PORTABLE ALTERNATIVE SANITATION SYSTEM (PASS) 2.0

An Addendum to the Portable Alternative Sanitation System Final Report from Kivalina, Alaska in 2017

Abstract

The Portable Alternative Sanitation System was developed in 2014 and piloted in nine homes in one community from 2015-2016. Since the pilot study, upgrades were made to PASS based on user feedback and engineering concerns, and the new units (called "PASS 2.0") were installed in ten new homes in four communities. The pilot units were also upgraded to reflect the changes to the system. This report documents the system upgrades, current units installed, use and function of the units in households, and future installations planned. Recommendations to continue to improve the PASS program are also included. This document updates the previous report on the PASS that focused on the pilot project in Kivalina and was published in 2017.

Jacqualine D. Schaeffer and Kaitlin J. Mattos

September 30, 2019

Contents

Executive Summary

This report is an updated addendum to the Portable Alternative Sanitation (PASS) Report completed in 2017. This report describes the reengineered upgrades from the PASS 1.0 unit to the PASS 2.0 unit and the manufactured unit currently being deployed in Kivalina and Mertarvik.

Portable Alternative Sanitation System was developed in 2014 and installed in nine homes the community of Kivalina from 2015-2016 as part of a pilot study. Since the pilot study, upgrades were made to the PASS unit based on user feedback and engineering concerns. The new units, called PASS 2.0, were installed in ten new homes in four communities across the state: Oscarville (YK Delta); and Chalkyitsik, Allakaket, and Alatna (Interior).

These installations allowed the PASS engineering and research team to observe, investigate and understand the various environmental and climate conditions in three regions of Alaska. The pilot units in Kivalina were also upgraded to reflect the changes to the PASS 2.0 unit. This report documents the system upgrades, current units installed, use and function of the units in households, and future installations planned. Recommendations to continue to improve the PASS program are also included.

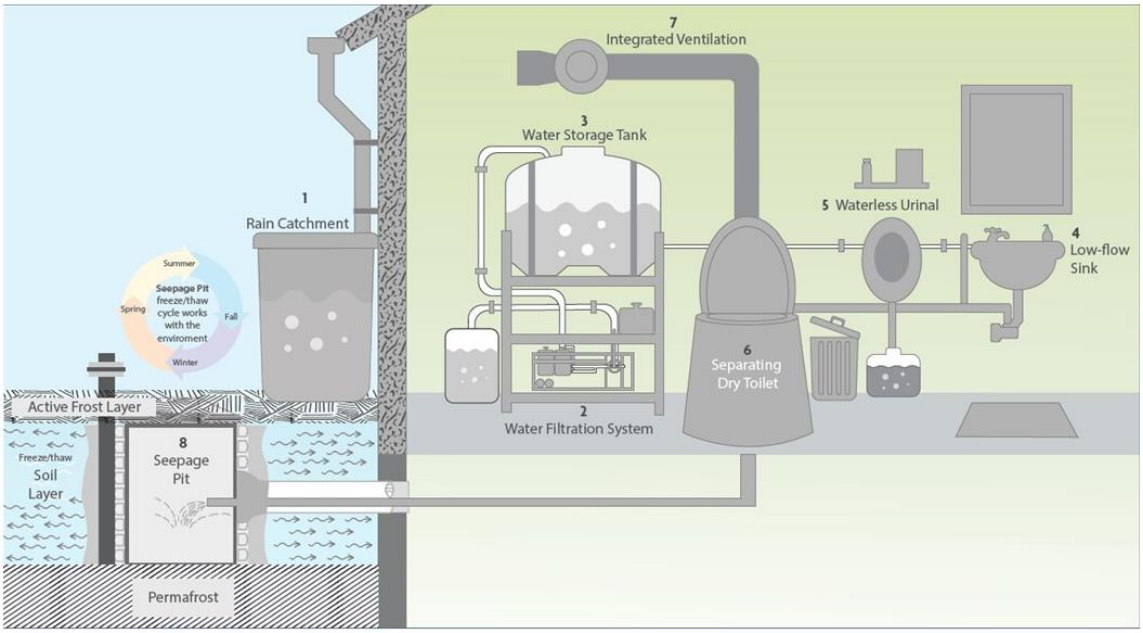
The progress of this system transitioned from research and development into full production mode in January 2019. A collaborative effort between Lifewater Engineering and Camp Water Industries allowed the formation of Silverline, LLC, which is currently the sole manufacturer of PASS 2.0. Silverline is located in Delta Junction, Alaska. All system questions and concerns, including repair and installation questions, and ordered parts are handled through Silverline, LLC. Silverline has both phone assistance and a website https://alaskacleanwater.com/. The PASS 2.0 unit cost shows a slight increase from the PASS 1.0 unit due to the upgrades and redesign of the final manufactured unit and adjusting cost dependent on the numbers of units ordered. PASS 1.0 unit cost: $47,726 PASS 2.0 unit cost: $52,907.

Based on observations, it is clear that the failure or success of PASS is highly dependent on resident engagement and training in homes where the units are installed. To assist in the system success, ANTHC Marketing produced the PASS 2.0 Installation video and the PASS team published both visual and written Operations & Maintenance manuals. A 3-part team effort, including Engineering, Construction and Homeowner Engagement, proved the best approach when working with rural homeowners.

Ongoing PASS health, well-being and water use research will provide a comprehensive look at in-home water use and the health effects of using the PASS unit. These studies are ongoing and expect to publish reports in 2020.

Components of PASS 2.0

The different parts of the PASS 2.0 are shown below and include:



1. *Water storage tank:* A 50- or 100-gallon water tank stores treated water for use in the bathroom sink or drinking, washing and cooking. Water from any source (e.g., water plant, rain, river) is treated with a strainer, a high efficiency sediment filter and a cryptosporidium-rated cartridge filter to remove dirt and germs as it is pumped into the tank with the electric pump or by hand. A chlorine injection valve is included that allows homeowners to measure and inject small amounts of household bleach into the water line as water flows into the tank. Use of chlorine kills viruses and bacteria in the water, provides a chlorine residual to protect stored water, and keeps the tank from growing biofilms. Water is safely stored in the covered tank and protected from debris or user contamination.

2. *Bathroom sink:* The water from the tank flows without electricity into a slow flowing bathroom sink to provide clean water to wash hands, wash up, or clean. The low flow ensures that water is not wasted and represents a tenfold increase in efficiency for hand washing as compared to flows from standard faucets. A spigot on the side of the tank provides faster-flowing water to fill up water pitchers or cookpots if desired. The bathroom sink has a salon-style p-trap to prevent solids from entering the seepage pit and for easy cleaning.

3. *Separating toilet:* The HD-USIT toilet has a seat that is designed to separate urine and feces. The urine goes into the front of the toilet and down a pipe that leads to the seepage pit. Feces goes into the back into a plastic bag-lined 5-gallon bucket. A ventilation fan with manual diffuser on the toilet dries the feces over a few days and removes odors from the toilet. The bucket can be emptied whenever it gets full or before it gets too heavy for homeowners to carry. If homeowners have issues with their drain lines, they can convert the toilet into a containerized manual discharge mode using the urine jug provided. If homeowners prefer not to adapt to the separating toilet, they can remove the separator seat and use the toilet in a vented honeybucket mode, where all solids and liquids go into the bucket, but the ventilation fan stays on to remove odors, reduce moisture and eliminate the need for Pine-Sol or other chemicals used to mask the odor of human waste.

4. *Urinal:* A wall-mounted urinal is provided for users who prefer to stand to urinate. The urinal drains directly into a manual discharge container.

5. *Seepage pit:* The seepage pit is a large covered pit that collects the greywater from the sink and the urine from the toilet. The liquid is conveyed in an insulated pipe bundle with one pipe for the greywater, one pipe for the urine and one pipe for an electric heat trace. The heat trace can be unplugged when the ground thaws in the spring/summer. The heat trace is plugged in inside the home during the onset of cold temperatures to prevent freeze-up of the greywater and urine lines. In the pit, liquid seeps into the ground for natural treatment. If the pit or the pipes going into the pit freeze, the PASS can be changed so that greywater and urine goes into containers for hauling by hand.

6. *Rainwater catchment system:* Two 25-foot sections of gutter are included in each PASS unit and are mounted onto the roof of the home. The gutter funnels rainwater into a first- flush apparatus that discards the first several gallons of rainwater that cleans the roof and is likely contaminated with dirt, bacteria and debris. After the first flush is full, the subsequent rainwater is funneled into a 33-gallon plastic barrel. This can be directly loaded into the PASS tank through the filtration system, eliminating the need for homeowners to haul high quantities of water during rainy periods.

Current PASS Units in Alaska

As of June 2019, nineteen PASS units have been installed in five rural Alaskan communities. Seventeen units are still operational (table 1).

Table 1: Installed and operational PASS units in rural Alaska communities as of June 2019

Community (Region)	Number of units installed	Number of units operational	Installation date	Project close-out date
Kivalina (Northwest)	9	7	Aug 2015	Mar 2019
Allakaket (Interior)	4	4	Jan 2018	Mar 2019
Alatna (Interior)	3	3	Jan 2018	Mar 2019
Chalkyitsik (Interior)	2	2	Jan 2018	Jan 2019
Oscarville (Southwest)	1	1	Jan 2018	Mar 2019

Kivalina

Nine PASS 1.0 units were installed in Kivalina in 2015 as part of a pilot Research and Development (R&D) project testing the PASS concept. By 2018, seven homes were still using at least either the water system or the toilet, and had made necessary adaptations to the units to accommodate remodeling of their homes or their household preferences. Two units were uninstalled or unused due to changes in home ownership. During the fall of 2018, all but one of the seven PASS 1.0 units still being used were upgraded to the PASS 2.0 in Kivalina. (The final home is planned for upgrade in June 2019). The following upgrades were made to the units:

Water unit: All sink Gleco P-traps were upgraded to salon-style traps. Most homes preferred not to have the chlorine injection line installed.

Toilet: All toilets were upgraded to the HD-USIT toilet 3-option toilet system. All plumbing lines were replaced to accommodate changes to drain lines and to eliminate the greywater holding tank.

Drainage: All seepage chambers were upgraded to the PASS 2.0 seepage pit system.

Ventilation: No changes were made to the ventilation system aside from the minor changes needed to integrate to the new toilet.

Of the seven current PASS homes in Kivalina, three are making full use of their water and toilet systems and are able to convert to different drainage modes or trouble-shoot the system as needed. Three homes are using the toilet in vented honeybucket mode because of household preference not to use the urine separator in the toilet. The water tanks and sinks were still functional at each of these homes. The remaining homeowner moved to a new house and took the water unit with them. The PASS 1.0 toilet was left behind at the prior residence but is reportedly still in use by the renters staying there.

In addition to the expected use of the PASS units, two households in Kivalina have upgraded their units on their own to add pressure pumps, showers, water heaters, kitchen sinks, and additional disposal areas for added volumes of greywater (e.g., from showers and kitchen sinks). These upgrades demonstrate the versatility of PASS and the capacity of homeowners to customize and adapt the system to their needs.

Allakaket

Four PASS 2.0 units were installed in Allakaket in 2018 – two in January and two in September. All four units are in the homes of elders who were chosen by the community of Allakaket to be served with water to make it easier for them to age in place. The units are currently operating well and the most commonly mentioned benefit is the improved ability for elders to wash at home. The community has a history of using outhouses (outdoor pit latrines, as opposed to indoor honeybuckets), and most homes still use their outhouses along with their PASS toilets, depending on the time of year and weather. One water treatment unit in Allakaket had considerable freeze damage when the home was left for several days without heat while the owners were traveling. All plastic fittings in the unit cracked and the entire unit was replaced by ANTHC. This experience resulted in a more thorough examination of how to ensure that all water is drained from low points in the system when homeowners prepare to be away from home. Improved training materials are also being developed.

Alatna

Three PASS 2.0 units were installed in Alatna in 2018 in the homes of elders. The units are currently operating well and the most commonly mentioned benefit of the system is the ability to use an indoor toilet at night or when the weather is bad, as opposed to having to go outdoors to the outhouse. One home in Alatna has had difficulty with getting all household members comfortable with the separating piece inside the toilet bowl. This concern has been echoed in other communities as well. This feedback led ANTHC to emphasize social adaptation and encourage conversations about proper use of the toilet when initially discussing PASS with candidate households. Another home in Alatna has had several issues with the heat trace malfunctioning and ice buildup clogging the drain lines during the long and very cold winters (with temperatures below 20 degrees Fahrenheit for months). The homeowner kept the toilet and sink in containerized discharge mode for months rather than disposing of the system and returning to pre-PASS habits. The homeowner reported that the containerized discharge was a little inconvenient, but that they were still happy to have the system as an overall benefit to their quality of life.

Alatna is unique among PASS communities because there are only approximately 6 occupied households in the village. (Therefore, PASS homes represent 50% of all households.) They have a tribal-run system of support for elders and their water system, which includes water delivery and operation and maintenance needs. This system is likely critical for ensuring that elders can make full use of their PASS unit and for providing enough hauled water to the home so that PASS households experience a benefit from their increased storage capacity. For example, one elder who was in a wheelchair and unable to leave the home for several months was able to get assistance with filling the tank and maintaining the system throughout the winter.

Chalkyitsik

Chalkyitsik has two PASS 2.0 units that were installed in January 2018. Both homes reported liking the use of the handwashing sink, but had difficulty adapting to the separating toilet. In one home, the urine

lines kept backing up and causing a mess in the toilet base, while in the other home, children were uncomfortable with using the toilet. Both homes were converted into vented honeybucket mode. This is also a community that typically uses outhouses, so the use of the PASS toilet as a vented honeybucket is often just for children, elders and use during bad weather or in the middle of the night. Able-bodied adults still prefer to use the outhouse and there is some aversion to having a toilet inside the home.

Oscarville

A newly constructed home privately built in Oscarville, chose to install PASS with ANTHC labor assistance. The homeowner was integral to the layout and construction of the PASS unit and upgraded it to include a pressure pump, water heater, shower, and kitchen sink with separate greywater disposal area. Since the home was new and also made use of an innovative atypical home ventilation system, there was a trouble-shooting period for the homeowner to get the regular ventilation system and PASS vent to not interfere with one another and to decrease the odors from the bathroom. Once these issues were worked out, the homeowners report the system to be working well and enjoying the increased volume of water storage that the tank accommodates.

Homeowner Engagement and Interviews: Perception, Use and Function

Prior to PASS installation, all homeowners were engaged as part of the recruitment process with diagrams and explanations of what PASS is, how it differs from a traditional water and sanitation system, and what is required for operation and maintenance. After construction of PASS, ANTHC staff returned to households to train them on the daily use and care for the unit. Homeowners were also provided with starter kits of bleach, plastic 1mL droppers, chlorine test strips, extra filters, a long-form operation manual and a visual quick- start guide. On subsequent visits, homeowners were offered additional retraining if needed, and problems were documented and troubleshot.

PASS Program staff from ANTHC conducted follow-up interviews by phone and in person at every available opportunity to determine how PASS units were perceived, used and functioned in the home. Interviews were planned to be conducted at 1-, 3-, 6- and 12-months after installation during home visits, but due to the remoteness of communities and difficulty of travel, many of these interviews were pushed forward or backward or were conducted by telephone when in-person visits were not possible. In some cases, homeowners were not available or declined to participate in interviews.

Perception, use and function were chosen as three critical components of long-term sustainability of PASS because they play important roles in the provision of water and sanitation services by ANTHC. If households do not perceive PASS to be an improvement in services compared to before they received the units, then the community might still want to pursue other capital infrastructure investments. If units are not in use due to social or educational needs, then PASS will not improve access to water and sanitation in the home. If units do not function due to environmental or engineering issues, then water and sanitation services are not being provided.

Figure 2 shows use and function of sixteen PASS units over their first year after installation. Water units (including the water treatment unit, storage tank, handwashing sink and greywater discharge to pit) were more likely to stay functioning and in use over time than toilets, possibly because the water unit required very little social and behavioral adaptation compared to traditional water tank and sink systems, while the urine-separating dry toilet was a significant change from honeybuckets, outhouses

and flush toilets that users had experienced before. It was common for components to go in and out of use and operation, for example if there was a technical issue that took the homeowner or ANTHC some time to address, or if there were freeze-up issues during winter but the system returned to normal functioning when temperatures rose in the spring. Function and use of the units were also highly dependent on the preferences and capacity of the individual homes. Some homeowners were determined to keep their system working despite challenges, while others preferred to return to their prior water storage and toilet systems if they had issues with PASS.

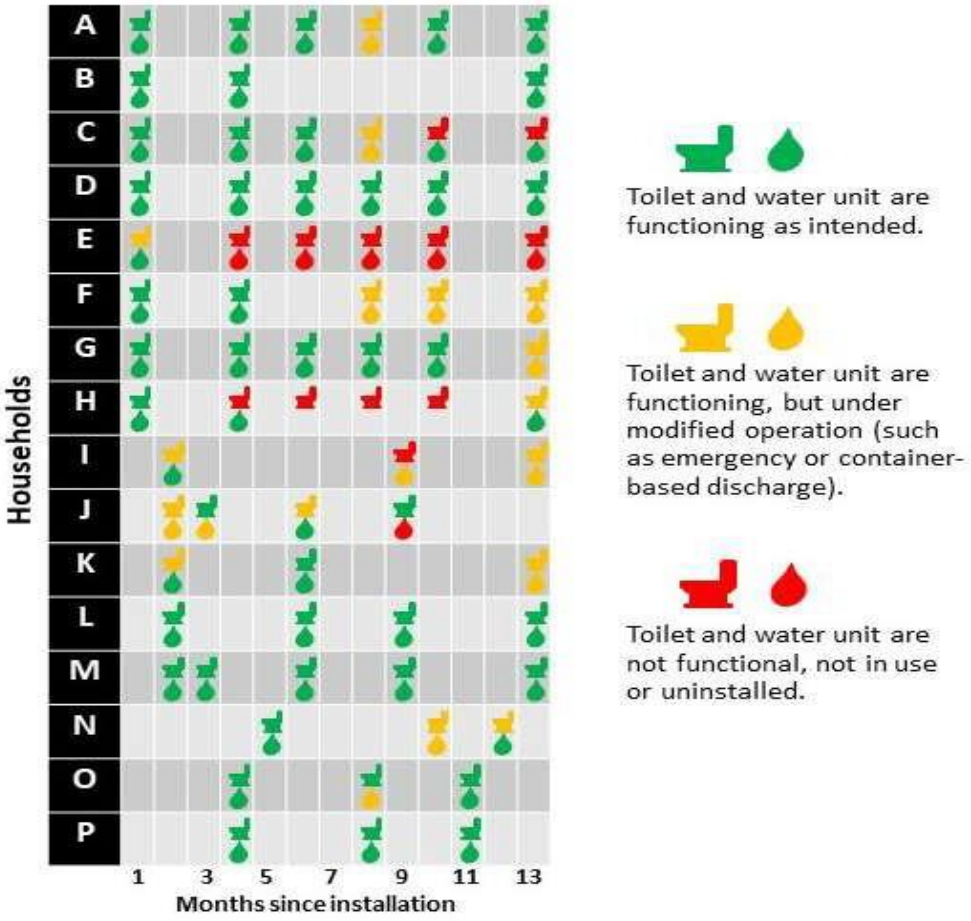


Figure 2: Function and use of the water and toilet components of PASS 2.0 units over the first year after installation for selected households. Household consent was given to share information in this way. Note: PASS units were installed in different years and seasons, so "months since installation" do not refer to specific calendar months or years.

Cost and Funding of PASS

Capital Costs

Cost per unit depends on which components are included for installation. There are two major components. 1. PASS Water Component, which includes the water tank – both 50 gallon and 100 gallon, filtration system, base cabinet – both tall and short, and sink. 2. PASS Wastewater System, which includes the HUD-IT separating toilet, seepage pit and plumbing materials. The Homeowner Starter Kit, which comes with all PASS Wastewater applications, includes a plumbing snake, 25-foot NSF water hose, disposable cleaning gloves, soap, chlorine injection syringes and test strips. As shown below, cost varies on the content and quantity.

SILVERLINE

Silverline LLC juliahphelan@gmail.com 907-460-9365

PASS Package Unit and Bulk Pricing

Contract Item #	Description	1-9 units/order	10 - 29 units/order	30-49 units/order	50+ units/order
1	Basic PASS Package				
1A-1	PASS Water Component, 18AL	$7,675	$7,602	$7,530	$7,493
1A-2	PASS Water Component, 18AH	$7,839	$7,764	$7,690	$7,653
1A-3	PASS Water Component, 18BL	$7,290	$7,221	$7,152	$7,117
1A-4	PASS Water Component, 18BH	$7,459	$7,388	$7,317	$7,282
1B	PASS Wastewater System (Toilet & Seepage Pit)	$12,133	$12,018	$11,903	$11,845
1C	Homeowner Starter Kit - PASS	$95	$94	$93	$93
2	Deluxe PASS Package				
2A-1	PASS Water Component, 18AL	$7,675	$7,602	$7,530	$7,493
2A-2	PASS Water Component, 18AH	$7,839	$7,764	$7,690	$7,653
2A-3	PASS Water Component, 18BL	$7,290	$7,221	$7,152	$7,117
2A-4	PASS Water Component, 18BH	$7,459	$7,388	$7,317	$7,282
2B	PASS Wastewater System (Toilet & Seepage Pit)	$12,133	$12,018	$11,903	$11,845
2C	Homeowner Starter Kit - PASS	$95	$94	$93	$93
2D-1	PASS Rain Catchment Component - 2 sides	$1,741	$1,724	$1,708	$1,700
2D-2	PASS Rain Catchment Component - 1 side	$1,097	$1,087	$1,076	$1,071
3	Basic Separating Toilet System				
3A	Basic Separating Toilet Component	$6,066	$6,009	$5,951	$5,923
3B	Homeowner Starter Kit - Wastewater	$69	$68	$67	$67
4	Deluxe Separating Toilet System				
4A	Deluxe Separating Toilet System (Toilet & Seepage Pit)	$12,133	$12,018	$11,903	$11,845
4B	Homeowner Starter Kit - Wastewater	$69	$68	$67	$67
5	PASS Water System				
5A-1	PASS Water Component, 18AL	$7,675	$7,602	$7,530	$7,493
5A-2	PASS Water Component, 18AH	$7,839	$7,764	$7,690	$7,653
5A-3	PASS Water Component, 18BL	$7,290	$7,221	$7,152	$7,117
5A-4	PASS Water Component, 18BH	$7,459	$7,388	$7,317	$7,282
5B	Homeowner Starter Kit - Drinking Water	$58	$57	$57	$57

Lead Times, all components:
1-5 units: 4 weeks (after May 1, 2019)

6-49 units: 3-4 months

50+ units: negotiable

Operation and Maintenance Costs

Costs in table 2 are based on a four-person household using approximately 84 gallons of water per week. This allows around 3 gallons of water per person per day (gpcd). This quantity represents a slight increase in water use compared to self-haul communities without PASS, but is still less than the amount of water used by newly piped communities (Thomas et al. 2016). The 3 gpcd number used here is based on measured water use with the PASS units and is consistent with published data regarding self-haul quantities in many regions around the world. Community water prices, haul rates, and costs of consumables vary widely, and the use of some of these may vary through the year (for example, in the

summer households may prefer to haul natural water sources rather than purchase treated water; the heat trace will be unplugged in summer; and households may have vehicles to haul water and waste themselves during some seasons but not others).

Table 2: Monthly and annual operation and maintenance costs of PASS, including water and waste costs and services, consumables for the water unit and dry toilet and electricity.

Category	Item	Unit cost	Purchase frequency	Cost per month	Cost per year
Consumable	Treated water	$0.05/gal	84 gal per week	$4	$48
Consumable	Bleach (for water tank)	$2/bottle (16 fl oz.)	Twice a month	$4	$48
Consumable	Trash bags	$10/box (40 bags)	Once every 2 months	$5	$60
Consumable	Vinegar (for urine lines)	$5/gallon	Once a month	$5	$60
Electricity	Heat trace* (0.06 kW)	$0.20/kWh	Monthly, 8 months of the year	$9	$72
Electricity	Ventilation fan (0.044 kW)	$0.20/kWh	Monthly (720 hours)	$7	$84
Electricity	Pump	Negligible**	Monthly	$0	$0
Parts	Filters (two types)	$20 (DGD2501) $45 (FloPlus 10BB)	Once a year	$6	$72
Part	Pump	$100	Once every 2 years	$4	$48
			TOTAL COST	**$44**	**$492**

*Electric costs of heat traces are not included in traditional piped system costs, but are included here for homeowner reference. This number should be subtracted from total costs to compare to piped systems.

**The pump is run infrequently and for such a short time that power analyses have not been done.

Planned Future PASS Installations

The R&D process was completed in January of 2019 and a patent and full production of the system was implemented in the summer 2019 construction season. Several additional modifications, aside from those mentioned above, were made to the PASS 2.0 for subsequent installations:

1. The hand-pump was removed from the treatment unit because it was not being used by households and represented an unnecessary fail-point when the bladder cracked. All homes have at least intermittent or semi-reliable power, so the electric pump is sufficient.
2. The filtration system will be enclosed in a cabinet with doors to make the unit more aesthetically pleasing, to keep children safe from the components and to keep the components protected from damage and to provide storage for system consumables.
3. The urinal is no longer connected to the seepage pit because of crystallization issues with the longer line and elbows required to connect it to the toilet urine line. Instead, urine from the urinal is collected in a jug directly beneath the urinal and manually emptied.

Major installations have been planned for two communities in 2019-2020. A two-phase project is underway in Kivalina, where 19 units are being installed in the summer and fall of 2019 and an additional 26 units are scheduled to be installed in 2020. After this installation, Kivalina will have PASS units in 52 homes and the community will have almost complete coverage of water and sanitation by PASS.

There are also 21 new PASS units planned for new and existing homes in Mertarvik, a new village site where the community of Newtok is relocating in the fall of 2019 due to severe erosion of their current lands. Mertarvik will also have complete coverage of household water and sanitation by PASS. Both of these communities would still like to pursue funding for traditional community-wide piped systems, and so PASS is viewed as temporary solution that will improve water access and waste management while other infrastructure funding is sought. The process of obtaining funding and constructing piped infrastructure can take decades to complete.

Recommendations for the PASS Program

The PASS program has taken several steps towards streamlining production, improving recruitment processes and homeowner contracts, and building capacity for construction and installation as it moved out of R&D in 2018-2019. There are still gaps in understanding the full health impacts of PASS, increasing local capacity for operation and maintenance of systems, and labeling and marketing of the system.

Understanding health impacts: The PASS Health and Well-being Study

The PASS health and well-being study was launched in 2018 to collect rigorous data on household use of the PASS units and to link that use to germ exposure, health and well-being. Researchers are collecting data on water quality inside the home, water quantity used inside and outside the home in self-haul communities, and methods of waste management (e.g. frequency and location of honeybucket emptying) throughout the year. Data is also being collected on health records related to water-washed illnesses – respiratory illness, skin infections, and gastrointestinal diseases. These metrics will continue to be measured after the large installations of PASS units in Kivalina in 2019 and 2020. This data will help ANTHC to understand how well PASS is addressing water and sanitation needs in communities without pipes and how it can be used to increase the number of homes served in additional communities. Continued community support and continued funding for this research is critical.

Increasing local operation and maintenance capacity

The pilot R&D period of the PASS program revealed that continued follow-up with homeowners and assistance with operation and maintenance tasks is critical to the long-term use and acceptance of PASS units. In order to support homeowners in properly up-keeping their system and troubleshooting issues that arise, ANTHC is working on building local capacity in communities by incorporating PASS O&M into the job description for the water operators in communities and integrating automatic billing for services. The integration of homeowner engagement, training, O&M capacity building, and billing into future PASS projects from the beginning is highly likely to determine the success of the system in future communities and households.

Labelling and marketing of PASS

PASS units production and communication between manufacturers has been streamlined since the units were developed. Marketing materials have been created and homeowner recruitment, engagement, and training has been standardized to improve the process of providing PASS units to interested households and communities. This process will continue to create a product that any consumer can buy off the shelf and install in their home to expand the availability of PASS in Alaska and other communities without water and sanitation.

Acknowledgements

Thank you to the communities who have participated in the PASS program so far and especially to the households who have consented to follow-up interviews and allowed use of the interview data in this report. The Indian Health Service and ANTHC provided funding for this project. ANTHC would like to thank our industry partners Lifewater Engineering, Campwater Industries LLC, Silverline, and the Cold Climate Housing Research Center who assisted with the design, manufacturing, installation and reach back support for the PASS program. This report was written by Kaitlin Mattos and Jacqualine Schaeffer with help from John Warren and Mia Heavener at ANTHC 2019.

References

Thomas T.K., T. Ritter, D. Bruden, M. Bruce, K. Byrd, R. Goldberger, J. Dobson, K.A. Hickel, J. Smith, T. Hennessy. 2016. “Impact of providing in-home water service on the rates of infectious diseases: results from four communities in Western Alaska.” Journal of Water and Health 14(1): 132-139.