WIHAH

ANCHORAGE, ALASKA 2016 SEPTEMBER 18 - 21

WATER INNOVATIONS FOR HEALTHY ARCTIC HOMES

WIHAH2016.COM

CONFERENCE

WATER INNOVATIONS FOR HEALTHY ARCTIC HOMES

ADDRESSING THE CHALLENGES OF PROVIDING SAFE AND AFFORDABLE ACCESS TO HOUSEHOLD RUNNING WATER AND SANITATION IN REMOTE ARCTIC AND SUB-ARCTIC COMMUNITIES

CONFERENCE THEMES

THE IMPACT OF HOUSEHOLD WATER AND SANITATION ON ARCTIC HUMAN HEALTH

CLIMATE CHANGE IMPACTS ON WATER AND SANITATION INFRASTRUCTURE IN THE ARCTIC

INNOVATIVE ENGINEERING APPROACHES TO INCREASE ACCESS TO WATER OF ADEQUATE QUALITY AND QUANTITY, INCLUDING WATER REUSE

METHODS OF OWNERSHIP, OPERATIONS AND MAINTENANCE TO MAXIMIZE USEFUL LIFE OF WATER AND SEWER SYSTEMS IN THE ARCTIC

REGULATIONS AND POLICIES AFFECTING ACCESS TO AND THE COST OF PROVIDING ADEQUATE QUANTITIES OF WATER IN THE HOME

ANCHORAGE HILTON
ANCHORAGE, ALASKA
SEPTEMBER 18-21, 2016

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EXECUTIVE SUMMARY & FORWARD

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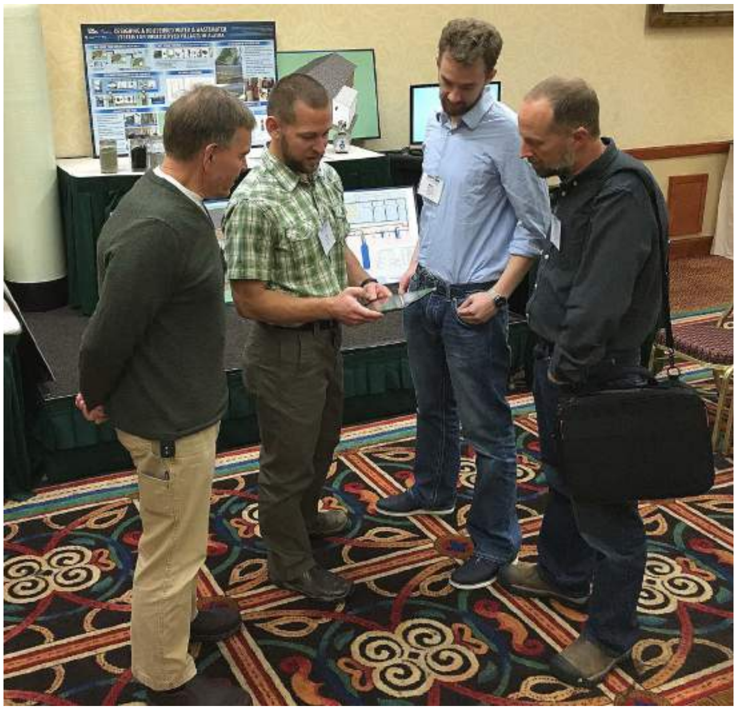

SUMMIT's Dave Cramer, DOWL's Chase Nelson and Mitch Titus, Bob White from YKHC

The Water Innovations for Healthy Arctic Homes (WIHAH) conference was held in Anchorage, Alaska, September 18–21, 2016, and was hosted by the Alaska Department of Environmental Conservation. WIHAH was part of an Arctic Council project, endorsed by the Council's Sustainable Development Working Group and co-lead by the United States and the Kingdom of Denmark during the U.S. Chairmanship in 2015-2017. A related meeting, "Sanitation in Cold Climate Regions" (ARTEK Event), was held in Sisimiut, Greenland, in April, 2016[1]. Both meetings convened international experts, engineers, health experts, academics and community members to share information, explore innovations, and encourage partnerships toward the goal of promoting safe and affordable access to household running water and sanitation services in remote Arctic communities.

The United Nations Sustainable Development Goal (SDG) #6 aims to "achieve universal and equitable access to safe and affordable drinking water for all" by 2030[2]. Many Arctic and sub-Arctic households in Alaska, Canada, Greenland and Russia suffer from a lack of access to sufficient water and sanitation services, contributing to high rates of infectious diseases. Such services are fundamental to sustainable development and community resilience in a rapidly changing Arctic. However, the challenges associated with building and operating water and sanitation systems in the Arctic are formidable. Construction costs often exceed available government funding and rural communities face logistical and economic difficulties to keep systems running. Unless alternative funding mechanisms are adopted or innovative approaches to water and sanitation services are implemented, many Arctic and sub-Arctic residents may never have indoor plumbing and SDG #6 will not be met in the Arctic region.

Arctic nations and communities have responded to the challenges of providing water and sanitation service in different ways. These include differences in planning, design and construction techniques; water and sanitation service expectations; regulations for water and wastewater; and use of subsidies to support the cost of operating sanitation systems. Further, climate and environmental change is forcing many communities to adapt to changes in source water, infrastructure support and shorelines. These differences represent opportunities and both WIHAH and ARTEK events in 2016 were convened so that the Arctic communities could meet, compare experiences, learn from each other and develop new approaches that increase access to water and sanitation services and improve the health of Arctic residents.

Conference Themes

The WIHAH Conference was organized to promote learning and discussion among persons with a range of professional and personal experiences. Invited keynote speakers and presentations submitted by attendees were selected to address five conference themes to promote interdisciplinary learning. These five themes are described in the paragraphs below.

Bill Griffith talks with Blanche Okbaok-Garnie

The First Theme – The first theme addressed the direct and indirect effects of household water and sanitation on Arctic human health. One presentation covered community perspectives on water insecurity in three remote Iñupiaq villages in rural Alaska. Another addressed water infrastructure and its effect on health and well-being in the context of a First Nations community in northern Canada. A third presentation described significant declines in skin, respiratory, and gastrointestinal illness following the first-time provision of piped water to the homes in four rural Alaska Native communities. A fourth evaluated the association of gastrointestinal illness with contaminated stored household drinking water in a rural Canadian community. The final presentation covered health education and behavior change perspectives to maximize the health benefits of existing infrastructure.

The Second Theme – The second theme focused on climate change effects on water and sanitation systems across the North, with impacts on traditional and engineered water sources. The Arctic is experiencing thawing permafrost, rising sea levels, increases in the number and intensity of storm surges, saltwater intrusion into coastal groundwater, and northward movement of animal populations that bring with them new pathogens. Additionally, climate-related environmental changes have caused loss of tundra ponds and caused damage to water intakes and impoundments from sediments, ice and erosion. In this session, presenters described these changes, identified key vulnerability points in water systems and urged managers to pursue water resource vulnerability assessments. Presenters also reviewed data collected from the Arctic Council Survey on Water and Sanitation in the Arctic, which documented the status of water and sanitation service and associated health outcomes, and described climate-related vulnerabilities and adaptation strategies for community water and sanitation systems and source water protection.

The Third Theme – The third theme highlighted innovative engineering approaches to increase access to water of adequate quality and quantity, including water reuse. Two engineers presented information about novel methodologies for treating wastewater from domestic and fish processing sources. A unique concept came from a university in Florida, where 100 percent of the water used in a student dormitory is treated and reused on-site. An Alaskan engineer shared new research on the generation of energy from household wastewater treatment systems, and others shared information about a pilot project to convert human waste to bio fuel. Finally, an industry engineer presented information about a small community wastewater treatment system that may hold potential for Alaska villages.

Innovative Decentralized Approaches to Household Running Water & Sanitation Service

The conference also featured sessions on research and development of innovative decentralized approaches to household running water and sanitation service. In Alaska, there are four pilot systems in development or early trials, and each was showcased at the conference. Three systems are being developed as part of the Alaska Water and Sewer Challenge[3]. These systems would all provide running water and sewer for a kitchen and bathroom sink, a toilet, a clothes washing machine and a shower. Performance targets include capital and operating costs, water quality and quantity, and constructability. Design teams reported on current progress toward meeting these targets. In addition, the Alaska Native Tribal Health Consortium (ANTHC) developed a pilot system which includes a bathroom sink and a toilet. This system is being field tested in the village of Kivalina, Alaska. Thirty people from remote Alaska villages attended the conference and each attended this session on demonstration systems. After

Megan Alvanna-Stimpfle

the conference, a special meeting was held with these village residents to gather their feedback and ideas on the systems.

The Fourth Theme – The fourth theme covered methods of ownership, operations and maintenance to maximize the useful operational life of existing water and sanitation systems in the Arctic. One speaker addressed how utility systems can apply energy efficiency improvements and risk assessment tools to improve system operation and maintenance. Another presenter discussed how outreach and education can improve a community's knowledge and appreciation of its water system, thus extending the health benefits. Another presentation addressed methods to assess the affordability of water service at the household level and how this could be used in evaluating sustainability of a new community system. These examples included methods that have been implemented successfully in sanitation systems across the Arctic.

The Fifth Theme – Theme five covered regulations and policies affecting access to, and costs of, providing adequate quantities of in-home water. Although water and sanitation regulations differ across the Arctic, no Arctic Council member state has regulations on water reuse at the household level. The closest documents are 2012 Water Reuse Guidelines published by the United States Environmental Protection Agency. A risk-based framework for the development of public health performance standards for decentralized non-drinking water systems is being developed by the Water Environment Research Foundation (WERF) in Alexandria, Virginia. How these performance standards are accepted by the public may depend on an approach utilizing social change marketing, which could include greater involvement of communities and regional institutions to gain acceptance of water reuse within the home and the new WERF standards.

Ways Forward & Next Steps

The following are ideas and suggestions from WIHAH participants for the next steps needed to improve health of Arctic residents through improved access to water and sanitation services. These were the perspectives of individuals and do not necessarily represent the official recommendations of the conference supporters or national governments.

Innovations

- Continue to evaluate alternatives to centralized and fully piped systems (examples include household systems, separator toilets, and countertop drinking water treatment systems) for their suitability in isolated Arctic communities and their impact on human health. These alternatives could be components of future Alaska Challenge systems.
- Consider an integrated approach to introduce components of the Alaska Water and Sewer Challenge so the communities do not have to wait until the end of the piloting stage to see improvements in the level of service in their homes.
- Ensure new systems are simple and reliable.
- Research and develop ways to dispose of waste and to take advantage of waste

Members of the conference core planning group included Dennis Wagner, Tom Hennessy, Cheryl Rosa, Jonathan Bressler, Bill Griffith and Fatima Ochante

as a potential resource. One example suggested was bio-digesters for Alaska villages that will provide both a method of disposing of human waste and a source of energy for the community. Another suggestion was composting waste to support food production.

Communications
- Create materials that describe the health impacts of inadequate access to water and sanitation service in Arctic communities that can be used to educate legislators and decision makers.
- Seek community input (e.g. Alaska village residents) early and often when developing new approaches to water and sanitation services.

Addressing Changing Environments
- Develop a database of water and sanitation infrastructure, source water or treatment systems at risk from environmental or climate change.
- Conduct a comprehensive Arctic-wide hydrologic modeling and water resource assessment.
- Develop and implement a water resource vulnerability assessment.
- Review the findings of the 2008-2009 Alaska Climate Change Sub-Cabinet to consider current relevance or informative value.

Operations, Maintenance & Regulation
- Apply a scoring methodology that integrates risk and cost in order to prioritize further planning, monitoring and response efforts.
- Follow-up with the (WERF) for the development of public health performance standards for decentralized non-potable water systems that could be used in the Arctic.
- Evaluate the economics of providing a subsidy to remote communities for supporting operations and maintenance and preventing catastrophic system failures.

Building Local Capacity
- Encourage and support community planning efforts that specifically address climate change and its impacts on water and sanitation source water and infrastructure.

- Encourage and support emergency response preparations to ensure villages are ready to address water and sanitation-related disasters. Scenario planning may be a good activity to use in these preparations.

Addressing Health Concerns

- Quantify the economic consequences of inadequate access to in-home water and wastewater services, including direct health care costs (morbidity and mortality, health care expenses) and indirect costs, such as lower educational attainment due to illness, decreased subsistence and employment activities. Such analyses should include methods that account for the unique cultural context of the Arctic, including individual and cultural values.
- Conduct an assessment of how much water is needed per-person per-day to provide the best benefit for health in Arctic communities. In doing this, consider newer technologies not available in prior World Health Organization (WHO) water quantity standards. These could include low-flow faucets, separating or dry toilets, and water reuse methods that could conserve water and reduce cost for a similar gain in health. Also, consider the water related needs that can be centralized (e.g. laundry) versus those that must be available in the house (e.g. handwashing).

Circumpolar Cooperation

- Through the Arctic Council Sustainable Development Working Group and its Arctic Human Health Expert Group (AHHEG), Arctic states should cooperate to share data about water and sanitation access in their Arctic communities, as well as progress toward the Sustainable Development Goal #6.
- Through AHHEG, and through non-Council bodies such as the International Circumpolar Surveillance network, Arctic states should cooperate to track water-related infectious diseases (both water-borne and water-washed) in the Arctic region over time, and to study how changes in water and sanitation access affect these rates.
- The Arctic Council should continue to create forums for Arctic communities to share innovations in water and sanitation technology, cost management methods, and climate change adaptation strategies.
- Arctic states should cooperate with one another to assess the quantity of water needed for good health in the Arctic, and to consider adopting standards for providing adequate

Alaska press member, Johanna Eurich, talks with conference participants water quantity and engineering methods for achieving these standards.

Conclusion

In conclusion, both the WIHAH and ARTEK conferences were successful in promoting useful discussions among groups that do not usually interact, but have a shared interest in improving water and sanitation services. The suggestions for next steps provide a way forward and offer action items for groups ranging from local communities to the Arctic Council. The durable record of this Arctic Council project will include these conference proceedings and a special Arctic-themed issue of the journal, "Environmental Science and Pollution Research," which will feature research articles written by attendees of the WIHAH and ARTEK meetings. Further progress on innovations in water and sanitation services can be found at the websites of the Alaska Water and Sewer Challenge[3] and the U.S. Arctic Research Commission[4]. The WIHAH sponsors and organizers sincerely thank the conference participants and hope that our efforts will be a step toward improving health for Arctic residents through the provision of in-home water and sanitation services for all.

References

[1] http://www.conferencemanager.dk/ArtekEvent2016 Accessed 16 December, 2016
[2] http://www.un.org/sustainabledevelopment/water-and-sanitation/ Accessed 16 December, 2016
[3] http://watersewerchallenge.alaska.gov/ Accessed 16 December, 2016
[4] https://www.arctic.gov/water-san/index.html Accessed 16 December, 2016

Plenary speaker Danielle Arigoni

ORGANIZING COMMITTEE

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Bill Griffith, Alaska Department of Environmental Conservation

Brian Bearden, Tanana Chiefs Conference

Brian Lefferts, Yukon-Kuskokwim Health Corporation

Carolyn Kozak, University of Alaska Fairbanks

Carrie Eischens, U.S. Arctic Research Commission

Cheryl Rosa, U.S. Arctic Research Commission

Dennis Wagner, U.S. Environmental Protection Agency

Elizabeth Hodges, University of Alaska Anchorage

Fatima Ochante, Alaska Department of Environmental Conservation

Jonathan Bressler, Alaska Department of Health & Social Services

Josh Glasser, U.S. Department of State

Korie Hickel, Alaska Native Tribal Health Consortium

Sharon Hildebrand, University of Alaska Southeast

Stephen Bolan, U.S. Indian Health Service

Tasha Deardorff, U.S. Department of Agriculture, Rural Division

Thomas Hennessy, U.S. CDC Arctic Investigations Program

Tim Thomas, Alaska Native Tribal Health Consortium

PRESENTATIONS

Presentation slides are available for download at http://wihah2016.com/presentations/

PRESENTATIONS

Opening Remarks

- Welcoming Remarks – Larry Hartig, Commissioner, Alaska Department of Environmental Conservation
- Opening Session – Bill Griffith, Facility Programs Manager, Alaska Department of Environmental Conservation

Keynotes

- An Introduction to the Arctic Council and the Sustainable Development Working Group – Ann Meceda, Arctic Affairs Officer, Acting Chair SDWG, U.S. Department of State
- Climate Change, Disaster Resilience and Relocation at HUD – Danielle Arigoni, Acting Director, HUD's Office of Economic Resilience
- Climate Change Consequences – Eric Hoberg, US National Parasite Collection, Agricultural Research Service, US Department of Agriculture and Smithsonian Institution
- The Impact of Water and Sanitation Services on Health – Tom Hennessy, Director, Arctic Investigations Program, National Center for Emerging and Zoonotic Infectious Diseases, US Centers for Disease Control and Prevention
- Pathogen Risk Management Considerations for Safe Household Water Uses – Nick Ashbolt, AI-HS Transitional Health Chair in Water, University of Alberta School of Public Health
- Reuse Regulations and Challenges of Regulating On-site Systems – Guy Carpenter, President, WateReuse Association
- Water Security in the Arctic: Perspectives from the Model Arctic Council - Carolyn Kozak, Sharon Hildebrand, Stephen Penner

International Reception Presentations

- Household Water Treatment and Safe Storage: Experience from the Developing World Lessons for Rural Alaska? – Robert Quick, MD, MPH, Centers for Disease Control and Prevention
- Arctic WASH Contributions from the Kingdom of Denmark – Greenland – Pernille Jensen & Kristian Hammeken, Centre of Arctic Technology, Department of Civil Engineering, Technical, University of Denmark
- A Bend in the River: Transitioning to a Time of Permanent Change – John Matthews, Alliance for Global Water Adaptation

Overview of Household Pilot Systems in Development

- State of Alaska's R&D Project: The Alaska Water & Sewer Challenge – Bill Griffith & Fatima Ochante, Village Safe Water Program, Alaska Department of Environmental Conservation
- Alaska Water Sewer Challenge – Phase 3: Team University of Alaska Anchorage (view animation), Aaron Dotson, Associate Professor, University of Alaska Anchorage

- Alaska Water & Sewer Challenge: Designing a Household Water & Wastewater System for Underserved Villages in Alaska, Chris Schulz & Janelle Rogers, CDM Smith, Chase Nelson & Mitch Titus, DOWL, Bruno Grunau, CCHRC, Laurie Krieger, Manoff Group
- Alaska Water + Sewer Challenge: Water Innovations for Healthy Arctic Homes, Summit Consulting Services
- The Portable Alternative Sanitation System (PASS)

Conference Theme: The Impact of Household Water & Sanitation on Arctic Human Health

- Community Perspectives on Water Insecurity in Rural Alaska – Laura Eichelberger, PhD, MPH, Univeristy of Texas at San Antonio
- Education and Behavior Change Efforts to Maximize the Health Benefits and Sustainability of Water and Sanitation – AJ Salkoski, Sr. Program Manager & John Nichols, Manager of Utility Operations, Alaska Native Tribal Health Consortium
- Impact of In-home Piped Water on Rates of Infectious Disease – The Four Village Study – Tim Thomas, Alaska Native Tribal Health Consortium, Centers for Disease Control and Prevention, Arctic Investigations Program
- Water Infrastructure and Well-being: What Does the Data Tell Us? – Melanie O'Gorman & Stephen Penner, University of Winnipeg MB, Canada
- Water Quality and Health in Northern Canada: Contamination of Stored Drinking Water and Associations with Acute Gastrointestinal Illness in an Inuit Community – Carlee Wright

Conference Theme: Climate Change Impacts on Water & Sanitation Infrastructure in the Arctic

- Vulnerability of Northern Water Supply Lakes to Changing Climate and Demand– Michael Bakaic, York University
- Vulnerability of Fresh Water Supply in Arctic Canada – Andrew Medeiros & Michael Bakaic, York Univserity, Department of Geography
- Climate Change and Community Water Security Emerging Challenges and Strategies – Mike Brubaker, Alaska Native Tribal Health Consortium
- Survey on Water and Sanitation in the Arctic: Access, Disease Surveillance, and Threats from Climate Change – Jonathan Bressler, MPH, Section of Epidemiology, Division of Public Health, Alaska Department of Health and Social Services & Tom Hennessy, MD, MPH, Arctic Investigations Program, National Center for Emerging Zoonotic Infectious Diseases, Centers for Disease Control and Prevention

Conference Theme: Innovative Engineering Approaches to Increase Access to Water of Adequate Quality & Quantity, Including Water Reuse

- Charting a New Direction for Wastewater Treatment in the Canadian North – Ken Johnson, Planner, Engineer and Historian, Cryofront
- Natural Engineered Wastewater Treatment: NEWT – Thomas Kasun, Natural Engineered Water Treatment

- Preliminary Test Results from an Electrically-Assisted, Anaerobic Sewage Treatment System – Bob Tsigonis, Lifewater Engineering Company & Yehuda Kleiner and Boris Tartakovsky, National Research Council of Canada
- Relocate: Kivalina Biochar Reactor – Jennifer Marlow & Michael Gerace, Re-Locate LLC
- Net-Zero Water: Energy-Positive Municipal Water Management – James Englehardt, University of Miami College of Engineering
- Potentials and Challenges of Biogas from Fish Industry Waste in the Arctic – Pernille Jensen, Arctic Technology Center, Department of Civil Engineering, Technical University of Denmark

Conference Theme: Regulations & Policies Affecting Access to and the Cost of Providing Adequate Quantities of Water in the Home

- EPA Regulations, Policies, and Guidelines for Water Reuse: Implications for Decentralized Greywater Reuse – Robert Bastian, Senior Environmental Scientist, Office of Wastewater Management, U.S. Environmental Protection Agency
- Greenland: Far from Reaching The United Nations Millennium Development Goals. Why? – Kåre Hendriksen, Arctic Technology Centre, Technical University of Denmark
- Beyond Education: Using Social Change Marketing to Drive Behavior Change – Kathy Anderson, MPRH, PhD, University of Alaska Anchorage, Alaska Pacific University, University of South Florida
- Sewer and Water Regulatory Reform in Alaska – Megan Alvanna-Stimpfle, Nome Port Commission

Conference Theme: Methods of Ownership, Operations & Maintenance to Maximize Useful Life of Water & Sewer Systems in the Arctic

- Techniques and Design to Adapt – Michael Black, Department of Rural Utility Management, Alaska Native Tribal Health Consortium
- Applying a Water Safety Plan Approach – Graham Gagnon, Kaycie Lane & Amina Stoddart, Civil and Resource Engineering, Dalhousie University
- A New Affordability Indicator for Rural Alaskan Water Utilities – Barbara Johnson, Ms Resource and Applied Economics candidate, School of Management, University of Alaska Fairbanks
- Maximizing Sustainability in Arctic Water and Sewer: Energy Efficiency – Gavin Dixon, Senior Project Manager, Alaska Native Tribal Health Consortium Rural Energy Initiative
- Water is Life Project – James Temte, Alaska Native Tribal Health Consortium, National Tribal Water Center & Alaska Rural Utility Collaborative

Country Comparisons: Water & Sanitation Service

- Country Comparisons
- Water and Sanitation Summary for Greenland – Kåre Hendriksen, Associate Professor PhD, Arctic Technology Centre, Technical University of Denmark
- Department of Health Nunavut – Michele LeBlanc-Harvard, EHS to the CMOH Territory of Nunavut
- Water and Sanitation Summary for Northwest Territories-Canada – Peter Workman, Chief Environmental Health Officer, Department of Health and Social Services, Government of Northwest Territories
- Water and Sanitation Summary for Yukon, Canada – Tyler Heal, EIT, Civil Eingineering Lead, Yukon, Stantec Consulting Ltd.
- Water and Sanitation Summary for Alaska – Bill Griffith, Facility Programs Manager, Alaska Department of Environmental Conservation
- Peculiarities of Water Supply and Drinking Water Quality in the Russion Arctic – Cheryl Rosa on behalf of Alexey Dudarev, Head of Hygiene Department, Northwest Public Health Research Center, St. Petersburg, Russia.
  [Note: This presentation is not available. Please refer to the abstract on page 73 for background and contact information.]

County Comparison presenters Cheryl Rosa (on behalf of Alexey Dudarev), Bill Griffith, Peter Workman, Michele LeBlanc-Harvard, Tyler Heal and Kare Hendriksen

PRESENTER BIOGRAPHIES

PRESENTER BIOGRAPHIES

Megan Alvanna-Stimpfle was born and raised in Nome, Alaska. She is of King Island Inupiaq heritage and takes pride in Eskimo dancing and learning her language. She holds a master's degree in applied economics from Johns Hopkins University and a Bachelor of Science in economics from George Mason University. For five years, Alvanna-Stimpfle served as a legislative assistant for Senator Lisa Murkowski in Washington D.C., responsible for helping develop policies addressing infrastructure and sanitation, housing, health delivery, public safety and justice, land management, and fish and wildlife management for Alaska Natives and rural Alaskans. She helped organize the Arctic Imperative Summit to bring Arctic and Coastal Alaska issues to the forefront of American policy. Living in Nome, she serves on the Nome Port Commission and is an elected member of the King Island Traditional Council.

Kathryn Anderson holds adjunct faculty positions at the University of Alaska Anchorage (UAA), Alaska Pacific University, and the University of South Florida, where she teaches social change marketing, commercial marketing, and program management. She is the owner of Pescatore Systems International, an Anchorage-based consulting firm specializing in social change marketing and program evaluation. Anderson holds an interdisciplinary Ph.D. from the University of Alaska Fairbanks and a Master's in Public Health from UAA. She also holds a Bachelor of Science degree in mathematics from Arizona State University, a Master's in Computer Science from Rutgers University, and she completed the Harvard Business School Advanced Management Program in 1995. Anderson currently serves on the governing boards of Providence Alaska Health and the Allergy and Asthma Foundation Alaska Chapter. She resides in Anchorage and Homer with her husband.

Danielle Arigoni has been a leader in key federal efforts to expand investment in sustainability and resilience for almost two decades. She serves as acting director for the U.S. Housing and Urban Development (HUD) Office of Economic Resilience, which recently awarded $1 billion to states and localities to pilot resilient disaster recovery strategies considering climate risk. She serves as staff lead on the White House Council on Climate Preparedness and Resilience and for HUD Secretary Julian Castro's Climate Council.

Nicholas Ashbolt received his Ph.D. in microbiology from the University of Tasmania in 1985 and specializes in applying microbial risk assessment to support guidelines and water safety plan management of urban water services. Since September 2013 he has been the Alberta Innovates-Health Solutions Translational Health Chair in Infectious Diseases (water), School of Public Health at the University of Alberta. Previously, he was the senior research microbiologist in the Office of Research and Development, U.S. Environmental Protection Agency, in Cincinnati, OH, (2007-2013); head of the School of Civil and Environmental Engineering (2005-2007), University of New South Wales,Sydney, where he was a professor (1994-2007) and deputy director of theCentre for Water & Waste Technology (1996-2005); and principal scientist (wastewater) from 1990 to 1994 at Sydney Water Corporation, Australia.

Dr. Ashbolt's present research focuses on understanding the ecology of saprozoic pathogens in engineered water systems to develop improved management of Legionella, non-tuberculous mycobacteria and Pseudomonas aeruginosa within water safety plans. Through his career he has focused on translating microbiological risks into best management practices and regulatory reform; pioneering developments and uptake of quantitative microbial risk assessment (QMRA) into the World Health Organization's (WHO) harmonized approach (Stockholm Framework) and its incorporation into Australian, Canadian, Scandinavian, American, and WHO drinking water, recreational water and reuse water guidelines and regulations. He has focused his research on filling research gaps identified by QMRA-derived performance targets used in water sanitation safety plans. This involves not only researching enteric pathogens, but also opportunistic (saprozoic) pathogens that grow in environmental media and engineered systems. He has a record of substantial research funding ($13 million) and has supervised 14 Master of Science and 23 Ph.D. students to completion, and is currently advising four Master of Science and two Ph.D. thesis students.

Michael Bakaic graduated from the Master of Environmental Studies program at York University. Through studies in Toronto and at the University of Alaska Fairbanks, Bakaic has focused his research on the development of water infrastructure in Canada's North. His major project has been to conduct water supply forecasts for the communities in the Canadian territory of Nunavut. By developing novel climate and demand forecasting methods, his research has contributed to the development of water security in this territory.

Bob Bastian is a senior environmental scientist with EPA's Office of Wastewater Management in Washington, D.C., where he has worked for more than 40 years dealing with a wide range of wastewater and biosolids management issues associated with publicly owned treatment works and on-site wastewater treatment systems, such as innovative treatment processes, wastewater and biosolids reuse, decentralized wastewater treatment, water quality benefits of wastewater treatment, on-site power production and energy recovery, and toxics control, including coordinating the agency's efforts to develop and update the EPA Guidelines for Water Reuse document. He has also has served as an EPA liaison with numerous interagency workgroups and committees, as well as external groups such as the Water Science & Technology Board of the National Academy of Sciences, WEF, WE&RF, NWRI, WRF, WateReuse Association, and NSF International's Joint Wastewater Committee. Bastian earned his Bachelor and Master of Science degrees in biology, earth sciences and mathematics from Bowling Green State University in Ohio. He also served as an officer in the U.S. Army Corps of Engineers before joining EPA in 1975.

Michael Black has overseen the Department of Rural Utility Management at the Alaska Native Tribal Health Consortium (ANTHC) since December 2012. Prior to this appointment, he was Director of Program Development for the consortium's Division of Environmental Health and Engineering. Before joining ANTHC in 2010, in 2007 he was appointed as Deputy Commissioner for the Alaska Department of Commerce, Community and Economic Development. The previous 25 years he worked with rural communities on the issues of economic development, local governance, infrastructure development and financial management as a local government specialist for the Department of Community and Regional Affairs, and later as Director of the Division of Community and Regional Affairs in the Department of Commerce, Community and Economic Development. He has served on numerous committees, boards and task forces dealing with rural issues in his tenure with the State of Alaska, including the Rural Sanitation Task Force, Federal Field Work Group on Alaska Rural Sanitation, Alaska Climate Change Subcabinet, Immediate Action Work Group, Alaska Workforce Investment Board, and the Alaska Rural Action Subcabinet. He earned a Bachelor of Business Administration in business development from Ohio University (1970) and a Master of Management Studies in environmental management from Duke University (1974).

Jonathan Bressler is a Council of State and Territorial Epidemiologists fellow, working as an epidemiologist with the Environmental Public Health Program at the Alaska Department of Health and Social Services. He earned a Master of Science in public health in global epidemiology from Emory University, where he conducted his thesis on the impact of pit latrines on trachoma prevalence in Guinea. He served as a Peace Corps volunteer in Burkina Faso, Africa. Bressler enjoys writing, language, travel, hockey, skiing, hiking, playing music, GIS mapping, statistical analysis, and good food.

Mike Brubaker specializes in assessing health conditions in rural communities, focusing on environment, pollution, development, and climate change. Brubaker was born in Juneau, Alaska, and raised in Anchorage. He earned his Bachelor of Science in biology from St. Lawrence University in New York and a Master of Science in environmental management from the University of San Francisco. He was a Peace Corps volunteer in Hungary from 1995 to 1997. Since 1998 he has worked in the Alaska Tribal Health System. Before coming to the Alaska Native Tribal Health Consortium, he spent 10 years working for the Aleutian and Pribilof Islands Association, a regional tribal health consortium. He was a founding member of the Center for Climate and Health and started the Local Environmental Observer Network in 2011. Brubaker has been lead author on more than a dozen books and reports about climate change impact on rural Alaska communities. He publishes a weekly e-journal entitled, "The Northern Climate Observer."

Guy Carpenter is a senior water executive whose 25-year career includes utility operations, water resources planning and management, public policy development, engineering consulting, elected public service, and bringing intellectual property to commercialization. He earned a Bachelor in Science in chemistry from Northern Arizona University and is a registered civil engineer in Arizona. Carpenter currently serves as a board member for the Central Arizona Project, which delivers Colorado River water to the three-county area in Arizona where 85 percent of the state's population lives. He is also National WateReuse Association President, and has served on the association board for six years. He also serves on advisory boards for the University of Arizona Water Resources Research Center, and the Arizona State University Kyl Center for Water Policy at the Morrison Institute. Carpenter recently resigned from Carollo Engineers as its national water reuse technical practice director to become senior vice president of strategic operations for AquaTecture, which develops public-private partnerships for water and wastewater projects, bringing transformative intellectual property to market, and providing temporary staffing services for water and wastewater systems.

Gavin Dixon is a senior project manager for the Rural Energy Initiative at the Alaska Native Tribal Health Consortium (ANTHC). In this role, he manages energy auditing, energy efficiency projects and renewable energy projects for sanitation systems in rural villages across Alaska. He is also responsible for the development of an innovative energy efficiency training for sanitation operators in partnership with Alaska's Institute of Technology. Dixon has been with ANTHC since 2011, working with the energy program since its inception.

Alexey A. Dudarev has been head of the hygiene department of the Northwest Public Health Research Centre in St-Petersburg, Russia, since 2000. He graduated from the St-Petersburg State Medical Academy in 1987. He has more than 20 years of experience studying environmental health conditions in the Russian Arctic. From 1987 to 2000 he was a researcher at the Research Institute of Radiation Hygiene, also in St. Petersburg, where he studied the problem of increased levels of natural and artificial radioactivity in the Russian Arctic, including consequences of Novaya Zemlja nuclear testing explosions and the Chernobyl disaster. Since 2000, he has been involved in research related to issues on the occurrence of persistent toxic substances in the Russian North, and health effects among the indigenous population. He has also organized and participated in multiple field expeditions throughout the Russian Arctic.

Dr. Dudarev is a key researcher in several international projects including the Arctic Monitoring and Assessment Program (AMAP) and Global Environmental Facility project called the "Persistent Toxic Substances, Food Security and Indigenous Peoples of the Russian North" (2001-2004); the AIA project "PTS in Kamchatka and Commander Islands" (2003-2004), and IPEN projects on PCBs and DDTs in the Russian Arctic (2006). Other accomplishments include co-authoring the First Regional Monitoring Report (Eastern Europe) for POPs Global Monitoring Plan under the Stockholm Convention (2008), and being the principal investigator from the Russian side of the AMAP Sustainable Development Working Group project called "Food and Water Security in the Context of Health in the Arctic" (2012-2013), and for the EU Kolarctic project "Food and Health Security in the Norwegian, Finnish and Russian Border Region" (2013-2016). Dudarev has been a member of the AMAP Human Health Assessment Group (HHAG) since 2002 and co-authored its "Human Health in the Arctic" reports from 2009 to 2015. He is a member of the International Union for Circumpolar Health and has written or co-authored more than 170 scientific publications addressing Arctic environmental health; exposure and effects of persistent toxic substances in the Arctic; Arctic food and water security; cancer epidemiology; indoor air quality; air ionization; and radiation ecology.

Laura Eichelberger holds a Ph.D. in cultural and medical anthropology from the University of Arizona, and a Master of Science in public health from Johns Hopkins Bloomberg School of Public Health. She is an assistant professor of anthropology at the University of Texas in San Antonio, and a former cancer prevention fellow at the National Cancer Institute. In her research, Eichelberger combines ethnographic and epidemiologic methods to examine the relationships between issues of water insecurity, energy security, sustainability, and health at different life stages. Throughout, she examines how people make sense of experiences of water insecurity through political, economic, and cultural frameworks.

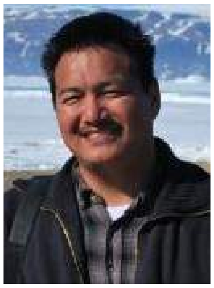
Eichelberger's interests in water and health brought her back to her home state of Alaska, where she has examined problems related to adequate water and sanitation in remote communities in Western and Northwestern Alaska for more than 10 years. Her current research investigates how climate change is affecting health through the built environment. She is also exploring how local definitions of sustainability and the concept of "community-based adaptation" inform responses by community leaders, government agencies, and private entities.

James Englehardt has been a professor of environmental engineering at the University of Miami since 1992. Previously, he was research engineer for Johns Manville Corporation's filtration and minerals division (1983-1987), and field engineer for GE Water Treatment and Process Technologies (1978-1980). He serves on the EPA Science Advisory Board and Drinking Water Advisory Committee; the editorial board of the ASCE-ASME journal; and the Miami-Dade County Small Business Advisory Board for Architecture and Engineering. He has published 112 peer-reviewed journal articles and technical papers. Awards include the EPA NCEA Science Advisor's Award; the AAAS-EPA Robert C. Barnard Environmental Science & Engineering Award for Advances in Risk Assessment; the University of Miami Johnson A. Edosomwan Outstanding Publication Award; and two Eliahu I. Jury Awards for excellence in research.

Graham Gagnon is a professor in the Department of Civil and Resource Engineering at Dalhousie University in Nova Scotia, Canada. He holds a Ph.D. in civil engineering from the University of Waterloo (1997) and a Bachelor of Engineering degree in environmental engineering from the University of Guelph in Ontario, Canada (1993). In 1998, Gagnon was hired as an assistant professor in civil engineering at Dalhousie University in Nova Scotia, Canada, and in 2002 he was awarded a Canada Research Chair in water quality and treatment. In 2006, he became the engineering faculty's first Natural Sciences and Engineering Research Council (NSERC) of Canada Industrial Research Presenter biographies Chair, through a partnership between NSERC and Halifax Water. In 2012, this position was renewed with additional industrial partners, namely: Cape Breton Regional Municipality, LuminUltra, Ltd., CBCL, Ltd., and Mantech, Inc. Gagnon works closely with his students and research partners to deliver timely solutions that have broad impacts on the water industry. He has authored more than 125 peer-reviewed journal articles, 250 conference proceedings, and has supervised more than 50 graduate students in his 18-year career at Dalhousie University. In 2013, he was awarded the Fuller Award from the American Water Works Association through the Atlantic Canada section for his constructive leadership in the water industry.

Michael Gerace, artist and architect, is the co-director of Re-Locate, a transdisciplinary and global collective collaborating with the Inupiaq Eskimo and whaling community of Kivalina, Alaska, to develop strategies for village relocation due to rising seas and melting permafrost. Re-Locate brings public attention to the political, cultural, and environmental issues underlying relocation and the climate displacement of communities around the world. It also works with the village to initiate a community-led and culturally specific relocation.

Bill Griffith has managed State of Alaska Department of Environmental Conservation Division of Water facility programs since 2004. He holds a Bachelor of Science degree in civil engineering and English from Carnegie Mellon University, and a Master of Science degree in construction engineering from the University of New Mexico. After serving as a U.S. Peace Corps volunteer in Nepal, he spent 10 years helping design, construct and operate water and sewer systems on the Navajo Indian Reservation, and then with villages in Alaska's Interior. He worked as a program manager for the Alaska Native Tribal Health Consortium before coming to work for the state.



Kristian Hammeken has studied Arctic Technology (Bachelor of Engineering) and has focused on environmental aspects and planning from The Technical University of Denmark (DTU). Inuit and born in Scoresbysund, he spent his childhood in a little settlement called Kap Tobin where his family's livelihood was hunting. Later he moved to the town of Scoresbysund and finished primary school, before attending Danish/Greenlandic college in South Greenland. He began studying engineering in 2006 in Sisimiut Greenland and finished in Denmark in 2015. Between 1998 and 2006, Kristian worked as a local firefighter and deputy in the leisure center for school children. In 2000 he worked as a reserve officer. He has four children and is working on completing his master's degree in Environmental Engineering at Technical University of Denmark.

Larry Hartig is an attorney with more than 20 years of experience in environmental law, regulations, permits and land use issues. Prior to his appointment in 2007 as the Alaska Department of Environmental Conservation Commissioner, he was in private practice as an attorney with the Anchorage law firm of Hartig Rhodes Hoge & Lekisch. Joining the firm in 1983, he worked primarily on environmental, natural resources, and commercial matters. His practice included assisting clients in obtaining environmental and other permits for natural resource development projects, as well as those involving environmental compliance and cleanup of contaminated properties. Clients included government, private developers, industry, and Alaska Native Corporations. He also worked as a landman in the Alyeska Pipeline Service Company Land/Legal Department from1972 to 1976. Hartig has a bachelor of arts degree from the University of Utah and received his law degree from Lewis & Clark College in Portland, Oregon. He is a member of the Exxon Valdez Oil Spill Trustee Council and the Alaska Bar Association, as well as being a former member of the Alaska Board of Forestry.

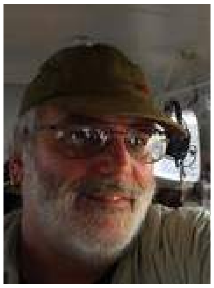
Tyler Heal was born and raised in Yellowknife, Northwest Territories. His family has been working in civil construction in Northern Canada since 1939. As Stantec's civil engineering lead for the Yukon, he continues in this commitment to, and passion for, the North. Having lived and worked in the Northwest Territories, Nunavut and the Yukon (where he is currently based), his interests include community-based solutions to infrastructure challenges, the history and heritage of Northern Canada, and the contemporary issues faced by Northern and indigenous communities.

Kåre Hendriksen is associate professor at the Technical University of Denmark, Arctic Technology Centre (ARTEK) and is affiliated with the Arctic engineering study program. He divides his time between Sisimiut, Greenland, and Denmark, teaching courses on sustainable development, Greenlandic social studies, and planning. Hendriksen has also worked as a consultant for the Greenlandic Home Rule Government and managed local vocational schools in Greenland during the 1990s. Over the last 20 years, he has conducted research and innovation projects in Greenland on sustainable development with emphasis on the local development dynamic, including the economic aspects of settlements, the island's economic character, trade possibilities, the interaction between the infrastructure level and business development, and governance and capacity building. Through his research, Hendriksen has collected empirical data in most Greenlandic settlements and often explored these locations with local hunters by boat or a dogsled team. Current activities in the Arctic focus on sustainable development in existing and new industries around infrastructure, business development and settlement patterns; capacity building and intercultural aspects of learning in relation to the role of consultants and governments in processes of certification; and the role of professional knowledge. He is an accomplished facilitator and specializes in the processes of dialogue and learning in relation to social and technological change.

Tom Hennessy is Director of the Arctic Investigations Program for the US Centers for Disease Control and Prevention (CDC), a field station for infectious diseases in Anchorage, Alaska. Dr. Hennessy joined the U.S. Public Health Service in 1990 and served on the Navajo Reservation until he joined CDC in 1994. He graduated from Antioch College in Ohio, the Mayo Medical School in Minnesota, and Emory University's Rollins School of Public Health in Atlanta, Georgia. He completed residencies in family and preventive medicine and is a graduate of the CDC Epidemic Intelligence Service. His interests include vaccine preventable diseases, food and waterborne infections, zoonotic infectious diseases and reducing health disparities. He was part of the Ebola outbreak response in West Africa in 2014 and 2015 and led an investigation of risk factors for Ebola transmission within households in Sierra Leone in West Africa. Hennessy is an affiliate faculty member of the University of Alaska Anchorage, Department of Health Sciences. He is also co-chair for the Arctic Human Health Experts Group, a multinational advisory group to the Arctic Council.

Korie Hickel is a senior environmental health consultant with the Alaska Native Tribal Health Consortium. She oversees environmental public health programs that address topics including healthy homes and air quality, water and sanitation, and brownfields and community environmental health. Undergraduate studies in international health, then earning a Master of Public Health degree through the University of California at Berkeley, equipped her efforts to partner with Alaska Natives and American Indians to address diverse water and sanitation public health issues through research, health education and promotion, and environmental health field work. Hickel's interest in water and sanitation work focuses on human health, including access to adequate and sustainable water and sanitation services, and how residents use the provided services. She works on multi-disciplinary teams to incorporate health education and behavior change methods in water and sanitation projects and advances efforts to maximize health benefits provided by available water and sanitation technology.

Sharon Hildebrand An educational plan is the standard in Western culture. However, this long-term planning is not a new concept to indigenous people. In growing up along the Yukon River, Sharon learned early on that family members and people in her community were also planners and coordinators. For example, her grandmother knew the importance of seasonal planning, preparing for camp, and caring for the fish in the summer. She also learned the importance of helping where needed and treating people with respect. These values prepared her for her current educational endeavors, which includes earning her graduate degree in public administration. She also contributes to her community by volunteering for various organizations and is part of an international research team in cooperation with Russia and Galena, Alaska. She lives in Fairbanks with her husband and two sons.



Eric Hoberg is a field biologist and biogeographer who explores the history of the biosphere in a continuum across evolutionary and ecological time. Born in San Francisco, he was educated at the University of Alaska in biology (1971-1975) where a passion for high latitudes first developed. His graduate studies followed at the University of Saskatchewan, Canada (1979), and the University of Washington (1984). He has also worked at Oregon State University, the Atlantic Veterinary College, University of Prince Edward Island, and since 1990 in his current positions as a senior research zoologist and chief curator of the U.S. National Parasite Collection with the Department of Agriculture and appointment as the curator of parasitic nematodes at the Smithsonian Institution's National Museum of Natural History. Field-based research over the past several decades has centered on the high northern latitudes spanning Siberia, Alaska, and the Central Canadian Arctic. Episodic climate change and ecological perturbation over the past 3 million years are examined as drivers of faunal assembly, structure and patterns of diversity. Integrated studies, field collections, museum archives and transboundary approaches are the baselines for defining pathogen biodiversity. The nature of historical processes emphasizes the impact of ecological perturbations and the necessity to anticipate the outcomes of accelerating climate warming and globalization on emergence of pathogens and diseases which now pose direct consequences for ecosystem integrity, and animal and human health.

Pernille Erland Jensen has been affiliated with the Arctic Technology Centre (ARTEK) at the Department of Civil Engineering of the Technical University of Demark since 2006. She heads the center's research area on Arctic Environmental Engineering, and teaches undergraduate and graduate courses on Arctic environmental engineering topics in Greenland and Denmark. She has developed courses for ARTEK including field work courses in Greenland and e-learning courses and modules, which may be taken online. Pernille's research sets off in the field of environmental engineering, and her goal is to contribute to develop solutions for sustainable management residuals and prevent loss of resources from the technosphere of urban environments. In the Arctic context, her focus has been on developing technologies for safe domestic wastewater handling tailored for the small remote Arctic communities, and on safe and sustainable management of residuals from the dominant industries in Greenland: fish production and mining. She has been a member of the International Association for Cold Regions Development Studies since 2013, and she is also a member of the Thematic Network of Environmental Impact Assessment under the University of the Arctic. She has authored more than 40 scientific journal papers, supervised five Ph.D. students and participated in numerous national and international research and development projects.

Barbara Johnson is a graduate student in the Master of Science resource and applied economics program at the University of Alaska Fairbanks. Her current research centers on issues surrounding water resources in Arctic and Subarctic communities. She has also researched the costs and benefits of the development of water infrastructure for the United Nations University Institute for Water, Environment and Health.

Ken Johnson is a planner and engineer with more than 30 years of experience in planning and engineering in remote and cold regions. His experience and expertise includes community planning and water and sanitation infrastructure, including treatment, distribution, collection, and disposal, solid waste management, drainage management, and climate change adaptation. He has lived and worked in the Yukon, Northwest and Nunavut territories, and has completed work in more than 40 communities across the Northern Region.

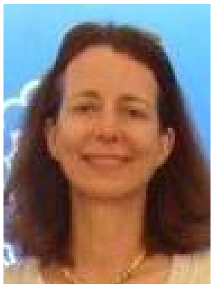
Tom Kasun is a senior business development manager at the Alcoa Technical Center (ATC) near Pittsburgh, PA. For the past three years, he has been a member of ATC's commercialization group, which helps companies match innovative, Alcoa-developed technology solutions with complex, recurring challenges. Two years ago, his role was expanded to include collaborating with third parties to grow the company's Natural Engineered Wastewater Treatment (NEWT) technology. Prior to this, Kasun led the rolling lubrication and surface technology group where he developed a passion for reducing Alcoa's environmental footprint through enabling water and oil reuse. He continues to be a thought leader in this area, and his experience in development, implementation and management of metalworking fluids has helped save Alcoa tens of millions of dollars each year through increased productivity, lower scrap and reduced lubricants usage. Kasun has been an integral member of the Alcoa lubricants commercial team since 1991. He holds five patents and recently served as chairman of the Alcoa Global Rolled Product patent committee managing the full life cycle of intellectual property from invention through licensing of patents and trade secrets. He has worked at ATC for 32 years. Prior to this, he worked in the metallization department at IBM in Endicott, NY, where he developed a "dry process" for etching metals to eliminate "wet chemicals" and process step elimination. He received his bachelor (1981) and masters (1983) degrees in chemical engineering from Pennsylvania State University.

Carolyn Kozak is a graduate student in Arctic and Northern Studies at the University of Alaska Fairbanks (UAF). Prior to moving to Fairbanks, she worked as a curator and public programmer for the Anchorage Museum at Rasmuson Center for more than six years. This practical application of history with the museum, through exhibition development and public engagement, sparked an intellectual curiosity for the circumpolar north and a sense of personal responsibility to its people, both past and present. Since joining the UAF campus, Kozak has been selected as a student ambassador to the University of the Arctic (UArctic), a cooperative network of universities, colleges, research institutes and other organizations concerned with education in the North. She participated in the first fully international Model Arctic Council in March 2016 and attended the UArctic Congress in St. Petersburg, Russia, as part of her student ambassadorship. Kozak's research interests include national identities, image literacy, and media messaging of climate change.

Michele LeBlanc-Harvard has bachelor degrees in psychology and environmental health, applying her skill set in the fields of public and environmental health in Canada and the United States, She was an instructor in the environmental health program at Cape Breton University in Nova Scotia, Canada, where she enjoyed facilitating a love of environmental health in her students. LeBlanc-Harvard moved to the Arctic during a leave of absence from her position as an environmental health officer for Health Canada where she was part of the traveling public program. As an environmental health specialist for the chief medical officer of health for the Territory of Nunavut, she is responsible for developing Nunavut's environmental health program, which includes developing new drinking water regulations. This is an important time in Nunavut's population health development and she feels honored to contribute to these efforts. LeBlanc-Harvard has lived in the Arctic for seven years and now calls Iqaluit Nunavut home. She lives there with her three children and husband who works as an extreme guide. As a family, they enjoy dog sledding, snow sailing, ice fishing, skiing and camping.

Jen Marlow co-owns Re-Locate, joint developers of the Kivalina biochar reactor. She is also co-executive director of Three Degrees Warmer, a climate justice nonprofit; co-director of Re-Locate, a transdisciplinary global collective working in Kivalina, Alaska, to support village efforts to relocate; and an affiliate professor at the University of Washington School of Law. As a lawyer, Marlow has worked on landmark state and federal climate change lawsuits, advising clients and courts of the applicability of international human rights laws to climate change-related claims.

John H. Matthews is the Secretariat Coordinator and co-founder of the Alliance for Global Water Adaptation, which is hosted by the World Bank and the Stockholm International Water Institute (SIWI). His work blends technical and policy knowledge for climate adaptation and water management for practical implementation. He has worked on five continents and in more than 20 countries. He has written primarily on decision-making frameworks for adapting water infrastructure and ecosystems to climate impacts. He co-founded the #ClimateIsWater advocacy group, led by the World Water Council. Recent projects have included leading teams to develop green and climate bond resilience criteria for water investments, co-authoring a guidance and leading a global community of practice focused on mainstreaming climate adaptation into public water management institutions, developing climate-sensitive approaches to environmental allocations such as eflows, working with global policy instruments and institutions to embed water-climate knowledge into climate mitigation and adaptation initiatives, coordinating efforts to use finance mechanisms to implement nature-based solutions to climate adaptation, assembling curricula to build capacity around sustainable resource management, and exploring new economic tools to support integrated long-term planning. He is a columnist with OoskaNews, a senior water fellow at Colorado State University, and a courtesy faculty member of the Water Resources Graduate Program at Oregon State University. Previously, John started and directed global freshwater climate adaptation programs for WWF and Conservation International. He has Ph.D. in ecology from the University of Texas, where he studied long-distance migration of dragonflies.



Ann Meceda is a Foreign Service Officer with the U.S. Department of State. She currently serves as an Arctic Affairs Officer for the Bureau of Oceans and International Environmental and Scientific Affairs, where she works as the U.S. Head of Delegation to the Sustainable Development Working Group of the Arctic Council. During the fall of 2016 she was the acting chair of this group, supporting the U.S. Senior Arctic Official and other key stakeholders on Arctic policy issues. Recently, Meceda served as the political and labor officer in Casablanca, Morocco, working extensively on interagency programs addressing labor and social issues. She has also served in Germany, Slovakia, and Tunisia. She has an undergraduate degree from the University of California, Los Angeles, in mass communications and business, and earned a Master's degree in Business Administration from the Haas School of Business at University of California, Berkeley.

Andrew Medeiros is an expert in freshwater ecology, biogeochemical processes, and Arctic environments. His research focuses on understanding the ecological trajectory of northern ecosystems in the past, present, and future. Research on the evolution of northern aquatic ecosystems over thousands of years enables him to make predictions and create models of future responses to environmental change. Medeiros is motivated by seeing science in action and has worked to build relationships and establish trust with First Nation and Inuit communities, each at the forefront of environmental change in the North. This allows him to combine quantitative modeling to examine issues of fresh water quantity and quality as it applies to northern communities. The data allows researchers to conduct risk analysis for municipal water supplies, and research areas of concern for local residents. His findings resulted in a fundamental shift in the way this knowledge is applied to water security challenges faced by northern communities. These research methods can be applied to freshwater resource assessments, fisheries management, and biomonitoring. Medeiros has received numerous awards, internships and grants throughout his career including the W. Garfield Weston Postdoctoral Fellowship in Northern Research in 2012 and 2013. He has contributed his Arctic expertise to 15 peer-reviewed scientific publications, and for regional and international television segments. He was also a scientific advisor and contributing author for The Economics of Ecosystems and Biodiversity, an initiative of the Arctic Council administered by the Conservation of Arctic Flora and Fauna. Medeiros is currently an adjunct professor in the Department of Geography at York University in Canada.

John Nichols has 19 years of experience with water and sewer design, construction and operations. He currently serves as manager of utility operations for the Alaska Native Tribal Health Consortium (ANTHC). He leads a department of 35 direct and 100 contract employees, providing engineering services and technical assistance to 150 rural Alaska community water and sewer systems. Technical assistance includes water plant operator training, energy efficiency training and retrofits, troubleshooting and operational engineering assistance, and emergency response. The department also provides full water and sewer management services to 27 rural Alaska communities through the Alaska Rural Utility Collaborative (ARUC), which provides customer billing and collections, water operator guidance, purchasing of supplies, rate setting and data collection for each member of the community, resulting in some of the most complete village water and sewer operational data in Alaska, especially in the areas of energy use and energy efficiency results. ARUC's purpose is to empower communities in rural Alaska to sustainably provide safe water and sanitation services. Nichols is a licensed engineer who started his career as public works director in Dillingham, Alaska. He then joined ANTHC in Anchorage, Alaska, designing and building water and sewer system in Western Alaska villages. He has also worked as a field engineer at the Indian Health Service Fort Hall Field Office in Idaho, designing and building water and sewer mains on the Fort Hall Reservation, before returning to ANTHC in 2007.

Jim Nordlund was appointed by President Obama to the position of Alaska State Director for the U.S. Department of Agriculture, Rural Development (USDA-RD), in August 2009. Since then, USDA-RD has invested nearly $2 billion in Alaska's rural communities in electric, telecommunications, and sanitation projects; community facilities; and housing, energy and business development. He has lived in Alaska for 33 years and was previously the owner of Nordlund Carpentry, a residential building contractor in Anchorage. His work in Alaska includes seven years as the director of public assistance, where he managed 500 employees and a $250 million budget, serving in the Alaska State House of Representatives, and being a commercial fisherman. Nordlund has a bachelor's degree from St. John's University in Minnesota and a Master of Public Administration from the University of Colorado. He lives in Anchorage with his wife and daughter.

Melanie O'Gorman is an associate professor in the University of Winnipeg Department of Economics. Her research and teaching are in the areas of macroeconomics and economic development. She is currently leading a research project which explores the determinants of high school graduation and achievement in the Canadian Arctic, and another on the financing of water infrastructure in Manitoba First Nations. She continues to conduct research related to hydroelectric development with the Wa Ni Ska Tan Hydro Alliance. O'Gorman also chairs the master of arts program in environmental, resource and development economics at the University of Winnipeg, which trains students in the area of sustainable development.

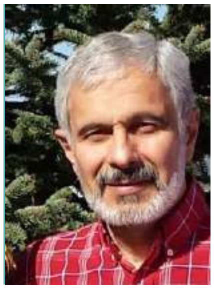
Stephen Penner Stephen Penner is an experienced senior leader with tactical and strategic experience in building resilient communities. He is pursuing a master's degree in development practice in indigenous development at the University of Winnipeg while maintaining ties to his 25 years of businesses development. His focus has been around building bridges between social business and the needs of healthy communities. This includes examining how access to healthy water infrastructure supports northern communities. He is also working with Professor Melanie O'Gorman researching existing positive community models that maintain healthy water infrastructures and discovering how they accomplish this feat. His recent summer placement was with the Cree Nation Government and it was built around two projects involving community consultations, with the main project involving the building of a framework for a trade and commerce agreement. The second project was to gather opinions on the idea of the "Cree Story," which would authenticate and certify Cree arts and crafts. Stephen and his facilitation team conducted consultations with more than 18 Cree entities and economic development corporations, seven chiefs and councils, and meeting with entrepreneurial groups totaling 500 people across Eeyou Istchee Territory. After the WIHAH Conference, Stephen will present a paper entitled "Gathering Circles for Indigenous Ecopreneurship Among First Nations Communities of Southern Quebec" at the International Summit of Co-World Cooperatives in Quebec City. The cooperative model is explored in the context of marketing traditional foods within a confederation of first nations. He is also employed at the University of Winnipeg, serving as the marketing liaison for athletics where he launched the Wesmen's Indigenous Days. He also works as a volunteer with inner city high school students.

Robert Quick is a medical epidemiologist in the Waterborne Diseases Prevention Branch at the Centers for Disease Control and Prevention. He received his medical training at the University of California, San Francisco, obtained an MPH from the University of California, Berkeley, completed residencies in family practice and preventive medicine, and worked as medical director and clinician at the Indian Health Service hospital in Bethel, Alaska. For the past 25 years, he has worked at CDC, conducting research on the etiology, control, and prevention of enteric diseases in the developing world. His work on cholera in Latin America and Africa revealed the seriousness and extent of the problem of lack of access to safe water and sanitation in the developing world and inspired a research focus on waterborne diseases and their prevention. With colleagues at CDC and the Pan American Health Organization, he developed the Safe Water System, a simple, inexpensive household based water quality intervention, and has conducted field trials in Latin America, Africa, and Asia to establish the evidence base regarding its use and dissemination (www.cdc.gov/safewater). More recently, he has conducted field trials of other water treatment technologies, and has designed, implemented, and evaluated projects that integrate water treatment technologies, handwashing, and other public health interventions (including micronutrient Sprinkles, improved cook stoves, HIV counseling and testing, rapid syphilis screening, and nurse training) with maternal and child health services, school programs, and HIV care and support services. To carry out this work in the developing world, he has collaborated with numerous partners from the public and private sectors, Rotary Club, NGOs, UN agencies, and academic institutions.

AJ Salkoski is senior program manager for the Alaska Native Tribal Health Consortium (ANTHC) Tribal Air Quality & Healthy Homes Programs and has eight years of environmental health experience in Alaska. He works on several government-funded studies and projects to find the relationship between indoor air quality and the need for respiratory medical care among high risk Alaska Native children, and to work on air quality issues in Alaska Native communities. He also has experience with projects focused on solid waste management, community planning, and energy efficiency in rural Alaska communities.

James Temte is a member of the Northern Cheyenne Tribe and grew up in the Rocky Mountains of Wyoming and Colorado. He joined the National Tribal Water Center (NTWC) in 2014 and now serves as its director. Temte earned his undergraduate degree in molecular biology and chemistry from Fort Lewis College in Colorado, and a Master of Science at the University of Alaska Anchorage in applied environmental science and technology. He was the Alaska Tribal Conference on Environmental Management Director, National Tribal Air Association Vice Chair, and served on the Climate Registry Board of Directors. He has a passion for public art, tribal sovereignty, self-determination, protecting the environment, and human health. His interest in water and sanitation work focuses on human health, including affordable access to adequate and sustainable water and sanitation services. He loves to work with communities on multidisciplinary teams to incorporate innovative health education techniques to inspire positive actions.

Tim Thomas, M.D., works as Clinical and Research Services Department Director in the Native Tribal Health Consortium (ANTHC) Division of Community Health Services. He has expertise as a medical epidemiologist with considerable clinical and research experience in Kenya and Alaska, addressing issues of health disparity among impoverished and minority populations. His clinical experience has involved work in Somalia for the "Doctors Without Borders" program in Kenya at a mission hospital, and at the Yukon Kuskokwim Health Corporation in Bethel, Alaska. He completed the Centers for Disease Control and Prevention (CDC) Epidemic Intelligence Service training in 1999 and has subsequently been primarily engaged in research. He worked in Kenya for seven years as head of an HIV research department at the Kenya Medical Research Institute (KEMRI) CDC Field station. As principal investigator of this CDC-sponsored phase 2B clinical trial, he investigated the use of antiretrovirals during late pregnancy and breastfeeding. Dr. Thomas returned to Alaska in 2008 to work with the CDC Arctic Investigations Program, primarily on water and sanitation and oral health issues. In October 2011, he joined ANTHC as director of its clinical and research services department where he has continued his work on oral health and sanitation, along with other research activities.



Bob Tsigonis earned a Bachelor of Science in engineering from Thayer School of Engineering at Dartmouth College in New Hampshire and a master's degree from the University of Alaska Fairbanks. He is a registered engineer who has practiced environmental engineering in Alaska since 1973. Tsigonis founded Lifewater Engineering Company, which manufactures innovative on-site sewage treatment systems for extremely cold climates and poor soils. He holds U.S. and Canadian patents on these sewage treatment systems and a U.S. patent on a fluid distribution box that distributes fluid equally from all ports, regardless of the orientation of the box. Lifewater also manufactures extremely rough duty boats for the shallow rivers of Alaska. He helps teach a cold region engineering short course for the University of Washington in Seattle and enjoys volunteering with organizations that provide water and sanitation services to people in underdeveloped areas around the world.

Peter Workman became the chief environmental health officer in the Northwest Territories in 2015. Prior to that, for 10 years he worked as a health emergency planner, environmental health consultant, and environmental health officer in Nunavut. He has experience working in rural, urban and remote regions in Canada with public health as his focus, in the areas of drinking water, sanitation, communicable disease investigation and food safety. Workman is a member of the Canadian Drinking Water Committee, which is the federal provincial and territorial group that authors Canadian Drinking Water Quality Guidelines, a national set of standards used to govern drinking water across Canada.

Carlee Wright completed her baccalaureate degree at the University of Guelph in Ontario, Canada, in 2014, majoring in biological science. She is a thesis-based master of science student in epidemiology at the Ontario Veterinary College, working with Dr. Sherilee Harper. Her research focuses on drinking water and acute gastrointestinal illness (AGI) in northern Canada, in the Inuit community of Rigolet, Nunatsiavut. Her project makes use of an EcoHealth research framework to assess the contamination of stored drinking water and its possible associations with self-reported AGI, and aims to understand drinking water consumption patterns in Rigolet and how they have changed, resulting from new drinking water infrastructure in the Canadian Inuit community. The goal of this work is to help inform sustainable drinking water interventions to reduce risk of waterborne infections, and to inform risk assessments and public health messaging in Nunatsiavut and other Northern indigenous communities.

Greenland and Norway participants Kristian Hammeken, Kåre Hendriksen and Pernille Jensen


Water and Sanitation in the Arctic
Healthy Alaskans 2020 estimates that in 2010, 78% of rural Alaskan homes had water and sewer service
Among all Alaskan homes, 95.6% have complete plumbing
Among all U.S. homes, 99.6% have complete plumbing
Access to water and sewer is still inadequate, and SDG #6 for access to water and sewer service for all has not been achieved in the Arctic region.
Higher water service has been associated with lower rates of water-washed disease in the Arctic, such as skin and respiratory tract infections

ABSTRACTS

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The Impact of Household Water & Sanitation on Arctic Human Health

Climate Change Impacts on Water & Sanitation Infrastructure in the Arctic

Innovative Engineering Approaches to Increase Access to Water of Adequate Quality & Quantity, Including Water Reuse

Regulations & Policies Affecting Access to, & the Cost of, Providing Adequate Quantities of Water in the Home

Methods of Ownership, Operations & Maintenance to Maximize Useful Life of Water & Sewer Systems in the Arctic

Country Comparisons

[Note: Abstracts for Country Comparison Overview; Greenland; Canadian regions of Nunavut, Northwest Territory and Yukon; and Alaska are not available – please refer to presentations for information. Presentation for Russia is not available – please refer to the abstract on page 73 for background and contact information.]

Overview of Household Pilot Systems in Development

State of Alaska Department of Environmental Conservation: The Alaska Water & Sewer Challenge Project Teams:

TITLE

Accelerating Climate Change and a Warming World: Consequences for Sustainability and Safety of Arctic Water and Food Resources

PRESENTER

Eric P. Hoberg
Agricultural Research Service, USDA, Animal Parasitic Diseases Laboratory, BARC East 1180, 10300 Baltimore Avenue, Beltsville, MD 20705
Eric.Hoberg@ars.usda.gov

CONCLUSIONS

Dramatic environmental and ecological perturbations have swept across Arctic latitudes as global warming has accelerated over the past 50 years. Climate change is now strongly modifying physical environments with direct and indirect impacts that cascade through terrestrial, aquatic and marine systems. Northern latitudes historically have been dominated by events of extreme climate variation, such as those characterizing earth history and cycles of glaciation over the past 3 million years. These episodic events resulted in the world around us and the diversity of plants and animals that have come to symbolize the far north and which remain the cultural focus of traditional subsistence lifestyles across the circumpolar region. Climate determines activity and distribution, timing of migrations, and the seasonally circumscribed windows that define life histories for a diverse interconnected assemblage of fishes, birds, mammals and invertebrates. The northern world is now in rapid transition that is historically unprecedented. Perturbations to this natural world, particularly new patterns of temperature, precipitation and humidity, sea-level rise and marine incursions, directly influence ecosystem structure and the occurrence of pathogens. Disruption of long established biotic connections and development of new pathways for pathogen transmission serve as the potential for emerging diseases in animals and humans related to surface water resources and subsistence food chains. Interacting with overall habitat change and other biotic and abiotic factors, the potential for disease can have an influence on the availability and consistent access to potable drinking water and sustainable, safe and secure food resources on which northern communities are dependent. Accelerating environmental change associated with increasing rates of anthropogenic perturbation is exerting a pervasive impact on the Arctic Region. Recognition of the biotic impacts of climate warming can contribute to active anticipation, adaptation and mitigation of the emerging effects of environmental disruption and changing pathogen distribution for northern communities.

TITLE

Pathogen Risk Management Considerations for Safe Household Water Uses

PRESENTER

Nicholas J. Ashbolt, School of Public Health, University of Alberta, Edmonton AB, Canada (Ashbolt@ualberta.ca)

CONCLUSIONS

In general, about 80 percent of all infectious diseases are environmentally transmitted, with viral illnesses dominating. In developed regions, like the United States, the annual rate of water-associated diarrhea runs at about 0.7 cases per 100,000, and results in about 5,000 deaths by year from enteric (waterborne) pathogens. However, water-based, environmental pathogens (e.g. Legionella pneumophila, non-tuberculous mycobacteria and Pseudomonas aeruginosa) cause some 7,000-20,000 deaths by year in the United States, mostly from respiratory and wound infections. For remote Arctic communities with very limited access to clean liquid water and sanitation systems, there are additional infectious disease issues including from a lack of wash-water, which is compounded by social and cultural conditions[1]. For example, sharing clothes washing machines in confined washeterias is known to increase respiratory disease, but inadequate clothes and body washing increases skin infections. However, simply installing traditional centralized water and wastewater services is neither economically sustainable nor practical for remote communities often lacking trained personnel and who are unable to maintain such infrastructure[2]. Though widely recognized that water services need to integrate social, cultural and economic factors so as to provide effective solutions, various groups working with remote aboriginal Arctic communities have largely not succeeded in achieving that goal. Furthermore, there are often large voids between groups working on community health and those deciding on water and sanitation service innovation. Of the myriad of factors to consider, a key engineering question is, "What is the per capita drinking versus household water requirement for good health, and how can water services be managed effectively?" Current targets may range from 100-L per person per day (pppd) to the World Health Organization (WHO) suggesting a minimum of 50-L pppd. In considering what constitutes safe drinking and washing water quality, we need to move beyond outdated reliance on E. coli criteria (say < 1 per 100 mL of drinking water, and <200 if not <10,000 per 100 mL of treated wastewater), which are not based on site-specific risk assessment approaches (e.g. to achieve WHO tolerable annual health burden of < 1 disability adjusted life year [DALY] per million people), and are likely to result in systems meeting criteria but delivering unacceptable levels of pathogens to consumers[3]. Furthermore, when considering pathogens that are largely person-to-person spread but potentially also via water systems, such as Helicobacter pylori, overall health benefits versus the need to treat are not simple decisions[4]. This presentation will provide a systematic approach to design potable and non-potable household waters to meet disease burden benchmarks within a community, as a guide to those seeking input to improve the knowledge base, management, and health targets for remote Arctic communities.

[1] Thomas, T. K.; Ritter, T.; Bruden, D.; Bruce, M.; Byrd, K.; R. Goldberger; Dobson, J.; Hickel, K.; Smith, J.; Hennessy, T. (2016). Impact of providing in-home water service on the rates of infectious diseases: results from four communities in Western Alaska. J Wat Health 14:132-141.
[2] Daley, K.; Castleden, H.; Jamieson, R.; Furgal, C.; Ell, L. (2015). Water systems, sanitation, and public health risks in remote communities: Inuit resident perspectives from the Canadian Arctic. Soc Sci Med 135: 124-32.
[3] Ashbolt, N.J. (2015). Microbial contamination of drinking water and human health from community water systems. Cur Environ Health Rep 2: 95-106.
[4] McMahon, B. J.; Bruce, M. G.; Koch, A.; Goodman, K. J.; Tsukanov, V.; Mulvad, G.; Borresen, M. L.; Sacco, F.; Barrett, D.; Westby, S.; Parkinson, A. J. (2016). The diagnosis and treatment of Helicobacter pylori infection in Arctic regions with a high prevalence of infection: Expert Commentary. Epi Inf 144:225-233.

Key words: Rainwater, drinking water, blackwater, greywater, quantitative microbial risk assessment, water and sanitation safety plans

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TITLE

Reuse Regulations and Challenge of Regulating On-site Systems

PRESENTER

Guy Carpenter

CONCLUSIONS

Abstract not available. For more information contact Guy Carpenter at gcarpenter@aqua-tecture.net or (424) 832-7017.

TITLE

The Impact of Water and Sanitation Services on Health

PRESENTER

Dr. Thomas Hennessy

CONCLUSIONS

Important health disparities have been documented among northern populations with limited access to in-home improved drinking water and sanitation services. The Arctic Council recognized this in 2016 by endorsing the initiative entitled "Improving Health through Safe and Affordable Access to Household Running Water and Sewer in Arctic and Sub-Arctic Communities." This presentation will review the evidence linking water to health, with a focus on water-borne and water-washed diseases. We will also explore the water-health relationship and the implications for how we design and operate water systems, how we evaluate the benefits of water service and how we work with communities and homeowners to maximize the benefits of water services.

TITLE

Water Security in the Arctic: Perspectives from the Model Arctic Council

PRESENTERS

Carolyn Kozak, Graduate Student
Arctic and Northern Studies, University of Alaska Fairbanks

Sharon Hildebrand, Graduate Student
School of Business, University of Alaska Southeast

Stephen Penner, Graduate Student
Development Practice in Indigenous Development, University of Winnipeg

CONCLUSIONS

This presentation will discuss the perspectives of students who attended the first fully international Model Arctic Council (MAC) in March 2016. This was held in conjunction with the Arctic Science Summit Week (ASSW) at the University of Alaska Fairbanks. The ASSW brought researchers, traditional and local knowledge holders and policymakers together to advance research objectives in the Arctic. The MAC is an experiential learning exercise in which undergraduate and graduate students of institutions from around the world gather to represent and simulate the work of the Arctic Council member states, permanent participants, and observers. The perspective of three student representatives to the MAC will be shared as they considered the new Arctic Council initiative called "Improving Health through Safe and Affordable Access to Household Running Water and Sewer" (Arctic WASH). Their experiences participating in the simulation and the resulting recommendations to the Fairbanks declaration at the MAC conclusion will be shared. These actions focused on three themes: social justice, economic sustainability, and environmental protection. Strong local participation in water and sewer projects was deemed vital, with special emphasis given to the role of traditional local knowledge and traditional ecological knowledge holders in the planning and implementation process. International cooperation was also heavily stressed, encouraging complete participation in international water and sewer conferences, comprehensive reports on climate change vulnerabilities and adaptation strategies needed, and the need for established metrics and best practices for monitoring implementation.

THE IMPACT OF HOUSEHOLD WATER & SANITATION ON ARCTIC HUMAN HEALTH

TITLE

Community Perspectives on Water Insecurity and Climate-Related Vulnerabilities in a Remote Iñupiaq Community

PRESENTER

Laura Eichelberger, MPH, Ph.D., University of Texas at San Antonio

INTRODUCTION & METHODS

Less than five years ago, the sound of running water finally became a daily reality for most residents in the Village of Buckland, a small Iñupiaq community just south of the Arctic Circle in Northwest Alaska. Based on a total of over two years of ethnographic fieldwork during the years of 2008, 2009, and 2016, involving interviews, observations, and surveys, I examined what daily life was like for residents prior to the completion of the running water and sewer system, and how life has changed since its near completion this year.

RESULTS

In 2008 and 2009, a survey of 21 households revealed that residents consumed an average of less than three gallons per person, per day. The amount of water they had access to depended on a combination of physical ability, access to gasoline or a vehicle, and male kin. In 2016, Buckland residents overwhelmingly reported an improvement in public health, particularly among their children who they report are sick less often. They attribute these observed improvements in health on increased access to clean water, which has improved their ability to maintain clean living conditions. Many residents, however, fear that the rapid rate of erosion and the lack of erosion prevention near the new system represents a significant threat to their newly constructed infrastructure.

This study provides local perspectives on the importance of clean water access, and concerns about climate-related vulnerabilities. It also highlights how anthropological methods can be used to study the status of water and sewer service, health outcomes, and climate related vulnerabilities.

TITLE

Education and Behavior Change Efforts to Maximize the Health Benefits and Sustainability of Water and Sanitation Infrastructure

PRESENTERS

Korie Hickel: Presented by John Nichols and AJ Salkoski

INTRODUCTION

The Indian Health Service (IHS) has provided water and sanitation infrastructure in American Indian and Alaska Native (AI/AN) communities since 1958 with the goal to prevent water- and sanitation-related disease. However, challenges remain as some communities still lack piped service, residents don't always use available services, and utilities communities struggle to operate and maintain their water and sewer systems. This evidence suggests that an ecological approach made up of education, engineering, and support at all levels of the community is needed.

METHODS

The Alaska Native Tribal Health Consortium (ANTHC) has established several programs that target all levels of the community: individuals (residents, operators, managers); social and community networks (families, neighbors, opinion leaders); and social systems (councils, utilities, collaboratives).

RESULTS

ANTHC efforts to improve customer knowledge resulted in increased knowledge, increased payments of bills, decreased operations and maintenance O&M issues, and decreased utility debt. Health education and promotion efforts resulted in improvements in healthy behaviors and outcomes. Efforts to increase consumption of treated water showed a significant increase pre- to post-intervention (39-60 percent). Preliminary results from a healthy homes study also found improved health such as reduced hospitalizations and clinic visits following the intervention.

CONCLUSIONS

The health benefits of sanitation systems are greatly impacted by how they are used, operated, and managed long term. ANTHC supplements engineering and construction services with education and behavior change efforts to maximize the health benefits and sustainability of the provided infrastructure.

This presentation will give an overview of ANTHC's education, promotion, and behavior change efforts; lessons learned; and steps forward to further improve our services and work to achieve the vision that Alaska Native people are the healthiest people in the world.

TITLE

Impact of In-home Water Service on the Rates of Infectious Diseases: Results from Four Communities in Western Alaska

PRESENTERS

Thomas TK, Ritter T, Bruden D, Bruce M, Byrd K, Goldberg R, Dobson J, Hickel K, Smith J, Hennessy T

BACKGROUND

About 20 percent of rural Alaskan homes lack in-home piped water so residents must haul water to their homes. Recent studies in Alaska demonstrated associations between increased rates of skin and respiratory tract infections and lack of in-home piped water, presumably due to a reduced quantity of water available for handwashing, bathing and laundry, resulting in what are known as "water-washed" infections. We assessed rates of water-related infections in residents of communities transitioning to in-home piped water.

METHODS

Residents of four communities consented to a review of medical records for the period three years before and three years after their community received piped water. We selected clinic and hospital encounters with ICD-9CM codes for respiratory, skin and gastrointestinal (GI) infections, and calculated annual illness episodes for each infection category after adjusting for age and removing repeat encounters within 14 days of the initial report.

RESULTS

We enrolled 1,032 individuals (72 percent of the 2,010 total among a four-community population) and obtained 5,477 person-years of observation. There were 9,840 illness episodes with at least one ICD-9CM code of interest; 8,155 (83 percent) respiratory, 1,666 (17 percent) skin, 241 (two percent) GI. Water use increased from average 5.7 liters, per capita, per day (l/c/d) to 97.3 l/c/d. There were significant (p-value <0.05) declines in respiratory [16.4 percent, 95 percent confidence interval (CI): 11.5-21.0 percent], skin (20.4 percent, 95 percent CI: 10.0-29.7 percent), and GI infections (37.8 percent, 95 percent CI: 13.3-55.3 percent) in homes that received piped water, primarily among those aged 0-19 years.

DISCUSSION

Households that must haul water are severely limited in the amount of water available for personal hygiene. We demonstrated significant declines in respiratory, skin and GI infection rates among individuals in communities that transitioned from hauling water to in-home piped water. This study reinforces the importance of adequate quantities of water to address the morbidity caused by water-washed infections.

TITLE

Water Infrastructure and Well-being: What Does the Data Tell Us?

PRESENTERS

- Stephen Penner, Master of Development Practice (Indigenous Development) student, University of Winnipeg
- Melanie O'Gorman, Associate Professor, Department of Economics, University of Winnipeg

INTRODUCTION

In this presentation, we will discuss the findings of three statistical analyses relating data on water infrastructure and well-being in First Nations, Métis and Inuit communities in Canada. The question our study addresses is: Are poorer quality water/wastewater systems associated with poorer health outcomes in Canada, and if so, to what extent?

METHODS

Our first analysis explores the relationship between self-reported health among individuals off-reserve using two waves (2001 and 2006) of the Aboriginal Peoples Survey (APS). We then conduct a similar analysis using the First Nations Regional Health Survey (RHS). This wide-ranging dataset allows us to control for a larger number of factors influencing health relative to the APS, for example, the extent to which a community is remote, an individual's emotional well-being, and the quality of governance. The third analysis uses data collected jointly by our research group and St. Theresa Point First Nation. This data includes information from a survey among individuals, and thus allows us to better understand community members' concerns about the quality of their water and wastewater services, and how such inadequate services affect them.

RESULTS

We find large, negative impacts of unsafe drinking water, a lack of indoor plumbing and the use of cisterns on self-reported physical and mental health.

CONCLUSIONS

These three analyses demonstrate that inadequate access to water and wastewater services disadvantage residents in multiple ways, or rather, that having indoor plumbing, safe drinking water and proper sanitation facilities have wide-ranging and large benefits. This paper sheds light on the magnitude of health costs resulting from a lack of water access and poor water quality in First Nations, Métis and Inuit communities.

TITLE

Water Quality and Health in Northern Canada: Contamination of Stored Drinking Water and Associations with Acute Gastrointestinal Illness in an Inuit Community

PRESENTERS

C. Wright[1], J. Sargeant[1], V. Edge[1,4], J. Ford[2,4], K. Farahbakhsh[1], RICG[3], IHACC Research Team[4], and S. L. Harper[1,4]

[1] University of Guelph, Guelph, Ontario, Canada;
[2] McGill University, Montreal, Quebec, Canada;
[3] Rigolet Inuit Community Government, Rigolet, Nunatsiavut, Labrador, Canada;
[4] Indigenous Health Adaptation to Climate Change Research Team

INTRODUCTION

One of the highest self-reported incidence rates of acute gastrointestinal illness (AGI) in the global peer-reviewed literature occurs in Inuit communities in the Canadian Arctic. This may be, in part, due to the consumption of contaminated drinking water. For instance, in many communities, water is stored in containers, which may result in secondary water contamination. Using an EcoHealth research framework, the goal of this study was to characterize how households stored drinking water, identify potential risk factors for contamination, and examine possible water-related associations with AGI in Rigolet.

METHODS

A retrospective, cross-sectional census survey was conducted in June 2014, capturing data on water storage, potential demographic and behavioral risk factors, and self-reported AGI. Water samples were collected from storage containers and analyzed for presence of total coliforms.

RESULTS

Most households stored drinking water in containers despite the availability of tap water, and 25.2 percent (95 percent CI 17.7-34.7 percent) of stored samples tested positive for coliforms. Transfer devices were significantly associated with increased odds of coliform presence. The annual incidence rate of AGI was 2.43 cases per person, per year (95 percent CI 1.76–3.10); however, no water-related risk factors for AGI were identified.

CONCLUSIONS

Potential exposure to waterborne pathogens may be reduced through simple household-level interventions, such as regular cleaning of transfer devices.

CLIMATE CHANGE IMPACTS ON WATER & SANITATION INFRASTRUCTURE IN THE ARCTIC

TITLE

Vulnerability of Northern Water Supply Lakes to Changing Climate and Demand

PRESENTERS

M. Bakaic, A.S. Medeiros

METHODS

Arctic regions face a unique vulnerability to shifts in seasonality, which will influence the summer recharge potential of freshwater reservoirs from decreased precipitation and increased evaporative stress. This pressure puts many northern communities at risk due to limited existing freshwater supply. However, many small, remote northern communities in Canada lack baseline knowledge of their own existing supply, demand, or knowledge of reservoir recharge potential. We therefore address this knowledge gap through a water resource assessment of municipal supply over a 20-year planning horizon in two of the largest populated communities in Arctic Canada using existing data sources. Forecasts are made for several climate and demand scenarios. Generated models found significant and immediate vulnerability of the end-of-winter freshwater supply. This was pronounced for climate scenarios indicating reduced winter precipitation and/or increased ice thickness of reservoirs. Our heuristic supply forecasts indicate an immediate need for freshwater management strategies for northern communities in Canada.

The development of our novel Long Term Forecasting (LTF) protocol employed climate and growth scenarios which were intended for applications where historical in situ data was limited and in situations of limited local funding and capacity for conducting water resource assessments. While these limitations restrict in-depth fieldwork and detailed assessments, they do not preclude the immediate need for supply forecasting. The LTF protocol can provide heuristic supply forecasts able to be expanded in detail based on the severity of vulnerability presented.

This method can rapidly generate preliminary forecasts using accessible data with low fieldwork commitment for small communities that rely on unassessed water supplies. Thus, short-term risk can be identified to direct planning, adaptation, and infrastructure responses to changing climate and demand.

TITLE

Vulnerability of Freshwater Supply in Arctic Canada

PRESENTERS

Andrew S. Medeiros[1*], Michael Bakaic[2], and Jessica F. Peters[3]

[1] Department of Geography, York University, Toronto, ON, M3J 1P3, Canada
[2] Department of Environmental Studies, York University, Toronto, ON, M3J 1P3, Canada
[3] Department of Geography and Environmental Studies, Wilfrid Laurier University, Waterloo, ON, N2L 3C5, Canada

INTRODUCTION

Water is a fundamental component of the ecological integrity, economic development, and sustainability of northern regions, as well as being critical for the health and well-being of northerners. However, environmental change has altered fragile thermodynamic relationships of northern ecosystems by shifting seasonal transitions, altering precipitation regimes, reducing long-term snow cover, and increasing the high sun season. Snow melt is a crucial source of water for many shallow subarctic lakes, but snowfall is projected to decrease in some regions, with profound ecological consequences. Here, we assess the relative importance of hydrological processes on the sustainability of lakes and rivers as municipal water sources in Arctic Canada using water isotope tracers and hydrologic modeling.

METHODS

An isotope mass balance model was used to calculate input water isotope compositions and evaporation-to-inflow (E/I) ratios to distinguish the relative roles of snowmelt, rainfall, and evaporation on lake and river water balances. We then utilized Hydrological Modeling Software (HMS-HEC) to examine the influence of climate on municipal supply.

RESULTS

Results show that both lakes and rivers were strongly influenced by rainfall throughout the open-water season. Supply lakes were found to have little evaporative enrichment. We also note a systematic, positive offset measured between lake water $\delta^{18}O$ and $\delta^{18}O$ inferred from cellulose in recently deposited surface sediments from multiple northern regions. Forecasts of municipal water supply indicate a pronounced vulnerability to reduced winter precipitation and/or increased ice thickness of reservoirs on the municipal supply.

CONCLUSIONS

Our findings indicate a lower-than-average snowmelt runoff in recent years, which is forecast to significantly affect municipal supply. Notably, some lakes were observed to undergo near-complete desiccation following a winter of very low snowfall. These findings fuel concerns that a decrease in snowmelt runoff will lead to widespread desiccation of shallow lakes, including the primary municipal supply of many northern communities in Canada.

TITLE

Climate Change and Community Water Security: Emerging Challenges and Strategies

PRESENTER

Mike Brubaker, Director Community Environment and Health, Alaska Native Tribal Health Consortium

CONCLUSIONS

Climate change is having a wide range of impacts on community health, including on the water resources and infrastructure. From source waters to point of use, the tribal health system is awakening to new challenges and responding by developing adaptive strategies that are effective and appropriate.

In 2008, responding to the growing concerns about climate change, ANTHC's Board of Directors established the Center for Climate and Health, for the purpose of describing the connections between climate change, environmental impacts and health effects. Community listening sessions and assessments have been performed across Alaska, providing an in-depth analysis of local impacts and concerns. Water security has been an important focus and priority.

The condition of drinking source waters (lakes, reservoirs, rivers, and groundwater) have never been so dynamic, with communities facing unprecedented challenges with the water season, supply and quality. The infrastructure that delivers water to homes and businesses is also impacted, in some cases with widespread damage and service interruption. ANTHC has developed a variety of strategies to help communities address climate change impacts. The approach can be divided into three categories: 1) building capacity, 2) raising awareness, and 3) engineering for resilience.

In this presentation, selected findings from community assessments are described, including specific examples of environmental drivers (erosion permafrost thaw, snow season change, drought) and examples of strategies that are increasing water security by building capacity, raising awareness and by engineering for greater resilience.

TITLE

International Survey on Water and Sanitation in the Arctic

PRESENTERS

Jonathan M. Bressler, Thomas W. Hennessy

INTRODUCTION

The 2015 United Nations Goals for Sustainable Development include providing access to safe and affordable drinking water, and adequate sanitation and hygiene for all by 2030. In the Arctic, inadequate water and sanitation services are associated with poorer health status, and mostly affect rural and indigenous populations. For Arctic nations, providing and maintaining water and sanitation services presents unique challenges including emerging threats related to climate change. As an endorsed project of the Arctic Council's Sustainable Development Work Group, we seek to describe the current state of water and sanitation services, water-related disease monitoring, and the environmental changes affecting water and sanitation in northern circumpolar populations.

METHODS

We surveyed professionals in Arctic health, water, and sanitation; government officials responsible for health, environment or water sanitation; and interested residents in Arctic and sub-Arctic communities through an online survey.
The survey collected information on access to water and sanitation facilities, reportable water-related diseases, and the impact of climate change on water and sanitation.

RESULTS

The survey is ongoing. As of June 30, 2016, 130 responses from seven countries have been received. Detailed information was provided by four respondents from Canada, six from Finland, five from Greenland, one from Iceland, one from Norway, three from Sweden, and 32 from the United States. Reported access to water and sanitation varied from 75 to 100 percent of the population, though other sources indicate that this percentage is much lower in some communities. Reportable diseases and data sources vary by country, and respondents reported that climate change affects water and sanitation access in six arctic nations.

CONCLUSIONS

Initial survey responses indicate that inadequate access to water and sanitation exists throughout the Arctic, related health measures are commonly recorded, and climate change is affecting water and sanitation service in many communities.

INNOVATIVE ENGINEERING APPROACHES TO INCREASE ACCESS TO WATER OF ADEQUATE QUALITY & QUANTITY, INCLUDING WATER REUSE

TITLE

Charting a New Direction for Wastewater Treatment in Nunavut

PRESENTER

Ken Johnson

CONCLUSIONS

The so-called "leaky lagoon" was a generally accepted design concept for many years in the Nunavut Territory, formerly the Northwest Territories. However, because of the application of more stringent effluent quality standards and the requirement of a controlled effluent discharge, this design concept is now unacceptable. The current design concept applied for lagoon systems in the Far North is a retention lagoon with a seasonal discharge. In addition, use of wetlands has emerged as a supplementary process for lagoon systems.

The construction of retention lagoons applies modern geomembranes in many cases because of the absence of fine soil materials for the construction of structures with low permeability. New issues are emerging with the construction of these relatively complex earth structures because of the extreme cold climate, permafrost earth regime, and construction techniques.

The anticipated costs of remedial work to address these issues are about half of the capital costs of the original multimillion dollar structures, which are beyond the available capital funding. A much-needed new direction is being charted based on research to develop northern science for wastewater treatment. This science is being communicated to regulators and communities, to incorporate social science, and engineering and applied science. With this activity, it is anticipated that a new, more appropriate direction for wastewater treatment may emerge for Nunavut.

TITLE

Natural Engineering Wastewater Treatment (NEWT™) for Alaska Villages

PRESENTER

Thomas Kasun

INTRODUCTION

NEWT™ is an innovative wastewater treatment system that cleans wastewater while meeting stringent permitting requirements, even in the most challenging environmental conditions. It also provides high quality water treatment at a lower total cost. By engineering and enhancing the familiar biological, chemical, and physical processes from conventional wastewater treatment, NEWT™ provides a wetland-based technology that serves as a cleaner and greener solution.

METHODS

The NEWT™ system's three steps include: (1) anaerobic treatment tanks which break down and separate organic material in the water; (2) passive engineered wetlands that use vegetation and oxygenation for further treatment of organics and removal of nitrogen and metals; and, (3) a UV system to disinfect the water. The combination of these stages enables a dramatic reduction in sludge disposal over the system lifetime. The result is water treated to the same or better quality as that of a conventional system.

RESULTS

Alcoa has used the NEWT™ system in two different climates: one at the Alcoa Technical Center near Pittsburgh, PA, and the second in Saudi Arabia. Both systems have delivered superior water quality across six and two years of operations, respectively. In Pittsburgh, the NEWT™ system cleans the water sufficiently enough to meet a discharge permit, while in Saudi Arabia 90 percent of the water is reused as industrial process water and 10 percent is used for irrigation, which must meet Royal Commission Standards. The treated water from these processes is water quality, sufficient to consider reuse.

Both processes have been through some notable extremes while in operation. For example, in 2015, the Pittsburgh NEWT™ system was subjected to ambient temperatures of -30 F in the first quarter of 2015 and 13 inches of rain in June 2015. The effluent quality of the water stayed within the permit levels in both of these extreme conditions. With a similar design, the system in Saudi Arabia has produced superior water quality, where temperatures can reach 110 F.

CONCLUSIONS

Extra benefits of the NEWT™ system include a significant reduction in operating and maintenance costs because of its simplicity, and there are virtually no mechanical operations that need monitoring. The capability for water reuse increases access to scarce water resources. All of this makes NEWT™ an ideal solution for remote areas of the world, including the Arctic.

TITLE

Design, Construction, Operation, and Demonstration of a Municipal Net-Zero Water System for Nearly Closed-Loop Reuse of Water and Energy

PRESENTERS

James D. Englehardt, Ph.D., P.E.
Tingting Wu, Ph.D.
Lucien Gassie
Tianjiao Guo, Ph.D.

INTRODUCTION

Net-zero water (NZW), or nearly closed-loop direct potable water reuse systems, can recycle both water and thermal wastewater energy. However, design and operating experience are limited. The objective of this paper is to present results of a project to develop an advanced oxidation-based NZW system.

METHODS

A mineralizing urban NZW system was designed for energy-positive, 100 percent recycling of comingled black and grey water to drinking water standards, and mineralization of emerging organics, constructed and operated for two years to serve a four-bedroom, four-bath university residence hall apartment. The system comprises a septic tank, denitrifying membrane bioreactor (MBR), aerated aluminum electrocoagulation/flocculation, vacuum ultrafilter, and peroxone or UV/H_2O_2 advanced oxidation, with 14 percent rainwater make-up and concomitant discharge of 14 percent of treated water (ultimately for reuse in irrigation).

RESULTS

The process produced a mineral water meeting 115 of 115 Florida drinking water standards with total dissolved solids of ~ 500 mg/L, pH 7.8, turbidity 0.12 NTU, and NO_3-N concentration 3.0 mg/L. Chemical oxygen demand was reduced to below the detection limit (<0.7 mg/L). None of 97 hormones, personal care products, and pharmaceuticals analyzed were detected in the product water. Neither virus nor protozoa were detected in the treated water. All but six of 1,006 emerging organic constituents analyzed were either undetected or removed >90 percent in treatment.

CONCLUSIONS

An urban net-zero water system has been demonstrated capable of recycling 85 percent of municipal water. No concentrate is produced, and sludge pumping was projected on a 12- to 24-month cycle. A distributed, peroxone-based NZW system is projected to save more energy than is consumed in treatment, due largely to retention of wastewater thermal energy. Costs in urban and suburban areas are projected to be competitive with current water and wastewater service costs at scales above ca. one plant per 100 - 10,000 residences.

TITLE

Preliminary Test Results from an Electrically-Assisted, Anaerobic Sewage Treatment System

PRESENTERS

Bob Tsigonis, Primary Author and Presenter
Yehuda Kleiner and Boris Tartakovsky, Co-authors

INTRODUCTION

The correlation between health and affordable access to running water and sewer services in Alaska has been well documented, and a similar correlation exists for communities in northern Canada. Engineers, public health officials, and social scientists are working on both sides of the border looking for solutions.

METHODS

National Research Council Canada (NRCC) has been developing and testing an innovative, anaerobic sewage treatment technology that they think could be well-suited for northern homes and communities. This technology uses low voltage electricity to enhance microbial performance, and if a simple method can be found to harness the energy from low volumes of methane, it may be net energy positive.

When NRCC contacted Lifewater Engineering Company (Lifewater) in the latter part of 2015, both organizations immediately recognized the synergy of working together to advance this technology from the lab to the field, so a collaborative working agreement was established whereby each organization could provide expertise, equipment, and manpower to jointly accomplish in a short time what would otherwise take many years.

RESULTS

A pilot test system was designed jointly by NRCC and Lifewater, was fabricated by

Lifewater, and is being tested by Lifewater in their shop in Fairbanks, with input and oversight from NRCC in Ottawa. A summary of preliminary pilot test results will be presented.

CONCLUSIONS

The potential for use of this sewage treatment technology in northern homes and communities will be discussed. Possible deployment scenarios in Alaska, Canada, and around the world may also be presented.

TITLE

The Kivalina Biochar Reactor: The Arctic's First Human Waste Bioreactor

PRESENTERS

Re-Locate LLC (either Michael Gerace or Jennifer Marlow) and Jeff Hallowell, President, Biomass Controls, LLC, Co-authors

INTRODUCTION

Working with Kivalina City and Tribal Councils and families, Re-Locate is partnering with Biomass Controls, LLC, to design and build a winterized human waste biochar reactor to improve sanitation with relocatable technologies in Kivalina, Alaska. The Kivalina Biochar Reactor is built to run successfully in Kivalina's Arctic environment, and to coexist within existing social and economic roles and responsibilities for managing waste.

METHODS

Re-Locate conducted ethnographic research into current waste management practices in Kivalina. We mapped waste collection, circulation, and disposal with honeybucket collectors in Kivalina; and installed a waterless toilet as a dewatering front-end strategy for making biochar reactor technology more compatible with freezing Arctic temperatures on the whole. Biomass Controls built a prototype reactor, validated cold-weather operability, and is keeping daily records of data on: moisture content of feedstock that mimics expected Kivalina waste volumes and inputs, heat exchange in the unit's catalytic converter, stack temperatures, emissions, and quality and contents of output biochar.

RESULTS

We tested the prototype reactor by processing solid waste, wipes, plastic bags, toilet paper, and cardboard—waste streams that mimic the kinds of inputs we expect the Kivalina reactor will handle. A solid waste mix tested at around 55 percent moisture pyrolyzed waste at 1,300 degrees F and produced verifiable biochar.

CONCLUSIONS

Human waste biochar reactors are a relocatable sanitation solution for Kivalina and other villages without adequate water and sanitation. The applicability of biochar reactor technology to as an Arctic sanitation solution compels further testing and innovation of alternative waterless/dewatering toilet technology to replace the honey bucket system, and other relocatable alternatives to centralized piped infrastructure.

TITLE

Potentials and Challenges of Biogas from Fish Industry Waste in the Arctic

AUTHORS

Pernille Erland Jensen*, Arctic Technology Centre, Department of Civil Engineering, Technical University of Denmark. DK-2800 Lyngby, Denmark
Stefan Heiske, Department of Chemical Engineering, Technical University of Denmark. DK-2800 Lyngby, Denmark

INTRODUCTION

The fish industry is a main industry in many Arctic locations. In most places with local fish and seafood processing facilities, by-products are disposed of at sea. Oxygen depletion and dead sea bottom is observed, and by the anaerobic conditions developed at the seabed, the organic material is biodegraded and methane produced, contributing to the global warming. The objective of this study was to determine the biogas potential of fish industry by-products from Greenland. The biogas potential arises from the same organic fraction causing the methane production at the seabed, and takes advantage of the same microbiological processes, however under controlled conditions and with collection of the biogas for energy utilization.

METHODS

Methane potential of Greenlandic shrimp, crab, and halibut by-products, as well as co-digestion of shrimp by-products with waste water sludge and common brown algae, was tested in lab scale batch experiments at mesophilic conditions. Fate of indicator microorganisms was investigated.

RESULTS

All residues had biogas potentials similar to, or higher than, conventional feedstocks like manure and silage. Waste water sludge and brown algae had potentials comparable to manure. The combined shrimp and algae digestion showed indication of synergistic effects. Indicator bacteria were reduced significantly while coliphages (virus indicators) were not.

CONCLUSIONS

Fish and seafood by-products from the fish processing industry constitute a significant resource for energy and may provide an economic incentive to install digesters, which can also partly stabilize waste water sludge, though additional heat treatment may be necessary depending on final use of digestate.

REGULATIONS AND POLICIES AFFECTING ACCESS TO, AND THE COST OF, PROVIDING ADEQUATE QUANTITIES OF WATER IN THE HOME

TITLE

EPA Regulations, Policies, and Guidelines for Water Reuse: Implications for Decentralized Greywater Reuse

PRESENTER

Robert K. Bastian, Senior Environmental Scientist
Office of Wastewater Management
U.S. Environmental Protection Agency
Washington, D.C. 20460

INTRODUCTION

How do current EPA regulations, policies and recommendations from the agency address decentralized greywater reuse? Do other standards and sources of guidance address decentralized greywater reuse?

METHODS

Provide background information on the EPA 2012 *Guidelines for Water Reuse* document and its coverage of decentralized greywater reuse, as well as other sources of standards and guidance, such as applicable NSF/ANSI standards, examples of state standards, WateReuse Association/WEF/AWWA *White Paper on Graywater,* and the NRC/NAS report.

RESULTS

We do not have any EPA regulations focused on water reuse in general, or specific to decentralized greywater reuse. However, among many other things, the 2012 EPA *Guidelines for Water Reuse* document provides recommended minimum requirements for a series of water reuse practices that may be helpful. And there are other sources of standards and guidance that may also be helpful.

CONCLUSIONS

Indoor uses of greywater will likely need to comply with standards similar to those imposed on indoor use of reclaimed water.

TITLE

Greenland – Far from Reaching the United Nations Millennium Development Goal - Why?

PRESENTER

Kåre Hendriksen, Associate Professor, Ph.D., Arctic Technology Centre, Technical University of Denmark

CONCLUSIONS

Too few households in Greenland have piped water, just as a good part of the population must leave their black wastewater in plastic containers, often referred to as "honeybuckets." Consequently, Greenland is far from meeting The United Nations Millennium Development Goal. There are social and geographical inequalities. Typically, it is the socially disadvantaged families who do not have running water. Sanitation is a virtually unknown phenomenon in the smaller settlements.

The lack of access to piped water and sewer reflects some key issues:
It may be technically challenging to ensure adequate water supply at a number of Greenlandic settlements. Large parts of the High Arctic Greenland are desert, and many settlements are located on small islands without large water reserves. Because of climatic and geophysical conditions, sewage systems are costly to establish and operate, and it requires adequate water supply.

There are political and institutional challenges, too. Water and sanitation in small settlements does not seem to be a priority, compared to investments in other forms of infrastructure and social facilities in major cities.

For Greenland settlements, infrastructure such as electricity, water, and sewage are based on island operation. Over the latest decades, the former nationwide technical organization, which was responsible for the establishment and operation of infrastructure, has been divided into sectors in a number of independent companies, with no financial incentive for cooperation. This means that coordinated rationalization gains are not exploited, whereby infrastructure cost–

especially in smaller settlements—will increase significantly.

The factual distribution of household tap water and sewer connections across settlement types will be presented, and the social aspects will be explained. Discussion will center around why Greenland does not make meeting The United Nations Millennium Development Goal a bigger priority—one that could be well within reach—and what can be done to achieve this goal.

TITLE

Beyond Education: Using Social Change Marketing to Effect New Behaviors

PRESENTER

Kathryn J. Anderson, Ph.D., MPH

INTRODUCTION

Knowledge is not always sufficient to motivate people to change. While educational campaigns have been effective for relatively simple behavior changes, many problems we are tackling today are far more complex and, quite simply, people do not always practice what they know is best. Humans have free will, competing interests, live in particular social contexts that may be different from ours, and have unique psychological makeups.

Social change marketing is a well-established discipline that has been used successfully worldwide to affect behavior change in these more complex situations. It has been used to change behaviors in arenas such as conserving water and energy conservation, using pesticides, breastfeeding, and practicing safe sex.

Social change marketing is built on principles from diverse fields such as commercial marketing, psychology, and behavioral economics. It is behavior-change centric, theory informed, and research directed. Social marketers emphasize the need for the careful segmentation of audiences, and they strive to deeply understand the barriers to change and the potential benefits of change, specifically from the target audience perspective. Social marketing programs, or interventions, are built upon these principles and insights, and they are crafted to make behavior change easier, less objectionable, and more related to the target audience's own perception of value.

CONCLUSIONS

This talk will discuss the principles of social change marketing, describe some interesting successful programs, and lay out some ways that this discipline might be appropriate for influencing behavior changes relative to rural sanitation initiatives.

TITLE

Proposed Reforms to Alaska Water & Sewer Improvement Efforts

PRESENTER

Megan Alvanna-Stimpfle

CONCLUSIONS

Addressing the issues of housing, and sewer and water in our communities, remains Kawerak's top priority. While funds are needed for first-time service, operations and maintenance funds are needed for infrastructure improvements. Five villages within the Bering Straits Region remain unconnected to running water and sewer: Diomede, Wales, Shishmaref, Stebbins and Teller. In three other communities, 30-50 percent of the homes in the community still need to be connected: Golovin, Gambell and St. Michael. Ongoing sewer and water upgrades and maintenance remain concerns in the remaining seven communities of Elim, Koyuk, Savoonga, Shaktoolik, Unalakleet, White Mountain and Brevig Mission.

Multiple Federal Programs

There is an average of $68.2 million annually funded by a combination of six federal funding streams and the State of Alaska. Designated sewer and water funding includes:

- United States Department of Agriculture Rural Development Capital Improvement Program
- Environmental Protection Agency (EPA) Infrastructure Grant Capital Improvement Program
- Indian Health Service Sanitation Program
- Environmental Protection Agency Safe Drinking Water Act
- Environmental Protection Agency Clean Water Act Indian Set Aside
- Indian Health Service Housing Priority System

There are three main allocation systems for these funds that ultimately end up being managed or administered by either the Alaska Native Tribal Health Consortium (ANTHC) or the State of Alaska Village Safe Water Program, which may or may not duplicate government services. Roughly $33 million is allocated by the capital improvements program in the form of grants, accounting for 44 percent of funds going into sewer and water investments. The Indian Health Service (HIS)

Sanitation Deficiency System represents 30 percent of total funding, reflecting an investment of $22.5 million annually.

Complex Regulatory Structure

As highlighted by the ANTHC, federal funding streams must be coordinated to complete construction of a community system. For example, EPA Safe Drinking Water Act funding can only be used for community water facilities and water service lines, but no funding can be used for hooking up homes, or for interior plumbing. IHS housing dollars can be used for water and sewer facilities on “like new” Alaska Native-owned homes, but cannot be used for interior plumbing. IHS sanitation funding can be used for interior plumbing and Alaska Native-owned homes. An EPA Infrastructure Grant can be used for planning, water and sewer facilities, and indoor plumbing, however it cannot be used for plumbing or service lines to HUD homes constructed after 2000. This regulatory structure provides for complicated planning and delays as funding must be pieced together to complete a community.

Reform Principles

- Greater involvement and coordination by communities and regional institutions, including accuracy and consistency of data
- Leveraging federal investment with private sector investment
- One regulatory structure supporting community development/investment plans

It is important to acknowledge that some communities in Alaska have strong local leadership, while others rely on the expertise of the state or ANTHC to administer development projects. It will be important for decision makers to discuss transferring the responsibility or portions of it to communities or regional institutions, allowing for knowledge to empower communities as they try and determine how to manage or coordinate funding the investment of sewer and water. Knowing where communities and regions lie on the statewide IHS sanitation deficiency system, and the timeline for construction and investment, empowers leaders with how to coordinate or solicit private sector funds.

Currently, it is the responsibility of engineers managed by ANTHC or the state to input data into the IHS Sanitation Deficiency system. It is important that communities and regional tribal organizations take an active role in the input of data, ultimately determining their position within the IHS Sanitation Deficiency System. Ensuring the accuracy and consistency of data for communities across Alaska is imperative for a just system.

Many communities use private donations (by CDQ groups for example) to manage sewer and water, and utility systems. Active, real-time updates to the IHS sanitation deficiency system are a possibility to improve the current management of the list, not only to reflect priority local investments in the region, but also to examine greater leveraging and coordination of private, state and federal funds.

Once a development plan for a community is formed and verified by an administering agency, any source of federal funding could be used to complete the project. Such a system would require federal agencies to waive the regulatory structure in support of a community development plan, or to adopt a common regulatory structure. Should timelines and federal funding sources be identified, communities, regional institutions, the statewide tribal health organization, or the State of Alaska could enter into contracts with the private sector to construct systems with federal and state programs, making payments over time, as established by the IHS Joint Venture Program or the tribal transportation options.

METHODS OF OWNERSHIP, OPERATIONS & MAINTENANCE TO MAXIMIZE USEFUL LIFE OF WATER & SEWER SYSTEMS IN THE ARCTIC

TITLE

Techniques and Design of Building to Make It More Compatible With This New Arctic Environment

PRESENTER

Michael Black

INTRODUCTION

Much of rural Alaska is experiencing a changing environment related to a warming Arctic. Much of these changes are reflected in the warmer seasons and the amounts and form of precipitation. There are increasingly obvious changes in the natural environment. With those changes, there are also changes in the built environment. Roads are unstable, building foundations are compromised, barge landings and fuel delivery points are lost to both erosion and sedimentation, lack of sea ice allows fall flooding and storm surge to threaten coastal infrastructure, and snow loads are increasingly stressing roof structures. Water and sewer is experiencing its share of threats from the changing environment. Traditional engineering of water and sewer systems will be challenged by these changing conditions.

METHODS

The Alaska Rural Utility Consortium (ARUC) is a group of 29 communities from around Alaska that have entrusted the Alaska Native Tribal Health Consortium (ANTHC) to operate and maintain their water and sewer utilities. This consortia of Arctic and sub-Arctic systems is a natural laboratory for the ANTHC Division of Environmental Health and Engineering to discover the problems that are emerging for sanitation systems in a warming environment. Through innovative engineering and operating methodologies, ANTHC has had to address changing Arctic conditions to keep these systems working and affordable for the customers.

The lessons learned by ARUC should be shared. That is the purpose of my presentation. I will examine the changing conditions that are challenging traditional water and wastewater engineering and share some of the ways we have adapted traditional approaches.

RESULTS

We are losing some of our source water as tundra ponds disappear. We are having to reach out for source water to more reliable sources such as groundwater and rivers.

Rivers, however, are increasingly laden with sediment and their chemistry is changing. We have had to further filter water from rivers as thermokarsts have dumped large amount of sediment into the water column.

Southeast Alaska and Kodiak Island are experiencing less precipitation and the source waters are being lost for some communities. We have found the need for more impoundments. Permafrost is melting, which means our pipes require different pilings and can no longer rely on cribbed foundations. We have also seen pipes sagging and differential settling with buildings that require a flexible connection to allow for movement of the pipe in relation to buildings they serve.

Lack of sea ice allows for a longer flooding and storm surge season that requires us to protect pipes by elevating the pilings or armoring the vulnerable areas. Melting permafrost also threatens water treatment plant foundations. We are currently designing a retrofit of the traditional passive thermosyphon to convert to an active refrigeration of the foundation using solar powered chillers.

CONCLUSIONS

The engineering community must modify the techniques and design of buildings to make it more compatible with this new Arctic environment, or we stand to lose all the hard-fought gains in public health infrastructure that have significantly extended life quality and expectancy.

TITLE

Applying a Water Safety Plan (WSP) Approach to Small Systems in Northern Canada

PRESENTERS

Graham Gagnon, Amina Stoddart, Kaycie Lane
Centre for Water Resources Studies, Dalhousie University Halifax, Nova Scotia

CONCLUSIONS

The typical model for potable water delivery by the Government of Nunavut (GN) in Canada is to extract water from surface waters and pipe or truck it to reservoirs within the community. From there, it is trucked to public buildings and households and stored in small on-site tanks. Depending on the community, chlorination for microbial control is performed either upon discharge from the reservoir, or directly within the water delivery truck. Communities in Nunavut face unique potable water treatment and delivery challenges associated with climate and remoteness, including a lack of operator training; lag time between sample collection, analysis and reporting; and aging infrastructure.

To address the unique challenges associated with potable water treatment and delivery in these communities, we are developing a water safety plan (WSP). WSPs are a preventative risk assessment and management tool, recommended by the World Health Organization (WHO), that critically analyze a water treatment system from source water to consumption to identify water quality hazards and associated risks to human health. Although use of WSPs has been advocated by the WHO since 2001, WSPs are not ubiquitous across Canada. However, other Arctic jurisdictions, such as Iceland, have successfully used WSPs as a regulatory tool to help ensure safe drinking water.

The objective of this paper is to describe a WSP framework that has been uniquely tailored to identify risks to drinking water safety, from the source to the tap, for GN communities. The proposed framework relies on a series of survey questions that, when answered, can be used to systematically determine the likelihood and consequence of predetermined hazards to provide a semi-quantitative assessment of risk. When a threshold risk is identified, the hazard is revealed and preventative measures for the hazard are suggested. The proposed WSP will require pilot application to understand adoption, but is a first step in preventative drinking water regulations from a risk management perspective.

TITLE

A New Affordability Indicator for Rural Alaska Water Utilities

PRESENTERS

Barbara Johnson, Joseph M. Little, Co-presenters

INTRODUCTION

This research presents an alternative to the current affordability indicator used by Village Safe Water, a program of the Alaska Department of Environmental Conservation (DEC). Both indicators are used and compared to assess whether rural Alaska communities can financially sustain water utilities over the lifetime of the infrastructure. Currently, the DEC considers a water utility to be affordable if annual operations and repair costs do not exceed five percent of the community's median household income (MHI). Because many rural Alaska community economies are a mixture of subsistence and cash activities, the MHI indicator often fails to accurately assess affordability.

METHODS

After a literature review, the EPA affordability matrix for sewage utility was picked as a template. The matrix was adapted to the Alaska context and the new indicator applied to past and future projects.

RESULTS

The new indicator combines a residential indicator (RI) and a financial capability index (FCI). RI is based on the percentage for each income quintile of the annual utility cost. FCI is composed of socioeconomic indicators. The new indicator was retroactively applied to a project and found to more accurately assess affordability. The new affordability indicator assesses utilities as unaffordable more often than the MHI indicator.

CONCLUSIONS

A community's socioeconomic situation impacts the affordability of water utilities. Given this, it is recommended that affordability assessments include socioeconomic indicators. Furthermore, using income quintiles rather than MHI is encouraged as the quintiles provide a more detailed picture of the impact of user fees on the population.

TITLE

Affordable Sustainable Sanitation Through Energy Efficiency

PRESENTER

Gavin Dixon, Alaska Native Tribal Health Consortium (ANTHC), Rural Energy Initiative

INTRODUCTION

Providing basic sanitation service of any type in rural and Arctic Alaska is very expensive. This is partially due to the extensive use of high-cost fuel and electricity in operating water and sewer systems in these harsh climates. On average, energy costs make up 40 percent of the total cost of providing services. The ANTHC Rural Energy Initiative has worked for six years to identify and implement opportunities to reduce energy consumption and decrease the cost of providing water and sewer service, thereby expanding access to basic sanitation through affordability of service, as well as through sustainability of sanitation infrastructure.

METHODS

Our team set out to identify the best opportunities to reduce energy costs through a series of sanitation facility energy audits. Once completed, ANTHC worked with funding agencies and communities to identify funding to implement relatively low-cost energy efficiency measures in a variety of community sanitation systems across Alaska. Based upon the findings of the audits, it was determined that a team that could provide minor plumbing and electrical improvements and focus on providing operator training would be best.

RESULTS

More than 35 communities have received energy efficiency improvements and training in their sanitation systems over the last two years. These systems have benefitted from reduced costs of providing services through reduced energy usage, with an estimated annual energy savings of $500,000 annually. Additional benefits of the program include improved functionality and reliability of delivering services, increased operator confidence, improved comfort, and expanded lifespan of struggling facilities.

CONCLUSIONS

Energy efficiency improvements solve a variety of problems for water and sewer systems in rural Alaska. ANTHC's low cost sanitation energy efficiency training and retrofit program has reduced costs, improved reliability, expanded the useful life of aging infrastructure, and improved operator confidence and effectiveness.

TITLE

National Tribal Water Center

PRESENTERS

James Temte, Alaska Native Tribal Health Consortium
Marleah Labelle, Alaska Native Tribal Health Consortium

INTRODUCTION

Access to clean water is vital to good health. In rural Alaska, residents in villages with higher service rates—where more than 80 percent of residents have clean water and sanitation access in the home—have shown a significant decrease in hospitalization due to pneumonia, diarrhea, respiratory diseases and skin infections. Unfortunately, Alaska ranks last amongst U.S. states in percentage of the population with access to water and sanitation facilities (93.7 percent as of 2000). Many of the existing water systems are at risk of failure due to the multitude of challenges inherent in operating, maintaining and managing them in harsh Arctic environments.

METHODS

In an effort to improve the sustainability of these systems, the "Water is Life" project was started. This health promotion campaign targets three specific groups at different levels of the social ecological model of public health: 1) water consumers, 2) water treatment plant operators, and, 3) utility managers and tribal governments. The project unites these groups to create a shared vision and raise public awareness of their water and sanitation system through the creation of a large-scale mural. The mural serves as a catalyst to create teachable moments that encourage water infrastructure awareness and behavior change. The mural and educational activities connect the traditional water culture and values of the tribe to the modern sanitation infrastructure and healthy water use behaviors.

RESULTS

"Water is Life" helps build community pride and ownership of the system, improving water system sustainability. Results from pilot projects demonstrate successful water system financial sustainability, as seen from a $50,000 deficit becoming a positive balance, city government involvement, and effective community engagement.

CONCLUSIONS

This presentation will discuss the vision, process, evaluation and results of the "Water is Life" project conducted in Russian Mission and Deering in May and June 2016.

TITLE

Peculiarities of Water Supply and Drinking Water Quality in the Russian Arctic
Note: This presentation is not available.

PRESENTER

Alexey Dudarev
Head of Hygiene Department, Northwest Public Health Research Center
St Petersburg, Russia

CONCLUSIONS

Population of the "Arctic Zone" of the Russian Federation (Murmansk Oblast, Northern Karelia, Northern Arkhangelsk Oblast, Nenets Okrug, Yamal-Nenets Okrug, Taimyr, Northern Yakutia, Chukotka) is about 2.5 million, including 115,000 indigenous people. Half of the total Arctic population lives in the cities and the other half lives in small settlements (90 percent of habitation). Centralized water supply exists in most of the big towns, but not all of them are equipped with water pre-treatment facilities. In rural areas, most of the population uses drinking water from non-centralized sources. Continuous permafrost, which occupies most of the Russian Arctic Zone (excluding Murmansk Oblast), is the main cause of infrequent use of underground water sources. In small settlements, water pipes usually supply untreated and non-disinfected drinking water directly from surface water sources. A majority of these water supply systems in rural areas are used only in summer. During the winter months, most water for household needs and drinking is delivered from surrounding reservoirs. Some communities have ''technical'' pipeline water-delivery systems from the nearest lake or river, and use constant water preheating during cold seasons, which serves as a centralized combination of house heating and hot-water supply, to prevent the water from freezing. In severe cold climate zones, where wells are unavailable or impossible to construct, water is typically delivered by trucks carrying water tanks in summer and sawn ice blocks in the winter. Usually the drinking water quality is low due to weak protection of aquifers from pollution, lack of sanitary protection zones, serious deterioration of water distribution and sewerage networks, and the numerous accidents on these networks that leads to secondary pollution of drinking water. Drinking water in the Russian Arctic, as a rule, does not meet hygienic standards for chemical substances and biologic agents.

TITLE

University of Alaska Anchorage (UAA) Team

PRESENTER

Aaron Dotson, UAA

CONCLUSIONS

The University of Alaska Anchorage (UAA) team has developed a prototype treatment system utilizing membranes and high dose ultraviolet light (UV) to demonstrate on-site water reuse as an alternative to a conventional community water and sewer system. Further, in-home plumbing concepts evaluated include isolated systems for each fixture that operates on 12-volt direct current electrical power and are pneumatically driven with low-pressure air.

At the time of the conference, the team is testing treatment system configuration No. 4 since the Phase II proposal. The current configuration recycles used water originating from the kitchen sink, bathroom sink, shower and clothes washer. Recycling is performed by initially concentrating this greywater using nanofiltration (NF), where NF reject is recycled to the greywater tank and the NF membrane permeate product is disinfected by ultraviolet (UV) and sent to an intermediate tank. From this intermediate tank, the water is fed to a reverse osmosis (RO) membrane filtration step, where RO reject is recycled to the intermediate tank and RO membrane permeate product is disinfected by UV and sent to the wash water tank where is it pumped into the home for non-potable, full-body contact reuse.

The Wostman EcoFlush diverting toilet, used in this prototype, flushes into a 15.5-gallon tank intended for sealed small system haul. In the case of a non-functional community haul system, the tank is small enough for personal haul.

Treatment system configurations operated prior to this conference produced wash water with turbidity <1 NTU, no observable color and ultraviolet transmittance of greater than 95 percent. Ongoing modifications are aimed at reducing the concentration of organic matter in the wash water believed to originate from urea in urine and soap. To date, the system reuses each gallon of water hauled into the system at least five times prior to disposal.

TITLE

DOWL Alaska Team

Christopher R. Schulz, P.E., CDM Smith, Denver, CO
Janelle Rogers, Ph.D., P.E., CDM Smith, Nashville, TN
Chase Nelson, PE DOWL, Fairbanks, AK
Mitch Titus, DOWL, Fairbanks, AK
Bruno Grunau, CCHRC, Fairbanks, AK
Laurie Krieger, Ph.D., Manoff Group, Washington, DC

PRESENTER

Christopher R. Schulz, P.E., CDM Smith, Denver, CO

CONCLUSIONS

The Alaska Department of Environmental Conservation (ADEC) has initiated the Alaska Water and Sewer Challenge (AWSC), an applied research project to create innovative and cost-effective home-based water and wastewater system (HWWS) solutions for households in remote Alaska villages. The DOWL Team is one of three engineering teams selected by ADEC for Phase 3 of this project which covers design, construction, monitoring, testing and optimization of a prototype HWWS. Our prototype system includes greywater and blackwater (waste) storage tanks in a small "bump out" (vestibule) attached to the house, treatment and recycling of greywater for cleaning and washing in the home, and a separate point-of-use (POU) filter for drinking water. The greywater treatment system includes a two-stage granular activated carbon (GAC) filter for tubidity and disolved organics reduction, and a two-lamp self-cleaning ultraviolet system for disinfection. The POU filter includes replaceable ceramic filter elements and is designed to treat and store melted ice water in the winter and rainwater in the spring and summer. A low-volume flush toilet (< 0.5 gallons per flush) can be used to reduce wastewater volumes to the blackwater tank and the frequency of wastewater hauling. The HWWS is designed to supply 40 to 80 gallons per household per day assuming an average household size of four people. The capital cost of the system, including shipping and household plumbing improvements, is about $53,000, and the monthly operating cost based on unit prices for power, water and liquid waste hauling in the village of Shishmaref is $141.

This presentation will highlight the key design features of the HWWS and how we co-designed the system with end-users in three villages we visited during the project—Shishmaref, Kwigilingok and Tununak—to meet their specific needs. We will also present the test plan and preliminary results of prototype testing of the HWWS at the Cold Climate Housing Research Center in Fairbanks, Alaska.

TITLE

Summit Consulting Services Team

PRESENTER

Parke Ruesch, Summit Consulting Services

CONCLUSIONS

Summit's proposed system for the Alaska Water Sewer Challenge is intended to be flexible and modifiable to meet the needs and capabilities of the individual homeowner, and to be installed and maintained with a local labor force. Summit is working with Agnew::Beck Consulting, Re-Locate and the communities of Kongiganak and Kivalina on the system design and increasing end user acceptance.

Summit is testing the prototype system in a building designed like a typical home in rural Alaska and in environmental conditions similar to what would be expected in more remote villages. We are utilizing standard village home construction techniques such as the plumbing wall and raised platforms to install tankage and system components. Our goal is to reduce the amount of water and waste water hauled by reusing wash water. The 50-gallon raw water storage tanks would need to be filled every three days and waste water would need to be pumped from the home every three days. Fifty-seven gallons are treated and cycled through the system for wash purposes.

Raw water is added to the system from rainwater off the building roof and three surface water sources. Raw water is treated to drinking water standards by multi-stage cartridges, an ultrafiltration membrane and media disinfection. It is also added as make-up to the wash water system as needed. Wash water will be reused from the bathroom sink, laundry and shower. This wash water is treated via an aeration and biological process, and disinfected by ultraviolet or advanced oxidation. The cleaned and treated wash water is then available at the bathroom sink, laundry and shower, as well as at the kitchen and utility sinks, and for flushing the toilet. The system is being tested with two toilet configurations, a low-flush toilet and a urine-diverting dry toilet.

TITLE

Alaska Native Tribal Health Consortium (ANTHC)
The Portable Alternative Sanitation System (PASS):
A Water and Sanitation Pilot Project

PRESENTERS

Korie Hickel, Senior Environmental Health Consultant, ANTHC
Mia Heavener, Senior Civil Engineer, ANTHC

INTRODUCTION

Residents of Kivalina, Alaska, are faced with dire sanitation needs, but struggle to obtain funding assistance because of the community's threatened status. Flooding and erosion have impacted critical sanitation infrastructure and make investment in new stationary infrastructure undesirable. Effective low-cost methods to address sanitation are needed for the interim, until the community relocates.

In 2015, the ANTHC led a team in designing and installing nine in-home water and sanitation systems as a pilot project. The systems incorporated low-water use fixtures, separating toilets, rainwater catchment systems, and seepage pits. The systems were designed to address basic sanitation needs of the residents including safe potable water, hand washing with flowing water, and safe handling and disposal of sewage. Homeowner training and involvement in the project were incorporated as critical elements to the project's success.

METHODS

An evaluation of the systems will be completed in August 2016. Outcomes include homeowner acceptance, mechanical functionality, amount of water used, and operational costs. Data is collected through questionnaires completed onsite with household representatives and documentation of activities.

RESULTS

Preliminary results demonstrate increased water usage, reduced exposure to sewage, and overall satisfaction. Key modifications carried out or planned in response to feedback include modifications to the greywater tank, refining the ventilation, exchanging the piping material for greater freeze protection, and improving the local support system.

CONCLUSIONS

The pilot project has been a success with improvements in quality of life and resident satisfaction. Installing any type of system in a home presents challenges when homeowners must maintain their own systems in remote locations and under extreme conditions. Operation and maintenance support will be a key element in the successful application of any type of community wide in-home sanitation technology.

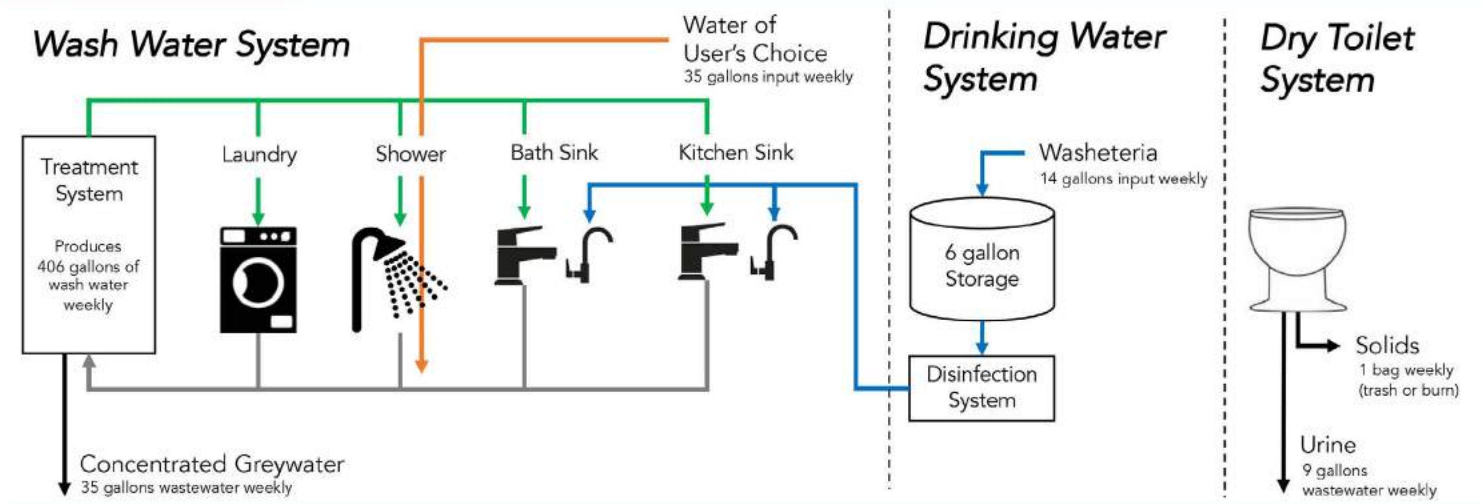
This presentation will explain the project, lessons learned, and outcomes of the evaluation.

OVERVIEW OF HOUSEHOLD WATER & SEWER PILOT SYSTEMS IN DEVELOPMENT

UAA

Alaska Water Sewer Challenge – Phase 3

Onsite Water Reuse Research Prototype Development



System Highlights

In order for a household of four people to use 420 gallons of water weekly, a total of 49 gallons of water will need to be brought into the home weekly, 14 gallons of drinking water from the washeteria and 35 gallons from a water source of user's choice (e.g. rain, ice, river, lake) to be used at the fixtures for washing.

Also, 44 gallons of wastewater will need to be removed from the home each week, 35 gallons of concentrated greywater created by the wash water treatment system and about 9 gallons of urine from the toilet.

System components for wash water treatment are located inside a shipping container attached to the house. The drinking water treatment is located under the kitchen counter.

The only source of water recommended for drinking and cooking purposes is washeteria water to ensure that this water meets drinking water standards. Drinking water is provided at the kitchen and bathroom sinks at a separate faucet.

Greywater from the kitchen sink, laundry, shower, and bathroom sink will be recycled and made available at the kitchen sink, laundry, shower and bathroom sink as wash water for uses other than drinking and cooking.

Hot water is made available in the system for showers, sinks and the clothes washer hook-up from small volume electric water heaters.

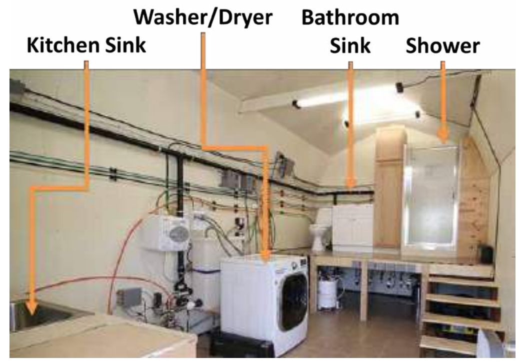
University of Alaska Anchorage is working with partner communities in the Yukon-Kuskokwim and Interior regions to gather feedback on the system from potential end users.

Questions, Comments or Looking for more information?

Website: www.ReuseWaterAK.com *Facebook:* www.facebook.com/ReuseWaterAK *Email:* addotson@alaska.edu *Phone:* 907.786.6041

UAA

Alaska Water Sewer Challenge – Phase 3
Onsite Water Reuse Research Prototype Development



Greywater Treatment System

- Air assisted soap removal
- Four stage filtration
  - strainer
  - ceramic microfilter
  - nanofilter membrane
  - reverse osmosis membrane
- UV disinfection
- Ozone tank disinfection

Daily Water Availability

Fixture	Operation	gallons
Toilet	24 uses	0
Shower	22 min	22
Bathroom Sink	24, ½ min uses	14
Kitchen Sink	user choice	10
Laundry	1 load per day	12
Drinking Water	0.5 gal/person/day	2
	TOTAL	60

Research Prototype

Left – 10-ft shipping container greywater treatment system

Right – Fixture prototype shed

Wash Water

Fixture Prototype

12 volt Battery Operated/Backup
- Air driven greywater plumbing
- Individual fixture pumps

Smart Small Tank Water Heaters

High Efficiency Water/Dryer

Fixture associated strainers

Wash Water Quality

Designed for greater than 99.99999% reduction of bacteria and viruses
- confirmed with total coliform bacteria

Typical Wash Water Quality

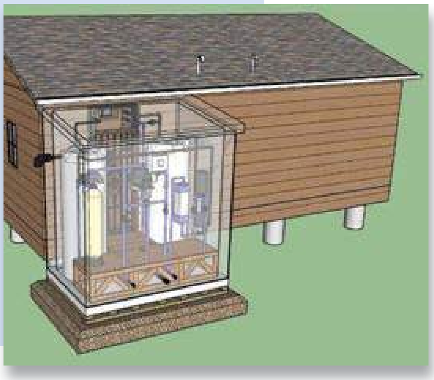
Turbidity - 0.1NTU
Organic Carbon – 0.5 mg-C/L
pH between 6-8
0 MPN/100mL total coliform
no odor
soft water

Questions, Comments or Looking for more information?
Website: www.ReuseWaterAK.com *Facebook:* www.facebook.com/ReuseWaterAK *Email:* addotson@alaska.edu *Phone:* 907.786.6041

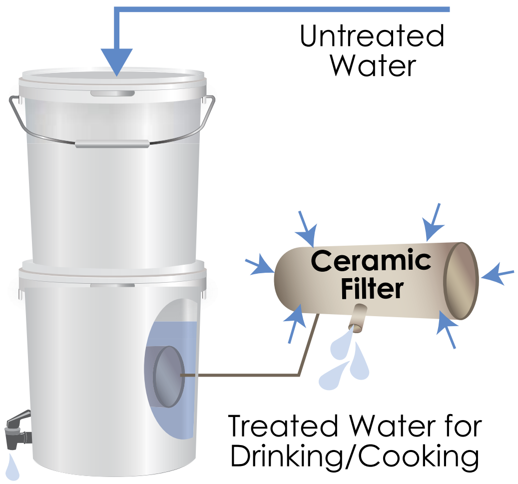
Prototype Household Water and Sewer System

System Highlights

- In order for a household of four people to use 60 gallons of water per day, a total of **90 gallons** of water will need to be **brought into the home** each week.
- Also, **90 gallons** of wastewater will need to be **removed from the home** each week. Wastewater is produced by flushing the toilet or using the kitchen sink. All other water; from the bathroom sink, the shower, and the wash machine is recycled.
- System components for water treatment are **located in a "vestibule" attached to the side of the house.**
- Sources of water that can be treated **for drinking and cooking** purposes include **rain water, water from a lake, or water from a river.**
- Sources of water that can be used **for wash water** include **rain water, water from a lake, or water from a river.** Wash water refers to the water used in the house for uses besides drinking and cooking. The drinking water system is completely separate from the wash water systems.
- **Hot water** can be made available to any of the fixtures based on plumbing arrangements and user preference.
- DOWL is working with partner communities in the **Yukon Kuskokwim and Norton Sound Regions** to gather feedback on the system from potential end users.



The proposed DOWL System has the following features:

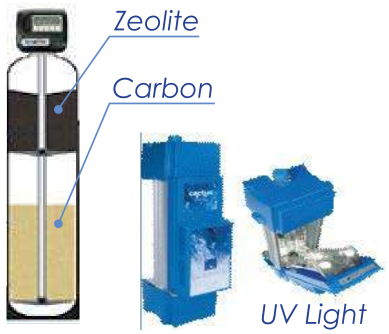


A stand-alone filtration system for drinking and cooking Water. This filtration system consists of a filter with special coatings to remove bacteria. It is also being tested to see if it removes viruses. The filter units are located in a 5-gallon bucket and the whole unit sits on a kitchen counter top. Untreated water from local sources can be loaded into the filter and treated for drinking. An additional bucket with holes can be placed in the top of the unit to hold melting ice. Information on this simple drinking water filtration system can be viewed on the internet: ***https://youtube/v5PKNtAoDHA***
Drinking water is safe and the filter units are inexpensive and user friendly.

Point of Use Filter

DOWL

A separate system that treats and recycles wash water in the home. This allows for water to be used multiple times before it turns to wastewater as it goes through the toilet and kitchen sink. The wash water recycling system takes water from the bathroom faucet, the washing machine, and the shower and filters it through a two-stage carbon/zeolite filter, and then disinfects it twice using Ultra-violet (UV) lights. (A zeolite filter uses minerals as adsorbents.) Wash water that goes through the recycling system is safe, but not meant for drinking and cooking. *Components within the proposed DOWL system are available commercially. A maintenance cooperative through a local government could stock replacement parts that would apply to all systems in a community.*



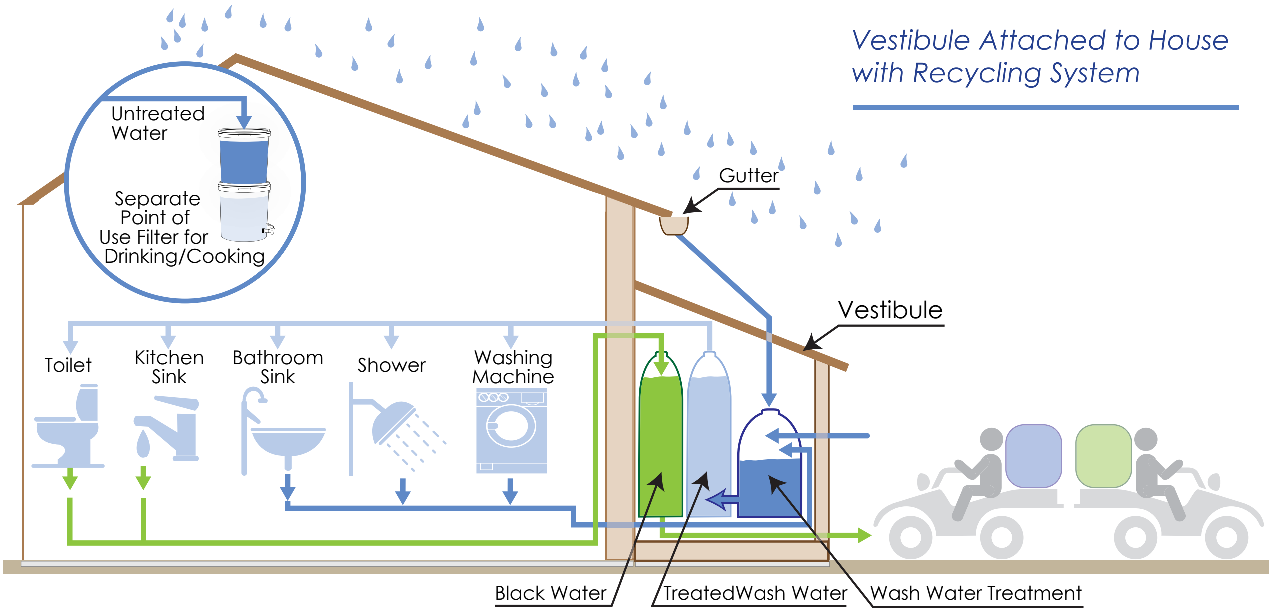
Two Stage Carbon/Zeolite Filter for Filtration Followed by Ultraviolet Light for Disinfection

- **Separate tanks for storing wash water and wastewater.** Wastewater generated from the flush toilet, and the kitchen sink is transferred to a holding tank where it is held until it can be pumped away from the household by the local government. No water from the toilet or the kitchen sink enters the wash water recycling system. There is a separate storage tank for treated wash water. Treated wash water is stored in this tank until it distributed to the different fixtures.

- **A "vestibule" attached to the side of the house.** The water recycling system and the tanks for storing water are housed in a "vestibule" that attaches to the side of the house. These components are placed in the vestibule so the tanks and recycling system do not take up space inside the home. The vestibule also allows heat from the house to drift into the vestibule, so a separate heating system is not required. The vestibule is super insulated and has a separate foundation system to allow the vestibule to allow for ground movement.

- **Low energy demand.** Since the vestibule is super insulated it will not take much energy to heat it. A small energy demand will come from the pumps and disinfection system. The disinfection system, which is an ultraviolet light, has about the same energy demand as a normal light bulb. Holding tanks for wastewater are kept inside the warm vestibule, so no heat trace is needed.

Vestibule Attached to House with Recycling System



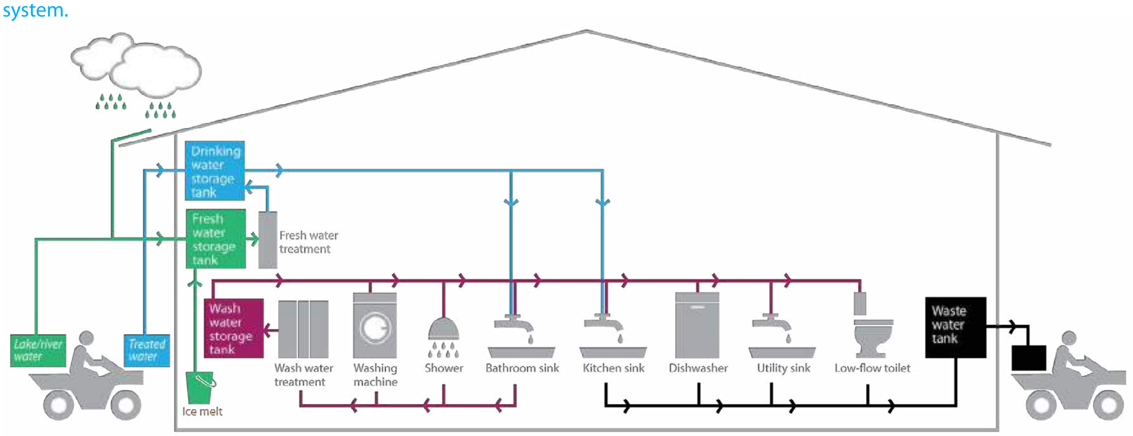
SUMMIT CONSULTING SERVICES, Inc. ALASKA
Water and Sewer Challenge

SUMMIT CONSULTING SERVICES

IN-HOME WATER TREATMENT AND WASTE WATER SYSTEM

Drinking Water

Drinking water is available at the kitchen and bathroom sink. Treated or fresh water must be hauled or collected every three to five days to refill the 50 gallon fresh water tank. Rain water can be directly piped into the system when available. Fresh or natural water passes through two pre-screening filters, two filters to remove bacteria, and a filter to remove taste and odor to clean it for drinking. Treated water can also be added to the system.



Wash Water

Wash water is recycled from the washing machine, shower and bathroom sink. The wash water is treated to be used again for washing uses at the washing machine, shower, bathroom, kitchen sink, dishwasher, utility sink and to flush the toilet.

Wash water is treated in four steps using a pre-filter to remove dirt and hair, a pump with air to remove soap, then a filter to remove oils and bacteria and an ultraviolet light to kill viruses.

Waste Water

Water from the kitchen sink, dishwasher, utility sink and toilets drain to a waste water tank. Waste water is pumped out of the house through a button on the outside of the house.

Ten to 17 gallons of waste water is produced each day, depending on the toilet choice. Waste water must be pumped and hauled every three to five days from the 50 gallon waste water tank.

SYSTEM HIGHLIGHTS

In order for a household of four people to use 60 gallons of water per day, a total of **70 to120 gallons** of water will need to be **brought into the home** each week.

Also, **70 to 120 gallons** of wastewater will need to be **removed from the home** each week. Wastewater is produced by the kitchen sink, utility sink, dishwasher and toilet.

System components for water treatment are **located inside the home. Tanks are incorporated into walls. The wash water treatment system is located in the bathroom.**

Sources of water that can be treated **for drinking and cooking** purposes include **rain, lake, river, ice melt, washeteria water**.

Sources of water that can be used **for wash water** include the **shower, bathroom sink and washing machine.** Wash water refers to water used in the house for uses besides drinking and cooking.

Hot water is made available by the system for showers, sinks and the clothes washer hook-up.

Summit Consulting is working with partner communities in the **Yukon-Kuskokwim and Northwest Arctic regions** to gather feedback on the system from potential end users.

Questions? Want More Info?

Website: www.summitwsc.com   Facebook: www.facebook.com/summitakwsc   Contact: meghan@agnewbeck.com or 907.222.5424

IN-HOME SYSTEM DESIGN

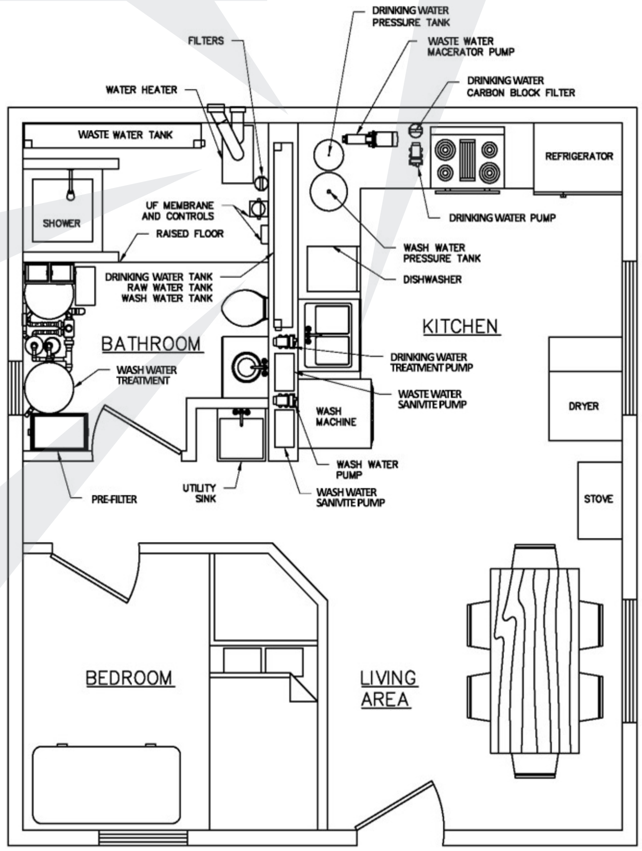
- Fits completely within the home.
- Flexible system components to meet home owner needs.
- Designed to be installed and maintained by local labor.

Rainwater catchment, intake and water overflow pipes, and waste water outlet.

Wash water and drinking water are available at the kitchen sink.

Waste water storage tank, drinking water filters and freeze-thaw protection using heat trace pipes

In-wall water storage tanks, drinking water filters, and a low-flow or dry toilet option.



THE TEAM

Summit Consulting Services
www.scsalaska.com

Agnew::Beck Consulting
www.agnewbeck.com

Re-Locate
www.relocate-ak.org

Questions? Want More Info?
Website: www.summitwsc.com Facebook: www.facebook.com/summitakwsc Contact: meghan@agnewbeck.com or 907.222.5424

⊕ CLEAN WATER AND SAFE WASTE DISPOSAL SOLUTION

PORTABLE

The biggest drawback of a typical piped water and sewer system is that they are not portable. Some Alaskan communities are vulnerable to flooding and erosion; therefore, some funding agencies have been reluctant to invest in infrastructure. The PASS systems can be assembled and reassembled if a community has to relocate.

ALTERNATIVE

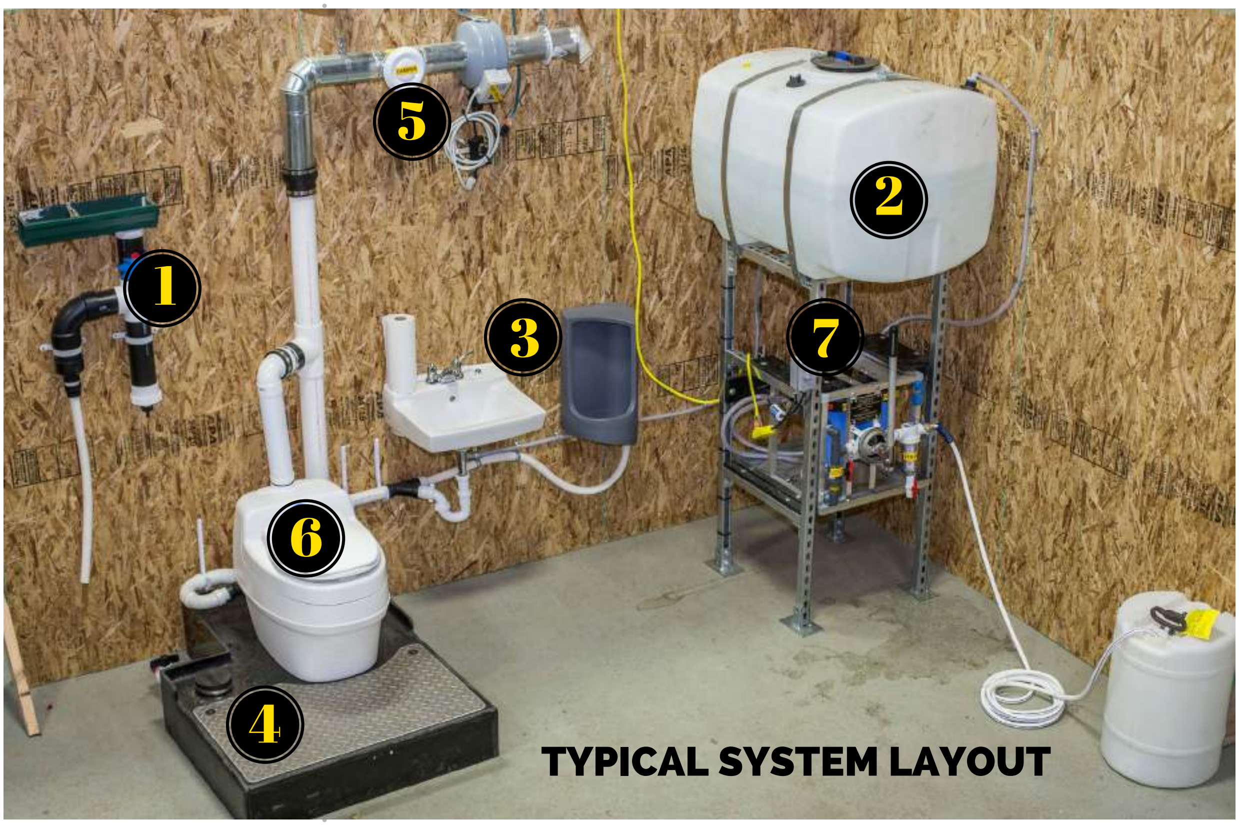
The Alaska Native Tribal Health Consortium and the Cold Climate Housing Research Center have designed and implemented a low cost sanitation alternative for communities that are affected by climate change. The PASS systems are approximately $26,000 per household as compared to a traditional piped system that costs approximately $168,000 per household.

SANITATION

The PASS was implemented in nine homes in Kivalina, Alaska. Kivalina has been operating on a self-haul system. This exposure to raw sewage places community members at risk for waterborne pathogens. The innovative systems vastly improve hauling by limiting exposure to waste, minimizing odor, and reducing frequency and weight of hauls.

SYSTEM

The system is entirely homeowner-based, designed to address the most basic sanitation needs, and can be moved with the community. The systems are stand-alone models; as homes are moved to the new village site away from the eroding coastline, residents can bring their clean water and safe sewer systems with them.



1. RAIN CATCHMENT

For an 800-square-foot home with a catchment area of approximately 1,200 square feet, it is possible to recover nearly 3,000 gallons or more of rain each year to supplement the quantity of water hauled to the home.

2. WATER STORAGE TANK

The 100-gallon, gravity-fed tank does not require electricity.

3. LOW-FLOW SINK AND WATERLESS URINAL

The sink and urinal conserves water while providing for hygiene and sanitation needs.

4. GREY WATER TANK

The grey water tank purges into the seepage pit below when full.

5. INTEGRATED VENTILATION

An energy-efficient combined ventilation system dries the waste, reduces odors, and ventilates the home.

6. SEPARATING TOILET

Waste is separated into liquid and solid components where the liquid is disposed of into a seepage pit and dried solids are disposed of in the landfill.

7. WATER TREATMENT SYSTEM

The water treatment system incorporates membranes and chlorination for point-of-use treatment to ensure the water is safe to drink despite its condition upon entering the system.

CONFERENCE PARTICIPANTS

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Debra Addie, Engineer
Village Safe Water
Anchorage, AK
debra.addie@alaska.gov

Clint Adler, Engineer II
Alaska Department of Environmental Conservation
Anchorage, AK
clint.adler@alaska.gov

Evelyn Agnus, Environmental Scientist
Zender Environmental Health & Research Group
Anchorage, AK
eagnus@zendergroup.org

Megan Alvanna Stimpfle, Principle
Arctic Geopolitical Consulting
Nome, AK
megan.suksraq@outlook.com

Kathryn Anderson, Affiliate Faculty
University of Alaska Anchorage
Anchorage, AK
kathyjanderson@outlook.com

Theodore Angaiak, Maintenance Mechanic
Lower Kuskokwim School District
Tununak, AK
theodore_angaiak@lksd.org

Don Antrobus, Environmentally Threatened Communities
Program Coordinator
Denali Commission
Anchorage, AK
dantrobus@anthc.org

Danielle Arigoni, Acting Director
HUD Office of Economic Resilience
Washington, D.C.
danielle.m.arigoni@hud.gov

Heather Arnett, Principal Advisor, Advocacy
North Star Group
Anchorage, AK
harnett@northstargrp.com

Nicholas Ashbolt, Alberta Innovates Translation Health Chair
Water School of Public Health,
University of Alberta, Edmonton
ashbolt@ualberta.ca

Martina Azean
Kongiganak, AK

Michael Bakaic, Graduate Researcher
York University
Toronto, Canada
mbakaic@yorku.ca

Kilby Baron, President
Cowater Alaska
Anchorage, AK
kbaron@cowateralaska.com

Robert Bastian, Senior Environmental Scientist
U.S EPA, Office of Wastewater Management
Washington, D.C.
bastian.robert@epa.gov

Brian Bearden, Operations & Maintenance Engineer/RMW Supervisor
Tanana Chiefs Conference
Fairbanks, AK
brian.bearden@tananachiefs.org

Andrew Beaver
Kwigillingok, AK
abeaver2005@yahoo.com

Veronica Bergman
Allakaket, AK
veronica_bergman@yahoo.com

David Beveridge, Director of Project Management
ANTHC
Anchorage, AK
dbeverid@anthc.org

Michael Black, Director of Program Development
Alaska Native Tribal Health Consortium
Anchorage, AK
mlblack@anthc.org

Carrie Bohan, Operations Assistance Program Manager
ADEC
Juneau, AK
carrie.bohan@alaska.gov

Stephen Bolan, Director Sanitation Facilities Construction
Indian Health Service
Anchorage, AK
stephen.bolan@ihs.gov

Jonathan Bressler, CDC/CSTE Applied Epidemiology Fellow
Alaska Department of Health and Social Services
Anchorage, AK
jonathan.bressler@alaska.gov

Candice Bressler, Public Information Officer
Alaska Department of Environmental Conservation
Juneau, AK
candice.bressler@alaska.gov

Michael Brubaker, Director Community Environment and Health
ANTHC
Anchorage, AK
mbrubaker@anthc.org

Sarah Buckles
Chefornak, AK
cityofchefornak@yahoo.com

Alida Bus, Legislative Liaison
Alaska Department of Environmental Conservation
Juneau, AK
alida.bus@alaska.gov

Michael Carey, Retired Plumber
UA Local 367 Plumbers and Pipefitters
Anchorage, AK
Goobers@alaska.net

Kimberly Carlo, COO
Interior Regional Housing Authority
Fairbanks, AK
KCarlo@IRHA.org

Guy Carpenter, President
WateReuse Association
NEED CURRENT LOCATION
gcarpenter@aqua-tecture.net

Cindy Christian, Program Manager
AK Department of Environmental Conservation
Fairbanks, AK
cindy.christian@alaska.gov

Jacqueline Cleveland, Cultural Sustainability Advisor
Inuit Circumpolar Council of Alaska
Anchorage, AK
jacqueline@iccalaska.org

Steve Colt, Professor of Economics
Alaska Pacific University
Anchorage, AK
scolt@alaskapacific.edu

Marcia Combes, Arctic Planner
USEPA
Anchorage, AK
combes.marcia@epa.gov

David Cramer, President
Summit Consulting Services, Inc.
Tok, AK
scsdac@aol.com

Chris Dankmeyer, Environmental Health Manager
Maniilaq Association
Kotzebue, AK
chris.dankmeyer@maniilaq.org

Harold David
Allakaket, AK

Valerie Davidson, Commissioner
Department of Health and Social Services, State of Alaska
Anchorage, AK
val.davidson@alaska.gov

Tasha Deardorff, WEP/RAVG Director
USDA Rural Development
Anchorage, AK
tasha.deardorff@ak.usda.gov

Gavin Dixon, Senior Project Manager
ANTHC
Anchorage, AK
gndixon@anthc.org

Kelly Donnelly, Executive Director
Yukon River Inter-Tribal Watershed Council
Anchorage, AK
kdonnelly@yritwc.org

Aaron Dotson, Associate Professor
University of Alaska Anchorage
Anchorage, AK
addotson@alaska.edu

Alexey Dudarev, Head of Hygiene Department
Northwest Public Health Research Center
St-Petersburg, Russia
alexey.d@inbox.ru

Jon Dufendach, President
CampWater Industries LLC
Delta Junction, AK
jondufendach@gmail.com

Rob Earl, Legislative Aide
Alaska State Legislature
Anchorage, AK
rob.earl@akleg.gov

Laura Eichelberger, Assistant Professor of Anthropology
University of Texas at San Antonio
San Antonio, TX
laura.eichelberger@utsa.edu

Carrie Eischens, Research Program Coordinator
USARC
Anchorage, AK
ceischens@arctic.gov

James Englehardt, Professor
University of Miami
Coral Gables, FL
jenglehardt@miami.edu

Marcie Fader, Grants Administrator III
Department of Environmental Conservation
Anchorage, AK
marcie.fader@alaska.gov

Mads Fægetborg, Executive Director
Inuit Circumpolar Council - ICC Greenland
3900 Nuuk
mads@inuit.org

Craig Fleener, Director of State & Federal Relations
Office of the Governor
Anchorage, AK
Craig.Fleener@alaska.gov

Kathryn Folger
Koyukuk, AK
kathryn.folger@tananachiefs.org

Eddy Frank
Venetie, AK
venetievillaecouncil@yahoo.com

Andrea Fruean, Grant Administrator II
Village Safe Water
Anchorage, AK
andrea.fruean@alaska.gov

David Fuente, Program Coordinator
The Water Institute at UNC Chapel Hill
Chapel Hill, NC
fuente@unc.edu

Graham Gagnon, Professor
Centre for Water Resources Studies, Dalhousie University
Halifax, Canada
graham.gagnon@dal.ca

Bailey Gamble, Mechanical Engineer and Educator
Alaska Native Tribal Health Consortium
Anchorage, AK
bbgamble@anthc.org

Hosea Aghogah Gemuh, Student
University of Canterbury
Christchurch, New Zealand
manudex25@gmail.com

Jana George, Chief Executive Officer
Interior Regional Housing Authority
Fairbanks, AK
jgeorge@irha.org

Michael Gerace, Co-Owner
Re-Locate LLC
Anchorage, AK
mjgerace@gmail.com

Stephanie Gould, Sr. Civil Engineer
Stantec Consulting Inc.
Anchorage, AK
stephanie.gould@stantec.com

Prabhu Gounder, Medical epidemiologist
CDC Arctic Investigations Program
Anchorage, AK
iym4@cdc.gov

Richard Greco, Chairman of the Board
Euro Mec Water Group (EMWG)
Seregno, Italy
richard_greco@idro.net

Bill Griffith, Facility Programs Manager
Alaska Department of Environmental Conservation
Anchorage, AK
bill.griffith@alaska.gov

Heather Gross, Summit Consulting Services
Tok, AK
heathergscs2@aol.com

Bruno Grunau, Senior Research Engineer
Cold Climate Housing Research Center
Fairbanks, AK
bruno@cchrc.org

Kristian Hammeken, Student of M.Sc.
Technical University of Denmark
Holte, Denmark
kris.hammeken@gmail.com

Eric Hanssen, Rural Energy Initiative Program Manager
ANTHC
Anchorage, AK
echanssen@anthc.org

Larry Hartig, ADEC
Anchorage, AK
larry.hartig@alaska.gov

Oral Hawley
NEED LOCATION
atmautluaktc@gmail.com

Tyler Heal, Civil Engineering Lead, Yukon
Stantec Consulting Ltd.
Whitehorse, Canada
tyler.heal@stantec.com

Mia Heavener, Senior Civil Engineer
ANTHC
Anchorage, AK
Mia.Heavener@anthc.org

Kåre Hendriksen, Associate Professor Ph.d.
Arctic Technology Centre
Sisimiut, Greenland/Lyngby, Denmark
krhe@byg.dtu.dk

Thomas Hennessy, Medical Director
CDC Arctic Investigations Program
Anchorage, AK
tbh0@cdc.gov

Sarah Henry
Akiachak, AK
aana_shenry@yahoo.com

Jay Hermanson, Sr. Project Manager
WHPacific
Anchorage, AK
jhermanson@whpacific.com

Joseph Hess, Civil Engineer
Alaska Native Tribal Health Consortium
Anchorage, AK
jehess@anthc.org

Korie Hickel, Sr. Environmental Health Consultant
Alaska Native Tribal Health Consortium
Anchorage, AK
khickel@anthc.org

Sharon Hildebrand, Grad Student
UAS
Fairbanks, AK
sfhildebrand@alaska.edu

Chris Hladick, Commissioner
State of Alaska, DCCED
Juneau, AK
chris.hladick@alaska.gov

Eric Hoberg, Senior Research Zoologist
Agricultural Research Service, USDA
Beltsville, MD
eric.hoberg@ars.usda.gov

Liz Hodges Snyder, Associate Professor of Public Health
Alaska Food Policy Council/University of Alaska Anchorage
Anchorage, AK
ehodges4@alaska.edu

Meghan Holtan
Agnew::Beck
Anchorage, AK
meghan@agnewbeck.com

Leigh Hubbard, Director of Design Services
ANTHC
Anchorage, AK
lphubbard@anthc.org

Melissa Ingersoll, CEO/Program Designer
Teayoumeak,Inc.
Anchorage, AK
Mingersoll80@gmail.com

Pernille Erland Jensen, Associate Professor
Technical University of Denmark
Lyngby, Denmark
pej@byg.dtu.dk

Kenneth Johnson, Principal
Cryofront
St. Albert, Canada
cryofront@gmail.com

Barbara Johnson, Research Assistant
University of Alaska Fairbanks
Fairbanks, AK
bajohnson20@alaska.edu

Jennine Jordan, AAC rep
Arctic economic council
Anchorage, AK
Jjordan@ganaayoo.com

William Justice, Director, Office of Environmental Health
Tanana Chiefs Conference
Fairbanks, AK
william.justice@tananachiefs.org

Kristin K'eit, Environmental Scientist
Zender Environmental Health and Research Group
Anchorage, AK
kkeit@zendergroup.org

Thomas Kasun, Sr. Business Development Manager
Alcoa
Alcoa Center
thomas.kasun@alcoa.com

Theodore Katcheak
Stebbins, AK
emkatcheak@yahoo.com

Camilla Kennedy, Economist
ADEC
Anchorage, AK
camilla.kennedy@alaska.gov

Erinne Kennedy, Resident
Harvard School of Dental Medicine
Boston, MA
erinnekennedy@gmail.com

Carolyn Kozak, Graduate Student
University of Alaska Fairbanks
Fairbanks, AK
cjkozak@alaska.edu

Marleah Makpiaq LaBelle, Project Manager
Alaska Native Tribal Health Consortium
Anchorage, AK
mmlabelle@anthc.org

Michele LeBlanc-Havard, Environmental Health Specialist
Government of Nunavut
Iqaluit, CANADA
mleblanc-havard@gov.nu.ca

Sean Lee, Engineer Associate
DEC Village Safe Water
Anchorage, AK
sean.lee@alaska.gov

Donna Lee, VSW Engineer
DEC Village Safe Water
Anchorage, AK
donna.lee@alaska.gov

Brian Lefferts, Director, Environmental Health & Engineering
Yukon-Kuskokwim Health Corporation
Bethel, AK
brian_lefferts@ykhc.org

Bernadette Lewis, Executive Director
Chefornak Traditional Council
Chefornak, AK
cyf_tcoffice@yahoo.com

Svetlana Maksimova, Associate Professor of Water Supply and Sanitation Department
Industrial University of Tyumen
Tyumen, Russia
msv020761@yandex.ru

Jennifer Marlow, Co-Owner
Re-Locate LLC
Anchorage, AK
jmarlow@hailmail.net

Holly Martinson, Postdoctoral Fellow
University of Alaska Anchorage
Anchorage, AK
hamartinson@alaska.edu

John Matthews, Secretariat Coordinator
Alliance for Global Water Adaptation
Corvallis, OR
johoma@alliance4water.org

Ann Meceda, Arctic Affairs Officer
Department of State
Washington, D.C.
mecedaa@state.gov

Andrew Medeiros, Adjunct Professor
York University
Toronto, Canada
fraggle@yorku.ca

Andrea Meeks, Project Manager
CRW Engineering Group, LLC
Anchorage, AK
ameeks@crweng.com

Paul Mountain, Tribal Administrator
Nulato Tribal Council
Nulato, AK
paul.mountain@tananachiefs.org

William Naneng, General Manager
Sea Lion Corporation
Hooper Bay, AK
will@sealioncorp.net

Joel Neimeyer, Federal Co-Chair
Denali Commission
Anchorage, AK
jneimeyer@denali.gov

Chase Nelson, Arctic/Civil Engineer
DOWL
Fairbanks, AK
cnelson@dowl.com

Heather Newman, Environmental Program Manager I
State of Alaska, Dept. of Environmental Conservation
Anchorage, AK
heather.newman@alaska.gov

Willie Nicholai
Atmautluak, AK
atmautuaktc@gmail.com

John Nichols, Manager of Utility Operations
Alaska Native Tribal Health Consortium
Anchorage, AK
jpnichols@anthc.org

Flora Nickoli, Council Member
Nulato City Council
Nulato, AK
igapntc@outlook.com

Leisha Nolen, Medical Epidemiologist
Centers for Disease Control and Prevention
Anchorage, AK
xdf8@cdc.gov

Jim Nordlund, Alaska State Director
USDA Rural Development
Palmer, AK
jim.nordlund@ak.usda.gov

Becky Norton
Kivalina, AK
beck_kvls@yahoo.com

Melanie O'Gorman, Associate Professor
University of Winnipeg
Winnipeg, Canada
m.ogorman@uwinnipeg.ca

Fatima Ochante, Program Planner & Coordinator
Alaska Department of Environmental Conservation
Fairbanks, AK
fatima.ochante@alaska.gov

Karl Ohls, Senior Policy Advisor
North Star Group/The Arctic Report
Anchorage, AK
kohls@northstargrp.com

Blanche Okbauk-Garnie
Teller, AK
sisgarnie@yahoo.com

Shady Grove Oliver, Reporter
The Arctic Sounder
Anchorage, AK
sgoarctic@gmail.com

Albert Oquilluk
Teller, AK
aoquilluk@yahoo.com

Ronald Parker, Project Manager
Cowater Alaska Inc.
Anchorage, AK
rparker@cowateralaska.com

Jonathan Pavila
Tuntutuliak, AK
jpavila@tuntutuliaktc.org

Moses Pavilla
Atmautluak, AK

Stephen Penner, Master's of Development Practice Student in Indigenous Development
University of Winnipeg
Winnipeg, Canada
srpenner@mac.com

Sean Peterson, Environmental Scientist
Zender Environmental Health and Research Group
Anchorage, AK
speterson@zendergroup.org

Rhonda Pitka, Chief
Beaver Village Council
Beaver, AK
rpitka@beavercouncil.org

Doug Poage, Engineer
Village Safe Water
Anchorage, AK
doug.poage@alaska.gov

Rebecca Pollis, Sanitation Facilities Program Manager
ANTHC
Anchorage, AK
rpollis@anthc.org

Patrick Pavila
Tuntutuliak, AK
patrickpavila97@gmail.com

Rob Quick, Medical Epidemiologist
CDC
Atlanta, GA
rxq1@cdc.gov

Susan Randlett, VSW Engineer I
State of Alaska
Anchorage, AK
susan.randlett@alaska.gov

Carma Reed, CPD Director, Anchorage Field Office
U.S. Department of Housing and Urban Development
Anchorage, AK
carma.reed@hud.gov

Daniel Reichardt, Engineer I, DEC
State of Alaska Drinking Water Program
Anchorage, AK
daniel.reichardt@alaska.gov

Roy Robertson, Engineer
State of Alaska DEC Drinking Water Program
Anchorage, AK
roy.robertson@alaska.gov

Janelle Rogers, Senior Vice President
CDM Smith
Nashville, TN
rogersjd@cdmsmith.com

Arthur Ronimus, Owner
A&E Professional Services
Eagle River, AK
aronimus@gci.net

Cheryl Rosa, Deputy Director
US Arctic Research Commission
Anchorage, AK
crosa@arctic.gov

Parke Ruesch, Engineering Manager
Summit Consulting Services, Inc.
Anchorage, AK
pruesch@scsalaska.com

AJ Salkoski, Sr. Program Manager
ANTHC
Anchorage, AK
ajsalkoski@anthc.org

James Sceeles, CEO
Tagiugmiullu Nunamiullu Housing Authority
Barrow, AK
James.Sceeles@tnha.net

Christopher Schulz, SVP
CDM Smith
Denver, CO
schulzcr@cdmsmith.com

Simone Sebalo
Zender Environmental Health and Research Group
Anchorage, AK
ssebalo@zendergroup.org

Kirsten Selinger, Senior Environment and Energy Officer
US Department of State
Washington, D.C.
selingerkb@state.gov

Brittany Seymour, Assistant Professor
Harvard School of Dental Medicine
Boston, MA
brittany_seymour@hsdm.harvard.edu

Jacqueline Shirley, Rural Development Specialist
Rural Community Assistance Corporation
Anchorage, AK
Jshirley@rcac.org

Terry Smith, Chief Operating Officer
Fluor-Brady
San Diego, CA
tsmith@rbrady.net

Henry Smoke
Stevens Village, AK
svs.ira.council@gmail.com

Dianne Soderlund
Director, Alaska Operations Office
Environmental Protection Agency
Anchorage, AK
soderlund.dianne@epa.gov

Dolly Swan, Community Member
Kivalina, AK
Anchorage, AK
korie.hickel@gmail.com

Replogle Swan, Community Member
Kivalina, AK
Anchorage
aviigan@yahoo.com

Dean Syta, Engineering Manager
Stantec Consulting Services
Anchorage, AK
dean.syta@stantec.com

Julia Taylor, Journalist, Rural Development student
UAF
Fairbanks, AK
Jmtaylor14@alaska.edu

James Temte, Director, National Tribal Water Center
Alaska Native Tribal Health Consortium
Anchorage, AK
jrtemte@anthc.org

Timothy Thomas
Director, Clinical and Research Services
Alaska Native Tribal Health Consortium
Anchorage, AK
tkthomas@anthc.org

Mitch Titus
Civil Engineer
DOWL
Fairbanks, AK
mtitus@dowl.com

Vincent Tocktoo
Village of Shishmaref
Shishmaref, AK
cityofshhclerk@gci.net

Bob Tsigonis, Founder/President
Lifewater Engineering Company
Fairbanks, AK
bob@lifewaterengineering.com

Luanne Urfer, Principal/Owner
Sustainable Design Group
Palmer, AK
luanneu@sdg-ak.com

Jeanine Vance, Environmental Program Specialist
Alaska Department of Environmental Conservation
Anchorage, AK
jeanine.vance@alaska.gov

Dennis Wagner, Infrastructure Programs Manager
EPA
Anchorage, AK
wagner.dennisx@epa.gov

Jeff Warner, Environmental Program Manager
State of Alaska/DEC
Anchorage, AK
jeff.warner@alaska.gov

John Warren, Engineering Services Director
Alaska Native Tribal Health Consortium
Anchorage, AK
jwarren@anthc.org

Steve Weaver, DEHE Senior Director
ANTHC
Anchorage, AK
sweaver@anthc.org

Kate Wedemeyer, Fisheries Oceanographer
BOEM
Anchorage, AK
kate.wedemeyer@boem.gov

Bob White, Remote Maintenance Worker
Yukon-Kuskokwim Health Corporation
Bethel, AK
robert_white@ykhc.org

Corrie Whitmore, Assistant Professor of Health Sciences
University of Alaska Anchorage
Anchorage, AK
whitmore@uaa.alaska.edu

Erin Whitney, Research Assistant Professor
Alaska Center for Energy and Power, University of Alaska Fairbanks
Anchorage, AK
erin.whitney@alaska.edu

Jonathan Widdis, Vice President
NANA Pacific, Inc.
Anchorage, AK
jonathan.widdis@nanapacific.com

MaryAnn Wiehl
Rampart, AK
maw.rvc@gmail.com

George Wilson, VSW Engineer II
SOA/Village Safe Water
Anchorage, AK
george.wilson@alaska.gov

Noah Wise
Nunapitchuk, AK
cityofnunap@yahoo.com

Peter Workman, Chief Environmental Health Officer
Department of Health and Social Services Government of Northwest Territories
Yellowknife, AK
peter_workman@gov.nt.ca

Carlee Wright, Masters Student (Epidemiology)
University of Guelph
Guelph, Canada
carlee@uoguelph.ca

Lynn Zender
Zender Environmental Health
Anchorage, AK
lzender@zendergroup.org

Fatima Ochante, Chris Dankmeyer and Andrew Beaver observe pilot systems presentations

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This circumpolar conference is identified as an official event in conjunction with the U.S. Chairmanship of the Arctic Council, as an endorsed project of the Arctic Council Sustainable Development Working Group. The Alaska Department of Environmental Conservation is partnering with a number of U.S. agencies to sponsor this informative conference. Federal sponsors include the U.S. Environmental Protection Agency, U.S. Arctic Research Commission; the U.S. Centers for Disease Control and Prevention; the U.S. Department of State; and the U.S. Department of Agriculture, Rural Development Program.