototype (TRL 5) was built with funding from the Bill & Melinda Gates Foundation. The system has parabolic dishes to concentrate solar energy that is transmitted through fiber optic cables to a pyrolysis reactor that thermally inactivates human waste at 300-700 ˚C, creating useful end products (char-based soil fertilizer or fuel). This household scale prototype was demonstrated at the World Toilet Fair in New Delhi, India in March 2014. A Phase II community scale toilet design is underway that is cheaper (~$0.02/person/day), can service up to 100 people per unit, has a 30 year lifetime, and will generate low grade heat as well as up to 15 kW h/day of electricity that can be used or stored for cloudy day operation. As the system runs on concentrated solar power, it can function in locations with no electrical grid that have Direct Normal Irradiance (DNI) levels of at least 3.0 kWhrs/m^2/day (Ideally >5.0).

The system can eliminate sanitation water demand for base camps because it is a waterless toilet. Furthermore, the system can reduce waste disposal burden for small contingency bases in the thrust areas of: waste to energy, waste reduction and stabilization and blackwater sludge processing. The Sol-Char toilet generates several energy products including electricity, heat and solid fuel (char). Furthermore, it can be used to process and treat human waste, food service waste, other biomass and plastic packaging waste and can convert it into char, an odorless pathogen-free product. Finally, the system can reduce solid waste mass of human feces by 85-92%, depending on the pyrolysis temperature achieved in the reactor.

Water Treatment from Environmental Control Units by Mistral Water

Military expeditionary and forward operating bases (FOBs) often include mobile Environmental Control Units (ECUs) to facilitate suitable working and living conditions for the soldiers occupying these bases. Each of these ECUs produces hundreds of gallons of water which goes onto the ground and is unused today. For example, a 60,000 BTU ECU can produce 1.2 gal/h in average conditions of 77 °F and 55% relative humidity.

The Water Gen Water Treatment Unit for ECUs (WTU-ECU) can collect, purify, and sterilize the water from either a single or multiple ECUs and will supply a healthy, safe, and good tasting supply of drinking water. The WTU-ECU can be tailored to fit multiple types of ECUs, making it a perfect water supply solution for point of use potable water treatment.

The WTU collects water produced by either a vehicle or ground-based HVAC or ECU (condensate) and purifies, sterilizes, and mineralizes this water source into pure, fresh, potable water for the soldiers occupying forward operating locations. The WTU-ECU is easily connected to any ECU and is capable of treating 2.5-20 gal/h of condensate from the ECU(s). Water quality meets the water purity standards of TB MED 577.

Finally, in the area of waste management, the water that is normally discarded by the ECUs onto the ground is no longer creating a large mud puddle in the middle of the FOB. Today, this discarded water can become a breeding ground for disease and other health issues. With the WTU this “wasted water” is no longer present, but is provided to the Warfighter as purified, sterilized and re-mineralized potable drinking water.

Energy and Water Conservation System by Marine Design Dynamics, Inc.

Marine Design Dynamics' (MDD's) proposed Energy and Water Conservation System (EWCS) consists of a gray water treatment and recycling system installed into a standard Joint Modular Intermodal Container (JMIC) (51.75″ L x 43.75″ W x 43″H) modified to accommodate installation of the filtration system. The EWCS allows for the wastewater produced from showers, laundry, and sinks (non-kitchen) to be filtered, recycled, and used again. This system is not intended to produce potable water for drinking or cooking, but for reuse in showers, sinks, and laundry facilities. This system currently has been tested to provide up to of 8,000 gallons per day (gpd) of recycled water for additional non-gray water use. Initially, potable water will be delivered to the Force Provider (FP) and used in showers and sinks. The EWCS is capable of being handled and transported using the standard equipment and vehicles found at US Army FPs. The weight and volume of the EWCS has been constructed such that it is consistent with the transporting and handling equipment capabilities used in conjunction with US Army FPs. The EWCS will significantly reduce Organizational Water Demands at FPs by efficiently utilizing potable water through recycling. Based on the water usage statistics provided in Attachment 1, MDD estimates that the EWCS can reduce daily water consumption, through recycling for subsequent reuse in showers and laundry, by as much as 5,031 gpd, which is 54% of the FP's daily total.

APPENDIX D: SLB-STO-D DEMONSTRATION STRATEGY DOCUMENT

(*Reprint of original)*

Technology-Enabled Capability Demonstration (TECD) Sustainability & Logistics: Basing (4a)
(TECD 4a) Demonstration Strategy Document
(V2.0)

Date: 6 July 2012
Purpose: This strategy is an internal guidance document that is intended to shape the demonstration planning activities associated with the program.

Introduction: In February 2012, the Department of the Army approved TECD 4a, a 6-year major science and technology (S&T) project that will demonstrate integrated solutions for improving the management of waste, water and fuel at expeditionary base camps. The objective is to reduce the need for fuel resupply by 25%, reduce the need for water resupply by 75% and decrease waste by 50% while optimizing quality of life options at basing camps ranging in size from 50-1000 PAX.

At the center of the program is the following problem statement:

"The Army needs improved capability to enable sustainment independence/self-sufficiency and to reduce sustainment demands at expeditionary basing level contingency bases. It is too costly, too unpredictable, and too labor intensive for a Small Unit to carry all required consumables to last for weeks or months at a Combat Outpost/Patrol Base (COP/PB). Storage facilities and systems do not meet needs of these small bases, and resupply efforts are highly unpredictable."

To put the problem in perspective, in 2011 contingency bases (all Services) consumed approximately 254,000,000 gallons of fuel which is equal to that of ground and air platforms combined (according to the Assistant Secretary of Defense for Operational Energy Plans and Programs (ASD, OEPP). At even a conservative fully burdened cost of $10 per gallon, this represents a significant cost. Even more significant is the risk to Soldiers who conduct tactical resupply to these bases.

Demonstration Concept: TECD 4a has adopted an incremental demonstration concept that accommodates a large number of S&T projects (currently more than 80) feeding into multiple demonstrations that have independent schedules and technology maturation paths. The incremental approach allows the management team to identify the most effective solutions available at a specific time and carry those elements into the ensuing demonstration. The incremental approach also provides the opportunity to move early successes to the appropriate transition path as soon as possible.

Definition: The term demonstration refers to the window of time that has been identified in the Integrated Master Plan/Schedule (IMP/IMS) for the demonstration of capability enabling solution sets. A demonstration is not a single activity. It is a series of events and activities that are synchronized and integrated for a specific purpose.

Demonstration Windows: As depicted in the overarching program summary (figure 1), the TECD schedule shows four different demonstration events occurring during the FY14-17 timeframe. There will be two Incremental Demonstrations, one Industry Comparative Demonstration, and potentially a Capstone Demonstration. The two Incremental Demonstration windows are 18 months in length and the Industry Comparative and Capstone Demonstration windows are 12 months long. The demonstration window does not include the planning activities associated with each event. Planning activities take place prior to the actual demonstration window and are shown separately in the schedule. There is a moderate amount of overlap among the demonstrations and this must be taken into account during the planning phases to ensure the quality of each event does not suffer due to a lack of resources, etc.

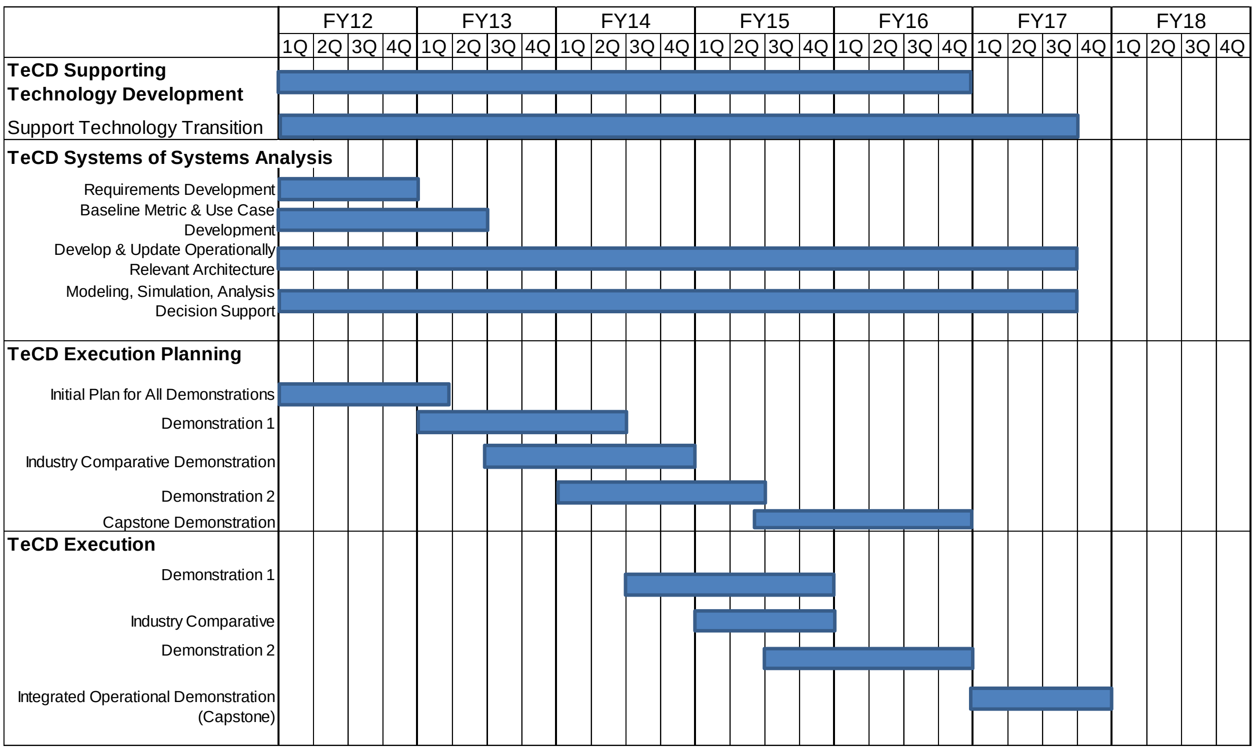

Figure 1: TECD 4a Overarching Schedule

Demonstration Intent: Demonstration Increment 1 and Increment 2 will follow the same basic concept. Each will identify and demonstrate the most effective solution set for the entire problem space (Fuel, Water, and Waste across the 50-1000 PAX base size range). The size range will be addressed according to the TECD demonstration concept depicted in figure 2 below, with three primary base sizes (50-150 PAX, 150-500 PAX, and 500-1000 PAX). These Incremental Demonstrations must identify integrated (DOTMLPF) capability solutions rather than being solely technology demonstrations. For TECD purposes (only), the base sizes will be managed as follows:

TECD Class I Base: 50-150 PAX
TECD Class II Base: 150-500 PAX
TECD Class III Base: 500-1000 PAX

The Industry Comparative Demonstration will be a streamlined version of the Incremental Demonstrations and will specifically target capability gaps that are identified during the analysis period leading up to demonstrations. The secondary thrust of the Industry Comparative Demonstration will be to solicit industry solutions that may be a better approach to enabling the desired capability.

The Capstone Demonstration, should it be conducted, will be a "best approach" demonstration and will only be conducted if there is value in doing so. If the contingency basing requirement development process deviates from the forecasted path, there may be some value in conducting the Capstone Demonstration. For example, it could provide final insight into the Capabilities Development Document(s) (CDD) and could also serve as an acquisition streamlining initiative in partnership with transition partner Product Managers, etc. Ultimately, a successful demonstration will manifest itself in the form of integrated capability enabling solutions transitioned to the warfighting community. This includes material hardware, knowledge products, etc.

Throughout all phases and portions of the demonstration program, quality of life must be regarded as an independent variable. The solution space does not include reducing the quality of life standards at any of the bases. For the very small bases (class I), the TECD must explore options that provide an enhanced quality of life, should it be deemed appropriate, that do not exacerbate the resupply challenges.

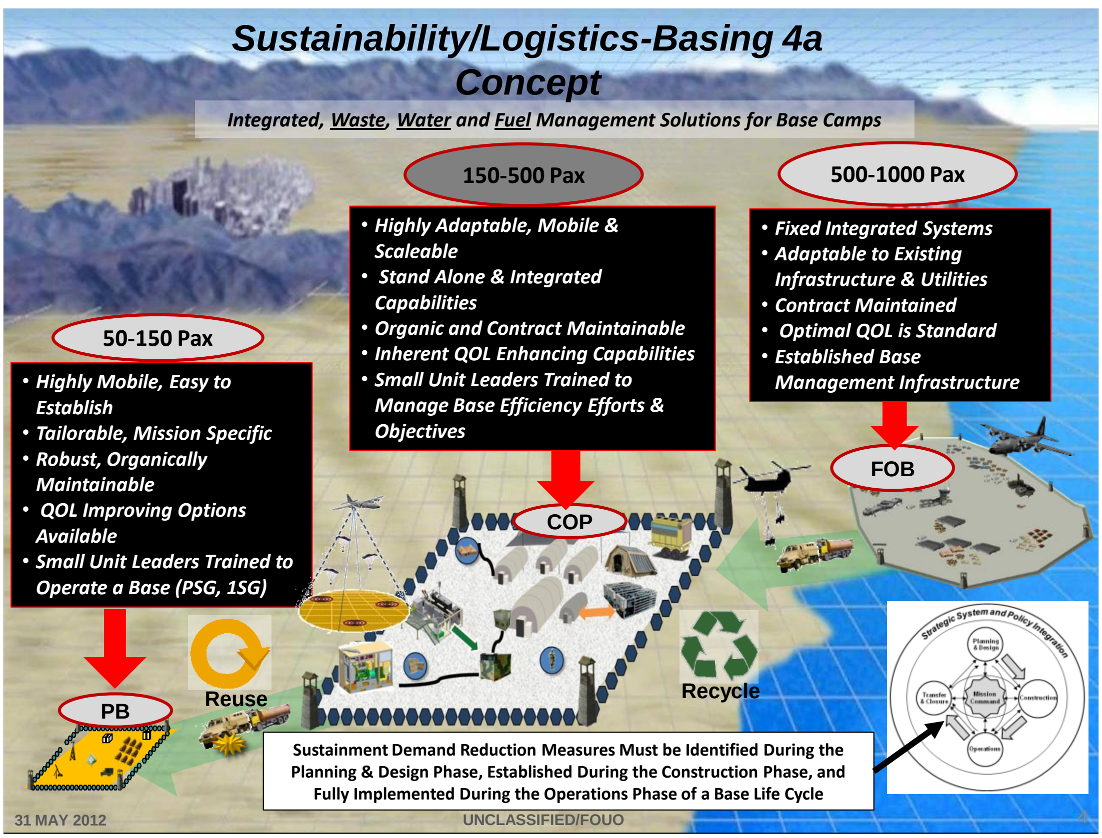

Figure 2: TECD 4a Demonstration Concept

Demonstration Planning: Detailed planning for each demonstration element must commence as early as possible to ensure thoroughness, etc. These demonstration plans will be reviewed during the Demonstration Technical Readiness Reviews to ensure adequacy of preparation and readiness to commence demonstration. There will be a demonstration plan for all four demonstrations and they will each develop on independent timelines.

Incremental Demonstrations: Within the 18 month Incremental Demonstration window there are three main phases of the operation:

Phase I: Technology & System Characterization – 6 month period that is intended to finalize and prepare the technologies to be demonstrated, conduct a basic system operations test, and to build momentum leading into Phase II.

Phase II: Integrated Capability Demonstration – 9 month period of actual demonstration that should address the goals of the TECD and should include hot and cold environment demonstration to the greatest extent possible.

Phase III: Demonstration Reporting & Closeout – 3 month period of concluding activities to include potential excursions, etc. Also includes the compilation of test data, etc.

Demonstration Entrance Criteria: Candidate technologies that have positive impact on TECD objectives will be identified during the analysis period. These are the technologies and solutions that appear to be the most effective in meeting the objectives of the TECD. The TECD project office will verify the technology/system compliance with the demonstration entrance criteria and provide formal authorization for the demonstration. Prior to entering the demonstration, each candidate technology/system must be ready for operational use and meet the following minimum entrance criteria (initial):

-TRL level and justification: Documented demonstration including bench test results that the technology meets the Technology Readiness Level (TRL) 5 definition as follows:

TRL 5: Component and/or breadboard validation in relevant environment: Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components. Results from testing laboratory breadboard system are integrated with other supporting elements in a simulated operational environment.

-Safety Release (If required): The technology/system must have a safety release from the appropriate agency (see AR 385-10) to support the safety of US Army resources (Soldiers, Army civilians, and Army property) participation in the demonstrations

-Operation and Maintenance Documentation/Manuals: The technology/system must have operating instructions and maintenance documentation/manuals. Repair instructions and parts must be available as applicable for maintenance supportability. A training package must be available and training provided to the users for familiarization of the technology/system capabilities including installation, operation, and maintenance functions prior to the demonstration events.

Demonstration Venues: Demonstration venues are the physical locations and exercises that could be leveraged for the TECD. The primary venues are those that will be depended on for most demonstration activities since they are contingency base focused and currently in existence or expected to be ready in the near future.

Primary Venues: The TECD should/will leverage the following facilities/venues to the maximum extent

Base Camp Integration Laboratory (BCIL): Located at Fort Devens, MA. This facility is ideally configured and sized to represent the class II sized base in the TECD. Could also represent the class I sized base. Facility is operated by the Product Manager, Force Sustainment Systems (PM-FSS).

Contingency Base Integration Technology Evaluation Center (CBITEC): Located at Fort Leonard Wood, MO. This facility is ideally sized to represent the class III sized base in the TECD. Could also represent the class II sized base. Facility is operated by the Maneuver Support Center of Excellence (MSCoE)

Fort Benning: There is an emerging effort to construct a very small base at Fort Benning to be used to support the AEWE exercises. Base would be sized to accommodate up to 100 PAX and would be an ideal replicate of the class I sized base. It is unclear who will operate the facility.

Secondary Venues: These facilities/venues will be used to fill gaps in the demonstration plans to include potentially using them for weather extremes, etc

Network Integration Evaluation (NIE): Fort Bliss, TX and White Sands Missile Range, NM
Army Expeditionary Warrior Experiment (AEWE): Fort Benning, GA
Joint Readiness Training Center (JRTC): Fort Polk, LA
Joint Multinational Readiness Center (JMRC): Hohenfels, Germany
National Training Center (NTC): Fort Irwin, CA
Yuma Proving Ground (YPG): Yuma, AZ
Cold Region Test Center (CRTC): Fort Greely, AK