BILL & MELINDA GATES foundation

WATER, SANITATION & HYGIENE: GRAND CHALLENGES EXPLORATIONS

ROUND 7 SUMMARY

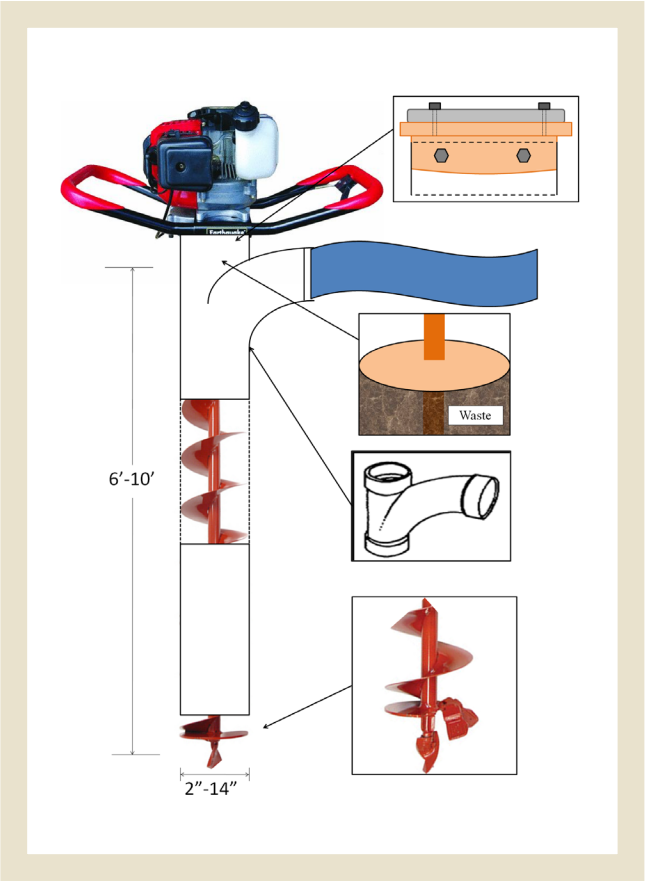
ROUND 7 GRANT SUMMARY AND ANALYSIS

The Water, Sanitation & Hygiene (WSH) program collaborated with Grand Challenges Explorations (GCE) in Global Health in 2010–2011 to solicit and fund concepts that can expand access to safe, healthy, and affordable sanitation. The first call for proposals was launched in September 2010, and 26 grants were disbursed in April 2011. The second call for proposals closed on May 19, 2011, and 31 new grants were announced on November 7, 2011.

The WSH program's challenge for this round of funding was to create the next generation of sanitation technologies in four specific areas associated with non-networked sanitation for the urban poor:

1. Hygienic and adequate pit/tank emptying and extraction
2. Recovery of energy from fecal sludge as a means to achieve safe and affordable treatment and disposal
3. Appropriate sanitation solutions for areas challenged by an abundance of water (e.g., communities that face seasonal flooding, high groundwater tables, riparian or tidal communities, etc.)
4. Easy-to-clean, attractive, and affordable latrine pan/squatting platform technologies

The following provides a summary of the grants that were awarded in each innovation area.



Power Auger Modification to Empty Cesspits

FOCUS AREA ONE: Hygienic and Adequate Pit/Tank Emptying and Extraction

Fecal Sludge Extraction and Disposal System in Situ

Jing Ning of the Shijiazhuang University of Economics will develop a waste extraction and disposal system that uses wind or solar power to pull waste from septic tanks or cesspools into a column. The waste is then dehydrated via solar energy, which kills all remaining pathogens and reduces waste volume. This system is designed to be durable and low maintenance, allowing for rapid, on-site waste disposal.

Power Auger Modification to Empty Cesspits

Robert Borden of North Carolina State University will develop an inexpensive method for emptying cesspits and latrines that uses gasoline-powered augers modified to operate as a progressive cavity pump for filling drums and other containers.

Method of Electrically Reducing Adhesion of Sludge to a Tank

Victor Barinov of the Polytechnic Institute of New York University will test the ability of electricity to change the consistency and adhesive properties of dense solids at the bottom of septic tanks. If successful, applying an electrical charge via a low-cost battery would allow vacuum pumps to operate at a significantly higher extraction rate in moving waste to treatment facilities

FOCUS AREA TWO: Recovery of Energy from Fecal Sludge to Achieve Safe, Affordable Treatment and Disposal

Increase of Biogas Production Using Low-cost Nanoparticles

Antonio Sánchez of Universitat Autònoma de Barcelona will test the ability of low-cost, iron-oxide, biocompatible nanoparticles to increase the production of biogas from sludge and other organic wastes and produce high-quality, sanitized compost.

Bioelectricity Generation from Domestic Waste

Caitlyn Butler, Mark Henderson, and Brad Rogers of Arizona State University will adapt pit latrines to harvest organic substrates and nitrogen compounds in human waste using microbial fuel cells that will transform biochemical energy into carbon-neutral electricity.

Something from Nothing

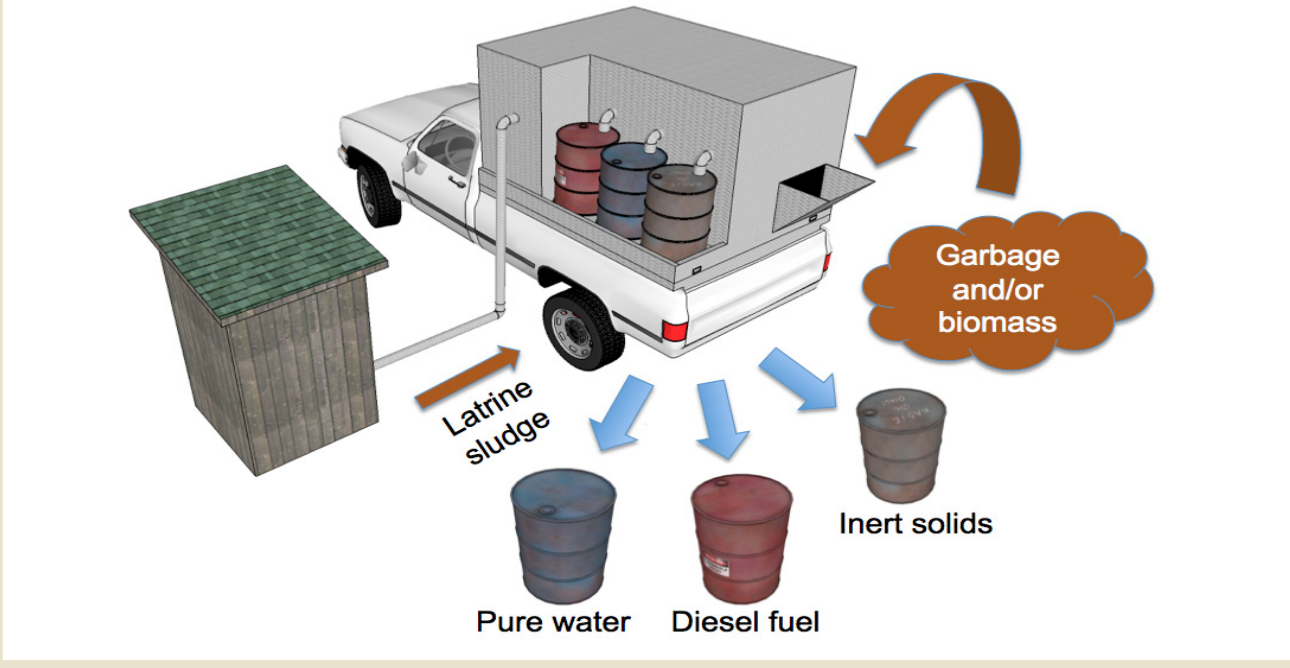
Steven Cobb and a team at the University of Durham will develop a macroporous scaffold that can support bacterial cells and metal nanoparticles that work together to catalyze conversion of fecal sludge into hydrogen for electricity. This technology could be used as a stand-alone sanitation solution or integrated into existing sewage pipe networks.

Urine-tricity: Electricity from Urine and Sludge

Ioannis Ieropoulos of the University of the West of England, Bristol, will test the ability of microbial fuel cells to convert urine and sludge into electrical energy while also purifying water by killing disease-causing pathogens in waste. This technology could enable energy recovery from urine and other waste streams.

Mobile Waste-to-Liquid-Fuels Conversion Plants

Leonardo De Silva Muñoz of AI3D will design a mobile waste treatment system that extracts fecal sludge and uses plasma gasification to turn waste into a gas that can be used to synthesize diesel fuel and produce electricity. The treatment system will be fitted into the bed of a pickup truck, and the resulting gas mixture will power the truck, the waste treatment process, and the fecal sludge extraction system.



Mobile Waste-to-Liquid-Fuels Conversion Plants

Sewage Containment and Mineralization Device (SeCoM)

Andrew Parfitt of the Institute for Residential Innovation (IResI) will develop a compact, stand-alone device that uses a non-microbial system of progressive reactor modules to mineralize biomass such as sewage and food waste and simultaneously generate electrical power. This system could be used in any location to provide sanitation and purified water for a potable water supply.

Enhanced Anaerobic Digestion: A Sanitation and Energy Recovery Technology for Developing Countries

Temesgen Garoma of San Diego State University will develop an enhanced anaerobic digestion system that uses algae as a supplement to treat human waste reliably and inexpensively while generating biogas for energy needs and biosolids for use as fertilizer.

A Solar Steam Sterilizer for Treatment of Human Waste

Naomi Halas and colleagues at Rice University will design and test a prototype sterilizer that employs metallic nanoparticles to absorb solar energy and convert water to steam that can sterilize human waste.

Using Fecal Sludge for Butanol Fermentation

Yinjie Tang at Washington University in St. Louis will develop a genetically engineered fungal species that can convert fecal sludge to butanol, a high-energy biofuel similar to gasoline. The fungal species could not only produce biofuels, but also kill pathogenic microorganisms in fecal sludge.

Vortex Bioreactors for the Processing of Fecal Sludge and Waste Water

Mike Allen of Plymouth Marine Laboratory will develop a low-cost, vortex-based bioreactor that is driven by hand or bicycle to separate fecal matter from waste water and introduce bactericidal agents to decontaminate the waste for recycling or safe disposal.

Conversion of Human Excreta to Energy and Biocharcoal

Jason Aramburu of re:char will use low-cost pyrolysis reactors to convert human waste into biochar, which can be used as a replacement for wood charcoal or chemical fertilizers. The grant will also assess the income-generating potential of this biocharcoal.

Effective Sewage Sanitation with Low CO_2 Footprint

Marc Deshusses and David Schaad of Duke University will develop a bioreactor system that converts waste to biogas, which is then burned and superheated by a heat exchanger to sterilize the treated effluent. This system could capture and reuse greenhouse gases while providing effective sanitation in developing countries.

Hybrid Microbial-Electrochemical System for Waste Utilization

Arum Han, Choongho Yu, and Paul de Figueiredo of Texas A&M University will develop a hybrid wastewater treatment system that uses microbial fuel cells to generate energy from wastewater. That energy will be used to power a microbial electrolysis cell that will produce biogas as a clean combustible fuel.

Biogas Generator Powered by Self-Sustaining Mixing Mechanism

Tim Canter of Frontier Environmental Technology will develop a biogas generator that employs a unique, self-sustaining mixing mechanism to effectively treat concentrated wastewater and produce biogas without extra energy or the need for trained personnel.

Creation of Economic Incentives for Improved Sanitation

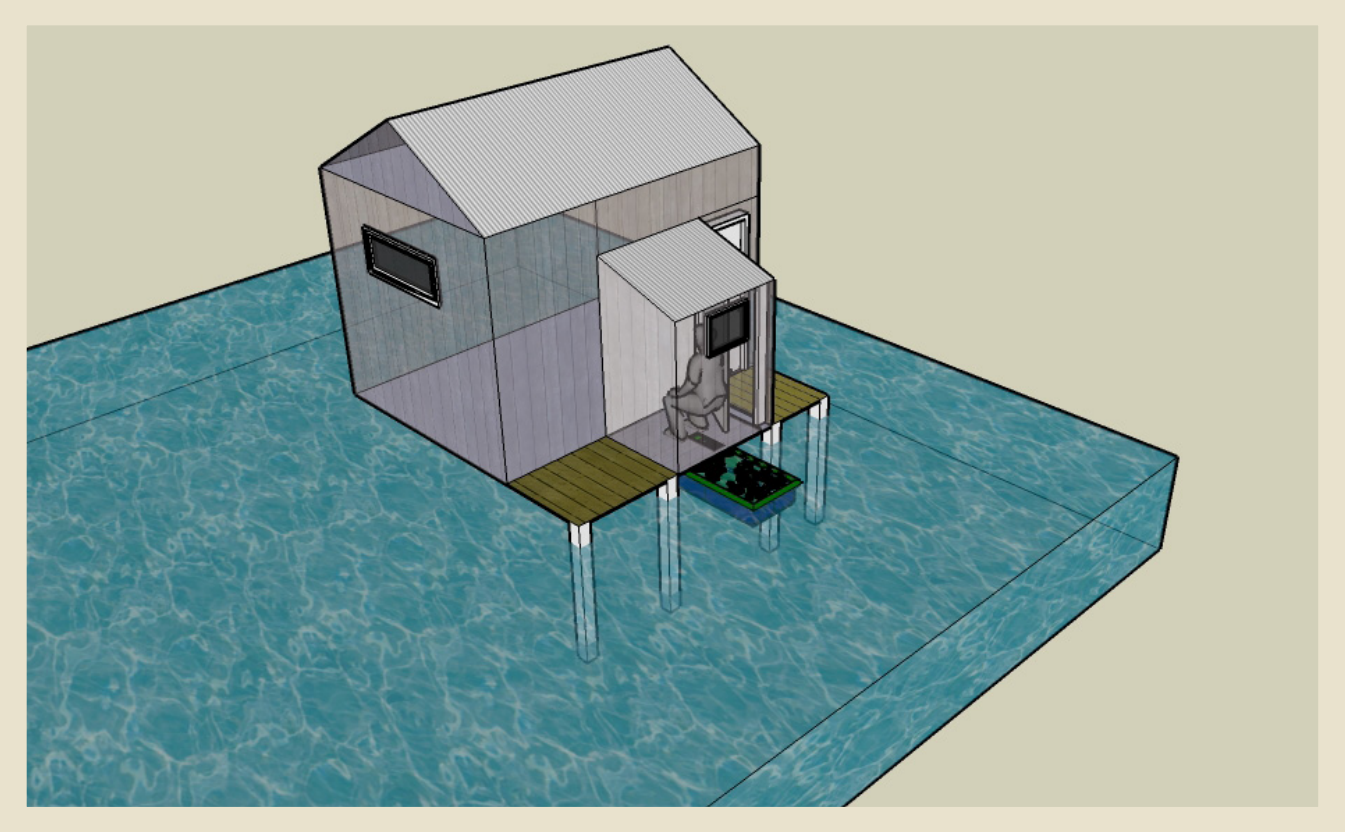
Mark Holtzapple of Texas A&M University will demonstrate that carboxylic acid fermentation can be adapted as a sanitation treatment to kill pathogens in waste and convert waste to liquid fuels, compost, and potable water that can be sold as byproducts.

New Generator for Nutrient, Energy, and Water Recovery from Human Wastes

Daniel Yeh of the University of South Florida will develop a decentralized sanitation system that uses an anaerobic digester and membrane biotechnology to treat waste water and produce methane for energy, clean water, and agricultural fertilizer.

Direct Electricity from Fecal Sludge in Bioelectric Systems

Zhiyong Ren of the University of Colorado, Denver, will develop a low-cost and easy-to-operate bioelectric system that uses microbes to break down waste and convert it to usable electricity. This technology could provide a self-sustainable solution for communities in need of both sanitary waste disposal and an energy supply.



Floating Community Wastewater Treatment in Asia

Sanitation and Electricity through Local Enterprise

Swapnil Chaturvedi of Samagra Off-Grid Utilities, Inc., will deploy an innovative service that integrates customers' emotional and aspirational motivations with the introduction of clean sanitation in Indian slums. The goal is to create a business network that encourages local entrepreneurs to collect human waste cartridges.

FOCUS AREA THREE: Appropriate Sanitation Solutions for Water-Abundant Areas

Floating Community Wastewater Treatment in Asia

Taber Hand of the Cambodian NGO Wetlands Work! will field-test a wastewater treatment system that uses floating "pods"—similar in appearance to children's wading pools—that can be positioned directly under the toilets of houseboats occupied by low-income fishing families. The pods will be filled with wetland plants, and bacteria that reside in the plant roots will create a biofilm capable of breaking down waste and cleaning water.

Energy Recovery and Waste Treatment with Floating Biodigesters

Rob Hughes and colleagues at Live & Learn Environmental Education will develop and test floating biodigesters for use by houseboat communities as a means to treat human waste and convert it to fertilizer and gas for light and cooking. These biodigesters can potentially provide affordable sanitation options and new economic opportunities for communities that live on water.

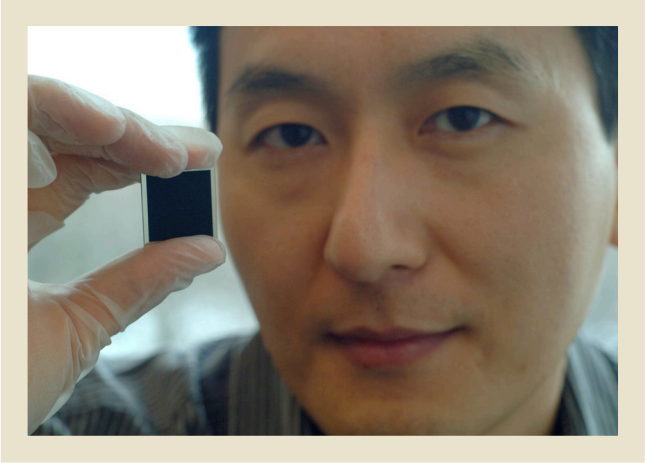
Breathable Membrane Enclosures for Fecal Sludge Stabilization

Steven Dentel of the University of Delaware will apply low-cost polymeric breathable membranes to fecal material and test their ability not only to protect groundwater from pathogen and contaminant releases but also to accelerate the drying and disinfection of these wastes.

FOCUS AREA FOUR: Easy-to-Clean, Attractive, and Affordable Latrine Platforms

Spray Paints for Self-Decontaminating Latrine Coatings

Yuanbing Mao of the University of Texas-Pan American will develop spray paints consisting of nanomaterials that work together to trap contaminants and destroy them using converted UV light. These spray paints could be used as decontaminating coatings for latrines.



A Revolutionary Sanitation Technology with Superhydrophobic Materials

Self-Sterilizing Easy Clean Latrine Mat and Casting Form

Paul Vernon and a team at Brighton Development, LLC, will develop a latrine mat made from a self-sterilizing plastic casting form that can be filled with concrete and set in place to provide a permanent antimicrobial surface for traditional squat latrines. The mat will be tested for its longevity and its ability to kill disease-causing pathogens and odor-producing bacteria.

Photoactive Silicones for Self-Cleaning and Antimicrobial Sanitary Units

Henry K. Malak of American Environmental Systems, Inc., will develop low-cost durable silicones with self-cleaning and antimicrobial properties for use as a coating on sanitary units. These silicones will contain embedded metal nanoparticles that react to light and kill microbes by creating electromagnetic fields.

A Revolutionary Sanitation Technology with Superhydrophobic Materials

Chunlei Guo of the University of Rochester will develop superhydrophobic materials that not only repel waste for use as a self-cleaning surface for latrines, but also can be used to capture and slough clean water into storage containers before it evaporates or is contaminated.

ADDITIONAL MODELING GRANTS

Modeling the Next Generation of Sanitation Systems

Luiza Cintra Campos of University College, London, will develop a simulation tool that can be used in developing countries to evaluate new sanitation technologies. By including parameters such as pit latrines served, distance to treatment, and potential for energy recovery, the simulation tool can aid communities in determining the best new systems for local needs.

Software to Identify and Quantify Pathogenic Helminth Eggs

Blanca Jimenez Cisneros of Mexican Autonomous National University in Mexico will develop software to identify and quantify parasitic eggs in a water sample. The software could provide a low-cost method for untrained personnel to test wastewater before its reuse in agriculture, thereby reducing parasitic infections in local populations.

Water, Sanitation & Hygiene

The Bill & Melinda Gates Foundation works with a wide range of partners through its Water, Sanitation & Hygiene program to reduce the burden of water-borne disease and improve the lives of the poor. Our approach aims to expand the use of sanitation that does not connect to a sewer, as this is by far the most common type used by the poor. We invest in effective approaches that help end open defecation and unsafe sanitation in rural communities, and we help develop the tools and technologies that will allow the urban poor access to sustainable non-piped sanitation.

Grand Challenges Explorations

The Grand Challenges Explorations (GCE) initiative is focused on engaging creative minds to work on scientific and technological breakthroughs for the world's most-pressing health and development problems. GCE is a grant program that fosters innovative, early stage research to expand the pipeline of ideas that can lead to those much-needed global health and development solutions.

Guided by the belief that every life has equal value, the Bill & Melinda Gates Foundation works to help all people lead healthy, productive lives. In developing countries, it focuses on improving people's health and giving them the chance to lift themselves out of hunger and extreme poverty. In the United States, it seeks to ensure that all people—especially those with the fewest resources—have access to the opportunities they need to succeed in school and life. Based in Seattle, Washington, the foundation is led by CEO Jeff Raikes and Co-chair William H. Gates Sr., under the direction of Bill and Melinda Gates and Warren Buffett.

For additional information on the Bill & Melinda Gates Foundation, please visit our website: www.gatesfoundation.org.